Water Markets and Water Security

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Introduction

Water, something which for many people is a normal as air. Open the tap and there is water, walk to the store and you can buy water, walk to the river and there is water. However, water is not as obvious as it seems, and water scarcity and droughts, as well as floods, are becoming more common. This raises certain questions and worries, which form a collective around water security. The privilege of having direct access to water, is not as normal as it seems. As water and water scarcity, or the opposite, the destructive force of water can form a serious security threat. Water security has been an issue around the world ever since societies emerged. For example, the fertile Nile River Delta which gave life to the Egyptian civilisation was the lifeblood they thrived on, without this river or with changes in what the river bought them, their civilisation would crumble. Same for the civilisations around the Tigris and Euphrates rivers, who did not only rely on these rivers but also fought over them. Or more recently, the ecological devastation of the Aral Sea, where mismanagement of the water has caused the sea to largely dry up. These three only scratch the surface of the importance of water, water security, and all that the environment supplies.

In current day, environmental issues are highly important, with rapid climate change and strong urbanisation, the water security issue has become more prominent. With the recently adopted UN Freshwater Strategy 2017-2021 stressing its importance even more. While in the past water security and water policy was largely a national or regional issue, the last decades it has also entered the international arena, with the United Nations leading charge. In both their widely adopted, and acted upon, Millennium Development Goals and the Sustainable Growth Development Goals, water and the environment play a big role. Often having an own separate goal as well as being incorporated in other goals, as water is a key player in our daily lives. The currently active Sustainable Growth Development Goals has various goals related to water security, namely goals 6 *Clean Water and Sanitation*, 11 *Sustainable Cities and Communities* and 13 *Climate Action*. Other goals also include more responsible production and consumption, goal 12, better protection for nature and biodiversity, goal 14 and 15, which also relate to lesser extend to water security. The increased popularity comes not only from the political sphere, but also an economic

one, as many multinational companies, especially energy companies, conduct research and have vested interests in the water-food-energy-climate nexus, which emphasises the interconnection between these four factors (Royal Dutch Shell, 2012).

Water security can be seen from two sides, either as a part of the larger human security paradigm, making water security a basic human right, or water security can be seen through economic eyes, resulting in water becoming a commodity market good to create the most efficient allocation and thus result in the highest water security (Conca, 2008, p. 219). This binary division can be seen as 'empowerment and participation' on the one hand, and on the other hand purely 'supply and demand management'. The economic recognition of water came from *The Dublin Statement on Water and Sustainable Development*, which has four principles; Principle 1 – "Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment"; Principle 2 – "Water development and management should be based on a participatory approach involving users, planners and policy-makers at all levels"; Principle 3 – "Women play a central part in the provision, management and safeguarding of water"; Principle 4 – "Water has an economic value in all its competing uses and should be recognised as an economic good" (International Conference on Water and the Environment, 1992). In this statement "economic value" is a key word, however, the participatory approach and the fact that water is finite and essential may not be overlooked. In the last principle it also states that it "... is vital to recognise first the basic rights of all human being to have access to clean water and sanitation..." Thus combining the economic and human security in one statement and even in one single principle of the statement. Therefore, for this work the definition of water security will combine both aspects of economic merit and the human factor. Water security is "the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (Grey & Sadoff, 2007, pp. 547-548). This definition encompasses the whole idea of water security, but is narrow enough to be workable and straightforward. Three key stakeholders come forth from this definition; people, environments, economies. Therefore, **how can water markets help increase water security for people, environments and possibly economies?**

This research is highly relevant in today's world of climate change and instability. Over the past decade's various scholars wrote on 'water wars' and although these have never happened, the value of water and its scarcity is something which is more and more recognised (Alam, 2002) (Starr, 1991). Therefore, solutions to this water insecurity needs to be found, and water management, or more specifically, water markets, are one way to possibly help solve water security issues. In the United Nations *Freshwater Strategy*, the use of market-based incentives is mentioned as a possible solution to water security issues (UN Environment Programme, 2017, pp. 10-11). They also mention the importance of preserving the environment and finding a balance between economic, community and environmental use of water. These are the three main pillars of this work, people, environments and economies.

To answer the research question various aspect of water security and water markets need to be assessed. Firstly, water security will be discussed in detail, to create the knowledge needed to further the research. This section will also include the basic principles of water markets and some of the important factors to find a basic understanding. Secondly, the value of water will be examined, which will not only include the actual price of water or the question whether water should be given a price at all, but also the economic, political-economic and environmental value which water and water markets may have. Thirdly, a deeper analysis of formal water markets will help to assess our later case study, whereby the ABCDE+F framework of Chris Perry will be analysed. Fourthly, a case study of the Murray Darling Basin in south eastern Australia using the ABCDE+F framework. And lastly, the concrete answer on the research question which explains the impact of water markets on water security. This answer can only be given because of the previous steps, creating a solid base knowledge, needed to answer the question how water market can help increase water security for people, environments and possibly economies.

Methodology

As can be extrapolated from the introduction the methods used will mainly be a literature review and analysis combined with a case study of a potential success story of a formal water market. Literature reviews will help give the basic knowledge to understand and analyse the the following case study, but will also be critically reflexive of the literature. With water security being a multidisciplinary subject many articles have been written on it, from various angles and with different ideas on the subject. Resulting in a wide array of differences between one another, with different models, suggestions and ideas on what a water market should entail. The importance of literature reviews should further be stressed by the plain fact that academics is building forward on previous work. One cannot simply grasp in the air and gain new insight. The case study has been selected due to an inability for fieldwork. A case study in general can give a in depth view of a certain area without necessarily having to be there on location. This is also one of the reasons for choosing the Murray-Darling Basis, which is often seen as a good example of a water market, not only because of its success but also because of its failures and the way that these failures have been dealt with. Furthermore, a case study is a good counterpart to the literature review and analysis, due to a case study being less theoretical and more hand-on, creating a good balance between theory in the literature review and a hands-on approach of the case study.

The selection of the case study, was a simple process of elimination. To answer the question at hand, a case was needed which successfully, and over a longer period, has been in existence and has adapted over time. The two other cases that were possible to use were cases of Chile, the Western United States of America or most recently China, however, none of these cases had as many sources, a clear institution leading it, or a long history of adaptation as the Murray-Darling Basin. The Murray-Darling Basin is often seen as the schoolbook example of a water market implementation and adaption, surely there are issues and it is not perfect, but it is the basin which comes nearest. Besides the practicality of the case, it also helps that the culture in Australia and the basic life conditions are similar to what many of the academics writing on the issues of water security and water markets experience, making that the analysis is on the same plain.

Another way, the case study could have been conducted is by trying to see if a water market could be implemented in a certain region according to the literature. However, due to this type of case study becoming more of a prediction or policy, than an analysis it was illogical. This does not mean however, that this type of research is not useful, but it does not suit the answering of the question at hand. Nonetheless, in the literature review and analysis of the model used to analyse the Murray Darling basin a quick glance will be given to another case, in order to show the potential of the model and use an example to make it clearer. This case is the Mackenzie River basin on the Southern Island of New Zealand. This basin does not have a water market in place, but will briefly be used as an example clarify the framework set up by Perry.

Overall, the methodology used in this work is limited to just the literature review and the case study, however, for the topic at hand and the fragmented academic standing of the topic, these two methods will prove to be sufficient to answer how water markets can increase water security for people, environments and economies in the last section of the dissertation.

1. Water Security and Water Markets – The Basics

To be able to answer the research question at hand a few other topics must be tackled first. This section will assess various terms and essential aspects needed to answer the question in what ways can water markets help increase water security for people, the environment and possibly economies? Firstly, the term water security must be clearly defined and discussed. Secondly, the term water markets need to be deconstructed to help understand what a water market is, what the limits are and what models exist. Thirdly, tying in with the last bit of the second point is the value of water and in what way this forms the models, especially economic, political and environmental aspects are important to explore. And lastly, a concluding line-up which will give an overview of the above and combine it with a requirement list for a possibly successful water market.

Water Security

In the introduction water security was defined as “the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (Grey & Sadoff, 2007, pp. 547-548). Grey and Sadoff coined this definition in their influential paper in order to give a holistic overview of what water security entails. Before this definition many practitioners and academics used highly incompatible definitions, causing water security to be a term that did not entail any core values (Cook & Bakker, 2012, pp. 94-95).

Water security used to be defined together with energy security and food security, also known as the water-food-energy-nexus, whereby it was simply stated to be reliable access to meet basic needs of individuals, societies and nations. However, there is an important difference between water security, the fact that the absence but also the presence of water can be a threat. This destructive quality of water makes it crucially different from food or energy.

To achieve and sustain water security, many factors need to be taken into account, however, four factors are key. Firstly, the hydrologic environment, which means the absolute level of water resources available, but also the seasonal changes and the special distribution of water in a certain area. If the hydrologic environment is 'easy' or beneficial, rain falls equally all year around, and river and ground water flows are stable. This makes water security easy to manage as the investments needed will be low and the region or nation does not need to worry overly much about storage and seasonal protection. It also means that investments made will quickly turn into increased water security and thus creates a reliable flow of water benefitting the community and the economy. 'Difficult' or disadvantageous hydrologic environments have either extreme water scarcity, like desserts, or face high risk of floods. Other factors that play into disadvantageous hydrologic environments are seasonal rainfall, extreme temperatures and fast changing weather from torrential rainfall to drought. This causes a need for high investments to achieve water security, whereby water storage, anti-flood measures and emergency plans are key aspects. This also means that these areas need a high level of institutional management and infrastructure investments. One often mentioned relation is the poverty and hydrology hypothesis, whereby countries with a difficult hydrology are also the poorest countries. This creates furthers a negative spiral, as these countries are less likely to gain large investments, due to the high risks and often low profits. Plus, most of these countries have limited strength institutions, which makes implementation and management of water security measures even more difficult (Grey & Sadoff, 2007, pp. 548-549).

Secondly, the socio-economic environment, which plays a big role in the before mentioned investment and management issues of difficult hydrology regions. Economic factors are very important in achieving water security. In heavily agricultural economies with floods or torrential rainfall achieving water security is harder to sustain and to obtain, higher investments, and little outcome at first. A key step for these economies is to diversify their economies, to sustain stability and attract investments to help with obtaining and sustaining more water security. Once the ball starts rolling, there is a potential for a virtuous circle, whereby water investments produce gains, which may in turn be invested into diversifying the economic activity. However, in many agricultural economies the farms are privately

owned by families, whereby investment is not on top of their agendas and survival is the real concern. This results rationally results into less investment into water security, decreasing the chance of the virtuous circle. This in turn will also be a disincentive for investments in other parts of the economy, such as industry and services, slowing down diversification of the economic development, thus reducing the potential growth.

Thirdly, changes in the environment, such as climate change, but also urbanisation and even the arrival or multinational corporations, which need water for their endeavours. Climate change makes water security more difficult to obtain and sustain, as the climate has become less predictable. Longer droughts, sudden heavy rainfall, whereby it is expected for an increase of rainfall in wet areas and less rainfall in already water scarce areas (Hirji & Ibrekk, 2001). This change enlarges the problems already at hand and will increase the cost to obtain and sustain water security, both in a financial way but also in terms of adaptability and management. One of the main issues to this increased cost is the resulting higher threshold to obtain water security, making it even more difficult for the poorest nations with the most difficult hydrology to achieve progress. Urbanisation is also heavily influenced by climate change, as people seek the security of well-developed cities. This causes the need for better sanitation, sewage, an increased flow of water in the city to keep up with the expanding population. These issues all tie into water security and are expected to continue in the coming decades, whereby the United Nations sees urban water security and especially sanitation and drinkable water as “one of the most pressing issues of this century” (United Nations: Water for Life Decade, 2014).

