Ruth Schaldach

Depletive Virtual Water Trade Embedded in the Water-Energy-Soil-Trade-Discourse Nexus

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Die vorliegende Arbeit wurde vom Fachbereich Gesellschaftswissenschaften der Universität Kassel als Dissertation zur Erlangung des akademischen Grades eines Doktors der Wirtschafts- und Sozialwissenschaften (Dr. rer. pol.) angenommen.

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Tag der mündlichen Prüfung: 01. November 2017

Bibliografische Information der Deutschen Nationalbibliothek
Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.dnb.de abrufbar.

Zugl.: Kassel, Univ., Diss. 2017
ISBN 978-3-7376-0778-0 (print)
ISBN 978-3-7376-0779-7 (e-book)
DOI: http://dx.medra.org/10.19211/KUP9783737607797
URN: https://nbn-resolving.org/urn:nbn:de:0002-407799

www.upress.uni-kassel.de

Printed in Germany

Zusammenfassung

Der Handel mit virtuellem Wasser steigt mit der Globalisierung und dieser Handelsstrom fließt nicht immer in die Richtung, dass wasserreiche Regionen wasserarme Regionen mit in der Herstellung wasserintensiven Produkten versorgen. Oft passiert das Gegenteil und Wasserknappheit wird verstärkt durch diesen wassererschöpfenden Handel. Wasser ist inmitten verschiedenster Diskurse, die beeinflussen was, wie, wieviel und unter welchen Bedingungen produziert wird. Die Wassergebietscharakteristika sind deshalb von diversen Diskursen und Kämpfen miteinander konkurrierender Interessen geprägt. In dieser Arbeit wird der Fokus auf den Water-Energy-Soil-Trade-Nexus gesetzt und die einzelnen Komponenten als eine Materialisierung dieser Diskurse angesehen. Zwei Fälle verdeutlichen spezifische Sektionen des Nexus. Der erste konzentriert sich auf den Zusammenhang von der Öffnung von Märkten und ausländischen Direktinvestitionen mit virtuellem in Zusammenhang mit Vietnams Doi Moi Politik und rasantem Wirtschaftswachstum. Des Weiteren werden die Verbindungen zwischen Wasser und Energie anhand von der unkonventionellen Gasförderung nachvollzogen von den Anfängen in Amerika bis hin zu Australiens Gasbohrungen, eingebettet in einen globalen Kontext. Zusätzlich zu der Analyse von Handels-, Wasserdaten, Abkommen und Berichten werden Medienartefakte untersucht um aufzuzeigen mit welchen Mitteln verschiedene Interessengruppen die Wasserrisiken dieser Technology darstellen. Ein Hauptresultat ist, dass der virtuelle Wasserhandel in viele Diskurse eingebettet ist und Handelsbewegungen schwer nachzuvollziehen sind bei einer rein neoliberalen Betrachtung wie sie oft propagiert wird. Diese Arbeit hilft Fälle zu verstehen bei denen der virtuelle Wasserhandel Wasserressourcen austrocknet in Gegenden die bereits gefährdet sind.

Abstract

Virtual water trade increased with globalisation but this trade does not always flow in such direction, that water abundant regions supply water scarce regions with water intense products. Often the opposite happens and depletive water trade intensifies causing water scarcity. Water has been the pivotal issue of several discourses, as it largely affects the type, manner and circumstances under which goods are produced. Therefore, discourses also shape the water regime. This work focuses on the Water-Energy-Soil-Trade-Nexus with each element seen as a materialisation of discourses. Two cases illustrate specific parts of the Nexus, firstly, the close relationship of market liberalisation, foreign direct investment and virtual water trade is represented with Viet Nam's Doi Moi policy and rapid economic growth. Secondly, the water-energy dimension linkages are drawn by following the case of hydraulic fracturing from the U.S. to Australia's gas drills embedded in a global perspective. Apart from the analysis of trade and water data, agreements and reports, material from various multimedia sources reveal how different interest groups shape a 'truth' on water risks related to hydraulic fracturing. One of the main outcomes is that virtual water trade is embedded in ample discourses and therefore difficult to understand just through the lens of liberal economics as widely promoted. This work helps to understand especially cases, where virtual water trade dries out water resources in already vulnerable areas.

Acknowledgement

The journey of this thesis has been long, traveling across several countries and bumpy roads, not just in the literal sense. Therefore, the list of people who accompanied me and made it possible to give shape to this book is rather long.

I thank my professors for their patience, my friends and wonderful colleagues at the TUHH for their support. Special thanks to my partner Jens Bulmahn, colleagues Tina Carmesin, Isidora Vrabvac and Berenice Lopez Mendes. Also thanks to Philipp Hülle, Anke Schwarz, Andreas Blechschmidt, Alexej Steinberg, Maike Grünwaldt, Ben Howe and Christian Hartz, who supported this work in one or another way with discussions or accompanying me on writing exiles in northern Germany or India. Also thanks to the BMBF IPSWAT programme, DAAD, GFEU and Oswald-Schulze Foundation for financial support.

I have been fortunate for having manifold experiences during the trips I had undertaken for research. There could perhaps be another book on those adventures, particularly; a chapter on the Australian bush, driving through the red dirt roads, living in a protest camp and learning to trust strangers, when one loses the way. The chapter on Viet Nam would be on the wonderful students I met, the projects I encountered, the city of Hanoi itself and the friends I made there. I thank my colleagues at the Hanoi University, RMIT and Tata Institute of Social Science in Guwahati for the warmth they extended towards ne during my stay.

Thank you all, the wonderful people who made it possible for me to actually finish this book even when there were times I did not believe that I could ever reach that stage of writing the acknowledgement of my work.

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List of Abbreviations

APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
BOD	Biochemical Oxygen Demand
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
FDI	Foreign Direct Investment
FTA	Foreign Trade Agreement
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation)
ICIMOD	International Centre for Integrated Mountain Development
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
LCA	Life Cycle Assessment
LNG	Liquefied Natural Gas
MDG	Millennium Development Goal
MEA	Multilateral Environmental Agreement
OECD	Organisation for Economic Cooperation and Development
RAM	Recently Acceded Member of the WTO
SDG	Sustainable Development Goal
SIA	Sustainability Impact Analysis
SOE	State-Owned Enterprise
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO-IHE	UNESCO Institute for Hydrological Education
WEF	Water-Energy-Food (nexus)
WTO	World Trade Organization
WWC	World Water Council

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1 Introduction

Anything that ships water as a commodity out of a watershed would be extremely disruptive environmentally, and it would be disruptive to democracy and the public trust. We've already seen water wars all around the world because of companies trying to do that and governments trying to do that.

Robert Kennedy Jr., president of Water Keeper Alliance in an interview for CNBC 2014

Water is becoming a severe problem day by day. Being finite, unevenly distributed and vulnerable, water resources are – in general at risk (FAO Agriculture and Consumer Protection 1995). In 1995, threatened by over-withdrawal and pollution, especially in already arid[1] regions, like Australia and most Middle Eastern countries, only less than 1 % of the world's water was usable for human nutritious needs (FAO Agriculture and Consumer Protection 1995). Fragile water systems can suffer non-repairable damages due to overexploitation. Even conservative predictions warn that, the usable part of our water cycle will shrink whilst the demand for water increases and that this chain reaction can only be broken if drastic changes are made in global water management (Fishbone 2007). Worldwide, more and more areas are suffering from water scarcity. Basins and aquifers are exploited faster than the time taken in replenishing them; each collapsed water system indicates the death of one natural storage system. Once collapsed, it is difficult to recover these systems, especially in the case of aquifers, and result on the long run in a loss of high quality drinking water.

More than ever, increased globalised production and international trade, and the development of analytical frameworks (De Sousa Santos 2002; Robertson 2012) on globalisation, glocalisation and the 'processes of globalisation' (Jessop 2001,

1 An area with less than 250 millimetres of rainfall per year is defined as an arid zone. A reference to bioclimatic factors may be included (UN Statistics Division 2015).

p.2). This study delves deeply how these processes are taking a toll on the global water resources.

Water globalised by shifting it from being a local public/common good towards a globally traded commodity. Water Trade augmented through trade of drinking water transported in water bottles and water pipelines; however, the majority of water travels in form of an embedded water content (Allan 1992) in traded goods, also called ‘virtual water’ (Barlow 2008; Hoekstra & Chapagain 2008). Therefore, if products are not produced locally, the producer and consumer are geographically separated, inducing environmental impacts of production and consumption. In terms of water impacts, producing regions suffer more from the withdrawal rates and pollution, than the consuming regions. Unfortunately, in some regions, such as Australia and Viet Nam[2], booming exports due to market liberalisation and foreign direct investment (FDI) resulted in the contradiction of developing into some of the world’s biggest virtual water net exporters, whilst both are at the same time experiencing great water stress[3] (Hoekstra et al. 2009). Although coming from very different political systems, Viet Nam as a (nominally) socialist republic and Australia as one of the most market-liberalised countries, have to endure similar environmental impacts on their water systems due to exports, increased productivity and resource exploitation. In their book *Globalization of Water*, Hoekstra & Chapagain (2008) revealed the extensive role of international trade and global production patterns in the interconnectedness of the global water cycle. They emphasise on free trade in order to save water. Even when this liberal approach in water conservation

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2 In this work is the separate country spelling used for the Socialist Republic of Viet Nam as this spelling is used on official documents and public appearances in English like on the Government Portal chinhphu.vn.

3 According to Intelligence Community Assessment (2012, p. 2) water stress can occur when ‘a country’s or region’s annual water supply is less than 1,700 cubic meters per person per year (for reference, US per capita total water used is 2,500 cubic meters per year) or a high water withdrawal ratio (WWR)’.

frameworks was widely adopted by international institutions, after the 1980s, its effectiveness was more and more questioned.

The following dissertation attempts to identify the destructive or regulative forces of the market on water resources. Challenging the liberal ideas on resource management the study insists on a more complex and critical approach towards understanding water dimension in global production patterns. New approaches are necessary to stop the downward spiral of unsustainable exploitation regimes by keeping resource loops in sync.

1.1 The Problem and its Current Research Gaps

Water as a resource is not only one of the basic elements of industrial productivity, but also one of the most essential needs for the survival of humankind. Apart from direct dependency on clean drinking water and sanitation needs, we rely on a water-intense food production system.

Hence, it is not surprising that we have a 5 000-year-old history of water laws and governance (Dellapenna & Gupta 2009). Early civilisations, such as Mesopotamia and Egypt, developed in close proximity to river basins, but the first rules concerning water established in inhabited areas with an arid climate. These necessary regulations shaped several cultures and can still be found in religious rules, such as the Islamic and Jewish water laws. Throughout history, we can find diverse water laws and management approaches revealing how water supply differed according to the political environment water systems were set up. In areas with a history of colonialism, however, hydro-politics became often overwritten and replaced with management approaches. As a result, for example, British water laws were imposed on areas with different geographic conditions, replacing local and historically grown hydro-politics, as in Australia and India. Even with this long and diverse history of water governance born in the most water stressed regions, water governance arrived only recently to an international scale (Dellapenna & Gupta 2009).

Water stress is becoming a more severe and an expansive global problem. Arid regions are the first to suffer, but as the supply worldwide is contracting, we are all becoming affected. Apart from the United Nations Conference on Water in Mar del Plata (1977), water became a significant international agenda after 1992. That year, the International Conference on Water and Environment in Dublin formulated four guiding principles (ICWE 1992), which defined the international water agenda for decades to come:

> 1. *Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.*
> 2. *Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.*
> 3. *Women play a central part in the provision, management and safeguarding of water.*
> 4. *Water has an economic value in all its competing uses and should be recognised as an economic good.*

As the fourth principle demonstrates, since 1992 water management (especially when concerned with tackling economic water scarcity) was guided by a liberal approach, riding the wave of neoliberalisation. Its recognition as an economic good has paved the way to allow the free market to handle water supply services and resource management. Dublin also marked the entry of Integrated Water Resources Management (IWRM)[4] as a theoretical concept based on these four principles. IWRM was embraced and incorporated by organisations such as: The United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), the World Bank (WB), the Asian Development Bank (ADB), the World

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[4] According to the Global Water Partnership (2010), 'IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.'

Water Council (WWC), the European Union Water Framework Directive (EU WFD), and most famously by the Global Water Partnership (GWP). The WWC (formerly Forum), has the status of being official consultants, which was granted by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and United Nations Economic and Social Council (ECOSOC). Since 1992, the WWC has been meeting every three years and the 2003 meeting is seen as the final marking point to push IWRM onto the international political agenda (Rahaman & Varis 2005); however, critics deem it as the 'waterish extension of the Washington consensus' (Merrett 2007, p. 74).

The IWRM has been predominantly criticised not only for its market- driven approach and the consequent social impact of water privatisation, but also for leaving out the stakeholders (Mukhtarov 2007). Due to the successful implementation of IWRM, commoditisation of drinking water expanded hand in hand with the processes of globalisation, as described by Maude Barlow in her 2002 publication *Blue Gold*, which can be seen as the first handbook for the water justice movement. Barlow's criticism focuses on the effects of globalisation on drinking water distribution. Her major argument is that neoliberal strategies such as privatisation and fewer regulations in the water sector trade environmental and social justice imbalances for short-term economic gain. These imbalances resulted in movements claiming water as a fundamental human right. This led to the United Nations Human Rights Council requesting the Office of the High Commissioner for Human Rights to conduct a study , in 2006, on the scope and content of human rights obligations in relation to access to water under international human rights instruments, and to include recommendations for future actions (Barlow 2008). In general, Barlow critics the market-driven drinking water management so that the poorest are protected from the worst effects of such policies, though she fails to propose alternative non-monetary strategies for sustainable water usage.

With the emerging awareness of water issues, as developed from IWRM-related water research projects and with the expansion of analytical tools, predominantly in engineering and natural science, a better understanding of the anthropogenic causes has evolved too, thereby linking human interference with water resources (Dublin Principle 1). While the climate change discourse evolved internationally, the discourse on the severity of water security has been increasingly noticeable in public media as evident from the coverage of the California water crisis in 2015 (Nagourney 2015; Scauzillo 2015). That the World Water Crisis became a more and more winged word outside the scientific community is shown in its growing internet presence. With 400 000 Google hits in 2012 on a verbatim search and 19 000 blogs on *world water crisis*, it can be assumed that there has been a recognisable rise in awareness about the crisis via online reachable media. However, there has been a remarkable shift of perception in recent time. In 2017, a search with the same parameters for the word water crisis only recorded 273 000 hits, but 409 000 for the term *water security*. Certainly, this does not say much about how the world water crisis is seen and which measures should be taken, but shows that the problem itself has gained more awareness.

The aforementioned third WWC meeting in 2003, Kyoto, was not only a remarkable event in terms of promoting a more liberal approach in water management, but was this also in introducing the relation between international trade and water resources across a broader international arena. In December 2002, Arjen Hoekstra's water footprint concept had just been proposed before the scientific community the scientific community at the international expert meeting on virtual water trade (ed. Hoekstra 2003). The footprint method calculates the water usage in the production per product, making water effects visible and computable. The water content of traded goods was reflected through the virtual water trade balance.

The idea of Virtual Water Trade was introduced in the early 1990s (Allan 1992), acknowledging an increase in the international trade of goods with high levels of water usage in their production. Allan's concept that this trade of, which he called *embedded water*, could to some extent solve the water stress in regions such as the Middle East received since then growing attention. Hoekstra's water footprint is a combination of Allan's virtual water trade and the environmental footprint, conceived in 1990 by Mathis Wackernagel and William Rees (Hoekstra et al. 2011). The necessary water usage for generating products serves as the data for calculating the footprint. Based on this concept, the University of Twente and UNESCO Institute for Hydrological Education (UNESCO-IHE) established a database and realised the water footprint project: www.waterfootprint.org.

In 2008, Hoekstra and Chapagain published *Globalization of Water*, one of the most recognised publications in the field of virtual water trade. They carried Allan's idea forward, extending the concept by distinguishing between green, blue and grey water[5]. Their more sophisticated concept aims in the same direction as Allan's idea of global water savings by trading water intense products. In 2005, Chapagain, Hoekstra and Savenije finalised their argument in their research report *Saving Water through Global Trade*, where they emphasised that, by comparing the terms of production, there can be some extent of global saving; for example, a greater amount of green water gets used than blue water. This is often the case if climatic conditions allow agriculture without irrigation. There is, therefore, some saving attained when the hypothetical production of the importing country would use more blue instead of green water. According to their 2005 report, 6 % water savings were made in the agricultural sector due to the annual international trade (during 1997-2001) as shown in Figure 1 (Chapagain, Hoekstra & Savenije 2005, p. 21).

5 Green water is water from rainfall stored in the soil or temporarily stays on top of the soil or vegetation. Blue water is a term used for fresh surface and groundwater, which include water in lakes, rivers and aquifer. How Greywater is conceptualised in Hoekstra's virtual water concept will be developed further in Chapter 3.2.3.

	Related to trade of crop products (Gm³/yr)	Related to trade of livestock products (Gm³/yr)	Total (Gm³/yr)
Global sum of virtual water exports, assessed on the basis of the virtual water content of the products in the exporting countries (Gm³/yr)	979	275	1254
Global sum of virtual water imports, assessed on the basis of the virtual water content of products if produced in the importing countries (Gm³/yr)	1286	320	1646
Global water saving (Gm³/yr)	307	45	352
Saving compared to the sum of international virtual water flows (%)	34%	16%	30%

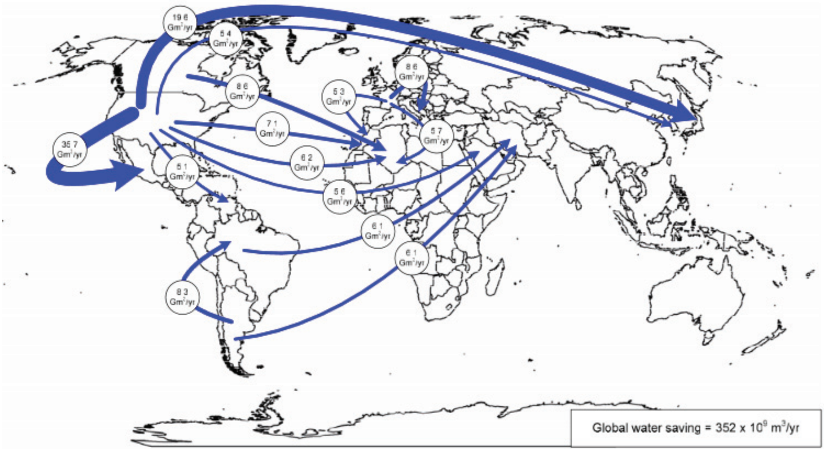

Figure 1: Global virtual water flows and water savings 1997-2001
(Chapagain, Hoekstra & Savenije 2005, p. 21)

In their calculation they estimated, that 352 billion m³ of water would be saved per year through international trade by summing up all international water flows.

However, virtual water trade often flows in the ‘wrong’ direction, as it gets exported by countries with water scarcity or, in economic terms, by a low factor endowment in terms of water. This phenomenon is the key focus of the present thesis. In publications of the water footprint project, such net virtual water exports by water-scarce countries are called *perverse trade*. This term will not be used in the present work as it suggests that this kind of trade patterns are exceptional and that trade flows supporting Hoekstra’s concept of water savings is the norm. It also suggests that these trade flows are intentionally in the right direction. The present work instead uses an alternative term: *depletive water exports* or *depletive trade patterns*. It suits to pinpoint the component of water depletion through trade rather than simply depicting it as a perversion of trade.

In summary, the research on virtual water trade shows that the impact on water resources by international trade has increased severely during the last decades and that trade flows can increase or decrease the pressure on systems (Chapter 3.2.3). Especially, in its analytical dimension, the water footprint approach is a much more differentiated concept, as it includes water pollution and recycling, instead of focusing only on water withdrawal rates. At this stage, the virtual water trade research gives us a more concise picture of our impact on local water systems through international trade. The existence of depletive trade patterns points already into the direction, that the water endowment of a country is not one of the major driving forces in terms of production, production patterns and trade flows. So, if Hoekstra's 6 % water savings were an unintentional by product, the severe effects of trade patterns increasing water scarcity can also occur more frequently. Whether water endowment of an economy actually influences trade patterns was analysed by Yang, Wang & Zehnder (2007), who discovered that only in extreme situations is water scarcity a driving factor for international trade, as in Jordan and Israel. This research disproved Hoekstra's argument that international virtual water trade leads to trade relationships with a water saving effect. The water endowment is only a driving force in such situations of severe water scarcity, therefore, when it already too late.

Exporting water, even when there is a local need, highlights that exporting virtual water can cause long-term or non-reparable damages due to over-withdrawal. This contradicts earlier water theorists like Allan (1992) who had hoped for the opposite effect. The German Development Institute (DIE, Deutsches Institut für Entwicklungspolitik) summarises the diverse criticism from different disciplines about virtual water trade as a non-realisable strategy for solving water stress in economies which are not centrally managed, environmentally questionable and cause severe damages, especially for developing countries, as they lack the capital to buffer effects via high tech solutions (Horlemann & Neubert 2007). Nevertheless, the data generated in the context of this approach is highly valuable to disclose underlying water issues in trade relations. Hoekstra's own work (2008) on the globalisation of water is able to map trade flows, but does not pay much attention to how these trade flows are generated and which factors play a role in shaping them. Based on these considerations, the present work refers to the virtual water trade research, aiming to widen its perspective, and discuss Hoekstra's work in more detail.

As Hoekstra's and Chapagain's *Globalization of Water* already indicates, the phenomenon of virtual water trade is part of the discourse on globalisation. While this term is commonly known and was highly discussed, promoted and criticised, often resting on rough definitions, a more complex understanding of globalisation is provided by Bob Jessop (2001). He speaks of *globalisations* in the plural as a multicentric, multiscalar, multitemporal, multiform, and multicausal process (Chapter 2.1) and, therefore, an emergent product of many different forces operating on many scales. Multiple factors shape globalised production, trade and resource exploitation. That water, in particular, is at the centre of multiple factors and ample synergies are embedded in the nexus discourse. The nexus discourse picks up the interconnectivity of resource cycles (like water, energy or soil) and some political, economic and social dimensions. One public key point for this was the Bonn 2011 Nexus Conference, titled 'The Water Energy and Food Security Nexus – Solutions for the Green Economy'. The title already implies: it is increasingly discussed as part of the green economy[6], a neo-liberal approach to environmental problems. The conference was organised by the German Government as a specific contribution to

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[6] Multiple definitions of green economy (GE) exist. UNEP (2010, p. 4) defines it as an economy 'that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. A GE is characterised by substantially increased investments in economic sectors that build on and enhance the Earth's natural capital or reduce ecological scarcities and environmental risks.'

the UN Conference on Sustainable Development Rio 2012. From that moment on, many publications about the nexus started flourishing and got picked up by UN publications. The 2013 UN Human Development Report, 2013 Millennium Development Goals Report and even more so the 2016 UN Development Report on Rural Development formulated a sharp criticism on the negative synergetic effects of resource cycles shaped by short-term profit oriented agricultural methods, fostered by globalisation and neo-liberal approaches ignoring sustainability. However, the claim for a green economy does not include questioning fundamentally capitalist production and resource distribution systems, as it remains at the level of improving production methods and pushing technocratic solutions. Therefore, only a few steps are undertaken initially to analyse local water scarcity caused by ample interconnected factors with multiple synergies by the forces of globalisations.

In summary, the anthropogenic link is made between consumption, international trade, production and water resources; however, the regulation of these water relevant spheres is stuck in the liberal paradigm of a self-regulating market often embedded in a technocratic discourse[7]. Even though some criticism found its way into the mainstream discourse, the present work aims to fill the gap pertaining to the driving factors for increasing water scarcity through virtual water exports in areas already struggling with water scarcity or being at the brink of it. This work develops an analytical framework for understanding the forces pushing local water users to unsustainable water usage, which affects the global water storage capacity.

1.2 Hypothesis and Leading Research Question

The leading hypothesis in this work is that international virtual water trade and market oriented water governance will not stir international productivity toward

7 Technocratic discourse can be defined as in Bryld (2000, p. 701): 'a discourse which focuses on technical and instrumental solutions to the problems related to developing countries'.

sustainable water usage. The opposite is assumed since over-extraction of water and quality risks are the outcome of hegemonic struggles shaping water usage.

This hypothesis considers resource cycles as a nexus connected, intertwined, synergetic and heavily influenced by the forces of globalisation and hegemonic struggles. Water quantities and ways of resource exploitation are a result of these struggles between competing interests. These forces and collaborative links create an interconnected global network of factors, which though socially and territorially can often remain disconnected from the water storage system, like a basins or aquifer, but are heavily affected locally. Each basin is embedded in a different social, cultural and political framework which is shifting, buffering or increasing the effects of factors straining basins.

It is assumed that these power relations and struggles on multiple scales shape water exploitation regimes in their local context and they are fought again and again in different constellations and forms. Discourse hegemony is currently only in some cases won in favour of sustainable usage, low water risks and water preservation. Therefore, other competing interests can override a general interest for potable water and stir trade into a direction of resource overexploitation with none or hardly repairable damages, thereby reducing the global storage capacity for water. Increasingly, countries (e.g., Jordan, Israel and Japan) are becoming highly dependent on virtual water imports (mostly in the form of food) as their water, soil or land capacities cannot sustain their population's consumption demands. However, if more and more storage capacity is lost, with the increasing straining of resources by virtual water exporting countries, water scarcity will spread.

The attached discourses produce synergetic effects on resource cycles and intertwined socio-economic relationships, affecting often conflicting and competing ideas of water usage. In order to understand the forces driving water into an exploitative and unsustainable spiral of water usage fuelled by international trade, synergetic effects on water cycles need to be understood from the social science perspective. The understanding of these synergetic effects and most influential factors is essential to finding answers on sustainable usage practices. This thesis connects virtual water trade data with the environment to analyse cases of global water losses. It represents a contribution in the development of theorising water exploitation regimes by using exemplary cases. These cases look at two identified driving forces by analysing at the outcomes of market liberalisation with a fast growing economy like Viet Nam and shifts in the energy sector towards unconventional resources with a focus on hydraulic fracturing. Apart from the leading research question this thesis will ask, which factors stir Viet Nam's economy into unsustainable water usage practices and which industries lead to this development? The second case is used to analyse the instruments pushing the discourse towards water conservation or extensive resource exploitation. However, it also tackles the question where and to which direction the discourse was successfully pushed, therefore where is hydraulic fracturing banned or is in abeyance.

1.3 Methodology

In order to tackle these questions a multidisciplinary framework is used with mixed methods drawn not only from disciplines like political science, but also sociology and environmental engineering. This work is a literature and data based work with empirical qualitative research elements. Six types of sources are used:

1. Reports and Literature
2. Trade and Water Data Analysis
3. Interviews
4. Media Analysis
5. Field Research

Each of these source types have their purpose in all areas of the research or are used for specific parts. In the following paragraphs, more details on the material, their purpose and the used methodology are given. The description also contains the process and mentions of the obstacles, while conducting the research.

1.3.1 Reports and Literature

This work is based on extensive research of reports, journal articles and books. As water is interrelated to all areas of life, all disciplines are touched and literature from a broad spectrum reaching from political science to natural science and engineering is necessary.

This extensive research is necessary not only to understand the current scientific discourse, but also to have a specific insight of the physiological questions, as well as the related state of art technological innovations. The first obstacle was to actually get access to specific publications and furthermore to get these in English or German. This was especially relevant with regard to Viet Nam and could only be solved by getting access to certain publications in Hanoi. Another problem was the necessity to review literature in a broad range of scientific disciplines, including environmental engineering as well as in the field of political science. Visits to conferences and a work environment shared with environmental engineers at the Institute for Wastewater Management and Water Protection was helpful to dive into the details of hydrology, geology and environmental engineering.

The purpose was not just to get an understanding on how to use specific water data, to compute this data, but to identify the scientific discourse in these specific fields. A comprehensive literature review is used to identify these fields. Onwuegbuzie & Frels (2016) seven step guidelines is used to explore, which nodes of other data sources seem to be useful for the further analysis.

1.3.2 Trade and Water Data Analysis

Trade and water data is retrieved from secondary sources and databases. The material is in most cases extracted with Excel and then combined, compared, sorted and calculated. Data is computed as per the specific purpose, which is explained accordingly. The main sources are trade databases of the United Nations Conference on Trade and Development (UNCTAD), Food and Agriculture Organisation of the United Nation (FAO) databases like AQUASTAT and database of the water footprint project for product data.

A leading purpose for using water footprint data is to illustrate the relationship of economic growth, production and water implications. In Chapter 4 on Viet Nam, this relationship analysed based on FDI, trade and water footprint data. Trade data can be retrieved up to a high level of depth (HS6) even though as further the data is dated back; less data on exports in tonnes is available. Another ongoing constraint is the lack of specific data on the water footprints of products as its calculation is still a young discipline. Based on Hoekstra et al.'s (2011) method global mean product footprints are taken to base the calculations in Chapter 4. The calculation itself is rather simple as the product weight can be multiplied with the products footprint. In case of industrial products, the estimations are based on US dollar, which makes it even easier to calculate even though these numbers are based on more estimates as explained in Chapter 3.

Owing to the lack of data especially on the water footprint of hydraulic fracturing caused question on how much water is needed for an extensive growth in mining operations cannot be answered with precision. This lack is actually part of the hegemonic struggles as only after dissent data collection and environmental assessments started, broad estimates were possible. These are based partly on assessed sites in the US, which are embedded in different conditions than Australia.

Chapter 3 not only explains in more detail the applied water footprint method, but it is also concerned with explaining in more detail the methodologies on measuring water scarcity. The choice of cases based on the water footprint data will be also laid out in more detail in this Chapter.

1.3.3 Interviews

Interviews are conducted in Viet Nam and Australia. In Viet Nam only in the form of expert interviews and in Australia expert and group interviews build the data base. The interviews serve as a source of information and give a better understanding on the protagonists of the discourse in a contested field.

In Viet Nam, expert interviews were conducted in 2012 and 2013 with members of the German Agency for International Cooperation (GIZ), a Federal Institute for Geosciences and Natural Resources (BGR) project, the Vietnamese water administration in Hanoi (MOST), a joint water information project of MOST and the German Federal Ministry of Education and Research (BMBF) and, in 2013, a wastewater plant development project in Nha Trang. During the visit in 2012, while simultaneously teaching as a guest scientist at the Hanoi National University of Viet Nam, university colleagues status provided me with some of the interview contacts, which set of a little snowball effect through recommendation for further interviews and one excursion. The interview partners listed in Table 1 represent institutions involved in the process of setting up legal frameworks for the water regime in Viet Nam or are part of specific projects working on improving the water or data situation.

Table 1 Interview Partner in Viet Nam

Surname	Organisation	Project/Department
Henschel	GIZ Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation)www.giz.de	MoC/GIZ Wastewater and Solid Waste Management Programme
Boehme	BGR Federal Institute for Geosciences and Natural Resources www.bgr.bund.de	Improvement of Groundwater Protection, Vietnam (IGPVN) Centre for Water Resources Planning and Investigation (CWRPI)
Ha	BMBF and MOST Federal Ministry of Education and Research (BMBF) The Vietnamese Ministry of Science and Technology (MOST)	Vietnamese-German Scientific and Technological Cooperation, Office for Water and Environmental Technology
Quảng*+	MOST	The Department of Water Resources Management (DWRM)
Nhan+	Nha Trang coastal development plan project	Deputy Director of Nha Trang PMU, Waste Water Treatment Plant Development Project

*Interview conducted with a translator.
+Interview conducted without audio recording.

The interviews are semi-structured expert interviews and provide the background information on the political economy of the water environment in Viet Nam and specific project information (Waibel 2010, p. 3). The leading questions were sent to the interviewees in advance in order to prepare some of the more specific information. Each interview partner used in this work signed a consent form, that the provided information can be used in this work. Most interviews are recorded, all paraphrased and some parts transcribed. These experts direct toward further research and information nodes apart from those provided directly. The interview with Ms Ha is an example for paving the way to access further information like a press review newsletter in English of all relevant articles on water in Viet Nam, which as an important source of information on the recent developments. Another snowball effect example was the contact to a Red Cross project further described in Chapter1.3.4, where instead of another expert interview access to a water and sanitation project in a village was gained.

In Australia, also expert interviews were conducted (see Table 2 Interview Partner in Australia).

Table 2 Interview Partner in Australia conducted in 2010 and 2011

Surname	**Organisation/Position**
Green	Director, Friends of the Earth, Melbourne
Harris-Buchan	ACF – Australian Conservation Foundation
Mildura	
Miln	Mayr of Mildura (2010)
Mansell	Mildura Development Cooperation
Bennett	Sunraysia Irrigation Council (Mildura)
Crisp	Member of the Victorian Legislative Assembly for Mildura
Stakeholders Groups	
Group of four growers	Growers in Mildura
Group of six activists	Activist at the Anti-Fracking Camp in Tara

The expert interviews aimed at providing a general understanding of not only water conservation issues related to gas extraction and agriculture, but also to map the lines of conflict in the discourse. However, this was not the starting point of the research design as after conducting the first wave of interviews the focus shifted toward hydraulic fracturing. When the research project was still in its first year the research framework in Australia concentrated just on the Murray-Darling Basin and the relationship of water trading and virtual water trade. The decision to put hydraulic fracturing into the centre of the research allowed to shed a light on the growing importance of the interlinkages between water, energy and agriculture; and not just the outcomes of virtual water exports related to agriculture in water scarce regions. However, interviews in Mildura are an important part of the research design as the agricultural sector is a powerful stakeholder competing with the mining sector on water resources in Australia.

A general overview on water conservation issues in Australia is provided in two interviews with NGOs: Friends of the Earth (FoE) and the Australian Conservation Foundation (ACF). Most interviews were conducted with key figures in Mildura, a town in the Murray-Darling Basin area struck by droughts and central for agriculture in Australia. On top of these expert interviews a group interview was conducted with four growers in Mildura to gain at an early stage of the research an understanding on the main issues these stakeholders relate to. Based on the same intention were interviews conducted with a group of activists from the Anti-Fracking Movement during a field study at the central camp in Tara.

The procedure of conducting the interviews is the same as in Viet Nam and each person signed an interview consent form after they were informed of the purpose of the research and that their names can be published. All interviews in Australia were recorded. In case of the activists and growers their information were kept anonymous as their names do not serve a specific research purpose, also, the minimal amount of personal data has been processed in this work. All interviews have been semi structured and conducted keeping space for interview driven commentary.

In both countries, the interview process had its own obstacles and could not have been done without the help of my guest Universities: The RMIT in Melbourne and Hanoi National University. At both universities, colleagues helped especially with their contacts to find interview partners, as especially in Viet Nam a personal entry point is often necessary to open doors. The RMIT was very helpful in preparing a specific interview consent form accordingly to their Human Research Ethics Committee regulations in 2010.

Figure 2 Van used for Research in Australia

Another obstacle was the logistics, which are challenging in Australia. The interviews with the Anti-Fracking Activist in the area of Tara (Queensland) would not have been possible without my van (Figure 3). Mildura is only 600 km from Melbourne, but for the interviews with the activists including the field trips to the gas fields my van drove over 7000 km.

1.3.4 Field Research

In each country, the research included a field trip to relevant project sites, however, each visit ha a different programme. In Viet Nam, a water and sanitation project was visited for one day. In Australia, a protest camp was visited with an extended stay for four weeks, which made it possible to conduct interviews with several activists as well.

Apart from conducting interviews a development project in the context of water conservation measures in Viet Nam was visited. The German Embassy recommended a Red Cross project working on drinking water treatment and sanitation. Instead of just visiting the project site, in April 2012 I got the opportunity of attending a field trip with my class of 41 students of Environmental Management. After permission from the Vietnamese project partner and the local administration of the village committee was given, stating the exact purpose along with a catalogue of questions, which the students had to answer in their exam in regard to the field trip, the visit could take place. These following exam questions and topics were covered by the talks given during the field trip (quoted from email conversations):

- *Project history*
- *What are the red cross project goals?*
- *Who are the project partners?*
- *What improvements were made. How do they work?*
- *What were the biggest challenges during the project? Which challenges made the realisation of the Red Cross Project difficult?*
- *Was it difficult to work together with international partners? (language difficulties, different culture) Which intercultural challenges had the red cross project to face?*
- *How did you get the local community involved? How well did the local population participate in the project?*
- *After several years into the project, what are the improvements for the area?*

The questions were well covered by the presenters of the project and ample opportunity was given to speak with villagers. The conservations were not recorded and relied on translators. The talks given by Red Cross Viet Nam were held in Vietnamese and simultaneously translated. The data was processed based on notes and cross referenced with the students' impressions. Therefore, this excursion was a field trip, but the collected data partly treated like several expert interviews with the Red Cross from Viet Nam. The project especially influenced the decision to include also the issue of arsenic poisoning as a challenging precondition for sub surface drinking water in Viet Nam and Asia in general.

In Australia also, a participatory observation method was used and the Anti-Hydraulic Fracturing Movement was visited for two months in the Australian outback at the middle of the biggest gas drilling fields in Queensland Australia in 2011 The purpose of this approach was to get a deeper understanding on stakeholders opposing the introduction of hydraulic fracturing and commercial exploitation of gas resources using this mining method. The research helped to map the stakeholders in the context of the non-institutional decision making processes shaping the discourse on hydraulic fracturing in Australia. The field notes were helpful to find further nodes of information and to get similar to the expert interviews a good understanding on involved parties and their historical development. This helped to understand specifically for the Australian context the relationship between stakeholders, which are on a first glance on a very opposing spectrum in regard to beliefs and habits, but still form temporary alliances.

1.3.5 Media Analysis

The analysis of various media pieces like websites, PR videos, advertisements, newspaper articles and reports is part of a critical discourse analysis. Each media piece is seen as an artefact in its specific context, often a tool to shift the discourse in a specific direction.

This analytical framework was used in the context of hydraulic fracturing case, where Australia is in the centre with the U.S. storyline as the prelude. As both are English-speaking countries, an advantage was that all artefacts are in English. A very good understanding of the artefacts' language is necessary, which made it unfortunately for this research not possible to apply this method on the Viet Nam case due to language restrictions of the researcher. The used methods to analyse the discourse and theoretical frameworks describes Chapter 2 in more detail. A central point is to damask persuasive moves according to van Dijk (1993, p. 264) in the context of presenting water risks by using rhetorical figures among other moves. A second point is to set temporary outcomes of the discourse into their context seen as nodal points according to the discourse theory of Laclau and Mouffe (2014).

Therefore, the method does not follow the idea of a positivistic approach; however, follows the idea that there is no objectivity and interests and agendas reproduce through the material.

1.4 Structure of the Work

In order to tackle the hypothesis, an analytical framework has been developed in the second chapter of this thesis, thereby embedding the water element into a much bigger discussion on resources and their distribution in general in the form of hegemonic struggles. Water as an essential element is used to show the synergetic effects of ample spheres for resource overexploitation. A new resource nexus framework has been developed to serve as a structuring element not only to connect each chapter, but also to show how factors like soil, energy, climate, water cycles, energy resources, international trade, policies, political systems and discourses on water risks are interconnected. This work concentrates on water, international trade and energy as aspects of the nexus framework. After an overview of the major factors in this synergetic network overreaching each discipline and touching each element in our ecosystem, a more specific focus has been framed to analyse pieces of the bigger picture. This theoretical framework setting includes the more specifically used theories from this evolving methodology.

The third chapter is more specifically concerned with the connection between the hydrological spheres, international trade and the global water situation in quantities and quality by mapping regions of concern, but also explaining in more detail the choice of cases. Drivers impacting the hydrological sphere have been discussed; though the main thrust has been on the globalisation of water and international trade relationships. Furthermore, this chapter prepares the reader for going into more detail in the following two chapters using case studies that are more specific.

In the fourth chapter, Viet Nam serves as an example to illustrate the impact of rapidly industrialising economies on water. After Doi Moi, economic growth accelerated which was related to the inflow of Foreign Direct Investment (FDI) and the developing integration of the region with the international trading system. This case illustrates the footprints trade and trade agreements can leave, especially, if a water infrastructure in terms of treatment, conservation and prevention measures is only slowly developing. Therefore, this chapter is also an example for countries using the economic growth first and clean up later approach.

Chapter 5 takes the mining technology hydraulic fracturing into focus to illustrate hegemonic struggles between water and energy security from a local up to a global scale. This chapter also takes the water footprint discourse further as it illustrates the impact of energy carriers on water resources and provides a global overview. A discussion on the results and a conclusion are given at the end of this work.

2 General Theory Framework

That the yielding water in its movement
Will, with time, defeat the mighty stone.
You understand: What's hard will be defeated.

(Daß das weiche Wasser in Bewegung
Mit der Zeit den mächtigen Stein besiegt.
Du verstehst, das Harte unterliegt.)

Berthold Brecht in Poems, cited in Haug (2007, p. 159)

In this chapter, the overarching framework and theoretical background is set. Specific applications of theoretical approaches are discussed in detail in relation to their relevant context. This chapter also explains, why the analysis of discourses was chosen as an analytical instrument for certain aspects of the phenomena.

In order to understand the phenomenon of exporting virtual water, while experiencing water problems, and to understand the link between liberal economic policies, it is essential to see the problem from different angles. As water is one of the most essential resources, it is intertwined with each aspect of life. This gets amplified through its importance and synergetic effects on other resource cycles, like soil and energy, which also play an essential role. Therefore, as water is so essential, it is also difficult to grasp.

Not only environmental conditions, but also major socio-economic driving factors have to be considered. There are ample challenges to capture water in one theory framework and some are listed here. First, water resource exploitation in the form of withdrawal and pollution is interrelated with all forms of production and reproduction as cause and problem at the same time. Therefore, a complex web of historically grown laws, regulations and behaviour affect water quantity and quality.

Second, an increasing number of scales, in the sense of the political scales, impact water resources, as all scales can impact laws, regulations and/or behaviour. Nevertheless, water is a very local resource in terms of usage practices. Third, there is an analytical challenge of water not caring about political borders. Rivers and aquifers do not follow artificial lines drawn on the map and a whole basin is kept in one political territory only in exceptional cases of islands and continental states, like Cuba, Australia, Iceland and New Zealand. Therefore, state-based approaches can often miss the full picture, which is further discussed in the following Chapter 3. However, most frameworks and data is considered on a national framework. Fourth, static approaches are not useful, as by working on resource cycles, like the water flux, replenishing times need consideration. Therefore, certain practices can be sustainable at a particular speed. A major difficulty is that there are severe research gaps regarding the measurement of water resources on a global scale. However, without a proper worldwide mapping of water resources, their interlinkages and replenishing speeds, the best management concepts would reach their limits. Lastly, interdisciplinary theory frameworks connecting the water cycle to other resource cycles and socio-economic dimensions are rare and were considered insufficient. The challenge of interdisciplinary work and thinking goes far beyond the social science interdisciplinary work, as natural science, engineering and social science had to be connected without losing a critical perspective in each discipline.

Nevertheless, a multidisciplinary approach is chosen; however, this work focuses in its analysis on the political economic environment, hegemony and the underlying socio-economic factors as manifested through discourses impacting resource cycles. The devastating impacts related to water scarcity are the materialised outcomes of hegemonic struggles, where diverse short-term interest can overwrite an assumed common long term interest of preserving water resources.

After discussing some challenges for theorising water and introducing the understanding of hegemony and discourses, the existing nexus concepts has been reviewed in this chapter, adding a new one into the picture. Accordingly, by including power and hegemonic struggles into the analytical framework, this work is situated in the canon of critical theory. There are ample theories of power and this work will not create another one in order to understand power in water relationships. However, the twist lies in integrating hegemony into the new nexus approach.

2.1 Globalisations of Water

Water phenomena are in the middle of processes and forces of globalisation, which are seen as the materialisations of discourses. As already mentioned in the introduction, for the purposes of this work, Bob Jessop's (2001) view on globalisations is used. He explains globalisations as a multicentric, multiscalar, multitemporal, multiform and multicausal process, therefore, an emergent product shaped by different forces operating from or in many dimensions (see Figure 3).

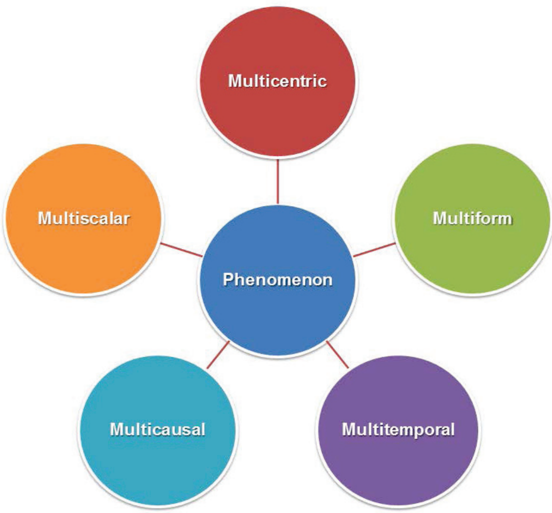

Figure 3 The dimensions shaping globalisations phenomena

Several countries are experiencing water stress, while exporting virtual water (see Chapter 3), a situation that emerged from activities in many places rather than from a single centre, from actions on many scales (local, cities, national, regional, global – non-hierarchical and chaotic). It also involves more complex restructuring and re-articulation of temporalities and time horizons (longer distances, greater areas, or more scales of activity – technical developments e.g. terms of production) and it results from the complex, contingent interaction of many different causal processes. Jessop promotes, according to his definition, that it is useful to see these forces and processes as globalisations (in the plural). Therefore, there are also globalisations of water.

According to Jessop (2001), the overall course of globalisations is largely unintended and a relatively chaotic outcome of interaction among various strategies to shape or resist globalisation in a complex, path-dependent world society. This is interpreted in this work for the water context as follows:

1. Water phenomena are the outcome of the course of water globalisations, like depletive virtual water trade shaped by the forces of globalisations always with an impact which can be either more or less.
2. Strategies to shape or resist water globalisations are struggles over the discourse hegemony; however, the phenomenon is shaped by various discourses (dimensions), which are also internationally linked.
3. Path-dependencies are shaped by environmental conditions and historical hegemonic blocs, which can also shape the environment through anthropogenic interdependencies.

Therefore, we have multiple phenomena in different shapes and forms as they were not shaped by the same forces. The globalisations of water and trade regimes take various shapes in their different context, as hegemonic blocs get historically shaped due to ample alliances and shifts. In case a counter hegemony could be formed, resistance has different appearances and strategies, as further developed in Chapter 2.2.

Globalisation of water, especially, depletive water exports are thus captured as the outcome of struggles materialising in discourses. Struggles with largely unintended outcomes, where water does not have to be the main issue, is mostly affected, due to its interconnectedness as an elementary good. Therefore, overlapping interdependent discourses impact trade and water resources with different outcomes, due to different path dependencies. As it is insufficient to explain depletive water exports just as 'perverse' trade and an exception of an otherwise working market distributing goods and trade in favour of water sustainability, it is important to pay more attention to discourses shaping depletive market exports with their embedded power relations. After developing a new nexus framework, based on Bob Jessops view on globalisation, part of the nexus will be analysed more deeply, in order to give a more complex picture on how depletive trade regimes can be established.

2.2 Hegemony, Discourses and Virtual Water

This chapter develops the role of hegemony in the analytical framework of capturing drivers for virtual water trade regimes. As depletive water exports can have severe negative environmental impacts, it is important to understand forces establishing this phenomenon. Therefore, this is an important cornerstone for the research on drivers influencing virtual water trade after having established, that water endowment plays only a minor role in directing international trade patterns. One general criticism on liberal economic theory for capturing trade phenomena is that most models would only work in an ideal market, which leaves out other ample components like power relations. The hypothesis is, that trade liberalisation will, therefore, not solve the water crisis, but can even increase it and water preservation is more so a hegemonic struggle for common long term interests. In order to analyse these often competing interests and alliances, establishing hegemony is seen as a process of power struggles between different interest groups shaping the discourse on issues influencing resource cycles.

2.2.1 Theories of Power

Max Weber's (1922) defines that power refers to each chance in social relationships that allows you to set your will above that of another person, where it does not matter on which ground this opportunity had been given or had remained unchallenged. However, more specific analytical frameworks have been developed. For this work, power is captured by the concept of hegemony in a Gramscian thinking. The concept of hegemony goes back to Antonio Gramsci, which he developed during his imprisonment at first in Turi and later in Formia, Italy, from 1926 to 1937 (Buttigieg 1999). He developed his ideas in captivity and they always have to be seen in the context of an analysis on how change is possible from a starting position as not being the hegemon. Therefore, Gramsci's school of thought can be also seen as a theory on establishing counter hegemony to actively realise change (Haug & Davidson 2004), but can also be used to analyse what is keeping people from change and revolution.

The formation of historically developed hegemonic blocs is extensively analysed in his work and was the foundation of more recent analytical frameworks working on conceptualising power. His idea of historical blocs is still used by Stephen Gill:

> *An historical bloc refers to an historical congruence between material forces, institutions and ideologies, or broadly, an alliance of different class forces politically organized around a set of hegemonic ideas that gave strategic direction and coherence to its constituent elements. Moreover, for a new historical bloc to emerge, its leaders must engage in conscious planned struggle. Any new historical bloc must have not only power within the civil society and economy, it also needs persuasive ideas, arguments and initiatives that build on, catalyze and develop its political networks and organization – not political parties such. (Gill 2003, p. 58)*

That more dimensions of power are needed to establish a historical bloc goes hand in hand with Gramsci's thoughts on establishing hegemony and the necessity of more avenues, than just economic and political power. This approach does not neglect the institutionalised side, but can explain that other components – the intellectual and moral dimensions – are necessary for establishing hegemony and that there are different avenues for groups becoming hegemonic.

> *not only a unison of economic and political aims, but also intellectual and moral unity ... the development and expansion of the [dominant] group are conceived of, and presented, as being the motor force of a universal expansion ... In other words, the dominant group is coordinated concretely with the general interests of the subordinate groups. (Gramsci 1971, pp. 181–2)*

These dimensions already imply that other tools are needed to analyse hegemony as, for example, moral shifts are more difficult to capture than counting money. Therefore, hegemony is established and can be analysed through discourses.

In general, establishing hegemony is seen as a process of power struggles between different interest groups shaping the discourse on issues. Hegemony, in the tradition of Gramscian thought, includes not just the domination of a political debate and the ability of a hegemon to quiet public dissent by force, but the capacity to shape interests of antagonists in order to reach a consensus in favour of the hegemon's interests (Wullweber 2009b). The hegemon is, therefore, the party, which was able to shape the discourse in its favour at a certain point of time, however, as these power struggles are a process, discourses are getting shaped by ample interest groups, which form different coalitions depending on the issue at hand. Furthermore, various actors forming these groups shape discourses differently in diverse structures of their historically grown environments. These temporary coalitions can be hegemonic for a shorter or longer period, as hegemony always has to be reconstituted.

Based on Gramscian thinking, Lukes (1974) differentiated three dimensions of power also called from him three faces of power. He published in 2005a the second edition of *Power – a radical View* and develops it further by incorporating the critical reviews of his first addition and adding a fourth dimension. The first face is summarised by him as follows:

> *Thus I conclude that this first, one-dimensional, view of power involves a focus on behaviour in the making of decisions on issues over which there is an observable conflict of (subjective) interests, seen as express policy preferences, revealed by political participation. (Lukes 2005a, p. 19)*

This face of power is referred to as hard or structural power and some see it as administrative or coercive power summarise Zeitoun & Allan (2008, p. 9) in their paper *Applying hegemony and power theory to transboundary water analysis* as part of a special issue on *hydro-hegemony*. The second face is concluded by Lukes:

> *(...) that the two-dimensional view of power involves a qualified critique of the behavioural focus of the first view (I say qualified because it is still assumed that non decision making is a form of decision-making) and it allows for consideration of the ways in which decisions are prevented from being taken on potential issues over which there is an observable conflict of (subjective) interests, seen as embodied in express policy preferences and sub-political grievances. (Lukes 2005a, pp. 24–5)*

This face can be summarised as the power to set agendas and to make decisions in a formal setting, but also its informal surroundings. In the context of hydro-hegemony Zeitoun & Allan (2008, p. 7) explain this face with the example that: 'through the use of secret police, dissident views may be kept covered and unexpressed in the first place.' One of the differences between the first and the second face is, that the second is less visible and, therefore is the second face often called the secret face. The third face is summarised by Lukes (2005b, p. 486) in his article *Power and the Battle for Hearts and Minds* as 'what I have called power's 'third dimension': the power to shape, influence or determine others' beliefs and desires, thereby securing their compliance.' In this article argues Lukes also against the assumption, that this third dimension is close to the concept of soft power Nye (1991) introduced, which is a contested ground and source of ample publications during the last decades. Lukes (2005a) argues, that Foucault's work is often seen as the fourth dimension of power, but also 'taken by some to undermine the kind of approach exemplified and advocated here (his dimensions of power)' (Lukes 2005a, p. 88). Haugaard (2012,

p. 47) summarises the fourth dimension as consisting 'in the process of subjectification' and explains it based on Foucault:

> *They become conscious of their own visibility and, as a consequence, start to observe themselves through the eye of the observing other. Thus they subject themselves to the normalizing judgements of the observer. Once this judgement is internalized, they become objects of knowledge for themselves, thus continually subject themselves to normalization. This Panoptical observation is coupled with discipline, which is characterized as enforced routinization. (Haugaard 2012, p. 48)*

These four dimension or faces of power are as mentioned already applied in hydro-hegemony, further reviewed in Chapter 2.2.3 by also looking closer into scientific hydro-hegemony discourse in which this work is situated.

Lukes's dimensions of power help to choose the analytical methods to analyse and visualise each face with the material already outlined in Chapter 1.3. This also explains the mixed methods applied in this work as several dimensions of power are relevant in the context of explaining the factors pushing international trade into a water depletive direction. Different dimensions need in this work different material and methods to visualise these. The Chapter: Trading Viet Nam's Water Security off after Doi Moi concentrates on analysing historical developments shaping the political and economic environment with its laws and regulations summarised as Doi Moi. A focus is set on the more visible face, but with less visible outcomes in the context of virtual water trade. The goal in this chapter is to visualise the water impact of certain actors like Multinational Corporations (MNCs) embedded in a specifically shaped set of Foreign Trade Agreements (FTAs) of an economy with dependency on Foreign Direct Investment (FDI). The dependency on FDI is understood in the sense of the second face, where in order to attract FDI certain regulations for example in regard to water conservation are not considered in the past as they are in conflict with the interests of FDI holders. The Chapter: Trading Water Risks for Energy the Global Spread of Hydraulic Fracturing also includes the third and fourth dimension incorporating the analysis of discourses on a micro level by looking more specifically into discourses embedding hegemonic struggles on water security vs energy security. During these two main chapters on specific cases, the second focus is set on the interlinkages with other discourses shaping the water exploitation regimes in the local environment. This analysis of power struggles is important to understand how certain hegemonic positions could be established and constantly re-established.

The interconnectedness of ample discourses shaping water regimes is the main point of this work and in order to illustrate this, in each of the main chapters, a certain analytical angle is used:

2.2.2 Discourse Analysis

Discourses are seen in this work in the tradition of Michel Foucault (1969): A discourse is not just what different protagonists of interest groups say or write. The character of a discourse is the ability to establish connections between 'institutions, economic or social processes, models of behaviour, normative systems, techniques, types of classification and characterisation'[8]. A discourse can be established and characterised in different forms as there are ample materialisations. Discourses are interactions, but also the material what is left due to these interactions and are seen as an ongoing process. In regard to Lukes's fourth dimension the reference is made to Foucault's understanding of discourses.

Methods to analyse discourses emerged especially since the 1990s and one of them is the critical discourse analysis (CDA), also called critical linguistics or critical discourse studies, developed by Theo van Leeuwen, Gunther Kress, Teun van Dijk, and Norman Fairclough among others (Amoussou & Allagbe 2018). Fairclough's work set the basic steps for analysing discourses with the three dimensions of: description, interpretation and explanation and even though his work is widely

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8 German original rephrased: 'Institutionen, ökonomischen und gesellschaftlichen Prozessen, Verhaltensformen, Normsystemen, Techniken, Klassifikationstypen und Charakterisierungsweisen herzustellen' (Foucault 1969, p. 86).

criticised and challenged it is often used at Universities argued Lukes (Henderson 2005). In this work are some of the CDA techniques used to demask artefacts and to interpret their function and to explain them in the context. Especially, important for the interpretation are van Dijk's described persuasive moves (van Dijk 1993).

