UNIVERSITY OF CAMBRIDGE

Eco-compensation, Water Management and Political Power in China

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Abstract

A growing number of Payments for Ecosystem Services (PES) schemes are being implemented in developing and developed countries alike in order to effect some internalisation of environmental costs. In China schemes under the name of 'eco-compensation' are often considered to be similar to PES. Neither the term eco-compensation itself, nor the projects that are supposedly examples of eco-compensation have been subject to scrutiny. This thesis therefore aims to investigate eco-compensation in China, with particular emphasis on water-related programmes.

The thesis begins with a comprehensive review of PES literature in order to establish the definition and essential characteristics of such schemes, and to enable an examination of how China's eco-compensation differs from PES. The analysis of PES provides a framework for focusing on eco-compensation by examining voluntariness, project types, payment, actors, and scales. A broad-scale analysis of 19 Chinese schemes is then undertaken, and this reveals that eco-compensation projects predominantly involve government agents, often with different levels of government as service sellers and buyers; in China individual land users are only directly involved in a few cases. Literature suggests that PES schemes are not simply technical solutions, but are inherently political. Having undertaken this general survey, the political dimension of eco-compensation is then examined in two case studies in great detail, based on semi-structured interviews and project documents.

The first case study is of the Xin'an River eco-compensation scheme in which an upstream provincial government is paid to protect water quality to benefit the downstream province. Drawing from studies of "scale", this case explores the power relationships of central-provincial governments and intra-provincial governments in transboundary river water quality management, especially in the negotiation process of the eco-compensation scheme. It finds that the upstream

government mobilises the concept of "eco-compensation" to persuade the downstream government to share the costs of protecting the river and to gain favourable terms in setting the water quality target, using the narrative of "climate change". The central government adopts a tough stance on the issue of environment protection by the upstream government by setting water quality targets and by introducing basin management planning. This case suggests that eco-compensation is shaped by struggles and conflicts among different actors concerning their strategies in defining eco-compensation rules, and that eco-compensation can also reconfigure power dynamics among these actors.

The second case study is of the Miyun Reservoir watershed scheme, in which farmers in the upstream of the contributing watersheds are paid to convert from growing paddy rice to less water-intensive crops, and to reduce fertiliser use. The declared purpose is to increase the water supply to Beijing city, and improve water quality. Applying a political ecology approach, the case examines the history of water provision to China's capital city, showing that Beijing has been extracting water from its territory and beyond by using its political power. This eco-compensation scheme is just a part of this story. The case also shows that the eco-compensation is justified by framing the upstream agricultural water consumption as the cause of decreasing water flow, while ignoring that large-scale afforestation has significantly contributed to water shortages through the excessive consumption of water. Meanwhile, Beijing has ignored its own huge environmental impact on water quality. This case provides useful insights into how eco-compensation is shaped and framed according to certain priorities and interests, and that it can lead to control over access to water resources amongst the less powerful farmers in order to support water uses in the politically-dominant urban centre.

This thesis suggests that although eco-compensation in some instances can be similar to PES, more often than not it is a mechanism used to adjust the relationships between different governments. It includes both incentive-based and regulatory components. That makes it a potentially effective arrangement for river basin water quality management, in spite of contested negotiations. But caution must be exercised, as it can also be used under the market logic by powerful actors to control water resources.

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Chapter 1 Introduction and Background

1.1 The Broader Context

Although ecosystems provide important and highly valued services though their complex functions, ecosystems and their services are experiencing a continuing decline in both extent and quality. The Millennium Ecosystem Assessment (2005) notes that human actions are the root cause of transformation and degradation of ecosystems, with the loss of 35% of mangroves and 20% of coral reefs; and it is estimated that global forest cover has decreased from 31.2% to 30.2% between the period from 1990 to 2005 (UNEP, 2006). Usually, the underlying drivers behind this trend are economic and financial in essence (Emerton and Bos, 2004). A major reason for degradation and damage is that ecosystems and the services they provide are under-valued and under-priced for a variety of economic reasons such as market failure and government failure. As a result, to combat market failure, payments for ecosystem services (PES), a mechanism to translate external, non-market values of the environment into real financial incentives for local actors to provide ecosystem services (ES), have become increasingly important; and this is as true in China as elsewhere.

The fast-paced economic growth in China, while having lifted hundreds of millions of people out of poverty, has unfortunately also greatly intensified the environmental challenges faced by policy makers at all levels, increasing pressure on fragile ecosystems, creating a range of environmental issues, and constraining to some extent further economic development. For example, according to the 2010 China Water Resources Quality Report, of 176,000 km of monitored rivers, 17.7% have water quality worse than Class V, 20.9% are of Class IV to V, 26.6% are of Class III, and 34.8% are of water quality Class II or better[1] (Ministry of Water Resources, 2010a). Water shortages

1 Water of Class I can be used as drinking water with simple filtration and sterilisation; water of Class II can be drunk after regular treatment; water of Class III can be used for drinking after special or intensive treatment, suitable for fish raising and swimming; water of Class IV cannot be used for drinking water source but can be used for industrial production and for recreational activities which do not touch human's bodies directly; water of Class V can be only used for irrigation and scenic areas.

affect about 400 of 640 major cities, and 700 million people suffer from a lack of safe freshwater for drinking (Turner and Otsuka, 2006). In order to combat these environmental issues and the ecological degradation that causes them, a wide range of policy and programme innovations, many under the broad heading of "eco-compensation", are being carried out (Bennett, 2009). In China policy makers believe that a purely environmentally-driven objective may increase socio-economic inequality, so most eco-compensation programmes are designed to strike a balance between environmental and socio-economic objectives (ADB, 2016). So far, the most developed PES schemes have been located in North America and Europe where multi-billion-dollar investments have been allocated to public agri-environmental projects and public and private conservation easements. When it comes to developing countries, while Latin America has experimented extensively with diverse types of system, developments in other countries have lagged far behind. Literature on PES has flourished recently. For example, since 2008 at least three special journal issues/sections on PES have been published (e.g. Engel et al., 2008; Joshua and Robert, 2010; Muradian et al., 2010). However, when searching literature on PES and eco-compensation in China, only a few results can be found (e.g. Bennett, 2008; Wang et al., 2016).

Although numbers of eco-compensation schemes have been and are being implemented in China, and increasing evidence shows that there are still a large number of similar projects to be carried out in the near future, yet the international efforts to document China's eco-compensation are not as intensive as in other countries. Thus it is valuable to enrich research on eco-compensation in China, and this research aims to make a contribution towards this. This chapter will first review some literature regarding ES and water, and China's water crisis, before suggesting coupling market-based solutions with water management could be one solution. Then it sets out the specific research questions and finally lists the structure of the thesis.

1.2 Ecosystem Services and Water

1.2.1 Ecosystem and Ecosystem Services

The most widely used definition of an ecosystem is "a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit" (the Convention on Biological Diversity, 1993). Through these complex biological and physical processes, ecosystems provide human beings with various kinds of benefits - usually the term "ecosystem services" is used to represent these benefits. In the Millennium Ecosystem Assessment's definition, ecosystem services are the benefits people obtain from ecosystems (MEA, 2005). However, it is notable that there are several other cited definitions as well. For example, in Daily's work, there is reference to ecosystem services as the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life (Daily, 1997); while ecosystem services are the benefits human populations derive, directly or indirectly, from ecosystem functions, according to Costanza and his colleagues' notion (Costanza et al., 1997). A number of academics have provided in-depth accounts detailing this definition, but this is beyond the purpose of the research of this thesis so this introduction does not seek to replicate these studies (see Boyd and Banzhaf, 2007; Fisher et al., 2009). The main disputes focus on whether ecosystem services should include ecosystem functions and processes through which benefits are delivered. In order to bring the concept of ecosystem services into effective practical use for the purpose of scientific research and policy-making, ecosystem services have been classified in a number of different ways (e.g. De Groot et al., 2002; Moberg and Folke, 1999; Norberg, 1999). So far the most enlightened and commonly referenced typology for categorizing of ecosystem services is probably the approach adopted by the MEA, using the groups of provisioning, regulating, cultural, and supporting services (see Table 1.1 on Page 4) (MEA, 2005).

Despite the fact that the MEA classification is representative, this does not necessarily mean that it can be used perfectly in operational cases. Using an example in which a natural resource manager wants to ensure good management outcomes in an area containing a mixture of agricultural land and natural vegetation, Wallace (2007) points out that some services listed in the MEA typology cannot coherently exist at the same level. Processes such as pollination, soil formation and water regulation are not the services from which humans can directly obtain benefits. Rather, they are intermediate processes through which many other end services are provided rather than services themselves (Wallace, 2007). For the reason mentioned above, the UK National Ecosystem Assessment (NEA) distinguishes between the "ecosystem processes and intermediate ecosystem services” and the “final ecosystem services” that directly deliver welfare gains and/or losses to people. “Intermediate ecosystem services and ecosystem processes” underpin “final ecosystem services”, but are not directly linked to goods and are less often to be intervened in or managed by people in order to influence the delivery of final ecosystem services; while “final ecosystem services” directly contribute to the goods that are valued by people, and people tend to focus on these services for management purposes (NEA, 2011).

Table 1.1 Classification of Ecosystem Services According to MEA’s Approach

Type of service	Provisioning services	Regulating services	Cultural services	Supporting services
Services	Food	Air quality regulation	Cultural diversity	Soil formation
	Fibre	Climate regulation	Spiritual and religious values	Photosynthesis
	Genetic resources	Water regulation	Recreation and ecotourism	Primary production
	Bio-chemicals, natural medicines, etc.	Erosion regulation	Aesthetic values	Nutrient cycling
	Ornamental resources	Disease regulation	Knowledge systems	Water cycling
	Fresh water	Pest regulation	Educational values	
		Pollination		

Source: MEA, 2005

Table 1.2 (Page 5) shows the full list of ecosystem services used in the UK NEA, according to both MEA’s classification typology by different ecosystem service types (provisioning, regulating, cultural and supporting) and whether they are final ecosystem services or intermediate services/processes.

1.2.2 Water-related Ecosystem Services

Water-related ecosystem services are among the most frequently studied services. Seppelt et al. (2011) found that 105 of 153 ecosystem services studies concentrated on water-related services

(60 fresh water provisioning, 52 water quantity regulation and 40 water quality regulation, with several studies focusing on different types of water-related services at the same time).