Fourthly, and thus lastly, is the factor of what water is, it is liquid it flows and is not stationary like food. The flow of water results that many water related issues are not specific to one nation or one region, but it transcends borders. This can cause problems between countries, regions, counties, but can also be used as a means to bring them closer. Often these borders are a result of colonial or post-colonial border forming, while historically rivers and lakes were often boundaries between certain groups of people (Grey & Sadoff, 2007, p. 549). Besides water flowing across manmade borders, it also has limits to how it can be used. The community upstream the river get the water first and could possibly take it all, leaving the downstream communities without any water. This power of the upstream communities can be

misused and is very important for the understanding of water security. Often water security cannot be obtained without the agreement of upstream communities, which becomes especially difficult when the upstream community is in another country, with another government. Some scholars even suggest that these upstream countries can use this power as a political instrument or even an instrument of war (Gleick, 1993, pp. 86-89).

Overall, water security is as “the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (Grey & Sadoff, 2007, pp. 547-548). Whereby three main groups come forth; people, environments and economies. One way to possibly increase the water security for all of these stakeholders is to use a market system, whereby water is traded as a commodity good.

Water Markets

Within water markets, formal and informal water markets are often differentiated between. In informal water markets, which are less regulated, farmers have an incentive to ignore the scarcity of water when the demand is higher than the supply (Zetland, 2014, p. 68). Thus, causing a risk on overusing water, especially by upstream users. On the other hand, formal water markets are more regulated than informal markets, and here the regulations are enforced (Easter, et al., 1999, pp. 100-115). These formal water markets, are often mentioned to bring the most benefit to a water market system, due to the high levels of control and regulation, resulting in an incentive for better and more efficient water usage.

Formal water markets may help solve an over drafting problem by increasing the incentives for efficient water use and it makes it possible to buy water from areas where water is abundant within the market. This ability to find another source of water, but with a higher cost which relates to the demand, can help promote community action for self-regulation, efficiency measures and demand management. Informal water markets can also improve water use and incomes in irrigated areas where water rights are not well defined or recorded. However, their implementation and regulatory abilities are less efficient than a formal market. Additionally, they may

be a good alternative option for formal water markets if It is likely that a formal marked would produce third-party challenges and result in excessively high additional costs, which is often thought to happen in countries with limited institutional power. Finally, informal markets would work well in traditional agricultural societies with traditional irrigation systems where the farmers manage the irrigation system themselves and would be able to maintain a relatively modest level of transaction costs (Griffin, 2015, pp. 109-110). Nevertheless, considering formal water markets as the most plausible and successful solution as they are likely to grow in efficiency when non-agricultural demands for water grow. Economic gains can be rather large, especially if water can be traded between individuals in the community, as not only the more efficient use increases industrial, service and agricultural output, but the trading itself can result in economic gain.

When discussing water markets, the concepts of third-party effects and social equity must be considered. Firstly, the third-party effects involve a third person or group in a transaction of water, either claiming a little share of the water being transacted or claiming a little of the money for transaction cost. This third party is often needed to provide the actual transaction of the water, whether that is driving a tank of water from place a to place b, or operating the pipelines, or even the purely administrative work needed for the transaction. This can have both positive and negative effects. Possible positive effects may include increased employment, due to the buying and selling of water, also known as the Area-of-Origin effect, and increased local awareness as more people are involved (Chong & Sunding, 2006, p. 31). The processing of the transaction will also create jobs. While negative effects may include unreliable supply, due to before mentioned problems such as climate change. Moreover, buying and selling of downstream water to upstream users will change the flow of water, resulting in an altering of the ecosystem and the general water use. A third person in between the buyer and the seller could potentially not have the availability to access water due to the changed flow, which has been allocated to them. Unemployment is another possible negative third party effect, as a certain employer who sells their water rights or allocations can lead to less work for the employees of that specific employer. In turn leading to community degradation and the intensification of inequality between communities in a certain region.

Secondly, Social equity is concerned with the cultural and historical context in which water trading is to be implemented. As the opinions of farmers towards water trading and water as a commodity, and how they perceive it in context with cultural perceptions of water is of equal importance to identifying economic or political factors. If water users, such as farmers and local communities, do not perceive water as a tradable commodity it will be difficult to implement an effective water market regardless of the economic benefits it brings to the community or the benefits they could get from a good institutional framework. To the users of water, historical and cultural factors may psychologically outweigh the economic benefits that a water market could bring (Easter, et al., 1999, pp. 101-103).

2. The Value of Water

In the literature on water markets the value of water is often a contested topic, but always recognised as a scarce, valuable and often economic asset. As established earlier in this work, water security is. This definition clearly specifies three groups – people, the environment and economies – as key stakeholders in water security. All three stakeholders value water for different reasons, and value different properties and uses of it. The aim of this section is to evaluate these different values of water, from a purely economic perspective, a political economic perspective, an environmental and human perspective. To help understand what makes water so special and why its availability of an acceptable quantity and quality is crucial to these stakeholders, and why markets are seen as beneficial or not by these stakeholders.

Price of Water

For the economic assessment, as well as general water market assessment, water needs to be priced. But when someone tries to put a price on water with the intention of creating an economic market on a supply and demand basis, different arguments and opinions emerge regarding how to create such a market and to what extent it should be free market. As mentioned before, the Dublin Principles gave international recognition for water having an economic value. This principle read: “Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources” (International Conference on Water and the Environment, 1992). Clearly stressing that water is not a capitalist good, it is a commodity which still is a basic human right, thus needing caution when seen in a purely economic way. Although, there is little controversy regarding the need of using water in an efficient and sustainable way, there is a difference in significance when referring to ‘water as an economic good’ even if this creation of an economic good would result in more efficient and sustainable use. Savenije and van der Zaag

argue for two sides when it comes to pricing water: Firstly, the side which argues that water should be priced at its economic value; Secondly, the side which argues that making the right choices in allocation is a form of economics, and this does not need to include actual financial transactions or pricing of water. (2002, p. 98). The first relates to the actual price of water, whereby the price should relate to cost recovery, but stay accessibly to all. While the second relates to the fact that water is a necessity and thus should be accessible to all, whereby pricing water might not be the only way to economically solve a water issue. As they suggest integrated decision making and choosing what option of water use is the most efficient and sustainable may lead to greater economic benefits (Savenije & van der Zaag, 2002, p. 99).

However, Rogers, de Silva and Bhatia strongly favour a more equitable distribution of water using increased water rates (2002, p. 14). The suggest a fully priced model, discarding the integrated decision making as a possibility. As they see the necessity of promoting equity, efficiency and sustainability in the water sector, they see proper market working of water will eventually result in increased efficiency and equity (Rogers, et al., 2002, pp. 1-2). Being aware of the price and value of water will be encouraged if the price is set to its actual value, thus resulting in more efficient use and less waste. Other measures such as effectively charging of groundwater extraction, wastewater and sewerage are some of the options they propose. Not only will this lead to a more sustainable use of water, but it even help change water use in production processes as “Industry innovates when it has sufficient incentive. Production cost reduction is often its best incentive” (Rogers, et al., 2002, p. 14).

Another view on the value and pricing of water is discussed by Savenije and van der Zaag, who point out that it is most preferable to keep water providers publicly owned, as demand for water varies is not constant, nor is the economic elasticity of the good. While private water providers are often not interested in adapting by demand, as people need water, regardless of the price. Publicly owned water providers and water providers will not be able to act in such a way and will be held accountable by both public and politics if people are left without water, either due to high costs or other issues. When water would be privately owned, and supplied, the poorer will be most affected by any increase in price or other tariffs imposed as they already use fewer amounts of water and surely cannot do with less amounts of water. While

wealthier people that use water for other, more luxurious meanings, are most likely not so much harmed by an increase in price given their economic situation although they often use more water (Savenije & van der Zaag, 2002, p. 102). However, keeping the price low to allow water to people with less economic funds is, according to Rogers, de Silva and Bathia, an argument with little credibility (Rogers, et al., 2002, p. 14). Their example shows the willingness of Indian farmers to pay for reliable and timely water, even though the prices go up, this has to do with the necessity of water. Furthermore, they suggest that some farmers spend up to 18% of their income on water, paying this high price for water would still encourage conservative use, improve water service coverage to reach the poorer areas – as companies have an incentive to construct infrastructure –, and there is an increase in equitable water distribution compared to the previous lower prices (Rogers, et al., 2002, p. 15). However, their research rests on a small amount of case studies and data for OECD countries and the Asian Development Bank, from this they draw the generalisation that the increased price will help in every region. This seems doubtful at least, as these farmers know what they will get and have trust in the system, while in many other regions this sort of trust in government or corporation is not as easy to come by.

As is clear now, how to price water, allocate water and the effects of this pricing or allocation is not very straightforward. Different arguments can be used and both sides have their pitfalls. Despite the disagreement on whether a market is and can be the best option to deal with water scarcity, allocation and a commodity like water, more is needed than just a price tag. A legal and institutional context is needed that allows temporary transfers of water between agriculture and urban areas in extremely dry years, to avoid bigger disaster (Savenije & van der Zaag, 2002, p. 103). This is either done through the means of efficient allocation with legal means or with a water market with full-cost pricing, both can reap economic benefits.

Economic Value of Water Markets

The idea of the economic value of water is rather complex and has resulted in many academics conducting research on this specific question. With this economic value, more is implied than just production and consumption. For example, W. Michael

Hanemann investigates whether water is an economic good or not, while Ronald C. Griffin considers what extent water markets can solve water scarcity. In other words, is it possible to put a price tag on water as a basic commodity good, which can be traded? Several other scholars discuss the possible benefits and downsides of water markets for an economy. Moreover, this has led to many academics to present their own ideas on working water markets, such as Howard Chong and David Sunding. Other academics, such as K. William Easter, Mark W. Rosegrant, and Ariel Dinar start off by discussing water scarcity and the possible causes of the problem, but quickly move to the economic costs of water and the problems of existing water markets, trying to come up with solutions for the existing problems in the water markets, often from a purely economic standpoint. Besides this academic assessment of the value of water and how they can form water markets, the value of water is also seen in the plain fact that water is needed to produce goods and energy, and thus corporations have an interest in gaining control over water to increase their output, and preferably minimise the cost of this water.