Another school to analyse discourses is mostly referred to as discourse theory (DT) developed by Ernesto Laclau and Chantal Mouffe and introduced in Hegemony and Socialist Strategy (1985). That this constructivist account for discourses has its roots in Gramscian thinking is again established in the foreword of the second edition and includes their take on the forces of globalisation:

> *The usual justification for the 'no alternative dogma' is globalization, and the argument generally rehearsed against redistributive social-democratic policies is that the tight fiscal constraints faced by governments are the only realistic possibility in a world where global markets would not permit any deviation from neo-liberal orthodoxy. This argument takes for granted the ideological terrain which has been created as a result of years of neo-liberal hegemony, and transforms what is a conjunctural state of affairs into a historical necessity. Presented as driven exclusively by the information revolution, the forces of globalization are detached from their political dimensions and appear as a fate to which we all have to submit. So we are told that there are no more left-wing or right-wing economic policies, only good and bad ones! To think in terms of hegemonic relations is to break with such fallacies. Indeed, scrutinizing the so-called 'globalized world' through the category of hegemony elaborated in this book can help us to understand that the present conjuncture, far from being the only natural or possible societal order, is the expression of a certain configuration of power relations. It is the result of hegemonic moves on the part of specific social forces which have been able to implement a profound transformation in the relations between capitalist corporations and the nation-states. (Laclau & Mouffe 2014, xvi)*

Based on this understanding of the forces of globalisation are water regimes seen as a conjuncture, an outcome of hegemonic moves of social forces. In their understanding each discourse has a nodal point where social dominance is reached (ed. Carpentier 2010).

> *The practice of articulation consists in the construction of nodal points which partially fix meaning; and the partial character of this fixation proceeds from the*

> *openness of the social, a result, in its turn, of the constant overflowing of every discourse by the infinitude of the field of discursivity. (Laclau & Mouffe 1985, p. 113)*

The concept of nodal points is applied in this work in Chapter 5, where a ban of the technology or support of a commercial exploitation is seen as a nodal point. However, this does not stop the discourse, but marks a point in time. This makes an analysis possible, which social forces reached hegemonic dominance at this nodal point. Each nodal point is in this case also seen it its specific geographical environment as some nodal points are more or less contested.

2.2.3 Hydro-hegemony

A hegemonic approach based on Gramscian thinking is not new, but not often used when theorising water issues. Zeitoun & Warner (2006) coined the term hydro-hegemony in their article *Hydro-hegemony: a framework for analysis of trans-boundary water conflicts*. As the title already hints, they concentrate on water bodies, which are shared or divided through political borders. Their main point is that there are ample struggles and power struggles, which are in-between armed conflicts or cooperation. They argue along with the Strategic Foresight Group (2013), that the absence of conflict cannot be measured merely from the absence of agreement and other parameters of cooperation. They published the following ten parameters to determine the water cooperation quotient (Figure 4).

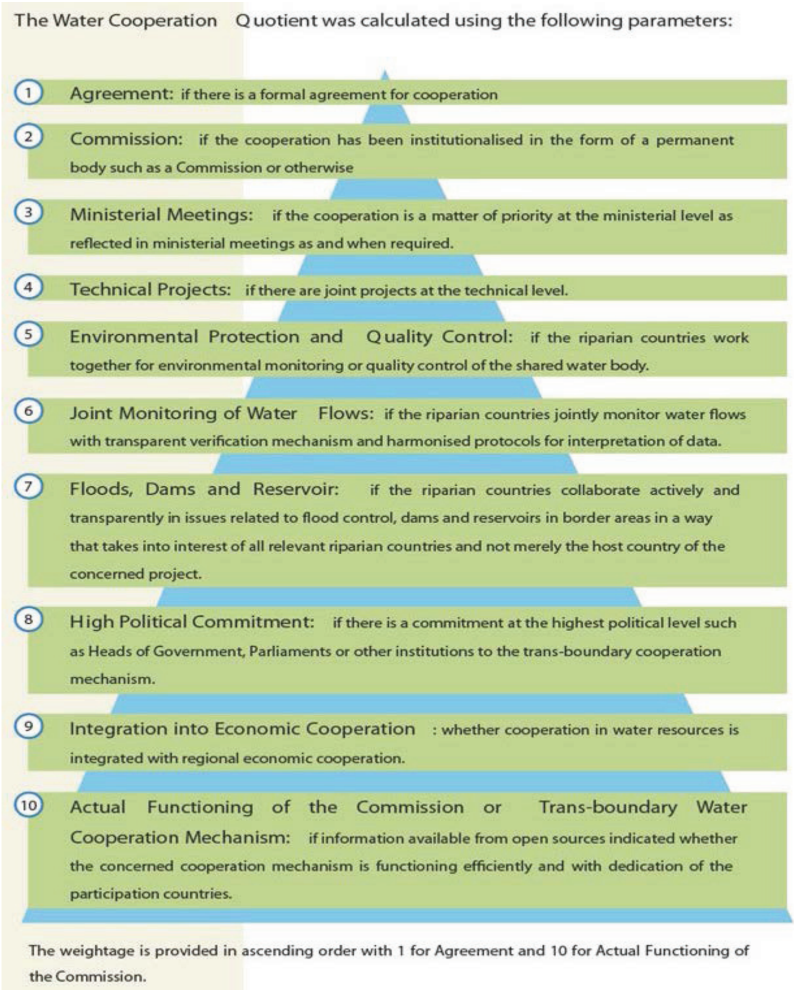

Figure 4: Methodology used for determining the Water Cooperation Quotient
(Strategic Foresight Group 2013)

Based on these parameters they created a map (Figure 5) giving a good overview on the status quo of transboundary water agreements, even though, as Zeitoun and Warner pointed out, it does not illustrate the underlying hegemonic struggles.

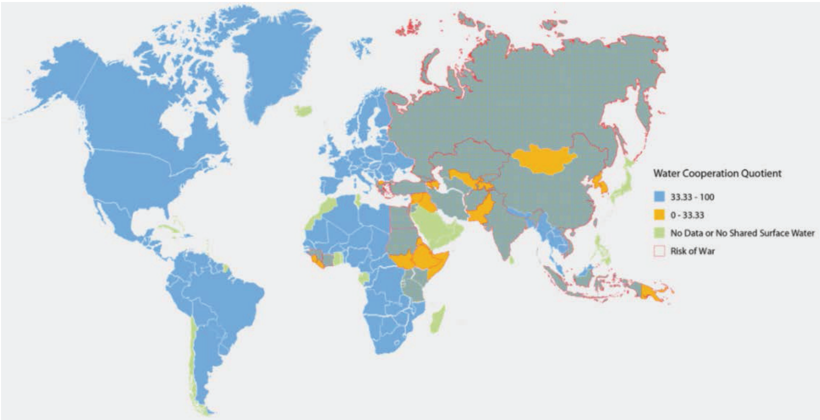

Figure 5: Water cooperation map (Strategic Foresight Group 2013)

Zeitoun and Warner's term for these hegemonic struggles on water is *silent wars* and it contradicts these commonly used concepts in water politics based on the idea, that cooperation on shared water bodies resolve conflict. They argue that the water hegemon rewrites the rules in the sense of Lukes's second dimension. Based on Gramscian thinking, they describe the continuum of interactions as follows (Figure 6):

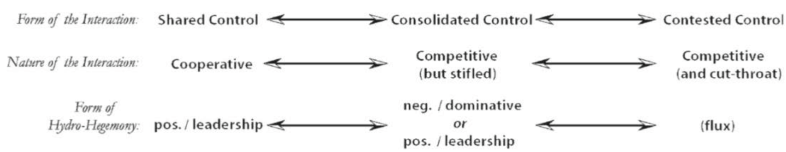

Figure 6: Continuum of forms of interaction over transboundary water resources
(Zeitoun & Warner 2006, p. 444)

The tactics and strategies were further arranged in a hierarchical order (Figure 7):

Figure 7: Water resource control strategies and tactics (Zeitoun & Warner 2006)

They summarise these hegemonic relationships with its hydrological manifestations as follows:

> *In cases where a river forms the border between competitors, diversion dykes may satisfy one competitor's demand, leaving the other dry; in the case of trans-boundary groundwater, high-capacity deep wells and pumps can drop the water level out of reach of the competitor's shallower, lower capacity wells located on the other side of the border. A state with the ability to plan, construct and operate large infrastructure projects has the physical ability to change the hydrogeology of the resource, thereby creating new hydro-strategic and hydro-political realities. (Zeitoun & Warner 2006, pp. 444–5)*

Their work is in the middle of the discourse on *water wars* in the sense of national military conflict. They provide a different analysis on why there is often no armed conflict on water. Therefore, their approach relates to Barlow and Clarke's understanding of water wars described in *Blue Gold (2002)* as hegemonic struggles on all scales of water issues, like the resistance against water privatisation.

The concept of virtual water trade, especially framed from a hegemonic perspective in Gramscian sense, is a rare find and got mainly applied in the form of an analysis on the role of agribusiness in global water governance (Sojamo et al. 2012). The cowriters of Suci Sojamo's (2012) article: 'Virtual Water Hegemony: the Role of Agribusiness in Global Water Governance' were Jeroen Warner, who had worked on hydro-hegemony, and John Anthony Allan, who had introduced the concept of embedded water in the 1980s. He has been one of the early scientists connecting water in form of embedded water with food trade and international relations. In their publication on virtual water hegemony, the focus was set on Western dominance in the global food markets through powerful agribusiness players. Their core question and argument is:

> *Who "manages" virtual water, and subsequently, who impacts water security in the global political economy? We argue that what we call an aspiration to achieve "virtual water control" and possibly challenge Western "hegemony" is a key driver in the current phase of foreign direct investment in land in Africa, Latin America, and South-East Asia. Since water and food security are so intimately related, a decreased dependency on Western agribusiness conglomerates with regard to virtual water also challenges the economic power relations in global agro-food trade. (Sojamo et al. 2012, p. 170)*

They connect the discourses on *land grabbing*[9], water security and international trade and explain this through a global hegemonic North-South conflict fought through trade agreements and resource exploitation in the form of FDIs and influence of trade flows. This work follows to some extent a similar chain of arguments, which will be explained in the following in regard to similarities and differences.

Sojamo (2012) argues that hegemonic struggles on the management of domestic drinking water supplies are small battles, compared to those over water supplies for food and energy production. First, the struggles on water privatisation, documented by Maude Barlow (Barlow 2008; Barlow & Clarke 2002), lost their

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9 Merriam-Webster (2017a) dictionary defines land grabbing as 'a usually swift acquisition of property (such as land or patent rights) often by fraud or force'.

conflict potential as MNCs are no longer interested in this market anymore (Biswas & Tortajada 2009). In this study this argument (Chapter 3.2.1, Figure 25), as recognised worldwide, has been followed. However, formed resistance also sharpens awareness as further discussed in Chapter 3.3. The assumption, that formed networks have their potential to reform counter hegemonic movements on closely related issues is discussed particularly in Chapter 5.2. Domestic water usage is a minor proportion of the bigger water picture, as agriculture, mining and other industrial activities have a much higher water demand and a greater impact on the water cycle. This will be further developed in Chapter 3 analysing which water bodies are more endangered and where, as well as identifying the specific drivers.

Chapter 4 analyses the importance of FDI and its water impact on a country like Viet Nam, experiencing thereby rapid economic growth after the collapse of the eastern bloc. Open market strategies and trade agreements have to be seen in the context of nodal points based on the understanding of Laclau & Mouffe (2014). Viet Nam as a small country, which was right after the collapsed bloc also in the middle of collapsed trade, is an example of an economy with at that time their back to the wall. This work concentrates on the aspect of drivers for a country to get the inflow of capital, however, owing to slow growth of an environmental infrastructure, the country would have to struggle to cope with the environmental water implications.

The agricultural sector, due to irrigation practices, is the biggest water user worldwide. With increasing energy demands more water usage conflicts are expected to arise in the energy food water nexus. Sojamo et al. (2012) used in their article the term land grabbing. However, in 2012 the term *water grabbing* already established picking up, what was described by them under the term land grabbing considering the water dimension. With the publication of the special issue in the journal *Water Alternatives* on water grabbing (Mehta, Veldwisch & Franco 2012) the term established. This special issue concentrated mainly on power disparities between buyers and sellers of land and provided an overview on the water dimension:

> *Despite headline attention to 'land grabbing' the implications for existing water resources (both surface water and groundwater) have largely remained ignored. Growing evidence suggests that in many cases land grabbing may be motivated by the desire to capture water resources (Smaller and Mann, 2009; Woodhouse and Ganho 2011; Skinner and Cotula, 2011). Although water is a potential constraint on large-scale agricultural projects, particularly in terms of their scale, many land deal contracts do not explicitly mention water requirements (Woodhouse, 2012). Meanwhile, as argued by several authors in this collection, the land subjected to new transactions is rarely 'marginal' but either already used by small and large scale producers, or of prime quality and associated with irrigation facilities, or with the potential for acquiring freshwater from river systems or aquifers (e.g. in arid areas land is plentiful and agricultural expansion will not create conflict until water is used). This raises the crucial question of whether this water is truly 'available' or whether this assumption will lead to unsustainable withdrawals ultimately undermining the quality of the land, or to unequal reallocations away from existing users. (Mehta, Veldwisch & Franco 2012, p. 194)*

These power relations appeared in the land grabbing discourse in NGO publications which defined water grabbing as follows:

> *Water grabbing refers to situations where powerful actors are able to take control of or reallocate to their own benefit water resources at the expense of previous (un)registered local users or the ecosystems on which those users' livelihoods are based. It involves the capturing of the decision-making power around water, including the power to decide how and for what purposes water resources are used now and in the future. (TNI 2014, p. 3)*

This definition captures Lukes's second dimension of power. Hydraulic fracturing as a technology peaked contested discourses on water security versus energy security on all scales as it had direct implications on water quality and quantities. There are other examples, where the water energy nexus gets tighter and conflict arises, like appropriation of land for agricultural products used for biogas, found more and more attention in the context of water grabbing. Land grabbing and water grabbing became part of the hegemonic struggles not only with regard to land appropriation for agricultural, but also for mining purposes. Worldwide, like in the U.S. and Australia, these struggles, were often highly connected to fights over indigenous land rights, like the conflict on the Blackfeet Reservation in the U.S. (Healy 2012).

The work of Sojamo et al. (2012) argues that water security is bound with food security in a water-food-energy-climate-trade nexus and that the key to understand this are the powerful actors in the global agro food trade system. Since then, numerous case studies have been conducted on the agro food business and virtual water trade (Duarte, Pinilla & Serrano 2015; Ruini et al. 2013; Sojamo & Larson 2012; Vanham 2013), though, the energy sector is still under-researched. This thesis, however, argues that the energy sector, with new technologies like hydraulic fracturing, plays a vital part in the hegemonic bloc formed called by Sojamo et al. the *virtual water managers*. However, this hegemonic bloc is can also be in conflict with the formed agribusinesses due to their conflicting water interests.

Consequently, resource cycles as a connected nexus are heavily influenced by the constantly re-established discourses, hegemonic struggles on quantities and ways of resource exploitation. More dimensions have to be included into the nexus framework to make the anthropogenic link more visible. In this analysis, the focus is set on the shifts in discourses, showing outcomes of struggles at specific points of time.

2.3 The Nexus Approach

The Merriam-Webster dictionary (2017b) defines a nexus as ‘a relationship or connection between people or things’, ‘a causal link’, or ‘a connected group or series’. The term in itself already hints towards the idea of anthropogenic interlinked causalities and is an effort to visualise these connections. The nexus shows how different discourses are interconnected and tries to give some structure on the interdependencies between different discourses. However, before this water-discourse-nexus is developed, a literature review gives an overview on the nexus debate and some of the most pushed nexus concepts.

The nexus is built upon elements, which are the resources we obtain from the Earth. This idea goes back to the mention of the four elements: water, earth, air and fire (energy) in mythologies. In most modern nexus concepts they appear as: water, energy and food (Bizikova et al. 2013; GRACE 2014; Hoff 2011; Mohtar & Daher 2012). Besides clean air, which is mostly left out, this is what homo sapiens need to support life and satisfy its most basic needs. Correspondingly, water security, energy security and food security are also intimately interconnected (Mohtar & Daher 2012). The nexus describes where and in which way systems interconnect. Food production requires water, energy and soil. That this implies healthy soils is often overlooked, but is getting more attention with ample UN publications especially in the year of soils 2015 (FAO 2015). To obtain water, we need to extract, treat and distribute it (Figure 8). This all requires energy (Mohtar & Daher 2012).

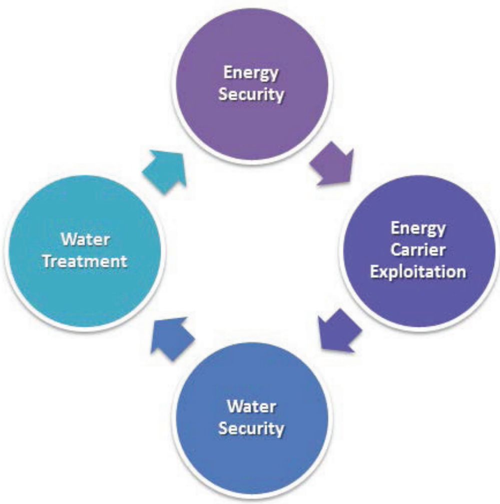

Figure 8: Water Treatment Energy Nexus

Water is needed in the production of energy to run power plants safely and to produce gas, oil and coal, as examples for energy carriers (GRACE 2014). In case of biofuels, a direct impact and competition is created with food production and an additional impact is created through water consumption and pollution, which are essential for both sectors. We have, therefore a close dependency among all these factors. A balanced nexus could provide water, energy, soil and food security by using synergetic effects in a positive way. However, when these systems come into conflict with each other they affect public health, economy and ecosystems (GRACE 2014). One of the water outcomes is the phenomenon of depletive water exports, where, for the sake of production or mining of products for exports, ecological trade-offs are made.

In 2011 the Nexus Conference: 'The Water Energy and Food Security Nexus – Solutions for the Green Economy' was organised by the German Government in Bonn as a specific contribution to the UN Conference on Sustainable Development, Rio, 2012. Since then, many publications on the water nexus started to flourish. Publications derived from the Nexus Conference (Hoff 2011) and other reports were written subsequently (Bizikova et al. 2013; GRACE 2014; Mohtar & Daher 2012), having in common that the most widespread nexus concept include water, energy and food as the main elements. The approach is still in its infancy, but is more and more recognised by international institutions. Therefore, further reports from international institutions (Gerten et al. 2011; Sønderberg Petersen & Larsen 2016; U.S. Department of Energy 2014; UN Water 2014; World Energy Council 2016) were used to verify the state of water and energy reservoirs, and energy and food production methods and their impact on the environment. In these publications, the nexus discourse is highly interconnected with the alarming upcoming resource crisis. The picture is drawn of a world moving into a dangerous direction full of uncertainties regarding the future supply capacity of Earth's resources. Human population and human use of the Earth's resources has never before been of such a magnitude as today. Neither has there been the anthropogenic pressure on the biosphere in the form of waste, pollution and natural-cycle-altering compounds and processes. The alteration of the Earth's ecosystem that human activities are causing has dramatically increased in the last century, especially in the last 60 years, and forecasts predict a further increase in the coming years. The nexus concept is used to visualise parts of these downward spiralling cycles.

The nexus system presented at the Bonn 2011 Nexus Conference (see Figure 9) focuses on promoting security of access to the three basic elements.

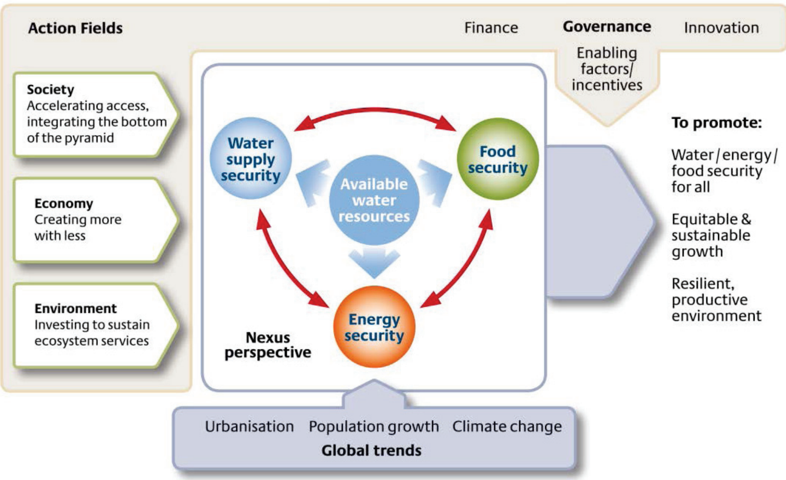

Figure 9: The WEF nexus presented in the Bonn 2011 Nexus Conference (Hoff 2011, p. 16)

The framework presents water resources as a central constraint that influences water supply, energy and food security. This system frames the nexus in the context of society, economy and environment; identifies the action fields: finance, governance and innovation; and points out the influence of global trends like urbanisation, population growth and climate change in the Water-Energy-Food (WEF) nexus. This is the most widespread and widely referenced nexus approach. It takes many nexus-framing elements into account and provides an overview of interconnected elements. However, this picture takes for granted that financial incentives and innovation will promote water, energy and food security for all. Such an approach is a simplified picture of the often challenged liberal trickledown effect. It also does not take into account that resources are uneven distributed even without scarcity. According to the WEF these global trends were made responsible for the depletion of available water resources through impacting food and energy security: urbanisation, population growths and climate change. Population growth is set in focus, but to take that factor as one of the major causes is questionable, as it leaves out consumption patterns and disparities. It overlooks global disparities though, in terms of resource consumption, even a small population in industrialised countries and developing economies can have a much bigger impact than the least developing countries with often a higher population growth rate. In summary, this nexus approach is a representation of the conference subtitle motto: solutions for the green economy. The green economy approach is trying to push sustainable development with neoliberal instruments, leaving out power relationships, unequal resource distribution and causalities within the political economic environment as a cause for increasing resource security risks.

The World Economic Forum (2011), well known for its meeting in Davos, called by the U2 singer Bono ‘fat cats in the snow’ (Reeder 2011), presented its own nexus chart (see Figure 10).

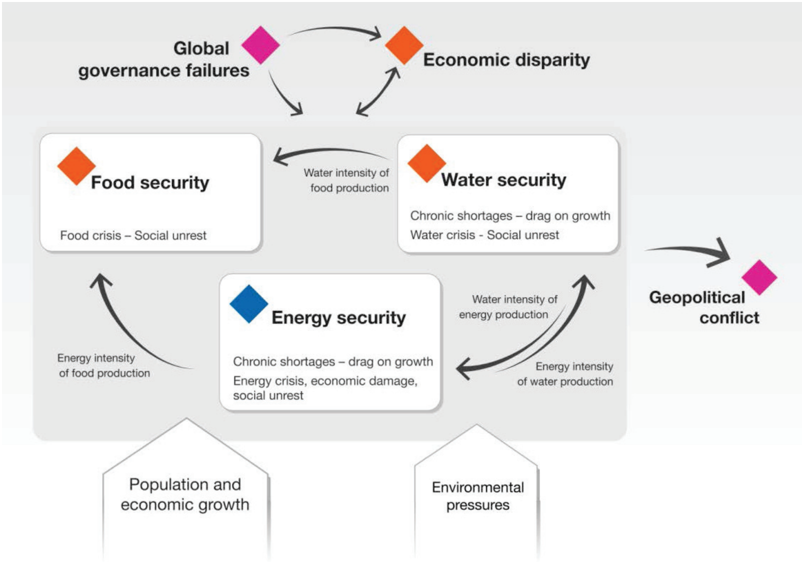

Figure 10: Approach to the WEF suggested by the World Economic Forum
(World Economic Forum 2011, p. 29)

Their nexus addresses political decision-makers and focuses on geological conflicts, which can arise, out of lacking water, energy and food security. The WEF nexus outcomes are represented as a major global risk, which is affected by global governance failure, economic disparity, population and economic growth, and environmental pressures (Bizikova et al. 2013). This nexus (Figure 10) takes into account that disparity has an impact on the resource cycle and vice versa, though, in an indirect way as social unrest is considered as an outcome of shortages. Missing food, water and energy security is considered as the direct outcome of governance failures. The responsible corporates, institutions or the state thus try to avoid shortages and struggles. Therefore, this nexus takes on an institutional view in the tradition of the argument that water shortages result in armed conflict, which is highly discussed, from some dismissed and mostly not interpreted as a state to state conflict.

The relationship of conflict and water already crossed our way, as it was the starting point for developing the embedded water trade theory by J. A. Allan. He further explored the relationship of the Middle Eastern conflict and water, which he wanted to solve through trade, by removing water stress by importing products with water-intense production (Allan 2001). However, the term water wars as already mentioned in Chapter 2.2 was mainly shaped by popular critical scholars, like Vandana Shiva, who wrote the book *Water Wars* in 2002 (Shiva 2016). She and Maude Barlow, with her widely received book: *Blue Gold* (Barlow & Clarke 2002) mark the era of scholars, who are also activists in a global resistance towards privatisation and a fight for the Human Right for Water like the water protests in Cochabamba, Bolivia, ultimately leading to policy changes.

The term water wars also shifted several times and is used in recent years more often in the context of shortages, which can promote terrorism in the Middle East (Goldenberg 2014; Peristianis & Abu-Hussein 2017; Shiva 2016). The National Intelligence Strategy of the United States of America (2014, p. 5) included resource scarcity in their catalogue of threats: 'Natural Resources: Competition for scarce resources, such as food, water, or energy, will likely increase tensions within and between states and could lead to more localised or regional conflicts, or exacerbate government instability'. This Assessment draws on the more elaborate Special Report Water Security (2012), which assesses the likely impacts due to water stress for the U.S., directly and indirectly. As Chapter 5.2 shows the U.S. reply to reach energy independence with the help of hydraulic fracturing, however, compromised their water resources.

In the following year, the nexus concept developed further and new components are considered. The International Centre for Integrated Mountain Development (ICIMOD) developed its own framework centred on ecosystem services (Figure 11) in the Himalayas and South Asia (Bizikova et al. 2013).

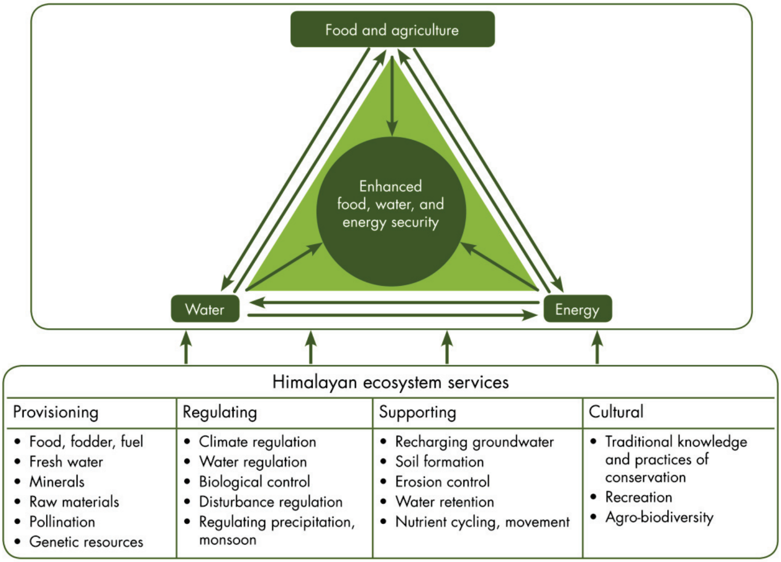

Figure 11: WEF framework developed by ICIMOD (ICIMOD 2012, p. 4)

This nexus view deals with a concrete ecosystem case and ignores higher-scale factors, such as climate change or increasing supply pressures, which can also affect local conditions. This concept offers to be able to measure the health of the nexus through the provision of ecosystem services. When it comes to defining these services, it is important not only to be able to transcend the mere supply of resources, but also identify those regulating and supporting functions that have effects ranging from local site conditions up to the whole biosphere.

The *Encyclopaedia of Agriculture, Food and Biological Engineering* (2012) presents in its second edition a nexus structure (Figure 12), represented by an inner sphere that includes water, energy and food and a single outer sphere comprising

rising economies, climate change, global population, international trade, and governance.

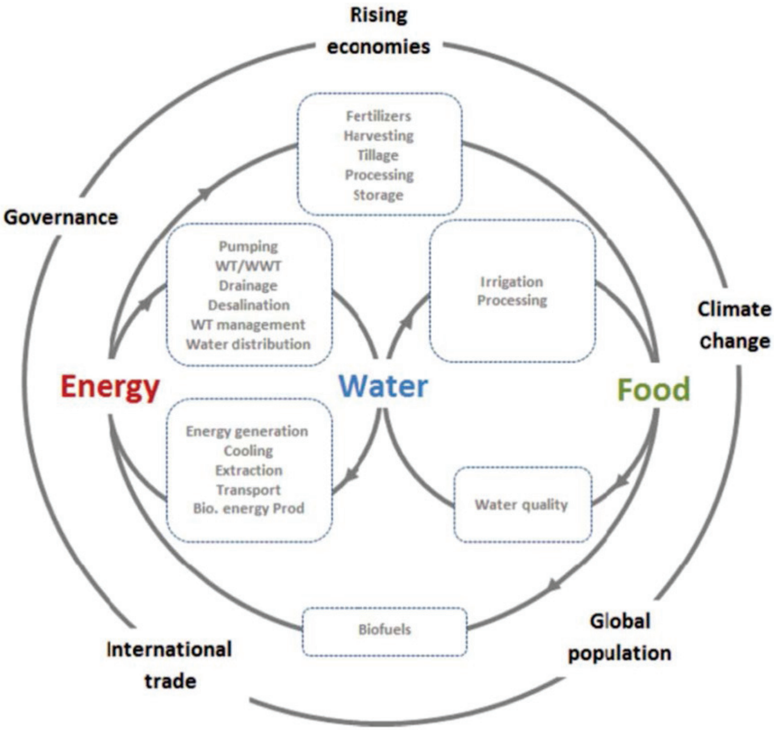

Figure 12: WEF nexus proposed in the Encyclopaedia of Agriculture, Food and Biological Engineering (Mohtar & Daher 2012, p. 2)

This nexus constitutes an intermediate step between the nexus proposed by ICIMOD and those presented in the World Economic Forum or at the Bonn 2011 Conference. It pays attention to local processes and practices like irrigation, wastewater management systems, or harvesting. At the same time, it frames the interactions on a global scale including factors such as global population, governance, and international trade and trends, like rising economies and climate change.

One of the more recent publications and visualisations is the FAO one, with a much more sophisticated concept, including goals and interests, drivers and visualising flows (Figure 13).

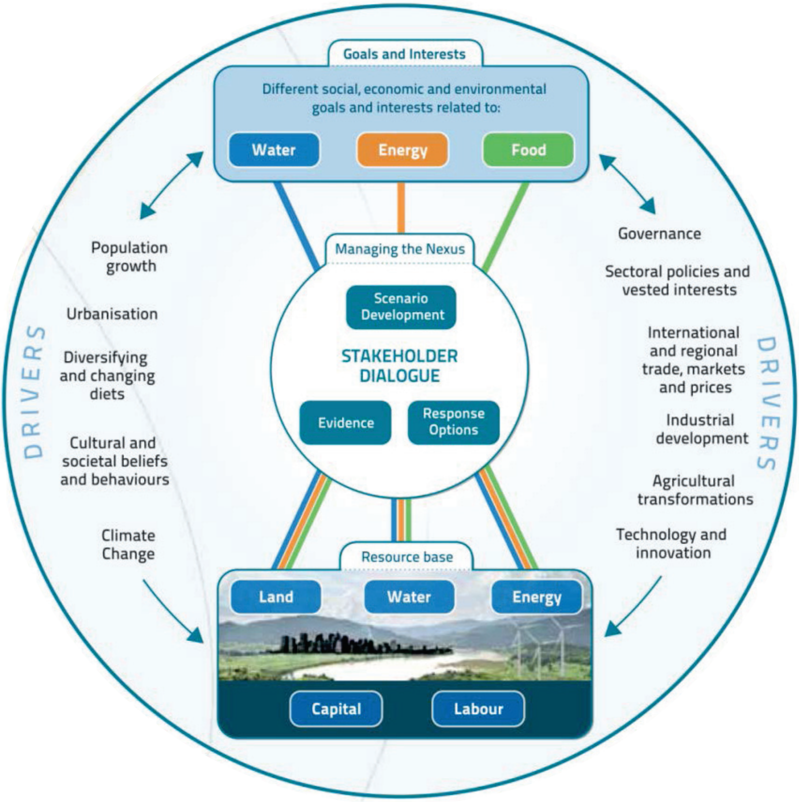

Figure 13: The FAO approach (FAO 2014, p. 9)

The most obvious difference is that the FAO included the management of the nexus, however, not the managers of the nexus like the approach taken by Sojamo et al. (2012), who included hydro-hegemony into their water-food-energy-climate-trade nexus. The FAO nexus hints, that there are different interests and goals with regard to water, energy and food influenced by different drivers.

The nexus used in this work (Figure 14) is a combination of the previous approaches.

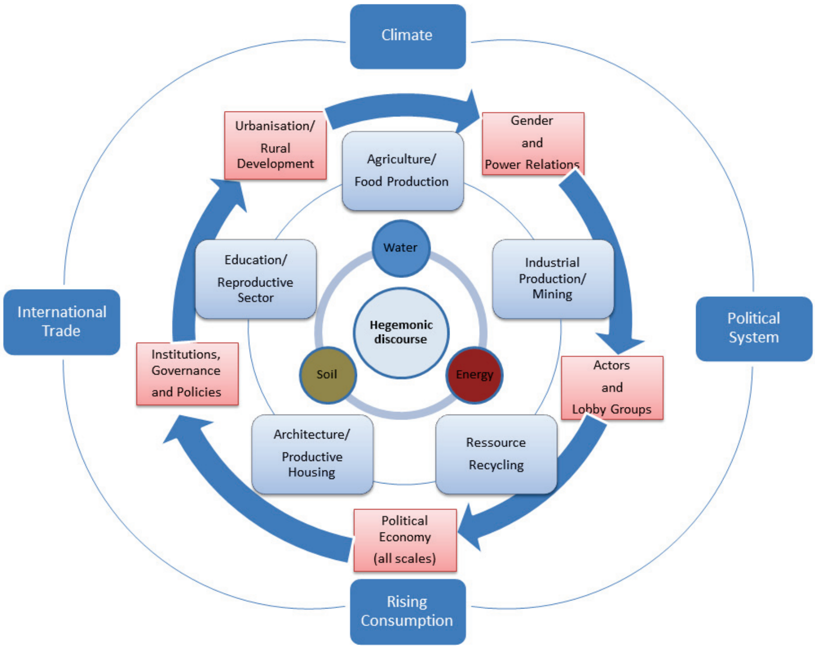

Figure 14: Discourse Nexus (Schaldach 2015, p. 707)

The Nexus visualises discourses impacting directly or indirectly resource cycles with the inner-middle spheres buffering or increasing the impacts depending on the regulative framework. The outer spheres impact the inner ones and vice versa. This framework can be used to concentrate on specific discourses, without losing the bigger picture of other dimensions and is the developed methodology for looking at local impacts and interlinked nexus cases. Inner, outer spheres and dimensions in one orbit impact each other and create synergies. The dimensions which have a stronger or weaker impact depends on the specific context; however, they always play a role and need to be filled with more specific sub-elements, depending on the phenomena at hand. Each dimension is seen as a discourse on the specific subject and the outcome of these struggles influence the others. This is mainly captured by the centre point: hegemonic discourse.

Three differentiated spheres form this nexus. It is similar to the nexus presented by the *Encyclopaedia of Agriculture, Food and Biological Engineering*, but with a stronger emphasis on the local nexus-influencing factors. The inner sphere of our nexus diagram comprises water, soil and energy. The inner arrows emphasise the interconnectedness of the three nexus elements and the two outer spheres represent the framework in which this interconnectedness takes place. The main difference with regard to the previous nexus approaches is that food will be displayed in the second sphere, as an outcome of discourses on the management of the main resources. At this point, air also plays a role, however, it is left out here in order to simplify the framework. The second sphere includes discourses, which have a direct impact on discourses related to the inner sphere resource distribution. In such cases, agriculture (food production), governance and policies like land rights or environmental regulations, local economy, and forms of resource recycling have a strong influence on discourses impacting directly water, energy, and soil resources. The elements of the second sphere are at the same time framing conditions and influencing factors that directly affect the balance between the different inner nexus elements. The outer sphere comprises the macro framework, with elements like the economic system, rising consumption patterns, international trade or the climate. These elements are also an outcome of former hegemonic struggles and shaped by anthropogenic activities, however, these elements are shaped on long-term time scale.

The main purpose is to visualise that, by affecting one resource cycle, another one is impacted, too, with all its further interconnected dimensions. For example, a different kind of energy carrier usage, due to certain policies driven by agents (like coal or wind) have a different impact on all resource cycles and interconnected discourses on all scales, as there is local impact at several geographical points at the same time and also future points of time.

3 The Physical and Virtual Journey of Water

Global freshwater consumption rose six fold between 1900 and 1995 – more than twice the rate of population growth. About one third of the world's population already lives in countries considered to be 'water stressed' - that is, where consumption exceeds 10 % of total supply. If present trends continue, two out of every three people on Earth will live in that condition by 2025.

Kofi Annan in We the Peoples (2000, p. 60)

Earth is covered with over 70 % water and fresh water is considered a renewable resource. However, water is not a renewable resource if exploited too fast, or if the contamination becomes too severe.

The current exploitation rates are linked to human needs, but not to the replenishing speeds of water bodies.

> *We'd like to believe there's an infinite supply of fresh water on the planet, and many of us have used water as if it would never run out. But the assumption is tragically false. Available Fresh Water amounts to less than one-half of all the water on the earth. The rest is sea water, frozen in the polar ice, or water stored in the ground that is inaccessible to us (Barlow & Clarke 2002, p. 5).*

Barlow and Clarke's analysis (2002) of the world water situation can be criticised from a technocratic viewpoint, claiming that desalination plants, wastewater treatment, piping water over major distances and transporting icebergs can easily fix the situation. However, already in 2000, Kofi Annan warned about water scarcity and his speech was a marking point to put water on top of the international political agenda with the Millennium Development Goals (MDGs). Even though some goals, especially the sanitation goal, were not met in 2015 and often led to results for major parts of the global population (Satterthwaite 2016). Research efforts increased in the water sector worldwide and ample research funding put water into focus. However, underground flows and storage capacities of aquifers are still one of the major research gaps. This work, therefore, has to refer to a highly estimated data based on research in some regions with a far too low amount of data entry points.

In September 2015, the MDGs reappeared in a new shape and the Sustainable Development Goals (SDGs) set new targets, with the plan to attain these new goals by 2030. The sixth goal (Figure 15) has been water, with the far-reaching target to (UN Water 2015): 'Ensure availability and sustainable management of water

Figure 15: SDG Goal 6: Water and Sanitation: the pathway to a sustainable future (UN Water 2015a)

and sanitation for all'. The Council of the Canadians, which is one of the world wide leading social action organisations, especially, on the right to water, celebrated the launch of these goals as a win (Patterson 2015). This has been mainly due to the inclusion of Paragraph 7, where The United Nations' member states pledged: 'A world where we reaffirm our commitments regarding the human right to safe drinking water and sanitation' (UN General Assembly 2015, p. 35). Maude Barlow, one of the authors of *Blue Gold*, is one of the council's representatives and along with activists all over the world, she advocated for the inclusion of the right to water, she was also the Senior Advisor on Water to the 63rd President of the United Nations General Assembly in 2008/2009. However, the Council of the Canadians criticised observing:

> *... we are troubled by the lack of clarity regarding the role of the private sector and the call in SDG 7 to expand 'modern energy'. Investments in 'modern energy' through this agenda would threaten global efforts to stop the spread of hydraulic fracturing and big dam development projects that have been detrimental to watersheds (The Council of Canadians 2015).*

The 6.4 target on water efficiency includes the rising energy demands, as one of the biggest challenges, which refers directly to SDG 7 on affordable and clean energy already criticised the Council of Canadians.

3.1 World Water Resource Distribution

The question 'Where is our water?' seems rather simple, however, water is not just changing its form from liquid, gas to solid (ice), it also travels through the hydrosphere within or from one storage system to another. This also makes it rather difficult to estimate the actual available quantities, as the hydrosphere system is highly interconnected and especially underground storage systems are still under exploration.

3.1.1 World Water Resources

The planet's ever-changing hydrosphere includes all types of natural storage capacities:

- Oceans and seas
- Glaciers, ice sheets and underground ice
- Surface water – lakes and rivers
- Groundwater (especially aquifers)
- Wetlands, soil, organisms and the atmosphere

Owing to the anthropogenic influence, several constructed water storage capacities, water transport systems, flood prevention measures and rainwater harvesting systems have been implemented. As more and more water has been stored and channelled, there has been an impact of its own, especially reflected in the discourse on flood prevention and on not channelling water streams (Li, Lu & Chen 2007; Morelli et al. 2012). Some examples for constructed water storage systems are (Johnston & McCartney 2010):

- Channels
- Dams (reservoir basins)
- Retention basins
- Constructed wetlands
- Water tanks
- Cisterns
- Water towers

In the following paragraphs, a more detailed list of the different storage systems will be presented.

Oceans

The world's oceans hold a major part of the total volume of water on this planet (see Table 3); however, seawater is non-potable, due to its high salinity. Desalination of seawater is possible, but it is a high energy resource intensive process and environmentally questionable (Arconada, Delgado & Garcia 2013; Raventos, Macpherson & Garcia-Rubies 2006; Roberts, Johnston & Knott 2010; Younos 2005), especially due to the high concentrated brine outflow.

Table 3: Water volumes in the world ocean (eds Shiklomanov & Rodda 2004, p. 2)

Ocean	Water volume in 10^6 km^3	Water volume in %
Pacific	707.1	53.4
Atlantic	330.1	24.6
Indian	284.6	21.0
Arctic	16.7	1.0

The discourse on the consequences and high energy consumptions is more and more at the centre of attention as more and more desalination plants are in several areas of the world the only solution for a sufficient drinking water supply of cities. In Australia, with in 2016, nearly every city has been connected with or in the process of building a desalination plant (IWA 2016; ed. Prosser 2011). Such development have major energy and water implications, especially, if the energy for the desalination plants is generated through energy carriers with a high water footprint. Consequently, seawater is one of least easily accessible resources for human usage, however, the biggest one.

Glaciers and ice sheets

Most of the freshwater on this planet is stored in the form of glaciers and ice sheets, estimating a total coverage area of around 16.2 million km^2. The mean thickness of the ice is 1 700 m, however, in Antarctica, the thickness can be over 4 000 m (eds Shiklomanov & Rodda 2004). While 90% of the glaciers are concentrated in and around Antarctica, 10 % are in the Arctic, or more specifically, in Greenland (Table 4).

Table 4: Global glaciers and ice sheets distribution (eds Shiklomanov & Rodda 2004, p. 14)

Region	Area of glaciers in km^2	Water volume in km^3
Arctic	2 028 490	2 423 500
Europe	21 415	4 090
Asia	109 085	15 630
North America	67 522	14 062
South America	25 000	6 750
Oceania	1 014.5	107
Africa	22.5	3
Antarctica	13 980 000	21 600 000

The status of glaciers represents a significant indicators of the world climatic and hydrological status.

Underground ice

Northeast Europe, Northeast Asia, including the Arctic islands, higher parts of South America and 80 % of Alaska are underlain by permafrost (Osterkamp, Esch & Romanovsky 1998), with the total area of permafrost being around 21 million km^2. The underground ice in ice-rich permafrost occurs primarily on the top 10 - 15 m of permafrost, while the depth of permafrost could range from 400 - 650 m. The water stored in this system cannot be simulated and calculated precisely due to the lack of data and study, but a rough estimation of the water volume is 300

000 km^3, two-thirds of which are in the form of river ice (eds Shiklomanov & Rodda 2004).

Surface water – lakes, rivers and channels

There are 145 large lakes in the world, which contain nearly 95 % of the water volume of all lakes across the globe (Table 5). The total volume of water in river channels is 2 115 km^3 (Table 6).

Table 5: Water volumes in the principal lakes (eds Shiklomanov & Rodda 2004, p. 16)

Continent	Number of lakes	Fresh water volume in km^3	Salt water volume in km^3
Europe	34	2 027	78 000
Asia	43	27 782	3 165
Africa	21	30 000	n/a
North America	30	25 623	19
South America	6	913	2
Australia and Oceania	11	154	174
Total	145	86 500	81 360

Table 6: Water volumes in river channels (eds Shiklomanov & Rodda 2004, p. 16)

Continent	Water volume in km^3
Europe	80
Asia	565
Africa	195
North America	250
South America	1 000
Australia and Oceania	25

Although the water quantity is much smaller than in other systems mentioned before, it is always recharged by groundwater, precipitation or glaciers' ablation. It is one of the most significant water with regard to its accessibility and recharge speed. The geographical position of surface water also played a significant role in the historical development of civilisations, as settlements always started in areas with close access to surface water.

Water stored in wetlands, soil, organisms and the atmosphere

Wetlands across the globe have a total area of around 2.7 million km^2, most of them being located in South America (Table 7). The water volume in wetlands was estimated to be 11 470 km^3, based on the assumption that the mean thickness of the wetland is 4.5 m, and that 95 % of water is contained inside (eds Shiklomanov & Rodda 2004).

Table 7: Global wetlands area (eds Shiklomanov & Rodda 2004, p. 16)

Continent	Wetlands area in 10^3 km^2
Europe and Asia	925
Africa	341
North America	180
South America	1232
Australia and Oceania	4

Water in soils is mainly concentrated within the top 2 m from above and the total volume of the water in soil has been estimated to be around 16 500 km^3 (eds Shiklomanov & Rodda 2004). Biological water, i.e., the water contained in animals and vegetation, was estimated to be 1 120 km^3 in total. The water contained in the atmosphere includes water vapour, water droplets and ice crystals. The total volume of this water was estimated to range from 12 900 -14 000 km^3 due to the different measuring methods (eds Shiklomanov & Rodda 2004).

Groundwater

Groundwater appears nearly everywhere beneath the land surface (Alley, Reilly & Franke 1999) and its distribution is related to the geological structure of the Earth's crust, as well as other factors, such as precipitation, evaporation and particularly infiltration (Table 8). The total volume of crustal groundwater is determined down to the absolute depth of 2 km (eds Shiklomanov & Rodda 2004). Groundwater is a renewable water resource, always recharged through precipitation and losses of water through the surface run-offs, or other surface water systems, such as lakes and wetlands (Alley, Reilly & Franke 1999).

Table 8: Water volumes in crustal groundwater (eds Shiklomanov & Rodda 2004, p. 15)

Continent	Total volume in 10^6 km^3
Europe	1.6
Asia	7.8
Africa	5.5
North America	4.3
South America	3.0
Australia and Oceania	1.2

The planet's water is stored in these different forms, which are more or less accessible and differ significantly in their direct portability.

Most of the 2.5 % potable water is frozen and the more accessible water storage systems, from which society mainly withdraws their water, contain only 0.5 % of the overall hydrosphere (Figure 16). Unfortunately, the more accessible the systems are the smaller is their occurrence and higher their contamination, as in the case of surface water (discussed in more detail in Chapter 3.3).

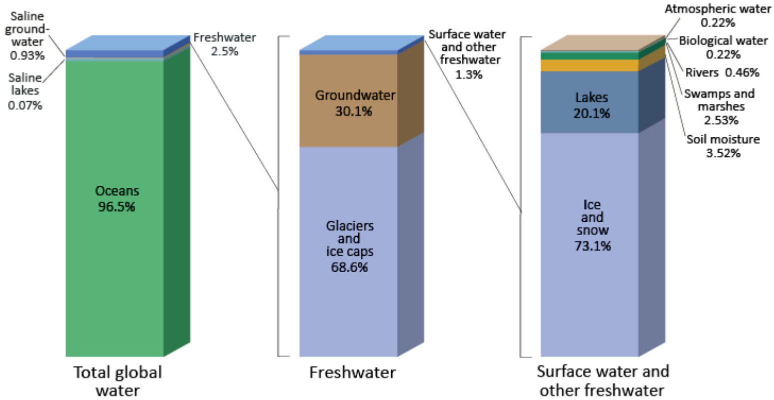

Figure 16: Global water distribution Shiklomanov cited in USGS (2015)

Storage systems can, therefore, be categorised as more or less accessible, depending on the amount of resources, such as desalination plants or pumps, that are needed to access them (Figure 17).

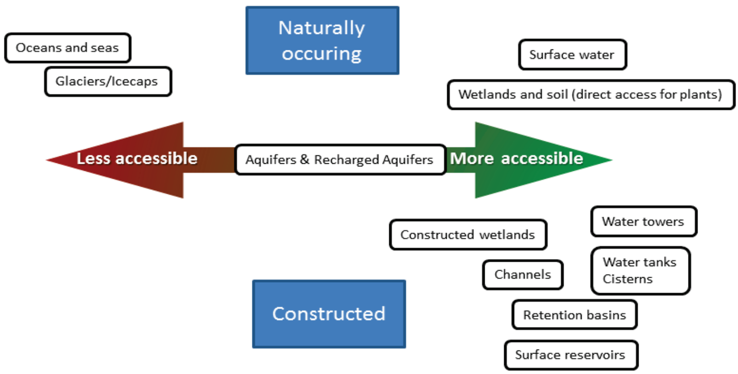

Figure 17: Water storage systems according to accessibility

The more accessible types of water storage systems are also geographically unevenly distributed and, therefore, different regions have major disparities with regard to easily accessible water resources (Figure 18). Due to major differences in a historically developed usage, the contamination of these resources also differs globally (Chapter 3.2).

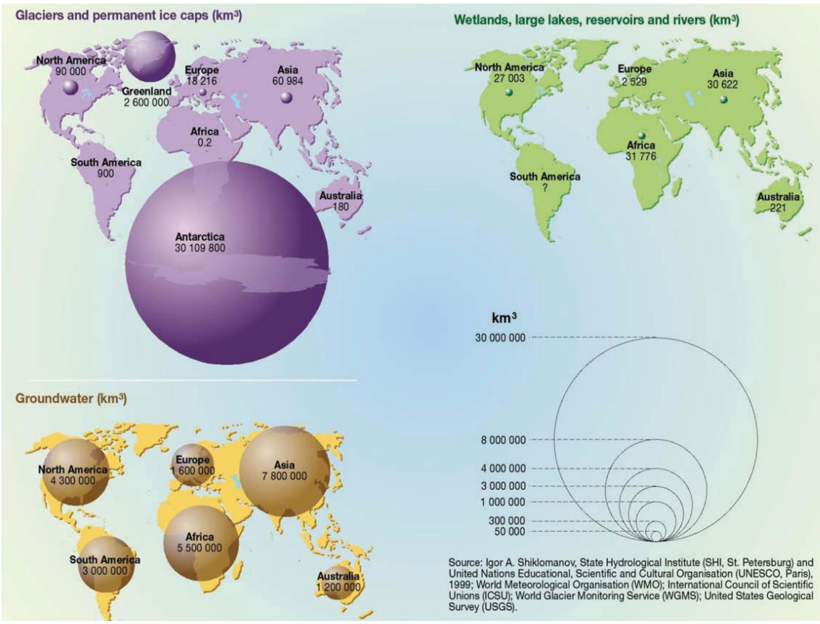

Figure 18: Volume of freshwater resources per continent (UNEP 2008a)

It can be put in a nutshell: even without considering anthropogenic factors influencing the water quality or storage systems at the brink of their collapse, the distribution of easy accessible water storage systems is highly unevenly distributed, leaving some regions at a more vulnerable situation, as others from their endowment even with an excellent water management (e.g., China).

3.1.2 The Hydrological Flux

All these water resources are naturally circulating and are recharged by a constant exchange. Water in the hydrosphere is constantly moving and changing its form, from one system to another. Water evaporates from the surface water reservoirs and enters into the atmosphere as water vapour. Once the temperature cools down, part of this water precipitates back to surface water systems in the form of rain or snow. This water partly returns to the soil, trickles down slowly to fill aquifers or remains as moisture near the surface and can be directly absorbed by plants, however, the majority of the precipitation and evaporation takes place over the oceans (Figure 19).

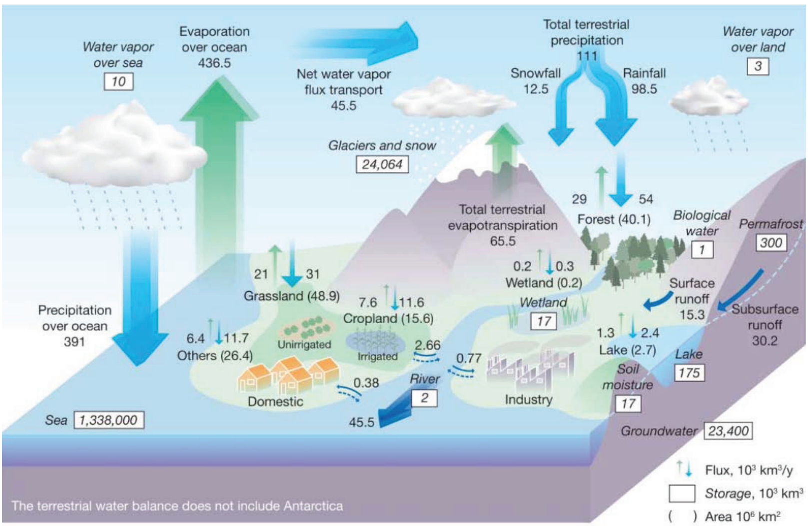

Figure 19: Hydrological fluxes (1 000 km^3/year) and storage (1 000 km^3) with natural anthropogenic cycles are synthesised from various resources (Oki & Kanae 2006, p. 1069)

*Big vertical arrows show total annual precipitation and evaporation over land and sea, including annual precipitation and evaporation in major landscapes presented by small arrows. Parentheses indicate area (10^6 km^2). Groundwater discharge is estimated to be about 10 % of total river discharge.

The hydrological flux shows the close relationship between storage systems. Figure 19 focuses on the surface exchange and the importance of microclimates and geographical surroundings of inhabited areas. However, groundwater and surface water have a close symbiotic relationship and disturbing the system of one or the other has a high impact on both. Surface water replenishes groundwater or vice versa by being pumped up and used for irrigation, domestic or industrial purposes. Then, surface water can again be a source of groundwater recharge. Due to the contaminants that can be carried on this journey, the quality of groundwater can be compromised (Winter et al. 1998).

Therefore, the most accessible resources are mostly the ones which are used and polluted first. Until now, there are only minor projects or plans to use water stored in ice caps or glaciers, for example, those stretching from Newfoundland to the Canary Islands (e.g. Casale & Harmanci 2014), however, due to water contamination, there has been a global trend to shift from surface water to underground water resources for drinking water purposes. How long it takes for the exchange between the different storage systems to take place and how long the water is stored in one form or another in one of the storage systems may significantly differ (Figure 20). Therefore, the replenishing speeds are flexible and residence times differ a lot.

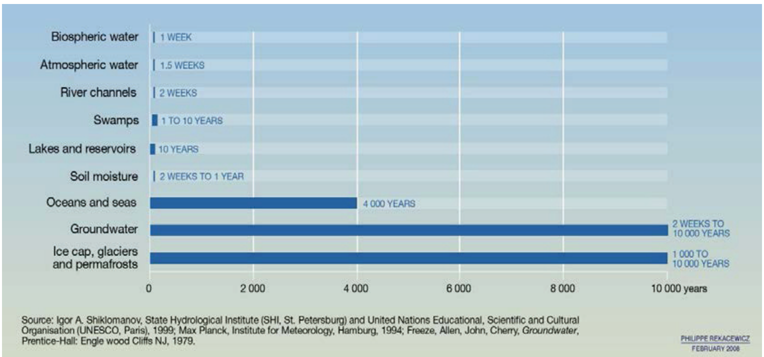

Figure 20: Estimated residence time of water resources (UNEP 2008b)

The knowledge of residence times and replenishing speeds is challenging to gather, but is of utmost importance for managing these water resources. Only when the travelling speed of the water is known, can it be withdrawn in a sustainable way. Surface water is the water source in the cycle that is most susceptible to the effects of direct pollution, but, due to its high recharge rates, it can be distributed quicker. A disadvantage of groundwater reservoirs, therefore, is that, compared to surface water, it is more susceptible to overexploitation, due to intense and fast withdrawal and pollution and its slow recharge pace. Some groundwater resources do not get a recognisable recharge at all, due to desertification and considerably changed climatic conditions in the area. If a water resource is considered to not be replenished and still used, it is called *water mining*. Once the water arrives in a slowly recharging aquifer, it also moves very slowly within the aquifers. Therefore, once a groundwater aquifer has become contaminated, it may take a very long time before the aquifer has become pure enough to be put into use again. Sometimes it is not possible at all, as the technical purification of a contaminated aquifer is a difficult and sometimes impossible task (Patra, Adhikari & Kunar 2016; U.S. EPA 2015).