Table 1.2 Ecosystem Services in the UK NEA

<table>
<tr><th colspan="2">Ecosystem process /intermediate services</th><th colspan="2">Final ecosystem services (example of goods)</th></tr>
<tr><td rowspan="4">Supporting services</td><td>Primary production</td><td rowspan="4">Provisioning services</td><td>Crops, livestock, fish (food)</td></tr>
<tr><td>Soil formation</td><td>Trees, standing vegetation, peat (fibre, energy, carbon sequestration)</td></tr>
<tr><td>Nutrient cycling</td><td>Water supply (domestic and industrial water)</td></tr>
<tr><td>Water cycling</td><td>Wild species diversity (bioprospecting, medicinal plants)</td></tr>
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<tr><td colspan="2">Weathering</td><td>Environmental settings (recreation, tourism, spiritual/religious</td></tr>
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<tr><td colspan="2">Evolutionary processes</td><td>Noise regulation (noise control)</td></tr>
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</table>

Source: UK NEA, 2011

In the Recommendations on Payments for Ecosystem Services in Integrated Water Resources Management, the United Nations Economic Commission for Europe (UNECE, 2007) refers to water-related ecosystems as “ecosystems such as forests, wetlands, grasslands and agricultural land that play vital roles in the hydrological cycle through the services they provide.” Water-related ecosystem services mean “such services as flood prevention, control and mitigation; regulating runoff and water supply; improving the quality of surface water and groundwater; withholding sediments, reducing erosion, stabilizing river banks and shorelines and lowering the potential of landslides; improving water infiltration and supporting water storage in the soil; and facilitating groundwater recharge. Water-related ecosystem services also include cultural services, such as recreational, aesthetic and spiritual benefits of forests and wetlands" (UNECE, 2007). Table 1.3 provides an overview of the main water-related ecosystem services.

Table 1.3 Water-related Ecosystem Services

Services	**Description**	**Examples**
Provisioning services	Focused on directly supplying food and non-food products from water flows	Freshwater supply Crop and fruit production Livestock production Fish production Hydro-electric power
Regulating services	Related to regulating flows or reducing hazards	Buffering of runoff, soil water infiltration, groundwater, maintenance of base flows Flood prevention, peak flow reduction, landslide reduction Soil protection and control of erosion and sedimentation Control of surface and groundwater quality
Supporting services	Provided to support habitats and ecosystem functioning	Wildlife habitat Flow regime required to maintain downstream habitat and uses
Cultural services	Related to recreation and human inspiration	Aquatic recreation Landscape aesthetics Cultural heritage and identity

Adapted from Smith et al. (2006)

Water is a vitally important component in maintaining healthy functioning of ecosystems, and provides a broad range of benefits while also ensuring their resilience to change (Costanza et al., 1997). The presence or absence of water in the landscape very often determines the characteristics of several supporting and regulating functions.

1.2.3 The Relationship between Water Quality and Ecosystem Services

Water quality is neither a static condition of a system, nor can it be defined by measurement of only one parameter. Rather, it is variable in both time and space and requires regular monitoring to detect spatial patterns and changes over time. There is a wide range of chemical, physical, and biological components that determine water quality, and many variables can be measured to provide a general indication of water quality. These variables include, but are not limited to, physical and chemical characteristics (e.g. temperature, dissolved oxygen, pH and alkalinity, turbidity and suspended solids, salinity and specific conductance), nutrients (e.g. nitrogen and phosphorus), heavy metal contaminations, organic matter (organic carbon, Biochemical Oxygen Demand and Chemical Oxygen Demand), biological components (microbes, algae and aquatic vascular plants, invertebrates and fish), organic contaminants and more. Currently, water quality issues are becoming an emerging global issue, and the water quality “crisis” has led to water-borne diseases, ecosystem dysfunction and loss of biodiversity, contamination of both surface water and groundwater, decline in sustainable food resources, poor water resources management decisions in some countries, environmental refugees, international instability, and high economic costs of remediation (Ongley, 1996).

Water quality degradation can be the result of natural processes but is more often caused by human activities and is closely linked to agricultural intensification and industrial development (UNEP, 2008). Production of synthetic chemicals used in industry and agriculture since the 19th century, eutrophication of surface water from human and agricultural wastes, nitrification of groundwater from agricultural practices, and construction of impoundments along watercourses to meet people’s needs for water can all alter water quality. In particular, agriculture, one of the dominant forms of land management globally, while meeting people’s increasing need for food due to population growth, puts great pressure on water quality. In the agrarian landscape, inappropriate application of nutrients (too much applied fertilizer) is one of these pressures. Agriculture has profound effects on biogeochemical cycles and nutrient availability in ecosystems (Galloway et al., 2004; Vitousek et al., 1997). Nitrogen and phosphorus are the two nutrients whose shortages most limit biological production in natural and agricultural ecosystems and they are therefore heavily applied as fertiliser in agro-ecosystems. Nitrogen and phosphorus fertilizers have greatly increased the amount of new nitrogen and phosphorus in the biosphere and have had complex, often harmful, effects on natural ecosystems (Vitousek et al. 1997). These mobilized nutrients have entered both groundwater and surface water, resulting in many negative consequences for human health and the environment. Galloway et al. (2004) points out that approximately 20% of N fertilizer applied in agricultural systems is leached from soils and moves into aquatic ecosystems. Impacts of nutrient loss from agro-ecosystems are diverse, including groundwater pollution and increased nitrate levels in drinking water, eutrophication, increased frequency and severity of algal blooms, hypoxia and fish kills, and 'dead zones' in coastal marine ecosystems (Bouwman et al., 2009)

However, water quality itself is not an ecosystem service, but rather is an indicator of the result of intermediate services such as water purification and erosion control; however, it may also be a driving factor which contributes to other services such as food provisions, recreation and so on. Actually, linking water-quality related ecosystem processes with changes in ecosystem services and goods is still a challenge today. Keeler et al. (2012) proposed a framework linking actions to a measured or modelled change in water quality and then to changes in the value of ecosystem goods and services for this purpose (see Figure 1.1).

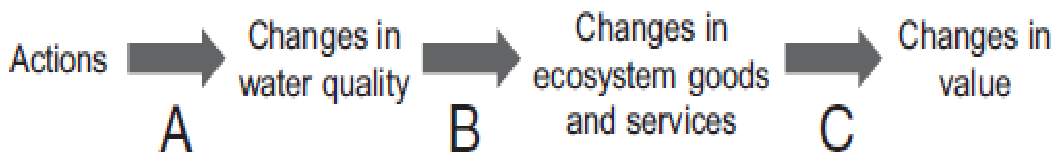

Figure 1.1 Framework for Linking Actions to Values for Water Quality-related Ecosystem Services.

Source: Keeler et al, 2012

In the second step, their framework links changes in water quality to changes in the provision of ecosystem goods and services that directly affect human well-being. In Figure 1.2, they chart the potential interactions between changes in water quality and multiple ecosystem services, based on the MEA's general framework which links ecosystem services to human well-being while specifying water-related services. One water quality characteristic may affect another one, and change in the provision of one service may also affect the provision of another service. As a result, a single change in one water quality constituent can affect multiple ecosystem services.

This framework makes it more transparent that nutrient loss from agro-ecosystems (mainly nitrogen and phosphorus), soil erosion because of farming on lands on steep slopes near rivers and pesticides used by farmers, are all related to complex interactions of water quality and to changes in ecosystem goods and services.

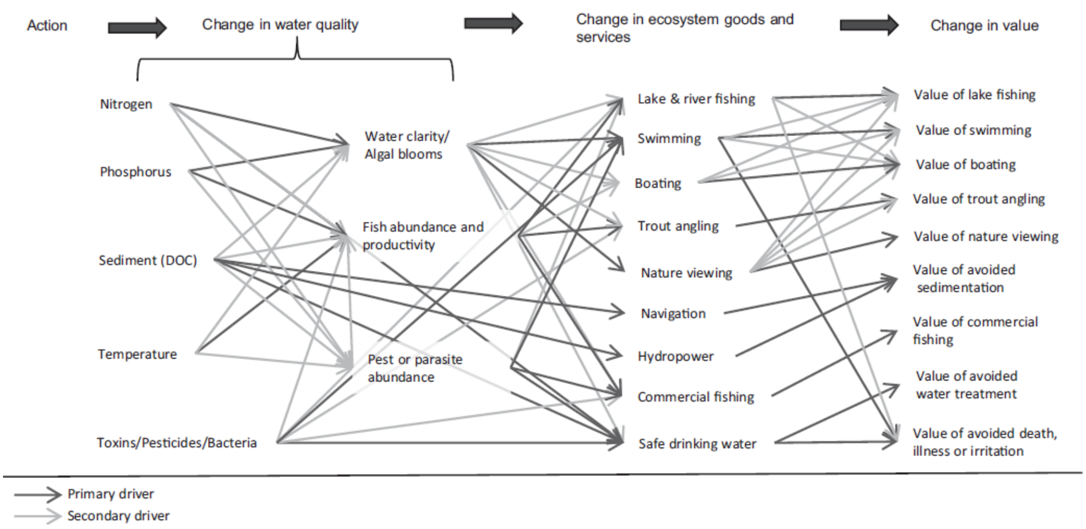

Figure 1.2 Relationships between Water Quality Change, Multiple Ecosystem Goods and Services, and Associated Changes in Values.

Source: Keeler et al, 2012

1.3 China's Water Crisis

China's economic reform from 1978 has been viewed as a significant success in terms of improving its citizens' living standards and fulfilling economic prosperity. With average annual GDP growth at around 10% from 1981 to 2010, about 680 million Chinese people were freed from extreme poverty (Morrison, 2017). However, these economic achievements have been made at the expense of tremendous environmental damage, such as severe water and air pollution, desertification, soil erosion, and biodiversity loss. A detailed study documenting these environmental challenges is out of the scope of this dissertation, but for the purposes of this thesis it is worth mentioning China's water crisis, one of the most serious environmental problems in the country.

1.3.1 Current Status of China's Water Problems

China has a total area of around 9,600,000 km^2. Overall, with the estimated average volume of internal renewable water resources in its vast area at 2812 billion m^3 per year, China's water volume ranks fifth in the world behind Brazil, Russia, Canada, and Indonesia (Jiang, 2009). China has more than 50,000 rivers with a catchment area over 100 km^2, and about 1500 rivers over 1000 km^2. At the first glace, China has abundant water resources. However, water shortage has been and will continue to be a major problem in China. While only having 7% of total water in the world, China has to feed around 20% of the world's population. In this sense, China's per capita availability of renewable water resources is just about a quarter of the world average. Over 400 out of China's 662 cities face insufficient water supplies to some degree and 110 of them experience severe water shortages, including 30 largest and fastest growing metropolitan areas (Li, 2006). Ministry of Water Resources (MWR, 2010c) estimates that the average water shortage is about 50 billion m^3 per year and that could rise to 75 billion m^3 per year in dry years. By 2030, China's total water deficit could reach 400 billion m^3 (roughly 80% of the current annual capacity of approximately 500 billion m^3) (Jiang, 2009).

