Fresh water management in New Zealand and China: similarities in different institutional frameworks

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Abstract

This paper compares water rights policies and allocation mechanisms between New Zealand and China. First, we give an overview of water law and rights, comparing these between the two countries. Second, we describe the allocation mechanisms in each country. Finally, we give a case comparison of Canterbury, NZ, and Gansu, China.

The countries are very different, and water policies were and are developed in different ways, yet the water law, rights, and ultimate problems of allocation are similar. The differences are mainly due to different scales of institutions and legal structures, one a small country, the other a very large one. Despite the different geography, and different institutional and legal structures, we found the water permits application and approval processes are similar between New Zealand and China, differing only in rather superficial details. We further found virtually identical outcomes with water markets: thin trading due to high transaction costs.

Key words: water allocation, water markets, transaction costs.

1. Introduction

In this paper, we compare two very different countries to examine what drives differences in water management, and to observe whether the differences ultimately result in different outcomes.

Governments and researchers have focused on common questions, such as whether water is a need, and whether it should be a universal right. How should water rights be secured for the poor, and what governance structures would ensure that their rights are protected? How should governments and markets play their respective roles in allocating water rights? What instruments are available to safeguard water users, while supporting equitable and efficient water allocation? How should society adjust when existing mechanisms fail to allocate water effectively? We would expect that very different countries would answer these questions in different ways, especially given the poor reliance on markets.

Our comparison will highlight the essential elements of water allocation, and bring into focus the reasons why water might be managed similarly or differently in different places. What is really at the heart of water allocation? Saleth and Dinar (2004), and Dinar and Saleth (2005), gave an index to check the health of water institutions, but we will not study differences in effectiveness per se. Instead, we compare the defined institutions and processes for water law, administration, and allocation. We shall see that New Zealand (NZ) has a relatively simple administrative structure in a small country with small independent catchments. China has a complex multi-layered administrative structure in a large country with large complex catchments. The two countries manage water allocation differently at high government levels. Despite these differences, water users face surprisingly similar procedures at the local level.

Theoretically, water markets could enhance the efficiency of water use (Grafton et al., 2011), and water market development has become a common goal in different countries. Researchers have

attempted to provide guidance for improving water markets (Easter et al., 1998; Easter et al., 1999 ; Howe et al., 1986; Rosegrant and Binswanger, 1994). But neither China nor NZ has been able to implement water markets effectively, and for similar reasons.

The paper is outlined as follows. Section 2 gives an overview of water allocation. Sections 3.1 and 3.2 describe water allocation for NZ and China respectively. Because research has recommended water markets, we examine them in NZ and China, specifically comparing the Opihi River region in NZ with the Liyuan River Irrigation Area in China. Section 4 gives results and conclusions. We found that the greatest differences are due to differences in scale of government, one a small country, the other a very large country. The water permits application and approval processes are basically similar. We found almost identical outcomes with water markets: thin trading due to high transaction costs, providing thickness, and simplify.

2. Overview of water allocation and law

The task of water allocation is to distribute water resources among users and manage the natural river basins. Forms of water allocation range from complete control by government, to a mix of market and government allocation (Dinar et al., 1997; Ford et al., 2001). Administrative allocation, usually referred to as public allocation, is the most common approach. Government intervenes in water resource allocation for three related reasons.

First, water is a public good. Governments have to ensure that citizens are involved in setting water allocation institutions and policy. However, water management is more complicated when it is done by multiple institutions, as Medd and Marvin (2008) describe for northwest England. We shall see that this is definitely the case for China, less so for NZ.

The second reason why government intervenes in water allocation is for efficiency. In theory, market allocation is more efficient than other allocation methods (Rosegrant and Gazmuri, 1995). Coase (1960) observed that market allocation will be efficient, given well-defined property rights and zero transactions costs. But the assumption of zero transactions costs is not true in water allocation. Users must find trading partners, arrange contracts, get government approval, and, if approval is granted, enforce the contracts. The variable nature of water makes defining water rights difficult. Water markets are thus likely to be thinly traded. Consequently, for the most part, water is allocated via applications to government following procedures specified in law.

The third reason for allocation by government is because water is mobile. Its supply varies over time and space, and it may be used simultaneously by many users. One person's use of water can affect many other people and the environment, in ways that depend on the hydrogeology, distance to the location of the abstraction, and time. As the available water becomes fully claimed, through whatever allocation system, the resource is impacted by over-use.