Another obvious disadvantage of groundwater storage systems is that access is more difficult, as pumping is required. The first access, in terms of drilling, requires resources and, afterwards, often a high energy input to run the pumps. The difficulty to get data on the withdrawal rates makes aquifer management worldwide highly problematic, especially as the exploration is not fully conducted on the theoretical storage volumes. Without knowing how much water can be stored and how much is actually stored, the exact recharge rates and how to quantify the water withdrawn, it is difficult to estimate at which point the system is at risk and the speed at which a particular quantum of water can be withdrawn without risking overexploitation. However, extensive research has been undertaken in the field of life cycle assessment (LCA) to tackle this problem (Bazilian et al. 2011; Mo et al. 2011).

A groundwater storage system can also collapse due to drying out, as the porous layers can get compacted and can lose their water holding capacity (USDA 2008). Overuse and pollution leave their first signs on groundwater resources worldwide:

> *Postel (1999) estimates that groundwater is overused by 200 km^3/year. The most serious over pumping occurs in India, the United States, the Mediterranean countries and China. Such practices are unsustainable and must be changed if irreversible ecological and economic damage is to be avoided. At present, over pumping is practiced in places as varied as Yemen, the Ogallala aquifer in the Texas panhandle, and the Paso del Norte on the US-Mexican border (Schmandt 2005, p. 137).*

Groundwater is highly precious because of the following three reasons:

1. Long underground storage time facilitates high volumes of minerals, an important factor in the human diet to be retained in.
2. Underground storage minimises evaporation rates.
3. The water has to trickle down through several earth layers, which act therefore as a natural filtering system.

These attributes also make it the least resource intensive (and cost effective) method of obtaining usable water, therefore Aquifers are the most precious sources for drinking water supplies.

3.2 The North-South Water Journey

The distribution of water resources is highly uneven from a geographical and geological perspective, but even more so from a socio-spatial one. Industrialisation, urbanisation and the green revolution were some of the main compelling factors for a steep increase during the last century in water withdrawal rates. Consumption patterns of products and water changed over time owing to developments in different parts of the world.

The consumption of products and usage of domestic water per person is also a reflection of the global North-South relationship; however, there are regional disparities in each country as well. In a nutshell, disparities are on all scales, but also as reflected in the average per person water usage of domestic and virtual water, with some countries using more domestic water and importing water-intense goods in their production. It is important to make the distinction between production and product consumption also from a water perspective, as the producing countries have to bear the burdens of over-withdrawal and pollution or to clean up these on the long run. This relationship will be shown in three steps:

1. Driving forces for an increased water demand
2. Global water withdrawal development and distribution
3. The Water Footprint and Virtual Water Trade.

The main point of this chapter is to show that the global North has not only a higher domestic water usage, but also in several cases uses indirectly the water resources of the global South through international trade and contributes to an unsustainable water usage. The water stress and quality data shows that most industrialised countries live through a long-term cycle of growth, industrialisation and cleaning up of environmental mess. These countries developed a water treatment infrastructure, as in Germany, but their water resources have increasingly become less strained by shifting their production towards-less water intense products and importing the remaining. However, countries considered by the UN as developed countries, like the US and Australia, with large agricultural areas and extensive mining operations still strain their water resources to generate products for export (see Chapter 5). This example illustrates, that not just developing countries compromise their water resources for short term gain or energy security, but also countries who would have other exit options. However, the environmental impact is for countries still developing their water treatment infrastructure even more severe in terms of water quality implications through pollutants and not just quantitative over withdrawal. Water quality and qualities are, therefore, objected to constant hegemonic battles globally and the globalisation of water increases interdependencies between countries on food, water and energy security through virtual water trade.

3.2.1 Driving Forces for an Increased Water Demand

Mass-consumption-orientated societies and changes in consumption patterns were the main drivers amongst a population growth to increase demand and, therefore, water usage. In general, the world's population has grown mainly due to better health-care systems, infrastructure and an increasing rate of production. There is a relationship between agriculture and population growth – the simple equation - that more people require more food. However, highly industrialised people demand even more water and food, which makes the number of people less relevant than the shift towards higher consumption patterns.

Biswas & Tortajada (2009) classified the driving forces affecting water availability and use patterns into three main categories:

1. Population and urbanisation,
2. Economic growth and energy generation,
3. Globalisation, free trade, immigration, advances in biotechnology and desalination, diseases like HIV/AIDS, changing management paradigms and evolving social attitudes and perceptions.

One of their main arguments is that the: 'third category of drivers is those which, for the most part, are being completely ignored by mainstream water professionals at present' (Biswas & Tortajada 2009, p. 3). However, in 2015, some of their remarks actually found their way from a scientific discourse, struggles and protest into the SDGs. Especially, changing management paradigms, even made it into the sixth goal's headline by targeting overall sustainable water management.

In the context of their first category of drivers, population and urbanisation, an important point to make here is that population growth will most likely be not the main issue of risking overexploitation of global water resources, but shifts in consumption patterns linked to economic growth are now and will be even more a major driver. The UN developed different scenarios on the expected development of global demographics until 2050. Table 9 shows the distribution by continent, as well as by more and less developed regions and the expected growth as per different scenarios developed by the UN, and according to the UN classifications of more and less developed regions:

Table 9: Population of the world, major development groups and major areas 1950, 1975, 2007, and 2050 according to different variants. (UN 2007, p. 1)

Major area	Population in million			Population in 2050 in million			
	1950	1975	2007	Low	Medium	High	Constant
World	2 535	4 076	6 671	7 792	9 191	10 756	11 858
More developed regions	814	1 048	1 223	1 065	1 245	1 451	1 218
Less developed regions	1 722	3 028	5 448	6 727	7 946	9 306	10 639
Least developed countries	200	358	804	1 496	1 742	2 002	2 794
Other less developed countries	1 521	2 670	4 644	5 231	6 204	7 304	7 845
Africa	224	416	965	1 718	1 998	2 302	3 251
Asia	1 411	2 394	4 030	4 444	5 266	6 189	6 525
Europe	548	676	731	566	664	777	626
Latin America and the Caribbean	168	325	572	641	769	914	939
Northern America	172	243	339	382	445	517	460
Oceania	13	21	34	42	49	56	57

The UN numbers predict that population growth will decrease or only rise a little in developed countries, while population numbers will increase in less developed regions.

There are ample scenarios on future demographics and a large discourse on future developments in general from a gloomy to an ever-growing economy, where technical development can fix environmental implications. The 2015 *Atlas of Globalisation* from LeMonde Diplomatique summarised in 300 pages very well the post growth discourse arguing that a degrowth of the industrialised countries is highly likely (Le Monde Diplomatique & Kolleg Postwachstumsgesellschaften 2015). Other authors like Elmar Altvater (2010) foresee a crash and see land grabbing as a new form of neo imperialism.

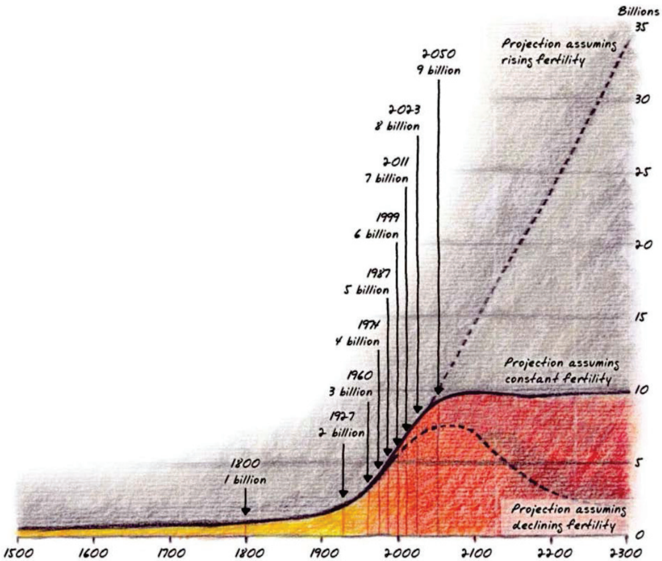

Figure 21: Global population projections (Rekacewicz 2011b)

In Figure 21 different demographical scenarios, based on different views of impacting future demographics, are illustrated, projecting that due to several drivers already in 2050, a decline in global population numbers could be expected. The main driver for a decrease in the total fertility rate[10], among others, is a wider spread of family planning methods and the usage of contraception, which is often an outcome of long lasting feminist struggles for the right of choosing to procreate or not. In several countries, family planning tends to create smaller families, often due to the lower importance of having children as insurance for being cared for in old age or in others due to policies like the one-child policy in China. Another component is the practiced sexism, in form of preferring male descendants over females, especially in India and China. As these countries are two of the most populated ones in the world, these demographic shifts have severe implications in the long run.

In India the discourse on these changing demographics, actually, is the subject of ample hegemonic struggles and the outcome of these struggles on the legal framework have its impact on India's as well as global demographics. The approach in India on the subject is to illegalise the screening of gender and methods of influencing gender before insemination. The Pre-Conception and Pre-Natal Diagnostic Techniques Act (1994), commonly called PC-PNDT Act, makes it illegal to screen the gender of an unborn. The act is the legal outcome of the long-lasting criticism by feminist groups on the wide-spread practice of avoiding female descendants. However, the act is still highly discussed. Women rights groups criticised the act for its lack of implementation (Mascarenhas 2016; Sinha 2016). The outcome of these hegemonic struggles influence demographics and India still has to deal with female to male sex ratios like in China (Figure 22). The female to male sex ratio is showing its sign even more prominently in China, mainly due to the one child policy, on top of years of preferred male children.

10 Total fertility rate is described as the 'total number of children born or likely to be born to a woman in her life time if she were subject to the prevailing rate of age-specific fertility in the population' (WHO 2017).

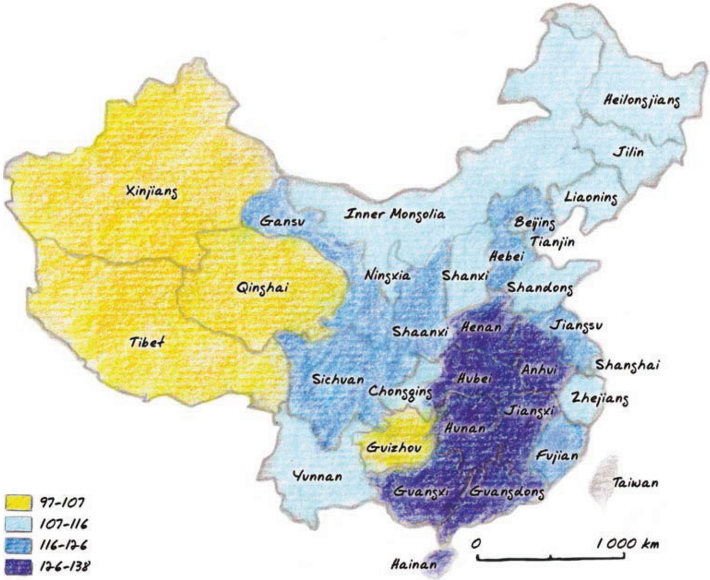

Figure 22: Sex ratio at birth in China in 2001 (Rekacewicz 2011a)

These examples of India and China are taken to demonstrate that demographic developments are part of ample hegemonic battles of interconnected discourses and that gender relations have a severe impact on future developments. The main body of feminist writings on water relations concentrates on the point that power relations are reproduced also through the distribution of resources like water (Ahlers & Zwarteveen 2009; Darling 2012; Delgado & Zwarteveen 2007; Truelove 2011). However, the argument here is, that global demographics are an outcome of hegemonic battles with expected regional differences impacted by feminists' discourses.

Even though it can be expected that demographics will stabilise in future due to ample drivers, major growth rates are expected during the forthcoming years in Africa and Asia. But only eight countries – India, Nigeria, Pakistan, Congo, Ethiopia, the United States, Bangladesh and China (UN 2007) – will probably experience almost half of the expected global population growth during 2005-2050 with the above mentioned shifts in gender ratio. These major population growth rates until 2050 are expected to be concentrated mainly in regions with a developing infrastructure. A big challenge will be to cater for the growing demands for water and wastewater treatment infrastructure. Depending on whether they can be met, and whether these formerly less developed regions demand the same resources and exploit them at the same rate as currently developed regions, it may be difficult to meet these growing water demands, as changes in consumption patterns have a much larger impact. With regard to the world's population consumption shifts and different demands for wastewater treatment, it is important to name certain sub drivers, as not only does the demand for industrial products and food increase in terms of quantity, but also shifts in the kind of products and food demanded take place and cause severe impacts, with certain developments creating more challenges for the treatment of pollutants and contaminations.

Another driver identified by Biswas & Tortajada (2009) is the spread of urbanisation and the growing challenges to meet the demands for energy, water and waste infrastructures. Figure 23 shows the urban and rural population growth of the world.

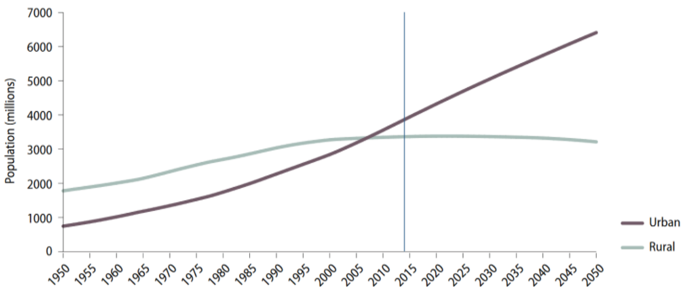

Figure 23: Urban and rural population of the world, 1950–2050 (UN 2014, p. 7)

The UN World Urbanisations Prospects Report (2014) projects that in Asia and Africa (Figure 24), especially, rapid developments of urbanisation are to be expected. Therefore, the expected growth is assumed to be mainly in the growing cities and the density in rural areas will not accelerate that much.

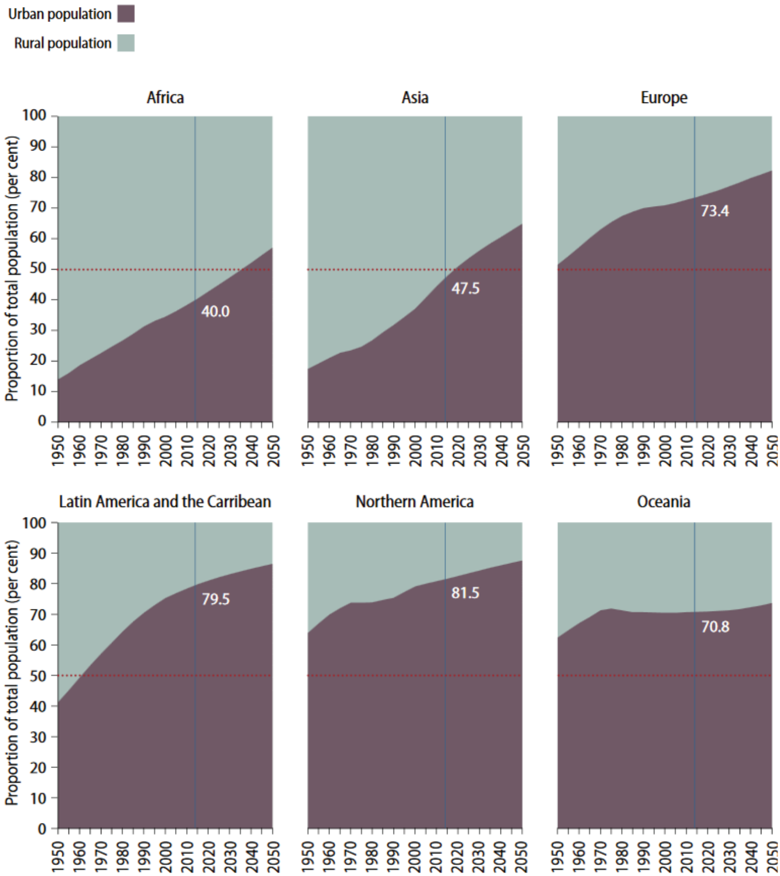

Figure 24: Urban and rural population as proportion of total population, by major areas, 1950-2050 (UN 2014, p. 8)

Figure 24 on the rural and urban developments shows the significant difference in growth rates between Europe on one side and Asia and Africa on the other. This rapid growth gives much less opportunities to develop water infrastructures fast enough. Biswas & Tortajada (2009) argue that from a water perspective, the mega cities, mainly, are in focus with regard to arising water challenges in terms of drinking water supplies and wastewater management; however, the growth rates of smaller urban centres are expected to be even higher. These cities will have significantly more difficult water problems, as their ability to solve them will be even more challenged, due to less financial and political power.

The question of who will provide for this demand kicked off the debate on water privatisation in the late 1980s. As Figure 25 shows there is a decline in privatisation due to battles on water from South Africa to Cochabamba and mainly as the sector did not turn out to be feasible because of the high maintenance costs.

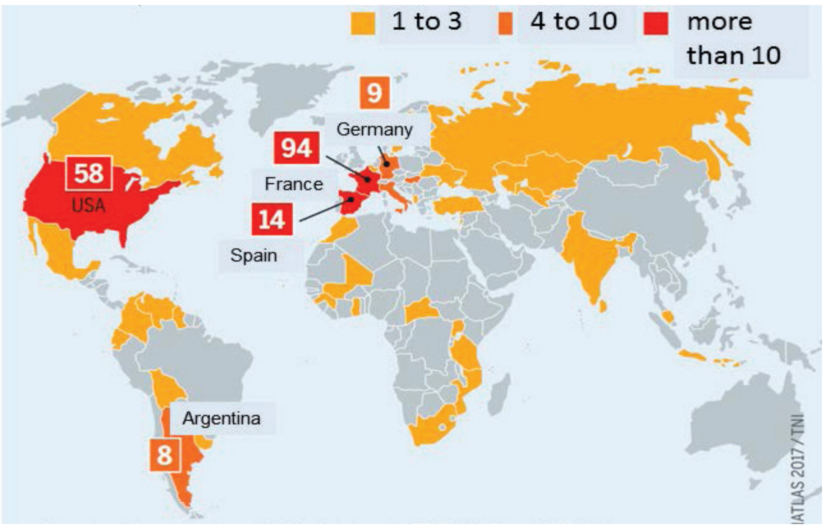

Figure 25: Decrease of Privatisation between 2000-2014 of the communal water supply adapted from Heinrich-Böll-Stiftung, Rosa-Luxemburg-Stiftung, Bund für Umwelt und Naturschutz Deutschland, Oxfam Deutschland, Germanwatch & Le Monde diplomatique (2017, p. 17)

Infrastructural investments were not made causing rise in global rates on spillages and wastage of water resources (Chapter 3.2.2).The development of a better infrastructure and health-care, another driver, should reduce high mortality rates and allow for a higher average life expectancy, as projected in Figure 26.

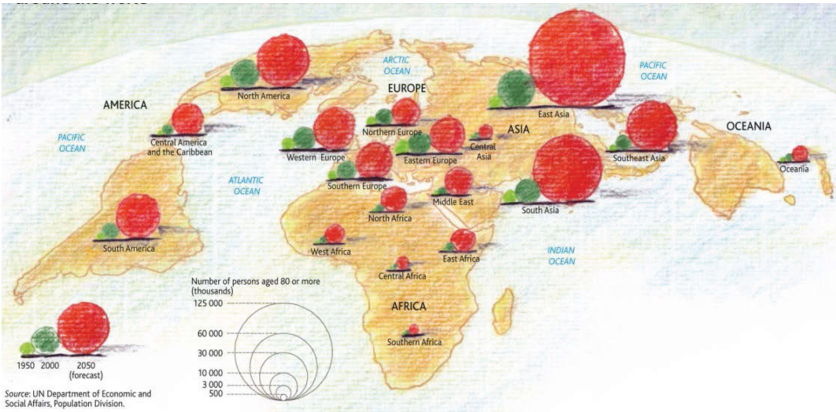

Figure 26: Senior citizens around the world in 1950, 2000 and 2050 (projected) (Rekacewicz 2013)

An aging population creates different water demands and these challenges will become more and more important due to a higher percentage of elderly population. Apart from more people, who will at the same time inhabit the planet, even with decreasing fertility, the major impact of an aging population on the water quality is a higher intake of pharmaceuticals. The implications of higher pollution rates due to pharmaceuticals on water quality issues, in general, will be further discussed in Chapter 3.3. These challenges are hitting developing countries at a much faster rate than countries where the system is already set up to cater for a longer life expectancy.

In terms of a qualitative shift in consumption patterns, it can also be observed that a higher household income often goes along with higher meat consumption, among other goods. Therefore, on a global scale, there is a development of a rising meat consumption connected to economic growth, which has severe impacts on the global livestock production. Livestock is one of the most water intense agricultural products and it can be expected that these shifts will have severe impacts on the global water situation. Currently, the average meat intake per person in the U.S. is 95.4 kg per year, EU-28 68.3 kg, BRICS nations 32.1 kg, while the world average per person consumption is 34.1 kg (OECD 2015). The example of China and India depicted in Figure 27 shows, that shifts in consumption patterns have a much higher impact on the existing diet than a population growth would have.

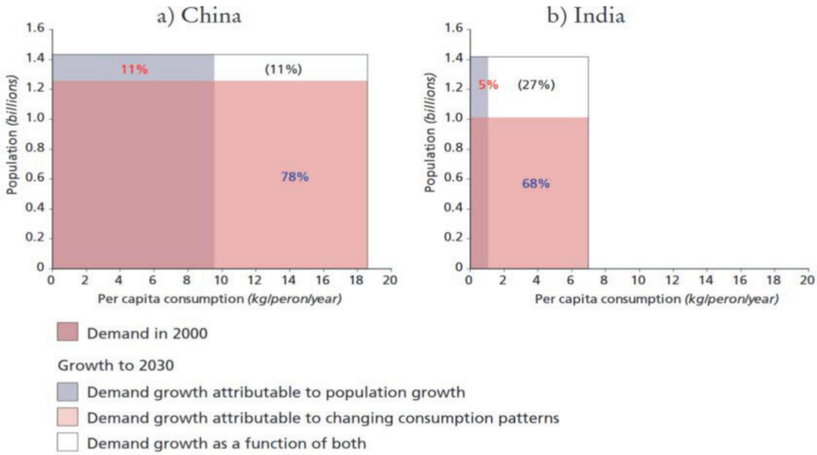

Figure 27: Demand growth for poultry meat in a) China and b) India, 2000 to 2030, disaggregated into that accounted for by population growth, versus that accounted for by changing consumption patterns (FAO 2011, p. 22)

Even though there is a trend in some industrialised countries to shift toward a vegetarian diet, the overall trend indicates a steep rise. These shifts will put enormous pressure on global water resources in terms of food production with much higher water requirements.

The following chapter will focus on the global withdrawal distribution by sector and geography and therefore also on the second dimension: economic growth and energy generation, as the increase in water withdrawal for industrial production and irrigated agriculture also affects energy requirements.

3.2.2 Global Water Withdrawal Development and Distribution

On a global scale, water withdrawal increased due to ample drivers to a different extent by sector and geography. Figure 28 shows these developments of rising water withdrawal and consumption by sector during the last century.

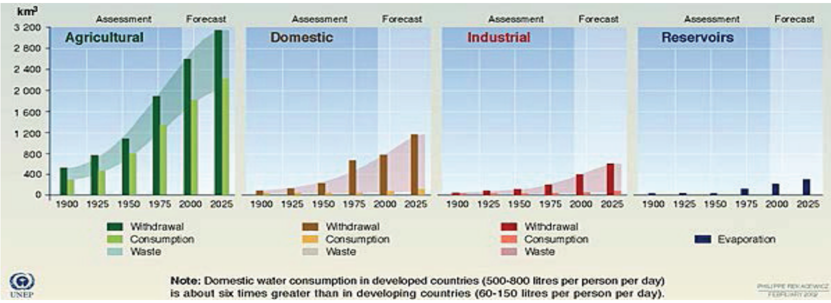

Figure 28: Evolution of global water use: Withdrawal and consumption by sector (Rekacewicz 2005b)

As per withdrawal rates, the main freshwater withdrawal sectors are: agriculture, industry and domestic use. A growing demand for food and domestic water, therefore, is most influential on withdrawal rates. Globally, the withdrawal rates for the use of agricultural, domestic and industrial water increased, especially during the last decades since the 1950s. This increase of withdrawal and consumption rates was reoccurring named *Evolution of Global Water Use* in the literature (Finger, Tamiotti & Allouche 2006; UNEP 2000). However, this gives a misleading picture of a determined link between evolution, development and increasing water withdrawal rates.

The sector of domestic water shows its widest gap (Figure 28) between the withdrawal of water and its consumption; – this gap illustrates the 'waste', which grows with growing withdrawal numbers and increases in its relevance as a growing number in the overall balance. Such waste is the loss of water between direct withdrawal and consumption, due to, for example, leaking pipes and non-sustainable usage. The waste mostly summarises water losses in constructions, which could have been avoided. One of the most prominent examples is the losses caused by a lack of maintenance in piping or other components. These numbers often reflect which priority is set on the maintenance of water services. Some of the major reasons are:

- Lack of resources for maintenance on existing facilities even if there are trained personnel. For example, the transformation of political, societal and economic systems in post-Soviet states caused a crash of the existing water treatment and supply systems, which were centralised and state managed (Sehring 2009; UCLG 2014).
- Lack of know-how and human resources. For example, in Viet Nam and other developing countries with GIZ cooperation, World Bank credits were given for the improvement of the water infrastructure and wastewater treatment plants were built. However, there was a lack of knowledge and trained personnel to maintain these new facilities. Several plants broke down after a short time, as the German engineers left after installation. More recent GIZ programmes in Vietnam include the training of the personnel (Henschel 2012, interview by R Schaldach, 20 March).
- Lack of infrastructural investments, even if the resources and the trained personnel are in place. For example, deterioration of British water services after privatisation (Cohen 2013; Graham 2014), exclusion of poor popula-

tion after privatisation and subsequent cholera outbreaks in South Africa (Marsden 2003; Megaloudi 2013; Tibbett 2004).

That the water infrastructure is not maintained well, therefore, is not always due to a lack of capital. The development of a water infrastructure does not mean that it provides its services on the long run as these examples showed.

Rising evaporation and increasing waste rates are significant indicators for a challenged water infrastructure battling with steep rising demands. With higher withdrawal rates and less easily accessible drinking water supplies, reservoirs became more and more important as storage systems. Even though underground storage is possible, major water resources still get stored in surface reservoirs worldwide, which are vulnerable to high evaporation rates, depending on the climate. As the freshwater withdrawal map by sector (Figure 29) shows, the global North mainly withdraws water for industrial and domestic purposes and the South mainly for agricultural production purposes. The industrial sector is the third largest user of water and continues to increase its consumption, especially the percentage of wastage (Figure 28), mainly in the Northern Hemisphere. Industrialisation relies on water, which highlights the importance of access to water resources for industrialised countries and for the industrial development of non-industrialised countries. The heaviest users of the second most water intensive sector are Germany and Finland,

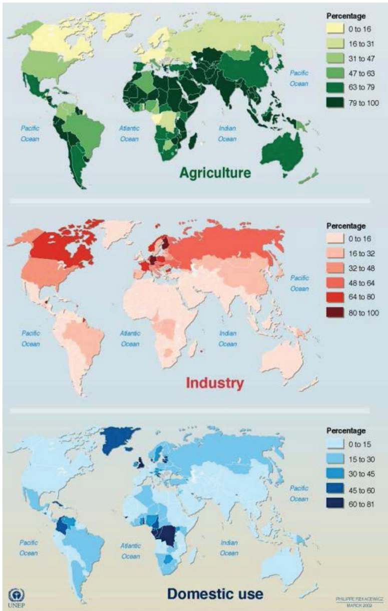

Figure 29: Freshwater withdrawal in agriculture, industry and domestic use (UNEP/GRID-Arendal 2005b)

followed by other industrialised countries of the Northern Hemisphere. The more industrialised a population is, the greater its demand for a domestic water supply (see in the note of Figure 28, which shows that developed countries consume six times more water). That increasing withdrawal rates for water are actually embedded in a much more complex nexus, rather than just a rise in population numbers, is part of the early nexus discourse.

There are ample drivers, which influence withdrawal rates: consumption patterns, but also evaporation rates and the degree of waste, in terms of this graph, locally and globally. However, all add up to increased withdrawal rates. Locally, vastly diverse developments took place, shaped through a history of struggles, wars, colonialization, industrialisation, causing highly diverse capital endowments, apart from the geographical preconditions of the land, which is also reflected in high disparities in the ability to consume products – therefore, also water. This has a severe impact on the distribution of water consumption patterns, which is only to a certain extent related to demographics.

The following map (Figure 30) on global water withdrawal and consumption shows this gap a bit more precisely (by continent). The Americas stand as an example of a North-South comparison of regional water withdrawal rates related to the population of an industrialised and developing area. The withdrawal rates of North America are several times higher than those in the South, however, the population of South America (with Caribbean 523 million in 2000) is nearly double the population of the more developed North (315 million in 2000) (UN 2007).

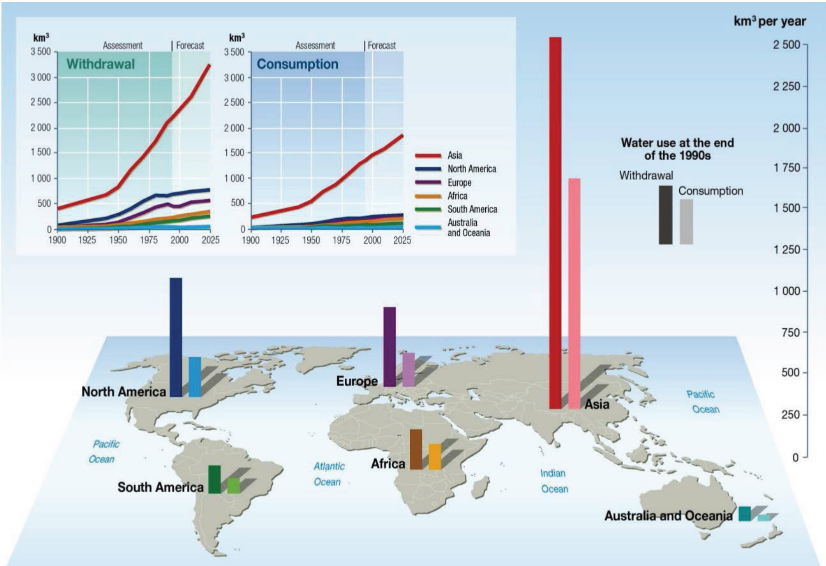

Figure 30: Global Water Withdrawal and Consumption (Rekacewicz 2009)

In summary, there are major water losses in the world and water gets mainly withdrawn in the global South for agricultural purposes and in the North for domestic and industrial purposes.

3.2.3 The Water Footprint and Virtual Water Trade

The withdrawal rates of different sectors with their geographical distribution showed that the production, especially of agricultural products, needs extensive amounts of water, impacting the water systems. However, these numbers only refer to estimates of surface and groundwater withdrawal. The impacts on water quality are not reflected and the withdrawal rates by continent in Chapter 3.2.2 do not consider how much of the withdrawn water is taken for the production of the domestic or international market. The virtual water concept will now be demonstrated in more detail and applied to show international water flows through virtual water trade.

Therefore, the first major difference to early approaches, like Allan's embedded water (Chapter 1 and 2), is to see it not just through the lens of withdrawal rates, but to understand the paradigm change, analyse water consumption including pollution in the form of a footprint that each production process, and therefore, product, leaves behind. Hoekstra et al. (2011) defined and differentiated the water footprints (Figure 31).

blue water footprint refers to consumption* of blue water resources

- surface
- Groundwater

green water footprint refers to consumption* of green water resources

- Rainwater, insofar as it does not become run-off

grey water footprint refers to pollution and is defined as:
the volume of freshwater that is required to assimilate the load of pollutants given natural background concentrations and existing ambient water quality standards.

* 'Consumption' refers to loss of water from the available ground-surface water body in a catchment area. Losses occur when water evaporates, returns to another catchment area or the sea or is incorporated into a product.

Figure 31: Water footprints adapted from Hoekstra et al. (2011, p. 2)

Agriculture taken place in fitting climatic conditions, where irrigation is not necessary has a large green water footprint, but low blue water footprint. Another example is the comparison of conventional and organic farming methods, as even if same water quantities are used for irrigation, the grey water footprint would differ severely, as no pesticides or mineral fertilisers are used. However, the grey water footprint in this concept can also be criticised, as it gives a misleading impression that pollution can assimilate in water bodies. Quite the opposite is the case, as pollutants accumulate. To put it more simply, just because a pollutant is thrown into a swimming pool instead of a bucket, it does not mean it will disappear. Thresholds on pollutants unfortunately, are still based on this false assumption that the solution to pollution is dilution (Cohen 2002). However, more and more attention is brought to the accumulation of micro-pollutants in water bodies close to the outflow of wastewater treatment plants (Choubert et al. 2011; Luo et al. 2014; Margot et al. 2015). If a low amount of pollutants under the allowed threshold is thrown again and again into a swimming pool, more and more pollutants would accumulate. However, even though the grey water footprint does not consider these effects, it is a good visualisation: it has to be considered that the effects of the grey water footprint can be increasingly severe, also depending on which kind of pollutants are used.

As already mentioned, another dimension came into this concept and Hoekstra classified the water footprint also in a direct and indirect water footprint. The direct water footprint is in the country or region of production and the indirect water footprint is in the country or region of consumption.

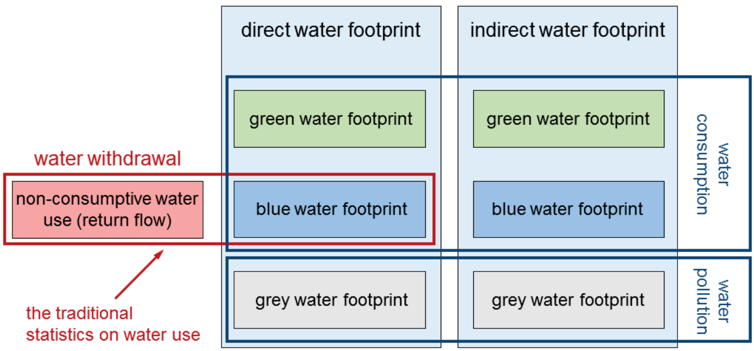

Figure 32: Direct and indirect water footprint adapted from Hoekstra et al. (2011, p. 2)

Figure 32 also shows that the section of the footprint expressed through withdrawal rates used in Chapter 3.2.2, is part of the direct water footprint.

Direct water footprint

The direct water footprint of a product can differ a lot. For example, 2 400 litre of water is needed to make a hamburger, in which the meat accounts for most of the water in the production process. The main influencing factor is the type of fodder given to the animals, as well as how and where this fodder was produced. Two extreme examples would be:

1. The whole production process takes place in Saudi Arabia and water from desalination plants is used for irrigation.
2. The fodder and cow come from rain-fed organic agriculture (Hoekstra et al. 2011).

The water footprint project developed a very user-friendly database, where it is easy to look up the water footprint of specific agricultural products at: waterfootprint.org. However, this database mainly concentrates on agricultural products and there is still a major lack of data on industrial, especially, mining data. Additionally, several water footprint articles were published to build up more data also on energy carriers (Gerbens-Leenes, Hoekstra & van der Meer 2009; Mekonnen, Gerbens-Leenes & Hoekstra 2015; Water footprint Network n.d.), yet even less is available on the direct water footprint of unconventional energy carriers, like hydraulic fracturing (Scanlon et al. 2016). Articles on energy carriers using the water footprint accumulated on the water footprint of biofuels, especially when the EU debate peaked on the issue of using potential food sources for energy (Berger et al. 2015; Lazarevic & Martin 2016; Pfister & Scherer 2015), summarised by Dominguez-Faus et al. (2009) as a *Drink or drive issue*. A more detailed footprint analysis could allow considering also the greywater footprint of biomass for energy production, as they are produced with conventional farming methods using high amounts of fertilisers and pesticides, pressuring the underground water quality. The following table

(Table 10) shows a comparative overview of the consumptive water footprint of different energy carriers from the perspective of electricity and heat generation.

Table 10: The consumptive water footprint per unit of electricity output for different energy sources per stage of production adapted from Mekonnen, Gerbens-Leenes & Hoekstra (2015, p. 290)

Energy source	Total consumptive water footprint of electricity in m^3TJe^{-1}
Coal	79 - 2 100
Lignite	93 - 1 580
Conventional oil	214 - 1 190
Unconventional oil (oil sand)	419 - 1 340
Unconventional oil (oil shale)	316 - 1 830
Natural gas	76 - 1 240
Shale gas	81 - 1 270
Nuclear	18 - 1 450
Firewood	48 000 - 500 000
Hydropower	300 - 850 000
Concentrated solar power	118 - 2 180
Photovoltaics	6.4 - 303
Wind	0.2 - 12
Geothermal	7.3 - 759

In the assessment of the consumptive water footprint of electricity and heat from firewood and hydropower, country-specific estimates are used, or regional estimates in the absence of country-specific data. For hydropower, the lowest value shown between brackets is for China; the largest value is for Africa.

This data is mainly based on the blue water footprint, except for the biomass production, and does not consider the grey water footprint. Table 10 shows that especially biomass has a very large water footprint and that wind and solar energy have a comparatively very low footprint. The following map (Figure 33) shows the global distribution and also makes visible how severely African water resources are strained by the practice mainly using firewood.

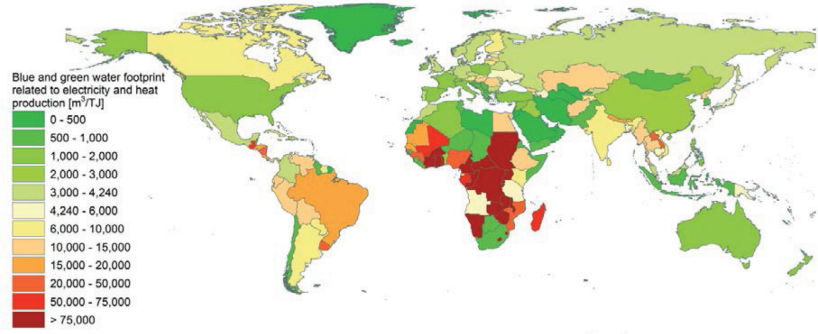

Figure 33: The average consumptive WF related to electricity and heat production, per unit of energy ($m^3TJ_e^{-1}$), per country for the period 2008-2012. Countries with some shades of green have a WF below the global average (4 241 $m^3TJ_e^{-1}$) while countries shaded yellow or red have a WF above the global average (Mekonnen, Gerbens-Leenes & Hoekstra 2015, p. 291)

At this point it is important, when looking at this data, that the grey water footprint is not considered and especially the grey water footprint of different energy sources is at the centre of attention, for example, in the discourse on hydraulic fracturing discussed and analysed in more detail in Chapter 5.

Indirect Water Footprint and Virtual Water Trade

Even though the data situation of specific products, like gas, is difficult to generate, especially the grey water footprint data, direct footprint can be used to show international trends on the impact international trade has on water resources.

Indirect water footprint refers to the water footprint of traded goods, consisting of all three components (green, blue and green water, see Figure 32). The import of products includes, therefore, an indirect water footprint. This indirect import and export of water is also called global virtual water trade, where actual water does not gets traded but its use as a product input by the country exporting the product or its non-usage by consuming country is indicated. As international trade increased during the last decades, virtual water trade augmented too (Figure 34).

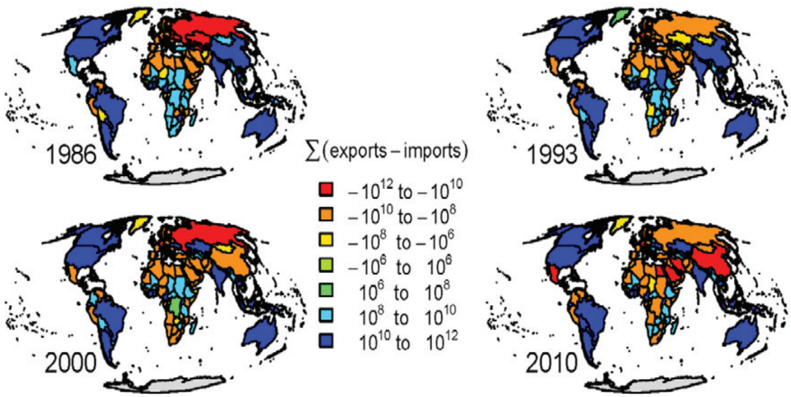

Figure 34: The virtual water import-export balance in m^3 for the years 1986, 1993, 2000 and 2010 (Carr et al. 2013, p. 2)

Carr et al. (2013) calculated that the overall trade of virtual water more than doubled in a timeframe of around 15 years until 2010. The ratio of importing (red and orange) and exporting (blue to green shades) countries also shifted from 127 to 149 importers and from 104 to 72 exporters. Therefore, virtual water trade increased, and more pressure is put on the water bodies of these net exporting countries.

Figure 35 gives a more detailed picture of virtual water trades based on data during the period 1996-2005. Here, the dark green countries are the biggest exporters and the red areas are the net importers. The bigger the arrows, the more virtual water is traded between these countries, however, when there is no arrow, the imports consist of multiple sources.

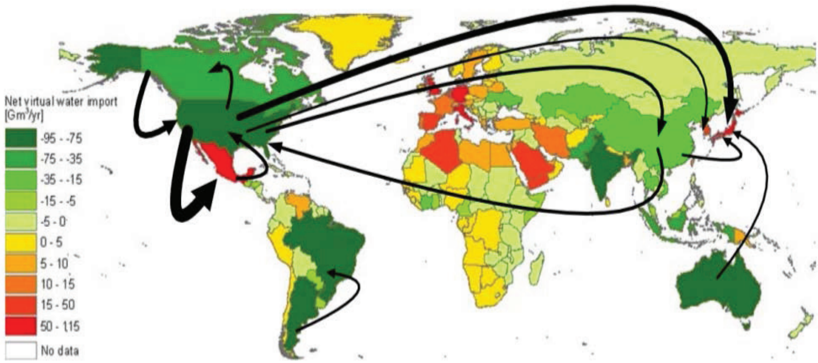

Figure 35: Virtual water balance per country and direction of gross virtual water flows related to trade in agricultural and industrial products over the period 1996-2005. Only the biggest gross flows (>15 Gm^3/yr) are shown; the fatter the arrow, the bigger the virtual water flow (Mekonnen & Hoekstra 2011, p. 21)

This gives a good indication on the trade relationships on water intense goods and the exact products can be more easily identified as in the case of Japan who imports major food supplies (especially meat) from Australia and the U.S. (WITS n.d.). Figure 35 does not show that some of the exporters are also major importers as only the net balance is shown. It also does not reveal, if these goods were produced with green or blue water, for example, if the agricultural products were produced with irrigation practices or without. Also, there is no indication, if the producing countries have water in abundance or not. However, the figure gives a good overview, whether countries have to rely on imports and indicates, their main suppliers by accessing to the more detailed data.

The internal water footprint refers to goods produced and consumed in one country. The national water footprint of a country is calculated considering the internal and external footprint, therefore, the national water footprint plus the virtual water imports. The following map (Figure 36) shows the total water footprint of countries by consumption.

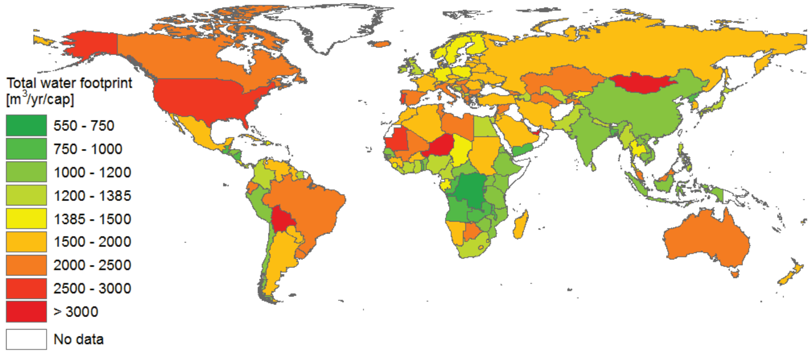

Figure 36: The total water footprint of consumption per country in the period 1996-2005 (m^3/yr per capita). Countries shown in green have a water footprint that is smaller than the global average; countries shown in yellow-red have a water footprint larger than the global average (Mekonnen & Hoekstra 2011, p. 29)

The red areas indicate high and the green areas a low water footprint. In other words, the red areas have a water-intense national consumption or import water-intense products, or both. Therefore, the green areas strain the world's water resources less for their national consumption.

For the impact on water resources are the exports of specific relevance. Table 11 represents the top 25 virtual water importers and exporters in total, but also the net importers and exporters. The U.S. is a specific case and example of being the biggest importers and exporters at the same time. The overview illustrates that the top 25 net exporting countries are dominated by countries with an extensive agricultural production or fast growing newly industrialised economies like China, India or Viet Nam.

Table 11: Top 25 virtual-water flows related to trade in crop, animal and industrial products (Mm^3/yr) for the period 1996-2005 adapted from Mekonnen & Hoekstra (2011)

Rank-ing	Total Import	Total Export	Total net virtual water import	Total net virtual water export
1	USA	USA	Japan	India
2	Japan	China	Mexico	Argentina
3	Germany	India	Italy	USA
4	China	Brazil	Germany	Australia
5	Italy	Argentina	UK	Brazil
6	Mexico	Canada	South Korea	Canada
7	France	Australia	Brunei Darus-salam	Pakistan
8	UK	Indonesia	Spain	Indonesia
9	The Netherlands	France	Trinidad and Tobago	Thailand
10	South Korea	Germany	Belgium	Côte d'Ivoire
11	Spain	Pakistan	Yemen	China
12	Russian Federa-tion	Russian Federa-tion	The Netherlands	Kazakhstan
13	Belgium	Malaysia	Saudi Arabia	Viet Nam
14	Malaysia	The Netherlands	Algeria	Ukraine
15	Canada	Thailand	France	Malaysia
16	Brazil	Italy	Iran	Paraguay
17	Indonesia	Spain	Portugal	Uzbekistan
18	India	Belgium	Libya	Ghana
19	Turkey	Côte d'Ivoire	Bangladesh	Somalia
20	Brunei Darus-salam	Kazakhstan	Egypt	Djibouti
21	Thailand	Viet Nam	Morocco	Cameroon
22	Trinidad and Tobago	Mexico	United Arab Emirates	Uruguay
23	Yemen	Ukraine	Israel	Honduras
24	Saudi Arabia	Turkey	Poland	Guatemala
25	Iran	The Philippines	Switzerland	Hungary

However, water resources get strained, especially locally for production, and so the water footprint related to production is especially interesting as it considers the production for exports (Figure 37).

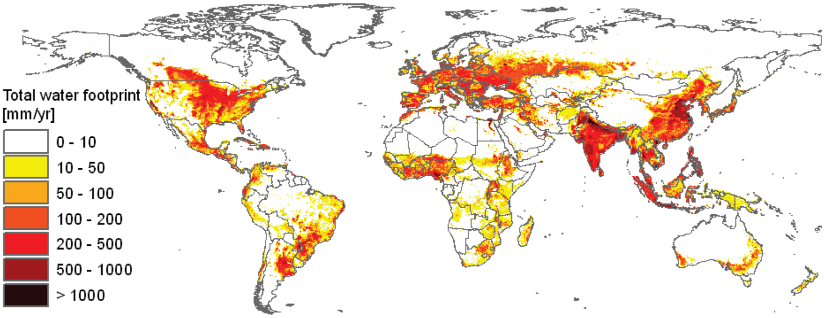

Figure 37: The water footprint of humanity in the period 1996-2005. The data are shown in mm/yr on a 5 by 5 arc minute grid. Data per grid cell have been calculated as the water footprint within a grid cell (m^3/yr) divided by the area of the grid cell (10^3m^2)
(Hoekstra & Mekonnen 2012, p. 3233)

Both maps together illustrate the water footprint for production in India and China is very high (Figure 37), but their national water footprint is low (Figure 36). This means that water resources are highly strained for the export market, even though their national water footprint is low compared to other countries. At this point, some interdependencies should also be named, as later Viet Nam will depict a more detailed example of a case showing the implications of being downstream of a country with a high water footprint for production (Viet Nam – China – Mekong and other rivers) and also having a high water footprint of production of its own.

The water footprint consists of three components and in terms of overexploitation of water bodies and pollution, the grey and blue water footprints are of more relevance than the green water footprint. In the following Figure 38, the blue and grey water footprint will also be shown.

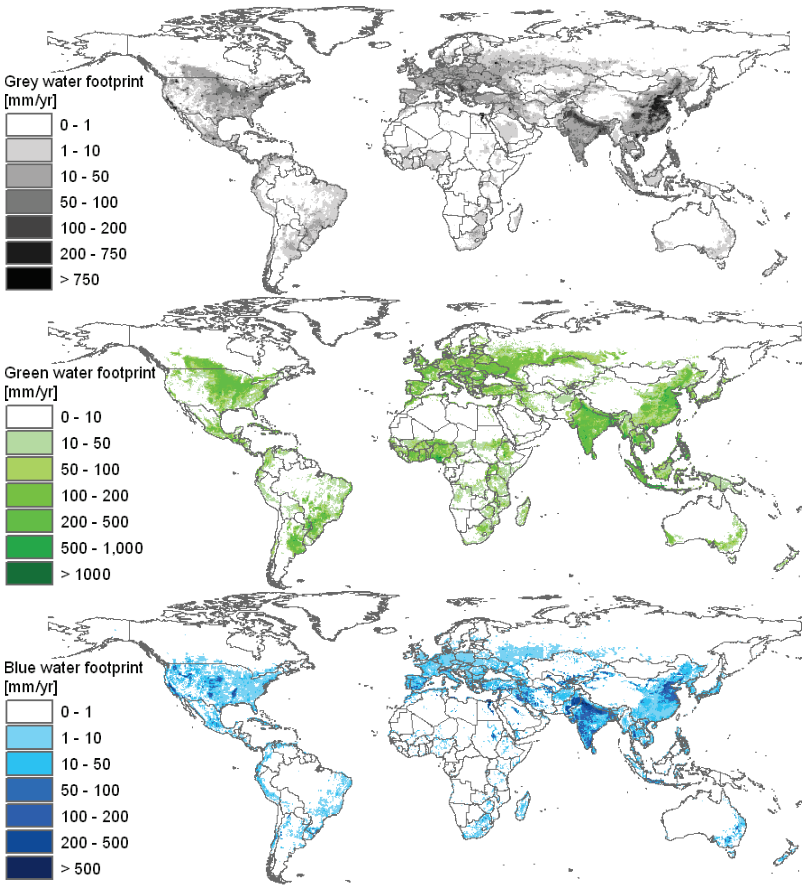

Figure 38: The green, blue and grey water footprints within nations in the period 1996-2005. The data are shown in mm/yr on a 5 by 5 arc minute grid. Data per grid cell have been calculated as the water footprint within a grid cell in m^3/yr divided by the area of the grid cell in 10^3 m^2 (Mekonnen & Hoekstra 2011, p. 18)

As explained with the example of the product water footprint of a hamburger, if a water intense production has a negative environmental impact depends also on the state of the affected water bodies. However, these are in general less affected with a low greywater footprint and as lower the blue water footprint is as lower is the impact on aquifers. This more detailed maps (Figure 38) show that the blue and grey water footprint is more concentrated in certain areas of intensive production. The straining of the blue water is especially of interest in terms of over extraction and mainly due to irrigation in agricultural production.

Table 12 shows the top 25 countries with the highest blue water imports and exports plus an estimate on the internal blue water resources available during the year. Therefore, this illustrates, that using high amounts of blue water for exporting goods does not correlate with a high availability of estimated blue water resources. Extreme cases are marked in red, if over 50 % of the yearly available blue water resources are used for the production of exported goods. Blue water exports in Pakistan and Uzbekistan are mainly related to water intense cotton production (Hoekstra & Chapagain 2008). Another extreme example is Egypt, where the already scarce water resources are being exported at a cost almost four times higher than the replenishment of blue water resources would entail. Egypt generates 12.7 % of its Gross Domestic Product (GDP) from export, most of which are water intense, such as crude oil and petroleum products and textiles (CIA 2017). The same is true for Syria, where, before the start of the civil war and the subsequent international sanctions, oil used to dominate the export market, accounting for as much as 67 % (Trading Economics 2017a). Turkmenistan is the fourth largest exporter of natural gas in the world (Trading Economics 2017b), although natural gas is the least water intensive fuel, the sheer volume of production significantly affects Turkmenistan's scarce water resources.

Table 12: Top 25 virtual-blue water imports and exports related to trade in crop, animal and industrial products (Gm^3/yr) in the period 1996-2005 based on Mekonnen & Hoekstra (2011), internal blue water resources in the period 1988-2014 based on FAO (2016)

	Total Blue Water Import		Total Blue Water Export		
Ranking	Country	Amount	Country	Amount	Internal Blue Water Resources*
1	USA	30.4	USA	39.2	2 818.0
2	Germany	15.8	Pakistan	34.2	55.0
3	Mexico	14.2	India	20.9	1 446.0
4	China	13.9	Australia	16.3	492.0
5	Italy	13.4	Uzbekistan	13.4	16.3
6	Trinidad and Tobago	13.1	China	12.7	2 813.0
7	Japan	11.1	Turkey	11.4	227.0
8	UK	11.0	Spain	9.0	111.2
9	France	10.5	Mexico	8.9	409.0
10	Russian Federation	9.5	France	7.4	200.0
11	South Korea	7.7	Germany	7.4	107.0
12	Turkey	6.7	Italy	7.1	182.5
13	Indonesia	6.1	Egypt	6.8	1.8
14	Papua New Guinea	6.1	Thailand	5.4	224.5
15	Belgium	6.0	Iran	4.7	128.5
16	Spain	5.8	The Netherlands	3.9	11.0
17	The Netherlands	4.7	South Korea	3.8	67.0
18	Canada	4.7	Belgium	3.7	12.0
19	Brunei Darussalam	4.5	South Africa	3.4	44.8
20	Bangladesh	3.2	Russian Federation	3.3	4 312.0
21	Thailand	3.2	Syria	3.3	7.1
22	United Arab Emirates	3.0	Canada	3.2	2 850.0
23	Portugal	2.8	Turkmenistan	3.0	1.4
24	Malaysia	2.8	Tajikistan	2.9	63.5
25	Pakistan	2.8	Greece	2.8	58.0

*By definition 'long-term average annual flow of rivers and recharge of aquifers generated from endogenous precipitation' (FAO 2016) which can be understood as internal blue water resources

The grey water footprint of industrial production is based on very rough estimates (Hoekstra et al. 2011), as data was often not available, which is why for the impact of production on water quality other indicators need to be considered. Virtual water trade data always has to be seen in the context of the water situation in the country of production and in order to analyse the impact of production, the following chapter will also show in detail how the impact can be measured. However, the water footprint can give a good first indication on which industries need to be further analysed.

3.3 Over Extraction and Water Quality – How are the Water Resources and where are they Gone

Water stress and scarcity are becoming a more serious challenge worldwide, which raises the importance of water-rich regions. Aquifers in general will become more important than surface water with regard to the increasing pollution worldwide. The reasons behind an increasing water stress are linked to industrialisation with direct environmental effects – pollution – and the socio-economic structure (mass production and higher consumption) manifested in higher withdrawal rates per person. Apart from the geological circumstances (e.g., Middle East), this is one reason that the more industrialised regions are earlier affected by water stress (USA and Europe). The areas which experience freshwater stress will increase. China, with one-quarter of the world's population and only 6 % of its fresh-water is in one of the worst geo-strategic positions (Barlow & Clarke 2002).

This chapter will show the direct interface between the hydrological flux and water usage, emission rates and the resulting water global water stress.

3.3.1 Hydrological Flux and the Human Factor

Human impact on the hydrological flux is getting more and more severe though ample avenues of usage return flows and other interdependent relationships. According to Armstrong (2009), for the analysis of the hydrological flux four principles[11] need to be considered:

1. Allocation
2. Alteration
3. Landscape
4. Quality.

Figure 39 shows how these principles are according to the UN interlinked with regard to food security.

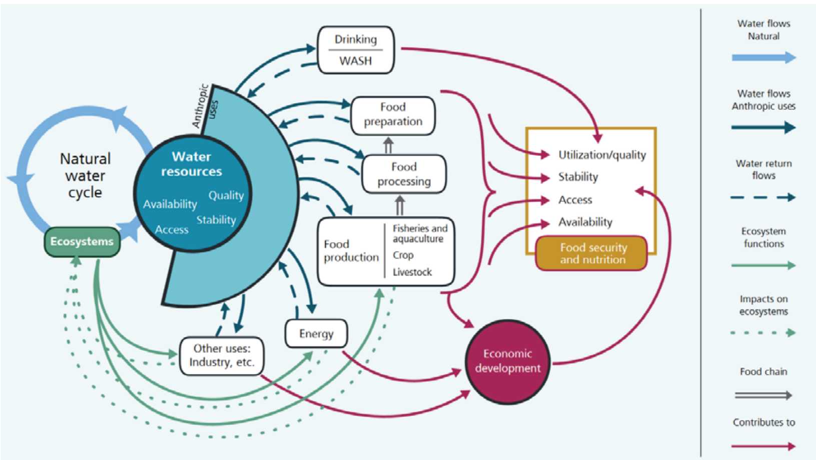

Figure 39: The Multiple Interfaces between Water and Food Security and Nutrition (UN Water 2016, p. 41)

11 'The first principle is that in allocating water, we are effectively allocating life. ... A second principle is that altering the fluxes of water in the landscape affects the functioning of a whole hydro geomorphological system. ... The third principle is that water is in its own right a component of the landscape. ... The fourth principle is that we need to consider not only the quantity but also the quality of the water fluxes in the system.' (Armstrong 2009, pp. 140–1).