The spatially uneven distribution of water resources means that northern China especially bears the brunt of water shortage. The average annual per capita availability of water there is only 271 m^3, about one tenth of the national average and one twenty-fifth of the world average (Guan and Hubacek, 2008). In the Hai River Basin, the runoff has decreased by 41% during the past two decades (MWR, 2007). In the meantime, some other large river basins - the Liao, Yellow and Huai River basins - have also seen runoff declined by 9-15%. During the worst years, some rivers (e.g. the Hai River basin and the Yellow River basin) in North China Plain have failed to reach their lower courses (Wang et al., 2009). As a result of lack of sufficient surface water resources, people in northern China have begun to turn to groundwater, which in turn has caused increasing groundwater depletion. It is estimated that 70% of the North China Plain has been affected by groundwater over-extraction (Liu and Yu, 2001). In the early 2000s, about 70% of farmland in norther China is irrigated by groundwater, and groundwater is used about 70% of the drinking water there (Wang et al., 2009, Qiu, 2010). Consequently, agricultural withdrawal of groundwater has led to an average decline of about 1.5 m per year since 1990s (Zhang et al., 2004)

Beyond water shortage caused by insufficient water quantity, China also has been experiencing water quality deterioration. As shown by Table 1.4, China's major rivers suffer from poor water quality. According to these data, in South China about 20% of the monitored water sections in the Yangtze and Pearl River basins have water quality worse than Class III. However, these rivers in the north see even more serious water pollution. To be more exact, only about a quarter of monitored water sections in the Hai River Basin are good enough for human use (in some cases with treatment) according to China's water quality categorising system, and there are similar trends in the Songhua River and the Huai River.

Table 1.4 Surface water quality classification in China in 2007 (%)

River Basins	**Classes I- III[2]**	**Class IV**	**Class V**	**Over Class V**
Liao	43.2	10.8	5.5	40.5
Songhua	23.8	52.4	4.8	19.0
Hai	25.9	9.7	11.3	53.1
Yellow	63.7	9.1	4.5	22.7
Huai	25.6	39.5	9.3	25.6
Yangtze	81.5	3.9	7.8	6.8
Pearl	81.8	15.2	0	3.0
Southeast rivers	78.2	21.8	0	0
Southwest rivers	82.4	11.7		5.9
Northwest rivers	82.1	14.3	0	3.6
Average	49.9	26.5		23.6

Source: Adapted from Shen (2009), two spaces without data are blank in Shen (2009)

In addition to major rivers, China has a large number of lakes and reservoirs, and a significant proportion of these lakes and reservoirs are confronted with accelerated eutrophication and degraded water quality. Currently, 58% of the 40 major freshwater lakes are experiencing eutrophication and hypertrophication; and among the 27 lakes which are prioritized for pollution control only eight have a quality standard monitored to be good (Jiang, 2009).

China is also seeing frequent flooding because of a combination of large rivers, variable climate, and vast populations living in floodplains. A telling example is that floods in 2007 affected about 180 million people and caused more than 1200 deaths, ruining 12 million hectares of crops and

[2] Class I, Class II and Class III are considered to be 'good' while others are 'poor'.

destroying over 1 million houses (Gleick, 2009).

1.3.2 Drivers of Water Challenges

A number of physical and socio-economic factors are blamed for China's water crisis. In terms of water shortage, mismatch between the natural distribution of China's water resources on the supply side and its socio-economic needs is the main culprit. There is abundance of water in South China, while water needs are mainly concentrated in the northern and eastern parts of China due to the large population, agricultural activities, and industrialisation in these regions. For example, 45% of China’s population lives in North China which has less than 20% of the total water resources (Jiang, 2009). As a result, water availability on a per capita basis in the northern part of China is extremely low, with Beijing’s average annual per capita water availability just one tenth of the national average figure as mentioned above. Additionally, rapid industrialisation and urbanisation have intensified water shortages. It is estimated that by 2030 about 50% of Chinese people will be living in cities (UN-Habitat, 2011), and as the level of income and the rate of urbanization increase people tend to lead a more water intensive lifestyle. Another factor contributing to China’s increasing water challenge is inefficient water use. Significantly more water is used to produce per unite of GDP or industrial production, compared to advanced economies. For example, in 2003, the volume of China's water use per 10,000 CNY GDP and per 10,000 CNY in industry-added value were 465 m^3 and 218 m^3 respectively, and the latter one was 5-10 times of the levels in developed countries (Gleick, 2009). Only about 40% of water withdrawal for agriculture is actually consumed by crops (Jiang, 2009), much of the water in open channel irrigation system leaks before it reaches the field. Many crops that China grows are water-intensive, such as wheat and rice, especially in North China.

As for water quality problems, industrial wastewater, domestic sewage and non-point source agricultural pollution are the three main pollution sources contributing to continuous water pollution in China. In spite of construction of wastewater treatment plants, industrial wastewater discharge has been increasing since 2000 (Jiang, 2009). This could be partly explained by the deficiency in environmental regulation implementation - enforcement at local levels remains weak due to shortages in financial resources, technology and institutional capacity, and officials in environment protection bureau often have to prioritize the areas and industries considering multiple factors, such as economic development in the enforcement areas (Tilt, 2007). More domestic sewage is discharged than industrial wastewater nowadays, and the consequence of this trend pushes up pollution levels as a result of underinvestment in urban sewage treatment facilities, especially in small cities and counties (Jiang, 2009). Agricultural pollution is considered to be one of biggest water quality problems in many countries, and there is no exception to this in China. Heavy applications of chemical fertilisers and imported feeds, as well as the waste accompanying the intensification of livestock production, have contributed large amounts of nutrients to downstream water bodies (Jiang, 2009). Unlike point source pollution whose discharge volume is typically well known and can be regulated by adopting maximum pollutant concentrations standards for the aquatic environments, non-point source pollution is normally difficult to control since there are so many points of discharge that setting individual controls at each point would be impractical. Smith and Siciliano (2015) argue causes of inefficient fertilizer use in China are complex, ranging from national politics to household behaviours, and hence the problem cannot be addressed by single regulatory or policy measures.

1.4 Policy Options for Managing China's Water Problems

The Chinese government has already recognized the water resource issues and has been taking steps to promote sustainable water use. In 2011 the Chinese government's annual "No. 1 Document" outlined a plan to support water conservancy development and reform and to achieve sustainable use and management of water resources within this decade, with a total investment of four trillion CNY (U.S. $ 635 billion) in the 10 year period (Liu and Yang, 2012). Also the recent Chinese Five-Year Plan for Water Resources Development shows the ambition for sustainable water resource development, including developing water rights systems, implementing quotas and demand-side management, and improving water use efficiency and benefits. In spite of these, there are still many management challenges, including: a) over reliance on expanding water supply, and this can be illustrated by a prominent example of the massive South-to-North Water Transfer Project which will divert up to 45 billion m^3 of water per year from Yangtze River via three routes[3]; b) lack of an integrated, efficient, and effective institutional system; c) slow establishment of water markets; d) weak water resource management, including planning, monitoring, and implementation enforcement; and e) a lack of a stable financing mechanism for environmental investment (Jiang, 2009). Effective water resource management is a promising approach to alleviate China's water crisis, as population growth trends and regional economic structure are unlikely to change dramatically in the short term. Given the complexity of the challenges, a holistic and integrated approach with coordinated efforts from various stakeholders is needed.

1.4.1 Integrated Water Management

The water sector usually has indispensable linkage with other sectors, such as environment, agriculture, energy, infrastructure, and several others. In other words, water itself links and cuts across many natural and management functions in these sectors, and at the same time it overlaps with these sectors. Thus planners, managers and policymakers need to shift to a more integrated approach to manage water to balance different social, economic and environmental needs. And there is no exception in China. Considering the complexity of China's water problems and its historically poor management, China needs an approach which considers many different and competing interest groups, the sectors that use and abuse water, and the needs of the environment.

For this end, one option may be Integrated Water Resource Management (IWRM), "a process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems" (Global Water Partnership (GWP), 2000). Taking into account the various uses of water and the range of people's water needs, it has been recognized as the fundamental platform for pursuing the harmonization between people and nature, urban and rural areas, and economic and social development. IWRM challenges conventional, fractional water development and management approaches but instead places emphasis on integrated approaches with maximum involvement of all relevant stakeholders to

[3] The western route planning to divert water from upper Yangtze River has not been started yet due to controversy of there not being enough water to transfer, and the future of this route is uncertain.

build consensus in decision-making processes. Through this wide participation, IWRM seeks to break departmental, sectoral and administrative barriers in the management of river basins to build a systematic and comprehensive management regime to master the rivers. As a result, it is potentially helpful in China, a country notorious for lacking coordination between different agencies within and across various levels. In order to make IWRM work, it also implies and requires transformations in legal frameworks, management approaches and institutional arrangements which can include organization building, participatory processes, operation and maintenance, monitoring and evaluation. It is said that in these aspects there are many challenges existing in the current Chinese water management system (Jiang, 2009).

However, it is worth mentioning that IWRM has often been subject to criticisms due to problems in transition from research to practice. One challenge for successful achievements of IWRM goals is often associated with the ambiguity about the IWRM concept itself. While there are many encouraging words in the concept of IWRM, it does not provide enough operational guidance on the governance configurations and processes. Biswas (2004) argues that the definition formulated by GWP is unusable or incapable of implementation when it comes to operational reality. In addition, the necessity to adapt the IWRM concept to accommodate different contexts in different regions makes it difficult to develop a generic and detailed description of strategies and techniques, casting further doubt on the adequacy of the understanding of the relationships between knowledge production and water resource management outcomes covered by IWRM (Jeffrey and Gearey, 2006). Furthermore, establishment of suitable policies and laws, political institutions, financing arrangements, self-governing and self-supporting local systems, and a variety of other institutional arrangements under different social, political and economic contexts is hard (Medema et al., 2008). As a result, IWRM becomes difficult to achieve in practice because of extensive turf wars, bureaucratic conflicts, and legal challenges even within the management process of a single resource like water, not to mention any combined institution covering two or more Ministries which have competing interests. Sometimes such integration is more likely to compound the complexities of the problems, instead of solving them. This challenge could particularly cause problems in China where the fragmented water management regime has long been notorious for the weak coordination between different Ministries, and the lack of authority of River Basin

Commissions (Shen, 2009). What's more, the common practice of IWRM under the governance unit of "river basin" is increasingly questioned (Norman and Bakker, 2009), interrogating the appropriateness of this scale.

Despite the scepticism over IWRM, this does not necessarily mean that we should abandon it altogether. By applying a more integrated and holistic approach, IWRM encourages the blending of different viewpoints of water users, planners, scientists and policy makers, and aims to create collaboration, cooperation, and coordination. From this point of view, IWRM could potentially provide remedies for China's water problems

1.4.2 Market-based Approaches

China needs to apply softer approaches of market-based solutions as opposed to relying on a hard path approach which relies intensively on engineering measures to expand water supply. Without doubt, engineering projects such as large dams and water infrastructure are important aspects of ensuring water supplies for sustainable socio-economic development. Adopting engineering projects to meet water demands, however, may not always provide an effective and efficient approach. In China water prices have long been heavily subsidized by the government, and water tariffs in most cities and rural areas alike do not reflect the full cost recovery principle. Low water prices for irrigation and domestic uses tend not to be effective in encouraging water-users to adopt water-saving methods and improve water-use efficiency. In this case, merely pursuing engineering measures to meet increasing demand at huge cost is not an inefficient way to combat water shortage. Alternatively, market-based approaches such as water pricing reform and water rights trading can be a more effective way to balance the water demand-supply relationship. These market-based mechanisms help to limit water demand while providing incentives to save water. Allocating water rights and allowing water rights trading between regions and sectors could provide an effective approach to resolve water scarcity by providing economic incentives to those who take measures to save water. And market-based approaches are not only limited to providing useful solutions to fight water shortages, they may also function as an effective way of improving water quality as well. The payment for water services in the Catskill / Delaware Watershed, which supplies water to New York City, is one of the more well-known cases[4]. This programme pays upstream private land owners for their stewardship, which then results in a supply of clean water without the need to build a new water filtration plant which otherwise would cost $8-10billion (Defra, 2010).