Whatever the process, even with good hydrological understanding, the complexity of hydrological flows and the externalities make water difficult to regulate. Conflicts arise from shortages and diversions, where price signals are not available to direct water use by time and location. Activities associated with pollution usually lack appropriate price signals. Further complicating private rights to water is the need for in-stream flows for the environment.

A water-related transaction between any two parties, even if one party is government, is likely to affect third parties. If two parties wished to seek agreement among all the affected parties, they would find that making the deal was too complicated and expensive. In the worst case, they may have to get agreement from everyone in the catchment, including non-commercial users who have interests in environmental, cultural and recreational use of the water. To reduce contention, policymakers are increasingly emphasizing participation of the public and stakeholders (Kallis et al., 2006; Messner, 2006; Ostrom, 2009; Rauschmayer et al., 2009), Hence, government does not leave water allocation to "free market" forces, because any trade affects third parties. Consequently, the

transaction costs are very high. This is not an argument against trading. Rather, the high transaction costs simply explain why trading is rare in practice.

In the next section, we show how these problems arise for two different countries.

3. Water administration in New Zealand and China

3.1. NZ's water laws and institutions

3.1.1. Role of the central government

NZ water law is specified primarily in the Resource Management Act 1991 (RMA). The RMA is NZ's main environmental legislation, and is uniform throughout the country. The RMA provides a statutory framework for a relatively integrated approach to water resource management. The RMA established a structure of national and regional planning documents regarding water. The main responsibility for allocating water under the RMA 1991 is exercised by regional councils and unitary authorities.

The Ministry for the Environment (MfE) and the Department of Conservation (DoC) have the primary national roles in water resource management, which are to develop policy statements and write environmental standards.

MfE's responsibility is environmental sustainability and international matters that affect the environment. MfE primarily advises the Cabinet on environmental affairs. DoC manages the public conservation estate and is responsible for protection of freshwater fisheries and habitats.

Depending on location, NZ has two or three levels of government: national, provincial, and possibly town or city. Application of the RMA is delegated to elected local agencies at the provincial level: twelve regional councils and four unitary authorities. These 16 agencies are responsible for water management within their boundaries. (Under a given regional council, territorial authorities manage urban water supply networks. Unitary authorities also managed water supply networks for towns in their jurisdiction.) We will refer to these 16 agencies as *councils*, which were established under the Local Government Act 2002 (LGA).

The councils have responsibility to implement national policies, identify water management issues, monitor waters against the national environmental standards, and manage the coasts (Memon, 1997). Thus, the bulk of the nation's water is managed through only two layers of government.

Councils are required to develop regional plans for guiding resource decisions. These plans implement national policy, and customize the RMA for local conditions. Regional plans must assess cumulative effects of consents, and limit the water that can be abstracted (Robb et al., 2001). The plans specify environmental baselines, and how water will be shared between users.

3.1.2. NZ's water permit system

The RMA sets the primary criteria for decisions on individual applications for resource consents. Under the RMA, if a proposed activity is permitted, the applicant must obtain a certificate of compliance from the regional council, indicating that the applicant will comply with the relevant conditions in the regional plan, but the applicant does not need a full resource consent. The RMA allows users to take water without a resource consent for reasonable individual domestic and stock water needs, and for fire-fighting purposes. If the regional plan does not permit the proposed activity, the applicant must apply for a consent. The RMA requires consents for "damming, diverting, taking or using natural water, whether underground water or surface water," (ECAN(1), 2009).

3.1.3. Canterbury's water permit system

For the region of Canterbury, the regional council Environment Canterbury (ECan) is responsible for consents. Canterbury has about 6,845 consent holders for surface and ground water (ECAN(3),

2010). Steps to apply for a water consent are shown in Figure 1. This long application process is a large transaction cost.

A consent may have duration up to 35 years; it cannot be extended, but the user may apply for renewal. A consent becomes effective when the activity commences; the consent may be cancelled if activity is discontinued for five years. If the application is not approved, the applicant can appeal; a hearing will be arranged to address the objection. The applicant can further appeal to the Environment Court.

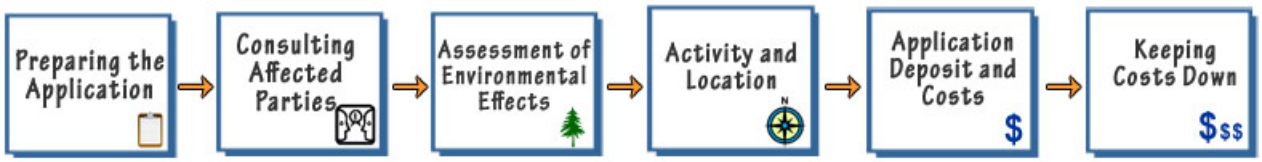

Figure 1. Steps to apply for a water consent from ECan (ECAN(2), 2009).