This overview shows the exchange of water separated by its usage and the impact on the ecosystem in general and on water resources in regard to four factors:

1. Availability
2. Stability
3. Access
4. Quality.

These components influence and are influenced by water flows (indicated by blue arrows). All four factors have an impact on the first principle of Armstrong (2009): the allocation of life directly through water or indirectly, if there is no sufficient water supply for food production. Water flows are the withdrawal and return flows impacting all four components. There are ample water flows with a certain colour scheme, which is commonly used in the wastewater treatment discourses (Table 13).

Table 13: Types of Water Flows

Water Flow	Definition
Blackwater	'Blackwater is the mixture of urine, faeces and flushwater along with anal cleansing water (if water is used for cleansing) and/or dry cleansing materials. Blackwater contains the pathogens of faeces and the nutrients of urine that are diluted in the flushwater.' (Tilley et al. 2016, p. 10)
Blue water	'Fresh surface and groundwater, in other words, the water in freshwater lakes, rivers and aquifers.' (Hoekstra et al. 2011, p. 187)
Green water	'The precipitation on land that does not run off or recharge the groundwater but is stored in the soil or temporarily stays on top of the soil or vegetation. Eventually, this part of precipitation evaporates or transpires through plants.' (Hoekstra et al. 2011, p. 189)
Greywater	'Greywater is the total volume of water generated from washing food, clothes and dishware, as well as from bathing, but not from toilets. It may contain traces of Excreta (e.g. from washing diapers) and, therefore, also pathogens. Greywater accounts for approximately 65% of the wastewater produced in households with flush toilets.' (Tilley et al. 2016, p. 10)
Yellow water	'Yellow water means urine with or without flush water. Yellow water is collected in urinals and no mix toilets.' (eds Brebbia et al. 2009, p. 997)

In order to analyse the environmental impact, it is important to differentiate between these flows. The question: 'Which water source is used?' refers to these different sources with their specific implications. The following chapters will concentrate mainly on green and blue water usage. The shift from green water towards blue water in food production flows is especially recognisable, if there is a shift towards irrigation. Then, it is relevant in which speed and quantities blue water gets extracted, since if it is not in sync with the recharge speed, water stress occurs (Chapter 3.2). For grey, yellow and black water, it is important to note whether they are treated and to which extent they can provide an addition to the water backflow, without quality and health implications. Furthermore, these flows are now sometimes already treated as a resource rather than waste.

This was a major paradigm shift, which took place in wastewater treatment science, looking at these water flows for a long time as waste and a biohazard, which needs to be taken care of if health risks got too severe. Since the 1980s, the discourse started on nutrient recovery, but it took some time until this shift took place on the international agenda with the 'Bellagio Principles for Sustainable Sanitation', which were endorsed during the 5th Global Forum of the Water Supply and Sanitation Collaborative Council in November 2000 (ed. EAWAG 2000):

1. *Human dignity, quality of life and environmental security* at household level should be at the centre of any sanitation approach.
2. In line with *good governance* principles, decision making should involve participation of all stakeholders, especially the consumers and providers of services.
3. *Waste* should be *considered a resource*, and its management should be holistic and form part of integrated water resources, nutrient flow and waste management processes.

4. The domain in which *environmental sanitation problems* are resolved should be *kept* to the *minimum practicable size* (household, neighbourhood, community, town, district, catchments, city).

One example of a major research network is SuSanA (Sustainable Sanitation Alliance n.d., www.susana.org), which is an initiative based on the Bellagio Principles. Closing the loop is one of the goals and Figure 40 shows the flows in more detail.

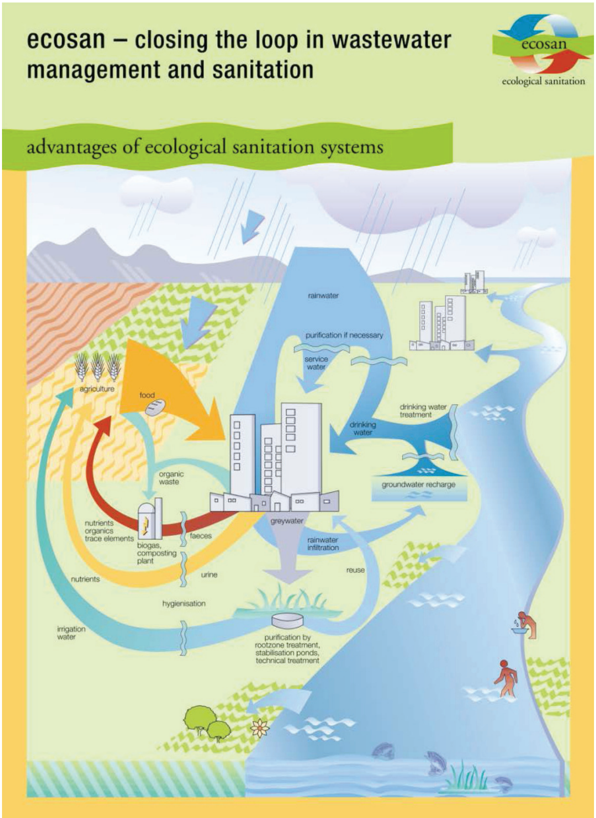

Figure 40: Advantages of Ecosan Systems (GTZ 2003)

Chapter 3.3 will concentrate on the *what* and *where*, as the concept of virtual water trade and water footprinting reflects this component well and it is possible to compare the impact of production in different environments. Factors like water quality are highly linked with the terms of production, therefore it is important to understand 'how' it is connected, especially if the production process is embedded into a proper wastewater treatment infrastructure to reduce the caused pollution and, in an ideal case, to recover nutrients. Historically, treatment plants were implemented as a remedial measure, due to urbanisation and industrialisation, but with growing water scarcity and rising water prices, industries shift more and more towards concepts with embedded recycling systems and smart water saving planning in order to minimise the resource intake for production. However, this mainly takes place in the high-tech sector in developed countries.

Unfortunately, it seems the historical development path was not broken and industrialisation goes at first hand in hand with untreated wastewater, high pollution and severe environmental implications before environmental regulations are set, implemented and the infrastructure is built. This will be further described with the case study in Chapter 4 on the fast growing economy of Viet Nam, where the water treatment infrastructure develops much later than the industrial zones out of pure necessity.

3.3.2 Water Scarcity Indicators

The following subchapter concentrates on water scarcity indicators describing the global situation in relation to availability, stability, quality and access, which are also interlinked. The scientific debate on how to measure if there is enough water is rather vibrant. In order to grasp the global situation from these four angles, different indicators will be introduced and reviewed.

Availability

Water availability indicators have a long history and more sophisticated indicators have been developed during the last decades. The first major paradigm shift was to measure not how much water one human needs, but how much water a water body needs to function in a sustainable way. Therefore, all early indicators operated in the framework of political borders, but this shifted towards an analysis on the basin level. The development of indicators also reflects the development of the forces of globalisation, as the influence of international trade was increasingly considered to be a factor.

Falkenmark & Brouwer (1989) started rather simple, estimating water use per capita (WUPC). They estimated how much water an average person requires and then divided the estimated yearly available blue water quantities with this amount, without considering the quality. There is water scarcity, according to the authors, if there are under 1 700 m^3 per capita per year (around 4 600 litres per capita per day) and defined the sub stages in Table 14.

Table 14: Water barrier differentiation proposed by Falkenmark (1989) cited in Brown & Matlock (2011, p. 1)

Index in m^3 per capita	Category/Condition
>1 700	No Stress
1 000-1 700	Stress
500-1 000	Scarcity
<500	Absolute Scarcity

In the context of emergency situations, the absolute minimum for human survival is estimated, based on an average usage of water for drinking, cooking and personal hygiene in any household, and this amounted to be at least 15 litre per person per day (The Sphere Project 2011, p. 97).

Gleick (1996) developed some years later, based on Falkenmark's idea of a scarcity indicator, the Basic Water Requirements indicator. He estimated that a person needs per day 50 litre of tap water:

- 5 litre drinking water
- 20 litre sanitation facilities
- 15 litre hygiene
- 10 litre preparation of food.

The idea is not to take the estimated available blue water resources per year, like Falkenmark. The indicator shows if it is possible for a country to provide enough tap water for the population. As ample socio-economic factors have a role in facilitating a society with tap drinking water, they are indirectly embedded in this indicator.

Both of these early indicators have four major problems and can provide a skewed picture of the water situation in an area.

1. The water amounts for food and industrial production is not accounted for in either of the indicators. Food production has a major impact, especially if irrigated already for the national food production. In export-oriented countries, the production for the world market has a major role in the exploitation of water resources and is completely left out. Therefore, water resources in the production country get exploited to feed people in other regions of the world or provide them with products.
2. Seasonal and regional differences are not made. A flood and drought at different localities or points of time do not make on average an overall well provided water supply.
3. Raskin, Gleick & Kirshen (1997) criticised that these indicators do not consider the difference in multiple in-stream uses.
4. These indicators do not give a picture of the pollution levels of water bodies in the territory.

These early indicators reflect only partly the water availability of some countries and have worked only on smaller countries, which do not produce many products for export. Especially large countries with a high diversity in climatic and geographical conditions cannot be sufficiently portrayed by these indicators. For example, in Australia, these indicators would give a different picture to the actual, worrisome water situation. Australia is a large, sparsely populated continent. The economy is export oriented and its pillars are agriculture and mining, both water-intense industries. The climatic conditions are diverse and on this continent there are areas in the tropical climate and deserts, affected by droughts and floods. The water infrastructure is highly developed and even when there are water-saving measures in place, there is enough tap water for the population, so according to Gleick's indicator, the Australian water situation would be good.

The availability was also seen in a yearly frame and not if the water body will still hold water in the next years, or if this capacity would get destroyed. Based on these first indicators, the critical ratio of withdrawal was more and more taken into account with indicators like: Water Resource Based Vulnerability (Kulshreshtha 1993), Raskin Indicator (Raskin, Gleick & Kirshen 1997), Withdrawal to Availability Index (WTA), Water Stress Index (WSI) (Pfister et al. 2009), UN-Water Indicator (UN-Water Task Force on Indicators, Monitoring and Reporting 2010), Organisation for Economic Cooperation and Development (OECD) Indicator (OECD Environment Directorate 2004). Raskin's indicator (Raskin, Gleick & Kirshen 1997) set, for example, a ratio of withdrawal in relation to the available source and in his definition there is:

- Withdrawal of more than 20 % of the available water source = water scarcity
- Withdrawal of more than 40 % of the available water source = severe water scarcity

This early critical ratio indicator was the root of several other indicators, working in a similar manner. Therefore, more and more came within the analytical framework.

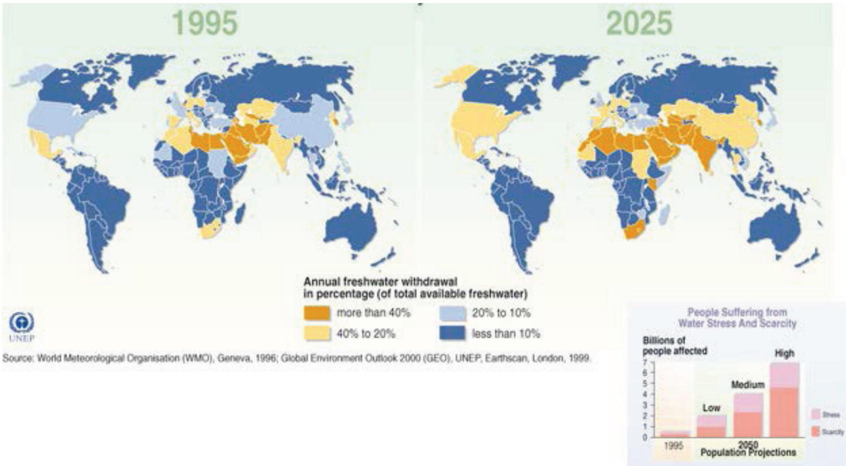

Figure 41: Freshwater Stress (Rekacewicz 2005a)

Figure 41 published by the UNEP shows projected water scarcity using a critical ratio. Mapping water scarcity and projecting bleak future scenarios played actually a major role in shifting the discourse and bringing water higher up on the agenda.

Stability

The research on global water resources accelerated significantly, as water resources appeared more in the public discourse and more water scarcity indicators were developed. Another shift has been recognisable in the development of indicators paying attention to water bodies itself and leaving political borders behind them (Alcamo, Henrichs & Rösch 2000; ed. Guinée 2002; Milà i Canals et al. 2009; Smakhtin, Revenga & Döll 2004a; Smakhtin, Revenga & Döll 2004b). Political borders were still used in the ample critical ratio indicators, which are close to a next set of indicators taking the environmental water requirements into account. Therefore, a stable supply of water can only be reached if the water resource is not overexploited and the water bodies run dry, with later indicators also considering the weather extremes throughout the year.

The following map (Figure 42) shows an often used map based on Alcamo, Flörke & Märker (2007) and presents that a perspective based on national data compared to basin data provides a very different picture of the world.

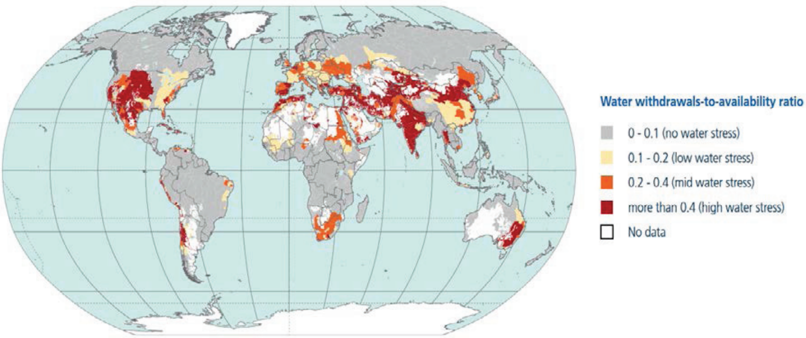

Figure 42: Annual average water stress based on the withdrawals-to-availability ratio (1981-2010) (UN Water 2016, p. 17)

Note: Baseline water stress measures the ratio of total annual water withdrawals to total available annual renewable supply, accounting for upstream consumptive use. Higher values indicate more competition among users.

Since this shift appeared, the term *water hot spots* in the public discourse define areas with local water scarcity. The earlier mentioned Australia case can again here be a good case to show the differences, as the freshwater stress map (Figure 41) based on national data shows Australia in blue, without any freshwater stress, and the map based on Alcamo's basin based indicator (Figure 42) shows severe water stress in South-Eastern Australia, as the Murray-Darling Basin is one of the most stressed basins in the world.

All indicators mentioned earlier, do not consider the yearly weather extremes, which is more and more relevant, as a drought and a flood can significantly influence average water data, even though it is not a reflection of the reality. In many cases, these extremes are even worse, as they create ample additional problems. Sadoff et al. (2015) created the index of frequency of shortages of water availability for use on a month-to-month basis and created a map (Figure 43) based on basin data:

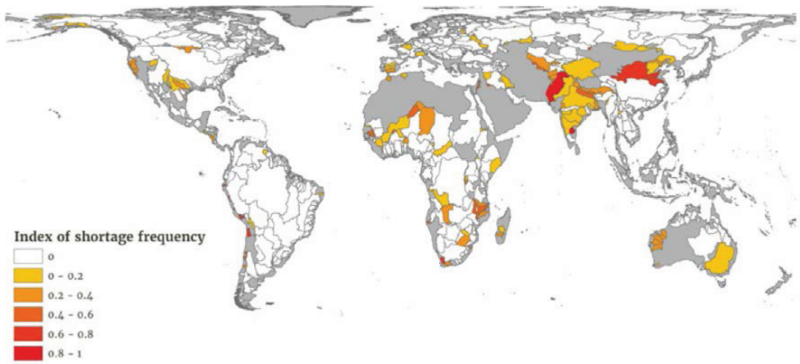

Figure 43: Index of frequency of shortages of water available for use on a month-to-month basis (Sadoff et al. 2015, p. 77)

This indicator is based on river basins, therefore, provides only a partial picture of the local situation. When reading the map, it should be kept in mind that grey areas can also be areas without any river flows and that there the availability of water is even worse, like in North Africa or the Australian deserts. Therefore, it is always recommendable to look at more than one indicator to complete the picture like the following map (Figure 44) on groundwater storage anomalies, which includes also the groundwater situation.

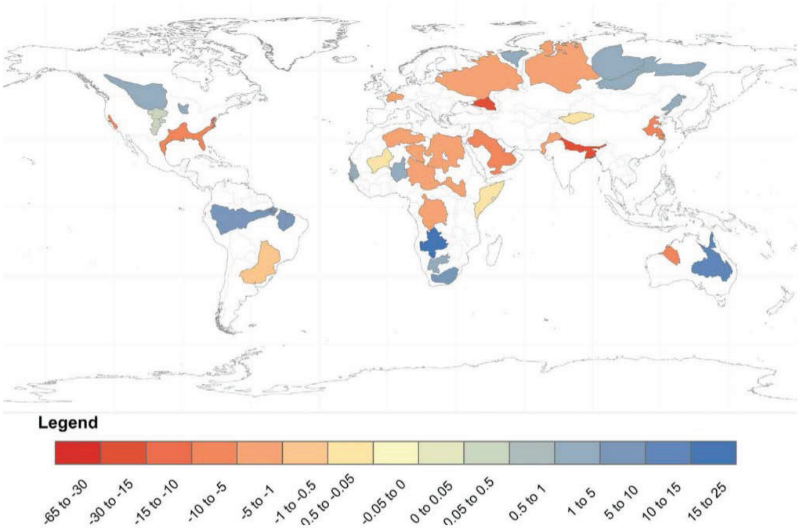

Figure 44: Basin-averaged groundwater use quantified by GRACE-derived depletion in mm per year (Richey et al. 2015, p. 5228)

Both maps together draw a much bleaker picture of the global water situation with regard to physical availability and especially stability of these resources. Water scarcity is not just a problem of the Middle East and some deserted areas, especially on a seasonal base, as every continent is affected, even though some areas suffer much more severely.

Access

Another relevant dimension to look at scarcity is the lack of being able to access existing resources. The situation that there are water resources, but they cannot be accessed for human requirements, because there is not enough capital for the infra-structure. This dimension of water scarcity can be seen also as a poverty index and reflection of the wide gap between the global North and South.

This is illustrated through the Figure 45 created by IWMI on physical and economic water scarcity:

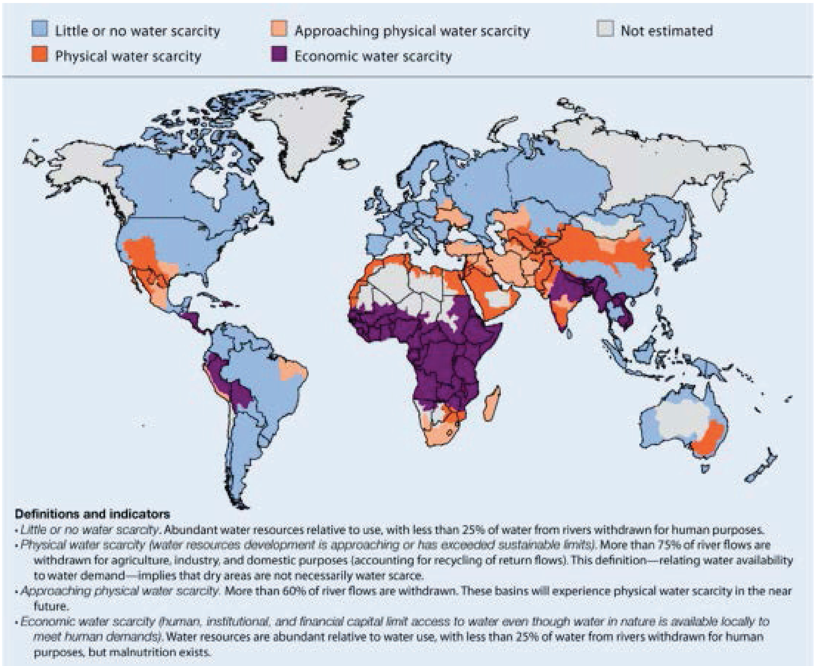

Figure 45: Areas of physical and economic water scarcity (UNEP/GRID-Arendal 2008)

This cruel form of water scarcity is more defined in the table as 'human, institutional and financial capital limit access to water', therefore, there is not enough infrastructure, knowledge or capital for the machinery to get to water resources. This makes the easy accessible water resources even more relevant in these areas and low tech solutions, which are not that capital and institutionally intensive more relevant.

Quality

Another important dimension has to be layered on the existing data, as only available quantities are considered and not in which quality they exist.

Water quality is mainly affected by anthropogenic factors, with the three main sectors contributing to it: agriculture, industry (including mining operations) and domestic. These sectors are getting partly treated. There are regulations regarding the contaminants which can be used, however, this depends on the local legal framework to which extend polluters are made responsible. The measurement of water quality is actually a very broad field in hydrological science which takes into account physical, biological and chemical aspects. Biological indicators, for example, measure health and occurrences of aquatic organisms. Chemical indicators measure, for example, these parameters among others: pH, Nitrogen (NO_3^-, NO_2^-, NH_4^+), Phosphorus (PO_4^{3-}), and Biochemical Oxygen Demand (BOD). The rise of pollutants in water bodies and fall of water quality is a major issue, since industrialisation and developments in water treatment have to react to each new challenge, even though in some industrialised countries the rise of pollutants with economic growth could be nearly stopped. The following map (Figure 46) considers BOD, which gives a broad overview on how organic water pollution was distributed in 2004. Non-organic pollutants like heavy metals, which are linked to industrial production have to be considered separately and waged toward their toxicity. Relevant regulatory institutions have published guidelines for priority pollutants to be considered especially in developing national discharge standards, such as the U.S. Environmental Protection Agency (EPA) under the Clean Water Act 2014 of the U.S. and the Water Framework Directive 2008 (2000/60/EC) of the EU. These directives most prominently refer to the regulation of levels of harmful substances like heavy metals, pesticides, PCBs, PAHs and other hydrocarbons. These extensive water regulations are in force, but still under development, as constantly new challenges arise.

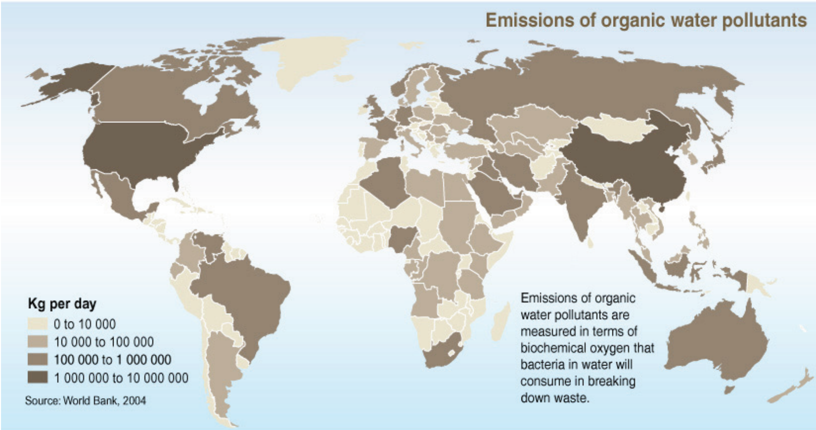

Figure 46: Emissions of organic water pollutants (Rekacewicz 2004)

Germany is a good example for the development of wastewater treatment infrastructure, after ample rivers basins were nearly lost. Therefore, even though formerly highly polluted, on the map (Figure 46) it is categorised as the grey middle field (100 000 to 1 000 000 kg of organic water pollutants per day). At the start of the 2000s, new analytical technologies and more and more micro-pollutants could be detected, which are unfortunately mostly not filtered by regular treatment plants (Meyer et al. 2016; Meyer, Reich & Otterpohl 2014; Scheurer & Otterpohl 2011). Micro-pollutants are mostly residues from pharmaceuticals, which increase with more developed health systems, an aging population and overall availability of pharmaceuticals. Due to these new research results, the improvement of treatment plants started and the so called forth wastewater treatment step was highly debated (Dehmer 2015; Edler 2013; Reske 2016). Part of the debate is who is paying for this additional treatment, as it is a major investment and the pharmaceutical industry is seen as partly responsible, however, difficult to hold responsible.

In developing countries, especially in the context of sudden economic growth, the water quality gets mostly compromised to a worrisome extent, China being the leading example (Han, Currell & Cao 2016). The USA is another example of having compromised their water quality, as the BOD map shows, compared to Europe for example. The International Food Policy Research Institute (IFPRI) developed a prediction model on future water quality developments; however, even though the recent water quality hotspots are well shown, these predicted developments always have a speculative element.

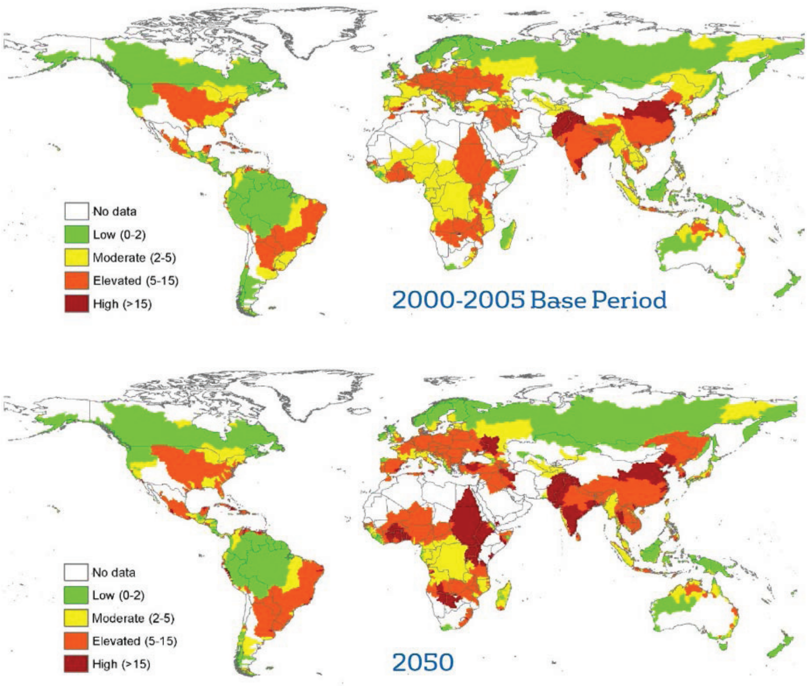

Figure 47: Water quality risk indices for major river basins during base period (2000-2005) compared to 2050 (N index under the CSIRO* Medium Scenario**) (Veolia & IFPRI 2015, p. 9)

*Commonwealth Scientific and Industrial Research Organization
**This scenario takes into account a drier future, as projected by the CSIRO climate change model, and a medium level of socio-economic growth.

How water quality will develop is dependent on ample factors, like the treatment of domestic and industrial water, the extent of mining operations and how they are run and very much on the future of agricultural practices, as the water quality is to a large extent compromised by conventional agriculture through fertilisers and pesticides. In this prediction, the biggest changes towards a compromised water quality are expected in Africa and Asia, which is likely as the ample drivers for withdrawal and pollution, as depicted, combined with expected developments in rising demands in these areas.

The gap between North and South would then be also reflected in the rates of water pollution, as most developing countries are stuck between increased production, but not having developed a sufficient wastewater treatment system. Furthermore, developing countries carry in several cases the burden of high withdrawal rates and low water quality by producing for industrialised countries through virtual water exports. This will severely impact the livelihood of people depending on these resources, but this development would also affect the global storage capacities of the precious blue water resources. The specific course of events is dependent on ample discourses to be fought impacting water resources and their storage systems.

4 Trading Viet Nam's Water Security off after Doi Moi

There is a need to change the development mind-set towards promoting socio-economic development in close connection with environment protection and sustainable development, with a resolution not to harm the environment in exchange for initial profits.

Prime Minister Nguyễn Xuân Phúc at an environmental protection conference cited in Viet Nam News (08.24.2016)

Viet Nam is often referred to as the last awakening tiger (van Arkadie & Mallon 2003) or a dormant dragon woken up from its slumber (Stewart et al. 2012; Tran-Nam & Pham 2003), by publishers from the *Lonely Planet* to *The Economist*. Both titles refer to Viet Nam's rapid economic growth, but also to its rising regional role and increased interlinkage within multinational organisations, like ASEAN (Association of Southeast Asian Nations), APEC (Asia-Pacific Economic Cooperation) and WTO (World Trade Organisation). As mentioned by Viet Nam's Prime Minister at the beginning of this chapter, there was an urge to see the country's economic development without harming the environment. But unfortunately, Viet Nam is one out of the many examples who follow the *grow first and clean up later approach*. Viet Nam has been in the 13th position in the top list of the virtual water net exporters (Chapter 3.2), which is related to its high green, but also nearly as high grey water footprint. This indicates that this country is suffering from the outcomes of a rapid industrialisation (Mekonnen & Hoekstra 2011).

Even though Viet Nam has one of the world's highest growth rates, the process started only 20 years ago at a very low rate with the opening up of its economic gates through Doi Moi , the Vietnamese way of opening markets, also translated as renewal (Athukorala 2009; Que & Phuc 2003). Viet Nam with a, in some regards, developed infrastructure and education system providing 90 % literacy rate in 2008 (Delaunay & Torrisi 2012), which reached 94 % in 2017 (Australian Government Department of Foreign Affairs and Trade 2017b), has a promising factor endowment. After Doi Moi policies took effect in Viet Nam, the extensive private and FDIs, in addition to government funded projects, facilitated the emergence of an export-orientated, highly productive and, for some years, rapidly growing economy. This increased productivity was mainly due to the fast growing manufacturing and slower growing agricultural sector. Economic growth rates of over 6 % can, therefore, be also read as a statistical description of industrialisation at an accelerated speed with higher environmental costs.

Unfortunately, the environmental price can be literally experienced on arrival at Hanoi airport. Air, soil and water pollution are getting more and more visual and show their impacts on human health. In Viet Nam and other newly industrialised countries, a discourse has evolved on quality investment, in the aftermath of fast economic growth with extensive environmental and labour exploitation. However, Viet Nam is also caught in the trap of competing for investment with other countries of the global South. This has resulted also in national competing interests of regulative regimes: attractive investment environments versus labour and environmental regulations. This conflict is part of the international relations discourse on different paths on implementing social and environmental standards, especially in developing countries. Apart from fair trade and other consumer based approaches, FTA and WTO negotiations are discussed as possible tools for implementing these standards in form of environmental and social articles.

The water footprint method is applied to identify the industries and in some cases companies, which are most responsible for decreasing water quality and quantities in Viet Nam. This will connect the dots between consumption patterns, trade agreements, terms of production, water management and water resource pollution and depletion with the help of the water footprint concept, however, also by considering the faces of power.

4.1 From Doi Moi to Export Nation

Viet Nam has a communist one party system, is a partly planned economy, but after Doi Moi more so a coordinated economy, also termed as state capitalism (Aligica & Tarko 2012) or a socialist-oriented market economy (Trong 2004). These cornerstones led to one of the highest growth rates worldwide and a late special entry into the WTO (Thanh & Duong 2009), like China, with special conditions. Therefore, globalisation and the worldwide shift towards market liberalisation took a Vietnamese path that differs from most countries of the global South and North; however, at the same time there has been similar trends and common developments. Market liberalisation was not forced on Viet Nam through World Bank conditionalities, like in South American or African countries, or by a change towards a liberal or conservative party, as in Australia or the UK. Trong (2004) argues that Doi Moi was begun by the people (trading and having their private businesses, even though not set in a legal framework) and then developed as a theoretical concept focusing on economic and, later on, political change.

On the 6th Party Congress in 1986, Doi Moi got introduced, at a time when the Soviet Union initiated Perestroika and China started its open door policy. The Central Committee defined in July 1994 at the 7th Plenum, the targets of national industrialisation and modernisation up to the year 2000 (Trong 2004). In order to reach these targets, guidelines were developed and conditions defined to maintain the socialist orientation. Apart from the leading role of the state, Trong (2004, p. 63) summarised the goals as:

> *economic growth should be closely linked with social progress and equity for the sake of the people; efforts should be made to develop culture, protect the ecological environment, and preserve and promote cultural identity.*

The discrepancies between goal and reality with regards to environmental protection will be discussed in more detail in Chapter 4.2.1.

4.1.1 Opening Viet Nam's Doors

The early 1990s reform processes begun with a semi-privatisation of state-owned enterprises (SOEs). The next big policy step toward privatisation took place in late 2007, when the government announced that privatisation extends to sectors such as banking, insurance, aviation, cement, steel and textiles, with a target to reduce the SOEs to around 550 by 2010. This privatisation was accompanied by changes in the Enterprise Law (2005) and Investment Law (2005), which came in 2006 into effect and resulted in peaking numbers in private investment capital (Australian Government Department of Foreign Affairs and Trade 2013).

These reforms are reflected in major economic changes, with investment capital shifting from mainly government-owned capital towards private and FDI (Figure 48).

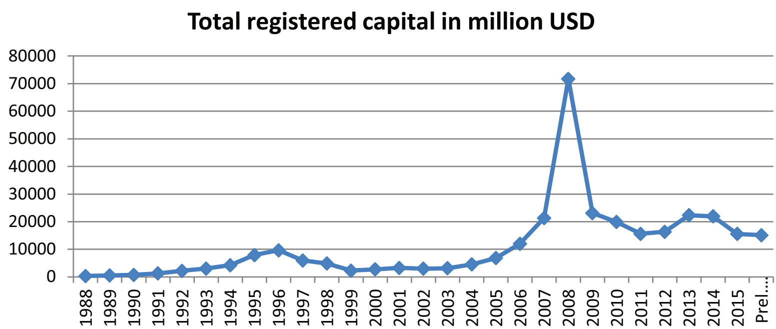

Figure 48: FDI projects licensed in period 1988-2016 based on data from General Statistics Office of Vietnam n.d. until 2015, 2015 Hanoi Times (2015) and 2016 Viet Nam Net (2016b)

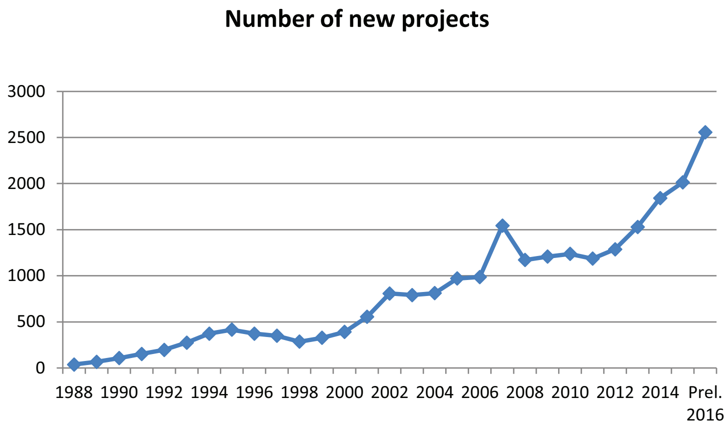

Figure 49: New FDI projects licensed in period 1988–2016 (General Statistics Office of Vietnam n.d.; Hanoi Times 2015; Viet Nam Net 2016b; Viet Nam News 2013; Viet Nam News 2014; Viet Nam News 2015)

Since then, a growing capital inflow boosted Viet Nam's economy and since 1988, FDI projects got increasingly approved.

Figure 48 shows that they peaked in 2008, when the 2006 reforms revealed results. This with a record of a total registered capital of USD 71 726 million in and 1 557 approved projects (Figure 49). Between 1995 and 2011 the total percentage of foreign investment towards the overall investment structure fluctuated between 14.2 % in 2004 and 30.9 % in 2008 as Table 15 shows. Since 2009 and until 2011 foreign investment stabilised at around 25 %. Therefore, foreign investment increased not just in total numbers, it also played a vital part in Viet Nam's investment capital, accounting for between a quarter to a third of the overall projects. Figure 49 also demonstrates that the formerly single role of the state as an investor shifted to mostly under 40 % since 2007.

Table 15: Investment by ownership in % (General Statistics Office of Vietnam n.d.)

Year	State in %	Non-State in %	FDI in %
1995	42.0	27.6	30.4
1996	49.1	24.9	26.0
1997	49.4	22.6	28.0
1998	55.5	23.7	20.8
1999	58.7	24.0	17.3
2000	59.1	22.9	18.0
2001	59.8	22.6	17.6
2002	57.3	25.3	17.4
2003	52.9	31.1	16.0
2004	48.1	37.7	14.2
2005	47.1	38.0	14.9
2006	45.7	38.1	16.2
2007	37.2	38.5	24.3
2008	33.9	35.2	30.9
2009	40.5	33.9	25.6
2010	38.1	36.1	25.8
Prel. 2011	38.9	35.2	25.9

Consequently, Viet Nam was able to attract major investment capital to boost the economy from foreign and national non-state investors. This restructured the economy severely towards a less state owned productivity.

Even when in 2012, Viet Nam could attract 28 % less investment, compared to 2011, FDI still accounted for USD 9.5 billion, with 61 % mostly new Japanese investors (Australian Government Department of Foreign Affairs and Trade 2013). In 2013, Japan headed the list of investors from 48 countries and territories with USD 4.736 billion, accounting for 31.6 % of the total registered FDI, followed by Singapore with USD 3.95 billion and the Republic of Korea, USD 2.636 billion (Vietnam Investment Review 2013). In 2016, the FDI hit a record high of USD 15.1 billion, with the main investment, around 12 %, coming from South Korea, mainly due to the relocation of the factories of Samsung Electronics Co. and LG Electronics Inc. (Nguyen 2016a; Reuters 2016b). In the footwear and partly apparel sector these inflows can be traced back to Nike, Adidas and Puma with an increasing tendency to shift the production from China to Viet Nam. In 2018 Nike produced already over 45% of their shoes in Viet Nam, followed by Adidas and then Puma with over 30% (Pham 2018).

Investment in general increased with growing private national and foreign capital, due to changed policies based on the Doi Moi principles. These investments are mirrored in a growing number of projects, boosting development in a variety of sectors. These projects also grew exponentially in capital size, especially from 2008 to 2009 (Figure 48 and Figure 49), when a major step towards privatisation was made, and even though the financial crisis slowed the investment markets down, they started to peak again in 2016.

4.1.2 Who Stepped into the Door?

Viet Nam's productivity increased after Doi Moi with a faster growing manufacturing sector than agricultural production. Viet Nam's GDP increased rapidly by 5.03 % since 1999, with the lowest rate in 2012, as the General Statistics Office announced (2016). In 2016, the second year in a row, Viet Nam has maintained economic growth above 6 %, defying a regional slowdown and remaining one of the world's best performers; manufacturing surged (Nguyen 2016b) as an outcome of increased industrialisation.

As, productivity increased, these goods had to be sold; as the national market has been small; hence, external markets had to be found. This explains that more and more of the GDP was generated through exports, therefore, establishing a close relationship between FDI, increased productivity, growing exports and GDP generation related to these exports. Figure 50 illustrates this steep development since the Doi Moi reforms were launched in 1986 till 2015. The reform started with a sudden peak from far under 10 % to over 30 % in the mid-1990s. In 2012, 80 % of the GDP was generated through exports and in 2015, 90 % was reached.

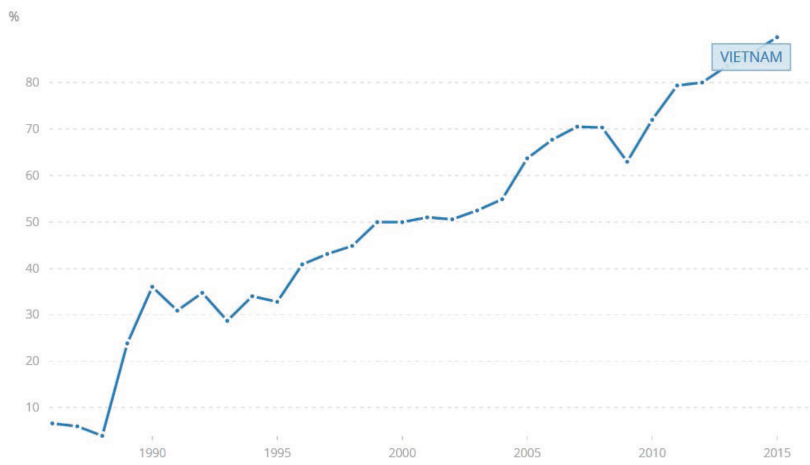

Figure 50: Percent of Viet Nam's GDP generated through exports 1986-2015 (World Bank 2016)

Therefore, is Viet Nam’s economy also more and more dependent on exports to generate their GDP. At the same time, this means that Viet Nam is getting more and more dependent on straining its resources for the global market. Private national and foreign capital fostered industrialisation and the ability to export extensively, with Viet Nam being in 2015, the 24th largest exporter in the world, which is in relation to the country size enormous (The Observatory of Economic Complexity n.d.). These exports are more and more related to manufactured goods.

Viet Nam's major exports in 2017 are telephones and spare parts (19 % of the total shipments), textiles (14 %), electronics, computers and components (10 %), shoes and footwear (7 %) and other machinery, equipment, tools and spare parts

(5 %) (Trading Economics 2017c). However, this mix of mainly secondary products developed out of an agricultural economy. Figure 51 shows how exports developed and split up by products group and growth, which goes hand in hand with increased investments in certain sectors.

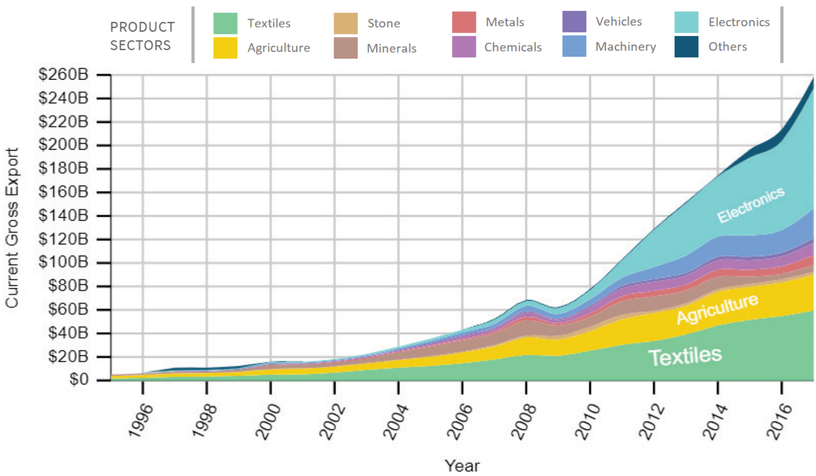

Figure 51 Vietnam exports between 1995 and 2017, grouped by main sectors (The Growth Lab at Harvard University 2019)

The graph demonstrates that exports in manufactured goods by dollars increased much steeper than trading with agricultural products and, therefore, its growth in GDP is much related to industrialisation and the development of industrial zones.

At the same time, the rocketing GDP also increased the ability to import more goods. However, by looking at Viet Nam's imports, it needs to be differentiated between end or intermediate products, which are used for further production processes. The World Integrated Trade Solution (WITS) database differentiates these product stages in four categories: raw materials, intermediate goods, consumer goods and capital goods. Table 16 illustrates import and export by product type in

2015 with nearly 34 % products compromise of intermediate goods being imported, which are mainly used for further production.

Table 16: Vietnam exports and imports of product groups in 2015 (WITS n.d.)

Product Categories	Exports		Imports	
	Million USD	Product share in %	Million USD	Product share in %
Raw materials	18 102	11.17	12 594	7.60
Intermediate goods	20 741	12.80	56 325	33.98
Consumer goods	65 303	40.31	25 819	15.57
Capital goods	56 095	34.62	68 683	41.43

One example for these imports, which are linked to the production for their exports are a wide range of chemical products (Trading Economics 2017c) imported from China, or rubber used for the shoe industry. Viet Nam's trade balance leans towards exports, as the following trade balance shows, even though imports also increased (Figure 52).

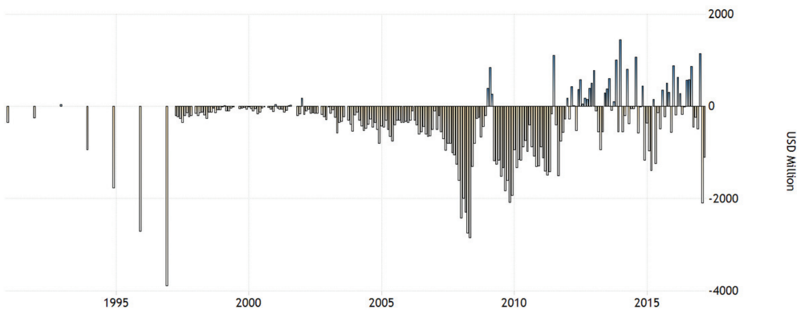

Figure 52: Viet Nam balance of trade (Trading Economics 2017c)

The trade balance is easily misread due to the imports which are linked to exports with China as the main trading partner for intermediate products over the years (Table 17). The imports are mainly received in the close proximity of Asia in the form of intermediate products. Table 18 shows that a major part of the exports travel to the U.S. and to a growing extent the EU.

Table 17: Viet Nam's import partners 2009, 2012 and 2015 (WITS n.d.), EU values based on European Commission (2017)

2009			2012			2015		
Import Partner	Billion USD	Share in %	Import Partner	Billion USD	Share in %	Import Partner	Billion USD	Share in %
China	16.7	23.8	China	29	25.5	China	49.4	29.8
Japan	7.5	10.7	South Korea	15.5	13.6	South Korea	27.6	16.6
South Korea	7.0	10.0	Japan	11.6	10.2	Japan	14.2	8.5
Other Asia*	6.2	8.9	Other Asia*	8.5	7.5	Other Asia*	10.9	6.6
Thai-land	4.5	6.4	Singa-pore	6.7	5.9	Thai-land	8.3	5
EU	4.1	5.8	EU	5.8	5.1	EU	9.2	5.5

*Other Asia, not elsewhere specified in principle represents trade data for territories belonging to Asia, but not specified by country. In practice, only trade of Taiwan is included under this code. For political reasons the UN is not allowed to show trade statistics referring to Taiwan. (UN Trade Statistics 2010)

Table 17 shows in more detail that the U.S. as a trading partner in terms of imports is not visible, even though Viet Nam's products travel to a large extent to the U.S., as evident from the list of the most important export partners (Table 18). Therefore, through the rubber for the shoe industry is procured from China to Viet Nam, the shoes are exported to the U.S. and Europe. It is very likely, that this shoe is a Nike model produced in one of the 105 Nike factories (Nike 2019) or an Adidas produced in the one of the 80 factories (Adidas 2019). The U.S. as their main export partner also grew in importance, as Table 18 demonstrates, with a share of USD 11.4 billion in 2009, USD 19.6 billion in 2012 and USD 33.4 billion in 2015 with a share of 20.7 %. China is also getting more important with a share of USD 16.6 billion and took Japans place as the second most important export partner.

Table 18: Viet Nam's export partners 2009, 2012 and 2015 (WITS n.d.), EU values based on European Commission (2017)

2009			2012			2015		
Export Partner	Billion USD	Share in %	Export Partner	Billion USD	Share in %	Export Partner	Billion USD	Share in %
US	11.4	20	US	19.6	17.2	US	33.5	20.7
Japan	6.3	11.1	Japan	13.1	11.4	China	16.6	10.2
China	5.4	9.5	China	12.8	11.2	Japan	14.1	8.7
Swit-zerland	2.5	4.4	South Korea	5.6	4.9	South Korea	8.9	5.5
Aus-tralia	2.4	4.2	Malay-sia	4.5	3.9	Hong Kong	7.0	4.3
EU	8.5	14.9	EU	20.3	17.7	EU	32.6	20.1

South Korea came later into the picture with growing importance and a share of 5.5 % in 2015. The EU also plays a growing role as an export market and as Chapter 4.3 will show the EU will be an even more important market in future.

This increase in trade is related to the economic integration of Viet Nam into the global market, also through Trade Agreements lowering tariffs and encouraging trade. As the increased production was in need of more markets, Viet Nam stepped into further bilateral, regional and international integration starting with the ASEAN and APEC, a forum of the Pacific rim member states founded in 1989 (APEC 2017b). Vietnam is an ASEAN member since 1995 and joined APEC as the last member in 1998 (Table 19). In 2017 Vietnam hosted the yearly APEC meeting with the theme: 'Creating new dynamism, fostering a shared future' (APEC 2017a).

The following list of members gives a good indication of the growing integration of Viet Nam and is followed by listing FTAs with the related export data for one year before and one year after the agreement.

Table 19: ASEAN Member States (ASEAN n.d.) and APEC Member Economies (APEC 2017b)

Members	ASEAN Date of Accession	APEC Date of Accession
Australia	n/a	6-7 November 1989
Brunei Darussalam	7 January 1984	6-7 November 1989
Cambodia	30 April 1999	n/a
Canada	n/a	6-7 November 1989
Chile	n/a	11-12 November 1994
People's Republic of China	n/a	12-14 November 1991
Hong Kong, China	n/a	12-14 November 1991
Indonesia	8 August 1967	6-7 November 1989
Japan	n/a	6-7 November 1989
Laos	23. July 1997	n/a
Malaysia	8 August 1967	6-7 November 1989
Myanmar	23 July 1997	n/a
Philippines	8 August 1967	6-7 November 1989
Singapore	8 August 1967	6-7 November 1989
Thailand	8 August 1967	6-7 November 1989
Republic of Korea	n/a	6-7 November 1989
Mexico	n/a	17-19 November 1993
New Zealand	n/a	6-7 November 1989
Papua New Guinea	n/a	17-19 November 1993
Peru	n/a	14-15 November 1998
Russian Federation	n/a	14-15 November 1998
Chinese Taipei	n/a	12-14 November 1991
United States	n/a	17-19 November 1993
Viet Nam	28 July 1995	14-15 November 1998

Table 20: Vietnam's FTAs in the context of ASEAN, FTA information based on ASEAN Briefing (2014), values derived from WITS n.d.

FTA	In force since	Members apart from Viet Nam	Imports 1 year before enforcement		Imports 1 year after enforcement		Imports 2 years after enforcement		Exports 1 year before enforcement		Exports 1 year after enforcement		Exports 2 years after enforcement	
			Million USD	Share in %	Million USD	Share in %	Million USD	Share in %	Million USD	Share in %	Million USD	Share in %	Million USD	Share in %
ASEAN-People's Republic of China Comprehensive Economic Cooperation Agreement (ACFTA)	1 July 2005	ASEAN China	4 595.1	14.37	7 391.3	16.47	12 709.9	20.25	2 899.1	10.95	3 242.8	8.14	3 646.1	7.51
ASEAN-Korea Comprehensive Economic Cooperation Agreement (AKFTA)	1 June 2007	ASEAN South Korea	3 908.4	8.71	7 255.5	8.99	6 976.4	9.97	842.9	2.12	1 793.5	2.86	2 077.8	3.64
ASEAN-Japan Comprehensive Economic Partnership (AJCEP)	1 December 2008	ASEAN Japan	6 118.9	9.86	7 468.1	10.6 8	9 016.1	10.63	6 090	12.54	6 335.6	11.1	7 727.7	10.7
ASEAN-Australia and New Zealand Free Trade Agreement (AANZFTA)	1 January 2010	ASEAN Australia	1 050	1.5	2 123.2	1.99	1 772.2	1.56	2 386.1	4.18	2 601.9	2.69	3 208.7	2.8
		New Zealand	249.7	0.36	383.9	0.36	384.9	0.34	70.5	0.12	151.4	0.16	184	0.16
ASEAN-India Comprehensive Economic Cooperation Agreement (ASEAN-India CECA)	1 January 2010	ASEAN India	1 634.8	2.34	2 346.4	2.2	2 160.5	1.9	419.6	0.73	1 553.9	1.6	1 782.2	1.56

Table 21: Vietnam's FTAs, FTA information based on U.S. Department of Commerce (2017), values based on WITS n.d., 2016 South Korea information derived from Customs News (2017)

FTA	In force since	Members apart from Viet Nam	Imports 1 year before enforcement		Imports 1 year after enforcement		Imports 2 years after enforcement		Exports 1 year before enforcement		Exports 1 year after enforcement		Exports 2 years after enforcement	
			Million USD	Share in %	Million USD	Share in %	Million USD	Share in %	Million USD	Share in %	Million USD	Share in %	Million USD	Share in %
Vietnam - USA Bilateral Trade Agreement	10 December 2001	USA	363.9	2.33	458.6	2.32	1 144.1	4.53	732.9	5.06	2 453.2	14.68	3 939.6	19.55
Japan-Viet Nam Economic Partnership Agreement (Japan-Viet Nam EPA)	1 October 2009	Japan	8 240.3	10.21	9 016.1	10.63	10 400.7	9.74	8 467.7	13.51	7 727.7	10.7	11 091.7	11.45
Viet Nam-Chile Free Trade Agreement (VCFTA)	14 March 2012	Chile	335.7	0.31	314.8	0.24	367.5	0.25	137.5	0.14	219.6	0.17	520.8	0.35
Eurasian Economic Union (EEU)	1 January 2015	Armenia	0.2	0	n/a	n/a	n/a	n/a	21.5	0.01	n/a	n/a	n/a	n/a
		Belarus	93.1	0.06	n/a	n/a	n/a	n/a	14	0.01	n/a	n/a	n/a	n/a
		Kazakhstan	10.4	0.01	n/a	n/a	n/a	n/a	219	0.15	n/a	n/a	n/a	n/a
		Kyrgyz Republic	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		Russian Federation	826.7	0.56	n/a	n/a	n/a	n/a	1 274.9	1.15	n/a	n/a	n/a	n/a
[Republic of] Korea-Viet Nam Free Trade Agreement (KVFTA)	20 December 2015	Korea	21 728.5	14.7	32 030	18.4	n/a	n/a	7 167.5	4.77	11 420	6.5	n/a	n/a

The top trading partners of Vietnam (Table 17 and Table 18) are reflected in the list of APEC member states, but also in the list of trading partners in form of bi- and multilateral trade agreements. Viet Nam is in 2016 with 10 FTAs in effect, 1 signed, but not in effect and 5 more under negotiations already well connected. Therefore, trade agreements fostered trade in the past as the two lists of agreements in place with the imports and exports one year before and one and two years after the enforcement reflects (Table 20 and Table 21). This demonstrates the general impact these trade agreements have on fostering trade, as it is their main purpose, even though some show only long term effects. The outcome of negotiations is difficult to predict and if one country signs it does not mean that others will follow and between the first negotiations and enforcement, long periods of time can pass.

All over the world several trade agreements are highly debated and in each country hegemonic battles are fought over them. The Trans Pacific Partnership (TPP)[12] is an example for this, as it is signed by Viet Nam, but as the U.S. President Donald Trump rejected the agreement, even though his predecessor Barack Obama pushed for it. In 2017, plans were made public that the negotiations will proceed, however, without the U.S. (Direcon 2017; Dumalaon 2017). Trade agreements are an outcome of ample battles on discourses fought by their interest groups and they start even before negotiating the clauses on which countries sit at the table, if they stay seated. In the case of the U.S., the inner country power relations changed and, therefore, in this case, they left the seat. In 2017 the following six agreements were under negotiation Table 22:

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12 Other TPP Partners are Australia, Brunei Darussalam, Canada, Chile, Japan, Mexico, New Zealand, Malaysia, Peru, and Singapore (Direcon 2017)

Table 22: Pending FTAs based on Delegation of the European Union to Vietnam (2016), Chandran (2017), Embassy of Israel in Vietnam (2016)

FTA	Members apart from Viet Nam	Status
Trans-Pacific Partnership Agreement (TPP)	Australia Brunei Canada Chile Japan New Zealand Peru Singapore USA* Malaysia Mexico	Signed 4 February 2016, in 2017 not ratified by parlia-ments of member countries
Viet Nam-EFTA (European Free Trade Agreement)	Switzerland Iceland Norway Lichtenstein	Negotiations launched in April 2012, in 2017ongoing
Viet Nam- European Union FTA	EU	Concluded in December 2015, pending signature and ratification, expected to enter into force in early 2018
ASEAN-Hong Kong, China Free Trade Agreement (AHKFTA)	ASEAN Members (see Table 19) Hong Kong China	Negotiations still ongoing, set to be finalised by the end of 2017
Regional Comprehensive Economic Partnership (RCEP)	ASEAN Members (see Table 19) Australia India China Japan South Korea New Zealand	Negotiations launched in November 2012 and set to be finalised by the end of 2017
Viet Nam-Israel Free Trade Agreement	Israel	Negotiations launched in March 2016

Instead of the TPP the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) is since 2018 in place without the U.S. (DFAT n.d.). The Viet Nam-EFTA is in 2019 still under negotiation (EFTA 2019) as well as the RCEP and FTA with Israel (WTO Center and Integration n.d.). The EU Agreement is in place (European Comission 2018) and the AHKFTA.