1.5 Research Needs

From the above discussion of policy options, the rationality is apparent of using more market-based approaches to manage water resources holistically and systematically in China. Among these approaches, PES could be a mechanism for enhancing water resource management. This resonates with those practitioners who are promoting an integrated and adaptive approach to water resource management which takes better account of bundles of water-related ecosystem goods and services and the multiple uses and management of them (Kolinjivadi et al., 2014). Indeed, the Chinese government at various levels has been realising the importance of using market-based approaches to address water problems, with many schemes, such as pollution charges, pollutant emission trading, and water rights reforms, being piloted widely across China. One particular scheme called "eco-compensation", whose underpinning concepts are adapted from PES, is gaining momentum there. Although "eco-compensation" is dominantly used by China's researchers and policy makers alike, more often than not, the word "eco-compensation" and "PES" are used interchangeably in international publications (e.g. Bennett, 2009; Zhang et al., 2010) without carefully interrogating the similarities and differences between the two. Since the underlying concepts of "eco-compensation" are similar to PES to some extent, this thesis draws lessons intensively from PES when analysing eco-compensation.

PES is founded on the belief that market failures constitute a main cause of environmental degradation, and these market failures could arise from the public good nature of many ecosystem services, externalities, a lack of property rights, and so on (Engel, et al., 2008). According to the Coase Theorem, if transaction costs are low and property rights are clearly defined, individual and voluntary bargaining through the market will overcome the problem of externalities (Coase, 1960). Applying this perspective, delivery of ES is likely to be achieved if individual or collective land

[4] Blanchard et al. (2015) show that the story of Catskills is overblown, and propose the preservation of the Wasatch watershed as an alternative success story that uses regulatory instruments and zoning to protect an urban water supply.

users have economic interests in adopting environmental-friendly management strategies (Engel, et al., 2008).

With PES initiatives continuously growing, a large amount of research on various aspects of PES has been conducted, and we can see a diversity of burgeoning published journal articles on PES. One strand of this existing literature focuses on trying to establish a universal definition which can represent the various forms of payment scheme in practice under the umbrella of PES. So far, the most widely-cited of these attempts is Wunder's definition that describes PES as a voluntary transaction where a well-defined ES is being 'bought' by a buyer from a provider conditional on provision of the ES (Wunder, 2005). In spite of high citation levels, there are lots of criticisms of this overly simple definition (e.g. Muradian et al., 2010; Tacconi, 2012). Alternatively, Muradian et al. (2010) provide a broader definition of PES "as a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources." In this way, the authors move away from simply mentioning the ideally pure market to acknowledge the social contexts in which these PES projects are implemented. Other research interests include i) reviewing and characterising PES schemes and assessing the effectiveness of these initiatives (e.g. Pattanayak et al., 2010; Wunder, 2007); ii) the relationship between PES and poverty (e.g. Grieg-Gran et al., 2005; Landell-Mills and Porras, 2002; Pagiola et al., 2005); and iii) identifying the fundamental elements (such as economic and institutional factors) that contribute to successful implementation of PES (e.g. Engel et al., 2008; Gios and Rizio, 2013; Wunder, 2005, 2008).

Unlike those scholars who promote PES as a win-win solution to improve environmental management outcomes, there are a growing number of critical social science scholars who show their scepticism towards this trend of over optimism towards a "commodification of nature" (Castree, 2003) in order to save it. Kosoy and Corbera (2010) argue that PES schemes reflect a "commodity fetishism" that narrows down the complexity of ecosystems to one certain kind of service, reduces multiple ecosystem values to a single exchange-value for trading, and obscures the power asymmetries embodied in "producing" and "selling" ecosystem services. Along similar lines, Adams (2014) argues that valuing nature does not automatically lead to the conservation of biodiversity since several challenges exist and there are trade-offs among wealthy and poor social groups in their access to ecosystem service benefits. Learning from his experience as an ecosystem assessment technician, Robertson (2006) says that the science of ecosystem assessment cannot provide rigorous biological data which are meaningful in economic terms, and thus field experts need to deliberately translate and articulate these data in order to make the trade in nature happen. What's more, he notices that numbers of wetland restoration programmes fail to replace the functions of the wetland that they are intended to replace. Some others contest that it is risky to erode landowners' intrinsic motivations by applying monetary value to those social actors' social norms, and this is likely to lead to worse ecological outcomes if payments are suspended (Muradian et al., 2013; Vatn, 2010).

From the above, it can be seen that in spite of a large volume of literature and a diversity of focal perspectives on PES, very little attention in the academic debate has been paid to positioning PES in a water management context. This thesis intends to consider PES as a tool to advance IWRM. However, neither PES nor IWRM is merely a technical issue; they are inherently political as well. PES systems are not created in an institutional vacuum, and the PES literature illustrates the importance of the wider institutional setting for the success of PES programmes. Muradian et al. (2010) criticise many economically-incentivised conservation initiatives for ignoring the institutional setting in which interaction takes place. Vatn (2010) points out that one of the main challenges linked to PES development is an appropriate consideration of the variety of social-ecological systems including the existing, often complex, institutional settings. While institutions of the market, specifically positive economic incentives, are the core characteristic of PES, in most cases PES schemes cannot be implemented in reality without the influence of hybrid governance structures - institutions of hierarchy and/or institutions of community (e.g. Corbera et al., 2007, Matzdorf et al., 2013; and Vatn, 2010). Indeed the state, by means of institutions of hierarchy plays an important role in PES (e.g. Engel et al., 2008; Landell-Mills and Porras, 2002; Vatn et al., 2010). In a similar vein, IWRM is criticised for neglecting the social and political dynamics which play vital roles in avoiding an implementation gap associated with the concept. For example, Chéné (2009) argues that "water issues are not only technical and institutional issues: they have also intrinsic political content which has to be explicitly considered in order to be able to solve effective difficulties linked to competition among stakeholders and interests". Water management in essence is about interventions trying to affect the time and/or spatial characteristics of water availability and/or its qualities, and thus it is a process of politically contested resource use (Mollinga, 2008). Water management arrangements such as legal, administrative and other mechanisms including eco-compensation certainly are not immune to contestations. Thus, a perspective of political ecology which studies the relationship between political, economic and social factors with environmental issues would provide useful insights.

It is against this background that this thesis aims to investigate the political nature of using PES to manage water, deepening the current understanding of how the social and political context play out behind these programmes. Furthermore, despite the fact that a number of eco-compensation schemes are carried out in China, very few researchers have so far systematically reviewed these schemes (except see Wang et al., 2016), and no one has examined the social and political nature of specific eco-compensation projects in a detailed manner yet.

1.6 Objectives and Research Questions

Without doubt, researchers and policymakers need to spend more effort and resources to identify realistic and innovative approaches to generate and deliver viable financial means for water resources management. Nonetheless, these endeavours need to be complemented by a more nuanced understanding of how these financial means could be affected by the broad context of political, economic and social factors, as these incentive-based solutions will not lead to "win-win" solutions automatically. For this reason, the objective of this PhD thesis is to question what role social and political factors play in eco-compensation projects. That said, the focus here is to uncover the politics behind implementing eco-compensation as a market-based solution for water management. In addition, although there is an expanded growth in literature on PES across various regions (e.g. Engel et al., 2008; Farley and Costanza, 2010; Muradian et al., 2010), studies focusing on eco-compensation in China are rather limited (e.g. Bennett, 2008; Yang et al., 2013), especially for reviewing the status of China's eco-compensation development.

In order to fill the research gaps as outlined above, the objectives of this PhD thesis are to provide insights into the current status of eco-compensation schemes in China in general, while informing how these programmes might be shaped by certain social and political factors. These objectives are addressed through two specific but representative case studies.

Therefore, I address the following main research questions:

(1) What is the overall picture of China's eco-compensation schemes? And what are the similarities and differences between China's PES and those practices worldwide?

(2) How do social and political contextual factors influence the eco-compensation schemes in China?

To be more specific, first by reviewing a relatively large number of eco-compensation cases in China, I will question what eco-compensation is and what the main features of these projects are. In addition, the "hidden" process behind eco-compensation negotiation will be interrogated. In this context, I will try to answer how economic asymmetries and fragmented institutions will make water quality management difficult in a transboundary river basin, and how these factors influence the negotiation process of setting up an eco-compensation programme to address the water quality problem in one of the case studies. In a similar vein, trying to unveil the politics of eco-compensation in a programme that aims to compensate farmers to improve water quantity and quality for urban use in Beijing, I will ask how such a project can be strongly influenced by more powerful political and economic actors by framing "the problem and solution" to meet their own interests.

With these research questions, this thesis adds to the existing PES literature by providing theoretical and empirical insights from China's efforts to use eco-compensation as innovative financial means to solve water problems.

Consequently, the scientific contributions of this PhD thesis are as follows: (i) it addresses significant research gaps in the PES and eco-compensation literature; (ii) it adds to the PES and eco-compensation literature with empirical studies from two unique study sites in China where PES-like programmes have been adopted; and iii) it applies a political ecology perspective to explore how eco-compensation projects are shaped by politics and political power.

1.7 Overview of the Thesis's Structure

The following chapter presents a methodological approach. In this chapter, the selection of two PES cases - one in the upstream of Beijing Miyun Basin and one in the Xin'an River Basin - will be explained, along with the research methods used and challenges met while using these methods. After that, practical challenges and ethical issues of access to information and informers will be dealt with. Finally, some reflections on why China's social science research is less developed than natural science will be offered. It will also hold implications on how Chinese geographers could connect with Western geographers.

The third chapter attempts to provide an overall picture of eco-compensation schemes in China. After an introduction to debates on the definition of PES by international scholars, a working definition of eco-compensation in China will be examined. This will be followed by attempts to categorise and characterise eco-compensation projects in China based on an analytical framework draw from PES literature.

After this, in Chapter 4 an eco-compensation example between upstream and downstream in the Xin'an River Basin is used to explore theoretical and empirical findings. It will set up a theoretical framework drawing on political geography and the governance of water resources. The study of the political and institutional dynamics of eco-compensation in a water governance system at multiple scalar dimensions and levels will be based on the study of problems of scale.

Another PES case in the upstream of the Beijing Miyun Watershed will be studied in Chapter 5. Using a political ecology perspective, the case study will show how this case is framed and shaped by certain groups according to their priorities and interests.

In the final chapter (Chapter 6), the thesis conclusion explores empirical research contributions from the case studies and their theoretical implications as well. These findings will hopefully constitute a useful contribution to the study of eco-compensation in China while providing useful insights on the political and social aspects of using eco-compensation and PES as mechanisms for water management in general.