Chong and Sunding mention, in regards to economic theory, that the ideal textbook conditions, allows successful markets and trading of a commodity, in this case water, to develop socially optimal allocation and use of this commodity, despite of the initial allocation failure (2006, p. 48) . But, the management of water resources is poorly regulated in many countries and areas of the world and thus the ideal textbook conditions do not apply. Especially poor people living in rural areas lack access to a clean and decent water supply and sanitation and could benefit from better management and infrastructure (Hanemann, 2006, p. 61). Hanemann gives his definition of a water market “in a market system, economic values of water, defined by its price, serve as a guide to allocate water among alternative uses, potentially directing water and its complementary resources into uses in which they yield the greatest total economic return” (2006, p. 62). As this definition suggests the emphasis here is on “total economic return” and not on wellbeing, environment or social use. However, this definition is commonly used to push for water markets by multinational corporations as well as local businesses, as it stresses the benefits for economic return. Another idea of what a water market could be comes from Griffin, who states that water markets regulate “the exchange of natural water rights by willing buyers and sellers” (2015, p. 204). Thus, individual owners who possess

water rights may sell their water rights. Hence, allocating water by giving individuals specific water rights, allowing them to trade freely with these rights, can possibly lead to optimal and most efficient allocation of the available water in this specific region. Griffin suggests this on a local scale to ensure local availability of water and avoid politics from entering the arena. Although this model still purely focusses on the economic side of water markets, it does take the local community into account, resulting in a system that does lightly include two of the three stakeholders, both economies and humans.

Nonetheless, establishing a properly functioning water market is rather difficult. Hanemann concludes that “while there clearly are some distinctive emotive and symbolic features of water that make the demand for water different, there are also some distinctive physical and economic features which make the supply of water different and more complex than that of most other goods” (Hanemann, 2006, p. 88). Thus, it is evident that a water market is complex and establishing one relies not only on economic ideas, but also on the institutional and organisational arrangements in a region. Besides the complexity of a water market, they should help a region with the most efficient allocation of water and thus create the most economic benefit, but also help battle water scarcity.

Political-Economic Value of Water Markets

Owning water gives power, both political as well as economic power. Therefore, some scholars use a political-economic approach to analyse and criticise water markets and include this political or power layer on top of the economic. Zetland for example uses a political-economic approach to analyse and criticise water markets in the United States of America in his book *Living With Water Scarcity*. He states that; “Economics is useful for understanding water management in an era of scarcity because economists […] want to get as many benefits as possible from scarce resources” (Zetland, 2014, p. 4). The book contains a call for incentives for people to trade water like a commodity good, to create a more efficient water allocation and be involved in the decision making around water policies (Zetland, 2014, p. 5). He sees water as this commodity good that can be traded to make one’s own position stronger, either by increased water ownership or increased economic power. He

does give some preconditions, such as knowledgeable regulators for pricing, setting water aside for the environment and solving political issues before trying to implement a water management system. His political-economic and realist analysis, however, is widely criticised as it fails incorporate all negative side effects of such a market-capitalist approach to water management and is largely focussed on highly developed areas. For example, it mentions the preconditions but does not take into account changing situations such as different quantity of available water flow, or a change in the international politics. Factors like these are highly important for use and establishment of water management.

Another important political, or rather institutional, factor cannot be overlooked either as it is key to understand "a country's institutional framework before embarking on a comprehensive overhaul of water policies and review the conditions required for effective water markets" (Easter, et al., 1999, p. 99). In other words, the establishment of an efficient water market or allocation system in a certain region relies strongly on the institutional and organisational framework in that specific region. M. Mariño and K.E. Kemper discuss in their article "Institutional Frameworks in Successful Water Markets: Brazil, Spain, and Colorado, USA" that the institutional aspects of a water market can improve the efficient allocation and use of water, as institutional and organisational efficiency will help streamline the water allocation (Mariño & Kemper, 1999). However, before a water market can exist most effectively, the institutional framework must be developed first, thus without an institutional framework it is hard to establish a functioning water market or allocation system. This is due to the fact that the lack of institutions will result in a lack of regulation. The creation and implementation of such an institutional framework relies on the cultural and local point of views on water allocation and markets. This also means that it does not need to be a similar institution all over the world, as in some parts a bureaucratic legal system might not result in the most efficient foundation to build on.

Besides the water is power and institutional approaches to the value of water and water markets, political-economic models also allow for a more social-cultural approach. For instance, the system by WaterAid, which blames the unequal distribution of water, especially among the world's poorest communities, on failed government. In order to even the distribution they suggest a community-based water

resource management program, which wants to create a bottom up framework for water management on a local level (WaterAid, 2012, p. 48). They suggest that if the local and individual level benefits from the system, it will benefit the greater economic good as well. As in total there will be more efficient allocation and thus more left to be used for economic merit such as industrialisation and agriculture. This approach puts the socio-political interests before the economic ones in contrast to the other.

These three political-economic approaches to water markets, and thus the value of water, are fairly different, but do all seem to advance from the purely economic model. All three include some sort of social and political system into the approach, resulting in a more coherent approach with the three stakeholders in water security.

Environmental Value of Water Markets

Researchers have emphasised the importance of ecosystems and the environment for the well-being of humans, because of the services it provides to people, such as fresh water, food, fuel and a safe place to live (National Water Commission, 2011, p. 1). Some even see it as the a meta capability for justice, as without the environment and earth as a whole, life could not exist and thus should be on the top of any security list (Holland, 2008) Due to climate change, many studies which have been conducted on this topic argue that in the recent years the problems with the management of ecosystems – including water – will have increasingly negative implications in the long term sustainability of crucial ecological services (National Water Commission, 2011). Furthermore, the Millennium Ecosystem Assessment, an assessment of the effects of human activity on the environment has shown that around 60% of these ecological services, including fresh water is degrading over the course of their five-year assessment (2005, p. 1). A main reason is the increased need, and thus expansion of, food supply, whereby the impact on an ecosystem is often not regarded in the decision making. The authors of the Millennium Ecosystem Assessments report *Ecosystems and Human Well-Being* state that despite the economic development that results from the using of the services provided by an ecosystem, government structures should keep a clear focus on the damage done and implement a more market based approach and new, innovative economic

instruments to achieve global environmental goals, as well as preserve the services for future generations (2005, p. 1).

Research has shown that there is correlation between countries, which have implemented water trading and the protection of the environment as a whole (Millennium Ecosystem Assessment, 2005, p. 93). Furthermore, water markets have direct impacts on the environment, as water is being reorganised and reallocated outside of the environments will, especially in relation to agriculture. For example, the transfer from downstream water to upstream users, resulting in less flow downstream and altering the ecosystem. One method to counteract this phenomenon has been the Payment for Environmental Services (PES) transaction, which are economic incentives designed to enable farmers to conserve and help sustain ecological services (Tacconi, et al., 2011, p. 1). For example, farmers will have to pay for the ecological services they will receive, such as fuel, fertile ground, etc. In this way, farmers are encouraged to not abuse or overuse on the environmental services they get, and thus resulting in more sustainable use of these services (Tacconi, et al., 2011, pp. 1-2). Furthermore, the sustainable use means that these services will be provided for a longer and more stable period, which is crucial as these farmers are often highly economically dependent on fertile ground and other services the environments provides. The Payments for Environmental Services, which is a payment used in the market located in between the buyer and seller of the water and has a positive impact in the economic activity both in the short term and in the long term of communities based in these regions. In the short term, the potential benefits can be higher income for the local communities, which can give them access to education, health care, new investments or more products in the market (UNEP, 2014, p. 11). Moreover, Payments for Environmental Services incentives will provide these local communities with more knowledge in how to use the natural resources in a more sustainable way, while still increasing their business activities. In the long term the use of this system is beneficial, because of the efficient and sustainable use of natural resources, elongating their livelihood, resulting in communities having a prolonged flow in the ecosystems services, high productivity land and thus higher investments and profits (UNEP, 2014, p. 11). The money made by these payments can be used to help improve the environment and

ecosystems, but investing the money in sustainability funds, as well as wildlife conservation.

The environment and in, particular, the biodiversity could be positively impacted under the strict environmental regulations, if implemented, of water markets, and the payments for environmental services. For example, the community or the business will not have unlimited access to environmental services, but they will have to get certain permits to go fishing, hunting or they will need to conserve the biodiversity, as well as use bio diverse friendly products (UNEP 6). Some examples of water market payments have shown the positive outcomes of water markets for the environment and biodiversity. For instance, in France, the United States, Costa Rica and Australia there has been a significant improvement of the quality of water available in nature, and in the water allocated to the irrigation systems, this has resulted in the reforestation, limiting the impact to the biodiversity loss and reduced the soil erosion and salinisation (UNEP, 2014, p. 7). Even though not many studies have properly studied the effects of water markets on the environment, it is often assumed that its effect are generally positive depending on the responsibility of the buyers and sellers and the capability of the institutions in place to implement legislation (Millennium Ecosystem Assessment, 2005, p. 93).

To conclude, the price of water and the question if water should be prices is a contested topic, whereby arguments can be made for pricing and as well as not-pricing. However, the economic, political, environmental and societal value of water cannot be denied.

3. Formal Water Markets

As mentioned before, water markets come in two versions, formal and informal. This section will dive deeper into formal water markets and will try to find an assessment mechanism to use for assessing the potential success of implementing a water market. And these water markets are a way to achieve increased water security when effectively used.

Formal water markets are a system where water can be traded in a institutionalised formal way, whereby legal prescriptions ensure certain aspects. They are most often government regulated and have as key aspect clear regulations on water rights. Water rights are the allocation that a certain user gets per period. For example, farmer A has a farm twice as big as farmer B, thus farmer A will receive a water right double the size of farmer B. An important aspect of water rights is whether they are hard numbers, so in gigalitres of water, or if they are relative to the total flow of water. This distinction is very important, not only due to the benefit upstream users will have in the absolute number case, but also because of natural fluctuation in water flow. Water rights are often distributed to economic actors, such as businesses, farmers, industry, etc. While communities in ideal cases have an assured share of the water for which no extra payment must be made. Water rights are therefore an economic-legal tool, just like selling licenses to taxi drivers.

In a formal water market these water rights can often be traded, depending on the system intercommunity trade is allowed, meaning that farmers are able to trade their water rights to each other. Allowing either a small part or the whole part for a certain period. This intercommunity trade can give economic benefits to the owners of the rights, as they can make a trade off whether to produce something and utilise the water, or if it is more economically beneficial to sell the rights to someone else and live of the money gained from the sale. However, as explained previously, a third party might be involved in the transaction of water rights, whether it is for transportation, administration or just bureaucracy.

This leads to the next major point in formal water markets, the price. In formal water markets water is seen as an economic good. The international recognition of water as an economic good comes from the Dublin Principles, as discussed in the introduction, which also states the importance of water for humans. However, in

formal markets this economic value is the argument for putting a price on water, which is in some cases regulated but in some cases, fully market based. This pricing of water is needed to effectively trade the water rights from one owner to another. Some markets, or attempted markets, did not include pricing due to the government overseeing the water right and the trading. Which sometimes is not seen as a proper water market, but more of a governmental allocation system, which was previously the case in the USSR and China.

ABCDE+F

Besides the Dublin Principles many other documents have been drawn up over the years, multiple World Water Forum's, two Rio conferences with statements, and many discussions on both academic and policy level. However, most of these are considerably vague and hard to use for analysis purposes. Therefore, Chris Perry has created a framework for effective water management (Zetland, 2014, p. 51). Whereby, a market is not necessary, but possible, and effective is the key word. He states that effective does not need to mean good, effective is that the policies are followed and that the outcomes of these policy are generally positive (Perry, 2013, pp. 96-99). Sometimes, effective management is not good management. For example, in the Aral Sea Basin all regulations were followed, as the policy said increase the water supply to the cotton fields as it yields great economic value. However, the result is that the Aral Sea has lost most of its water, and some parts have completely dried up (Liston, 2014). Although, this was effective management in the short run, it was not good management, which now results in ineffective management due to changes which the local population cannot adapt to.