In general, Viet Nam privatised, industrialised and opened its markets, which resulted in an economic boom and it can be expected that economic growth will further exceed.

4.2 Environmental and Social Aftermath and Virtual Water Trade

Economic growth has its environmental costs and only in some industrialised countries this has been partly brought under control. There are several influential components that break the link between economic growth and deep environmental footprints. Viet Nam's water resources will be used as an example to demonstrate the link between Doi Moi policies, exports and undrinkable tap water. When analysing the anthropogenic factors, a special focus will be set on identifying sectors with a high water footprint causing problems and an infrastructural setup.

4.2.1 Water Situation in Viet Nam

Viet Nam is actually, especially in terms of water, a very fortunate country, as it is richly endowed with surface and groundwater, replenished by a rainy tropical climate. A dense hydrographic surface structure, with a river network of 2 360 rivers (of more than 10 km length), 8 large basins and two main river deltas: Mekong and Red River, gives the country a good hydrological condition and a catchment area of more than 10 000 km^2 (FAO 2016).

Figure 53: Water Situation in Viet Nam (FAO 2016b)

Apart from these river systems, there are several lakes and groundwater resources, which account for 30 % of Viet Nam's water resources (Figure 53). These 3 600 reservoirs are of various size and unevenly distributed. Out of them, 400 are mineral and thermal sources, with 287 exploited ones. However, two thirds of Viet Nam's water resources have their origin in riparian countries, which faces Viet Nam with the challenge of being a downstream country. Another water feature is Viet Nam's long coastline of 3 260 km (Waibel 2010).

Altogether, water abundance made Viet Nam well suited for farming, which is reflected in 9.63 million ha of arable land registered in 2009, out of 331 052 km^2. However, in 2006, *Viet Nam's strategy on water resources to 2020* (2006) was approved and it was recognised that these abundant water resources are not treated sustainably, therefore, substantial changes were needed to avoid the risk of water scarcity. One of the first outcomes was an extensive environmental assessment of Viet Nam, including its water quality, especially surface bodies, with an expectation that pollutant levels will increase instead of decrease. The decreasing water quality is in Viet Nam, according to the 2008 environmental performance assessment report, the most important concern, even prior to the widely discussed air pollution.

Figure 54 and Figure 55, respectively, show the BOD and NH_4 concentrations in some major rivers of Viet Nam and it can be noted that they are far above Viet Nam's national standard (marked with red line in both figures).

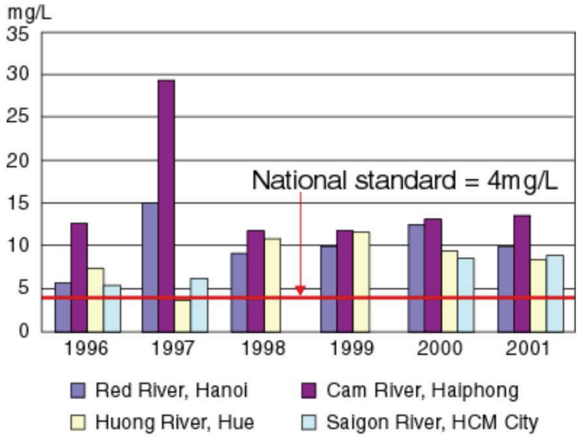


Figure 54: BOD levels in Vietnamese major rivers (WEPA n.d.)

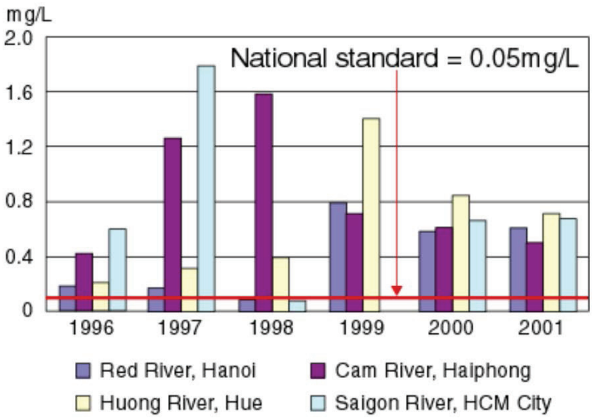


Figure 55: NH_4 levels in Vietnamese major rivers (WEPA n.d.)

Figure 56 shows that, the BOD levels related to industrial discharge are on the rise.

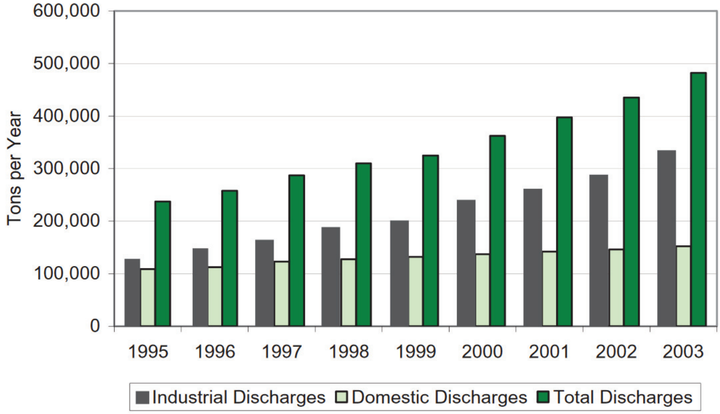


Figure 56: Estimated BOD discharge in tons per year for the period 1995-2003 (Ministry of Natural Resources and Environment 2008, p. 10)

A decrease in water quality in a country where the drinking water supply is mostly untreated is an even greater health hazard. In Viet Nam, the MDGs on improved drinking water was met (WHO 2015). The often quoted number according to the updated 'Progress on Drinking Water and Sanitation Report 2012' is that 95 % of the population in Viet Nam has access to improved water. However, by looking closer into the numbers it is important to recognise that only 23 % have piped water on their premises and 72 % have 'other improved' drinking water sources (UNICEF & WHO 2012, p. 55). Other improved sources mean for example: protected dug wells, boreholes, rainwater collection and standpipes. However, these improvements do not protect users from industrial pollutants and the water infrastructure lacks far behind the fast growing challenges. The Environmental Performance Assessment Report (2008, p. 45) analysed the situation on environmental expenditures as follows:

What can be said with more certainty is that economic growth as reflected in GDP outpaced official environmental expenditure during the period under review. This pattern seems common to the "tiger" economies of Asia during the last two decades. Whether such outcome in Viet Nam is a classical illustration of the "grow-first-clean-up-later" approach or an interpretation distorted by the methodological weaknesses of official environmental expenditure data cannot be established without careful analysis.

Table 23 shows the investments on environmental protection in relation to the GDP.

Table 23: Investment for environmental protection from national budget 1996-2000 in billion VND adapted from Ministry of Natural Resources and Environment (2008, p. 46)

No.	Item	1996	1997	1998	1999	2000
1	GDP	258 609	295 700	34 500	400 000	456 000
2	Total public expenditure	70 270	773 80	80 770	85 500	98 320
3	Total public operating expenditure	43 066	48 953	48 200	47 400	54 000
4	Total public development investment from state budget	14 679	15 964	17 630	24 000	28 320
5	Total environmental expenditure from state budget	481	546	571	570	720
6	Operating expenditure for environment	390	425	450	420	550
7	Environmental expenditure from state development investment	91	121	121	150	170
8	Ratio of total environmental expenditure/GDP in %	0.19	0.18	0.17	0.1	0.11
9	Ratio of total environmental expenditure/total public expenditure in %	0.68	0.71	0.7	0.61	0.51
10	Ratio of operating expenditure for environment/total public operating expenditure in %	0.91	0.87	0.93	0.81	1
11	Ratio of environmental expenditure from state development investment/total public development investment from state budget in %	0.62	0.76	0.69	0.61	0.6

As Table 23 shows, the total ratio of environmental expenditures in relation to the GDP actually decreased instead of increasing; contradicting the increasing level of pollution.

Apart from water quality issues related to Viet Nam's increased productivity and lack of a solid water infrastructure there are some other limiting factors to Viet Nam's water resources. These can be divided into non-anthropogenic and anthropogenic factors. Non-anthropogenic factors refer to the geographical pre-disposition of a country; however, that does not mean that these are not influenced by human activity. Some of the major Non-Anthropogenic factors for Viet Nam are:

1. Distribution of water resources.
2. Long coastline (increases danger of salination)
3. Flooding
4. Aquifers have natural arsenic poisoning levels.
5. Tropical climate

Anthropogenic factors are, especially since Doi Moi, at an increasing pace highly entangled with the processes of globalisation. In order to understand each factor, Bob Jessop's understanding of globalisation (Chapter 2.1) will be used, as he sees it as a multicentric, multiscalar, multitemporal, multiform and multicausal process (Jessop 2001). The anthropogenic factors are categorised according to the level of possible avoidance through a change in human behaviour. In this regard, the temporal dimension plays a major role, as past contaminations simply cannot be avoided, therefore, discourses on remediation are linked to these cases. Commonly known in relation to these questions is the polluter pays principle, however, the implementation is often a major challenge that Viet Nam is facing now.

There are two main examples:

1. Soil contamination levels from the war have a high impact on groundwater contamination. For example, Agent Orange (Unabhängiges Institut für Um-

weltfragen n.d.). There are efforts to clean up this hazardous part of war history. Former U.S. President Barack Obama pushed for an environmental assessment, which was conducted in 2016 (U.S. Aid 2017); however, further developments remain unclear (especially under the new U.S. leadership).

2. There are ample cases of contaminated industrial sites and the question now is if these companies are part of the FDI, who pays for cleaning up the environment (Associated Press 2016). One case has been a fish disaster caused by a steel plant, which caused major public criticism on FDI and reported by ample Vietnamese Newspapers (Hanoi Times 2016; Viet Nam Net 2016a; Viet Nam News 2016). Major compensations (USD 500 million) were pledged to be paid by Formosa Ha Tinh Steel Corp, a subsidiary of Taiwan's Formosa Plastics Group, after they admitted that their steel operation had caused an environmental disaster. However, less prominent cases do not reach the public nor push for remediation.

These two examples illustrate that even when remediation is at least partly paid, the process can last for decades and a major hegemonic shift is necessary in order to push for payments. Furthermore, these shifts are vulnerable to a changing political climate and it will be an interesting case to see whether the Viet Nam war clean-up efforts will be affected by the change in the presidency of the U.S.

Another important dimension with regard to the avoidance of environmental implications is considered to be the amount of scales, forms and causes involved, therefore, to distinguish between who, where, with what and in which quantity water quality and quantities are affected. Avoidance or recovery can be easier, as fewer dimensions play a role, so, for our understanding, it is important to distinguish between whether there is a local community with one major contaminator or if multiple actors on multiple scales are acting in multiforms. This is likely the case with extensive connected cross-border river systems and climate change, as water regulations and restrictions are still commonly made on a national scale (apart from the

EU). The following two examples influencing Viet Nam's water bodies are embedded in multiscalar, multiformal and multicausal dimensions, which are difficult to influence and where a multilateral approach is necessary:

1. Viet Nam is a downstream country and suffers from upstream pollution levels
2. Climate change.

As already mentioned in Chapter 3.2.3, not only does Viet Nam have an extensive water footprint related to the production of goods, China's footprint is even larger and therefore it is not surprising that the contamination of river bodies is also extensive. China's water treatment infrastructure is also in a state of development and, as most rivers of Viet Nam actually start in China, this pollution gets washed down. The other neighbouring countries Laos, Cambodia and Thailand with developing infrastructure add to this problem.

Non-anthropogenic factors and contaminations through past events cannot be avoided or regulated through influencing human activities in the present, but legal frameworks on remediation practices can be implemented. They mainly differ in severity of their influence, costs of recovery, or how they amplify other factors (e. g. recovery of soil contamination). In this regard, Viet Nam has a mixed position, as it had, apart from the arsenic contamination, good geological and climatic starting conditions, if managed well. Unfortunately, there are severe contaminations through war and economic activities, which are resource intensive to recover. Climate change and pollution levels coming from upstream countries play a major role, which would presumably increase.

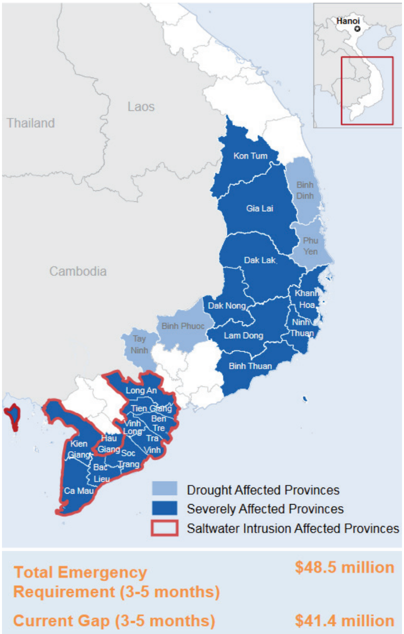


Figure 57: El Niño induced drought per region. (OCHA 2016)

One sign for this is the worst drought in 90 years in June 2016 (still ongoing), which shows that all these factors can accumulate. Viet Nam is much more vulnerable to weather extremes affected by El Niño. Eighteen provinces of Viet Nam and over 2 million people were being declared to be in a state of emergency (Relief Web 2016); in 2017, 2 million people were without access to safe drinking water, as the emergency plan for 2016/17 states (OCHA 2016). Figure 57 shows that, mainly South Viet Nam had been affected and Viet Nam called for an international emergency help, as there was still a gap of USD 41.4 million to be covered for several emergency relief measures. In case of drought, rivers carry less water and there is not only the problem of lower amounts of water, also the concentration of pollution increases and the risk of salt water intrusion becomes much higher.

Unfortunately, Viet Nam's wastewater treatment infrastructure is under development and in some areas neglectable, as just the initial steps of evaluating the problem and getting regulations into place have been taken. Furthermore, as the ratio of investment in the environmental infrastructure showed, this is not one of the highest priorities. Ground-breaking infrastructural investments and regulations are necessary to break the link between economic growth and water pollution. In order to implement a treatment plan with a combination of low and high tech, centralised and decentralised solutions, a monitoring system needs to be put in place in order to get to know the exact amounts of sustainable withdrawal at each point in time. Based on this knowledge, urbanisation and production can be planned more thoroughly, setting wastewater treatment with flexible solutions into place. This would also lower the costs; as expensive high tech solutions could be avoided in several cases without compromising water security. Especially some industrial zones need high tech solutions; however, this is a heavy burden on Viet Nam's economy and increases its dependency on international loans, as in 2012 wastewater treatment plants were only properly running in exceptional cases (Henschel 2012, interview by R Schaldach, 20 March). As in 2013, the first water and wastewater industry show in Viet Nam, Vietwater, projected, high tech solutions (Vietwater 2013), which gives the impression that Viet Nam's water crisis can be easily solved through a higher density of wastewater treatment plants and sewage systems. However, the most sustainable and also cheapest way is to avoid water pollution and overexploitation by non-sustainable withdrawal rates. Therefore, apart from a proper water resource and recharge monitoring system, it is necessary to evaluate the sources for pollution.

In conclusion, even when Viet Nam seems at a first glance as a country without water problems due to its abundance, water scarcity is severe and will rapidly increase if not managed well.

4.2.2 International Trade and Water

Worldwide there are plenty of cases of water scarcity linked to anthropogenic causes, human overexploitation, driven primarily by agricultural or industrial production, mining activities or urbanisation. The previous chapter already introduced a great body of work developed in recent years on water footprinting (Hoekstra et al. 2009) and water economics (eds Albiac & Dinar 2009). However, there is an underrepresentation of country studies in the body of work on globalisation of water in Recently Acceded Members (RAMs) of the WTO, apart from China. China is the main example for economic growth and its related land and water problems; however, though China and Viet Nam have their similarities in this respect, there are also major differences. Country studies were increasingly linked to international trade, mainly as a criticism on globalisation, e. g. how flowers for Mother's Day in Germany can contribute to drying out Lake Naivasha Basin in Kenya (Hoekstra & Mekonnen 2010). The water used, towards the production of each flower includes the virtual or embedded water. Therefore, if Kenya exports flowers, this trade is also a trade of virtual water (Chapter 3.2.3).

Viet Nam was in 2015 the world's 24th biggest exporter (The Observatory of Economic Complexity n.d.) and therefore it is not surprising that Viet Nam is also under the 25 biggest virtual water exporters. However, in order to identify the industry and products most responsible for an increasingly worrisome water situation a more detailed analysis of the trade and water footprint data is necessary. Textiles, Agriculture and Electronics are the fastest growing industries with the biggest share in exports in 2017 and steepest growth rates in terms of American dollars. Accordingly, these three sectors are analysed in more details on a HS 6 Level[13], therefore this data is broken down to product specifics like footwear made out of rubber or leather and how processed the rice for example is. Then, the top ten products since 1995 are identified for each sector. The shooting stars are excluded and only the products which were since 1995 at least 5 times in the top 10 appear in the graphs.

Figure 58 shows the top exports in the textile sector. Footwear exports dominate with sports footwear overtaking the footwear with upper leather material.

13 The Harmonized Commodity Description and Coding Systems (HS) is an international classification that allows classifying traded goods. A 6-digit code system can be broken down. There are approximately 5,300 product descriptions that are organized as headings and subheadings, arranged in 99 chapters, and grouped in 21 sections (UN Comtrade 2017). The product descriptions shown in the graphs are according to the HS92 revision.

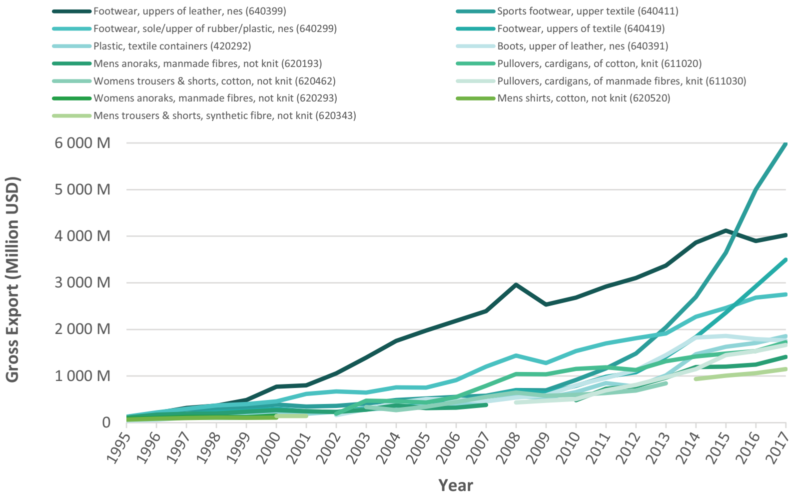


Figure 58 Vietnam's top 10 export products (HS 6-digit) in the textile sector between 1995 and 2017 appearing more than 5 times (Simoes 2019)

The fast growing sports footwear exports are, as already described (see 4.1.1 and 4.1.2), mainly related to foreign direct investment. The sports shoe giants Nike and Adidas shifted their production more and more from China to Viet Nam reflected in the steep curve.

In terms of the water footprint shifts in production patterns from leather to other main materials used for producing the shoes cause severe differences as the average water footprint of leather with 17093 litre/kg (Mekonnen & Hoekstra 2012, p. 407) is much higher than 2495 litre for 250 gram cotton (Chapagain et al. 2006, p. 193). A major part of the intermediate products is imported from China, a part of the water footprint is therefore in China (Herr, Schweisshelm & Truong 2016) by considering the production chain. However, Viet Nam is downstream from China, which in this case brings the greywater partly back to Viet Nam. The garments in the top 10 are also partly imported, especially cotton, however silk is mainly produced locally. This makes the footprint calculations of manufactured goods especially difficult and further research is necessary for a better understanding of the water part of the production chain. The water footprint of the accumulated top 10 footwear and textile products is calculated, therefore, in this work based on the average water footprint for industrial products in Viet Nam estimated with 1 350 m3/USD (67,5 blue and 13500 m³/USD greywater) (Mekonnen & Hoekstra 2011) illustrated in Figure 61, therefore a high grey but low blue water footprint is used.

The electronic sector (see Figure 59) accelerated the exports exponentially since 2010.

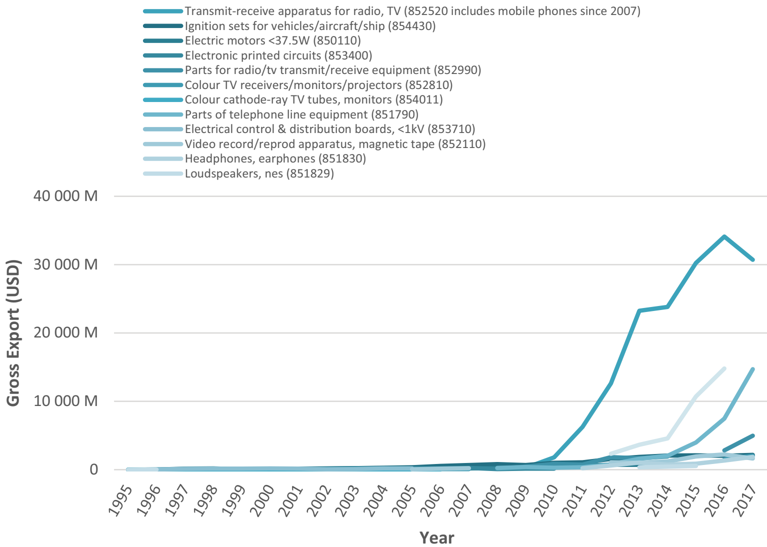


Figure 59: Vietnam's top 10 export products (HS 6-digit[14]) in the electronics sector between 1995 and 2017 appearing more than 5 times (Simoes 2019)

14 The correspondences of the HS-6digit code 852520, after the HS07 revisions, correspond to the sum of transmission apparatus for radio-broadcasting or television (852560), machines for reception, conversion and transmission or regeneration of voimages or other data, incl. switching and routing apparatus (851762), Base stations of apparatus for the transmission or reception of voice, images or other data (851761) and telephones for cellular networks, mobile telephones or for other wireless networks (851712) (ITC 2019).

This acceleration is mainly related to mobile phones as Samsung Electronics Vietnam, Microsoft Mobile Vietnam, and LG Electronics among other increased production in Viet Nam (VOV 2015). The water footprint of the products in this sector were also calculated according to the average industrial water footprint of Viet Nam.

The agricultural sector is the third largest and slowest growing export sector (see Figure 51) with coffee and rice constantly at its top and a growing importance of cashew nuts. Figure 60 gives an overview on the top 10 export products excluding the products, who could not make it at least five times to the top 10. The method to calculate the water footprint differs from the calculation method used for industrial products as more precise water footprint data is available for agricultural products.

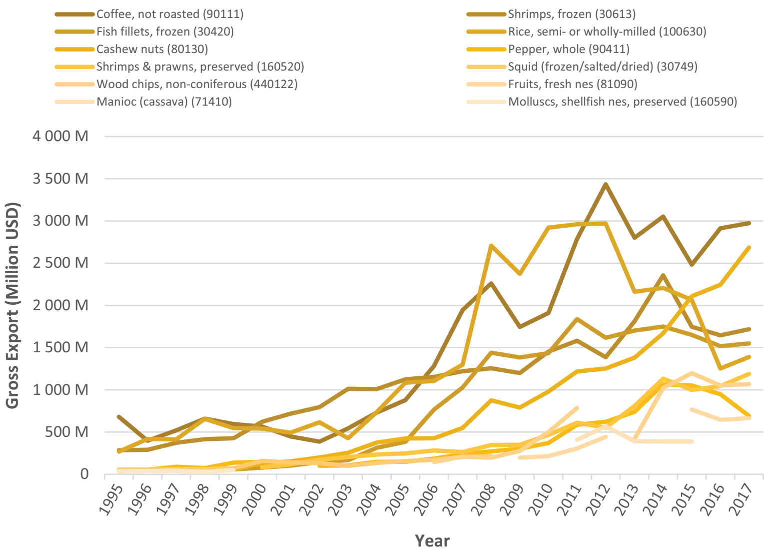


Figure 60: Vietnam's top 10 export products (HS 6-digit) in the agriculture sector between 1995 and 2017 appearing more than 5 times (Simoes 2019)

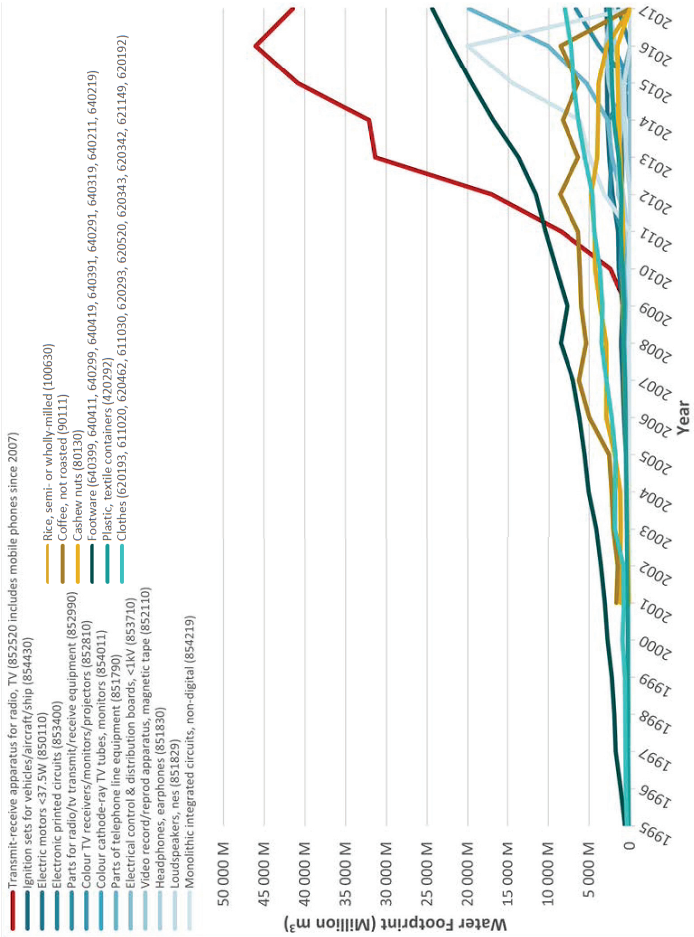


Figure 61 Water footprint of Vietnam's top export products (HS 6-digit) in the textile, agricultrual and electronics sectors between 1995 and 2017. Agricultural products (ITC 2019) were calculated using specific crop water footprint: rice 638 m^3/ton (Chapagain & Hoekstra 2010, p. 20), coffee 5 085 m^3/ton (Chapagain & Hoekstra 2007, p. 113) and cashew nuts 4 696 m^3/ton (Mekonnen & Hoekstra 2010, Appendix II - 826).Textiles and Electronics were calculated using average industrial water footprint of Viet Nam 1 350 m3/USD (Mekonnen & Hoekstra 2011).

In Figure 61 the top three export products in terms of USD are considered: coffee, rice and cashew nuts. According to the export volumes in tonnes, retrieved from the ITC database, the water footprint of these products based on country specific data could be calculated for 2001-2017. All agricultural products are produced in Viet Nam. Compared to the other sectors is the agricultural sector less impacted by FDI. Revenues due to agriculture account for less than a third, however, as part of these exports was Viet Nam with Thailand, for example, responsible for 50 % of global rice exports in 2009 (Schreier & Pang 2012).

Viet Nam has enough water to be independent from desalination plants, but nonetheless it suffers from partial water stress or scarcity, due to increased exports as a virtual water exporting country. In general, especially, as the industrial footprint data relies on estimates and exact production chain calculation would be necessary for more accurate data, as already discussed. However, shifting the shoe and mobile phone production to Viet Nam can be identified as one major source for water pollution due to an extensive grey water footprint. Therefore, it is important to have a specific look at the water quality data to estimate the increasing impact of industrial operations.

The contradiction of exporting water, even when there is a local need for it highlights that the concept of exporting virtual water, if not regulated, can actually increase the water footprint and can cause long-term or non-reparable damages, due to over-withdrawal and high pollution rates. This is the opposite to what early water trade theorists like Allan (1992) in the early 1990s hoped for. The German Development Institute summarised the diverse criticism from different disciplines on promoting the virtual water trade as a non-realisable strategy for solving water stress without worldwide centrally managed economies, environmentally questionable and causing severe damages, especially for developing countries (Horlemann & Neubert 2007). However, Horlemann & Neubert (2007) point out that, as globally economies shifted toward more liberal and less regulated concepts, they did not take economies like Viet Nam and China into account, with opened planned economies. On a national scale, these economies are more planned and regulated, which can be an advantage in terms of directing patterns of production into a water-wise direction. However, as discussed before, Viet Nam's capital inflow stands now on two private capital pillars, relying to some extent on FDI as an outcome of Doi Moi. Further tools need to be used in order to direct trade patterns and improve quality of investment.

4.3 WTO Entry, FTAs and Environmental Articles

Environmental long-term ramifications need to be considered by steering the economy into a sustainable future. Globalisations have an increasing influence and environmental implications, especially in highly export-oriented economies. Planned economies are like all others entangled in a net of interdependencies and power relationships of a global economy and in order to direct economic developments in a sustainable way and pace, a multi-layered approach is necessary. One example for these entanglements is that Viet Nam is caught in the trap of competing for investment, resulting in national competing interest and fields of regulating regimes: attractive investment environments versus labour and environmental regulations.

A discourse evolved in Viet Nam on the quality of investment, due to the aftermath of fast economic growth with extensive environmental and labour exploitation. Therefore, the long term gains or losses and synergetic effects of, especially FDI, came more into focus. As discussed, Doi Moi resulted in increased productivity and trade, which also caused the necessity to enter into new markets, especially after the collapse of the Eastern Bloc. Viet Nam has a rising regional role in Asia and increased interlinkages within multinational organisations, like ASEAN, APEC and WTO. One tool to direct capital inflow, the creation for increased demand and a bi or multilateral understanding of social and environmental standards can be trade agreements. The main purpose of trade agreements is to open new markets and pave the way for trade and investments. Investments have their impact on productivity as the past chapters argued; however, FTAs and WTO membership create the environment for these investments and market entries. They shape preconditions and demand at the same time, affecting water resources significantly.

Even when the WTO, with Viet Nam as one of the RAMs, plays an important role in influencing trade, past cases showed that it is extremely difficult, especially as one of the less powerful members, to use this institution for environmental standards. This was demonstrated by the shrimp-turtle case against the U.S. (WTO 1998), without getting into the details of this case. The WTO argues that there are already about 200 multilateral environmental agreements (MEAs) and that 20 can affect trade, like the Montreal Protocol for the protection of the ozone layer, the Basel Convention on the trade or transportation of hazardous waste across international borders, and the Convention on International Trade in Endangered Species (CITES). Interestingly, the WTO committee triggered debate:

> *the basic WTO principles of non-discrimination and transparency do not conflict with trade measures needed to protect the environment, including actions taken under the environmental agreements. It also notes that clauses in the agreements on goods, services and intellectual property allow governments to give priority to their domestic environmental policies. (WTO n.d.)*

Therefore, apart from MEAs, FTAs seem as the more likely option to successfully implement social and environmental articles for setting standards and influencing trade patterns.

In international relations, a discourse evolved on how to implement social and environmental standards, especially in fast-growing formerly developing countries. Apart from fair trade and other consumer-based approaches, there are FTAs and WTO negotiations to implementing these standards in form of environmental and social articles. In the field of labour standards some promote the inclusion of social articles in trade contracts (Scherrer et al. 2013) with the following arguments:

1. Standards provide long term economic advantages instead of just short term gains.
2. Standards should be on the long run international as this secures to avoid a race to the bottom due to competition.
3. Even when it is not likely that the WTO would include social and environmental standards in FTA negotiations these standards find increasing acceptance.
4. Financial support and aid can be helpful to establish standards.
5. Sanctions for not non-compliance are necessary, but need to be agreed on with local experts.

This advice can be helpful for social and environmental standards; as similar mechanisms apply.

FTA negotiations seem more promising for generating standards and influencing trade patterns. The current trade agreements in place have to be seen in the light of the already discussed data and, for example, give further explanation for having Japan as one of the major investors and trading partners. The link between trade agreements and being close trading partners is well known and was already shown through the increase of trade after the agreements were in force. Most of the agreements, which are already in force, have no environmental articles implemented and no environmental and social assessment was done earlier. However, the newest trade agreement between Viet Nam and the EU illustrates also a paradigm shift as a Sustainability Impact Analysis (SIA) was conducted during the negotiations. The final report (2009) is part of an overall SIA on the ASEAN-EU trade with special respect to Viet Nam. Negotiations still took several years after the report. The report included four points as possible impacts on environmental quality, fresh and wastewater (European Commission 2009, p. 18):

> • *Effects of the FTA on environmental quality and fresh and waste water relate mostly to increased economic activity, urbanization and consumption as a consequence of the FTA.*
>
> • *The impacts on environmental quality and fresh and waste water will differ per sector and will also depend on the extent to which investments in environmental goods and services sectors will be enhanced (e.g. waste water treatment plant (WWTP) and water supply, recycling, waste management).*
>
> • *As the EU has substantial expertise in this area and is a world leader in environmental technologies, allowing for more investments in such sectors may allow for promoting trade and investment in innovative technologies and best practice implementation in the environmental goods sectors in ASEAN, improving environmental quality.*
>
> • *At sector level the main potential impacts of the FTA in terms of environmental quality, fresh and waste water will likely stem from the fisheries (aquaculture) and the TCF sectors.*

And in more detail, on the sector level (European Commission 2009, p. 39):

> *Generally speaking, the expansion of the textile and footwear sectors in particular warrant close monitoring of health and environmental impacts. Current issues related to chemical usage, fresh water usage, waste and waste water production and poor health and safety standards in particularly the textiles and footwear sectors may be improved through more strict government regulation and pressure from EU importers post FTA, leading to greater overall environmental quality.*

The overall SIA of the FTA is that the FTA will not degrade the environmental situation and that the overall environmental quality will improve. However, in contrary to these predictions an intensification of water stress can be expected as productivity is predicted to increase. In the actual FTA environmental and social articles were implemented, which is a new development in general. Chapter 15 is on trade and sustainable development; environmental and labour standards found their way into the agreement, which was actually a big commitment for Viet Nam (European Commission 2016). However, the implications for Viet Nam's water resources will be probably severe, if the predictions hold and these FTAs actually increase Viet Nam's exports by 50 % in the next years (Nguyen 2017).

Therefore, Viet Nam's water situation has severely deteriorated and even when efforts are made to develop the water infrastructure, these investments would have to be made in the same degree as when the economy grew. The new development of FTAs will have positive impacts, especially through increasing the know-how in environmental technologies and by pushing the implementation of certain environmental regulations. However, the increase in production, especially in sectors likes aquacultures and shoe industry, which have a severe impact on water quantities and quality, will probably increase stress and water resources, especially aquifers and water quality will further decrease.

5 Trading Water Risks for Energy the Global Spread of Hydraulic Fracturing

Fracking is an extreme form of oil and gas extraction that leads to water contamination, air pollution, earthquakes, illness, exacerbates climate change and turns communities upside down.

Mark Ruffalo in EcoWatch 2016

Regulations on water and decisions on industry support or their ban play a major role on an economy's product mix. Therefore, the water footprints of these products in terms of impacting quantities and quality are also linked to these regulations. Water security for current and future generations is highly dependent on the forms of water usage and drivers influencing these. Water risks taken with the implementation of new technologies are a hegemonic battlefield in terms of waging the risks and gains for interest groups.

Hydraulic fracturing is one of these 'new' technologies and can be used to retrieve several forms of gas, as explained in Chapter 5.1.2. This work concentrates on shale gas and coalbed methane, in Australia called coal seam gas, as these are the main sources extracted through hydraulic fracturing. In the U.S. was the gas boom mainly related to shale gas and in Australia to coal seam gas. There were some first mover countries using hydraulic fracturing with the U.S., Canada and Australia at the forefront among many test drills and smaller explorations throughout the world.

As part of rising environmental concerns, growing awareness and the building of a counter hegemonic bloc against hydraulic fracturing, one outcome was that environmental assessments started and in many countries moratoria were held. As these developments started at first in the U.S. and the decision making process in Europe, but also in Australia, were influenced by the U.S. discourse the Australian case is introduced by a subchapter on the U.S. developments. This after giving some more details on the global energy discourse and more detailed information on the technology itself.

Both countries started hydraulic fracturing without an environmental assessment before commercial exploitation and environmental concerns resulted in first bans in some areas. In other areas increased commercial exploitation is practiced leaving extensive water footprints.

5.1 From 'Peak Oil' Discourse to the 'Golden Age of Gas'

The gas revolution – for some it is the golden age of gas, but for others a fight about water resources. Public discourse on peak oil and social unrest in oil resource-rich regions made unconventional energy carriers more attractive and through technical developments and peaking oil prices at the start of the new millennium more feasible. In the light of the international climate change discourse, fossil energy carriers are highly criticised. However, unconventional resources as a replacement have to be seen not just through the lens of carbon footprinting, as they often go along with a deep water footprint. Especially with increasing water stress, the link between energy, water and food gets tighter and, therefore, power struggles with these contradicting interests more intense.

5.1.1 Global Energy Demands and Climate Change Adaption

Even though it has been highly debated for over 50 years when peak oil will come, the discourse got more popular in connection with last decades' Gulf Wars and when fuel prices increase. The discourse got picked up by public media, especially in the U.S., more than ever after Fatih Birol, the chief economist of the International Energy Agency (IEA), predicted it to be before 2030 (Birol 2011; The Economist 2009).

Peak oil's hot topics are: firstly, understanding fossil energy carriers as a finite resource and, secondly, fearing for energy security in high energy consumptive countries. The U.S. Energy Information Administration (EIA) predicts that there will be a steep increase in energy demands and that this increase is mainly linked to increased demands in currently developing countries, especially in Asia. The following graph (Figure 62) shows these predictions in more detail.

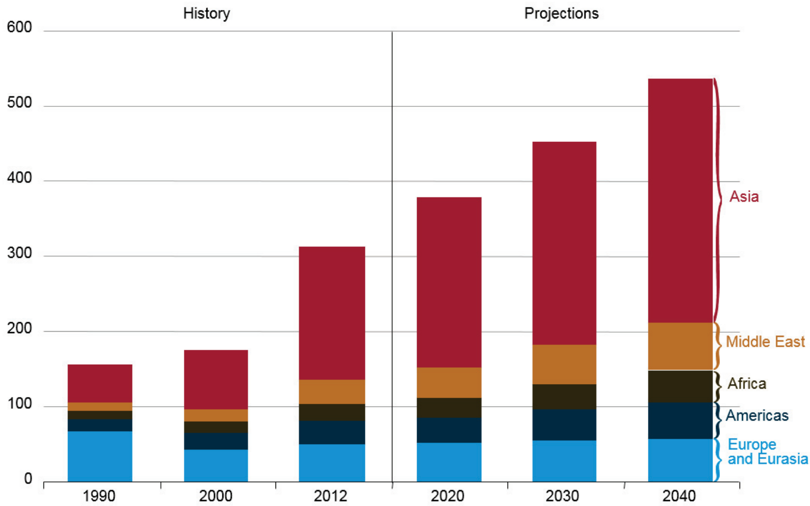


Figure 62: Non-OECD energy consumption by region in the period 1990-2040 (quadrillion Btu) (IEA 2016, p. 9)

In this prediction are India and China counted into Asia and they are the driving countries for this steep development in energy demands. Therefore, the areas with already very high energy consumption are expected to stay at this level, even when a small decrease could be reached between 1990 and 2000, and all other areas will have steep rising energy demands on top. The EIA also predicts in their World Energy Outlook the energy mix development (Figure 63) and assumes that the world's energy consumption will be mainly generated through non-renewable sources: liquids, coal and natural gas.

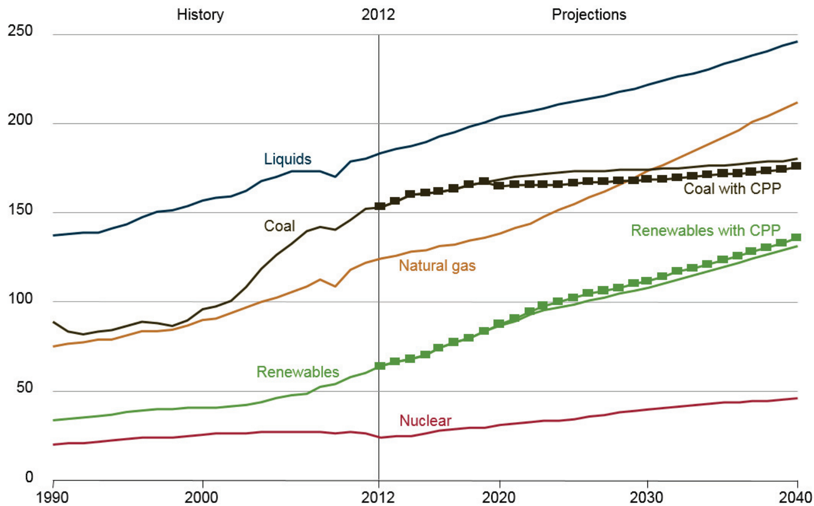


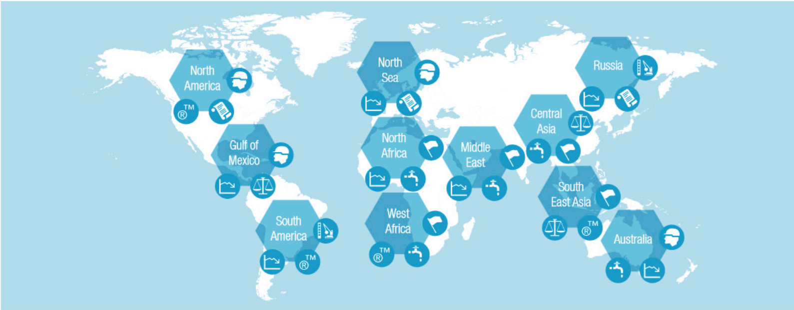
Figure 63: World energy consumption by energy source in the period 1990-2040 (quadrillion Btu) (IEA 2016, p. 9)

They project a steep development of renewable energy sources, but in the lowest market share after nuclear energy. The increase in natural gas consumption assumes that hydraulic fracturing will increase and the steep increase just before 2012 is already related to hydraulic fracturing operations in the U.S. and Canada (IEA 2016). Therefore, this scenario assumes already the *Golden Age of Gas*, which was also the title of their 2011 Special issue report (IEA 2011). Figure 63 also includes two scenarios predicting the Clean Power Plan (CPP) regulations in the U.S. on renewable and coal consumption on a global scale. Therefore, the EIA tried to include some regulative effects on climate change regulations, however, only reflected through the predicted steep rise in renewables.

A new spin on fossil energy carriers got certainly triggered by the Intergovernmental Panel on Climate Change (IPCC) and the IPCC Report (1990), causing a broader acceptance for anthropogenic climate change. The paradigm change results in carbon emission cut-off targets, however, with a globally diverse time frame and extent of implementation. One indicator for an adaption process in the private sector has been the increasing number of companies providing data for the Carbon Disclosure Project, with, in 2008, 49 % of the 128 largest oil and gas companies globally (based on market capitalisation) providing detailed responses (Acclimatise 2009, p. 1). The 'Carbon Disclosure Project Report Global Oil and Gas Building business resilience to inevitable climate change' published in 2009 and sponsored by IBM illustrates the planned measures of the industry (Acclimatise 2009). The report includes an analysis of a global risk landscape for the oil and gas mining industry caused directly or indirectly by climate change. They list eight main risks for these companies and number one and two relate directly to water stress and risks of causing conflict with local communities and other water users on a local, but also national scale (Acclimatise 2009, p. 2):

> *1. Increasing stress on water resources will create operational problems for companies and conflicts with local communities and other water users*
>
> *2. Communities and nations under increasing stress will change the geo-political risk landscape. New challenges will arise for companies' operations in new at-risk area*

The following map shows where these risks are expected by Acclimatise. Conflicting interests with mining companies are mapped in regard to not just water, but also health implications for the work force according to the IBM analysis.



Risk	Impacts	Risk	Impacts
Resource stress	Increasing stress on water resources particularly in central Asia and the Middle East will create operational problems for companies and possible conflicts with local communities and other water users.	Litigation	Business process failures, for example contractual relationships that do not adequately foresee and manage risks driven by climate change, could increase the risk of parties turning to litigation.
Geo-political	Communities and nations under increasing stress will change the geo-political risk landscape. New challenges will arise for companies operations in new at-risk areas.	Workforce	Operating existing assets under changing conditions presents new and changing health and safety risks and challenges for employees.
Reputation	Any failure to monitor and report on the impacts of climate change on social and ecological resources is likely to harm the reputation of a company.	Decommissioning	Current balance sheets may underestimate decommissioning liabilities by failing to recognise the climatic changes that have taken place since the decommissioning costs were assessed at the time assets were first created.
Regulation	Changes in regulations in response to the impact of climate change could increase the operating and compliance costs for existing assets.	Asset performance	Existing plant and equipment were designed on the basis of historic climatic conditions. Their performance may be impaired under changing conditions, increasing the risk of downtime and system failures with HSSE and regulatory implications. Operational costs may increase.

Figure 64: Global risk landscape (Acclimatise 2009, p. 5)

Conflicting water interest risks are mainly seen in Africa, Middle East and Australia, however, the study also emphasises that there is a gap between risks and the risk perception of companies and that their actions to avoid these risks are focused on short term solutions. These short term solutions are in the area of climate change adaption in form of stronger materials for offshore operations. They summarise the results of their questioned companies: ‘Some companies do not appear to recognise that the risk landscape is changing – 6 % reported potential civil and geo-political risks and only 3 % identified adverse risks for local communities’ (Acclimatise 2009, p. 16). Therefore, actions in terms of water scarcity are taken, if there is not enough water for their operations to run, but long term implications are not considered. An example for this context is the BHP Billiton’s enlargement of uranium mines above the Great Artesian Basin in Australia, where they had to build a desalination plant due to water shortages (Mudd 2007) also pictured in the documentary *Uranium is it a country?* (Auth, Huber & Schnatz 2008).

In terms of water scarcity and implications for the gas and mining sector, a feared change in U.S. legislation with regard to hydraulic fracturing is first named in the final summary of the IBM report (Acclimatise 2009, p. 21):

> *Due to concerns over water shortages and access to safe drinking water, legislators in four states in the USA want to pass a bill regulating companies' use of hydraulic fracturing. According to a study undertaken by the American Petroleum Institute, US oil and gas production would drop 20.5% over five years if federal regulation of hydraulic fracturing becomes law. (PennEnergy (2009) Study finds that US production would dip under hydraulic fracturing law). Climate change would increase the likelihood of such bills being passed, though added pressure on water resources.*

The awareness is rising on the conflict potential due to water competition and it can be assumed, that this will be increasingly considered in form of starting operations, preferably in regions with less conflict potential.

In the light of the climate change and energy crisis discourse, unconventional gas seemed as an especially elegant solution, as it is considered to have a smaller carbon footprint compared to other fossil energy carriers. Subsequently, the publication by Howarth, Santoro & Ingraffea (2011) caused severe criticism, as they questioned former assumptions on the climate 'cleanness' of hydraulic fracturing. Their calculations even go so far as to claim that the greenhouse gas footprint of natural gas obtained by hydraulic fracturing is not only much bigger than expected, instead the footprint seems to be even bigger than the coal footprint due to methane emissions. This example illustrates that unconventional resources are in the centre of a global energy crisis debate and often seen through the lens of carbon footprinting, but more attention needs to be paid to further environmental impacts. In general, the environmental impacts of unconventional resources, like tar sand, biofuel, coalbed methane and shale gas are highly publicly debated and criticised (Greenpeace 2010; Harrison 2011). Increasingly, a more holistic environmental impact assessment is requested as energy production is not just linked to climate change, but in the middle of Energy-Soil-Water-Food Nexus.

However, the rhetoric of energy independence is reoccurring with every new U.S. president, but it shifted after the attacks on September 11 in 2001 to 'enhance energy security' through expanding the types and sources for the U.S. energy supply from the following areas: 'Western Hemisphere, Africa, Central Asia, and the Caspian region' (The White House 2012, p. 19), therefore, to avoid the Middle Eastern suppliers. The U.S. developed in between their strategy towards energy independence, therefore to have the production in their own hands. This shift can be also recognised in the 2015 strategy under Barack Obama, as there the energy chapter is called 'Advance Our Energy Security' and it starts with 'The United States is now the world leader in oil and gas production' (The White House 2015, p. 16). This shift was only possible due to a new found resource abundance accessible through hydraulic fracturing, making the U.S. gas boom possible, which is one of the pioneer countries to actually develop unconventional resources.

That the development of drills is more problematic in Europe, like in France, where hydraulic fracturing got banned in 2011 (Bloomberg 2013) and more likely in China was already foreseen in 2010 by the EIA outlook:

> *The outlook for unconventional natural gas production is more positive in China than in OECD Europe first and foremost because China's geology suggests a greater unconventional resource potential than in Europe. Further, although natural gas production from conventional resources in China, as in Europe, cannot keep up with domestic demand, China's government strongly supports unconventional gas development, and public resistance is likely to be less of an impediment in China than in OECD Europe. (U.S. Energy Information Administration 2010, p. 50)*

With a rising pressure due to growing energy demands, it can be assumed that developing countries are more likely to compromise their water resources for energy supplies, if it is possible to extract them.

5.1.2 Hydraulic Fracturing, History and Distribution

Globally several drivers increased unconventional resource exploration and production with most popular examples: Venezuela's crude oil, Canada's tar sand, U.S. shale gas and Australia's coal seam gas explorations, with further test drillings or starting explorations in China, Europe and South America. Comparable to the green revolution in agriculture, research and development caused a shift in the expected fossil fuel production. New techniques made it possible to reach or generate resources, which were assumed to be unreachable or rising oil and gas prices made expensive methods worthwhile. If new techniques are applied, they are referred to as unconventional resources. Main types of unconventional liquid resources:

- Oil shale
- Coal-to-Liquids
- Tar Sand
- Biofuel
- Natural gas plant liquids
- Extra heavy oil or crude oil.

The main types of unconventional gas resources:

- Tight gas
- Coalbed methane or Coal seam gas (term mainly used in Australia)
- Shale gas
- Gas hydrates.

The main ones are the first three and therefore will the focus be set on these, with coalbed methane and shale gas as the main ones, due to their relatively higher distribution.

In the gas sector, a combination of two techniques triggered the gas revolution: hydraulic fracturing and horizontal drilling. Hydraulic fracturing is a mining method developed by Halliburton firstly used in 1947, Kansas, for flow stimulation of natural gas. The main feature of this combined technique is that a mixture of water, sand and chemicals is sent with high pressure into deep horizontal drillings producing rock fractures as shown in Figure 65.

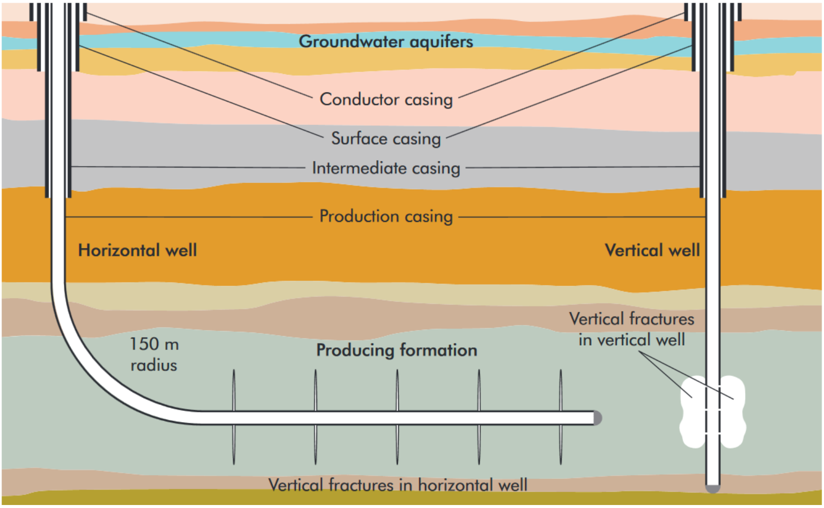


Figure 65: Horizontal well with multiple hydraulic fractures (IEA 2013, p. 177)

Unconventional gas is one of the major prospects in terms of extended fossil energy supplies, as this drilling technique makes gas reserves of tight gas, coalbed methane and shale gas accessible, claims the IEA (Lynch 2009). The estimations on these overall extractable resources is an ongoing process and under constant revision, as the following table (Table 24) shows, especially additional unknown occurrences are in the unconventional gas sector very high. Figure 66 and Table 25 show the estimated distribution in more detail by region.

Table 24: Fossil and uranium reserves, resources and occurrences (GEA 2012, p. 431).

	Historical production through 2005 in EJ	Production 2005 in EJ	Reserves in EJ	Resources in EJ	Additional occurrences in EJ
Conventional Oil	6 069	147.9	4 900-7 610	4 170-6 150	
Unconventional Oil	513	20.2	3 750-5 600	11 280-14 800	> 40 000
Conventional Gas	3 087	89.8	5 000-7 100	7 200-8 900	
Unconventional Gas	113	9.6	20 100-67 100	40 200-121 900	>1 000 000
Coal	6 712	123.8	17 300-21 000	291 000-435 000	
Conventional Uranium	1 218	24.7	2 400	7 400	
Unconventional Uranium	34	n.a.		7 100	>2 600 000

Reserves, resources and occurrences of uranium are based on a once-through fuel cycle consumption. Closed fuel cycles and breeding technology increase the uranium resource dimension 50-60 fold. Thorium-based fuel cycles would enlarge the fissile-resource base further.

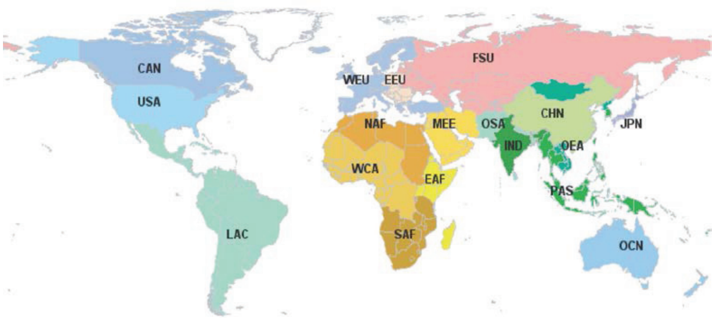


Figure 66: Detailed GEA regions (GEA 2012, p. 1816)

Table 25: Unconventional gas resource potential (without hydrate) adapted from GEA (2012, p. 455)

Region	Resource Potential in EJ				
	Coalbed Methane	Deep Gas	Shale Gas	Tight Gas	Total
USA	1 677	1 677	4 098	1 416	8 868
CAN	559	373	373	820	2 125
WEU	559	186	559	186	1 490
EEU	186	186	559	186	1 117
FSU	1 863	1 863	5 402	1 304	10 432
NAF	373	559	373	373	1 678
EAF	186	186	186	186	744
WCA	186	559	745	559	2 049
SAF	186	186	186	186	744
MEE	186	559	373	745	1 863
CHN	1 490	186	186	186	2 048
OEA	37	37	186	186	446
IND	559	186	186	186	1 117
OSA	112	373	559	373	1 417
JPN	112	0	0	0	112
OCN	373	186	373	186	1 118
PAS	112	186	186	373	857
LAC	559	559	373	559	2 050
TOTAL	9 314	8 048	14 903	8 010	40 275

The distribution of gas resources paint a very different picture of the world's energy resources compared to the oil resource distribution. In particular, high energy demand countries would have the possibility to be more independent from gas or oil imports or even become exporters, with the U.S. having stepped already into that direction. However, these are only estimates, as especially with running mining activities data is getting more accurate and often further resources getting explored.

Whether the exploitation is feasible also depends on the available already discovered quantities. These amounts are an important part in the decision making process on the feasibility of further developments, especially if resistance against the operations can be expected. The overall picture of the gas reserves, which can be reached through hydraulic fracturing is led by the USA and FSU region (Figure 66). The OCN resource potentials are mainly related to Australia. China has nearly double the amount of resource potential than India and by recent estimates even larger amounts than the U.S., however, these are more difficult to reach (Tollefson 2013). Figure 67 shows an overview of drilling activities for coalbed methane.