An application must include an assessment of environmental effects, a description of the activity and its site, a location plan and site map, a description of mitigation measures, and statement of other required consents. The assessment of environmental effects should describe potential environmental impacts of the activity, and assess how to mitigate those impacts, with tracking and monitoring measures. The application must include written approval of neighbours and affected parties (downstream or in the same groundwater resource), as well as the DoC, and NZ Fish and Game Council.

Applicants pay for the entire application process, including staff time and expenses, site inspections and the associated travel, staff time for attending meetings and hearings, venue costs if necessary, and newspaper advertising if the application is publicly notified. The fee must be paid even if the application is refused.

Compliance officers enforce the consent conditions. They respond to activities that may have an adverse environmental impact, and work with other enforcement officials to deal with unauthorized activities.

There is no charge for the water itself. Once the consent is approved, the user pays only for his or her own cost of abstraction.

3.1.4. Strengths and problems

NZ has a lot of water, and a relatively low population. Per capita, it places tenth in the world, about the same as Norway, with about eighty thousand cubic meters per person. Much of the available water is allocated. NZ is the most honest country in the world, tied with Denmark (TI, 2009). It is ninth equal in economic freedom, tied with Australia and the U.S. It is first on the Yale University environmental scorecard. NZ has good law enforcement. The population is generally well-educated and aware of the issues. Government, the public, and commercial users believe the environment is important and want water to be managed better.

In addition to its institutional strengths as a nation, its water allocation system has strengths which are not found together in the same degree almost anywhere in the world. Rights are clear. Users generally know whether they can take water, and how much water they can take. Water may be transferred legally under the RMA, though transfers happen rarely, as we shall see. The law is consistent. Contributing to the consultative society is excellent information technology. Councils post usage data on well abstractions and river levels, on the internet for all to see. Councils are now requiring users to install meters that can be monitored remotely at the council office. A national policy is being developed on the required accuracy and operation of those meters. Councils employ trained hydrologists, often with doctoral degrees. Overall, there is a good understanding of the resource, though questions remain about some complex aquifer structures, especially in Canterbury.

Despite these strengths, commercial users' increasing demands for water put them in conflict with each other, with the water management authorities, with non-commercial users, and with people who are concerned about the environment. Contention especially occurs with over-allocation, where more rights have been granted than there is water. Over-allocation occurs because of the large transaction cost associated with obtaining the right. These transactions costs are well known (See Dinar (2000), pp. 32, 85, 109-110, and Stavins (1995)). Because of the high cost of application, users request consents not for their average water requirements, but for their maximum water requirements, thus ensuring availability during drought. Because the council is aware that users are not likely to use their full consent, they have given more consent than there is water actually available. Consequently, catchments will tend toward over-allocation.

With increasing over-allocation in the past few years, councils have started to deny consent applications. Commercial users feel they have to fight for every drop; applicants often exercise their right to appeal to the Environment Court. These legal fights often hinge on the testimony of the council hydrologists against that of consulting hydrologists. Recreation seekers and environmentalists feel that nature is getting shorted. Seniority of rights between users is becoming contentious.

3.2. China's water laws and institutions

3.2.1. Water-related law

The current Chinese water rights regime started in 1978 (Huang, 2005), when China began planning for protection of water resources. Water law issued in 1988 stated that water resources are owned by the state, though water in ponds and reservoirs is owned by collective agricultural organizations. The law established China's legal framework for assessment of water resources, water allocation and licensing, approval for construction in rivers, protecting groundwater, consulting in water disputes, and flood control. In the 1990s, water shortages, floods, and environmental degradation were still unsolved. In 1993, the State Council issued the Implementation Measure for the Water Use Permit System, setting rules for water resources administration, including water permit procedures.

In 2002, the New Water Law delegated authority over the water resources to the State Council. Water in ponds and reservoirs of rural collectives may be used by those organizations, but is no longer owned by them. Chinese water law, as in NZ, does not recognize private ownership of water. Water rights can be divided into national water rights (state-owned water), regional water rights, water rights for users' collectives and associations, and individual water rights (Shen, 2006).

China's administrative districts have considerable authority over their local economies. A regional government can be a special owner of water rights, and can trade water with other local governments or water users. Regional water rights are shared by inhabitants in each administrative region.

Collective water rights refer to the right of rural collective economic organizations to use water in local ponds and reservoirs which they have built. Within the collective, members have nonexclusive use of the water. The collectives manage their water themselves.