Chapter 2 Methodology

2.1 Introduction

In this thesis I first investigate the general picture of eco-compensation in China and then explore several key aspects of the political dynamics of eco-compensation in water resources management. To achieve this purpose, a qualitative methodology concerned with power relations and context (Limb and Dwyer, 2001: 6) was applied in the empirical investigation. This approach stipulates that actors are intentional and creative, and they tend to interpret events, contexts and situations and act according to these contexts. It thus enables researchers to explore people's perceptions in order to understand how they behave to social contexts. Considering the very nature of my research, quantitative research which tries to use mathematically-based methods, especially statistics, to generalise a finding is not applicable, except when overviewing China's eco-compensation cases and some basic quantitative methods are employed.

Qualitative research methods enable researchers to access "unquantifiable facts about the actual people researchers observe and talk to or people represented by their personal traces […], and explore how people structure and give meaning to their daily lives" (Berg, 2001: 7). Qualitative research does not try to explore social phenomenon in a quantitatively measurable way, but instead considers the social world always to be socially and psychologically constructed through cultural, economic, social and political processes (Dwyer and Limb, 2001: 6), and to be a complex network of processes that cannot readily be reduced to simply measurable entities. Reductive approaches that facilitate measurement may inhibit rather than facilitate analysis of this complex.

2.1.1 Extensive Analysis

The first phase of my research involves adopting the approach of an extensive review of eco-compensation projects in China, with the aim of attempting to develop a framework to classify these projects into different types. This serves as a useful tool for systematically characterizing eco-compensation approaches in China. Through this exercise, I assumed that there would be certain similarities as well as differences among these eco-compensation projects. This method of analysing a large number of eco-compensation programmes broadly also laid the foundation for comparison between these Chinese practices and wider international experience. In addition, I employed this approach before starting in-depth case studies partly in order to aid in the selection of case studies, focusing on examples that could be considered distinctive “types”, and partly for the purpose of exploring research questions covering a wide range of issues while, at the same time, being able to focus on some of specific issues in the case studies.

2.1.2 Intensive Case Study Approach

There are multiple definitions and understandings of the term “case study”, but this epistemology can be said to refer to “systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest” (Bromley, 1990:302). Yin (1984:23) defines the case study research method “as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used.” It can be seen from these definitions that the case study enables researchers to explore a phenomenon within its context, evaluating phenomena within the complex range of interacting processes that affect it, and using a variety of data sources. An advantage of this method is said to be that the issue is not explored through one lens, but rather a variety of lenses which allows for multiple facets of the phenomenon to be revealed and understood (Baxter and Jack, 2008).

However, what actually is ‘a case’ is not well defined and remains a subject of debate. The case is in effect a unit of analysis, but determining what this unit is can be really challenging. A case may be a relatively bounded object or a process; it may be theoretical, empirical, or both (Ragin & Becker, 1992). The notion of ‘a case’ is complicated in another respect - sometimes a case focusing on a particular phenomenon may be investigated as a different phenomenon when a new theoretical lens is applied. That is to say what cases are “cases of” may change over time through the research process (Ragin and Becker, 1992).

Although case studies are often criticised for providing very little basis for rigorous scientific generalisation since they use a small number of subjects, a single case study may still constitute an important testing ground for theoretical propositions and can provide sufficient evidence to challenge prior knowledge. Actually, even single cases can be seen as belonging to a larger class of events in a theoretical universe. Therefore, traditional case studies in certain places can easily become generalizing studies in themselves if carried out in some numbers, so that judgement of their typicality can justifiably be made (Giddens, 1984: 328). In addition, comparative case studies can reveal new understandings from differences and similarities.

Case studies, in essence, examine and investigate real-life phenomenon with emphasis on detailed contextual analysis of a limited number of events or conditions and their relationships. Therefore, the case study approach will provide valuable insights in this research when considering that one research aim is to interrogate how eco-compensation projects in China are influenced by broader political, social and economic contexts.

In this project, I mainly apply within-case analysis, in order to reveal how incentive-based eco-compensation schemes may be influenced and shaped by the social contexts in which they are carried out in each case.

2.1.3 Case Study Selection

Given the problems of water management experienced in China, and the Chinese Government's efforts to use eco-compensation to address water problems, but with very limited studies in English language literature documenting these endeavours, I decided to choose eco-compensation projects in China as my research focus. Furthermore, this choice was made because of my previous educational background. As a Chinese citizen, I did my undergraduate study in hydrology and water resources management and spent my time in Masters' study on sociology. Thus, I have fairly amount of knowledge about Chinese water resource and resource management challenges.

The reason why I decided to choose two cases is that an outcome of the review of a large number of eco-compensation projects in China before starting the in-depth analysis of cases, led to the conclusion that there are two main distinctive groups of eco-compensation according to whom are the ecosystem service providers and buyers; namely a government - government mode and a government - individual mode[5] (for the detailed review of China's eco-compensation cases, see Chapter 3). In order to cover both categories of eco-compensation mode, I selected one case from each group, so that the case studies can represent PES projects from a large group of programmes. In this respect, this further justifies the necessity of conducting a large-N analysis of eco-compensation projects in China before starting the small-N case studies.

Both case studies were chosen on account of their regions' water problems, namely environmental degradation in the Xin'an River Basin and water scarcity and pollution in Beijing and its surrounding region. Political and economic history contributes to these problems in both cases.

A second reason to adopt the Xin'an River as a case study was the important role that different types of sub-national borders play, with significant levels of financial and administrative autonomy enjoyed by provincial governments. This leads to a certain degree of central-local conflict, especially on issues such as water environment management in a transboundary river basin. This kind of problem is less obvious in many of the other water-related eco-compensation schemes as they do not cover different provincial jurisdictions except in the case of the Beijing Miyun Watershed eco-compensation case. In addition, the Xin'an River case was the first eco-compensation case supported and facilitated by China's national government, and has been gaining considerable publicity across the country. In a country such as China where campaign-style project promotion is not uncommon, the experience in water quality management using eco-compensation in Xin'an River may be showcased to other regions where conflicts on transboundary water quality management are an urgent problem. As a result, exploring this case may provide useful insights for other government-funded eco-compensation schemes, a prevailing form of eco-compensation projects in China.

In the context of the Miyun case, this was chosen because it is one of few projects which individual land users are involved, and it is worth to explore how such programmes work in China that relies heavily on top-down mandates for water management. This case also has significant

[5] In the latter case government still needs to work as mediator for individual services provider.

implications as there is a severe water shortage - with the average water availability per capita from 2003 to 2011 at only 145 m^3 far below the recognised water scarcity level of 1000 m^3 according to international standard (ChinaWaterRisks, 2013) - in the capital region (the Jing-Jin-Ji region of Beijing-Tianjin-Hebei), the eco-compensation scheme, if working well, could provide useful lessons for other big cities which are encountering similar problems. Moreover, as the capital, Beijing has a large number of water scientists and engineers, and they have forged strong collaboration with big international non-governmental organisations and international researchers. For example, the World International Union for the Conservation of Nature (IUCN) has initiated a programme that promotes sustainable management of forests and non-timber products, aiming to increase water supply in the Miyun Watershed (Li and Emerton, 2012). Furthermore, Beijing municipal government has reached an agreement with the upper Hebei provincial government, which compensates farmers who are obliged to convert rice cultivation through flood-irrigated paddies to dry land cultivation in the upper region of Miyun Watershed. This eco-compensation programme was depicted as a “win-win” solution which can address complex water resources management challenges (Zheng et al., 2013). It is necessary to interrogate this case through a social lens to unravel a more nuanced understanding of this case.

Moreover, in terms of their regional political economy, it is interesting to see that in both cases there are significant economic and political asymmetries existing between upstream and downstream. This might be useful to explore how these factors play out in affecting the outcomes of the cases. It is worth to mention that these two case studies are not used to compare with each other as the dynamics of them are different; still both of them show that eco-compensation schemes are influenced by social power relations.

2.2 Fieldwork

With regard to fieldwork in China, research was mainly conducted in two periods during which a series of semi-structured interviews was carried out at local, municipal, provincial and national levels; together with activities involved document gathering and collection. The first, also the longer period, lasted for around 7 months, having started in early June 2014 and finishing in December 2014. This period could be divided into two sections: the months from June to early

August were spent in Huangshan City where around four fifths of the Xin’an River Basin is located; and the remaining months I was mostly in and around Beijing where there is reliance on the Miyun Reservoir as an important drinking water source. When I was in Beijing, contacts for China’s eco-compensation policies were possible as two main facilitators at national level for PES in China - the National Development and Reform Commission and the China Academy of Environmental Planning - are based in Beijing. Additionally, when informants on Xin’an River Basin at national level were available, I could do some interviews about that case. Another three months in Beijing during the summer of 2015 were used to get more information on the Miyun case, because in my first fieldtrip in and around Beijing region some key information was not accessible. The main reason is that, given that Beijing is the political centre of China, sometimes informants were reluctant to talk frankly with me on serious water problems in Beijing, worrying that could create a picture of government’s inability to manage water properly. The visit in 2015 was also used for the purpose of following up important topics with interviewees and closing the information gaps remaining after the first period.

2.3 Research Methods

More than one method was used to explore the various analytical themes selected, namely document analysis and interviews.

2.3.1 Document Analysis

Firstly, an extensive document analysis of existing eco-compensation schemes in China was conducted, which enabled me to develop a description of the characteristics of these schemes and make a comparison with international PES projects by referring to existing review papers on PES. To do this, a simple database (using Excel) was constructed with information on different water–related eco-compensation programmes in China (including some forest schemes since they are implemented for the purpose of soil conservation and water purification). This step aimed to gather useful information on the type of environmental goods and services provided, the buyers and sellers involved, the environmental objectives of these schemes, the mode of participation, selection criteria for service providers, payment mechanisms, the scale of operation and so on. This part of the work was expected to illustrate what types of eco-compensation programmes exist and how they are implemented in China, as well as what the main differences are comparing those eco-compensation in China to typical PES abroad.

Document analysis about this included both peer-reviewed and 'grey' literature. Relevant literature was identified via computerized searches, using the terms (in English and in Chinese) 'water', 'ecosystem service(s)', 'watershed service(s)', 'water service(s)', directly and coupled with the terms 'payment(s)', 'compensation' or directly using the term of 'eco-compensation'. Papers were collected through data sources from Science Direct, Social Science Index and China National Knowledge Infrastructure (an e-resources database in China). Additionally, Google and Baidu, a dominant search engine in China, were used to obtain open-accessed reports on eco-compensation projects. Abstracts of articles and reports identified using the keywords were reviewed, and apparently appropriate articles were examined in their entirety. In recent years, thanks to the enforcement of the Governmental Information Disclosure Regulation in 2008 and rapidly updating Internet accessibility, the Chinese government, whether at central or local levels, has made an increasing number of official documents available online (State Council, 2007). As a result, this enabled me to gain ready access to over a dozen official documents regarding eco-compensation at different places. Since some projects have not been documented and made available in public literature, relevant informants (such as scholars, project managers and so on) were consulted via phone or email about potential projects and during some interviews the interviewees were also asked if they knew some other projects and could help facilitate relevant document retrieval. At the same time, project reports, relevant documents and other secondary data were collected. With this information, both quantitative and qualitative analyses were carried out and detailed characteristics of China's eco-compensation schemes were illustrated. Further, a comparative analysis between China's eco-compensation schemes and international PES projects were made. Existing PES-papers which are frequently cited (e.g. Engel et al., 2008; Wunder, 2005; Wunder et al., 2008) were used for comparative purposes here.