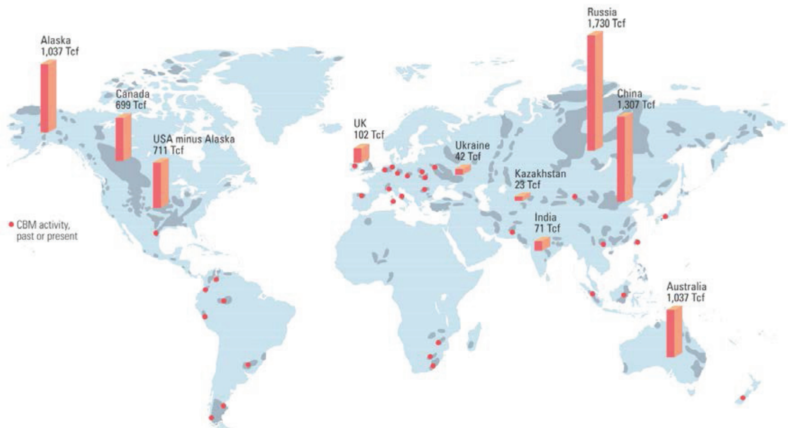


Figure 67: Coalbed methane reserves and activity in 2009
Major reserves (dark blue) of the 69 countries with the majority of coal reserves, 61 % have recorded some form of coalbed methane activity – investigation, testing or production
(Al-Jubori et al. 2009, p. 5)

However, as Table 25 demonstrated, the shale gas resource potentials are on a global scale even more relevant, as they are a third larger than the coal seam gas potentials. In 2009 were shale gas drills mainly in the U.S. and China had set plans to boost the annual shale gas production from near zero in 2013 to 2 trillion cubic feet (Tcf) in 2020 (Tollefson 2013). In Europe is the leading country with test drills in 2009 Poland, followed by explorations in Germany, Spain, Ukraine and the UK

(Lynch 2009). In 2016, four countries are exploiting shale gas on a larger scale: United States, Canada, China, and Argentina and the IEA projected, that it is most likely that Mexico and Algeria are the next countries with commercial explorations (IEA 2016).

In summary, exploration of unconventional energy carriers increased generally. Hydraulic fracturing stepped from a local to a global scale.

5.1.3 Environmental Assessment of Hydraulic Fracturing with a Focus on Water

Water concerns in regard to hydraulic fracturing, similar to other products, are in general two folded: pollution and withdrawal. These water concerns are getting intensified by the circumstance, that most shale basins are in already water stressed regions as Figure 68 shows.

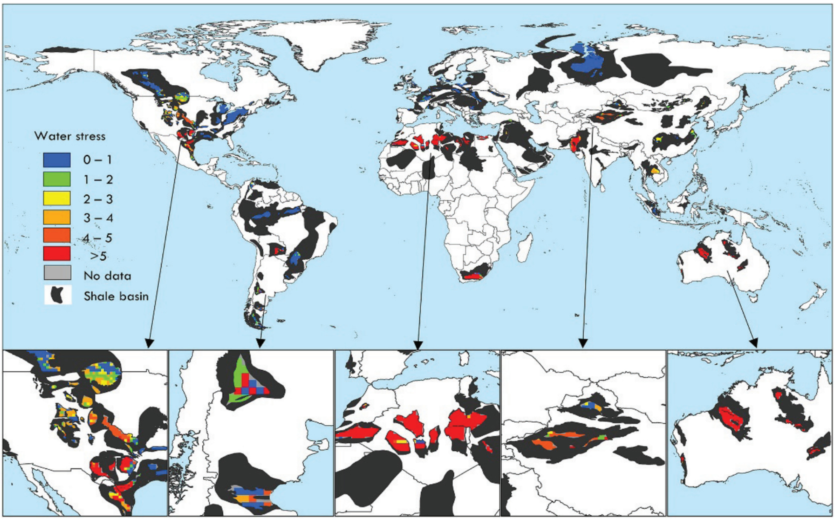


Figure 68 Map of water stress within shale deposits. Pixels with water stress indexes greater than one are subjected to unsustainable water consumptions (i.e., water consumption for human activities exceeds the limit imposed by environmental flow requirements). Rosa et al. (2018, p. 749)

This makes an environmental water assessment even more relevant as in these areas are water usage regimes already a contested ground.

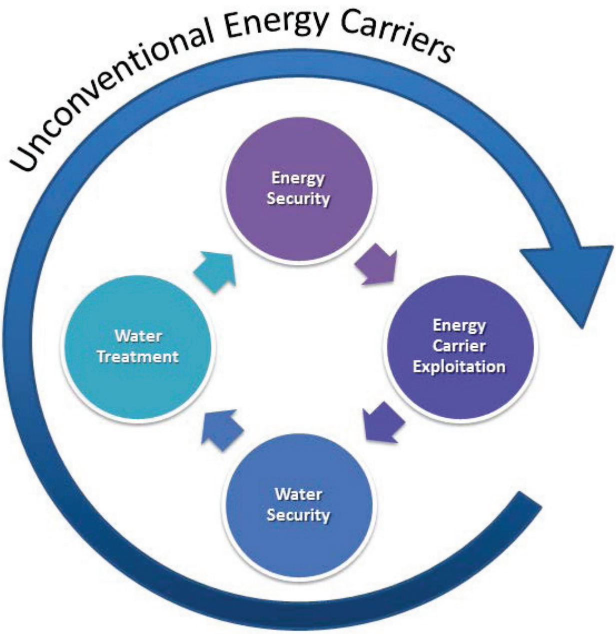


Figure 69: Unconventional Resources-Wastewater-Energy Nexus

Especially in water scarce surroundings there is the danger of reinforcing the water crisis through unconventional energy carriers (Figure 69). A water crisis through pollution and scarcity can also impact the energy crisis as wastewater treatment or desalination plants are highly energy consumptive. In the executive summary of the World Energy Outlook (2016) it is calculated, that the energy sector is responsible for 10 % of global water withdrawals, mainly for power plant operation, as well as for production of fossil fuels and biofuels. Water is essential for all phases of energy production. They predict a future growth in water requirements, especially for water that is consumed, but not returned to the source in adequate quality. Therefore, hydraulic fracturing can play a quite severe role in the energy-water nexus, impacting also other elements like air and soil.

One outcome of the heated discussion on the environmental implications of hydraulic fracturing in the U.S. was that the EPA was pushed, as they formulate it ‘urged by the congress’ (U.S. EPA 2016, p. 1), to generate an environmental assessment on hydraulic fracturing. Elsewhere, for example, in Germany, this report was long awaited, as the U.S. is seen as a large field study on the environmental implications of hydraulic fracturing (Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen 2012, 7 September; Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen 2014).

The EPA Report (2016, pp. 1–2) considered five major environmental impacts and all of them have a direct or indirect implication on water:

> *The following combinations of activities and factors are more likely than others to result in more frequent or more severe impacts:*
>
> • *Water withdrawals for hydraulic fracturing in times or areas of low water availability, particularly in areas with limited or declining groundwater resources;*
>
> • *Spills during the management of hydraulic fracturing fluids and chemicals or produced water that result in large volumes or high concentrations of chemicals reaching groundwater resources;*
>
> • *Injection of hydraulic fracturing fluids into wells with inadequate mechanical integrity, allowing gases or liquids to move to groundwater resources;*
>
> • *Injection of hydraulic fracturing fluids directly into groundwater resources;*
>
> • *Discharge of inadequately treated hydraulic fracturing wastewater to surface water resources and*
>
> • *Disposal or storage of hydraulic fracturing wastewater in unlined pits, resulting in contamination of groundwater resources.*

Based on these areas of risk, a water life cycle analysis was conducted with these five steps (Figure 70).

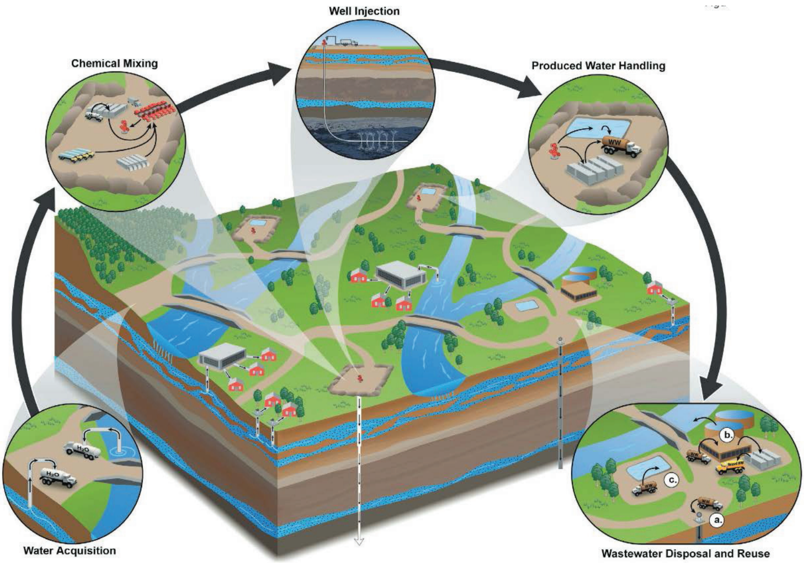


Figure 70: The five stages of the hydraulic fracturing water cycle. The stages (shown in the insets) identify activities involving water that support hydraulic fracturing for oil and gas. Activities may take place in the same watershed or different watersheds and close to or far from drinking water resources. Thin arrows in the insets depict the movement of water and chemicals. Specific activities in the 'Wastewater Disposal and Reuse' inset include (a) disposal of wastewater through underground injection, (b) wastewater treatment followed by reuse in other hydraulic fracturing operations or discharge to surface waters, and (c) disposal through evaporation or percolation pits. (U.S. EPA 2016, p. 8)

Since this report, more exact data is available on withdrawal rates throughout the life cycle of a well (Figure 71 and Table 26):

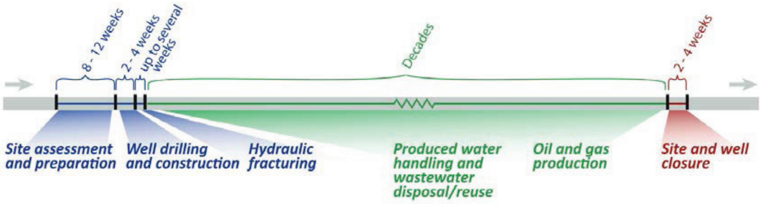


Figure 71: General timeline and summary of activities at a hydraulically fractured oil or gas production well (U.S. EPA 2016, p. 4)

Table 26: Water use per hydraulically fractured well between January 2011 and February 2013 (U.S. EPA 2016, p. 11)

State	Number of FracFocus disclosures	Median volume per well in million litres
Arkansas	1 423	19.9
California	711	0.3
Colorado	4 898	1.8
Kansas	121	5.5
Louisiana	966	19.2
Montana	207	5.5
New Mexico	1 145	0.7
North Dakota	2 109	7.7
Ohio	146	14.7
Oklahoma	1 783	9.8
Pennsylvania	2 445	15.8
Texas	16 882	5.4
Utah	1 406	1.1
West Virginia	273	19.0
Wyoming	1 405	1.2

The report considered not just withdrawal rates with reuse flows in the U.S., as Table 26 illustrates, but also qualitative impacts. These impacts were accessed through identifying the pollutants in each step. The lack of data was an obstacle to this environmental assessment, even though the contested ground in the U.S. paved the way for opening up some of the companies' data on pollutants. A database on U.S. drills can be reached on www.fracfocus.org; managed by the Ground Water Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC).

The discourse on hydraulic fracturing is also a communication battle of risk perception, with one side showing risks, like in the two sequences of the documentary Gasland (Fox 2010; Fox 2013) and on the other side ample lobby groups downsizing them (EID 2012). In this context it is important to know which data is used for the footprint or LCA assessment calculations often presented to support one or the other side. An example for a misleading direct water footprint calculation is the article: Water footprint of Hydraulic fracturing by Kondash & Vengosh (2015). In their article they called their results the first 'overall water footprint of hydraulic fracturing' (Kondash & Vengosh 2015, p. 276) and came to the result, that:

> *While new exploration of unconventional shale gas and oil formations in the United States has increased the overall water use for hydraulic fracturing (a total of 940 billion liters from 2005 to 2104) and has generated new sources of highly saline and toxic wastewater (a total of 775 billion liters), our water use and produced water intensity evaluation indicates that hydraulic fracturing is not extracting more water and generating more wastewater relative to conventional oil or coal mining while normalized to the energy production. (Kondash & Vengosh 2015, p. 279)*

Even though this article claims to calculate the overall water footprint of hydraulic fracturing, it only calculates, on top of the withdrawal rates, the amounts of wastewater, but not the impact of the wastewater on the water systems. This is an even less appropriate quantification of the pollution caused by the process, than to calculate it like Hoekstra & Chapagain (2008) with a dilution factor. Therefore, these quantifications can be misleading, as several impacts are not considered, but a whole assessment is suggested. The direct water footprint is therefore not just a tool to calculate personal, regional or national footprints based on estimates, it can also be a powerful tool used as an argument in discourses on water security as a very different picture can be created. Therefore, it is important, when analysing discourses using water footprinting data, to analyse on which data sets, which assumptions and which methods the calculations are based on.

5.2 The Hydraulic Fracturing Discourse in the USA and Australia

In general, as a recapitalisation, establishing hegemony is seen as a process of power struggles between different interest groups shaping the discourse on issues. Hegemony, in the tradition of Gramscian thought and Lukes's (1974) dimensions of Power, includes not just the domination of a political debate and ability of a hegemon to quiet public dissent by force, more so, the capacity to shape interests of antagonists in order to reach consensus in favour of the hegemon's interests (Wullweber 2009a). The hegemon is therefore the party which was able to shape the discourse in its favour. In the case of hydraulic fracturing, there are two main positions: implementing the technology or not and ample interest groups try to shape the discourse into one direction or the other.

In between these positions is the field of implementing it to a certain extent and under certain conditions. There are three main scenarios identified as nodal points:

1. unconventional gas exploitation ban (complete and temporary)
2. moratorium (an environmental assessment is in the process and the political decision making process on its way, mostly test drills are allowed during that)
3. large scale, mostly commercial exploitation (with and without environmental regulations on the most hazardous aspects of the process)

Scenario 2 represents an undecided stage, while scenario 1 and 3 is more outcome in its outcome. However, hegemonic discourses are not at a halt and have to be fought again and again, as otherwise the outcome or nodal point can swing back one way or the other.

Discourses are getting shaped by ample interest groups, which form coalitions on certain issues and others on others. Regulations on the sector like the obligation to treat the fracturing fluid are also an outcome of these discourses, therefore each nodal point can be shaped differently. Furthermore, different actors or actors in different structures shape discourses differently. So, what worked in France, where hydraulic fracturing got banned in 2011 (Bloomberg 2013), probably will not work in the USA and vice versa, as there are different constellations of allying interest groups. Furthermore, it is important to consider whether in the area of a ban are actually reserves, which can be exploited to a feasible volume, as shifting the hegemonic discourse towards a ban is considered to be much easier, if there is not much of an interest to exploit resource as there is a lack of them. If there are no interests, not much of a counterhegemonic effort is necessary to swing the discourse. Therefore, each nodal point has also to be seen its geological environment.

The U.S. serves as an example for an unconventional gas industry pioneer country driven by national security aspirations. A prelude to Australia's case as an energy exporting country with an emerging competition for water resources between two major economic pillars: energy carriers and agriculture.

5.2.1 Prelude in the United States

The United States has been a pioneer in using hydraulic fracturing for commercial extraction and has the second highest estimated reserves (Tollefson 2013). These ambitions have to be seen in the context of high aspirations for energy autarky due to lost conflicts over external energy supplies.

At the same time, the U.S. is an example for a hot peak oil debate as currently one of the top energy consumers, however, predicted to be overtaken by China until 2020 (EIA 2010) . Former U.S. president Obama summarised planned policies on 30 March 2011, as follows:

> *We cannot keep going from shock to trance on the issue of energy security, rushing to propose action when gas prices rise, then hitting the snooze button when they fall again. The United States of America cannot afford to bet our long-term prosperity and security on a resource that will eventually run out. Not anymore. Not when the cost to our economy, our country, and our planet is so high. Not when your generation needs us to get this right. It is time to do what we can to secure our energy future. President Obama, March 30, 2011 (The White House 2011)*

The White House (2011) published the *Blueprint for a secure energy future* and expands on how the U.S. wants to secure their energy future. Apart from enhancing energy efficiency a two folded plan is proposed:

> *Expand Safe and Responsible Domestic Oil and Gas Development and Production Lead the World Towards Safer, Cleaner, and More Secure Energy Supplies ... And, because we know we can't just drill our way out of our energy challenge, we're reducing our dependence on oil by increasing our production of natural gas and biofuels, and increasing our fuel efficiency. (The White House 2011)*

Therefore, biofuels and unconventional gas resources seem to be the solution for securing U.S. energy security. President Obama's 2011 statement acknowledges the link between fossil fuels and environmental costs, however, in the light of the U.S. increasing market share of unconventional gas explorations, this link could only be made by considering unconventional gas as a low carbon emission energy carrier. Unfortunately for Obama's argument, since the Howarth, Santoro & Ingraffea (2011) study unconventional gas is criticised for its greenhouse gas footprint, affecting climate change.

During campaigning for presidency, Senator Obama got already criticised in 2008 by his competitor, Senator Hillary Clinton, for voting for the 2005 Bush administrations energy bill (Energy Policy Act of 2005 2005) for subsidising oil companies (Murray 2007). This energy policy act of 2005 is a forerunner of the 2011 plan and got not only criticised for its subsidies. Especially, SEC 322 (Energy Policy Act of 2005 2005) is highly criticised, as it exempts the mining technique hydraulic fracturing from the Safe Drinking Water Act. Later on, this act was also called the 'Halliburton Loophole' (Hand 2017; Hauter 2015; Horn 2017), as it exempted hydraulic fracturing from EPA water monitoring in favour of the patent holding company: Halliburton. Media criticism concentrated on promoting mining techniques, firstly, without drinking water risk assessment and, secondly, for Dick Cheney being Vice President at that time (2001-2009). He was the former Halliburton CEO, which gets estimated 5 % of its revenues from hydraulic fracturing (Houston Chronicle 2003). The promoters of hydraulic fracturing were, therefore, that powerful to be able to change the rules in place, by exempting hydraulic fracturing from environmental regulations.

Since 2005, unconventional gas exploitation rocketed in the U.S., although criticism and environmental concerns also formed. Public debate peaked at the issue of hydraulic fracturing drills above and under New York water supplies and resulted in three major changes in 2011, since the energy policy act of 2005:

- Companies using hydraulic fracturing publish the chemical substances in the fracturing fluid, like Halliburton (Halliburton 2011).
- The environmental protection agency (EPA) got the assignment to conduct a study on effects hydraulic fracturing can cause water resources, which was expected to be finished in 2012, but was finalised in 2016 (U.S. EPA 2016).
- High public awareness of the issue and calls for banning the technology. Example: New York Times conducted a research project in order to find a solid case to link hydraulic fracturing with drinking water contamination and found one: Parsons, 1987 (Urbina 2011).

In summary, hydraulic fracturing in the U. S. showed, that there are drivers strong enough to push for domestic energy carrier exploitation by using hydraulic fracturing.

However, since 2005, the U.S. economy had several turning points, with the then new Obama administration having to deal with the financial crisis. The changed political climate combined with growing public awareness on drinking water supply risks caused the first regulatory steps by initiating the risk assessment by EPA, whose outcome was already used in Chapter 5.1.3 to demonstrate the environmental implications of hydraulic fracturing.

Hydraulic fracturing was therefore also a topic of debate in the 2016 election campaigns, when Donald Trump as an election candidate stirred up criticism from oil and gas companies, which were supporting his election campaign:

> *I'm in favor of fracking, but I think that voters should have a big say in it," Trump said in the interview. "I mean, there's some areas, maybe, they don't want to have fracking. And I think if the voters are voting for it, that's up to them."(Cama 2016).*

This has to be seen in the context of a growing discourse on banning hydraulic fracturing and ample campaigns pushing for regulations for the industry and a growing number of local bans answered by several PR agencies of the oil and gas industry. There are ample glossy brochures and television spots (distributed through YouTube) downsizing the risks of hydraulic fracturing and emphasising the technological skills of their engineers and safety of the process (Chesapeake Energy 2012; ConocoPhillips 2011; ExxonMobil 2011; MarathonOilCorp 2012). A critical discourse analysis shows that their main instruments are to use the words 'safe', 'clean' and 'healthy' on several occasions or comparing the fracturing fluid substances to seemingly harmless substances or even food. Families, which all follow the traditional stereotype of family are shown. They combine workers with helmets and 'scientists' dressed in lab coats to communicate professionalism. They all commonly show that the drilling goes very deep and that it is far away from groundwater aquifers. In order to show the depth and extend of the drills the distance is illustrated by, for example, piling up Empire State buildings.

Most furores in expressing concerns made the documentary movie Gasland (Fox 2010) and later its sequel (Fox 2013), which picked up the issue in a catchy way using also social networking and a modern designed page (Gasland n.d., www.gaslandthemovie.com) to organise activism against hydraulic fracturing. The documentary sequel had a major impact on shifting the discourse in the U.S., but also globally, especially in Australia. In the movie trailer Josh Fox says: 'the war on who is gonna tell the story is on' (Fox 2010). The first movie shows the process and health implications in shocking pictures and, on several occasions, snippets of a YouTube video are shown, which travelled around the world through social media, showing a farmer firing up his tap water (Gas Drilling Awareness Coalition 2011). This picture is one puzzle stone in shifting the discourse against commercial exploitation and has had actually more impact than other arguments, which were less impressive to watch. That a household water tap can be set on fire is actually only in a very few cases imaginable, as this can only occur if the house is supplied by a decentralised well and both boreholes are close to each other.

Fox's burning tap was actually one of the main issues, when the oil and gas industry answered Josh Fox's declaration of a communication war on hydraulic fracturing. A website got launched in 2009 by the Independent Petroleum Association of America (IPAA): www.energyindepth.org (Energy in Depth n.d.). Energy InDepth has declared their goals as follows:

> *is a research, education and public outreach campaign focused on getting the facts out about the promise and potential of responsibly developing America's onshore energy resource base – especially abundant sources of oil and natural gas from shale and other "tight" formations across the country (EID n.d.).*

One of their campaigns was to publish a detailed list of inaccuracies in Gasland I and II. They also produced a movie called *Truthland* (2012) with the main goal to discredit Josh Fox in person and his movie, which was globally successful in triggering shifts in discourse.

Another documentary movie is notable in the discourse on hydraulic fracturing, which was criticised for its hydraulic fracturing industry stand called FrackNation, which also claims to tell the truth (Fracknation 2017). On the movie's webpage the movie makers claim:

> *In FrackNation journalist Phelim McAleer faces threats, cops and bogus lawsuits questioning green extremists for the truth about fracking. McAleer uncovers fracking facts suppressed by environmental activists, and he talks with rural Americans whose livelihoods are at risk if fracking is banned. Emotions run high but the truth runs deep. (Fracknation 2017)*

The movie was another reply to Gasland, but had a much bigger impact than Truthland and got picked up by lobby groups in the European decision making process in form of organising public screenings (Young Petro 2014). That these movies are on both sides of the discourse is also reflected in the conflict of a small movie festival (Frozen River Film Festival) in the U.S., where the decision, if one or the other movie is shown stirred up controversies, especially, after only Gasland II was shown (The Washington Free Beacon 2014).

Resistance against hydraulic fracturing spread and also forms of protest changed according to technological developments and highly sophisticated activism in form of global mapping got increasingly used Figure 73.

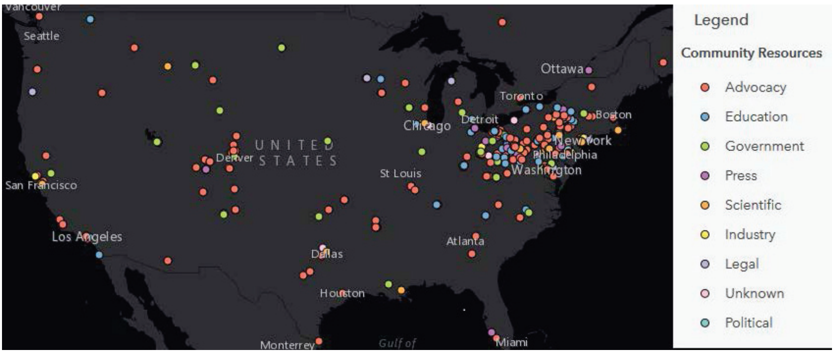


Figure 72: Fracktracker Alliance Map (Fracktracker Alliance 2017b)

The webpage www.fractracker.org documents spills, new mining projects, health data, new legislations, but also has provided a good overview of activist groups working on hydraulic fracturing (Figure 72). In 2016, a total number of 1 182 278 wells was distributed throughout the U.S., however, these are just the ones counted of the responding companies in the study (Fracktracker Alliance 2017a). The following map (Figure 73) gives an overview of the geographical positioning of people next to these mining operations in the U.S.:

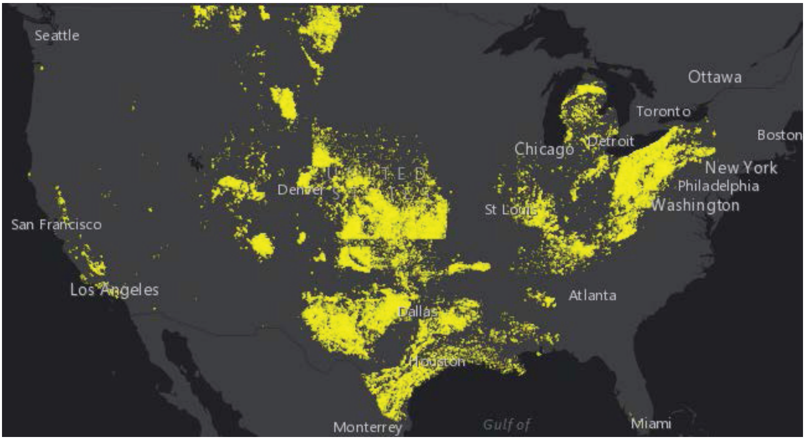


Figure 73: Threatened population in the U.S. (Oil and Gas Threat Map 2017)

This information makes it much easier for the people living in proximity of wells to form resistance.

These alliances also spread not just nationally; they are also well connected internationally. However, in the U.S. are bans for this industry spreading on several scales, as cities, municipalities and federal states started with moratoria and ample communities voted for a ban of hydraulic fracturing operations in their area. On local scale, ample communities voted against hydraulic fracturing, but the extent of these 'bans' differs in form and the number of years they are valid. The following overview shows the local bans of hydraulic fracturing in place in the U.S. mapped by Food and Water Watch, an NGO working among other topics on hydraulic fracturing (Figure 74):

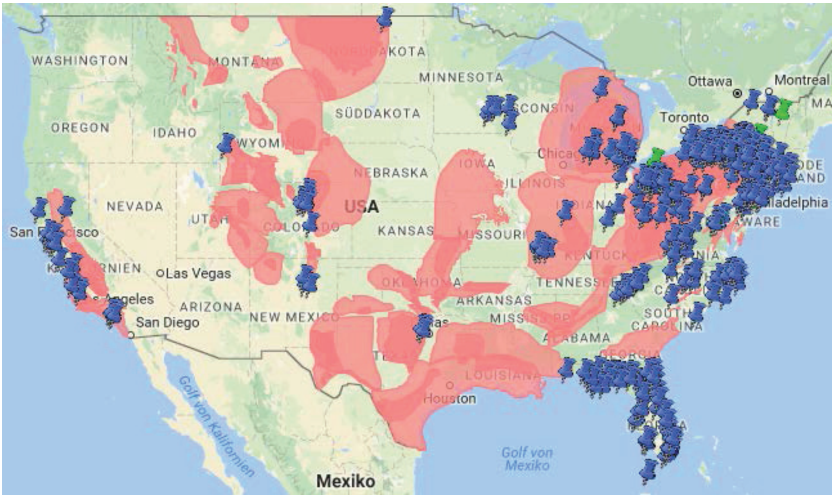


Figure 74: Local resolutions against fracking (Grant 2017)

In March 2017, Maryland, the first ban established in a state with proven exploitable gas reserves (Hicks & Wiggins 2017), but they are very low compared to others. This ban was compared to the more symbolic 2012 ban in Vermont, where hydraulic fracturing was banned, but no reserves are detected anyway (CNN 2012; Wood 2017).

The situation in the U.S. and the overall discourse on hydraulic fracturing is shifting after the swift introduction of the new mining technology, however, these shifts take place mainly on the small local scale and the federal situation did not change that much, especially considering that bans could be mainly established in areas without many reserves.

5.2.2 Australia

Australia is one of the driest continents and a major energy carrier exporter with an expanding market in unconventional gas. In 2016, 18 % of the gas production derived from coal seam gas (internationally called coalbed methane) (Water Act 2007: Basin Plan 2012). A continent with rocketing mining activities during the last decades and unconventional gas drilling activities.

Water stress led already to a politically tense situation, especially in times of drought, when cities are under water restrictions irrigators have only sparse flows. In times without immediate drought irrigators and the state fight over minimum flows to keep the aquatic ecosystem alive. The mining industry adds to these water conflicts as another party using severe amounts of water. The discourse on the water implications of the enlargement of the Roxby Downs Olympic Dam uranium mine has been an example for the contested water grounds in Australia and was the subject of ample PhDs from several disciplines (Apukhtina 2016; Johnson 1993; Shao 2017). The mining operation had to use a desalination plant in order to supply enough water from the Great Artesian Basin (Roxby Water 2017), which was otherwise too saline and brackish. Ample environmental implications were criticised: used water quantities, direct pollution through the mining process and brine discharge, which all have a severe effect on marine life (Botelho et al. 2011). Therefore, the 'new age of gas' came into a political environment in Australia with already established hegemonic and counterhegemonic interest groups formed and aligned around water.

Due to droughts and water scarcity, it is surprising that Australia is one of the leading virtual water exporters worldwide, as an exporter and total net exporter (Chapter 3.2.3, Table 11), and especially the Murray-Darling and Great Artesian Basins are suffering. Australia has, apart from mining, a strong economical pillar in agriculture and one of the highest percentages of organic farming worldwide (Neales 2014). A coexistence of farming, especially organic, and coal seam gas mining is highly contested; expressed mainly through water quality concerns. Therefore, resistance forms by rural landholders and diverse other interest groups with a uniting concern on water quantities and qualities.

The Australian economy is export oriented and relies mostly on exporting minerals and fuels (Figure 75) with a share of 42.6 % followed by services with 20.9 % and food production with 13.3 %. So, nearly 50 % of the economy relies on mining.

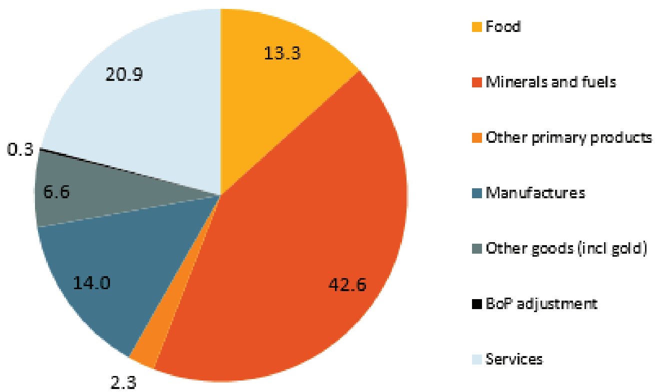


Figure 75: Composition of Australian exports in 2015 (Australian Trade Commission 2016)

In the past Australia's economy centred on agriculture and was described with the saying: 'riding on the sheep's back' due to wool production as a supply for Great Britain. Wool is not any more even in the top 10 and not many ships are still heading towards Europe. The main trading partners are in Asia and trade with the U.S. is mainly service related (Table 27).

Table 27: Top 10 exports of goods and services in 2015
(Australian Government Department of Foreign Affairs and Trade 2015)

Ranking	Goods and Services	Billion AUD	Share in %
1	Iron ores and concentrates	49.1	15.4
2	Coal	37.0	11.6
3	Education-related travel services	18.8	5.9
4	Natural gas	16.5	5.2
5	Personal travel (excluding education) services	15.9	5.0
6	Gold	14.5	4.5
7	Beef, f.c.f.	9.3	2.9
8	Aluminium ores and concentrates (including alumina)	7.5	2.4
9	Crude petroleum	6.0	1.9
10	Wheat	5.8	1.8
	Subtotal	180.4	56.6
	Total	318.7	100.0

Coal makes Australia especially one of the major global energy carrier exporters highly linked to China’s increasing demand, as one of their major trading partners in total, but even more so, if only the merchandise exports are considered (Table 28) and trade in services excluded (UNCTAD 2016).

Table 28: Main merchandise export destinations 2015-2016
(Australian Government Department of Foreign Affairs and Trade 2016)

Main Export Destinations	Share in %
China	30.8
Japan	14.7
South Korea	7.3
U.S.	5.6
India	3.9

Trade can be expected to increase with China and is linked to the China-Australia Free Trade Agreement (ChAFTA) entered into force on 20 December 2015 (Australian Government Department of Foreign Affairs and Trade 2017a). After coal, Liquefied Natural Gas (LNG) is the next biggest fast growing sector, mainly due to gas extraction with the help of hydraulic fracturing. Due to resource abundance and low population numbers, even with high per capita consumption, energy production is not driven by seeking energy autarky. The energy flow graph shows the import and export mix in 2016 (Figure 76):

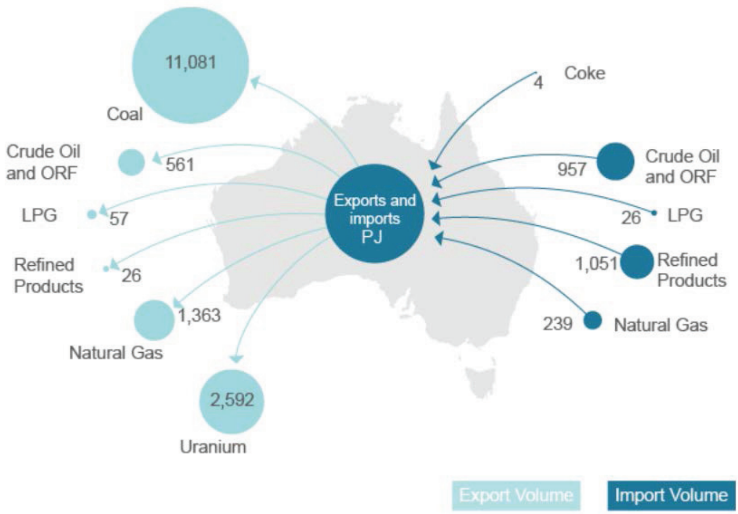


Figure 76: Energy import and export mix 2016 (Water Act 2007: Basin Plan 2012, p. 22)

The second biggest energy carrier sector is uranium, as Australia is one of the top uranium exporters in the world, after Kazakhstan and Canada (World Nuclear Association 2016). Australia holds 34 % of the world uranium resources and in 2013 were the Olympic Dam and Ranger mine the world's second (6 % of world uranium production) and fifth (4 % of world uranium production) largest uranium producing mines. After the Fukushima nuclear power plant accident in Japan in 2011 a small decrease in orders occurred, but due to the enlargement of nuclear power plants in India and China, this decrease was levelled and is expected to increase according to the Australian Government Department of Foreign Affairs and Trade (2014). The uranium industry is a major pillar of the Australian economy and in the centre of the discourse on nuclear disarmament and the environmental impact of mining operations. The new agreement on 'Cooperation in the Peaceful Uses of Nuclear Energy' (2014) between Australia and India is in force since November 2015 in order to supply uranium for India's '24x7 power for all' plan (2017). This agreement has been criticised in Australia (Spring & Dillon 2016) and internationally, for harming the non-proliferation treaty signed by Australia (Safi 2015).

Anti-uranium mining protests were in Australia a mass movement and closely tied to the indigenous land rights movement (Adamson 1999). The outcome in regard to uranium mines was that there are no nuclear power plants (expect one test plant) in Australia for generating electricity. Also a growing discourse established and research was conducted the environmental implications of the mining industry. Water concerns, specifically implications to the great artesian basin, were in the focus (Mudd 2007). The Anti-Nuclear Movement is important as a movement closely linked to the Anti-Fracking Movement and several activists have their roots in the Anti-Nuclear Movement according to the interviews conducted with a group of activists in Tara (2011). The movement was part of shaping the political and legal environment in Australia, when hydraulic fracturing got introduced.

Figure 77 shows, there was a general increase in exporting fuel carriers with a steeper development since 2009. This increase roots in the introduction of hydraulic fracturing. The Greens Party criticised this expansion and especially the expansion plans accounting for 40 000 more drills in Queensland until 2030 (Australian Greens Policy Initiative 2011).

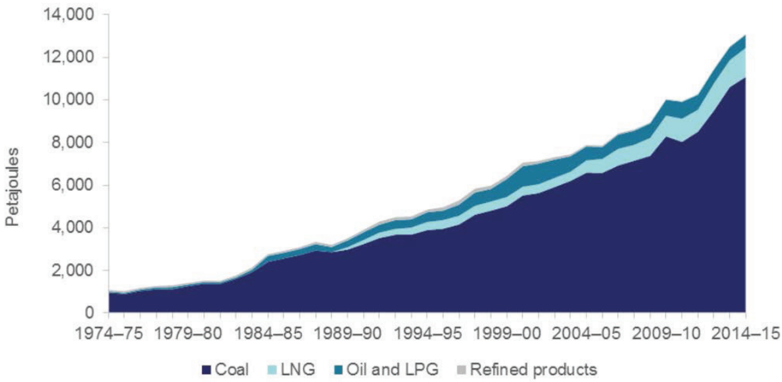


Figure 77: Australian energy exports by fuel type (Water Act 2007: Basin Plan 2012, p. 21)

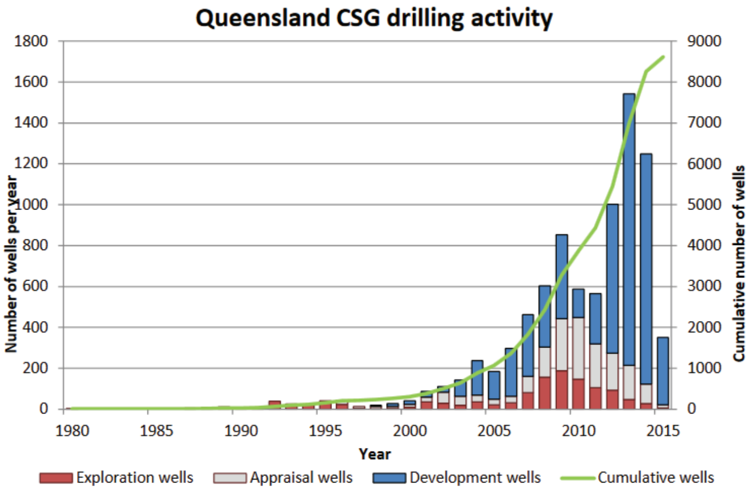


Figure 78: Well drilling rates and cumulative coal seam methane wells drilled (COAG Energy Council 2015, p. 11)

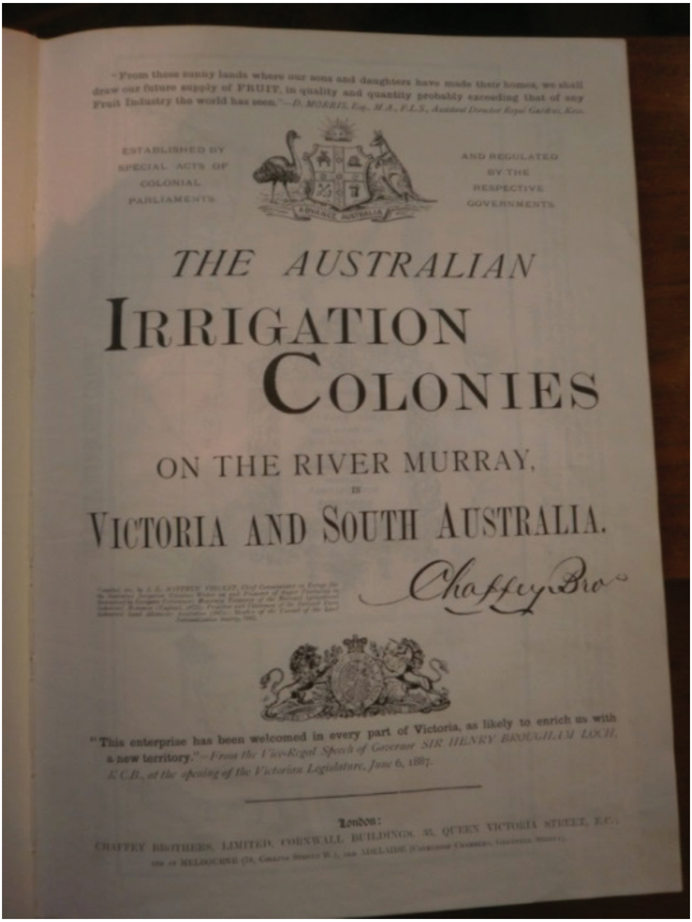
Queensland is in the centre of the discourse on hydraulic fracturing in Australia, as this state holds most of the reserves and the majority of test drilling took place in Queensland in the early phase of explorations (Figure 78). These drilling activities are planned to expand in order to export LNG and to fulfil the contracts of operations, which are already planned out until 2022 by the companies operating them (COAG Energy Council 2015).

Therefore, Australia goes into the same direction as the U.S. in regard to the expansion of hydraulic fracturing operations. However, especially the expansion in Queensland stirred protests and environmental concerns. Water was at the top of these concerns and triggered conflict between competing water users.

The water scarcity discourse in Australia developed throughout the last 150 years. Due to the vast geographical dimensions of the continent and sparse population, the perception was that resources would never run out and the biggest underground water supply of Australia, the Great Artesian Basin, would always flow, as expressed in Banjo Patteson's Song on the Great Artesian Basin in 1896:

But it's hark! the whistle's blowing with a wild, exultant blast,
And the boys are madly cheering, for they've struck the flow at last:
And it's rushing up the tubing from four thousand feet below,
Till it spouts above the casing in a million-gallon flow.
And it's down, deeper down-
Oh, it comes from deeper down:
It is flowing, ever flowing, in a free, unstinted measure
From the silent hidden places where the old earth hides her treasure-
Where the old earth hides her treasures deeper down.

A water rich area was the Murray-Darling Basin, which is now one of the water stress hotspots of the world. In the middle of the basin was Mildura founded in 1887 as an irrigation colony (Figure 79).


"From these sunny lands where our sons and daughters have made their homes, we shall draw our future supply of FRUIT, in quality and quantity probably exceeding that of any Fruit Industry the world has seen."—D. MORRIS, Esq., M.A., F.L.S., Assistant Director Royal Gardens, Kew.

ESTABLISHED BY SPECIAL ACTS OF COLONIAL PARLIAMENTS

ADVANCE AUSTRALIA

AND REGULATED BY THE RESPECTIVE GOVERNMENTS

THE AUSTRALIAN

IRRIGATION COLONIES

ON THE RIVER MURRAY,

IN

VICTORIA AND SOUTH AUSTRALIA.

Chaffey Bros

"This enterprise has been welcomed in every part of Victoria, as likely to enrich us with a new territory."—From the Vice-Regal Speech of Governor SIR HENRY BROUGHAM LOCH, K.C.B., at the opening of the Victorian Legislature, June 6, 1887.

London:

CHAFFEY BROTHERS, LIMITED, CORNWALL BUILDINGS, 35, QUEEN VICTORIA STREET, E.C.;

and at MELBOURNE and ADELAIDE

Figure 79: The Australian Irrigation Colonies on the river Murray founding document (Museum Mildura)

Production was directed to the needs of London and shaping the irrigation landscape in the area, causing long term ramifications: a long term intensively irrigated land and historically grown irrigation practices with a grid of surface channels vulnerable to high evaporation rates (Figure 80).

Figure 80: Surface channel in Mildura

In 1912, the first conference on water related issues was held as the water pressure of the Great Artesian Basin started to drop (Commonwealth Australia 2011). The perception of the importance to conserve water took from there a long path (Crichton 2016; Dolnicar & Hurlimann 2010). During the last decades drought and water restriction became a daily topic in Australian media (McCarthy, Burton & Spraggon 2015) and new regulative frameworks were shaped, especially in the water stress hotspot area of the Murray-Darling Basin (Bischoff-Mattson & Lynch 2016).

Australia's Murray-Darling Basin has been also an example for the introduction of a liberal market approach on water management after the implementation of IWRM based on a water pricing and then water trading scheme. The experiment resulted in an accumulation of water rights bought by the cotton and rice industry with high water needs. Due to severe environmental effects, the 'new' elected Labour government invested in 2007 AUD 3 billion for buying back water from farmers for the environment and AUD 7 billion to implement water saving irrigation methods (Crase, O'Keefe & Dollery 2009). The critical ratio of the environmental requirements for a basin was actually in the centre of the discourse, when the Murray-Darling Basin Plan (2012) was negotiated. The plan got implemented in 2012 and farmers feared in the process (Group interview with farmers in Mildura.) that the environmental water ratio would deduct irrigation water from their entitlements (Australian Government Murray Darling Basin Authority n.d.). The implementation of water trading was criticised from ample sides (Chong & Sunding 2006; Gawel & Bernsen 2011; Gawel & Bernsen 2013; Hepworth 2012) and the following picture (Figure 81) of the bus of the 'Growers action group' Mildura photographed in 2010 is an artefact of the formed farmers' resistance.

Figure 81: Protest slogans on a bus of the Growers action group

The ratio for the environment is under constant debate, as farmers claim for higher irrigation ratios (Harrington 2017; Le Grand 2017; The Irrigator 2017; Vidot & Worthington 2016).

This case illustrates that competing for water resources is in Australia contested ground. Furthermore, even when farmers do not have a water conservation approach, which is illustrated by the opposition towards environmental water ratios, other high water consumptive industries compete with their interests. This in water quantities, but impacting the irrigation water quality is another conflict line. Therefore, the water scarcity situation has an indirect impact on creating shared interests and forming alliances opposing the implementation of hydraulic fracturing.

The movements concerned with hydraulic fracturing grew when drilling activities expanded. The documentary movie 'Gasland', as already mentioned in Chapter 5.2.1, has its role in Australia. People were mobilised through the movie got screened all over the country. Activists brought the movie to small mining towns with discussions afterwards. One of the centres for Anti-Fracking activism is a piece of farmland close to Tara, in the middle of ample drilling activities. Inspired by Josh Fox, the owner of the farmland, one of the faces of the movement, Dayne Pratzky, made the Australian version of the Gasland documentary: frackmanthemovie.com (Frackman 2017). The film was shown on several occasions during the 2015 elections in Australia and affiliates with several groups concerned with hydraulic fracturing in Australia (e.g. Lock the Gate, GetUp! Future Super).

One of the major campaigns and overarching network for the Anti-Fracking movement in Australia was the Lock the Gate campaign organising protests in Queensland (Tara and Acland); Borroloola and Maningrida in the Northern Territory and Hunter Valley of New South Wales – all places with hydraulic fracturing activities. These are all rural communities, where the hydraulic fracturing opposition is linked to the land rights movement of the traditional owners[15] in the Northern Territory and in other areas linked to agricultural producers, mostly organic producers. Hydraulic fracturing united environmental activists with farmers.

The Anti-Fracking movement is, as in the U.S., in the middle of a hegemonic battle on the moral grounds related to hydraulic fracturing, with the arguments of creating jobs and wealth, opposed to water risks. These battles are fought very similar to the U.S. One example of a used method to shift the discourse in the direction of promoting hydraulic fracturing is analysed in more detail as an example for the usage of specific rhetorical figures to shift the discourse. The Australian Petroleum Production & Exploration Association (APPEA) is one of the industry's instruments to influence the discourse by their inputs. The association calls itself the voice of Australia's oil and gas industry and runs a well-designed website: www.appea.com.au promoting, that hydraulic fracturing causes only minor risks to the environment. More direct methods like articles directly addressing the issue with titles, for example, 'Horizontal drilling reduces environmental impacts, increases gas production' (APPEA 2017b) are shared or subtler methods used. One rhetorical figure to influence the perceived water risks is their used presentation of compounds in the fracturing fluid listed in Table 29.

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15 The term 'traditional owner' is believed to have first come into common use after the passage of the Aboriginal Land Rights (Northern Territory) Act in 1976, further fully or partially replicated in the Aboriginal Land Act (Northern Territory) and Environmental Protection and Biodiversity Conservation Act 1999. It allowed Aboriginal people to claim unalienated Crown Land in the Northern Territory, on the basis of being the 'traditional Aboriginal owners' of the land. This definition stands for a group of Aboriginals with common spiritual affiliations to a site on the land, placing the group under a primary spiritual responsibility, and those entitled by Aboriginal tradition of forage as of right over that land. Edelman (2009).

Table 29Typical chemical additive used in hydraulic fracturing fluids first three columns derived from (APPEA 2017a)

Compound	*Purpose*	*Common Application*
Acids	Helps dissolve minerals, initate fissures	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown	Table salt
Polyacylamide	Education-related travel services	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive Anti-freeze, deicing, household cleaners5
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as cross linkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilisation of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additives, food and beverages, lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair colouring

The list of additives in the fracturing fluids combined with the, here red marked, column ‘common application’ tries to communicate, that the compounds are harmless. They use the technique to relate the compounds to items of the daily life by leaving out their toxicity and also risks in higher concentrations.

The discourse has regulations, bans or supportive frameworks as outcomes and the picture has similarities to the U.S.. The Australian federal government supports the exploration of coal seam gas, however, states and municipalities can decide on the land use. In the following, some excerpts of the official statement of the Australian Government on hydraulic fracturing in 2017 and its rulings:

> *A key goal of the Australian Government's energy policy is to maintain a secure and sustainable energy supply while facilitating competitive and productive industry sectors. Unconventional gas development is already central to achieving this goal, and an issue of national importance, as it has the potential to impact Australia's prosperity. In 2015, over 40 per cent of the Eastern Australian domestic gas production was sourced from CSG and this production is expected to continue to grow to support domestic consumption and LNG exports from the East Coast. (Australian Government Department of Industry, Innovation and Science n.d.)*

However, the ruling lays in the state and territories:

> *Under the Constitution, ownership of mineral and petroleum resources onshore and within three nautical miles offshore vests with the state and territory governments – states have passed laws to manage land allocation which generally specifically withholds mineral rights to the Crown, and mechanisms to allocate those rights separately. The Constitution is silent on mining and therefore consistent with this understanding.*
>
> *There are some ways for the Commonwealth government to affect mineral production and trade through: interstate and overseas trade and commerce; taxation; defence; corporations; Aboriginal people; and external affairs. (Australian Government Department of Industry, Innovation and Science n.d.)*

Therefore, most regulations are in the hands of the federal states and territories, which differ severely. Additionally, the ruling of the federal state only includes onshore activities and the offshore activities are under federal ruling, which has especially implications for offshore reserves under the Great Barrier Reef. The regulative situation on hydraulic fracturing was in 2017 (Table 30) in some parts undecided and bans are only in place in states, where until now no reserves in commercially usable quantities were found, or where these are low (Figure 82). However, a counter hegemony is formed and new nodal points will be shaped.

Table 30: Regulations of hydraulic fracturing per state and territory

States & Territories	Ban or exploitation
Queensland	Commercial exploitation (Queensland Government Department of Natural Resources and Mines 2017)
New South Wales	Commercial exploitation (NSW Government Planning and Environment - Resources and Energy n.d.)
Victoria	Banned since 16 of March 2017 (Victoria State Government 2015) until 2020, until now no commercially recoverable reserves explored (Parliament of Victoria 2013)
Tasmania	Banned since 2015 until 2020, but no commercially viable sources (Tasmanian Government 2015)
South Australia	Commercial exploration (Department of State Development 2017)
Western Australia	Moratorium still ongoing, but exploitable resources exist (State of Western Australia 2015)
Northern Territory	Moratorium still ongoing, but exploitable resources exist (The Northern Territory Government 2017)

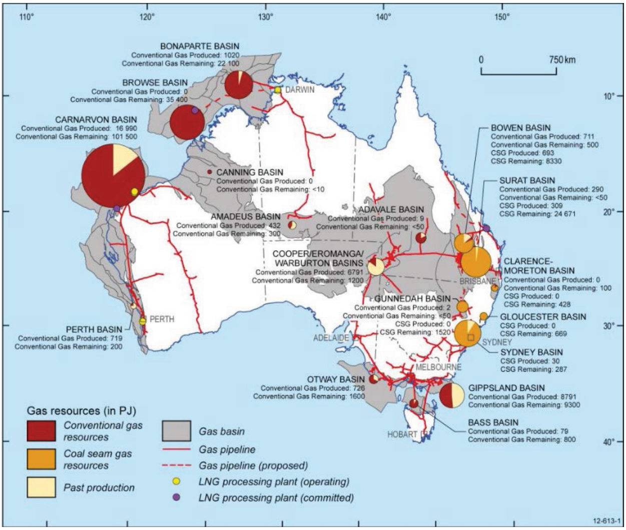

Figure 82: Australia's gas resources and infrastructure
(Williams, Milligan & Stubbs 2013, p. 2)

5.2.3 Global Outlook

Hydraulic fracturing is globally in a contested state. In Australia and the U.S. bans were mainly implemented locally or in areas of no interest for operations, due to a lack of reserves in the area.

In 2017, the situation is similar in Canada, as there are also the first federal bans, but as the following tables show (Table 31 and Table 32), these bans are mainly in areas with low or nearly zero reserves.

Table 31: Estimated coalbed methane and shale gas reserves

Province	Coalbed methane in Tcf	Shale gas in Tcf
Alberta	130 - 500 (Alberta Energy 2017; Doucet & Brown 2005)	200.5 - 3 425 (EIA 2015; Government of Canada 2016)
British Columbia	90 (Doucet & Brown 2005)	335.8 (EIA 2015)
New Brunswick	None to low reserves (Al-Jubori et al. 2009)	15 (Milke & Green 2014)
Newfoundland	None to low reserves (Al-Jubori et al. 2009)	None to low reserves (Government of Canada 2016)
Nova Scotia	None - 50 (Al-Jubori et al. 2009; Doucet & Brown 2005)	3.4 (EIA 2015)
Saskatchewan/ Manitoba	None to low reserves (Al-Jubori et al. 2009)	2.2 (EIA 2015)
Quebec	None to low reserves (Al-Jubori et al. 2009)	31.1 (EIA 2015)

Table 32: Regulations of hydraulic fracturing per province

Province	Ban or exploitation
Alberta	Commercial exploitation (The Council of Canadians 2014)
British Columbia	Commercial exploitation (The Council of Canadians 2014)
New Brunswick	Moratorium introduced in 2014 (Bissett 2014), indefinite moratorium as of 27 May 2016 (McHardie 2016)
Newfoundland	Ban on exploitation since 4 November 2013 (The Telegram 2013)
Nova Scotia	2 year moratorium introduced in 2012 (MacDonald n.d.) indefinite moratorium as of September 30th 2014 (The Canadian Press 2014)
Saskatchewan/ Manitoba	Commercial exploitation (The Council of Canadians 2014)
Quebec	Commercial exploitation (Jaremko 2016)

In Europe (Figure 83) it took a while until EU scale decisions were made and in 2012 more permits, than bans spread throughout the continent.

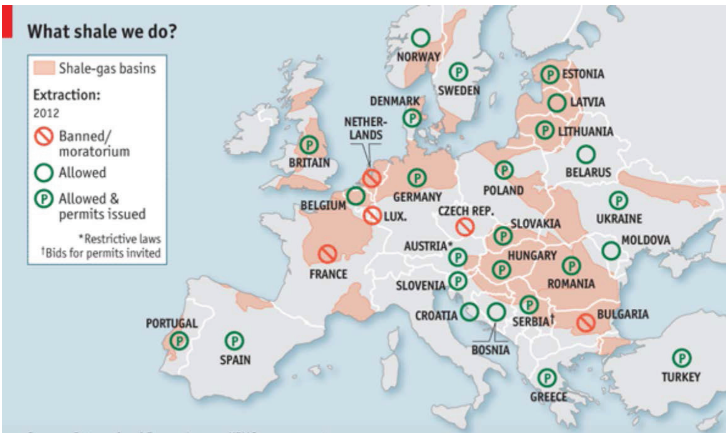

Figure 83: Shale gas exploration regulations in Europe 2012 (The Economist 2013)

Shale gas exploration and exploitation fell then under Directive 85/337/EC (EIA Directive 2009) considering the assessment of the effects of certain public and private projects on the environment and specifically Directive 2011/92/EU (2011) applies to shale gas projects. If an installation produces more than 500 000 m^3/day, then it will automatically fall under the Annex I list of activities subjected to a mandatory environmental impact assessment. Considering, that unconventional gas wells produce somewhere between 115 000 to 250 000 m^3/day, and taking into account the 2012 European Parliament Resolution on the environmental impacts of shale gas and shale oil extraction activities, the European Parliament's Environment Committee voted on 11th July 2013 in favour of a proposal imposing a mandatory EIA for all shale gas drilling activities in the European Union (European Parliament Legislative Observatory 2017). This ruling actually is not a ban of any sort as small test explorations do not need to be considered, but if large scale explorations are planned an environmental assessment needs to be undertaken. However, the communication from the EU commission to the council (2014) states that research on hydraulic fracturing in order to develop less hazardous practices to reach Europe's resources will be included and supported in the Horizon 2020 research program. Also, a research network is set up by the EU to foster exchange on the topic and to collect data, however, not to advice on policies as specifically stated (EU Science Hub 2016).