An individual water right refers to the right to use (a usufructory right), the right to transfer water, and individual control about how to use the water.

In 2006, the State Council issued the Water Charges and New Permit Regulations, which specified the following:

- clear definitions of water abstraction;
- water permits must be consistent with river basin planning, including long-term national and local plans for water; the amount of abstraction must comply with approved distribution plans;

- provincial governments could choose which uses obtained water permits, following local circumstances;
- regulation of over-exploited ground water, as designated by the provincial water and land resource departments, must be based on scientific research;
- how to restrict allocated water permit holders in dry season;
- a water permit registration system, with an appeals process;
- different rights to different grade governments to approve water permits, according to water quantity. Users apply to higher level agencies for permission to use larger quantities.

Besides the Water Law of 2002, the National People's Congress and the Standing Committee of the National People's Congress laws regarding environmental protection, water pollution, soil conservation, flood control, and fisheries.

3.2.2. Role of the central government

Under the State Council (the central government), the Ministry of Water Resources (MWR) has primary responsibility for management of the nation's water (MWR, 2009). MWR encompasses seven water resources commissions (WRC): Yangzi River WRC, Yellow River WRC, Songliao River WRC, Huihe River WRC, Haihe River WRC, Zhujiang River WRC and Taihu Lake WRC. The seven WRCs have responsibility for river basin management, including allocation, protection of water resources, flood control, drought relief, water projects, river sand extraction, water and oil protection, and hydrological research.

The Ministry of Environmental Protection (MEP) has the mission as follows: "Prevent and control environmental pollution, protect nature and ecology, supervise nuclear safety, safeguard public health and environmental safety, and promote the harmony between man and nature." (MEP1, 2009). MEP establishes and supervises water pollution control planning in key river basins. It plans environmental protection of drinking water sources, and controls permits for major pollutants.

Besides MRM and MEP, the Ministry of Housing and Urban-Rural Development (MOHURD) and Ministry of Agriculture also have water-related functions. MOHURD guides construction of sewage treatment facilities and pipe networks. The Ministry of Agriculture is responsible for development and protection of fisheries.

In 2002, China began water resources integrated planning (WRIP) in every river basin and at every government level. The government is accelerating planning for the main rivers, with more integrated control of the water system, across in river basins, provinces, municipalities, and counties. Each level of government writes a WRIP to allocate water within its jurisdiction, leaving detail to the lower levels of government. WRIP is intended to be fair and equitable, while improving water use efficiency.

China has five layers of government: national, provincial, prefecture, county, and town. Each level of government must supervise and manage water under the direction of the higher level of government. Local governments, from county level above, manage water resources through a water agency, in accordance with the provisions of the authority, with a department having similar responsibilities to those of the MWR.

The State Council regulates the water permit system. Each province and autonomous region has a Department of Water Resources. Detailed implementation is handled by provincial government. In prefectures, counties, autonomous counties and cities, the relevant agency is the Water Resources Bureau; in a township, it is named the Water Resources Station. Town governments also do some water management, but do not allocate water permits.

3.2.3. China's water permit system

On 1 September 1993, China implemented the regulation *Implementation Measures of the Water License System*. After 13 years, on 24 January 2006, the State Council executive passed a new regulation, *Water Charges and Water Resources Permit Regulations*, which came into effect on 15 April 2006, replacing the earlier *Implementation Measures*. The new regulation also added rules for fees for the use of water resources. The regulations require that the organizations and individuals who wish to access water must apply for water permits and pay a fee.

There are exceptions for rural collectives and their members to use the water from their own pond or reservoir; for household water use; for drinking water of small scale livestock and poultry; for interim water taking to ensure public safety or eliminate harm to the public interest; for temporary water taking in drought; and to maintain ecology and the environment. Exceptions, such as the quantity which can be taken without license, are managed by provincial governments.

The 2006 *Regulations* are the main rules directing water allocation in China. Water management departments at different governmental levels operate the water license system. Seven main water resource committees, serve as watershed management agencies of the Ministry of Water Resources (MWR). These seven committees are in charge of the organization and management of the water permit system in their jurisdiction.

Unlike NZ, Chinese users pay for their water. The fee is paid to the level of government which manages the user's jurisdiction. The fee for water is jointly specified by the water administration and financial departments, and the relevant authorities in province level. The fee structure must be approved by local government. Water administration departments are responsible for managing the application process, collecting the fees, and enforcing the regulations. Water permit processes and charges should be open, fair, impartial, efficient and convenient.