For the Xin'an River case study, the documents analysed included guidance documents on implementing the project, reports submitted to the national government during the project design phase, river management plans and project reviews at the end of the pilot phase. Some in-depth press releases were included as well. All these were particularly useful to serve the purposes of official data collection and discourse analysis. With regards to the Miyun Case study, policy documents, some memorandums of experts' meetings, Beijing water resource management plans, and water bulletins constitute important sources of data and information. Literature published relevant to water problems around the Beijing region was also considered.

2.3.2 Interviews

Semi-structured interviews enable interviewees to express their viewpoints more openly, compared to standardized interviews or questionnaires (Flick, 2014: 207). I conducted semi-structured interviews with a number of key figures or representatives of relevant organisations involved in the management of PES projects in China at the national level, and the main stakeholders in the two cases at different levels of administration. Throughout the research period in China, I have been able to get in touch with several key informants who introduced some other important participants, with the kindly help of a number of scholars in Hohai University and one researcher at the China Institute of Water Resources and Hydropower Research located in Beijing. Therefore, a snowball strategy to identify potential respondents was used during the interview process when at the end of each conversation the interviewee was asked to make some suggestions on new participants.

Interviews were usually arranged by phone or email before the scheduled meeting. But there were also some cases when no appropriate informant had been identified until I visited a particular organisation. On such occasions, interviews were carried out immediately if these participants were available. Otherwise, meetings were arranged and interviews took place at agreed times. The interviews were mostly conducted in the office of the interviewee, with the meeting lasting around 1 to 1.5 hours. Table 2.1 provides an overview of the interviews conducted at different levels in the administrative structure.

A topic guide regarding my research questions was prepared for those semi-structured interviews (See Box 2.1 on Page 34), and some questions were removed or more were added beforehand according to each interviewee's professional role and position. Questions were phrased by everyday language, considering different interviewees' socio-cultural and technical backgrounds; and long and complex questions and scientific concepts were avoided (Flowerdew and Martin, 2005; Flick, 2014: 210).

Table 2.1 List of Information about Interviews

Reference Code	**Name**	**Organisation**	**Position**	**Date**
Interview1	PXL	National Reform and Development Commission	civil servant	9/2015
Interview2	WHJ	Ministry of Water Resources	water specialist	12/2014
Interview3	MHL	Anhui Provincial Bureau of Water Resources	civil servant	7/2014
Interview4	TXH	Huangshan Municipal Bureau of Water Resources	civil servant	7/2014
Interview5	SLJ	Huangshan Municipal Bureau of Environmental Protection	civil servant	7/2014
Interview6	PFL	Huangshan Municipal Bureau of Xi'an River Protection	civil servant	8/2014
Interview7	SCC	Huangshan Municipal Bureau of Xi'an River Protection	civil servant	8/2014
Interview8	LXM	Huangshan Municipal Bureau of Xi'an River Protection	civil servant	8/2014
Interview9	ADB	Hangzhou Municipal Bureau of Water Resources	civil servant	8/2014
Interview10	GWJ	Zhejiang Water Resources and Hydropower Research Institute	water specialist	8/2014
Interview11	ZHJ	Beijing Municipal Bureau of Water Resources	civil servant	8/2015
Interview12	ZN	Beijing Institute of Water Resources and Hydropower Research	water specialist	8/2015
Interview13	FYM	Chengde Municipal Bureau of Water Resources	civil servant	8/2015
Interview14	LHY	Fengning County Bureau of Water Resources	civil servant	8/2015
Interview15	LBC	Fengning County Bureau of Water Resources	civil servant	9/2015
Interview16	SRF	Ruancheng County Bureau of Water Resources	civil servant	9/2015
Interview17	SZG	Zhangjiakou Bureau of Water Resources	civil servant	9/2015

Reference Code	Name	Organisation	Position	Date
Interview18	JLS	China Agricultural University	professor focusing on eco-compensation	11/2014
Interview19	ZH	Research Centre for Eco-environmental Science, Chinese Academy of Science	senior research fellow	11/2014
Interview20	ZHY	China Institute of Water Resources and Hydropower Research	water resources management research fellow	11/2014
Interview21	RBQ	China Institute of Water Resources and Hydropower Research	environmental economist	11/2014
Interview22	FYC	China Institute of Water Resources and Hydropower Research	environmental economist	11/2014
Interview23	HSF	China Institute of Water Resources and Hydropower Research	professor	11/2014
Interview24	TFQ	Tinghua University	professor of hydrology	9/2015
Interview25	YXZ	Eco-fish Research Ltd	environmental scientist who advised on eco-compensation	12/2014
Interview26	CZY	Beijing Normal University	research fellow	9/2015
Interview27	LGH	Chinese Academy for Environmental Planning, Ministry of Environmental Protection	environmental scientist	8/2015
Interview28	DZF	Chinese Academy for Environmental Planning, Ministry of Environmental Protection	environmental scientist	8/2015
Interview29	RB	McGill University	assistant professor, specialising on livelihoods and environment	10/2014
Interview30	LJ	IUCN-china	programme officer	12/2014
Interview31	ZQF	Asian Development Bank	environmental specialist	11/2014
Interview32	MB	Forests Trends	senior adviser	11/2014

Open-ended questions allow interviewees to take their own directions and give their true thoughts and feelings. As a result, I was particularly careful to prevent my own judgements from affecting participants' positions, so that those answers were real expression of participants' views and perspectives (Berg, 2009). At the same time, when interviewing, I tried my best to ensure that our conversations would not derail my research agenda. However, some flexibility was allowed so that new relevant topics would not be neglected. Whenever new topics emerged, I encouraged the interviewees to say whatever words they want to express. This grounded approach offered some new insights and partly helped set directions of my case studies.

Box 2.1 Sample Questions

Questions on general eco-compensation questions:

- What role do you perform within your organisation? How is your role related to eco-compensation in China?
- How many eco-compensation projects do you know in China? Could you give a little bit of detail on these projects?
- In your opinion, why does Chinese government promote eco-compensation?
- How do you understand eco-compensation?
- How do you compare China's eco-compensation with PES in other countries?
- Could you name one feature of eco-compensation that, you think, is distinctive?
- What are the major constraints in eco-compensation implementation?
- Does eco-compensation make a difference? IS there any particular improvement which should be made?

Questions about two specific cases:

- Why is the programme initiated?
- Could you say something about negotiating process? How many parties were involved?
- What were the main controversies between different actors?
- What were the difficulties in persuading other accepting eco-compensation? How do you address that?
- Could you give me some details on water quality and water quantity in the river basin? What are the main pollutants? Where do they come from? What are water consumption situations by different sectors?
- What do you think is the main cause of the water problem?
- What actions have you taken to address these water issues? Why are the water problems here hard to address?
- Do you think whether eco-compensation is an effective way to address that?
- What are the institutions governing the eco-compensation project? How do you cooperate with others?
- Are there any difficulties when carrying out the eco-compensation project? Is there any complaint over the project?

2.3.3 Triangulation

Given that various primary and secondary sources were used to investigate the selected research themes, triangulation, trying to link different sets of data, was important for information verification while helping shed adequate light upon the research questions and facilitating rich, robust, comprehensive and well-developed understanding. Overall, triangulation represented a "means of refining, broadening and strengthening conceptual linkages" (Berg, 2009:7).

2.3.4 Recording and Note-taking

Overall, it is difficult to deny that using recorders is not only a good practice but an important thing to do when conducting interviews, as it helps the interviewer to retain a solid database for analysis. However, depending on a number of factors, such as the sensitivity of the interviews, the level of the people being interviewed and so on, it is really hard to say if recording conversations is appropriate on any particular occasion. I asked if recording would be allowed before the interviews began and, when allowed, the process was recorded using a small digital recorder. But in most instances, and especially when interviewees were government officials, the participants explicitly or implicitly showed discomfort with requests for recording. In such cases, notes were taken instead. I tried my best to write quickly and neatly so as to get as much information as possible down on paper accurately. When necessary, I politely asked the interviewee to hold on for a few seconds to wait for my note-taking to catch up. During the interview I summarised what the respondents said if the answer to a single question was too long, then read it out. This showed I had understood what they had said, whiling giving them opportunities to modify in case of misunderstanding. After the interviews, interview reports were written with one or two days. Also, a field dairy was kept throughout the fieldwork period, and was used to document my reflections on research methods, questions, themes and observations.

2.3.5 Analysis

Primary and secondary data sources, including interview notes and documents collected, are analysed to unfold findings. Although most of interviews were not recorded using digital recorder, those interviews recorded with permission were transcribed, and small summary reports were produced accordingly following the general structure of topic guides. For most of the interviews where the interviewee preferred not to be recorded, summaries were prepared as well. In the first stage, these summaries were still written in Chinese. In spite of the awareness of advantages to share interview summaries with interviewees, this was not done on account of their massive daily workloads and their statements that there was no need to review summary reports. As a result, this prevented me from getting the opportunities to confirm their views and perceptions and to avoid misinterpretation of an interviewee's views. However, when I felt I was unclear something or more information was needed, I chose to call an interviewee, or, if necessary and possible, even arrange another meeting in order to gain a clearer picture of the questions. I employed this strategy mainly from my own experiences of doing interviews and group discussions in my intensive fieldtrips during my graduate study in China.

Interview-notes and transcriptions needs reduction, reorganisation and interpretation to be analysed (Roulston, 2014: 301). To analyse my data, thematic coding and content analysis approaches were applied - central perspectives mentioned by interviewees concerning my research topics were summarised and grouped into different analytic units, and then they were interpreted according to my theoretical framework. Although I know a main advantage of analysing qualitative data using a computer software is the speed in managing data and related codes, I acknowledge that computers can only help to organise my data, but this kind of software cannot automatically analyse my data (Dey, 1993: 55). This is to say we cannot simply suppose the results will come out automatically after inputting data, and it is still ourselves as researchers who are responsible for interpreting the results. For this reason, and given the manageable number of interviews and case studies, the data could be managed without the need for computer data-analysis packages, so during this process, I did not use specialized software for text and discourse analysis (e.g. Atlas.ti, NVivo or MAXQDA).

2.3.6 Language

Maintaining accuracy when representing people's views and perspectives when using qualitative approaches is important (Khan and Manderson, 1992), thus the language which is used to express meanings plays an important role in doing qualitative research.