Since 2012 (Figure 83) the European landscape on hydraulic fracturing regulations changes constantly in terms of moratoria and temporary bans. In Germany was hydraulic fracturing for commercial usage banned in 2016, but this decision will be revised in 2021 (Reuters 2016a). France strengthened the ban after legal disputes with the U.S. Company Schuepbach Energy (Jolly 2013; Patel & Viscusi 2013). In Luxembourg, the moratorium ended with a ban (Luxemburger Wort 2013) and in the Netherlands a ban is in place until 2020, too (Shale Gas International 2015). Bulgaria was actually the second country after France to ban hydraulic fracturing in 2012 (BBC News 2012). In Spain were local bans in 2013 in place (Reuters 2013). In Poland was the resource potential overestimated and therefore the interest actually shrank from the investor side (Strzelecki & Almeida 2014). In the UK, a ban was in place, but was subsequently lifted (Jaspal & Nerlich 2013; Smith-Spark & Boulden 2013), however, local bans are still in place, as in Scotland and Wales people voted against hydraulic fracturing (Heasman 2015; McCulloch 2017; Paterson 2017). In 2012, Austria adopted a new law, which made the Environmental Impact Assessment of hydraulic fracturing activities, including test wells, obligatory, causing the oil and gas company OMV to cancel operations in Northern Austria, allegedly due to economic reasons (Frack Free World 2013; Friedl News 2012; Reuters 2012). In Switzerland, the exploitation and use of natural resources is decentralised, with the cantons having a mineral royalty law that regulates the use of those resources, meaning that no hydraulic fracturing can take place without their express permission (Ingold, Fischer & Cairney 2016). These permission procedures take into account the protection of natural resources, drinking water and ecosystems. Certain cantons have already introduced bans, although there is almost a complete lack of concrete projects (Fischer & Ingold 2015). The prohibition of fracking is to continue in Ireland in 2016, as declared by the Minister for the Environment, upon the release of the EPA assessment report (The Irish Times 2016). In Italy, an expert panel concluded that two deadly 2012 earthquakes could have been triggered by human activities, sparking fierce opposition against new oil and gas drilling efforts (Cartlidge 2014). Based on this, the local authorities in Emilia-Romagna extended the ban on drilling activities in the earthquake area to the entire region (NewsHub 2014). In summary, in the European Union more and more countries shift their regulations towards bans and water concerns are a common driver, but which interest groups pushed the bans in detail is a subject of further research.

In South Africa, was a moratorium in place and subsequently lifted in 2012 and commercial explorations started (Artel 2012; Daly 2012; The Economist 2012). In Argentina, local bans are is in place, but overall commercial exploration takes place (Matze 2013). In India, some operations were stopped by farmers in Tamil Nadu using hunger strikes as their form of protest, but other extraction plans moved forward (Madhav 2017). However, in 2013 the Shale Gas and Oil Policy came out in India (Hindustan Times 2013), which restricts explorations to national companies (Singh 2015). Protests in China have stopped drilling operations in the Sichuan province, reportedly causing Shell to lose 535 working days between 2010 and 2013 at 19 of its shale gas wells due to villager blockades or government requests to halt operations (Lee & West 2014; Spegele & Scheck 2013).

These are just some snapshots and however triggered an international discourse on how hydraulic fracturing impacts human rights expressed in several reports:

- A Human Rights Assessment of Hydraulic Fracturing for Natural Gas for the State of New York (2011)
- A Human Rights Assessment of Hydraulic Fracturing and Other Unconventional Gas Development in the United Kingdom (2014)
- A Guide to Rights-based Advocacy: International Human Rights Law and
- Fracking (2015)
- Human Rights and the Business of Fracking (2015)
- Declaration on Human Rights and Climate Change (2016)

Therefore, the awareness and mobilising on human rights violations increased connected to hydraulic fracturing (Taillant, Glaub & Buck 2015) and in 2015 was hydraulic fracturing put on trial in front of the Permanent Peoples' Tribunal (2015).

The long term environmental implications and water risks related to hydraulic fracturing are difficult to foresee the global developments on implementing environmental regulations and bans is in flux.

6 Conclusion

The aim of this dissertation has been to analyse the drivers for exporting virtual water, whilst having water stress. This has been based on the leading hypothesis, that international virtual water trade will not automatically stir international productivity towards sustainable water usage as other forces direct international trade.

The following conclusion consists of two parts, first, the outcome of each chapter will be discussed and linked with each other. Second, recommendations for future research are given. This work filled the research gap in the context of understanding depletive water trade by including the analytical framework of hegemonic struggles into the picture. The research is driven by the idea that the storage capacity for water resources need to be preserved and depletive water trade avoided.

6.1 Outcome and Discussion

The hypothesis challenges the liberal approach that, virtual water trade gets automatically stirred into a sustainable direction. The opposite has been assumed in this work and several drivers and their connected discourses shaping these were analysed.

Water over-extraction and risking quality impacts were analysed as an outcome of hegemonic struggles shaping water usage regimes. The analysis showed that there are competing interests, which can override water conservation. As interest groups fostering water conservation are not in all water related issues the hegemon, depletive trade patterns can get introduced and persist. This is illustrated in more detail with three examples; first, the overarching North-South trade relationship in Chapter 3; second, the water impact of the Doi Moi policy and implications of FTAs in Chapter 4; last, the hegemonic struggles on hydraulic fracturing with water conservation at its centre in the U.S. and Australia in Chapter 5.

This hypothesis considers resource cycles in the middle of a nexus, connected, intertwined, synergetic and heavily influenced by the forces of globalisation and attached hegemonic struggles. These forces and synergetic links are an interconnected global network of factors socially and territorially disconnected from basins or other water storage systems, which are, however, locally heavily affected. Each system is embedded in a different social, cultural and political framework shifting the drivers, buffering or increasing depletive effects. However, even though each basin has to be seen in its specific environment, there are reoccurring trends.

Chapter 3 concentrates on the global water resource distribution, virtual water trade, drivers for withdrawal and already impacted areas. The global dimension of North-South trade relations were in the centre of attention. The goal of this chapter was to illustrate that water withdrawal is embedded in a network of discourses influencing the patterns of usage. Therefore, a shift in consumption patterns can have a local, but also global impact on geographically disconnected basins. The data is currently mainly based on food trade; however, energy carriers are getting more important with rising demands for both resources. The main purpose is to visualise that, by affecting one resource cycle, another one is impacted, too, with all its further interconnected dimensions. For example, a different kind of energy carrier usage, due to certain policies driven by agents (like coal or wind) has a different impact on all resource cycles and interconnected discourses on all scales, at several geographical points at the same time and also future points in time. After developing the global framework in Chapter 3 and illustrating the North-South implications of virtual water trade, this was further analysed in Chapter 4, by taking Viet Nam into the focus to illustrate the implications of rapid growth in terms of shifting towards an export oriented economy.

FDI and FTAs are identified as a driver for depletive water trade, as the Viet Nam example showed. Even when environmental articles are integrated into trade agreements, the environmental impact will be severe, due to the increased production directed by external market needs, and even when there is a know-how inflow, the water infrastructure will not be built at the same speed as the industrial development. Furthermore, water treatment has its limits, as discussed in Chapter 3, and developing countries carry the environmental burden of industries, which are moved out of the global North.

As developed in Chapter 3 and 5, water and energy carriers are in a close nexus relationship and this will hit the water resources of developing countries even harder, as three components come together:

1. It can be expected that energy and water demands will increase exponentially in developing countries (Chapter 3.2.1 and 5.1.1). The pressure on water is even more accelerated through the usage of water intense energy carriers like Chapter 3.2 illustrated.
2. Water infrastructures are not developed at the speed of demand growth; therefore, water quality impacts cannot get buffered and the effects of over withdrawal are exacerbated. The 'clean-up later' approach can result in a loss of storage capacities, which are difficult to recover, especially for countries with less investment potential. Furthermore, the possibility to shift to desalination plants are limited, as investment cost are high and energy intense to run, and also attached to further environmental implications (Chapter 5.2).

If extraction of unconventional energy carriers would shift to developing economies without strong environmental movements, regulations, but reserves water storage systems would be vulnerable in these regions.

However, as the analysis on international virtual water trade, combined with the development of unconventional resources (Chapter 3 and 5) in the U.S. and Australia, the phenomenon of depletive trade does not only occur in developing countries. Other interests, like in the U.S. energy autarky reshuffled priorities and interest groups pushing the discourse on energy could overwrite rules and regulations, which were once set to protect water bodies. And even as resistance established in Australia and the U.S., the interest groups pushing against hydraulic fracturing were up to 2017 not strong enough to push a ban though in an area with resources in quantities to make them commercially interesting. Australia is an energy carrier exporter and the U.S. is nearly shifting to become one, due to shale gas and coalbed methane exploitation. Both countries are already top virtual water exporters, even though, as Chapter 3.3.2 shows, water scarcity is an issue in both countries. Therefore, it is illustrated that in developed countries and rapidly developing countries like Viet Nam sustainable water usage is not one of the factors directing trade.

It is assumed that these power relations and struggles on multiple scales shape water exploitation regimes in their local context and they are fought again and again in different constellations and forms. Discourse hegemony is currently only in some cases won in favour of sustainable usage practices. However, in Europe was the ‘clean-up later’ approach already practised as a historical development with still severe water quality impacts, as Chapter 3.3 illustrated. The development of a growing water infrastructure was at each step a struggle for water conservation and a reply to increasing pollution, which went along with setting up a legal framework (Water Framework Directive). Each pollution threshold is the outcome of a discourse and competing interests, which are illustrated in Chapter 4 on Viet Nam on a larger scale.

Therefore, other competing interests can override a general interest for potable water and stir trade into a direction of resource overexploitation with hardly or non-repairable damages, reducing the global storage capacity for water. Chapter 3 also illustrated that countries (e.g. Jordan, Germany, Israel and Japan) are becoming highly dependent on virtual water imports in form of food, but this trend is expected to occur in regard to energy, too. Or it can be seen the other way around, that water depletive production shifts to countries, where the water conservation discourse is weaker. However, if more and more storage capacity is lost, as the virtual water exporting countries strain their resources more and more, water scarcity will spread. At the same time, this situation can foster the creation of different interest groups for sustainable water management in geographically separated places and on all scales, as the interdependences also grow. Therefore, not only water globalised, but also discourses effecting water basins globalised.

6.2 Restrictions, Further Research and Recommendations

This thesis connects the nexus framework with theories of power and the concept of hegemony as an important dimension to analyse depletive trade and drivers for unsustainable virtual water trade, stirring regions into water scarcity. It represents a contribution in theorising water exploitation regimes by using exemplary cases. This is at the same time the restriction of this work, as not a complete global overview could be given in detail and needs to be a subject of further research. At ample points only estimated data could be used as in certain areas of hydrology more research needs to be conducted on groundwater and water footprinting on industrial products.

In general, this work comes to a concluding recommendation. Virtual water trade can increase water stress severely and foster long term ramifications, which will impact the global water storage situation. The position of water conservation needs to be strengthened in the discourse on a global scale in order to preserve these storage systems, even though growing competing interests with the energy carrier sector can be expected, as otherwise long term implications can be expected.

References

24x7 Power for All 2017, *24x7 Power for All*, viewed 24 April 2017, <http://www.powerforall.co.in>.

Acclimatise 2009, *'Building Business Resilience to Inevitable Climate Change'. Carbon Disclosure Project Report 2008*, Global Oil and Gas, Oxford, viewed 19 April 2017, <http://www.acclimatise.uk.com/login/uploaded/resources/Acclimatise_CDP_Global_Oil_Gas_Adaptation_Report.pdf>.

Adamson, G 1999, *Stop Uranium Mining!: Australia's Decade of Protest 1975-85*, Resistance Books.

Adidas 2019, *Global Factory Lists*, viewed 13 September 2019, <https://www.adidas-group.com/en/sustainability/compliance/supply-chain-structure/>.

Ahlers, R & Zwarteveen, M 2009, 'The water question in feminism: water control and gender inequities in a neo-liberal era', *Gender, Place & Culture*, vol. 16, no. 4, pp. 409–26, viewed 11 April 2017.

Alberta Energy 2017, *Coalbed Methane*, viewed 24 April 2017, <http://www.energy.alberta.ca/OurBusiness/754.asp#Potential>.

Albiac, J & Dinar, A (eds) 2009, *The management of water quality and irrigation technologies*, Earthscan, London.

Alcamo, J, Flörke, M & Märker, M 2007, 'Future long-term changes in global water resources driven by socio-economic and climatic changes', *Hydrological Sciences Journal*, vol. 52, no. 2, pp. 247–75.

Alcamo, J, Henrichs, T & Rösch, T 2000, *World Water in 2025: Global modeling and scenario analysis for the World Commission on Water for the 21st Century*, Center for Environmental Systems Research University of Kassel, viewed 21 March 2017, <http://www.env-edu.gr/Documents/World%20Water%20in%202025.pdf>.

Aligica, PD & Tarko, V 2012, 'State capitalism and the rent-seeking conjecture', *Constitutional political economy*, vol. 23, no. 4, pp. 357–79.

Al-Jubori, A, Johnston, S, Boyer, C, Bustos, OA, Pashin, JC & Wray, A 2009, 'Coalbed Methane: Clean Energy for the World', *Oilfield Review*, vol. 21, no. 2, pp. 4–13, viewed 20 April 2017.

Allan, JA 1992, 'Fortunately there are Substitutes for Water otherwise our Hydropolitical Futures would be impossible', in Natural Resources Institute (ed.), *Priorities for Water Resources Allocation and Management*, Natural Resources and Engineering Advisers Conference, Southampton, Overseas Development Administration, ODA, London.

——2001, *The Middle East Water Question: Hydropolitics and the Global Economy*, I. B. Tauris & Co. Ltd., London.

Alley, WM, Reilly, TE & Franke, OL 1999, *Sustainability of Ground-Water Resources*, U.S. Geological Survey, Denver, viewed 13 March 2017, <https://pubs.usgs.gov/circ/circ1186/pdf/circ1186.pdf>.

Altvater, E 2010, *Der große Krach oder die Jahrhundertkrise von Wirtschaft und Finanzen, von Politik und Natur* (German), 1st edn, Westfälisches Dampfboot, Münster, viewed 15 April 2017, <http://www.socialnet.de/rezensionen/isbn.php?isbn=978-3-89691-785-0>.

Amoussou, F & Allagbe, AA 2018, 'Principles, Theories and Approaches to Critical Discourse Analysis', *International Journal on Studies in English Language and Literature*, vol. 6, no. 1, pp. 11–8.

Annan, K 2000, *We the Peoples: The Role of the United Nations in the 21st Century*, New York, viewed 13 March 2017, <http://www.un.org/en/events/pastevents/pdfs/We_The_Peoples.pdf>.

APEC 2017a, *APEC Viet Nam 2017*, Asia Pacific Economic Cooperation, viewed 13 September 2019, <https://www.apec.org/About-Us/About-APEC/Member-Economies>.

——2017b, *Member Economies*, Asia Pacific Economic Cooperation, viewed 17 April 2017, <http://www.apec.org/About-Us/About-APEC/Member-Economies>.

APPEA 2017a, *Hydraulic fracturing*, Australian Petroleum Production & Exploration Association, viewed 24 April 2017, <https://www.shale-gas.com.au/industry-operations/hydraulic-fracturing/>.

——2017b, *Horizontal drilling reduces environmental impacts, increases gas production*, viewed 18 September 2019, <https://www.appea.com.au/tech-drill/horizontal-drilling-reduces-environmental-impacts-increases-gas-production/>.

Apukhtina, O 2016, 'Distribution, petrology, geochemistry and geochronology of carbonate assemblages at the Olympic Dam deposit', PhD Thesis, University of Tasmania, viewed 21 April 2017, <http://eprints.utas.edu.au/23013/>.

Arconada, B, Delgado, P & Garcia, A 2013, 'Minimizing environmental risks on constructing marine pipelines: Aguilas desalination plant', *Desalination and Water Treatment*, vol. 51, 1-3, pp. 246–61, viewed 28 February 2017.

Armstrong, AC 2009, 'Viewpoint - Further Ideas towards a Water Ethic', *Water Alternatives*, vol. 2, no. 1, pp. 138–47, viewed 20 March 2017, <http://www.water-alternatives.org/index.php/allabs/41-a2-1-9/file>.

Artel, S 2012, 'South Africa Lifts Fracking Moratorium; Citizens Alarmed By U.S. Fracking Examples', *AlterNet*, 24 September, viewed 24 April 2017, <http://www.alternet.org/fracking/south-africa-lifts-fracking-moratorium-citizens-alarmed-us-fracking-examples>.

ASEAN n.d., *ASEAN Member States*, Association of Southeast Asian Nations, viewed 17 April 2017, <http://asean.org/asean/asean-member-states/>.

ASEAN Briefing 2014, *Understanding ASEAN's Free Trade Agreements*, viewed 26 April 2017, <http://www.aseanbriefing.com/news/2014/02/13/understanding-aseans-free-trade-agreements.html>.

Associated Press 2016, 'Vietnam blames toxic waste water from steel plant for mass fish deaths', *The Guardian*, 1 June, viewed 19 April 2017, <https://www.theguardian.com/environment/2016/jul/01/vietnam-blames-toxic-waste-water-fom-steel-plant-for-mass-fish-deaths>.

Athukorala, PC 2009, 'Economic Transition and Export Performance in Vietnam', *ASEAN Economic Bulletin*, vol. 26, no. 1, pp. 96–114, <https://muse.jhu.edu/article/266541/pdf>.

Atlas der Globalisierung: Weniger wird mehr 2015.

Australian Government Department of Foreign Affairs and Trade 2013, *Vietnam Country Brief*, viewed 10 October 2013, <http://www.dfat.gov.au/geo/vietnam/vietnam_brief.html>.

——2014, *Australia's Uranium Production and Exports*, viewed 24 April 2017, <https://dfat.gov.au/about-us/publications/international-relations/asno-annual-report-2013-14/html/section-2/australias-Uranium-production-and-exports.html>.

Agreement between the Government of Australia and the Government of India on Cooperation in the Peaceful Uses of Nuclear Energy 2014 (Australian Government Department of Foreign Affairs and Trade), viewed 24 April 2017, <http://www5.austlii.edu.au/au/other/dfat/treaties/ATS/2015/9.pdf>.

——2015, *Australia's Top 10 Goods and Services Exports and Imports*, viewed 24 April 2017, <http://dfat.gov.au/trade/resources/trade-at-a-glance/Pages/top-goods-services.aspx>.

——2016, *Australia*, viewed 24 April 2017, <http://dfat.gov.au/trade/resources/Documents/aust.pdf>.

——2017a, *China-Australia Free Trade Agreement: Implementation process and timeline*, viewed 24 April 2017, <http://dfat.gov.au/trade/agreements/chafta/fact-sheets/Pages/implementation-timeline.aspx>.

——2017b, *Vietnam country brief*, 9 March, viewed 5 April 2017, <http://dfat.gov.au/geo/vietnam/pages/vietnam-country-brief.aspx>.

Australian Government Department of Industry, Innovation and Science n.d., *Unconventional Gas*, viewed 24 April 2017, <https://industry.gov.au/resource/UpstreamPetroleum/Pages/UnconventionalGas.aspx>.

Australian Government Murray Darling Basin Authority n.d., *Environmental water*, viewed 24 April 2017, <https://www.mdba.gov.au/managing-water/environmental-water>.

Australian Greens Policy Initiative 2011, *Protecting our farms;protecting our water: Regulating the coal seam gas industry*, viewed 5 August 2011, <http://greens.org.au/files/Coal_seam_gas.pdf>.

Australian Trade Commission 2016, *Australia's export performance in 2015*, viewed 24 April 2017, <http://www.austrade.gov.au/news/economic-analysis/australias-export-performance-in-2015>.

Auth, S, Huber, I & Schnatz, K 2008, *Uranium: Is It a Country?*

Barlow, M 2008, *Blue Covenant: The Global Water Crisis and the Coming Battle for the Right to Water*, New Press, New York.

Barlow, M & Clarke, T 2002, *Blue Gold: The Battle Against Corporate Theft of the World's Water*, Earthscan Publications Ltd, London, UK.

Bazilian, M, Rogner, R, Howells, M, Hermann, S, Arent, D, Gielen, D, Steduto, P, Mueller, A, Komor, P, Tol, RSJ & Yumkella, KK 2011, 'Considering the energy, water and food nexus: Towards an integrated modelling approach', *Energy Policy*, vol. 39, pp. 7896–906, viewed 4 April 2017.

BBC News 2012, 'Bulgaria bans shale gas drilling with 'fracking' method', *BBC News*, 19 January, viewed 24 April 2017, <http://www.bbc.com/news/world-europe-16626580>.

Berger, M, Pfister, S, Bach, V & Finkbeiner, M 2015, ‘Saving the Planet’s Climate or Water Resources? The Trade-Off between Carbon and Water Footprints of European Biofuels’, *Sustainability*, vol. 7, no. 6, pp. 6665–83, viewed 11 April 2017.

Birol, F 2011, *Are we entering a golden age of gas?: World Energy Outlook Special Report*, International Energy Agency, viewed 14 March 2017, <http://www.worldenergyoutlook.org/media/weowebsite/2011/WEO2011_GoldenAgeofGasReport.pdf>.

Bischoff-Mattson, Z & Lynch, AH 2016, ‘Adaptive governance in water reform discourses of the Murray–Darling Basin, Australia’, *Policy Sciences*, vol. 49, no. 3, pp. 281–307, viewed 24 April 2017.

Bissett, K 2014, ‘New Brunswick introduces fracking moratorium’, *The Globe and Mail*, 18 December, viewed 25 April 2017, <http://www.theglobeandmail.com/news/politics/new-brunswick-introduces-fracking-moratorium/article22139797/>.

Biswas, AK & Tortajada, C 2009, ‘Changing Global Water Management Landscape’, in AK Biswas, C Tortajada & R Izquierdo-Avino (eds), *Water management in 2020 and beyond*, Water resources development and management, Springer, Berlin, pp. 1–34.

Bizikova, L, Roy, D, Swanson, D, Venema, HD & McCandless, M 2013, *The Water–Energy–Food Security Nexus: Towards a practical planning and decision-support framework for landscape investment and risk management*, International Institute for Sustainable Development, viewed 14 March 2017, <http://www.iisd.org/pdf/2013/wef_nexus_2013.pdf>.

Bloomberg 2013, ‘France cements fracking ban’, *The Guardian*, 11 October, viewed 19 April 2017, <https://www.theguardian.com/environment/2013/oct/11/france-fracking-ban-shale-gas>.

Botelho, DA, Barrym, ME, Collecutt, GC, Brook, J & Wiltshire, D 2011, ‘Linking Near and Far Field Hydrodynamic Models for Simulation of Desalination Plant Brine Discharges’, *International Symposium on Outfall Systems*, Mar del Plata, Argentina, May 15-19, 2011, viewed 21 April 2017, <http://www.osmgp.gov.ar/symposium2011/Papers/24_Botelho.pdf>.

Brebbia, CA, Neophytou, M, Beriatos, E, Ioannou, I & Kungolos, AG (eds) 2009, *Sustainable Development and Planning IV*, vol. 2, WIT Press, Southampton, viewed 21 March 2017, <https://books.google.de/books?id=kb5Txq2l57sC&pg=PA997&lpg=PA997&dq=yellowwater+sanitation+definition&source=bl&ots=hYW7ZeCf9d&sig=t6NdAGTOyJdwXzxXguSb44rZ8-E&hl=de&sa=X&ved=0ahUKEwjCk6iEuOfSAhXK1ywKHSTUArIQ6AEIHjAA#v=onepage&q=yellowwater%20sanitation%20definition&f=false>.

Brown, A & Matlock, MD 2011, *A Review of Water Scarcity Indices and Methodologies*, Sustainaiblity Consortium, viewed 21 March 2017, <https://www.sustainabilityconsortium.org/wp-content/themes/sustainability/assets/pdf/whitepapers/2011_Brown_Matlock_Water-Availability-Assessment-Indices-and-Methodologies-Lit-Review.pdf>.

Bryld, E 2000, ‘The technocratic discourse: Technical means to political problems’, *Development in Practice*, vol. 10, no. 5, pp. 700–5, viewed 10 March 2017.

Buttigieg, JA 1999, *Gefängnishefte* (German), Berliner Institut für kritische Theorie, viewed 14 March 2017, <http://www.inkrit.de/e_inkritpedia/e_maincode/doku.php?id=g:gefaengnishefte>.

Cama, T 2016, 'Trump rattles industry with fracking position', *The Hill*, 3 August, viewed 20 April 2017, <http://thehill.com/policy/energy-environment/290186-trump-rattles-industry-with-fracking-position>.

Carpentier, N (ed.) 2010, *Media and communication studies interventions and intersections: The intellectual work of the 2010 ECREA European Media and Communication Doctoral Summer School* (eng), The researching and teaching communication series, Tartu Univ. Press, Tartu.

Carr, JA, D'Odorico, P, Laio, F & Ridolfi, L 2013, 'Recent History and Geography of Virtual Water Trade', *PLoS ONE*, vol. 8, no. 2, 1-10, viewed 11 April 2017, <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0055825>.

Cartlidge, E 2014, 'Human Activity May Have Triggered Fatal Italian Earthquakes, Panel Says', *Science*, vol. 344, 11 April, p. 141, viewed 25 April 2017, <http://science.sciencemag.org/content/344/6180/141.summary>.

Casale, R & Harmanci, R 2014, *The Cold Rush: As the ice caps melt, more entrepreneurs are seeing opportunity in the future of iceberg harvesting*, Modern Farmer, viewed 15 January 2017, <http://modernfarmer.com/2014/01/cold-rush/>.

Chandran, N 2017, 'China-backed trade deal may not gain from TPP's loss. Blame India', *CNBC*, 12 January, viewed 18 April 2017, <http://www.cnbc.com/2017/01/12/trumps-win-puts-tpp-in-danger-but-china-backed-trade-deal-may-not-gain-because-of-india.html>.

Chapagain, AK & Hoekstra, AY 2007, 'The water footprint of coffee and tea consumption in the Netherlands', *Ecological economics*, vol. 64, no. 1, pp. 109–18, viewed 9 March 2019, <https://waterfootprint.org/media/downloads/ChapagainHoekstra2007waterforcoffeetea.pdf>.

——2010, *The water footprints of rice consumption: Assessing the impacts on local water resources resulting from the global consumption of rice*, Value Of Water Research Report Series no. 40, UNESCO-IHE, Delft, viewed 9 March 2019, <https://waterfootprint.org/media/downloads/Report40-WaterFootprintRice.pdf>.

Chapagain, AK, Hoekstra, AY & Savenije, HHG 2005, *Saving water through global trade*, Value Of Water Research Report Series no. 17, UNESCO-IHE Institute for Water Education, Delft, <http://doc.utwente.nl/58373/1/Report17.pdf>.

Chapagain, AK, Hoekstra, AY, Savenije, HHG & Gautam, R 2006, 'The water footprint of cotton consumption: An assessment of the impact of worldwide consumption of cotton products on the water resources in the cotton producing countries', *Ecological economics*, vol. 60, no. 1, pp. 186–203, <http://www.sciencedirect.com/science/article/pii/S0921800905005574>.

Chesapeake Energy 2012, *Chesapeake Energy horizontal drilling method*, viewed 21 April 2017, <https://www.youtube.com/watch?v=vvRCYLnVWG8>.

Chong, H & Sunding, D 2006, 'Water Markets and Trading', *Annual Review of Environmental Resources*, vol. 31, pp. 239–64.

Choubert, JM, Martin Ruel, S, Esperanza, M, Budzinski, H, Miege, C, Lagarrigue, C & Coquery, M 2011, 'Limiting the emissions of micro-pollutants: what efficiency can we expect from wastewater treatment plants?', *Water Science & Technology*, vol. 63, no. 1, pp. 57–65.

CIA 2017, *World Fact Book - Egypt*, Central Intelligence Agency, viewed 18 April 2017, <https://www.cia.gov/library/publications/resources/the-world-factbook/geos/eg.html>.

CNN 2012, 'Vermont first state to ban fracking', 17 May, viewed 21 April 2017, <http://edition.cnn.com/2012/05/17/us/vermont-fracking/>.

COAG Energy Council 2015, *Coal Seam, Shale and Tight Gas in Australia: Resources Assessment and Operation Overview 2015: Upstream Petroleum Resources Working Group Report to COAG Energy Council*, viewed 24 April 2017, <http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/UPR%20Unconventional%20Resources%20Report%202015%20-%20Final_0.pdf>.

Cohen, G 2002, *The 'Solution' to Pollution Is Still 'Dilution'*, Earth Island Journal, viewed 13 April 2017, <http://www.earthisland.org/journal/index.php/eij/article/the_solution_to_pollution_is_still_dilution/>.

Cohen, N 2013, 'The water companies and the foul stench of exploitation', *The Guardian*, 3 August, viewed 11 April 2017, <https://www.theguardian.com/commentisfree/2013/aug/03/water-industry-exploitation-pollution>.

Commonwealth Australia 2011, *Water Down Under: Understanding and Managing Australia's Great Artesian Basin*, viewed 24 April 2017, <https://www.environment.gov.au/system/files/resources/6405b0fb-1956-4790-9ca4-b138ed810717/files/great-artesian-basin-managing.pdf>.

Water Act 2007: Basin Plan 2012 (Commonwealth Australia), viewed 21 April 2017, <https://www.legislation.gov.au/Details/F2012L02240>.

ConocoPhillips 2011, *Natural Gas: The Energy to Move Forward*, viewed 20 April 2017, <https://www.youtube.com/watch?v=BzLZnidztpI>.

Crase, LR, O'Keefe, SM & Dollery, BE 2009, 'The Fluctuating Political Appeal of Water Engineering in Australia', *Water Alternatives*, vol. 2, no. 3, pp. 441–7, viewed 25 April 2017.

Crichton, M 2016, 'Endurance: Australian stories of drought', *Rural Society*, vol. 25, no. 3, pp. 268–70.

Customs News 2017, 'The main import and export markets in 2016', 3 February, viewed 26 April 2017, <http://customsnews.vn/the-main-import-and-export-markets-in-2016-2529.html>.

Daly, J 2012, 'South Africa Decides to go Forward with Hydraulic Fracturing', *Oilprice.com*, 28 September, viewed 24 April 2017, <http://oilprice.com/Energy/Energy-General/South-Africa-Decides-to-go-Forward-with-Hydraulic-Fracturing.html>.

Darling, K 2012, 'A Weight for Water: An Ecological Feminist Critique of Emerging Norms and Trends in Global Water Governance', *Melbourne Journal of International Law*, vol. 13, no. 1.

Dehmer, D 2015, 'Vierte Reinigungsstufe in Kläranlagen: Arzneimittelrückstände im Abwasser' (German), *Tagesspiegel*, 17 March, viewed 20 March 2017,

<http://www.tagesspiegel.de/weltspiegel/vierte-reinigungsstufe-in-klaeranlagen-arzneimittelrueckstaende-im-abwasser/11514110.html>.

Delaunay, C & Torrisi, CR 2012, 'FDI in Vietnam: An Empirical Study of an Economy in Transition', *Journal of Emerging Knowledge on Emerging Markets*, vol. 4, no. 1.

Delegation of the European Union to Vietnam 2016, *Guide to the EU - Vietnam Free trade Agreement*, viewed 18 April 2017, <http://trade.ec.europa.eu/doclib/docs/2016/june/tradoc_154622.pdf>.

Delgado, JV & Zwarteveen, M 2007, 'The Public and Private Domain of the Everyday Politics of Water: The Constructions of Gender and Water Power in the Andes of Peru', *International Feminist Journal of Politics*, vol. 9, no. 4, pp. 503–11.

Dellapenna, JW & Gupta, J 2009, *The Evolution of the Law and Politics of Water*, Springer Netherlands, Dorderecht.

Department of State Development 2017, *Unconventional Gas Projects*, viewed 24 April 2017, <http://www.statedevelopment.sa.gov.au/resources/unconventional-gas-projects>.

DFAT n.d., *Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP): Australian Government-Department of Foreign Affairs and Trade*, viewed 16 September 2019, <https://dfat.gov.au/trade/agreements/in-force/cptpp/Pages/comprehensive-and-progressive-agreement-for-trans-pacific-partnership.aspx>.

Direcon 2017, *Joint Statement by TPP Partners*, Chile, viewed 17 April 2017, <https://www.direcon.gob.cl/2017/03/30229/>.

Dolnicar, S & Hurlimann, A 2010, 'Australians' Water Conservation Behaviours and Attitudes', *Australasian Journal of Water Resources*, vol. 14, no. 1, pp. 43–53.

Dominguez-Faus, R, Powers, SE, Burken, JG & Alvarez, PJ 2009, 'The Water Footprint of Biofuels: A Drink or Drive Issue?', *Environmental Science & Technology*, vol. 43, pp. 3005–10.

Domm, P 2014, 'Why trading water futures could be in our future', *CNBC*, 2 July, viewed 25 April 2017, <http://www.cnbc.com/2014/07/02/why-trading-water-futures-could-be-in-our-future.html>.

Doucet, J & Brown, C 2005, *Coal Bed Methane: the Past, Present and Future of Alberta's Most Abundant Non-traditional Source of Natural Gas*, viewed 24 April 2017, <https://www.ualberta.ca/business/centres/applied-research-energy-and-environment/energy/~/media/98EB3F7A9723481AACD9D988DDD2C465.ashx>.

Duarte, R, Pinilla, V & Serrano, A 2015, 'The Spanish Food Industry on Global Supply Chains and Its Impact on Water Resources', *Water*, vol. 7, pp. 132–52.

Dumalaon, J 2017, *TPP after Trump: New deal coming?*, Deutsche Welle, viewed 17 April 2017, <http://www.dw.com/en/tpp-after-trump-new-deal-coming/av-37939323>.

EAWAG (ed.) 2000, *Summary Report*, Bellagio Expert Consultation on Environmental Sanitation in the 21st Century, Bellagio, February 1-4, 2000, EAWAG, viewed 20 March 2017, <http://www.sswm.info/sites/default/files/reference_attachments/EAWAG%20SANDEC%20WSSCC%202000%20Bellagio%20Principles%20Report.pdf>.

Edelman, D 2009, 'Broader native title settlements and the meaning of the term 'traditional owners'', in AIATSIS (ed.), National Native Title Conference: Spirit of Country: Land, Water, Life, Melbourne Cricket Ground, June, 3-5, 2009, Aboriginal and Torres Strait

Islander Studies, Melbourne, <https://aiatsis.gov.au/sites/default/files/products/report/broder-native-title-settlements-and-the-meaning-term-traditional-owner-davidedelman.pdf>.

Edler, J 2013, ‘Vierte Reinigungsstufe in der Kläranlage/Gebühren steigen: Mikroschadstoffe eliminieren’ (German), *Westfälische Nachrichten*, 17 January, viewed 21 March 2017, <http://www.wn.de/Muensterland/Kreis-Warendorf/Warendorf/2013/10/Vierte-Reinigungsstufe-in-der-Klaeranlage-Gebuehren-steigen-Mikroschadstoffe-eliminieren>.

EFTA 2019, *Vietnam | European Free Trade Association*, 16 September, EFTA, viewed 16 September 2019, <https://www.efta.int/free-trade/ongoing-negotiations-talks/vietnam>.

EIA 2010, *International Energy Statistics database (as of November 2009): Projections: EIA, World Energy Projection System Plus*, viewed 4 August 2011, <www.eia.gov/emeu/international>.

——2015, *Technically Recoverable Shale Oil and Shale Gas Resources: Canada*, U.S. Department of Energy, viewed 24 April 2017, <https://www.eia.gov/analysis/studies/worldshalegas/pdf/Canada_2013.pdf>.

EID n.d., *About EID*, Energy in Depth, viewed 21 April 2017, <https://www.energyindepth.org/about/>.

——2012, *Truthland* (Dispatches from the Real Gasland).

Embassy of Israel in Vietnam 2016, *Vietnam and Israel Negotiates for FTA*, viewed 18 April 2017, <http://embassies.gov.il/hanoi/Relations/BilateralNews/Pages/Vietnam-and-Israel-Negotiates-for-FTA.aspx>.

Energy in Depth n.d., *Energy in Depth*, Independent Petroleum Association of America, viewed 25 April 2017, <https://energyindepth.org/>.

EU Science Hub 2016, *European Science and Technology Network on Unconventional Hydrocarbon Extraction*, viewed 25 April 2017, <https://ec.europa.eu/jrc/en/uh-network>.

European Comission 2018, *EUTrade news*, viewed 16 September 2019, <http://trade.ec.europa.eu/doclib/press/index.cfm?id=1437>.

Water Framework Directive (2000/60/EC) 2008 (European Commission), viewed 17 April 2017, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0105&from=EN>.

——2009, *Trade Sustainability Impact Assessment of the FTA between the EU and ASEAN: Final Report Volume I - Main Findings and Recommendations*, Rotterdam, viewed 17 April 2017, <http://trade.ec.europa.eu/doclib/docs/2010/april/tradoc_145989.pdf>.

Communication from the Commission to the Council and the European Parliament on the exploration and production of hydrocarbons (such as shale gas) using high volume hydraulic fracturing in the EU /* COM/2014/023 final */ 2014 (European Commission), viewed 25 April 2017, <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1405070725236&uri=CELEX:52014DC0023>.

——2016, *EU - Viet Nam Free Trade Agreement Text -Chapter 15: Trade and Sustainable Development*, viewed 19 April 2017, <http://trade.ec.europa.eu/doclib/docs/2016/february/tradoc_154229.pdf>.

——2017, *European Union, Trade in goods with Vietnam*, viewed 25 April 2017, <http://trade.ec.europa.eu/doclib/docs/2006/september/tradoc_113463.pdf>.

Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 2009 (European Parliament), viewed 25 April 2017, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0031>.

Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification) 2011 (European Parliament), viewed 25 April 2017, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:026:0001:0021:En:PDF>.

Industrial, energy and other aspects of shale gas and oil: European Parliament resolution of 21 November 2012 on industrial, energy and other aspects of shale gas and oil (2011/2309(INI)) (2015/C 419/13) 2012 (European Parliament), viewed 25 April 2017, <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52012IP0444>.

European Parliament Legislative Observatory 2017, *Assessment of the effects of certain public and private projects on the environment: provisions concerning the quality of the EIA*, viewed 25 April 2017, <http://www.europarl.europa.eu/oeil/popups/ficheprocedure.do?reference=2012/0297(COD)&l=en#keyEvents>.

ExxonMobil 2011, *Hydraulic fracturing: How it works*, viewed 21 April 2017, <https://www.youtube.com/watch?v=WP5wSfD0fk4>.

Falkenmark, M & Brouwer, F 1989, 'Climate-induced water availability changes in Europe', *Environmental Monitoring and Assessment*, vol. 13, no. 1, pp. 75–98.

FAO 2011, *Mapping supply and demand for animal-source foods to 2030*, Animal Production and Health Working Paper. No. 2., TP Robinson & F Pozzi, Rome, viewed 11 April 2017, <http://www.fao.org/docrep/014/i2425e/i2425e00.pdf>.

——2014, *The Water-Energy-Food-Nexus: A new approach in support of food security and sustainable agriculture*, Rome, viewed 14 March 2017, <http://www.fao.org/nr/water/docs/FAO_nexus_concept.pdf>.

——2015, *International Year of Soils 2015*, viewed 25 April 2017, <http://www.fao.org/soils-2015/en/>.

——2016, *AQUASTAT Main Database*, viewed 9 March 2017, <http://www.fao.org/nr/water/aquastat/data/query/index.html>.

FAO Agriculture and Consumer Protection 1995, *Dimensions of need: An atlas of food and agriculture*, T Loftas, Rome, <http://www.fao.org/docrep/u8480e/u8480e00.htm>.

Finger, M, Tamiotti, L & Allouche, J 2006, *The multi-governance of water: Four case studies*, SUNY series in global politics, State Univ. of New York Press, Albany, NY, <http://www.loc.gov/catdir/toc/ecip056/2005001460.html>.

Fischer, M & Ingold, K 2015, *Fracking in Switzerland? If in doubt, just say no!*, EAWAG, viewed 25 April 2017, <http://www.eawag.ch/en/news-agenda/news-portal/news-detail/news/fracking-in-der-schweiz-im-zweifelsfall-nein/>.

Fishbone, A 2007, *The struggle for water: Increasing demands on a vital resource (Sourcebook on Contemporary Controversies)*, International Debate Education Association, New York.

Foucault, M (1997) 1969, *Archäologie des Wissens* (German), Suhrkamp-Taschenbuch Wissenschaft, 8th edn, Suhrkamp, Frankfurt am Main.

Fox, J 2010, *Gasland*.

——2013, *Gasland Part II* .

Frack Free World 2013, *Austria*, Frack Free World, viewed 25 April 2017, <http://frackfreeworld.org/158>.

Frackman 2017, *Frackman the Movie*, viewed 25 April 2017, <http://frackmanthemovie.com/>.

Fracknation 2017, *A journalist's search for the fracking truth*, viewed 21 April 2017, <http://fracknation.com/>.

Fracktracker Alliance 2017a, *34 states have active oil & gas activity in U.S. based on 2016 analysis*, viewed 21 April 2017, <https://www.fractracker.org/2017/03/34-states-active-drilling-2016/>.

——2017b, *The Alliance Map*, viewed 21 April 2017, <https://www.fractracker.org/resources/the-alliance-map/>.

Friedl News 2012, 'OMV Gives In: No Fracking in Austria', *Friedl News*, 5 May, viewed 25 April 2017, <http://www.friedlnews.com/article/omv-gives-in-no-fracking-in-austria>.

Gas Drilling Awareness Coalition 2011, *Light Your Water On Fire from Gas Drilling, Fracking*, viewed 13 April 2017, <https://www.youtube.com/watch?v=4LBjSXWQRV8>.

Gasland n.d., *Welcome to Gasland*, viewed 25 April 2017, <http://www.gaslandthemovie.com/>.

Gawel, E & Bernsen, K 2011, *What is wrong with virtual water trading?*, UFZ Discussion Papers, Helmholtz-Zentrum für Umweltforschung GmbH, Leipzig, viewed 25 April 2017, <https://www.ufz.de/export/data/global/26156_DP_1_2011_Gawel_virtWater.pdf>.

——2013, 'What is Wrong with Virtual Water Trading? On the Limitations of the Virtual Water Concept', *Environment and Planning C: Politics and Space*, vol. 3, no. 1, pp. 168–81.

GEA 2012, *Global Energy Assessment - Toward a Sustainable Future*, Cambridge University Press, Cambridge.

General Statistics Office of Vietnam n.d., 'Foreign direct investment projects licensed in period 1988 – 2011', viewed 10 October 2013.

——2016, *Gross domestic product at current prices by economic sector by Year, Items and Economic sector*, viewed 25 April 2017, <http://www.gso.gov.vn/SLTKE/pxweb/en/03.%20National%20Accounts%20and%20State%20budget/-/E03.02.px/table/tableViewLayout1/?rxid=5a7f4db4-634a-4023-a3dd-c018a7cf951d>.

Gerbens-Leenes, W, Hoekstra, AY & van der Meer, TH 2009, 'The water footprint of bioenergy', *PNAS*, vol. 106, no. 25, pp. 10219–23, viewed 25 April 2017, <http://www.pnas.org/content/106/25/10219.full.pdf>.

Gerten, D, Heinke, J, Hoff, H, Biemans, H, Fader, M & Waha, K 2011, 'Global Water Availability and Requirements for Future Food Production', *Journal of Hydrometeorology*, vol. 12, no. 5, pp. 885–99, viewed 14 March 2017, <http://journals.ametsoc.org/doi/full/10.1175/2011JHM1328.1>.

Gill, S 2003, *Power and Resistance in the New World Order*, International Political Economy, Palgrave Macmillan.
Gleick, PH 1996, 'Basic Water Requirements for Human Activities: Meeting Basic Needs', *Water international*, vol. 21, pp. 83–91, viewed 17 February 2012, <http://sgpwe.izt.uam.mx/files/users/uami/citla/Lecturas_Temas_selecto_IV_AGUA/basic_water_needs_IN_WATER_INTERNATIONAL_21.pdf>.
GNHRE 2016, *Declaration on Human Rights and Climate Change*, Global Network for the Study of Human Rights and the Environment, viewed 25 April 2017, <http://d3n8a8pro7vhmx.cloudfront.net/themes/578eca176ad575b709000001/attachments/original/1469660980/DHRCC-lettersize.pdf?1469660980>.
Goldenberg, S 2014, 'Why global water shortages pose threat of terror and war', *The Guardian*, 9 February, viewed 14 March 2017, <https://www.theguardian.com/environment/2014/feb/09/global-water-shortages-threat-terror-war>.
Government of Canada 2016, *Shale and Tight Resources in Canada*, viewed 24 April 2017, <http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17669>.
GRACE 2014, *Meet the Nexus: How Food, Water and Energy are Connected*, viewed 27 February 2017, <http://www.gracelinks.org/media/pdf/nexus_guide_finalforweb.pdf>.
Graham, R 2014, 'Water in the UK - public versus private', *Open Democracy UK*, 19 December, viewed 11 April 2017, <https://www.opendemocracy.net/ourkingdom/rachel-graham/water-in-uk-public-versus-private>.
Gramsci, A 1971, *Selections from the Prison Notebooks*, International Publishers, New York.
Grant, M 2017, *Local Resolutions Against Fracking*, Food and Water Watch, viewed 21 April 2017, <https://www.foodandwaterwatch.org/insight/local-resolutions-against-fracking>.
Grear, A, Grant, E, Kerns, T, Morrow, K & Short, D 2014, *A Human Rights Assessment of Hydraulic Fracturing and Other Unconventional Gas Development in the United Kingdom*, viewed 25 April 2017, <http://d3n8a8pro7vhmx.cloudfront.net/themes/578eca176ad575b709000001/attachments/original/1469661068/UK-HRIA-wo-appdx-hi-res.pdf?1469661068>.
Greenpeace 2010, *Tar Sands and Water: Watershed Issues*, Greenpeace, viewed 4 August 2011, <http://www.greenpeace.org/canada/Global/canada/report/2010/4/Watershed_FS_footnote_rev_5.pdf>.
GTZ 2003, *Advantages of ecosan systems*, Deutsche Gesellschaft für Technische Zusammenarbeit, viewed 21 March 2017, <http://www.susana.org/en/resources/library/details/1957>.
Guinée, JB (ed.) 2002, *Handbook on life cycle assessment: Operational guide to the ISO standards*, Eco-efficiency in Industry and Science, vol. 7, Kluwer Academic Publishers, Dordrecht.
GWP 2010, *What is IWRM?*, 25 March, Global Water Partnership, viewed 9 March 2017, <http://www.gwp.org/the-challenge/what-is-iwrm/>.
Halliburton 2011, *Hydraulic Fracturing In Focus: What`s in the fluids?*, <http://www.halliburton.com/public/projects/pubsdata/hydraulic_fracturing/fluids_disclosure.html>.

Han, D, Currell, MJ & Cao, G 2016, ‘Deep challenges for China's war on water pollution’, *Environmental Pollution*, vol. 218, pp. 1222–33, viewed 21 March 2017, <http://www.sciencedirect.com/science/article/pii/S0269749116310363>.

Hand, M 2017, ‘George W. Bush’s presidency was a worst-case scenario for environmentalists. Then came Trump’, *Think Progress*, 21 April, viewed 21 April 2017, <https://thinkprogress.org/george-bush-donald-trump-environmental-assault-6a1c0e0e6130>.

Hanoi Times 2015, *Vietnam attracts nearly 15.6 billion USD of FDI in 2015*, viewed 31 March 2017, <http://hanoitimes.com.vn/investment/news/2015/12/81E09CED/vietnam-attracts-nearly-15-6-billion-usd-of-fdi-in-2015/>.

——2016, ‘Formosa vows its total compensation of 500 million USD for mass fish deaths’, *Hanoi Times*, 1 June, viewed 19 April 2017, <http://hanoitimes.com.vn/social-affair/2016/07/81E0A570/formosa-vows-its-total-compensation-of-500-million-usd-for-mass-fish-deaths/>.

Harrington, T 2017, ‘Stop the flow now says Ley as farmers rejoice’, *Riverine Herald*, 14 April, viewed 24 April 2017, <http://www.riverineherald.com.au/2017/04/14/7019/stop-the-flow-now-says-ley-as-farmers-rejoice>.

Harrison, P 2011, ‘Europe's biofuel dispute splits the industry’, *Reuters*, 3 May, viewed 4 August 2011, <http://www.reuters.com/article/2011/05/03/us-eu-biofuel-idUSTRE7422XH20110503>.

Haug, WF 2007, *Philosophizing with Marx, Gramsci, and Brecht*, viewed 3 April 2017, <http://www.wolfgangfritzhaug.inkrit.de/documents/Brecht-B2-Fahne.pdf>.

Haug, WF & Davidson, A 2004, *Hegemonie* (German), Berliner Institut für kritische Theorie, viewed 14 March 2017, <http://www.inkrit.de/e_inkritpedia/e_maincode/doku.php?id=h:hegemonie>.

Haugaard, M 2012, ‘Rethinking the four dimensions of power: domination and empowerment’, *Journal of Political Power*, vol. 5, no. 1, pp. 33–54.

Hauter, W 2015, *10 Years Later: Fracking and the Halliburton Loophole*, EcoWatch, viewed 21 April 2017, <http://www.ecowatch.com/10-years-later-fracking-and-the-halliburton-loophole-1882083309.html>.

Healy, J 2012, ‘Tapping Into the Land, and Dividing Its People’, *The New York Times*, 15 August, viewed 3 April 2017, <http://www.nytimes.com/2012/08/16/us/montana-tribe-divided-on-tapping-oil-rich-land.html>.

Heasman, R 2015, ‘Welsh Government Votes Against Fracking Due To Climate and Health Fears’, 5 February, viewed 24 April 2017, <https://www.desmog.uk/2015/02/05/welsh-government-votes-against-fracking-due-climate-and-health-fears>.

Henderson, R 2005, ‘A faircloughian approach to cda: Principled eclecticism or a method searching for a theory?’, *Melbourne Studies in Education*, vol. 46, no. 2, pp. 9–24.

Henschel, C 2012, *GIZ and Vietnam*, interview by R Schaldach, 20 March, Hanoi.

Hepworth, N 2012, ‘Open for Business or Opening Pandora’s Box? A Constructive Critique of Corporate Engagement in Water Policy: An Introduction’, *Water Alternatives*, vol. 5, no. 3, pp. 543–62.

Herr, H, Schweisshelm, E & Truong, MHV 2016, *The integration of Vietnam in the global economy and its effects for Vietnamese economic development* (eng), Global Labour University Working Paper no. 44, Geneva: International Labour Organization (ILO), <https://www.econstor.eu/bitstream/10419/156308/1/874332303.pdf>.

Hicks, J & Wiggins, O 2017, 'Governor calls for ban on fracking in Maryland', *The Washington Post*, 17 March, viewed 21 April 2017, <https://www.washingtonpost.com/local/md-politics/md-gov-hogan-calls-to-ban-fracking-in-the-state/2017/03/17/2ea1e00c-0b45-11e7-93dc-00f9bdd74ed1_story.html?utm_term=.c796b6e33759>.

Hindustan Times 2013, 'India approves policy for shale gas and oil exploration', *Hindustan Times*, 25 September, viewed 24 April 2017, <http://www.hindustantimes.com/delhi/india-approves-policy-for-shale-gas-and-oil-exploration/story-681GAnyApU1ao8oiaEOg2I.html>.

Hoekstra, AY (ed.) 2003, *Virtual water trade*, Value Of Water Research Report Series, vol. 12, International Expert Meeting on Virtual Water Trade, Delft, December 12-13, 2002, Delft, <http://waterfootprint.org/media/downloads/Report12.pdf>.

Hoekstra, AY & Chapagain, AK 2008, *Globalization of water: Sharing the planet's freshwater resources*, Blackwell Publishing, Malden, MA, viewed 8 January 2016, <http://onlinelibrary.wiley.com/book/10.1002/9780470696224>.

Hoekstra, AY, Chapagain, AK, Aldaya, MM & Mekonnen, MM 2009, *Water Footprint Manual: State of the Art 2009*, Water footprint Network, Enschede, viewed 8 January 2016, <http://waterfootprint.org/media/downloads/WaterFootprintManual2009.pdf>.

Hoekstra, AY, Chapagain, AK, Aldaya, MM & Mekonnen, MM 2011, *The Water Footprint Assessment Manual: Setting the global standard*, Earthscan, London, <http://waterfootprint.org/media/downloads/TheWaterFootprintAssessmentManual_2.pdf>.

Hoekstra, AY & Mekonnen, MM 2010, 'Mitigating the water footprint of export cut flowers from the Lake Naivasha Basin, Kenya', in H Steusloff (ed.), *Integrated Water Resources Management Karlsruhe 2010: International conference, 24 - 25 November 2010 ; conference proceedings* (eng), Karlsruhe, November 24-25, 2010, IWRM, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung, International Conference on Integrated Water Resources Management & IWRM Karlsruhe Conference, KIT Scientific Publishing, Karlsruhe, pp. 374–81, viewed 8 March 2017, <https://books.google.de/books?hl=de&lr=&id=PEJAnpzb8kgC&oi=fnd&pg=PA374&dq=Lake+Naivasha+Basin+in+Kenya+virtual+water+trade&ots=c55yJLwpfb&sig=d0k_MgnVbymLCWa9-47szuKWSNY&redir_esc=y#v=onepage&q=Lake%20Naivasha%20Basin%20in%20Kenya%20virtual%20water%20trade&f=false>.

——2012, 'The water footprint of humanity', *Proceedings of the National Academy of Sciences*, vol. 109, no. 9, pp. 3232–7.

Hoff, H 2011, *Understanding the Nexus. Background Paper for the Bonn2011 Conference: The Water, Energy and Food Security Nexus*, Stockholm Environment Institute, Stockholm, viewed 14 March 2017, <http://wef-conference.gwsp.org/fileadmin/documents_news/understanding_the_nexus.pdf>.

Horlemann, L & Neubert, S 2007, *Virtual Water Trade: A realistic concept for resolving the water crisis?*, Studies / Deutsches Institut für Entwicklungspolitik, vol. 25, Bonn.

Horn, S 2017, ‘Architect of Federal Fracking Loophole May Head Trump Environmental Council’, *Common Dreams*, 19 March, viewed 21 April 2017, <https://www.commondreams.org/news/2017/03/19/architect-federal-fracking-loophole-may-head-trump-environmental-council>.
Houston Chronicle 2003, ‘Bill aims to protect gas-drilling technique’, *Houston Chronicle*, 7 September, viewed 4 August 2011, <http://www.halliburtonwatch.org/about_hal/fracturing_chronicle.html>.
Howarth, RW, Santoro, R & Ingraffea, A 2011, ‘Methane and the greenhouse-gas footprint of natural gas from shale formations’, *Climatic Change*, vol. 106, no. 4, pp. 679–90.
ICIMOD 2012, *Himalayan Climate Change Adaptation Programme: Contribution of Himalayan Ecosystems to Water, Energy and Food Security in South Asia: A nexus approach*, International Centre for Integrated Mountain Development, viewed 14 March 2017, <http://lib.icimod.org/record/1898/files/nexus1.pdf>.
ICWE 1992, *The Dublin Statement on Water and Sustainable Development*, International Conference on Water and Environment, viewed 13 March 2017, <http://www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html>.
IEA 2011, *World Energy Outlook Special Report: Are We Entering a Golden Age of Gas?*, viewed 19 April 2017, <http://www.worldenergyoutlook.org/media/weowebsite/2011/WEO2011_GoldenAgeofGasReport.pdf>.
——2013, *Reserves to Resources: Oil, Gas and Coal Technologies for the Energy Markets of the Future*, viewed https://www.iea.org/publications/freepublications/publication/Resources2013.pdf, <04/19/2017>.
——2016, *International Energy Outlook 2016 with projections to 2040*, viewed 19 April 2017, <https://www.eia.gov/outlooks/ieo/pdf/0484(2016).pdf>.
IFAD 2016, *Rural Development Report 2016: Fostering Inclusive Rural Transformation*, Rome.
Ingold, K, Fischer, M & Cairney, P 2016, ‘Drivers for Policy Agreement in Nascent Subsystems: An Application of the Advocacy Coalition Framework to Fracking Policy in Switzerland and the UK’, *Policy Studies*, pp. 1–22, viewed 25 April 2017.
Intelligence Community Assessment 2012, *Global Water Security*, viewed 10 April 2017, <https://www.dni.gov/files/documents/Special%20Report_ICA%20Global%20Water%20Security.pdf>.
International Trade Centre (ITC) 2019, *Trade Map: List of importing markets for a product exported by Viet Nam*, International Trade Centre UNCTAD/WTO, Geneva, viewed 11 September 2019, <https://www.trademap.org/Country_SelProductCountry_TS.aspx?nvpm=1%7c704%7c%7c%7c%7c851712%7c%7c%7c6%7c1%7c1%7c2%7c2%7c1%7c2%7c1%7c1>.
IPCC 1990, *Climate Change: The IPCC Scientific Assessment*, Intergovernmental Panel on Climate Change, viewed 19 April 2017, <https://www.ipcc.ch/ipccreports/far/wg_I/ipcc_far_wg_I_full_report.pdf>.
IWA 2016, *Desalination - the Australian Experience*, 17 August, viewed 25 April 2017, <http://www.iwa-network.org/news/desalination-australian-experience/>.