Perry's framework, called ABCDE+F, for effective water management consists of six steps, namely;

1. **A**ccounting
2. **B**argaining
3. **C**odification
4. **D**elegation
5. **E**ngineering
6. **F**eedback

(Perry, 2013, pp. 100-102)

Every step will be addressed separately and will end with a small section of an application on the model. The application will be done with the use of the example of the Mackenzie Basin in New Zealand. A river basin, with a difficutl hydrology, whereby droughts and floods follow each other and climate change has drastically worsened the situation over the past few years.

Firstly, **A**ccounting, this step deals "Clear and publicly available knowledge of resource availability in time and space" (Perry, 2013, p. 100) In other words, make sure that it is known how much water there is, and make sure that this information is available to everyone. This is an important step mainly for countries with less stable hydrology's, whereby fluctuation in flow is a major problem. If the authorities and the people know the status of the water flow, more efficient policies can be created, as well as, communities are better able to adapt to these changes. This step will also ensure that in the long run efficiency of the policies can be measured and analysed, which can then be used by the next steps to improve the management system. Besides this it is also important to look at environmental and ecological characteristics of the basin to avoid extreme disruption with newly implemented policies.

Accounting: The Mackenzie Basin is located on the Southern Island of New Zealand. It has large quantities of water at its disposal, but currently only a small amount of the annual flow balance is allocated. However, as a result of the intensification and increase of agriculture, the quality and quantity of the water is declining. The most important stakeholders for economic are the farmers, industrial water users, and the tourism industry. The other large stakeholder is the environment. In addition, water has significant cultural value for the indigenous population. No data on the water flow is available.

(Kaye-Blake, 2014)

Secondly, **B**argaining, this step describes "Policies governing water resources development, including assigning priorities among users for the available water" (Perry, 2013, p. 100). Which means the political process of setting up the policies,

using the knowledge given by the accounting step. Here it is also important to note the allocation process, whereby it is crucial to determine priorities within allocation. Does the focus lie on seasonal crops, or long lasting fruit trees for irrigation? Who gets prioritised when scarcity comes up? Or what will be sacrificed when a flood strikes, flood part of the city or destroy a field of crops? This essential step is highly important for the success of the system as whole. Perry himself barely suggests the importance of participation from the community in this step, however as mentioned before participation is key into creating a working water management system or market (International Conference on Water and the Environment, 1992) (WaterAid, 2012).

Bargaining: The regulations for water allocation are set in Resource Management Act (RMA) from 1991, this law regulates the water and serves as a backbone for Regional Plans which regional councils use for the actual allocation of the water. The RMA also allows for water allocation permits, which can be obtained through a bureaucratic process at regional councils, to be traded. The allocation is regulated on regional/municipal level.

(Beech, 2006, pp. 20-22) (Peart, 2001, p. 132)

Thirdly, **C**odification, a step where policies and allocations are being formed into legal frameworks. One of the most important parts of this step is to ensure regulations for changing conditions. Without a clause regulation increase or decrease of water flow, or another change is the natural circumstances, the market would hardly be able to be efficient, as it would mean a gap in the legislation. This in turn can result in chaos and disagreements, which can turn especially dreadful when the basin encompasses multiple municipalities, communities or even nations, as many natural river basins do. Therefore, this step can be regarded as foundation backbone of the management system and is also the base of possible analysis and improvements, because this step can be used to see if the management is effective.

Codification: As discussed at Bargain water allocation permits can be traded within catchment or transferred to other owners of the same site. However, permits can only be traded within a same catchment and can be transferred to another owner of the same site or to another owner of another site, though there are strict rules and high costs connected to the trading of these permits. The rules applying to the trade are set in the regional plans and differ per region even within the Basin

(Beech, 2006, pp. 20-22) (Peart, 2001, p. 132)

Fourthly, **D**elegation, whereby defining "...roles and responsibilities for provision of all aspects of the specified water" is the key. This step would hand authority to certain institutions or even erect institutions to uphold and check upon the set up policies in previous steps. For a water market, this step also includes the institution that oversees the water right trading, and is therefore the main implementer, or even police, of the water management system. Overall, institutions play a crucial role in water rights, water and rights management and their trade, all important aspects of a formal water market. Despite differences in various regions, the role of institutions help understand methods by which governments and institutional cooperation can function to further a regulated water market free from third-party effects or rather from monopoly control (Easter, et al., 1999). However, third-party effects are something which in many cases is inevitable as transaction costs and transportation is often not free. These institutions, formed with the delegation step, should enforce the legislation but try to remain neutral to the general situation. Its rights and duties should be clearly defined. One of the institutions main tasks should be making sure the water rights are fair and equally distributed. However, more importantly some suggest that the environments needs are an even superior task (Heaney, et al., 2006). This task is also stressed by indigenous populations and by environmental justice groups and scholars, who see the environment as the primary user of water, after which humans get the second share (Holland, 2008). This important task and if and how this is organised differs from region to region. The protection of the environment lies largely by institutions, but also by policy makers of the bargaining and codifying steps, as but just as well with accounting and engineering. Therefore the environmental needs can be seen as the overarching part of the framework,

which Perry himself largely lacks to address, due to the fact that he looks at effective policy focused management, and not on the good management, as he states himself (Perry, 2013, pp. 96-97).

Delegation: No clear institution is in place at this moment. An option would be a change of the RMA, which would involve the national government and set up national institutions. Another option would be to exploit the already existing tradability of water markets as set in the RMA but loosen the restraints within the regional plans, but increasing the oversight. Regional councils can change their regional plans in to give more liberty to the stakeholders wiling to trade water, also they could include market based instruments in their regional plans creating a real market instead of a one on one trading situation.

(Guerin, 2003, pp. 25-27) (Sharp, 2002, p. 57)

Fifthly, Engineering, which deals with the infrastructural needs to implement and sustain the water management systems. This can be large water transferral systems with pipelines and wastewater systems but also small improvements on irrigation systems, and water storage. The more well-developed infrastructure is already in place the easier it is to implement a water management system which includes water trading. Mainly, due to the investment costs being lower and thus a larger incentive to better the situation, than when a large investment is needed. This is also one of the main issues surrounding water management and ties up with the poverty and difficult hydrology connection. As poorer countries and people lack the capital to invest in expensive water management systems, while their needs are also more expensive than in regions with easier hydrology, it becomes a stalemate of the current situation, which in time might lead to a vicious circle of increased poverty and enlarged water security issues.

Engineering: Infrastructure in the Mackenzie River basin is partly developed and partly lacking. Especially, if droughts occur many problems will arise due to lacking connection to secondary water sources. This may be solved by creating canals or pipelines farms, as well as the river, to other water sources and lakes in the area. Thereby enabling a more precise regulation of the water flow by pumping water from the lakes into the river or from the river into the lakes.

Before discussing the last step, it is important to note that these steps are not fully chronological, as they are interconnected. The accounting is highly reliable on engineering, especially in a later state of the management system. While the codifying and bargaining will be a process which is slightly combined into one, and will need the delegation to keep track of everything bargained for and written down, while also having to be the communicator between engineering, accounting and bargaining, to ensure allocations to be updated to new situation. However, for analytical these steps will be kept as separate as possible.

Lastly, **F**eedback, this steps deals with the before mentioned social equity. Social equity is the social, historical and cultural context in which a system is implemented. The feedback session will need to entail a way for the communities living and working within the affected area to communicate their needs and desires on the water management system (Perry, 2013, p. 101). This is crucial to keep the willingness of the people to participate in the system, especially in regions where the technological engineering is not able to cut them off at the point of their allocation. This feedback look will make black market effect less likely, as people are able to voice their concerns and should be heard by the right authority. The feedback loop is often related to the delegation step, as there the institutions will be formed dealing with the actual management. Zetland sees this step as the most important, as it is the step which helps the system adapt to changes, and will keep attempt social equity. The issue with the feedback look is that often only the “losers” will raise their voices, while the positive is never addressed. This can cause a misbalance in the system, when repeatedly giving into the “losing” side. To avoid this, the feedback section is suggested to entail agents from all stakeholder, local communities,

farmers, representatives of corporations, and even schools and churches. The feedback loop should be as inclusive as possible, and can possibly be stylised to ensure everyone's voice to be heard. This will also help with the social equity problem, whereby it is important to understand the relationship between the people and, in this case, the water. People need to agree with the use of the water in order to support it. In case of the other steps are all perfect, but the local population is against the implementation of the system, it is unlikely to succeed. Therefore, it is important to understand this relationship with the water from a socio-historical-cultural perspective as it will give a clearer inside of water usage (Bjornlund & McKay, 2002). In this way, it is possible for the users of water to see a benefit in water trading, without taking away the individual's right to water.

Feedback: As has become clear in the parts Bargain, Codify, and Delegate, water allocation in the Mackenzie Basin is largely controlled by the Resource Management Act (RMA). Recent increased communication between the regional councils and stakeholders have increased the feedback loop. Besides this the Maori population is increasingly involved in the feedback and official institutions, due to the cultural and historical importance of the rivers in the basin to them.

(Environmental Protection Authority, 2015)

The exemplary case of the Mackenzie Basin shows that Bargaining, Codification and Feedback are well established. While there is a lack of Accounting the actual water flows, nor is there a good Delegation system, although the regional councils hold most power, the RMA still restricts them, causing a clash between what the regions want and what the law allows. Engineering, is not ideal either, as stated the lack of access to secondary water sources. However, due to New Zealand being wealthy and a thriving economy, the water security in the area is not to precarious. With time, investments and restructuring they can easily increase the situation. Besides this the situation is not as bad as in some areas with worse hydrology or no availability to investments. Perry's system is applicable both to water markets and to government controlled monopolies, whereby New Zealand is a clashing system. This monopoly does not even need to mean full control of the water but full strict centralised

governance of the water. Although, in monopolised water management the feedback loop is limited or highly specific in the feedback gathered, the most reliable way to water security is often suggested through centralised, or publicly owned means (Savenije & van der Zaag, 2002, p. 102).

The framework is more regularly used by consultancy companies and governments than by academics, due to its practical and direct approach, whereby judgement on good or bad are not the emphasis, but the emphasis on effective or ineffective. However, the use of the framework should be incorporated in academics as it gives a good and holistic base to build further research on.

4. Murray Darling Basin

The Murray Darling Basin is often seen as the most successful water market system in the world, and will therefore be used to conduct an analysis. In order to do so, substantial insight on the basin needs to be formed, what is the hydrology like, what is its history, what is the environmental situation. After which the specifics of water rights and water trading in the Murray Darling Basin will be discussed. This will lead to the analysis of the ABCDE+F framework of Chris Perry. Lastly, a critique on the water management system shall be made.