In all the cases when communication was with participants who were Chinese, conversations were conducted in Mandarin Chinese (Putonghua), China's official spoken language. This is not only because I am a native Mandarin Speaker, but the main practical reason was that most Chinese managers and decision-makers could not speak English or just had very limited capabilities to communicate using English. As a Chinese speaker myself, it was unnecessary for me to hire an interpreter to facilitate questions and answers between the interviewee and me, as some foreign scholars have to when conducting social science research in China. This was useful for me to gain an accurate view of what the interviewees meant, as far as possible, at the information-gathering stage. When using an interpreter to conduct interviews, potential threats to validity may arise from a number of factors. This could include the interpreter's effect on the informant, the interpreter's effect on the communicative process, and the interpreter's effect on the translation (Kluckhohn, 1945, cited by Birbili, 2000). Even in the case of Chinese academic experts who have fairly good English speaking skills, interviews were undertaken in Mandarin, as I believe using our native language was the best way to understand each other's words and meanings. As a result, language challenges did not exist in the interviewing process with Chinese participants as the researcher and the participants shared the same language.

There were also several instances when I needed to communicate with foreign experts who had been involved in eco-compensation projects in China. Under these circumstances, English was used as the working language. The language requirement for being admitted to the University of Cambridge is one of the highest in the UK and even throughout the world. Having met this prerequisite means I have a fairly good command of English. Also exposure to an English-speaking environment when I am in Cambridge gives me more opportunities to communicate via English. This enabled me to conduct these few interviews in English satisfactorily.

Another aspect with regards to the language issue during the research process was converting the information in Chinese gathered through interview and document analysis into English. Translating here was not just simply a process in which the meaning and expression in one language is tuned with the meaning of another, but was also a process of making sense of field texts and presenting them into research texts through making decisions about giving meanings and interpretations (Regmi et al., 2010). In the analysis phase, I followed a strategy of “free translation” - interpreting and analysing qualitative data in Chinese at first and translating only key themes into English, rather than translating notes at first word by word into English in a more “literal” manner (Birbili, 2000). With participants and the main researcher speaking the same language, together with “free translation”, no language differences were present in data gathering, transcription and during the first analyses. Otherwise, translating the transcriptions word by word at first could reduce the readability of the text, as translating a large quantity of texts could generate more mistakes and inaccuracies when gaining conceptual equivalence or comparability of meaning and grammatical forms (Birbili, 2000).

2.4 Constraints and Reflections

2.4.1 Positionality

Qualitative methodologies are based on human interaction which often involves in-depth interviews and personal responses to questions. The validity of data derived from qualitative research methods has been frequently debated, and this is especially acute for interview research as it is the researcher who frames the topics of interview questions (Kvale, 1996). Given this nature, interview research involves power asymmetric and is a result of different discourses, power relations, social norms, the expectations of the interviewees and their understanding of the researchers’ intentions (Flowerdew and Martin, 2005). Interviewers’ and participants’ own backgrounds, such as beliefs, political stance, socio-economic status, educational background, race, and gender, will have an impact on how they perceive and understand the matter to be discussed. That is to say research is not value-neutral and the knowledge production process through qualitative methodologies is socially and politically situated (Hammersley, 1995)

In social science, the concept of positionality refers to the researchers’ own world-views and values and the position they adopt in relation to research tasks (Foote and Bartell, 2011). Researchers’ positionalities affect their approaches to research problems and their relationships with participants. Therefore, it is important for a researcher to be aware of the relations during the design, data-collection and analysis stages of the research process.

I acknowledge that the contribution of my background to my research. My previous experience as a student in Hohai University - a leading institution focusing on water-related research and has a network of alumni holding senior roles in most of water-related bureaus - enabled me to be considered as an “insider”. This was the key reason why I was able to gain access to documents and to get in touch with a large number of key interviewees. At the same time, my identity as a PhD researcher from the University of Cambridge was also helpful for the purpose of research. Having conversations with me may empower the participants as it may make them feel that their knowledge is valued by academics. In this sense, I was considered as a student because of my search for knowledge; and also enabled me to appear trustworthy and thus unthreatening. It occurred to me that this may be very useful when one interviewee told me once that a journalist had created a strongly biased article after interview, after which they had been very careful dealing with journalists.

My identity as a Chinese citizen also helped me to avoid, in large measure, a typical problem facing many western social scholars in China when doing research, such as constraints on getting information and data, the length of time needed to build personal trust and relationships. Still my status as a current student in a foreign university placed some constraints on my positionality. For example, some interviewees were reluctant to answer some questions which they considered to be sensitive to foreigners even though if I am Chinese myself. Another case related to this aspect is that once a worker in a bureau at county level was sceptical of my real identity as I could not provide a formal letter in Chinese characters from the University confirming my identity as a student.

During the whole research process, I often self-reflect my own views in order to clearly identify, construct, critique and articulate my positionality. For example, in term of the Miyun case, I deliberately present myself in different positions, sometimes as a hydrologist to seek how farming affect water cycle while sometimes as a critical human geographer to explore how problems are socially constructed. That enables me to try to describe phenomena as they are, not only how I perceive them or would like them to be.

2.4.2 Ethics

Ethical issues are common in a wide range of research activities and arise especially when the conduct of research involves the interests and rights of others. Social science researchers can encounter ethical issues as they probe into sensitive topics, invade privacy, exploit Third World people and disrespect their local values, and subject participants to stressful experiences (Kelman, 1982). Considering the nature of my research and the methodologies that I have applied during the process of conducting my research, ethical considerations are especially wide-ranging and important.

I kept ethical awareness as one of my priorities. At first, before my fieldtrip started, I had undertaken a self-assessment on ethical issues according to the departmental guidance. My self-assessment had been approved by the departmental Ethics Review Group before my departure for my fieldwork. When I was conducting my fieldwork, I always ensured that the interviewees were well informed and explained the details of my research purposes before they agreed to participate. Recording our conversations was made only if permission was given, although as noted above most interviewees in China, especially those who work in government and related organisations, declined to be recorded and asked to be anonymous. In addition, I informed interviewees and those who helped me to get unpublished documents and data that this information would only be used for analysis in the research and may appear in my PhD thesis. During the whole process, data were stored securely and primary data were never shared with third parties. Besides, I have not paid informants for their time and information. But whenever I was back in China I gave some inexpensive gifts to those people who helped me a lot with interview arrangement and accommodation during my fieldtrips. But as I have known most of these key figures for a certain period, these gifts would not be regarded as paying them for access to information, in China this is seen to be common to establish “Guanxi” (relationships).

2.4.3 Constrains on Social Science Development in China

After coming to Cambridge, as the research continued, I came across many concepts and methods which I had not heard before, such as “hybrid” (Whatmore, 2002), “waterscape” (Budds, 2008), “hydro-social cycle” (Swyngedouw, 2009), “socio-nature” (Swyngedouw, 1997), “political ecology" (Bryant and Bailey, 1997). And I found them seldom appeared in Chinese literature. I was curious about what the reasons are for this and what could do to bridge the gap.

State of the art of China's science

Although historically the centre of science was, and currently it still is located in the Global North, accompanied with rapid economic growth, China is becoming a major contributor towards science and technology. Some big science projects, such as the biggest radio telescope, corneal transplantation from pigs to humans, the hunt for neutrinos, deep ocean exploration and space programmes, are telling examples that show China's enormous strengths in terms of science development (Morelle, 2016). By the measure of scientific articles published, China now lags only behind the United States (US), with the total number of science and engineering publications from Thomson Reuters' InCites and Essential Science Indicators databases increasing 20 times from 6104 in 1990 to 122672 in 2011. Even considering China's large population and hence the sheer numbers of researchers, China's scientific development cannot be denied. At the same time, there is an increasing trend in the number of citations per article, which means the quality of these papers had improved substantially (Xie et al., 2014). According to a report by the Organization for Economic Cooperation and Development (OECD), in China at least eight fields, including materials science, mathematics, chemistry and physics are currently very close to, and could even surpass the US in the near future (OECD, 2015). This considerable achievement can be attributed to four factors, namely the government's generous investment in science, a large human capital base due to higher education expansion, relatively high salaries in academia and the return of high-profile Chinese-origin scientists from overseas (Xie, et al., 2014).

However, when it comes to China's social science and humanities, there is a different picture. The Social Sciences Citation Index from Web of Science shows that only 6607 articles were published by Chinese scholars in 2011. Although there is a substantial increase compared to the figure of 173 in 1990, this number is much less than the science and engineering publications. The situation is even more alarming when one considers that four of the five most productive institutions in terms of publication are based in Hong Kong. It can be seen from this that mainland China's social sciences lag far behind its science and engineering counterparts in catching up with western researchers and scholars.

Reasons for social sciences' underdevelopment

Several factors can explain this striking contrast. But the main culprit appears to be uneven distribution of funding between science and social science. The country now invests more than 2% of its gross domestic product in research and development (R&D) - a larger proportion than the European Union - and plans to reach 2.5% by 2020 (Noorden, 2016). Notwithstanding the massive investment in R&D, second only to the US, the distribution of spending is rather unbalanced. Only a group of prominent universities and institutes represent the main beneficiaries of this major investment, and the money is largely spent on research concentrated in applied sciences and those with commercial potential (Ni, 2015; Yang, 2016). Even funding on basic research in natural science accounts for only about 5% of total spending (Yang, 2016), so it is not difficult to understand how the social science and humanities are not included amongst disciplines needing significant funding. It is estimated that only about 5% of universities' research expenditure is allocated to social science and humanities in China (UNESCO, 2010). Although the social scientists essentially need less funding as they do not need expensive equipment and consumable materials, China allocating 5% of the total research budget to the social sciences and humanities - compared to around 17% of European Research Council funding on social sciences (Nowotny, 2013) - indicates that China's social sciences and humanities are underinvested. This suggests that in China the social sciences may be considered less important than natural sciences and engineering.

This undervalued importance of social science is not only seen in terms of the research expenditure allocated by the government, but is deeply reflected in the Chinese society. A popular statement from ordinary Chinese people - 'a good mastery of mathematics or/and physics or/and chemistry is the foundation of every success after graduation' - shows that people favour the natural sciences over the social sciences. Most people think that students with social sciences and humanities backgrounds are less likely to get well-paid jobs. As a result, students are encouraged to, and finally choose, courses with good career prospects. This is also true for social scientists in academia. Analysing official data from a mini-census survey, Xie et al. (2014) claim that in China social scientists earn 25% less than scientists and about 40% less than engineers in terms of salary. Considering scientists may have additional income from part-time jobs in industry and consulting work, a not uncommon practice in China, this gap could be even more significant. This kind of instrumental rationality based on maximizing economic output when people choose fields of study constantly erodes the status of the social sciences and humanities in people's perception. This has lasting impacts on social scientists' research areas as well, with increasingly social science researchers turning towards research which is consistent with funding bodies' priorities theoretical research.