Jaremko, G 2016, ‘Quebec Prepares to Drill, Frack Its Utica Shale’, *NGI's Shale Daily*, 1 July, viewed 24 April 2017, <http://www.naturalgasintel.com/articles/106946-quebec-prepares-to-drill-frack-its-utica-shale>.

Jaspal, R & Nerlich, B 2013, ‘Fracking in the UK press: Threat dynamics in an unfolding debate’, *Public Understanding of Science*, vol. 23, no. 3, pp. 348–63, viewed 24 April 2017.

Jessop, B 2001, *The spatiotemporal dynamics of capital and its globalization-and how they Challenge State Power and Democracy*, viewed 10 October 2013, <www.comp.lancs.ac.ik/sociology/soc132rj.pdf>.

Johnson, JP 1993, ‘The geochronology and radiogenic isotope systematics of the Olympic Dam copper-uranium-gold-silver deposit, South Australia’, PhD Thesis, Australian National University, viewed 21 April 2017, <https://openresearch-repository.anu.edu.au/handle/1885/10918>.

Johnston, R & McCartney, M 2010, *Inventory of water storage types in the Blue Nile and Volta river basins: IMWI Working Paper 140*, International Water Management Institute, Colombo, Sri Lanka, viewed 27 January 2017, <http://africastorage-cc.iwmi.org/Data/Sites/25/media/PDF/wp140(web_version).pdf>.

Jolly, D 2013, ‘France Upholds Ban on Hydraulic Fracturing’, *The New York Times*, 3 November, viewed 24 April 2017, <http://www.nytimes.com/2013/10/12/business/international/france-upholds-fracking-ban.html>.

Kerns, T 2011, *A Human Rights Assessment of Hydraulic Fracturing for Natural Gas*, Human Rights Advisory, viewed 25 April 2017, <http://d3n8a8pro7vhmx.cloudfront.net/themes/578eca176ad575b709000001/attachments/original/1469661000/EHRA-frac-rpt-111212-1-final1.pdf?1469661000>.

Kondash, A & Vengosh, A 2015, ‘Water Footprint of Hydraulic Fracturing’, *Environmental Science & Technology*, no. 2, pp. 276–80, viewed 11 April 2017, <http://pubs.acs.org/doi/pdf/10.1021/acs.estlett.5b00211>.

Konzernatlas: Daten und Fakten über die Agrar- und Lebensmittelindustrie2017 2017, viewed 15 April 2017.

Kulshreshtha, SN 1993, *World Water Resources and Regional Vulterability: Impact of Future Changes*, 29 March, International Institute for Applied System Analysis, Laxenburg (Austria), viewed 16 February 2012, <http://www.iiasa.ac.at/Admin/PUB/Documents/RR-93-010.pdf>.

Laclau, E & Mouffe, C 1985, *Hegemony and socialist strategy: Towards a radical democratic politics*, 1st edn.

——2014, *Hegemony and socialist strategy: Towards a radical democratic politics* (eng), Radical thinkers, 2nd edn, Verso, London.

Lazarevic, D & Martin, M 2016, ‘Life cycle assessments, carbon footprints and carbon visions: Analysing environmental systems analyses of transportation biofuels in Sweden’, *Journal of Cleaner Production*, vol. 137, pp. 249–57.

Le Grand, C 2017, ‘Rural towns in northern Victoria ‘to die’ if water for farms withheld’, *The Australian*, 3 March, viewed 24 April 2017, <http://www.theaustralian.com.au/news/nation/rural-towns-in-northern-victoria-to-die-if-water-for-farms-withheld/news-story/a6b4fed20959fba5764532c94eb0116b>.

Lee, J & West, J 2014, ‘The Great Frack Forward’, *Mother Jones*, 18 September, viewed 24 April 2017, <http://www.motherjones.com/environment/2014/09/china-us-fracking-shale-gas>.

Li, L, Lu, X & Chen, Z 2007, ‘River channel change during the last 50 years in the middle Yangtze River, the Jianli reach’, *Geomorphology*, vol. 85, 3-4, pp. 185–96.

Lukes, S 1974, *Power: A Radical View*, Palgrave Macmillan.

——2005a, *Power: A Radical View, A Second Edition*, Palgrave Macmillan, Houndmiles.

——2005b, ‘Power and the Battle for Hearts and Minds’, *Millennium: Journal of International Studies*, vol. 33, no. 3, pp. 477–93.

Luo, Y, Guo, W, Ngo, HH, Nghiem, LD, Hai, FH, Zhang, J, Liang, S & Wang, XC 2014, ‘A review on the occurrence of micropollutants in the aquatic environment and their fate and removal during wastewater treatment’, *Science of The Total Environment*, 437-474, pp. 619–41.

Luxemburger Wort 2013, ‘No fracking of shale gas in Luxembourg’, *Luxemburger Wort*, 9 April, viewed 24 April 2017, <http://www.wort.lu/en/luxembourg/no-fracking-of-shale-gas-in-luxembourg-50a37ff8e4b0e83edf95f923#>.

Lynch, M 2009, ‘‘Peak Oil’ Is a Waste of Energy’, *New York Times*, 24 August, viewed 14 March 2017, <http://www.nytimes.com/2009/08/25/opinion/25lynch.html>.

MacDonald, M n.d., ‘N.S. gov't puts fracking on hold for 2 more years’, *CTV News Atlantic*, viewed 04/25/20, <http://atlantic.ctvnews.ca/n-s-gov-t-puts-fracking-on-hold-for-2-more-years-1.796707>.

Madhav, P 2017, ‘Tamil Nadu: Farmers unite to protest Centre's hydrocarbon extraction program in Neduvasal’, *India Today*, 26 February, viewed 24 April 2017, <http://indiatoday.intoday.in/story/tamil-nadu-hydrocarbon-extraction-methane-fracking-protests-neduvasal/1/891801.html>.

MarathonOilCorp 2012, *Animation of Hydraulic Fracturing (fracking)*, viewed 21 April 2017, <https://www.youtube.com/watch?v=VY34PQUiwOQ>.

Margot, J, Rossi, L, Barry, DA & Holliger, C 2015, ‘A review of the fate of micropollutants in wastewater treatment plants’, *Wiley Interdisciplinary Reviews: Water*, vol. 2, no. 5, pp. 457–87.

Marsden, B 2003, *Cholera and the age of the water barons*, The International Consortium of Investigative Journalists, viewed 11 April 2017, <https://www.icij.org/projects/waterbarons/cholera-and-age-water-barons>.

Mascarenhas, A 2016, ‘Sex determination: An old law, a new debate’, *Indian Express*, 4 February, viewed 10 April 2017, <http://indianexpress.com/article/explained/sex-determination-an-old-law-a-new-debate/>.

Matze, M 2013, ‘Río Negro Town Bans ‘Fracking’’, *The Argentina Independent*, 10 January, viewed 24 April 2017, <http://www.argentinaindependent.com/currentaffairs/latest-news/newsfromargentina/rio-negro-town-bans-fracking/>.

McCarthy, M, Burton, L & Spraggon, B 2015, ‘Before and after: How the drought is biting in regional Australia’, *ABC*, 17 December, viewed 24 April 2017, <http://www.abc.net.au/news/2015-12-17/queensland-drought-photos-before-after/7035610>.

McCulloch, S 2017, 'Fracking ban call by Labour in Scotland backed by nearly 90 per cent of public in consultation', *Insider*, 19 April, viewed 24 April 2017, <http://www.insider.co.uk/news/fracking-ban-call-labour-scotland-10252881>.

McHardie, D 2016, 'New Brunswick indefinitely extends hydraulic fracturing moratorium', *CBC News*, 27 May, viewed 25 April 2017, <http://www.cbc.ca/news/canada/new-brunswick/arseneault-fracking-commission-report-1.3602849>.

Megaloudi, F 2013, 'When Water Is for Sale: What Water Privatisation Really Means', *The Huffington Post*, 3 August, viewed 11 April 2017, <http://www.huffingtonpost.co.uk/fragkiska-megaloudi/water-privatisation-what-it-really-means_b_3381233.html>.

Mehta, L, Veldwisch, GJ & Franco, J 2012, 'Introduction to the Special Issue: Water Grabbing? Focus on the (Re)appropriation of Finite Water Resources', *Water Alternatives*, vol. 5, no. 2, pp. 193–207, <http://www.water-alternatives.org/index.php/volume5/v5issue2/165-a5-2-1/file>.

Mekonnen, MM, Gerbens-Leenes, PW & Hoekstra, AY 2015, 'The consumptive water footprint of electricity and heat: a global assessment', *Environmental Science: Water Research & Technology*, vol. 1, no. 3, pp. 285–97.

Mekonnen, MM & Hoekstra, AY 2010, *The green, blue and grey water footprint of crops and derived crop products*, Value Of Water Research Report Series no. 47, UNESCO-IHE, Delft, viewed 9 March 2019.

Mekonnen, MM & Hoekstra, AY 2011, *National Water Footprint Accounts: The Green, Blue and Grey Water Footprint of Production and Consumption*, Value Of Water Research Report Series no. 50, UNESCO-IHE, Delft.

——2012, 'A Global Assessment of the Water Footprint of Farm Animal Products', *Ecosystems*, vol. 15, no. 3, pp. 401–15.

Merrett, S 2007, *The price of water: Studies in water resource economics and management*, 2nd edn, IWA Publishing, London.

Merriam-Webster 2017a, *"land grab"*, viewed 3 April 2017, <https://www.merriam-webster.com/dictionary/land%20grab>.

——2017b, *"nexus"*, viewed 14 February 2017, <https://www.merriam-webster.com/dictionary/nexus>.

Meyer, W, Reich, M, Beier, S, Behrend, J, Gulyas, H & Otterpohl, R 2016, 'Measured and predicted environmental concentrations of carbamazepine, diclofenac, and metoprolol in small and medium rivers in northern Germany.', *Environmental Monitoring and Assessment*, vol. 188, no. 8, p. 487.

Meyer, W, Reich, M & Otterpohl, R 2014, 'Sind die Ökosysteme kleiner Fließgewässer aktuell und zukünftig durch den Eintrag von Pharmazeutika besonders gefährdet?' (German), *Korrespondenz Wasserwirtschaft*, vol. 7, no. 5, pp. 273–7.

Milà i Canals, L, Chenoweth, J, Chapaging, AK, Orr, S, Antón, A & Clift, R 2009, 'Assessing freshwater use impacts in LCA for the main impact pathways: Part 1: Inventory Modelling and Characterisation Factors', *The International Journal of Life Cycle Assessment*, vol. 14, no. 1, pp. 28–42.

Milke, M & Green, P 2014, *New Brunswick ignores energy success up north and in Pennsylvania*, Fraser Institute, viewed 24 April 2017,

<https://www.fraserinstitute.org/article/new-brunswick-ignores-energy-success-north-and-pennsylvania>.

Ministerium für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen 2014, *Hydraulic Fracturing (Fracking)* (German), viewed 21 April 2017, <https://www.umwelt.nrw.de/umweltschutz-umweltwirtschaft/umwelt-und-wasser/grundwasser/grundwasserschutz/hydraulic-fracturing-fracking/>.

Ministry of Natural Resources and Environment 2006, *National Water Resouces Strategy towards the Year 2020*, viewed 10 October 2013, <http://iwe.sharif.ir/c/document_library/get_file?uuid=a8c14f8b-22ef-4948-bffb-eeb51e396859&groupId=571836>.

——2008, *National Environmental Performance Assessment: (EPA) Report*, 8 May, viewed 18 April 2017, <http://www.gms-eoc.org/uploads/resources/24/attachment/Viet%20Nam%20EPA%20Report.pdf>.

Mo, W, Zhang, Q, Mihelcic, JR & Hokanson, DR 2011, 'Embodied energy comparison of surface water and groundwater supply options', *Water Research*, vol. 45, pp. 5577–86.

Mohtar, RH & Daher, B 2012, 'Water, Energy, and Food: The Ultimate Nexus', in DR Heldman & CI Moraru (eds), *Encyclopedia of Agricultural, Food, and Biological Engineering*, 2nd edn, Taylor & Francis, pp. 1–5, viewed 14 March 2017, <http://wefnexus.tamu.edu/files/2015/01/Mohtar-Daher_Water-Energy-and-Food-The-Ultimate-Nexus.pdf>.

Morelli, S, Segoni, S, Manzo, G, Ermini, L & Catani, F 2012, 'Urban planning, flood risk and public policy: The case of the Arno River, Firenze, Italy', *Applied Geography*, vol. 34, pp. 205–18.

Mudd, GM 2007, *The Sustainability of Mining in Australia: Key Production Trends and Environmental Implications for the Future. Research Report No RR5*, Department of Civil Engineering, Monash University and Mineral Policy Institute, viewed 19 April 2017, <http://users.monash.edu.au/~gmudd/files/SustMining-Aust-Report-2009-Master.pdf>.

Mukhtarov, FG 2007, 'Integrated Water Resources Management from a Policy Transfer Perspective', in General Directorate of State Hydraulic Works (ed.), *International Congress on River Basin Management Congress Book*, International Congress on River Basin Management, Antalya, Turkey, May 22-24,2007, pp. 611–25, viewed 22 December 2015, <http://www2.dsi.gov.tr/english/congress2007/chapter_2/49.pdf>.

Murray, S 2007, 'Clinton-Obama Differences Clear In Senate Votes', *The Washington Post*, 1 January, viewed 4 August 2011, <http://www.washingtonpost.com/wp-dyn/content/article/2006/12/31/AR2006123101004.html>.

Nagourney, A 2015, 'The Debate over Califonia's Drought Crisis', *The New York Times*, 15 April, viewed 25 November 2015, <http://www.nytimes.com/2015/04/15/us/the-debate-over-californias-drought-crisis.html?_r=0>.

Neales, S 2014, 'Organic farming will grow to $1-billion industry', *The Weekly Times*, 22 May, viewed 21 April 2017, <http://www.weeklytimesnow.com.au/news/organic-farming-will-grow-to-1billion-industry/news-story/4d58bf3a59286f86a6762fc1948a4433>.

NewsHub 2014, 'Italian region says fracking may have caused quakes', *NewsHub*, 15 April, viewed 25 April 2017, <http://www.newshub.co.nz/world/italian-region-says-fracking-may-have-caused-quakes-2014041606>.

Nguyen, DTU 2016a, ‘Vietnam Forecasts Record 2016 $15 Billion Foreign Investment’, *Bloomberg*, 9 December, viewed 6 April 2017, <https://www.bloomberg.com/news/articles/2016-12-09/vietnam-forecasts-record-15-billion-foreign-investment-in-2016>.

——2016b, ‘Vietnam Defies Asia Slowdown as Economic Growth Holds Above 6%’, *Bloomberg*, 28 December, viewed 6 April 2017, <https://www.bloomberg.com/news/articles/2016-12-28/vietnam-s-gdp-growth-quickens-to-6-68-in-4th-quarter>.

Nguyen, H 2017, ‘EU offers Vietnam a TPP alternative’, *Asia Times*, 17 February, viewed 19 April 2017, <http://www.atimes.com/article/eu-offers-vietnam-tpp-alternative/>.

Nike 2019, *Nike Sustainability - Interactive Map*, viewed 13 September 2019, <http://manufacturingmap.nikeinc.com/#>.

NSW Government Planning and Environment - Resources and Energy n.d., *FAQs on coal seam gas*, viewed 24 April 2017, <http://www.resourcesandenergy.nsw.gov.au/landholders-and-community/coal-seam-gas/the-facts/faqs#_is-_c_s_g-in-_n_s_w-different-from-other-states-and-countries__003f>.

Nye, JS 1991, *Bound to lead: The changing nature of American power* (eng), Basic Books, New York.

OCHA 2016, *Viet Nam: Emergency Response Plan 2016/17*, 22 April, Office for the Co-ordination of Humanitarian Affairs, viewed 18 April 2017, <http://reliefweb.int/sites/reliefweb.int/files/resources/Viet%20Nam%20ERP%20%28final_22.04.16%29.pdf>.

OECD 2015, *Meat Consumption*, viewed 4 April 2017, <https://data.oecd.org/agroutput/meat-consumption.htm>.

OECD Environment Directorate 2004, *OECD Key Environmental Indicators*, Paris, <http://www.oecd.org/dataoecd/32/20/31558547.pdf>.

Office of the Director of National Intelligence 2014, *The National Intelligence Strategy of the United States of America*, viewed 27 February 2017, <https://www.dni.gov/files/documents/2014_NIS_Publication.pdf>.

Oil and Gas Threat Map 2017, *United States Threatened Population*, viewed 21 April 2017, <http://oilandgasthreatmap.com/threat-map/national-map%20/>.

Oki, T & Kanae, S 2006, ‘Global Hydrological Cycles and World Water Resources’, *Science*, vol. 313, no. 5790, pp. 1068–72.

Onwuegbuzie, AJ & Frels, R 2016, *7 steps to a comprehensive literature review: A multimodal & cultural approach* (eng), SAGE, Los Angeles.

Osterkamp, TE, Esch, DC & Romanovsky, VE 1998, ‘Permafrost’, in G Weller & PA Anderson (eds), *Implications of Global Change in Alaska and the Bering Sea Region: Proceedings of a Workshop at the University of Alaska Fairbanks*, June 3-6, 1997, University of Alaska Fairbanks, Center for Global Change and Arctic System Research, pp. 115–8, <http://www.besis.uaf.edu/besis-june97-report/Ch10_Permafrost_pt1.pdf>.

Pre-Natal Diagnostic Techniques (Regulation and Prevention of Misuse) Act 1994 (Parliament of the Republic of India), viewed 10 April 2017, <http://www.ncpcr.gov.in/view_file.php?fid=434>.

Parliament of Victoria 2013, *Unconventional Gas: Coal Seam Gas, Shale Gas and Tight Gas*, viewed 24 April 2017, <https://www.parliament.vic.gov.au/publications/research-papers/send/36-research-papers/13717-unconventional-gas-paper-final>.

Patel, T & Viscusi, G 2013, 'France's Fracking Ban 'Absolute' After Court Upholds Law', *Bloomberg*, 11 October, viewed 24 April 2017, <https://www.bloomberg.com/news/articles/2013-10-11/fracking-ban-upheld-by-french-court-as-constitutional>.

Paterson, B 1896, 'Song of the Artesian Water', *The Bulletin*, 12 December.

Paterson, L 2017, ''87% backing' for Labour bid to ban fracking in Scotland', 19 April, viewed 24 April 2017, <https://www.sundaypost.com/fp/87-backing-for-labour-bid-to-ban-fracking-in-scotland/>.

Patra, HP, Adhikari, SK & Kunar, S 2016, *Groundwater Prospecting and Management*, Springer Singapore.

Patterson, B 2015, *WIN! Sustainable Development Goals include the right to drinking water and sanitation*, The Council of Canadians, viewed 10 April 2017, <http://canadians.org/blog/win-sustainable-development-goals-include-right-drinking-water-and-sanitation>.

Peristianis, A & Abu-Hussein, H 2017, 'Islamic State's 'water war' on Iraq', *BBC News*, 27 November, viewed 14 March 2017, <http://www.bbc.com/news/world-middle-east-34905237>.

Permanent Peoples Tribunal 2015, *Media Release*, Permanent Peoples Tribunal, viewed 25 April 2017, <http://www.tribunalonfracking.org/media_release>.

Pfister, S & Scherer, L 2015, 'Uncertainty analysis of the environmental sustainability of biofuels', *Energy, Sustainability and Society*, vol. 5, no. 30.

Pfister, S, Stoessel, F, Juraske, R, Koehler, A & Hellweg, S 2009, 'Regionalised LCIA of vegetable and fruit production: Quantifying the environmental impacts of freshwater use', in T Nemecek & G Gaillard (eds), *Proceedings of the 6th International Conference on LCA in the Agri-Food Sector*, Agroscope Reckenholz-Tänikon Research Station ART, Zürich, pp. 13–4, viewed 14 September 2011, <http://www.agroscope.admin.ch/aktuell/02720/02722/03985/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCEdIJ,fWym162epYbg2c_JjKbNoKSn6A-->.

Pham, P 2018, *Vietnam's Trade War Balancing Act*, Forbes, viewed 13 September 2019, <https://www.forbes.com/sites/peterpham/2018/11/29/vietnams-trade-war-balancing-act/#5655a2707b36>.

Prosser, IP (ed.) 2011, *Water: Science and Solutions for Australia*, CSIRO Publishing, viewed 25 April 2017, <http://www.publish.csiro.au/ebook/download/pdf/6557>.

Que, TT & Phuc, TX 2003, *The Doi Moi Policy and its Impact on the Poor*, Centre for Gender, Environment and Sustainable Development Studies, viewed 5 April 2017, <http://www.socialwatch.org/node/10854>.

Queensland Government Department of Natural Resources and Mines 2017, *Coal Seam Gas and Liquified Natural Gas*, viewed 24 April 2017, <https://www.dnrm.qld.gov.au/>.

Rahaman, MM & Varis, O 2005, 'Integrated water resources management: evolution, prospects and future challenges', *Sustainability: Science, Practice, & Policy*, vol. 1, no. 1, pp. 15–21, <https://sspp.proquest.com/integrated-water-resources-management-evolution-prospects-and-future-challenges-c43839577953#.zdmps6iir>.

Raskin, P, Gleick, PH & Kirshen, P 1997, *Water futures: Assessment of long-range patterns and problems*, Stockholm Environment Institute, Stockholm.

Raventos, N, Macpherson, E & Garcia-Rubies, A 2006, 'Effect of brine discharge from a desalination plant on macrobenthic communities in the NW Mediterranean', *Marine Environmental Research*, vol. 62, pp. 1–14.

Reeder, M 2011, 'What has Davos done for us?', *Reuters*, 20 January, viewed 15 January 2017, <http://blogs.reuters.com/davos/2011/01/20/what-has-davos-done-for-us/>.

Rekacewicz, P 2004, *Emissions of organic water pollutants*, UNEP/GRID-Arendal, viewed 21 March 2017, <http://www.grida.no/resources/5676>.

——2005a, *Freshwater Stress 1995 and 2025*, UNEP/GRID-Arendal, viewed 29 March 2017, <http://www.grida.no/resources/5785>.

——2005b, *Trends and forecasts in water use by sector*, UNEP/GRID-Arendal, viewed 4 April 2017, <http://www.grida.no/resources/5786>.

——2009, *Water withdrawal and consumption: the big gap*, UNEP/GRID-Arendal, viewed 6 April 2017, <http://www.grida.no/resources/5613>.

——2011a, *China's people problem*, Le Monde Diplomatique, viewed 11 April 2017, <https://mondediplo.com/maps/chinapeople>.

——2011b, *Life on Earth*, Le Monde Diplomatique, viewed 10 April 2017, <http://mondediplo.com/maps/lifeonearth>.

——2013, *Senior citizens around the world*, Le Monde Diplomatique, viewed 11 April 2017, <https://mondediplo.com/maps/seniors>.

Relief Web 2016, *South-East Asia: Drought - 2015-2017 (Ongoing)*, Office for the Coordination of Humanitarian Affairs, viewed 19 April 2017, <http://reliefweb.int/disaster/dr-2015-000180-vnm>.

Reske, U 2016, 'Beschluss: Vierte Klärstufe kommt' (German), *Westfälische Nachrichten*, 22 September, viewed 21 March 2017, <http://www.wn.de/Muensterland/Kreis-Steinfurt/Greven/2542135-Klaeranlage-Beschluss-Vierte-Klaerstufe-kommt>.

Reuters 2012, 'OMV abandons Austrian shale gas plans', *Reuters*, 17 September, viewed 25 April 2017, <http://www.reuters.com/article/omv-shale-austria-idUSL5E8KHHDG20120917>.

——2013, 'Shale-rich Spanish region vote to ban fracking', 8 April, viewed 24 April 2017, <http://uk.reuters.com/article/us-energy-spain-shale-idUKBRE9370G220130408>.

——2016a, 'German government agrees to ban fracking indefinitely', 21 June, viewed 24 April 2017, <http://www.reuters.com/article/us-germany-fracking-idUSKCN0Z71YY>.

——2016b, 'Vietnam's 2016 FDI inflow hits record high of $15.8 bln-govt', 27 December, viewed 6 April 2017, <http://www.reuters.com/article/vietnam-economy-fdi-idUSL4N1EG1XP>.

Richey, AS, Thomas, BF, Lo, MH, Reager, JT, Famiglietti, JS, Voss, K, Swenson, S & Rodell, M 2015, 'Quantifying renewable groundwater stress with GRACE', *Water Resources Research*, vol. 51, no. 7, pp. 5217–38, viewed 21 March 2017, <http://onlinelibrary.wiley.com/doi/10.1002/2015WR017349/full>.

Roberts, DA, Johnston, EL & Knott, NA 2010, ‘Impacts of desalination plant discharges on the marine environment: A critical review of published studies’, *Water Research*, vol. 44, pp. 5117–28.
Rosa, L, Rulli, MC, Davis, KF & D'Odorico, P 2018, ‘The Water-Energy Nexus of Hydraulic Fracturing: A Global Hydrologic Analysis for Shale Oil and Gas Extraction’ (en), *Earth's Future*, vol. 6, no. 5, pp. 745–56, <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2018EF000809>.
Roxby Water 2017, *Roxby Water*, viewed 21 April 2017, <http://www.roxbydowns.sa.gov.au/page.aspx?u=26>.
Ruffalo, M 2016, ‘Mark Ruffalo: There's No Fracking That Can Be Done Safely’, *EcoWatch*, 13 February, viewed 25 April 2017, <http://www.ecowatch.com/mark-ruffalo-theres-no-fracking-that-can-be-done-safely-1882173665.html>.
Ruini, L, Marino, M, Laio, F & Ridolfi, L 2013, ‘Water footprint of a large-sized food company: The case of Barilla pasta production’, *Water Resources and Industry*, 1-2, pp. 7–24.
Sadoff, CW, Hall, JW, Grey, D, Aerts, JCJH, Ait-Kadi, M, Brown, C, Cox, A & Dadson, S 2015, *Securing Water, Sustaining Growth: Report of the GWP/OECD Task Force on Water Security and Sustainable Growth*, University of Oxford.
Safi, M 2015, ‘Australian uranium 'could end up in India’s nuclear weapons program'’, *The Guardian*, 13 February, viewed 24 April 2017, <https://www.theguardian.com/world/2015/feb/13/australian-uranium-could-end-up-in-indias-nuclear-weapons-program>.
Satterthwaite, D 2016, ‘Missing the Millennium Development Goal targets for water and sanitation in urban areas’, *Environment & Urbanization*, vol. 28, no. 1, pp. 99–118.
Scanlon, BR, Reedy, RC, Male, F & Hove, M 2016, ‘Managing the Increasing Water Footprint of Hydraulic Fracturing in the Bakken Play, United States’, *Environmental Science & Technology*, vol. 50, pp. 10273–81.
Scauzillo, S 2015, ‘California has entered fourth year of drought, water experts say’, *Los Angeles Daily News*, 25 February, viewed 10 March 2015, <http://www.dailynews.com/general-news/20150225/california-has-entered-fourth-year-of-drought-water-experts-say>.
Schaldach, R 2015, ‘The forces of globalizations spin the resource cycles: Australia's water tradeoffs and the water-energy-food nexus’, in I Körner (ed.), *RAMIRAN 2015*, 16th International Conference Rural-Urban Symbiosis, Hamburg, September 8-10, 2015, Hamburg University of Technology, TU-Tech Verlag, Hamburg, pp. 705–9.
Scherrer, C, Langhammer, RJ, Matthes, J, Pies, I, Seele, P & Knebel, S 2013, ‘Inhumane Arbeitsbedingungen auf dem globalen Markt — Wer kann, wer soll handeln?’ (German), *Wirtschaftsdienst*, vol. 93, no. 4, pp. 215–32.
Scheurer, W & Otterpohl, R 2011, ‘Pharmazeutische Wirkstoffe in kleinen norddeutschen Fließgewässern und Kläranlagenabläufen’ (German), in S Beier, H Gulyas, S Köster & R Otterpohl (eds), *23. Kolloquium zur Abwasserwirtschaft* (German), August 31 - September 1, 2011, Gesellschaft zur Förderung der Forschung und Entwicklung der Umwelttechnologien, Hamburg, pp. 117–30.
Schmandt, J 2005, ‘Will we have enough water? An overview’, in J Norwine, JR Giardino & S Krishnamurthy (eds), *Water for Texas*, Texas A&M University Press.

Schreier, H & Pang, G 2012, ‘Virtual Water and Global Food Security: Implications for Canada!’, University of Britisch Columbia, viewed 10 October 2013, <http://wmc.landfood.ubc.ca/webapp/VWM/>.
Sehring, J 2009, *The Politics of Water Institutional Reform in Neopatrimonial States: A Comparative Analysis of Kyrgyzstan and Tajikistan*, VS Verlag für Sozialwissenschaften.
Shale Gas International 2015, *Dutch government bans shale till 2020*, viewed 24 April 2017, <http://www.shalegas.international/2015/07/13/dutch-government-bans-shale-till-2020/>.
Shao, Y 2017, ‘Accounting for the Right to Water: The Great Artesian Basin and Olympic Dam Mine’, Doctor of Philosophy Thesis, University of Wollongong, viewed 21 April 2017, <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1007&context=theses1>.
Shiklomanov, IA & Rodda, JC (eds) 2004, *World water resources at the beginning of the twenty-first century*, International hydrology series, vol. 41, Cambridge University Press, Cambridge.
Shiva, V 2016, *Water Wars: Privatization, Pollution, and Profit*, North Atlantic Books.
Simoes, A 2019, *The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development*, Vietnam, viewed 9 September 2019.
Singh, S 2015, ‘Where is India's fracking revolution?’, *Business Standard*, 21 October, viewed 24 April 2017, <http://www.business-standard.com/article/punditry/where-is-india-s-fracking-revolution-115102100273_1.html>.
Sinha, B 2016, ‘Supreme Court gives more teeth to law banning sex determination’, *Hindustan Times*, 6 November, viewed 10 April 2017, <http://www.hindustantimes.com/india-news/supreme-court-gives-more-teeth-to-law-banning-sex-determination/story-UyTcpke05RntGUNsdmT7wO.html>.
Sisters of Mercy 2015, *A Guide to Rights-based Advocacy: International Human Rights Law and Fracking*, viewed 25 April 2017, <http://d3n8a8pro7vhmx.cloudfront.net/themes/578eca176ad575b709000001/attachments/original/1469661028/Fracking-Hum-Rts-Guide-2015.pdf?1469661028>.
Smakhtin, V, Revenga, C & Döll, P 2004a, ‘A Pilot Global Assessment of Environmental Water Requirements and Scarcity’, *Water international*, vol. 29, no. 3, pp. 307–17.
——2004b, *Talking into Account Enivronmental Water Requirements in Global-scale Water Resource Assessment: Comprehensive Assessment of Water Management in Agriculture*, 16 March, viewed 16 June 2012, <http://www.iwmi.cgiar.org/assessment/FILES/pdf/publications/ResearchReports/CARR2.pdf>.
Smith-Spark, L & Boulden, J 2013, ‘UK lifts ban on fracking to exploit shale gas reserves’, *CNN*, 3 May, viewed 24 April 2017, <http://edition.cnn.com/2012/12/13/business/uk-fracking/>.
Sojamo, S, Keulertz, M, Warner, J & Allan, JA 2012, ‘Virtual water hegemony: The role of agribusiness in global water governance’, *Water international*, vol. 37, no. 2, pp. 169–82.
Sojamo, S & Larson, EA 2012, ‘Investigating food and agribusiness corporations as global water security, management and governance agents: The case of Nestle, Bunge and Cargill’, *Water Alternatives*, vol. 5, no. 3, pp. 619–35.

Sønderberg Petersen, L & Larsen, HH 2016, *DTU International Energy Report 2016: The Energy- Water-Food Nexus - from local to global aspects*, Technical University of Denmark, viewed 27 February 2017, <http://orbit.dtu.dk/files/128049733/DTU_INTERNATIONAL_ENERGY_REPORT_2016_reduced.pdf>.

Spegele, B & Scheck, J 2013, 'Energy-Hungry China Struggles to Join Shale-Gas Revolution', *The Wall Street Journal*, 5 September, viewed 24 April 2017, <https://www.wsj.com/articles/energyhungry-china-struggles-to-join-shalegas-revolution-1378350220?tesla=y>.

Spring, B & Dillon, D 2016, *Nuclear India and the Non-Proliferation Treaty*, The Heritage Foundation, viewed 24 April 2017, <http://www.heritage.org/defense/report/nuclear-india-and-the-non-proliferation-treaty>.

State of Western Australia 2015, *Guide to the Regulatory Framework for Shale and Tight Gas in Western Australia: A Whole-of-Government Approach*, viewed 24 April 2017, <http://www.dmp.wa.gov.au/Documents/Petroleum/WEB_Shale_and_Tight_Gas_Framework.pdf>.

Stewart, I, Atkinson, B, Dragicevich, P & Ray, N 2012, *Lonely Planet Vietnam*, Lonely Planet Publications.

Strategic Foresight Group 2013, *Interactive Map - Water Cooperation for a Secure World*, viewed 14 March 2017, <http://strategicforesight.com/water-cooperation-map/>.

Strzelecki, M & Almeida, I 2014, 'Fracking Setback in Poland Dims Hope for Less Russian Gas', *Bloomberg*, 10 October, viewed 24 April 2017, <https://www.bloomberg.com/news/articles/2014-10-09/fracking-setback-in-poland-dim-hopes-for-less-russian-gas>.

Sustainable Sanitation Alliance n.d., *Why sustainable sanitation?*, Sustainable Sanitation Alliance, viewed 25 April 2017, <http://www.susana.org/en/>.

Taillant, JD, Glaub, M & Buck, S 2015, *Human Rights and the Business of Fracking: Applying the UN Guiding Principles on Business and Human Rights to Hydraulic Fracturing*, The Center for Human Rights and Environment, viewed 24 April 2017, <http://www.ohchr.org/Documents/Issues/Business/ForumSession4/FrackingAndUNGPs.pdf>.

Tasmanian Government 2015, *Tasmanian Government Policy Statement on Hydraulic Fracturing (Fracking) 2015*, viewed 24 April 2017, <http://dpipwe.tas.gov.au/Documents/Tasmanian%20Fracking%20Policy%20Statement_26-2-15.pdf>.

Thanh, VT & Duong, NA 2009, 'Vietnam after Two Years of WTO Accession: What Lessons Can Be Learnt?', *ASEAN Economic Bulletin*, vol. 26, no. 1, pp. 115–35, viewed 9 March 2017, <https://muse.jhu.edu/article/266540/pdf>.

The Canadian Press 2014, 'Nova Scotia introduces bill to ban fracking', *The Canadian Press*, 30 September, viewed 25 April 2017, <http://business.financialpost.com/news/energy/nova-scotia-introduces-bill-to-ban-fracking>.

The Council of Canadians 2014, *Fracking Across Canada: A Fracktivist's Toolkit*, viewed 24 April 2017, <https://canadians.org/sites/default/files/publications/fracking-across-canada.pdf>.

——2015, *Human right to water and sanitation named and reaffirmed in post-2015 development agenda: Joint Media Release*, viewed 10 April 2017, <http://canadians.org/media/human-right-water-and-sanitation-named-and-reaffirmed-post-2015-development-agenda>.

The Economist 2009, 'The peak-oil debate - 2020 vision: The IEA puts a date on peak oil production', *The Economist*, 10 December, viewed 14 March 2017, <http://www.economist.com/node/15065719>.

——2012, 'Fracking the Karoo', *The Economist*, 18 October, viewed 24 April 2017, <http://www.economist.com/blogs/schumpeter/2012/10/shale-gas-south-africa>.

——2013, 'Frack to the future', *The Economist*, 2 February, viewed 24 April 2017, <http://www.economist.com/news/business/21571171-extracting-europes-shale-gas-and-oil-will-be-slow-and-difficult-business-frack-future>.

The Growth Lab at Harvard University 2019, *The Atlas of Economic Complexity: Vietnam exports between 1995 and 2017*, viewed 9 June 2019, <http://www.atlas.cid.harvard.edu>.

The Irish Times 2016, 'Minister signals ban on fracking to continue in Ireland', *The Irish Times*, 30 November, viewed 25 April 2017, <http://www.irishtimes.com/news/science/minister-signals-ban-on-fracking-to-continue-in-ireland-1.2888182>.

The Irrigator 2017, 'Basin plan is at 'tipping point'', 2 April, viewed 24 April 2017, <http://www.irrigator.com.au/story/4570123/basin-plan-is-at-tipping-point/>.

The Northern Territory Government 2017, *The Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*, viewed 24 April 2017, <https://frackinginquiry.nt.gov.au/>.

The Observatory of Economic Complexity n.d., *Vietnam*, viewed 13 April 2017, <http://atlas.media.mit.edu/en/profile/country/vnm/>.

The Sphere Project 2011, *Humanitarian charter and minimum standards in humanitarian response*, 3rd edn, Practical Action Publishing, Rugby, United Kingdom.

The Telegram 2013, 'Moratorium on fracking announced by Newfoundland government', *The Telegram*, 4 November, viewed 25 April 2017, <http://www.thetelegram.com/news/local/2013/11/4/moratorium-on-fracking-announced-by-newf-3465585.html>.

The Washington Free Beacon 2014, 'Film Fest Cancels Screening of Pro-Fracking Documentary', 20 January, viewed 21 April 2017, <http://freebeacon.com/issues/film-fest-cancels-screening-of-pro-fracking-documentary/>.

The White House 2011, *Blueprint for a secure Energy Future*, Washington, DC, viewed 4 August 2011, <http://www.whitehouse.gov/sites/default/files/blueprint_secure_energy_future.pdf>.

——2012, *The National Security Strategy of the United States of America*, viewed 21 April 2017, <https://www.state.gov/documents/organization/63562.pdf>.

——2015, *National Security Strategy*, viewed 21 April 2017, <https://obamawhitehouse.archives.gov/sites/default/files/docs/2015_national_security_strategy.pdf>.

Tibbett, S 2004, 'Privatisation doesn't hold water', *The Guardian*, 21 March, viewed 11 April 2017, <https://www.theguardian.com/business/2004/mar/21/theobserver.observerbusiness9>.

Tilley, E, Ulrich, L, Lüthi, C, Reymond, P & Zurbrügg, C 2016, *Compendium of Sanitation Systems and Technologies*, 2nd edn, viewed 20 March 2017, <http://www.iwa-network.org/wp-content/uploads/2016/06/Compendium-Sanitation-Systems-and-Technologies.pdf>.

TNI 2014, *The Global Water Grab: A Primer*, Transnational Institute for Hands off the Land Alliance, viewed 3 April 2017, <https://www.tni.org/files/download/the_global_water_grab.pdf>.

Tollefson, J 2013, 'China Slow to Start Fracking for Natural Gas in Shale', *Scientific American*, 20 February, viewed 20 April 2017, <https://www.scientificamerican.com/article/china-slow-to-start-fracking-for-natural-gas-in-shale/>.

Trading Economics 2017a, *Syria Exports*, viewed 18 April 2017, <http://www.tradingeconomics.com/syria/exports>.

——2017b, *Turkmenistan Exports*, viewed 18 April 2017, <http://www.tradingeconomics.com/turkmenistan/exports>.

——2017c, *Vietnam Exports 1990 - 2017*, viewed 6 April 2017, <http://www.tradingeconomics.com/vietnam/exports>.

Tran-Nam, B & Pham, CD 2003, *The Vietnamese Economy: Awakening the Dormant Dragon*, Routledge Studies in the Growth Economies of Asia, vol. 41, Routledge, London, New York.

Trong, NP 2004, 'Viet Nam on the Path of Renewal', *The Gioi Publishers*.

Truelove, Y 2011, '(Re-)Conceptualizing water inequality in Delhi, India through a feminist political ecology framework', *Geoforum*, no. 2, pp. 143–52.

U.S. Aid 2017, *Environmental Assessment*, 19 April, viewed 19 April 2017, <https://www.usaid.gov/vietnam/environmental-assessment>.

Energy Policy Act of 2005 2005 (U.S. Congress), viewed 4 August 2011, <http://www.gpo.gov/fdsys/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf>.

U.S. Department of Commerce 2017, *Vietnam - Trade Agreements*, https://www.export.gov/article?id=Vietnam-Trade-Agreements, viewed 26 April 2017.

U.S. Department of Energy 2014, *The Water-Energy Nexus: Challenges and Opportunities*, viewed 27 February 2017, <https://www.energy.gov/sites/prod/files/2014/06/f16/Water%20Energy%20Nexus%20Report%20June%202014.pdf>.

U.S. Energy Information Administration 2010, *International Energy Outlook 2010*, 22 November, Office of Integrated Analysis and Forecasting U.S. Department of Energy Washington DC, Washington, DC, viewed 24 June 2011, <http://www.eia.gov/oiaf/ieo/>.

U.S. EPA 2014, *Priority Pollutant List*, viewed 17 April 2017, <https://www.epa.gov/sites/production/files/2015-09/documents/priority-pollutant-list-epa.pdf>.

——2015, *Getting up to speed: Groundwater Contamination*, viewed 28 February 2017, <https://www.epa.gov/sites/production/files/2015-08/documents/mgwc-gwc1.pdf>.

——2016, *Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States*, Washington, DC, viewed 11 April 2017, <https://www.epa.gov/sites/production/files/2016-12/documents/hfdwa_executive_summary.pdf>.

UCLG 2014, *The Global Report on Local Democracy and Decentralization: Basic Services for All in an Urbanized World: GOLD III*, Taylor & Francis, New York.
UN 2007, *World Population Prospects: The 2006 Revision Highlights*, viewed 3 April 2017, <http://www.un.org/esa/population/publications/wpp2006/WPP2006_Highlights_rev.pdf>.
——2013, *The Millennium Development Goals Report*, New York, viewed 25 November 2015, <http://www.un.org/millenniumgoals/pdf/report-2013/mdg-report-2013-english.pdf>.
——2014, *World Urbanization Prospects: 2014 Revision*, viewed 4 April 2017, <https://esa.un.org/unpd/wup/Publications/Files/WUP2014-Highlights.pdf>.
UN General Assembly 2015, *Transforming our world: the 2030 Agenda for Sustainable Development*, viewed 10 April 2017, <http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E>.
UN Statistics Division 2015, *Environment Glossary: Term: Arid Zone*, viewed 22 December 2015, <http://unstats.un.org/UNSD/environmentgl/gesform.asp?getitem=122>.
UN Trade Statistics 2010, *Taiwan, Province of China Trade data*, viewed 6 April 2017, <https://unstats.un.org/unsd/tradekb/Knowledgebase/Taiwan-Province-of-China-Trade-data>.
UN Water 2014, *The United Nations World Water Development Report: Water and Energy*, viewed 27 February 2017, <http://unesdoc.unesco.org/images/0022/002257/225741E.pdf>.
——2015, *A Dedicated Water Goal*, 10 June, viewed 10 April 2017, <http://www.unwater.org/sdgs/a-dedicated-water-goal/en/>.
——2016, *The United Nations World Water Development Report 2016: Water and Jobs*, Paris, viewed 21 March 2017, <http://unesdoc.unesco.org/images/0024/002439/243938e.pdf>.
Unabhängiges Institut für Umweltfragen n.d., *Umweltschutz in Vietnam* (German), Unabhängiges Institut für Umweltfragen, viewed 10 October 2013, <http://www.ufu.de/de/internationales/vietnam.html)>.
UNCTAD 2016, *General Profile: Australia*, United Nations Conference on Trade and Development, viewed 24 April 2017, <http://unctadstat.unctad.org/CountryProfile/GeneralProfile/en-GB/036/index.html>.
UNDP 2013, *Human Development Report: The Rise of the South: Human Progress in a Diverse World*.
UNEP 2000, *Water Policy and Strategy of UNEP*, viewed 25 April 2017.
——2008a, *Freshwater resources: volume by continent*, viewed 20 March 2017, <http://new.unep.org/dewa/vitalwater/article32.html>.
——2008b, *The Water Cycle*, viewed 20 March 2017, <http://new.unep.org/dewa/vitalwater/article26.html>.
——2010, *Green Economy: Driving a Green Economy through Public Finance and Fiscal Policy Reform*, viewed 10 March 2017, <http://www.greenfiscalpolicy.org/wp-content/uploads/2013/08/Driving-a-Green-Economy-Through-Public-Finance-and-Fiscal-Policy-Reform.pdf>.
UNEP/GRID-Arendal 2008, *Areas of physical and economic water scarcity*, viewed 31 August 2009, <http://www.grida.no/resources/6352>.

UNICEF & WHO 2012, *Progress on Drinking Water and Sanitation: 2012 Update*, USA, viewed 19 April 2017, <https://www.unicef.org/media/files/JMPreport2012.pdf>.
United Nations Commodity Trade Statistics Database (UN Comtrade) 2017, *Harmonized Commodity Description and Coding Systems (HS)*, United Nations Statistics Division, viewed 9 September 2019, <https://unstats.un.org/unsd/tradekb/Knowledgebase/50018/Harmonized-Commodity-Description-and-Coding-Systems-HS>.
UN-Water Task Force on Indicators, Monitoring and Reporting 2010, *Monitoring progress in the water sector: A selected set of indicators*, viewed 29 March 2017, <http://www.unwater.org/downloads/TFIMR_FinalReport.pdf>.
Urbina, I 2011, 'A Tainted Water Well, and Concern There May Be More', *New York Times*, 3 August, viewed 5 August 2011, <http://www.nytimes.com/2011/08/04/us/04natgas.html?pagewanted=1&_r=1&hp>.
USDA 2008, *Soil Quality Indicators*, viewed 20 March 2017, <https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053288.pdf>.
USGS 2015, *Global water distribution*, 15 December, viewed 20 March 2017, <https://water.usgs.gov/edu/watercyclesummary.html>.
van Arkadie, B & Mallon, R 2003, *Viet Nam: A Transition Tiger?*, Asia Pacific Press at the National Library of Australia, Canberra.
van Dijk, TA 1993, 'Principles of Critical Discourse Analysis', *Discourse & Society*, vol. 4, no. 2, pp. 249–83.
Vanham, D 2013, 'An assessment of the virtual water balance for agricultural products in EU river basins', *Water Resources and Industry*, 1-2, pp. 49–59.
Veolia & IFPRI 2015, *The murky future of global water quality*, viewed 20 March 2017, <http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/129349/filename/129560.pdf>.
Victoria State Government 2015, *Onshore Gas Community Information*, viewed 24 April 2017, <http://onshoregas.vic.gov.au/>.
Vidot, A & Worthington, B 2016, 'Murray-Darling Basin Authority recommends reducing water buybacks in northern communities', *ABC*, 22 November, viewed 24 April 2017, <http://www.abc.net.au/news/2016-11-22/murray-darling-basin-northern-communities/8042496>.
Viet Nam Net 2016a, 'What is Formosa doing in Vietnam?', *Viet Nam Net*, 7 July, viewed 19 April 2017, <http://english.vietnamnet.vn/fms/business/159915/what-is-formosa-doing-in-vietnam-.html>.
——2016b, *FDI disbursement in Vietnam at record high in 2016*, viewed 31 March 2017, <http://english.vietnamnet.vn/fms/business/170389/fdi-disbursement-in-vietnam-at-record-high-in-2016.html>.
Viet Nam News 2013, *FDI figure revised for 2012*, viewed 31 March 2017, <http://vietnamnews.vn/economy/236522/fdi-figure-revised-for-2012.html#W8jMVSWAzb5E0qAA.97>.
——2014, *Ministry revises 2013 FDI figure*, viewed 31 March 2017, <http://vietnamnews.vn/economy/252415/ministry-revises-2013-fdi-figure.html#b4WYxiTplQjGuRwf.97>.

——2015, *Report revises 2014 FDI figures*, viewed 31 March 2017, <http://vietnamnews.vn/economy/267704/report-revises-2014-fdi-figures.html#dUgdmjUgA1vqmy4i.97>.
——08.24.2016, 'PM pushes for development without environment destruction', *Viet Nam News*, 08.24.2016, viewed 13 April 2017, <http://vietnamnews.vn/environment/301678/pm-pushes-for-development-without-environment-destruction.html#WteRGIbmq87WYzRp.97>.
——2016, 'Formosa blamed for fish death', 30 June, viewed 18 April 2017, <http://vietnamnews.vn/society/298928/formosa-blamed-for-fish-death.html#5VUZQYzXIZtIeOqS.97>.
Vietnam Investment Review 2013, 'Vietnam attracts $15 bil of FDO in nine months', *Vietnam Investment Review*, 2 October, viewed 10 October 2013, <http://www.vir.com.vn/news/en/coverage/vietnam-attracts-$15-bil-of-fdi-in-nine-months.html>.
Vietwater 2013, *Vietwater 2013 Technical Seminar*, viewed 19 April 2017, <http://site.swan.org.my/Clients/swanorgmy/programme%20seminar.pdf>.
VOV 2015, 'Vietnam's first-half cell phone production tops 107 million units', *The Voice of Viet Nam*, 7 March, <https://english.vov.vn/market/vietnams-firsthalf-cell-phone-production-tops-107-million-units-295918.vov>.
Waibel, G 2010, 'State Management in Transition: Understanding Water Resource Management in Vietnam', *ZEF Working Paper Series*, no. 55, pp. 1–59, <http://www.zef.de/fileadmin/webfiles/downloads/zef_wp/wp55.pdf>.
Water footprint Network n.d., *Product Gallery*, viewed 11 April 2017, <http://waterfootprint.org/en/resources/interactive-tools/product-gallery/>.
Weber, M (1980) 1922, *Wirtschaft und Gesellschaft: Grundriss der verstehenden Soziologie* (German), 5th edn, Mohr, Tübingen.
WEPA n.d., *State of water environmental issues: Surface water*, Water Environment Partnership in Asia, viewed 19 April 2017, <http://www.wepa-db.net/policies/state/vietnam/surface.htm>.
WHO 2015, *Viet Nam: Closer to bringing drinking water and sanitation to all*, viewed 19 April 2017, <http://www.who.int/features/2015/viet-nam-water-sanitation/en/>.
——2017, *Total Fertility Rate*, World Health Organization, viewed 10 April 2017, <http://www.searo.who.int/entity/health_situation_trends/data/chi/TFR/en/>.
Williams, J, Milligan, A & Stubbs, T 2013, *Coal Seam Gas Production: Challenges and Opportunities*, viewed 24 April 2017, <http://wentworthgroup.org/wp-content/uploads/2013/12/BREE_Coal-seam-gas-production_WILLIAMS-etal-.pdf>.
Winter, TC, Harvey, JW, Franke, OL & Alley, WM 1998, *Groundwater and surface water: A single resource*, U.S. Geological Survey, Denver, viewed 13 March 2017, <https://pubs.usgs.gov/circ/circ1139/pdf/circ1139.pdf>.
WITS n.d., *Japan SITC Rev2 Products exports and imports 2015*, viewed 25 April 2017, <http://wits.worldbank.org/CountryProfile/en/Country/JPN/Year/2015/TradeFlow/EXPIMP/Partner/WLD/Product/sitc-rev2-groups/Show/Product%20Group;XPRT-TRD-VL;MPRT-TRD-VL;XPRT-PRDCT-SHR;MPRT-PRDCT-SHR;RCA;AHS-WGHTD-AVRG;MFN-WGHTD-AVRG;/Sort/XPRT-TRD-VL>.
——n.d., *Vietnam Imports and Exports By Country*, World Integrated Trade Solutions, viewed 6 April 2017,

<http://wits.worldbank.org/CountryProfile/en/Country/VNM/Year/2015/TradeFlow/Import/Partner/by-country>.

Wood, P 2017, ‘As Hogan signs fracking ban, environmentalists question his record’, *The Baltimore Sun*, 5 April, viewed 21 April 2017, <http://www.baltimoresun.com/news/maryland/politics/bs-md-hogan-fracking-bill-signing-20170404-story.html>.

World Bank 2016, *Exports of goods and services (% of GDP)*, viewed 7 April 2017, <http://data.worldbank.org/indicator/NE.EXP.GNFS.ZS?locations=VN>.

World Economic Forum 2011, *Global risks: An initiative of the risk response network*, 6th edn, Geneva, <http://reports.weforum.org/wp-content/blogs.dir/1/mp/uploads/pages/files/global-risks-2011.pdf>.

World Energy Council 2016, *World Energy Perspectives 2016: The Road to Resilience - Managing the Risks of the Energy-Water-Food Nexus*, London, viewed 27 February 2017, <https://www.worldenergy.org/wp-content/uploads/2016/03/The-road-to-resilience-managing-the-risks-of-the-energy-water-food-nexus_-early-findings-report.pdf>.

World Nuclear Association 2016, *World Uranium Mining Production*, viewed 24 April 2017, <http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production.aspx>.

WTO n.d., *The environment: a specific concern*, World Trade Organization, viewed 10 October 2013, <http://www.wto.org/english/thewto_e/whatis_e/tif_e/bey2_e.htm>.

——1998, *India etc versus US: ‘shrimp-turtle’*, viewed 19 April 2017, <https://www.wto.org/english/tratop_e/envir_e/edis08_e.htm>.

WTO Center and Integration n.d., *TTWTO VCCI - FTA*, Viet Nam Chamber of Commerce, viewed 16 September 2019, <http://www.wtocenter.vn/fta>.

Wullweber, J 2009a, ‘Eine hegemonie- und diskurstheoretisch fundierte Kritik der (Internationalen) Politischen Ökonomie’ (German), in E Hartmann, C Kunze & U Brand (eds), *Globalisierung, Macht und Hegemonie: Perspektiven einer kritischen Internationalen Politischen Ökonomie* (German), Verlag Westfälisches Dampfboot, Münster, pp. 122–42.

——2009b, *Hegemonie, Diskurs und Politische Ökonomie: Das Nanotechnologie-Projekt* (German), Nomos, Kassel.

Yang, H, Wang, L & Zehnder, AJB 2007, ‘Water scarcity and food trade in the Southern and Eastern Mediterranean countries’, *Food Policy*, vol. 32, 5-6, pp. 585–605.

Young Petro 2014, *Young Petro is organizing Europe-wide FrackNation screenings*, Young Petro, viewed 21 April 2017, <http://youngpetro.org/2014/01/26/youngpetro-and-fracknation/>.

Younos, T 2005, ‘Environmental Issues of Desalination’, *Journal of Contemporary Water Research & Education*, no. 132, pp. 11–8.

Zeitoun, M & Allan, JA 2008, ‘Applying hegemony and power theory to transboundary water analysis’, *Water Policy*, vol. 10, S2, p. 3.

Zeitoun, M & Warner, JF 2006, ‘Hydro-hegemony – a framework for analysis of transboundary water conflicts’, *Water Policy*, vol. 8, pp. 435–60.

Virtual water trade increased with globalisation. However, this trade does not always flow in such direction, that water abundant regions supply water scarce regions with water intense products. Often the opposite happens and depletive water trade intensifies causing water scarcity. This work focuses on the Water-Energy-Soil-Trade-Nexus with each element seen as a materialisation of discourses. Two cases illustrate specific parts of the Nexus, firstly, the close relationship of market liberalisation, foreign direct investment and virtual water trade is represented with Viet Nam's Doi Moi policy and rapid economic growth. Secondly, the water-energy dimension linkages are drawn by following the case of hydraulic fracturing from the U.S. to Australia's gas drills embedded in a global perspective. This work helps to understand especially cases, where virtual water trade dries out water resources in already vulnerable areas.

ISBN 978-3-7376-0778-0

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