Priority for water is decided by the provinces, autonomous regions and municipalities, with inter-regional conflicts settled by the central government. If WRIP has not been done for a given river basin, then water permits should comply with the relevant water use agreement signed between local governments. The total approved volume of water in a given administrative region should not exceed the quantity that the higher-up watershed agencies or departments have specified.

The water permits application and approval process in different provinces is basically similar. Under the *Regulations*, the provincial governments were empowered to write some local regulations. For example, the Gansu Province local legislature, the Tenth People's Congress Standing Committee is preparing to amend local water regulations including the *Implementation Rules of Water Permits in Gansu Province* (1995) and *Water Resources Fee Levy Measures in Gansu Province* (2004).

3.2.4. The water permits process in Gansu

The water permit systems in Canterbury and Gansu Province are similar at an essential level. As in many countries, government grants water licenses for the benefit of water users. Generally, a water license indicates the amount of water, the specified purpose, the area of abstraction, the point of diversion, precedence date, the period of the year, and the maximum withdrawal rate. A water license grants rights to use of water under the specified conditions.

Each province writes local laws and regulations under the central regulations.

Figure 2 displays the key steps of the water permit application at present. However, the Gansu government is studying new regulations about water permits and fees.

Figure 2. Water permits application and approval process in Gansu.

We summarize the following water permit application process in Gansu based on the *Implementation Rules of Water Permits in Gansu Province* (1995), *Water Resources Fee Levy Measures in Gansu Province* (2004), and *Water Charges and Water Resources Permit Regulations* (2006).

Users do not need permits to take water for household and livestock, for quantities less than 10,000 m^3 of agricultural irrigation water, or for quantities less than 2,000 m^3. In contrast, Hubei Province allows higher limits, because it has more water available.

For other uses and larger quantities, applicants submit an application form with a brief description of the project, a quantity engineering analysis, water sources development, documents from third parties, and an environmental impact analysis.

An application for abstraction that has hydrological impact beyond the local area must be reviewed at a higher level. For example, an application for surface water abstraction from the Yellow River, which passes through Gansu Province, must be reviewed by the water resources departments at the county, at the prefecture, and at Gansu Province, and by the Yellow River Commission. An application for groundwater abstraction would be reviewed similarly, depending on its hydrological impacts, but also by the departments of geology and mineral resources. In urban planning, the water resource and urban construction departments jointly manage groundwater abstraction.

Usually, county departments can approve applications for industrial and urban surface abstractions of less than one million m^3, and for agricultural surface abstractions of less than 500 million m^3. For larger quantities, industrial and urban quantities to 5 million m^3/year, and agricultural quantities to 20 million m^3/ year, the county department conducts a preliminary review, and then forwards the application to the prefecture for approval.

For even larger quantities, industrial and urban quantities above 5 million m^3/year, or agricultural quantities above 20 million m^3/ year, the application is first reviewed by the prefecture, and then by the provincial water department.

The result is a complex process. Especially if an application contains insufficient information, the process may take considerable time.

A water license has a maximum duration of 5 years. To renew the license, the holder should submit the relevant documents at least ninety days before the permit expires. The documents include water permits approved and issued by the original approving authority. The relevant water departments make their decision whether to approve within sixty days from the date of receiving the water license application. For some urgent need, the renewal application should be decided within 30 days.

Compensated use of water resources is one of the fundamental principles of water management in China. Since 2004, Gansu Province has levied water resource fees. Water fees are collected by the approving authority, which is at county level and above. If a license is approved at prefecture level, then the prefecture collects that water fee. Fees are based on the quantity of water; hydro-electric fees are levied according to generation capacity. Money from fees is used to subsidize monitoring, conservation, and governance. Users must install water meters. Abstractions above the approved quantities are charged at a progressively increasing rate.

3.2.5. Strengths and problems

China has a long history of civilization and culture, with a tradition of invention and resourcefulness. The country has been managing its water resources for 5,000 years, and water governance has been an important public affair throughout China's history. China's government has always been committed to innovation in water resources management, constantly searching for more effective mechanisms and institutions to manage water resources. The Chinese people are concerned about

sustainable development. China's legal system addresses almost every field related to water. The basic rights of water users have been ensured.

The Integrated Water Management Information System (IWMIS) is being implemented in some water departments, especially in some cities. As a water management platform, IWMIS has integrated data acquisition technology, database tools, geographic information systems, and multimedia. Central government has sponsored water research projects in which ministries consult with experts on important topics, such as water pollution governance, drinking water management, and lake governance.