Overview of the Basin

The Murray Darling Basin is located in the south eastern region of Australia, stretching from the south of Queensland, to the Blue Mountains near Sydney, further south to the inlands of Victoria, all the way to Adelaide where it finally reaches the sea – see figure 1. The basin spans over one-seventh of Australia's total landmass and is the most important agricultural area in the country. It stretches over four different states in the Commonwealth, and is based inland, resulting in little direct rainfall, with many smaller rivers with slow flowing water. The hydrology of the area can be seen as difficult, although not severe during most years, and varies strongly between different points in the basin. The average annual flow equals about 24.000 gigalitres, which gives it the dubious title of having the lowest flow of water of all major river systems (Pigram, 2006, pp. 160-162). The basin itself can be divided into three areas or types; the Darling and Lachlan basins, which has a difficult

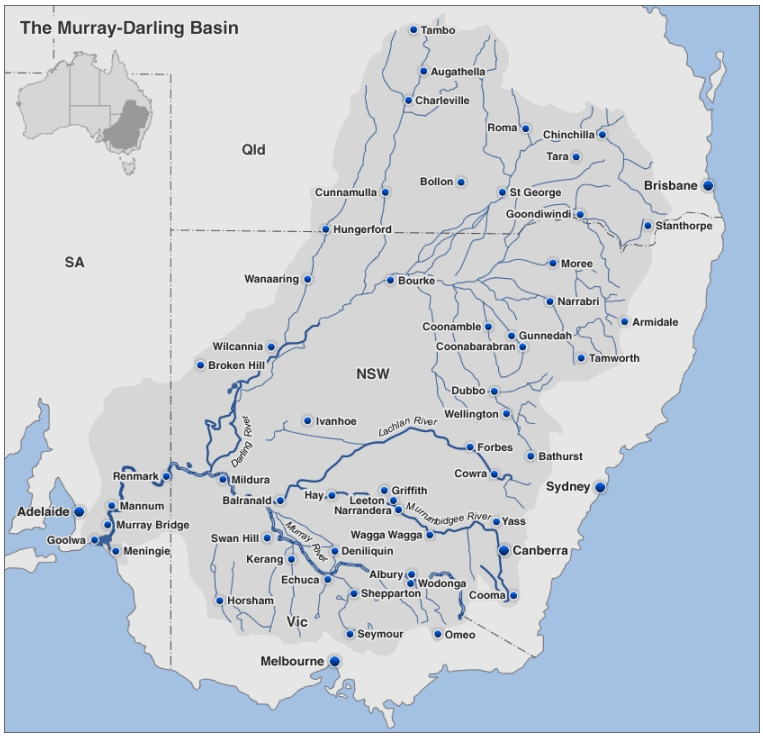

Figure 1 – Source: http://www.abc.net.au/site-archive/rural/murraydarling/map-large.png

hydrology with highly variable water flows per season as well as per year, their usage is predominantly for agriculture and mining; the second basin is the southwestern basin, which has a slightly easier hydrology with a more constant rainfall, however the soil is less fertile, resulting in high water and fertilisation usage, causing lakes and rivers to dry up from time to time. The basin also lacks regulatory dams and infrastructure; The Murray, Murrumbidgee and Goulburn Basins have the easiest hydrology of the three, as water streams from the mountains into the rivers, causing them to flow all year round (Brown, 1983). Although this research was conducted in the 80s the general hydrology of the basin hasn't changed and is thus still relevant to this day.

The people and companies that are active in this area are mainly agricultural companies, small scale mining companies, and small to medium sized local communities. No major cities are in the Murray Darling Basin, except Adelaide which is near the mouth of the river, however, this part is often not included in the basin or the policies of the basin. The area around Adelaide is largely part of the basin, and is a highly popular wine region for locals and tourist alike. Resulting in high economic importance for the region.

Trading of water rights started in response to the 1982-1983 drought. At this point trade was regulated per state, which caused that some agent with a water right could not trade with their close by neighbour, while the neighbour in their own state was miles away. In 1994 reforms were made and water rights were separated from land ownership. This nationwide reform resulted in an increase of trading and an increase of flexibility. This same reform also put the first cap on the maximum extraction of surface water in the southern part of the basin and did not allow for new claims on water resources, to ensure reliability of the water available to the agents who already had the rights. The reforms continued in the 2000s, until then interstate trading was not allowed and no institution was in place to oversee the trading on a basin wide scale. Similarly, the lack of accounting the water was causing problems with the amount of water withdrawn and the amount water right holders were allowed to withdraw. In 2004, after a few years of the 'Millennium Drought' the Australian government purchased A$500 million worth of water from the owners to ensure the environments wellbeing, under the National Water Initiative. The drought continued for another few years and in 2007 the government used another A$3 billion – of a

A$10 billion nationwide investment programme for environmental conservation and improvement – for investing in better regulation, accounting and to buy more water to ensure environmental wellbeing. More importantly the 2007 reform also established the Murray-Darling Basin Authority, which oversees the basin as whole and transcends state border. The ban on interstate water trading was lifted and a platform was set up to improve the information for buyers and sellers (Grafton & Horne, 2014). In between the years 2008 and 2009, which were the years where the Authority started to be fully operational, water trading resulted in the growth of Australia's gross domestic product by A$220 million and gross regional product in the southern area of the basin by over A$370 million (National Water Commission, 2011, pp. 101-102). This economic gain resulted in widespread local support by businesses, as well as many local groups, and the economic benefits of trading were most visible during the water scarce time (National Water Commission, 2011, p. 115). Most recently, in 2009, the work began to transform the current regulations into a more coherent and all-encompassing plan called the Basin Plan, the development process of this plan lasted 4 years and was enacted in 2012, where many water consumers were opposed to the plan and voiced their complaints. The plan itself was created after the recognition that the ecological services as well as the environment and biodiversity as a whole was degrading, largely due to over-allocation of water in the southern most area. The mantra of the Basin Plan is to achieve "a healthy working Murray-Darling Basis in that supports strong and vibrant communities, resilient industries, including food and fibre production, and a healthy environment" (Hart, 2016, p. 837) Whereby a healthy river refers to the human altered state of the river being able to retain "ecological integrity" while still supporting communities and the economy. The Basin Plan furthers the Water Act, which lacked a coherent strategy to cope with environmental degradation and climate change. The Basin Plan runs until 2024, and has recently been updated after the completion of the beginning stages. The plan entails a full analysis of the system, feedback from the local communities and business owners with and without water rights. It also hopes to further integrate the water system to provide better water security for the region.

Specifics of trading in the Murray Darling Basin

Trading in the Murray Darling Basin does not happen in one open market, but there are various small ones in the north and middle of the basin and one larger one in the south, these markets are unable to trade with one another, mainly due to lack of infrastructure between them, and geographical restrictions. One market in up in the north of the basin on the border of New South Wales and Queensland, while the second and larger market stretches from the mouth of the river near Adelaide in South Australia to the far south of the basin in Victoria to the east nearing the capital of Canberra in New South Wales. Both interstate markets are allowed to trade across the border, which has resulted in better water allocation and the development of better water management options.

The trading of water rights may be done in two way, either seasonal or permanent. Permanent trade of water rights – or legally called entitlements, or allocations depending what state the right is given – will fully transfer the permanent water right from one owner to another. This is the total amount of water, which the owner of the water right may take from the river in ideal circumstances. The second option is trading of water allocation, whereby a part of the water which a water rights holder can withdraw from the total flow is transferred temporarily to another. In this case the amount traded is approximately the amount received, regardless of the current standing of the river (Murray-Darling Basin Authority, 2015). This might sound odd, as the river flow might not allow the withdrawal of certain amounts. However, a water rights holder can never sell more than they have legally access to. As in every 1st of July the basin makes new announcements on the seasonal availability of water, whereby the water rights holder will receive a percentage relating to what he may withdraw. For example, when the river is on full or over capacity water rights owner A is allowed to take a thousand litres, but on the first of July the announcement says the river is only at 80 percent then water rights owner A may only take and thus can only sell, this 80 percent of his usual thousand litres. If he sells the whole right and not just a seasonal allocation, the new owner must abide by the same rules. Throughout the year, conditions may change resulting in a change of the river flow, the basin authorities will then update the status of the river accordingly.

The system is highly regulated, especially in the larger southern market, and legislation is set up in a way that trade downstream and upstream receive the similar treatment and that water right for the downstream owners are safeguarded by the Murray-Darling Basin Authority.

ABCDE+F Analysis

The Murray Darling Basin is often used as a schoolbook case for successful water management, increased water security and a functioning water market. As mentioned before the Murray Darling Basin does not exist of a single market, but two large individual ones, whereby the southern water market region is one of the largest in the world in terms of the number of transactions (Grafton, et al., 2011, pp. 228-229). However, for analysis purposes, we will look at the area as a whole, while trying to note the small difficulties which arise under this two markets and market exception system.

Accounting

Accounting referred to the knowledge and availability of information on river flows, environmental systems and trends that occur. Within the Murray-Darling Basin research and measuring has been done since the early 70s on a large scale, reassuring that the accounting section of Perry's network is secured. However, this accounting plays into many other issues, and has helped the Murray-Darling Basin Authority as well as the Australian National and State Governments to make quick adaptations, as well as, provide the information for proper allocation, year by year, and even periodically.

Accounting of the water flow is mainly done through various measuring stations along the river and its tributaries, where regulators regulate and measure the flow of the water. In the southern part of the basin, where the infrastructure is best developed the water measures are send daily to a website which logs the day by day flow of the rivers (Murray-Darling Basin Authority, 2017). These regulators do not only measure the water but also are part of the larger regulatory system making sure that water is available at every point on the basins flow, upstream and downstream.

The website clearly helps communicate the current state of the river system to the communities and water rights owners. The sophistication of this system is unprecedented by any other in the world and is the largest continual water monitoring system. Not only the flow is measured but also the level, temperature and salinity, and on certain locations even rainfall, and at dams the amount of water that is released. The system is open to anyone and can therefore be used not only by locals but also by academics. The system also gives automatic alerts if something changes in the area of interest to people in the water trading system.

The use of this sophisticated monitoring system lies in the ability to take action and quickly change a path. This also has led to the emergence of water brokers. These water brokers often work for many local farmers and mining companies, and try to gain water for them for the best price. This creates a third-party involved in the water trading, reducing the effectiveness of the market as mentioned before. Some of these third-parties are just online websites where owners themselves can do the bidding, but some of the brokers provide full services. These water brokers can be seen in two ways, either they add another dimension of economic merit to the water market system, or they can be seen as this third-party reducing the efficiency of the market as a whole.

With the new Basin Plan, an increased focus is put on the water quality and salinity management plan, which includes the focus of gathering all round data on the salinity of the water and gaining insight in the pollution of the river on a large scale. Out of the Basin Plan, this measure is most likely to be successful, as it builds on a previous system which measured the salinity and has helped reduce it in the entire basin (Hart, 2016, p. 840) (Murray-Darling Basin Authority, 2014). The overall water quality will not only benefit the economic use of the water, but moreover, the environmental use.

Another aspect of the Basin Plan includes ‘Long-term average sustainable diversion limits’ which call for increased accounting of water, not just surface water but also ground water. These limits, reduce the volumes of water, which can be used for consumption purposes, including urban, industrial and agricultural. This measure is taken to improve the water available for the environment to use. There are many challenges to this regarding the accounting step; Firstly, how to properly measure

the water required by the environment to sustain its altered form in a healthy manner; Secondly, different areas need different measures, which requires constant adaptation and thus a long-term strategy seems impractical, mainly due to climate change and changing situation with the agriculture around; Thirdly, a more practical challenge is the cost of the changes that need to be made, and the tight timeline which is set for the project. The project includes new infrastructure to measure the ground water, and new innovative systems to use pump groundwater more efficiently and locally, in order to counteract the loss of surface water availability. The scale of the project combined with the time, makes it highly unlikely for this plan to succeed. Nonetheless, if it does both the accountability of the basin as a whole will benefit, and the water security for the environment and communities.