Many departments are involved in implementing water rights. These agencies have complicated relationships. Although the Water Law (2002) stressed the status of the right to use, the Law did not have enough detail about implementation, including responsibilities of different levels of government. During a water drought, different regions may have conflicts because each region wants to increase water use. Higher levels of government then must help resolve the situation. Although some river basins have implemented water planning with the consequent improvements, other river basins require cross-regional water planning, under the direction of the next high layer of government. Further complicating this co-ordination problem, environmental, agricultural, construction, and other agencies have overlapping functions and authority in water management.

4. Comparison of water market mechanisms

The operation of water markets has demonstrated that water trading has benefits over command and control allocation. Water markets enable users to adjust to seasonal conditions. Water markets can reveal the opportunity costs of water, and raise the value of use, leading to increased economy activity in the region, especially improved value of agricultural production (Zaman et al., 2009). Water markets influence market participation decisions, water price movements, and distributional outcomes (Brennan, 2006; Crase and Dollery, 2006; Heaney et al., 2006).

However, implementing water trading can be complicated due to regulatory limitations, information asymmetries, lack of entitlement security, and unclear property rights (Brooks and Harris, 2008). Implementing a water market requires considerable strengths in hydrology, economics, management, law, engineering, and institutions. In the following, we review the water market design and operation in NZ and China.

4.1. Water markets in NZ

NZ water permits have attributes of property rights. However, section 122 of RMA explicitly states that resource consents are neither real nor personal property. Consequently a resource consent or water permit does not convey ownership of water, nor guarantee its availability; a permit cannot prevent "upstream" consents; they may be cancelled; they can lapse under certain conditions. Nevertheless, a resource consent to extract water is valuable.

Some people seem to be uncertain as to whether NZ law actually allows water trading, but it clearly does. McGregor (2007) states that "The RMA states that resource consents are neither real nor personal property, rather they grant a right to use a resource. This means that consents, and their associated rights, are not tradable in NZ." However, they go on to cite legal precedent and the 2005 updates to the RMA, saying, "Currently, the RMA has a limited capacity for transferring rights in existing consents to new users, whether wholly or partially. This has been partially addressed by the 2005 Amendments, where the existing provision was amended to allow transfer for a limited period." See also Begg (1996).

Lange et al. (2008) clearly believe that the RMA allows water trading: "The RMA allows water permits to be transferred between users as long as it is within the same catchment or aquifer, transfer is provided for in the regional plan, or approved by the appropriate regional council (NZ Resource Management Act 1991, s 136)."

So the barriers to water trading in NZ do not appear to be legal, but mainly public distaste for it. Lange et al. (2008) studied this question, finding that the NZ public has misconceptions about property rights, does not fully understand the hydrological issues, and is worried that monopolies may form, or that the market would result in inequity.

In any case, water is thinly traded in NZ. Some trading occurs in the Opuha Reservoir of south Canterbury, where users joined together to build a reservoir in 1995. The reservoir is operated by the users' group, the South Canterbury Farmers Irrigation Scheme (SCFIS). Trading is done by farmers trading shares, with approval by ECan when the quantity of shares exceeds the quantity of water associated the consent. The organization does not publicize trade data, so information is difficult to obtain. Lange, Winstanley, and Wood (2008) indicate that shares trade only infrequently: "To date, there have been few farmers trading or leasing shares, but according to the chair of SCFIS, the system is in place."

A private company, HydroTrader (www.hydrotrader.co.nz), runs a matching service for Canterbury water. These trades are subject to ECan's approval. A typical trade has a transaction cost of about $5,000, and takes two to three months, including the auction period, a subsequent buyer and seller discussion to finalize the trade, a consultant report to assist with the application to ECan, and then ECan's decision making process. Probably as a result of the high transaction cost, HydroTrader has assisted in only only a few dozen trades since it began in 2007 (HydroTrader, 2009).

What needs to be done to increase water trading in NZ? Memon and Skelton (2007) wrote, "The RMA permits regional councils to allocate surplus water by setting up an auctioning system in its regional water allocation plan. As an example of a water auction framework, the Raffensperger Milke model (Raffensperger and Milke, 2005; Raffensperger, Milke and Read, 2009), developed for the Tasman District, is designed to facilitate transfer of water permits or parts thereof within a particular catchment. They found that a market is unlikely to develop unless councils specify the conditions for transfer.

4.2. Water markets in China

The first important case of water trading in China happened between Dongyang city and Yiwu city in Zhejiang Province in 2000. Since then, China has explored different water trading models, including trading between governments, transactions between government and user, and transactions between different users. Water trading has been expanded in China because of the public water rights model. Local governments have become key participants. The higher level of government gives a quota to every lower level of government (Shen, 2006). In the second level, water rights allocated by higher-up government may be traded by local governments. The third level corresponds to trading between water users.

4.2.1. Background of the Heihe River

Gansu is part of three river basins, belonging to the Inland River, the Yellow River and the Yangtze River. Despite these three rivers, Gansu is still one of the most water short provinces in China. The Heihe River basin has historically been managed by the Yellow River Water Resource Commission.

The Heihe River is the second longest inland river in China. It originates at the Qilianshan Mountain in the Qinhai province. The river flows north through the cities of Zhangye and Jiuquan in Gansu province, and ends in Juyan Lake in Inner Mongolia. The area of Heihe River basin covers 143,000 km^2. The length of the main stream is 821 km.

Upstream, above Yingluoxia reservoir includes most of Qilian County of Qinhai Province, and part of Sunan County of Gansu Province. Midstream, between Yingluoxia reservoir and Zhengyixia reservoir, includes five counties in Zhangye City in Gansu province, Shandan County, Minle County, Ganzhou District, Linyi County, and Gaotai County. Downstream, below Zhengyixia reservoir includes most of Jinta County in Gansu Province and Ejinaqi County in Inner Mongolia.

Gansu's water allocation and use is affected by climate complexity and diversity, a dry and complex hydrological structure, and diverse geomorphology. The Heihe River basin is surrounded by high mountains, and scarce rain, strong winds, abundant sunshine. Since the 1960s, the amount of water downstream has gradually fallen. Small rivers and lakes have dried, degrading grassland and producing dust storms. In 1992, Juyan Lake, at the end of the Heihe River, dried up as midstream development exceeded sustainability. The ecological degradation in Juyan Lake resulted in shrinking oases and frequent dust storms, which affected large areas, including Beijing and even Japan. Inter-provincial water conflicts became more frequent in the basin.

To manage the Heihe River basin, the State Council in 1999 created a new agency named the Heihe River Basin Authority, under the Yellow River Water Resources Commission. This authority is in charge of water resources management in all three provinces. In 2001, the State Council approved the *Heihe River Basin Governance Planning in Future Years.* In 2002, for several days, the government prohibited all water abstraction upstream and midstream to ensure water flow to Juyan Lake. Since then, the Heihe River water flow has been similarly controlled depending on the environmental and climate situation.

It is with this complex background that we discuss the modest attempts at water markets in this area.

4.2.2. The Water Ticket System in the Liyuan River Agricultural Irrigation Area

We focus on the Liyuan River Agricultural Irrigation Area, midstream in the Heihe River Basin. The irrigation water comes from the Liyuan River, a first grade branch of the Heihe River.

The Liyuan River Agricultural Irrigation Area (LRAIA) lies in Linyi County. Luan and Zhang (2004) describe the region as follows. The irrigation area is 20,500 hectares. The area has 3 reservoirs, 52 trunk canals with total length 222.5 km, and 216 electric-pumped wells. Irrigation accounts for 89% of the total water, ecological water use (such as water use for natural plants and grass) account for 9%, industrial and domestic water use account for 1% each.

The LRAIA has to comply with allocation plans in Heihe River Basin. Following plans approved by the State Council, the water quantity in LRAIA must equal the input water minus the required outflow at Zhengyixia Hydrology Station, as calculated by the Heihe River Basin Authority. The county government allocates water to towns, and town governments then allocate water to collectives and user associations. Quota is further specified based on historical use and available water for households, industry, agriculture, and ecology. Household and ecological water must be ensured first, and then irrigation areas are allocated water. Quota quantities follow standard prices with increasing prices.

Water user associations are usually operated by the collectives, with considerable public participation. The associations are responsible for water works, management of channels, tariff collection, reconciling water use contradictions, and water trade among their users.

In 2002, the LRAIA implemented a system of tickets for water rights. A water ticket specifies the water rights, quantity and price. The user associations manage water rights by the tickets. The user associations match rights to tickets, and then distribute the tickets to users, as follows.

1. The LRAIA allocates quota to the water supply stations in each town.
2. User associations collect money from users, and buy tickets on their behalf from the town water management office, then give tickets to each user. A user's maximum quota is based on the users' proportion of land. The price is determined by government.
3. To obtain water, a user submits the ticket to the water supply station. A user would submit a ticket several times per year, following the irrigation schedule as set out by the user association.

Users can trade tickets among themselves; prices are supposed to be capped by regulation. Any quantity saved by the user can be traded. Figure 3 shows the trading process (Wu and Wu, 1993). Tradability increases incentives to improve efficiency.