Bargaining

Bargaining entails politically prioritising the needs of all involved stakeholders, including local and indigenous communities, as well as the environment and business owners. The Murray-Darling Basin Authority together with the state authorities allocate the water rights yearly, and have restricted new allocations to be made to avoid over allocating. This bargaining game does allow for existing rights to be split, and includes the negotiation with various stakeholders.

At the start of the basin's water management system, the states were fully in charge of who owned what water, and this proved to be detrimental to the environment as well as local communities, who in times of drought could not always access water freely. Regardless of the fails of the system, it was effective, as the allocation resulted in trading and policy, which did improve the situation slightly. Quickly after the first time a drought put urban areas out of water, the government issued a preference to water as a basic human right, which entails the priority is put with supplying water to humans, although mining and agriculture are nearly on equal foothold with these urban areas, resulting in conflicting interests from time to time (Grafton, et al., 2011, pp. 225-226) However, since the 2007 reform, and the establishment of the Murray-Darling Basin Authority, most of these issues have been streamlined, whereby the bargaining is done on a basin level, and less on a state level. The priorities used to be focussed on urban sustenance and economic benefit

alone, with a small section on the environment's wellbeing, due to the reliance on environmental services. However, with the new Basin Plan the shift towards a more environmental centred priority has been made. Over the past few years the environment has suffered more than expected and various large bushfires have struck various parts of the basin. This combined with the over-allocation in the south, has helped the Australian government to focus on protecting the environments altered, but current, flow. Nonetheless, critics argue that focussing on the current and already altered flow will not be enough to ensure environmental wellbeing, as the original flow was much larger and therefore a focus should be on enlarging and recreating the original flow. In order to help the environment, the Plan issues a government buy-back of allocation and water rights in the coming years, resulting in major costs. However, the focus of the plan prioritises infrastructure investments and modernisation over buy-backs. This prioritisation is critiqued as some have argued that buy-backs are the a more cost-effective and immediate means to recover water (Crase, et al., 2012) (Crase, et al., 2013). Besides this the investments in infrastructure and thus irrigation can be seen as a step to please farmers, which in the long run does not save water at the basin, and often becomes more expensive with every saving, as the first modernisation has a larger impact than the last. However, it is suggested that many farmers are in favour of buy-backs as it provides a steady income which is not related to any seasonal or climate changes. On the other hand, buy-backs create a asymmetry in the market, whereby the government overbids buyers with an economic motive, thus distorting the market as a whole, and influencing the price of buying and selling water (Wheeler, 2014, p. 68).

The establishment of the Basin Plan itself is part of the bargaining step, as the politicians together with academics and stakeholders have tried to find ways to improve the basin and ensure environmental water security, as well as security for economic purposes and urban areas. The Plan also get reviewed every five years, to check if updates need to be made from the perspective of policy and allocation. This review is not only part of the bargaining step but also one of the major ways the community can give feedback.

In general, the bargaining and prioritising of the government has clearly been established, especially in the past few years under the Basin Plan, a large step has been made. Before this the bargaining was still in good order, however, it was not

able to adapt quickly. The current changes made with the Basin Plan will prove to be difficult, however with the help of local governance and the Murray-Darling Basin Authority it seems likely that the main plans will timely come into effect.

Codification

Codification relates to the legal framework on which the water market relies. In the case of the Murray-Darling Basin this refers to a plethora of laws and protocols, which are all enforced by the Murray-Darling Basin Authority, state governments or the national government. The proper codification of the Basin's regulations started just as most improvements with in 2007 with the Water Act, which created the Murray-Darling Basin Authority as well as the Environmental Water Plan, which protects environmental goods, such as rivers and biodiversity (Norris, 2013, p. 60). This Environmental Water Plan includes the restriction of water trading, and stresses the importance of environmental services and the protection of these. It also included a framework which set up the further measures taken to improve the environmental situation of the basin.

The codification also set up the legislation surrounding water trading, and water rights. Whereby water rights are not connected to land ownership, nor are water right a full ownership. The rights are on statutory basis, which means that the Authority, the State and the National Governments, may revoke these rights without any compensation. However, in practice none of the institutions use this, and rather buy-back water from willing sellers to settle the environment's needs (Grafton, et al., 2011, p. 224).

The codification expanded over time with more regulations on trade, water use, irrigation, off-flow management, and environmental responsibilities. However, the largest change has been the Basin Plan, which also changes a lot of legislative issues. It further regulates the trading, and increases the required off-flow from irrigation into the ground. These legal changes are made through the codification process, and help sustain the water market system.

The legal system of the Murray-Darling Basin is very well developed, however the lack of representation or mentioning of indigenous people of the area is very

apparent. The Water Act for example does not mention indigenous involvement or rights of the water in any form. Historically, the indigenous population 'owned' all the water in the area, whereas now, they own less than one percent. This is largely due to the long marginalisation of the indigenous population. Because of the population being a limited stakeholder, they have not been considered a significant stakeholder and have not been engaged in decision making, unlike the Maori population in the Mackenzie Basin. Luckily the Basin Plan attempts to change this, as it addresses "...regional water source planning must have regard to the social, spiritual, and cultural values and uses of the Aboriginal people..." (Hart, 2016, p. 843) Whereby the cultural flow must be respected. It is important to recognise the Aboriginal community's involvement in water planning and management, and therefore the Plan has founded two independent Aboriginal advisory bodies – Northern Basin Aboriginal Nations and Murray Lower Darling Indigenous Nations –, which advice the Authority on general policy as well as increased Aboriginal involvement. This is a challenging engagement as this empowerment of these groups through partnership also means a high risk in collisions and misunderstandings. It will also be challenging as the Aboriginal people is a new field of involvement, which means that proper information needs to be given to these communities, in order to reach the full potential of the involvement. Otherwise, the advisory bodies will be more ceremonial than useful, and the involvement will only lead to frustration and a feeling of marginalisation due to the voicelessness of these groups. The involvement of the Aboriginal people also calls for further research to gain understanding of the cultural flows and importance of water or even specific rivers to them. This socio-cultural and economic research, should be done to be able to use the involvement of the Aboriginal people efficiently, otherwise it will be as if both sides speak different languages. This understanding often lacks, and can therefore be a big challenge, which needs to be overcome for their involvement to be useful and successful for both parties (Hart, 2016, pp. 843-844).

The Basin Plan also requires the formulation of regional water resource plans, which are plans that span a ten-year period. These plans state the precise use of water, the prioritisation of the water allocation as well as possible future investment. The process of forming and accrediting thirty-six plans by June 2019 seems ambitious. The legal aspect of these plans lies in the fact that many plans will be formulated

upon state-wide existing plans, but then transformed to a local level. The purpose of the regional plans will help increase the adaptability of the water market as a whole and ensure water security for both the economic actors as well as local communities. This action in the Basin Plan, was formulated largely due to criticism on the way the Murray-Darling Basin Authority was unable to properly deal with the effects of climate change. Critics of the regional plan system fear fragmentation, and reversal of the Water Act's successful unification of the water system (Hart, 2016, p. 841). This step of the Basin Plan does not only influence the codification, but all steps of the ABCDE+F, as regional plans can, to certain extent, change the system, although, many requirements remain the same for all regions.

Another important change, with the Basin Plan, is the basin-wide environmental watering, which wants to strategically use the increased availability for environmental water. An issue which is both relevant to bargaining and codification, as it requires prioritising use of the water in the environment and setting up the proper legislation for it. The regional plans, which the Basin Plan promotes, will have to address this issue of prioritising and executing to ensure effective use of the increased amount of environmental water available. This faces many challenges, as not only is environmental water the most poorly managed, but also finding an agreement between the regional plans on what gets priority and what results in efficiency. After an agreement is met the regulation might be done, but the continues monitoring and accounting, as well as, the possible infrastructure needed to achieve this effective use, might increase the cost of the plans and result in delays or possible new problems to occur between regions and communities (Hart, 2016, pp. 839-840).

Overall the codification and legal structure of the Murray-Darling Basin is very solid, especially since the Water Act of 2007 all laws and regulations are clearly formulated and easily accessible to everyone. Before 2007, laws were more fragmented on state level, but nonetheless were well developed. Which can be seen as a reason for the success of the water market.

Delegation

Successful and effective institutions are one of the key ingredients for a successful water market. They are tasked with upholding the system's regulations, adapting the system where needed and creating a platform for discussion.

In the Murray-Darling Basin the main institution is the Murray-Darling Basin Authority, which oversees the whole basin, without the state boundaries interfering. This interstate institution has helped make a shift from a fragmented basin before 2007, to the integrated and more effective system it is now. The main responsibility of the Authority is the planning of the Basin's water resources, whereby all plans should be made in the interest of the whole Basin (Murray-Darling Basin Authority, 2017). Their primary roles are the preparing, implementing and reviewing of new plans, operating the River Murray system – the system of water regulators –, monitoring and assessing the quality and quantity of the basins resources, supporting and conducting research about the Basin and dependent ecosystems, advising the Australian Government Minister for Water Resources, providing the water rights information to enable proper water trading, and engaging and educating the community about the Basin and its use. In other words, they are charged with taking care of the Basin's and the markets functioning, whereby they safeguard the priorities of stakeholders, and communicate with national and state policy makers to ensure a safe and secure future for the Basin and its dependencies. This Authority and the structure of it is often seen as an example of proper interstate cooperation. Surely, all states belong to the same country, but within the Australian Commonwealth system all states have own governments, water ministries and water agencies. This Authority combines all of these and transcends the state border. The question if this can be implemented in a same way in other countries, whereby an institution must transcend national borders is questionable. As state or nation borders have different questions around sovereignty and governance. However, the fact remains that this Authority is an example of effective cooperation on a massive scale, whereby many parties with different interests come together to agree on one single issue, water management and indirectly water security. This cooperation was not possible without the consent of local, state and national government, which also shows the importance of multi-level cooperation to achieve an effective institution.

The effectiveness of the Authority is also prevalent in the amount of research they conduct, not only by themselves but also in cooperation with academics. This does not only give an outsider, and possibly more objective, perspective on matters, but can also increase the community engagement. As mentioned before, understanding of social, cultural and economic circumstances is very important in order to get useful feedback from the community. The prime example for this is the involvement of the Aboriginal communities, whereby a lack of understanding can lead to decrease in trust and the increase of voicelessness.

Overall, the delegation of tasks in the Murray-Darling Basin is well developed, with an interstate authority overseeing the basins wellbeing, and attempting to engage with the community. However, some improvements can certainly be made, especially in the field of engagement with local communities.

Engineering

The infrastructure required for a successful water market and ensuring increased water security, is in place in most part of the Murray-Darling Basin. As previously mentioned, large parts of the basin are fitted with regulatory measuring stations. Besides this there is a large waterpipe network fitted in the southern region to increase the ease of water transportation and trading.

With the Water Act in 2007, regulation on irrigation were put into place, which heavily influenced the irrigation systems of many farmers. Large investments were done, often state subsidised, to help modernise the irrigation systems and help increase the sustainability of these system. Thus, less water was used and there was an increase in the water available for the environment. However, the downside was the decrease of ground water level, and the reduction of off-flow from the field, resulting in a totalling of less water for downstream users. This shows that efficiency and modernisation sometimes overlooks details. Water used in irrigation systems largely flows back into the groundwater or back into the river. Yet, due to increased efficiency less water was used in the irrigation, resulting in less off-flow. This issue will be resolved by the Basin Plan, which states that 50% of irrigation water needs to be returned in off-flows. This creates a problem, as it also wants to further improve the irrigation systems. Therefore, engineering has to come up with a innovative way,

allowing further flow of water, while also reducing the amount of water withdrawn from the water source.