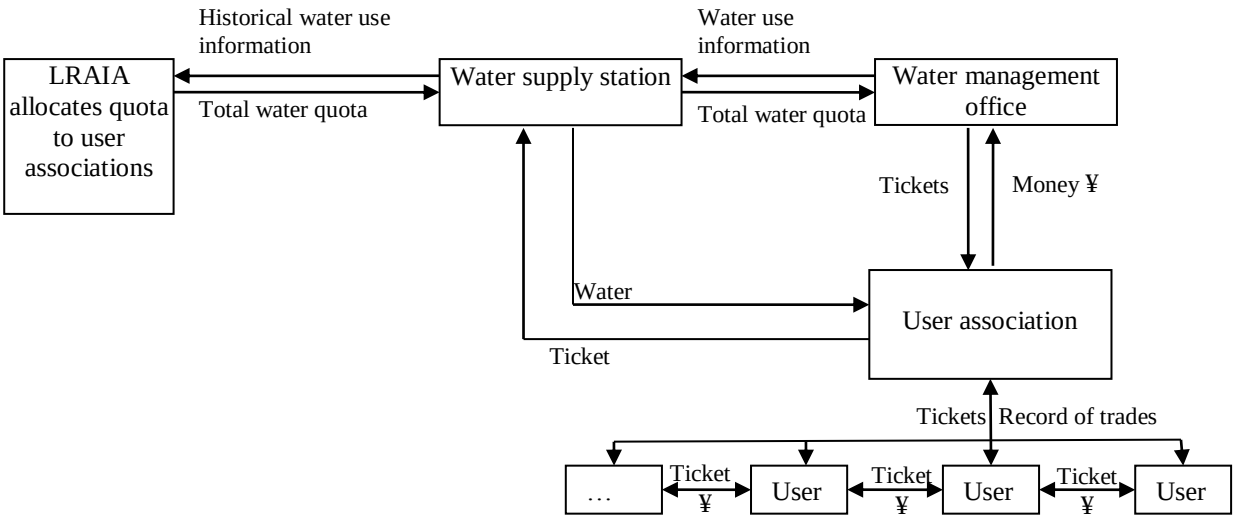

Figure 3. The water ticket process. Modified from Wu et al. (1993).

Although the water ticket system was implemented in 2002, water trading is still rare. The LRAIA case demonstrates that water trading in scarcity remains difficult, due to artificial shortage caused by capped pricing. In addition, lack of accurate measurement of water quantities also limits water trading. The cost of maintenance for the irrigation system is usually higher than the total fees paid for water, so management operations have suffered. Especially in drought, water scarcity continues to raise contention.

5. Results and conclusion

The natural endowment of water resources is clearly a critical factor in water allocation pressure. Per capita water resources quantities in NZ are about 40 times of China, so water allocation pressure in China is also much bigger than in NZ. This difference is not one of scale, and certainly not a difference of governance, but only of the different native endowment. Scale, however, does result in different institutional arrangements between NZ and China. In NZ, only two levels of government manage water resources. In China, because it is a much larger country, up to five levels of government and seven commissions play important roles. In NZ, regional governments cannot trade water, because few rivers cross regional borders, and the RMA prohibits trading between catchments. In China, regional governments do trade water, because China's long rivers cross regional borders. These differences are largely managed within government, and are not readily apparent to local users. These results do not seem surprising.

While both countries have public water rights, the systems of water law between NZ and China are different. Despite NZ's common law system, it operates as a unitary state, not as a federal system. China follows a civil law system. NZ uses its RMA for water and other resources. In NZ, national and regional governments write plans, and these plans are not only for water resources, but for the regional development. China's Water Law is mainly about water, and the planning system is more complicated. with water resource planning at every level. These legal differences appear to be largely superficial, and this result does seem surprising, as we would have expected so many high-level differences to ultimately result in significant differences to users themselves.

From our case, we found that the actual implementation of public water rights is similar between NZ and China, differing only in rather superficial details. Administrative allocation plays a critical role in both countries. Planning and permits are the two main methods for implementing administrative allocation. The fee structures are different, but the permit systems are similar. In NZ, users do not pay for water itself, but only pay for the approval process; in China, users pay a water resource fee for water itself. The length of water rights is generally different, with longer rights in NZ. Development of active water markets remains difficult, due to the high cost to allocate water

rights and the high transaction costs. In both countries, trading will require some means of reducing the transaction costs of allocation and re-allocation. The difficulties of managing water are universal.

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