Furthermore, the changes in local groundwater pumping and water withdrawal, also pose a challenge to the engineering step. As the plan requires a higher sustainable diversion limit on groundwater to ensure groundwater-dependent ecosystems to be maintained. For the engineering and infrastructure this means a reduction in groundwater pumping or an increase in specific groundwater pumping while ensuring enough groundwater in certain ecosystems. Pumping groundwater specifically in a certain location can be tricky and expensive, as groundwater flows, as the term suggests, under the ground. Whereas surface water can easily be spit or tapped, groundwater extraction poses a risk of causing land to drop, due to ground instability.

Overall, the infrastructure in the Murray-Darling Basin is very well developed, especially in the southern part of the basin. Since 2007 many improvements have been made and under the Basin Plan many infrastructural changes will follow. This well-developed infrastructure and forward looking planning will help retain the success of the water market, and further benefit the local communities, the environment and businesses in their water security needs.

Feedback

The Authority is not only an oversight institution but also a platform for feedback and communication. Since its establishment in 2007 the Authority has utilised many advisory boards, academic research, as well as, local involvement and community information meetings. The Authority states that it sees it engagement with, and education of, the Australian community as a primary role of the institution. In order to achieve this many feedback loops have been used in the past, from local advisory boards, direct local communication evenings and surveys. The effectiveness of this feedback however, is hard to measure. Often due to legal constrictions it is difficult to quickly adapt taking into regard the feedback of the community. Feedback of the community often included the visible degradation of the environment and environmental services, as well as regulatory disputes and infrastructural mismanagement.

In the Basin Plan, the Authority tries to increase its engagement with the population and increase its adaptability to changes. It also tries to create a more equal system, whereby all stakeholders will be held with the same regard, and were voiceless stakeholders are tried to be given a voice. For example, the creation of the Aboriginal people advisory boards. When planning and drafting the Basin Plan, the Authority attempted to involve local communities in the process, however, this proved to be rather difficult. Mainly because of two reasons, firstly the social equity of a change in the water market system, or for the water market as a whole, was negative. Meaning that many of the local population did not agree with chances to the system in the past and were weary for new changes. The Authority, was unable to find common ground with many communities which resulted in cancellation of communication sessions and thus a lack of involvement of these communities. Secondly, the information which was send around to prepare communities for such a communication meeting, was very complicated and overly large, the information was provided to late, and therefore many people and economic stakeholders could not prepare for the meeting in time, plus the information did not include any of the new ideas and changes. It basically recited the current situations and mentioned that change was needed, but did not provide insight in how this change would be achieved (Hart, 2016, pp. 844-845). However, in the following years the Authority changed its approach to engagement and focussed on more open discussion and tried to understand the cultural and economic situation of the people and stakeholders they were engaging with. Yet, the basic feedback concerning the Basin Plan is not ideal, as the Authority is used as a connection point, and communities and stakeholders often do not differentiate between the tasks of the Authority and other governmental agencies. This slows down the efficiency of meeting and engagement, which results in lower productivity and slow degradation of confidence in engagement from both the Authority's side as well as the community and stakeholder's side. A good example of the problem, can be seen in the Northern Basin Review, which was due completion in June 2016, but has thus far not been approved due to lack of community support, especially by the Northern Basin Aboriginal Nations and local communities, who fear water shortages and a decrease of the local economy due to the changes in the sustainable diversion limit, reducing the amount of water which may be used.

Another major feedback moment could be the full Review of the Basin Plan, which is required every ten years. To achieve this full review, the engagement of with the community should continuous which would help adapt the Plan also when it is not in full review. However, so far the Authority has been unable to engage with communities on this topic, as it seems that the engagement is more a short-term planning tool, than a long-term improvement tool for the whole system. This is problematic, as many challenges faced in the long run can have a direct impact on the water security of the people. Especially climate change adaption should be discussed with communities, to prepare resilient responses to sudden changes. Not only can this engagement prepare communities and economic stakeholders alike for these changes, but it can also help understand the limitations of their ability to adapt by themselves. It would help find solutions to climate problems relating to water security, resulting in an increased trust in the Authority which in term could lead to increased support for changes and further engagement.

Overall feedback is actively sought after by the Authority, and in recent years has gotten more successful, however, many issues are still apparent. Whereby, engagement with local communities should focus not only on short-term gains, but also on long-term solutions, and input by the community should be taken seriously in order to create an efficient and mutually beneficial relationship.

Analysis Conclusion

The Murray-Darling Basin ABCDE+F analysis, has shown the completeness and effectiveness of the current water market in place, but has also shown some concerns for the future.

The main concern of the system is the feedback step, which influences all the changes made in the other steps. The Murray-Darling Basin Authority should therefore heavily invest in increasing their engagement with the community, and try to find ways to engage with all stakeholders, small and large. In order to do so research is needed to create a common understanding between the communities and economic stakeholders and the Authority. As a result of this lack of mutual understanding concerns may arise over the agreement of communities with the proposed changes, as they feel left out of the decision making process. If the

Authority wants to avoid this, it could be useful to use a more bottom-up approach to the engagement, whereby not the Authority leads the discussions and engagement, but also gives the communities themselves ways to engage, from a different perspective.

The other big issue for the coming years is the effects of climate change and the changes which need to be made to keep the market functional, as well as, safeguard the water security of the local communities and economic stakeholders and build resilience. With the Basin Plan, a step has been made in order to cope with current climate change trends, however a worsening of the situation has not been included in the plan, nor are there any emergency plans in case of severe drought or sudden flooding. This is not only a risk for the effectiveness of the water market and its economic benefit, but also heavily affects the communities as well as the environmental wellbeing. To further improve the environmental wellbeing the Payment for Environmental Services could be introduced in the region, whereby users of these services, such as fishing and fertile land, would have to pay a small fee which can which in turn can be used for environmental protection measures, or even buy-backs.

Overall, the Murray-Darling Basin does tick all the essential steps of Perry's framework of efficient water management, and compared to the situation ten to fifteen years ago the current management system might even be considered good. As the water security for economic stakeholders has been improved, due to the ability to trade water rights, which gave an extra dimension to their business models. The water scarcity of local communities has been reduced, due to better management, accounting and clearer stipulated laws on the use of water. And the environment is set to benefit as well, as the Basin Plan highly prioritises the environmental wellbeing, in comparison to the years before. Hopefully the measures taken, will prove to be enough to restore the Murray-Darling Basin to a region fit for lively communities, healthy environments and a strong economy.

5. Impact of the Water Market on Water Security

After having analysed water markets and water security, and did a case study of the Murray-Darling Basin, proper analysis has been done to assess the impact of water markets on water security.

It is important to remember that water markets are an economic tool of water trading, and therefore are a capitalist tool. The use of water markets depends fully on the implementation of rules, legislations and social equity. However, the case study and literature review and analysis has shown three main issues which can positively impact water security with the use of water markets as a water management system. Namely, the positive influence of proper legislation and effective institutional management, increased engineering capabilities and infrastructure, and the building of better communication helping to build resilience.

Besides the three main issues a water market itself can help increase the water security for people, environments and the economy, as ideally a free market leads to a perfect balance of supply and demand, and thus the most effective allocation of water. However, as water is not a normal commodity but also a basic human right, and an important factor in sustaining environmental services a fully free market might not result in the best outcome. Nonetheless, water markets help change the mindset about water management, and therefore help focus on more efficient and sustainable use of water. The change in itself, should be beneficial for water security, even when not all preconditions of the ABCDE+F framework are met, or the implementation of the market might not be successful.

Legislation and Institution

In short, effective and clear legislation and functioning overseeing institutions are key elements of a successful water market, as was clear in the Murray-Darling Basin. These two factors also play a large part in water security, even if water markets are not put in place.

Legislation helps water security to be achieved by making responsibilities of stakeholders, rights of the environment and communities as well as restrictions for communities and stakeholders clear. This step is crucial to achieve water security, as chaos never led to security. Legislation can, for instance, ban the use of certain polluting chemicals or fertilisers to improve the water quality, which helps improve the water security. However, legislation is only useful if there is proper implementation and oversight. Therefore, a strong and capable institution is needed to oversee and implement the rules and regulations set up by the legislation. This duality is crucial as one cannot go without the other. The establishment of this legislative structure and an institution may also lead to greater understanding of the basin at hand, as an effective water oversight institutions require continuous information on the water flows as well as the communities and stakeholders. Therefore, gaining insight in the basin and its users, which will help understand the seasonal changes, effect of climate change, but also the changing needs and priorities of the users.

The effect of legislative changes and the creation of an institution might not be immediate, as all stakeholders need time to adapt, however, it will ensure future development and adaptation. As seen in the Murray-Darling Basin the Authority is a key player in communication to communities, in formulating changes in the Basin Plan and help run the basin on a day to day basis. An institution does not only do this, but it also helps unify in case of the basin transcending multiple counties, states or even nations. This border transcending quality is of high importance for the successful and equal distribution of water, which in term helps improve the water security for people, environments and economic stakeholders.

For example, in the Aral Sea region, which spans Kazakhstan and Uzbekistan, and the basin includes all Central Asian Countries, the establishment of an international institution could help streamline the legislative issues between the countries and reduce the devastating ecological impact of the water mismanagement. It must be clear that an effective institution and streamlined legislation are unlikely to happen, however, it would greatly benefit the management of the basin. This example, also shows the complexity of establishing proper legislation and institutions, as water rarely flows within manmade boundaries.

Another element legislation and an effective institution could include is the Payment for Environmental Services, this market instrument adds a small fee to the use of environmental services, such as fishing, fertile land and water. This type of payment would only work in a market system as it can be implemented as a small fee for transactions or be included in the yearly payment for the water allocation. This small fee would be used to further develop and protect the wellbeing of the environment, as well as, help fund investments with the same purpose.

Overall, effective water management, which would lead to increased water security, should start with proper legislation and an institution which oversees and implements this legislation. In this way, the management will be sustainable over a long period and it will work as an incentive and legitimising factor in implementing a water market. The water security improvement would mainly be attributed to the clarification of who may use what and for what reason, thereby benefitting economic stakeholders and local communities as well as the environment.

Engineering and Infrastructure

The second influential factor for improving water security through water markets is engineering and thereby creating efficiency and sustainability. Engineering should encompass more than just pipes from A to B – although this is important –, it should also try to innovate irrigation systems in agricultural areas, it should attempt to improve the efficiency of water extraction and increase the capabilities to reuse water. Furthermore, engineering is also key to understanding the ecological situation of the basin and the depending ecosystems. Hereby it is important that long term measuring needs to be done, and through engineering this can be done automatically, as seen in the Murray-Darling Basin.

To improve water security infrastructure could be put into place, connecting various urban areas, whereby water sharing in terms of scarcity can help alleviate water shortages and increase the reliability of the water quantity. Surely, this is not possible everywhere and can require high amounts of investments, when trying to build an automated water pipelines. However, a possible cheaper option is the creation of better roads between urban areas, so water trucks can more easily reach the areas in times of water scarcity. This option is highly plausible in poorer areas or

countries, which struggle with water security, as the comparatively limited investment needed, can result in a large improvement on the water security situation. Not only will this type of infrastructure help with water scarcity, but it can also benefit the economy of the region, the mobility of the people who live in the region, and will it enable more efficient water trading in the market. These profits can then be used to increase the sustainability of the water management systems, and a virtuous cycle is possible to emerge.

Engineering and infrastructure also play a large part in the quality of water, which is another key element in water security. Infrastructure can help measure the continual quality in the water, to give insight into the problems of pollution and salination. This in term can be used to help improve the situation and help reduce the water pollution. To do so, investments do need to be made either to hire people conducting the water quality tests, or an automatic system can be set up. The quality of water can also be increased by using better fertilisation techniques and fertilisers, as well as better water cleaning facilities before the water is given back to nature.

Engineering should be careful of its own downfalls, as seen in the Murray-Darling Basin, it is important to understand the complexity of water flows in a certain area. As increased sustainability in irrigation, can also lead to a disruption in the natural ground water flow, which was usually fed by the less sustainable irrigation system. While the new system negates this off-flow. Therefore, engineering might be the most difficult factor in achieving water security, however it also offers smaller solutions which can increase water security greatly.

Communication and Resilience

Water markets are meant to bring various stakeholders together and have these discuss their needs, often under the supervision of an oversight institution. These discussions will lead to better mutual understanding between local communities, urban areas, economic stakeholders and environmental representatives. This understanding may then be used by the institution to adapt and change the current situation to address the needs and concerns of the stakeholders, leading to greater water security. However, it is a balancing act, whereby the ‘losers’ are most likely to speak up the most, while the satisfied stakeholders will be less vocal, which can

result in misbalancing of the water management. Overall, engagement and direct discussions will help improve the water security for all, as long as the balancing is done properly.

Discussions and engagement also help create more resilience in communities to changes, such as climate change or legislative changes. Resilience is a term, which describes the capacity to adapt to constantly changing conditions, withstand shocks, crises and disruption while maintaining basic functions (Meerow, et al., 2016). Building resilience highly depends on cooperation between various groups in society, and the discussions and active engagement with all different parties, can help build cooperation. Governments often use the term resilience or building resilience to describe projects in poorer regions. Resilience is crucial for water security, as there needs to be an “acceptable level of water-related risks to people, environments and economies" (Grey & Sadoff, 2007, pp. 547-548) (UN Environment Programme, 2017, p. 7). This acceptable level cannot be obtained by going alone, it is only possible if all actors work together. The term ‘acceptable level’ is subjective, however, the legislation and institution should be able to determine what this acceptable level is. Surely, the wellbeing of humans is the key factor, where after the environment and the economy follows. Building climate resilience is not an easy task, as it requires hard work and deep understanding of the working of the groups one is dealing with. Therefore, not only local engagement and communication is needed but also research in the social-economic situation of stakeholders, the cultural and historic value of the area and its assets, and the economic trade-offs of businesses. Water markets can be an ideal model to engage on such a large scale, as they already require all stakeholder to be engaging and communication. Therefore, resilience building through water markets simplify the situation and lead to quicker results helping build resilience in favour of water security. Resilience building also is concerned with social equity, whereby the willingness to accept changes is very important. To achieve social equity communication and information are key, as well as mutual respect and understanding. Moreover, communication and engagement will become more important to sustain water security, as climate change may cause rapid weather changes, from drought to flood and from hot to cold (Leichenko, 2011, pp. 164-165). This in term leads to an ‘un-acceptable risk’ issue if not handled properly and quickly. Therefore, good communication, which water markets may

facilitate, can reduce the risk drastically and help build this required climate resilience. If relations and communications are already in place before a change or disastrous event, it is easier to act and respond more effectively. The effectiveness also comes forth from this established relationship, and the understanding of the situation at the point where help is needed. Communication and resilience also is important to the environmental justice, or the spread of the impact which climate change brings. The burden of climate change, as well as water security measures implemented, will need to be carried equally among all, whereby no specific groups should be marginalised. Regardless of economic situations or socio-economic standing. Free markets and capitalism is sometimes seen as an unfair distribution of wealth, and water markets, if left unchecked, can result in the same. Whereby the burden of policies and the effects of climate change will more harshly impact one party, whereas the other is hardly affected. However, the communication and engagement with the community should help reduce the environmental justice problems which may occur. For this open dialogue is needed, and assistance needs to be given to vulnerable groups by either the community, or the institution.

Overall, water markets can possibly help improve water security around the world. Mainly as a result of the inherent need for proper legislation and institutions, the infrastructure put in place to make the market function, and the established communication between stakeholders. However, markets do not need to be the only way of achieving this, other examples of regions without water markets can have similar characteristics which help improve water security. Most of these regions have easy hydrology and possible fund to invest. While water markets also allow for increased efficiency by making small inexpensive changes, which are achievable for poorer regions with a more difficult hydrology. Especially in areas with water scarcity, water markets can be used to improve a balanced distribution between people, the environment and economic stakeholders. As the market should largely regulate efficiency itself, nonetheless, legislative and institutional structures need to be well managed in order for the market to be successful and help improve water security.

Conclusion

Water is everywhere, and for many people having access to water is a given. However, this privilege is not as apparent as it seems. Water security is an issue worth talking about, and worth discussing. In this time of global climate change, rising sea levels, and technological advancement it is important to look at how secure our water situation is, and if it can be improved.

This dissertation has tried to answer the question; **how can water markets improve water security for people, environments and possibly economies?** A question which sounds easier to answer than it was. Information and agreement on water security alone and the value of water is an academic and policy issue, which has not yet been solved. Water markets are the second important aspect of this question, which clearly required a lot of attention after which many questions remain.

Water security was defined as “the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (Grey & Sadoff, 2007, pp. 547-548). A definition which combines the economic value of water with the basic right for access to water for humans. Terms which come straight from the beginning agreements on water security by the international community in the Dublin Principles. But water security entails more than just this as it has to take into account the special nature of water and the environment. Different levels of ease within hydrology, where many countries with difficult hydrology are poor and lack the ability to invest and improve their water security. But also economic factors, related to this investment or lack thereof and the possible vicious circle it can create. The importance of climate change to water security was stressed, as the changes in the climate enlarge existing problems of salination, drought and flooding, often hitting those with the least water security to start with. Moreover, water security has to do with the flow of water, it is hardly ever based in one country or region, plus the difference between up and downstream users must not be forgotten when talking about water security.

After this a discussion on the value of water and the value of water markets was conducted. Starting with the literal value of water, should water be priced or should allocation go in terms of most economic merit which benefits the community? This

led to a discussion of the economic value of water markets, which in an ideal situation would improve the economy due to perfect market working. However, water is not a standard commodity, nor is it available in a stable amount at any time in any place, causing issues. The economic value of money also clearly showed the need for proper institutions in order for a water market to function. Thereafter, a political-economic perspective was taken, whereby the power of the people owning the water was of major importance. If you own the water you have power over the ones that do not own any water. It also stresses the importance of the institutions being in place before the trading starts. Moreover, the political-economic view gives light to a socio-cultural idea about water markets, whereby it is locally set up in a bottom-up way, taking the environment into account at all times. The last section was about the environment and its value of water markets. The value of water markets for the environment is difficult to access, but with proper tools and measures water markets should not have a negative effect on the environment as it should optimise water use and increase it efficiency, thus more water remains for the environment. Another option to help the environment out is the Payment for Environmental Services system, which desires a small payment for the use of environmental services, such as water, fertile ground, fishing, etc. This money can then be used in sustainability programs or environmental conservation.

Next the actual analytical framework was discussed, there formal water markets with their specifics and Perry's ABCDE+F have been examined. Formal water markets include official institutions, clear water right and allocation and the ability to trade this water with other owners in the market. Perry's ABCDE+F framework; where A stands for accounting the total amount of water at any given time and place; B stands for bargaining where policymakers ensure correct allocation and distribution of rights; while C is codification, which is the legal framework ensuring the boundaries of the market system; D stands for delegation, whereby the information and legislation from ABC will be transferred to an institution, either newly founded or already in place. This institution oversees the daily activities in the market and should ensure smooth operation; E is engineering, which is concerned with the building and maintaining of infrastructure which enables the market and helps provide water security; and F stand for feedback, or feedback loop, whereby the communication with local communities to ensure smooth operation and agreement of these communities is

safeguarded to ensure social equity and help adapt the system in order to increase the general water security situation. The exemplary analysis of New Zealand helped show its potential, especially when needing a quick overview of which of the six need most working on.

This framework was then used to analyse the Murray Darling Basin in South Eastern Australia. A basin spanning about one seventh of the Australian landmass, which is largely agricultural and has a high variability in water flow. The basin is not one market, but two markets, whereby the two markets are thus far unable to trade with each other due to geographic and engineering restrictions. Using the ABCDE+F framework the Basin was assessed as effective, but with challenges of climate change and community engagement as major issues for the future.

The last section gave the overall assessment and tried to coherently answer the research question. The possible ways in which water markets can improve water security for people, environments, and economies are threefold. Firstly, implementation of a water market system, requires legislation and institutions, this can benefit all three parties, as it will clarify the responsibilities and rights of the parties, as well as lay boundaries protecting the environment and urban use of water. Secondly, water markets require advanced infrastructure. This infrastructure will not only help reduce economic water use, but also help interconnect urban areas which reduces the risk of water scarcity, and increases reliability of the quantity available. Advanced infrastructure can also help measure, and therefore help solve, water quality issues, as is shown by the Murray-Darling Basin salinity measures. Thirdly, water markets are meant to bring various stakeholders together and have these discuss their needs. Which in term will result in better mutual understanding and helps to create a balanced situation whereby people, economic stakeholders and environments thrive. This will also help build more resilient communities, which can withstand and adapt sudden changes, due to stronger cooperation. Surely water markets are not the only solution to obtain water security, however, it is a solution which could be useful, especially in regions with the availability to investments and regional cooperation.

It is clear that not all research on this topic has been don,e as this dissertation has been limited – especially the limitation on one case study and a literature review will

lead to some generalisations or conclusions, which with other cases might not have been the result – however, it has tried to give a holistic overview of the possible impact water markets can have on water security. More in depth research on long term environmental effects, or specific technological needs would help further the understanding of the relation between water markets and water security. Water security itself could also be investigated in more detail, as there seems to be limited consensus on the scope and definition of it. This also ties in to the price of water and water having economic value. The Dublin Principles might have given international recognition to the economic value of water, but consensus on how this value should be measured or even if water should be given a value is highly contested. Another very interesting research could be the influence of corporations and multinationals in pushing for the establishment of water markets, either because of their 'green' agenda or possibly for economic gain.

In conclusion, this dissertation has investigated how water markets can possibly increase the water security for people, environments and possibly economies. Whereby the outcomes were mainly benefits gained through in clearer legislative and institutional structure – benefits for all three stakeholders –, better engineering and infrastructure – also beneficial for all three –, and more community engagement, which helps build resilient communities– mainly important for people. These three important factors, may be seen as key elements for improving water security, whereby it is important to note that this is not only possible through the use of water markets but also by themselves. However, a water market system can help facilitate these factors and speed up the improvement of water security.

Water might seem as normal as air, however, crucial need of water for people, environments and economies combined with water being a scarce resource makes it more extraordinary than any other resource.

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