In addition to these two financial reasons, the government's tight control over western ideologies is detrimental to social science development. After the establishment of the People's Republic of China in 1949, intellectuals in the Mao era were harassed, suppressed, imprisoned and even persecuted with death in the Cultural Revolution period (Goldman, 2007). Those studying western ideologies took the brunt of this political movement most severely, as these ideologies were considered to be symbols of capitalism. In the post-Mao era, intellectuals gradually enjoyed the freedom of studying western ideologies such as democracy, liberty and so forth, which eventually led to the 1989 demonstrations. Not surprisingly, this has caused censorship of scholars studying western values, although that these ideas have not been completely banned. Ideological manipulation, propaganda, political education, and regulation of research funding, welfare facilities, salary and status influence have all affected the development of the social science (Goldman, 1999, 2007), and this trend is still evident in contemporary China. For example, in 2015 the then Minister of Education vowed to ban university textbooks which promote "western values" and instead promoted socialist ideologies (France-Presse, 2015). Even worse, in a string of latest efforts to crack down on academic freedom, the Chinese government's General Administration of Press and Publication requested Cambridge University Press (CUP) to pull over 300 articles and book reviews on its China site from the China Quarterly, one of the most prestigious journals in the China studies field, threatening to shut down the website of the CUP in case of no compliance. Some of the articles in question date back to as early as the 1960s, and the China Quarterly's editor told CUP had had similar requests to remove over 1000 e-books months earlier (Huang and Steger, 2017). That marks a worrying trend that the freedom of academic research is continuingly deteriorating. As a result, social science which originates from Europe and is still dominantly produced by Western scholars (UNESCO, 2010), is not well developed and conceptualised in China by Chinese social scientists. It is worth noting that this does not mean that Chinese social researchers should follow this Eurocentrism blindly, as these theories built upon western society's phenomena or western scholars' interpretations of social processes in other regions are not always able to describe local issues well. Another result of government's limitation of academic freedom is that China's social scientists are less critical towards government policies. Instead they are more instrumental and tend to undertake research projects related to the government's economic and social development strategies.

Besides these external factors, China's social scientists themselves are not without weaknesses. Their ability to use appropriate methodologies to investigate, analyse, interpret and conceptualise certain social processes; and communicate their findings with western scholars lies at the very heart of the problem of social science underdevelopment. Two possible reasons are likely to explain this. Firstly, while natural sciences aim to generate universal laws of the natural world, more often than not, via repeatable experiments or/and mathematically based methods, social sciences dealing with meanings and intentions usually need more critical thinking skills. To be more exact, there is more than one view, idea and philosophy, and these often conflict with each other, and to conceptualise human society, social scientists need to reflect with scepticism focusing on deciding what to believe or not. But this ability is claimed to be less-developed by Chinese (Zhang, 2017). Secondly, the linguistic positioning of Anglo-American social science has determined its current dominate role (Kong, 2010).

As a human geographer, I think the trajectory of China's human geography disciplinary development shares similar trends to those identified above for social science more broadly.

Approaches towards disciplinary development

In 2013 about 95% of the authors publishing research articles and progress reports in Progress In Human Geography had institutional affiliations in the Global North (Jazeel, 2016); and only three papers by mainland Chinese geographers - fewer than that of 11 by geographers based in Hong

Kong - have been published in the journal since 1990. Moreover, some branches of human geography, such as social, political, cultural geography, and other hotly debated topics in mainstream western geography are generally under-represented in China (Fan, 2016; Kong, 2010). Some assume this is because many Chinese human geographers who are trained as engineers are directed by government agencies to solve practical problems (e.g. Webber, 2010; Fan, 2016). With China becoming one of most influential economic and geopolitical players in the world, the flow of investment overseas, migration, the need for raw materials will all change the political, economic, cultural, social and environmental landscape of the world; there are growing considerations in human geography circles about China's rise (e.g. see Murphy, 2010). Having been exposed to British geographical practice for about 4 years, I often reflect on how to bridge the gap between Chinese geographers and Anglophone geography. Here, I list several points to contribute to this goal.

(1) Using Western methods and theories to analyse China's contexts

Although geography usually means different things to different people in different places (Livingstone, 1992), there always are certain geographical theories or analytical lenses that can be used universally. Chinese scholars could learn from their western counterparts and apply these theories in China. For example, from a critical political ecology perspective instead of a widely-used ecological modernization perspective, Muldavin (2013) suggests that logging and grazing bans, converting sloping farmland to permanent vegetation, which may be imposed to prevent soil erosion and flooding, actually can turn out to be counter-productive as people may then abandon more sustainable production methods and intensify their efforts to maintain livelihoods through resource extraction. This challenges the traditional neo-Malthusian way of framing soil erosion as a result of non-scientific and destructive land management practices. Consequently, important insights into environmental and social consequences can be drawn from this perspective.

(2) Using and improving Western theories

As China is experiencing rapid transformation, some social processes in China are unique, such as the urban-rural relationship that arises because of the household registration scheme under which migrant workers in the city cannot enjoy the same welfare as urban residents. This localised political and societal context means that some western theories are not directly applicable in China without rethinking. Adopting a Marxist commodity theory and organising the analysis along with (Harvey, 1996: 55) four stages of commodification, Zhang and Wu (2017) examine the political dynamics in a rural land development rights commodification programme. Interestingly, it is pointed out that no "accumulation by dispossession" (Harvey, 2003) appeared in this rural-urban land rights development project. Although this specific process of financialization of less powerful rural inhabitants' land may not exist in any other place[6], this study shows that "dispossession", usually by coercive deprivation of villagers' land rights, could not happen in Zhang and Wu's study area. Geographers both in and out of China could learn from this that mainstream Euro-American discourses and ideas might not be universal, and we need to revisit them gradually in order to make them more general.

(3) Developing local methods and theories in local reality

As it is difficult to name a geographical theory which originates from China, here I use a concept from Fei Xiaotong (or Fei Hsiao-Tung), a Chinese sociologist who is well-known internationally, as an example. His most theoretical contribution states that Chinese society is patterned through non-equivalent, ranked categories of dyadic social relationships, with everyone at the centre of his or her own specific network of social relationships, with closeness decreasing as one moves further from family towards neighbours, classmates, colleagues (Fei, 1985). This work argues China differs significantly from Western society where individuals are formally equal in their networks of social relationships. On the basis of this, he claims that small individual enterprises in townships and villages are the cornerstone of Chinese industrial development. Given that the theory covers a cultural aspect of Chinese social relationships and industrial development, Fei's work could be of relevance to cultural and economic geographical research to some extent. It can be seen that production of theories and concepts from the Chinese local practices can make contribution to geographical world.

[6] The authors say that other rural land commodification projects in other cities of China may see different outcomes due to different policies governing their concrete operation.

(4) Developing widely-applicable methods and theories

Fei's theory may only apply to China, but there are instances when practices of geographical knowledge generation in China could help with the development of broader theories in geography. Unlike the three previous cases which are mainly theoretical, the example used here provides useful insights on methodological development by using big data on urban studies. Wu et al. (2016) develop a "hybrid" approach that combines social media footprint data and linguistic data in order to study how cultural ties affect human mobility patterns between regions. Their efforts could transform traditional social science practices which depend on survey data, and also shed light on the role of cultural diversity in shaping individuals' mobility behaviour trends. This indicates that in the era of big data Chinese geographers' strong quantitative skillset can contribute to new research methodologies of data collection. This line of endeavour can also be applied in other counties. In terms of core theories, although it seems that currently in mainstream human geography, the conceptualisation of processes is still based on understanding of Western European and North American experience, there have been suggestions that China's rise is likely to force a re-conceptualization of existing concepts and theories, and change the way the discipline conducts its work, especially in economic geography (e.g. Murphy, 2010; Webber, 2010).

To sum up, unlike natural science, China's social sciences still lags far behind mainstream Anglo-American academia, and human geography is no exception. The development of Chinese human geography is criticised for limiting research to certain practical arenas, and under-representation of main concepts and theories. In order to bridge the gap, Chinese geographers need to look to Anglo-American human geography, import theories and validate them. Equal attention needs to be paid to the less practical sub-disciplines. With caution and reflection, Chinese researchers have to rethink and modify these theories to accommodate local social, political, cultural and economic contexts. Even more ambitious, Chinese human geography should be able to produce theoretical and methodological insights where there are no existing ones to be used, with possibility that these approaches might be generally used in the wider geographical world. All these could not be possible without more communication and cooperation between Chinese and international geographers. In this way, not only will China's human geography develop but also the mainstream Western geography may be diversified. In this research, I try to draw extensively from English-literature on “PES”, “scale and scaling” and “political ecology”, aiming to see how Western theories and analytical frameworks fit with Chinese contexts and what empirical studies can make contributions with them.

Chapter 3 Payment for Ecosystem Services and Eco-Compensation

In this chapter I first investigate the general picture of eco-compensation in China, and then compare China's eco-compensation with the general Payment for Ecosystem Services (PES) concept. To fulfill this purpose, I outline some similar concepts which are widely used outside China, before providing a descriptive analysis of meanings of "eco-compensation". Drawing on useful literature on PES cases, I develop a framework to analyse the features of eco-compensation in China.

3.1 Terminology

Policymakers in China have become increasingly interested in deploying a wide range of policies, under the broad heading of "eco-compensation", for the purpose of addressing the country's environmental challenges. Although the term "eco-compensation" is almost exclusive to China, it is believed by many scholars that this concept is similar to PES (e.g. Bennett, 2009; Yin and Zhao, 2012). Hence, I review some relevant concepts before discussing eco-compensation itself.

3.1.1 Payment for Ecosystem Services

PES has been an increasingly important mechanism for financing conservation of natural resources (see, e.g. Vatn, 2010; Wunder, 2007). In spite of a broad range of project structures and functions, PES programmes are generally designed to provide financial incentives to encourage land users to apply management practices that can generate and sustain valued ecosystem services (ES), and therefore cover the opportunity costs of more conventional alternative resource uses (Farley and Costanza, 2010; Pagiola, 2008; Wunder, 2007).

As implied above, PES, commonly described as a ''market-based mechanism'', intends to ascribe monetary value to natural resources based on the belief that environmental problems are mainly a result of "market failure" (e.g. Wunder, 2007). To be more exact, as a result of the public-goods nature of many ES, users cannot be prevented from benefiting from these services ("non-excludability"), but one person's consumption will not affect another's consumption ("non-rivalry")[7]. Therefore, it is likely that the "free-rider problem" will ensue. As a result, land users get less private benefit from environment-friendly land use, such as forest conservation. Such environmental stewardship is therefore less economically attractive than more ecologically harmful land uses, such as over-intensive farming.

Recognizing this fact, the "beneficiary pays" approach offers economic incentives to those who contribute to conservation. In order to internalise the value of natural resources into the monetary economy, the PES approach moves beyond the Pigouvian philosophy of taxing negative or subsidizing positive externalities within existing product markets (Van Hecken and Bastiaensen, 2010). PES can create markets in which the provision of positive ES is given monetary value. In fact, PES programmes are designed with the aim of putting into practice the Coase theorem, which stipulates that the problems of externalities can, given low to no transaction costs and clearly defined and enforceable property rights, be overcome through private negotiation between affected parties without governmental intervention (Coase, 1960).

Relying on the Coasean conceptualization of markets, Wunder was the first author to give a formal definition of PES. According to him, a PES is "(1) a voluntary transaction where (2) a well-defined ES (or a land-use likely to secure that service) (3) is being 'bought' by a (minimum of one) ES buyer (4) from a (minimum of one) ES provider (5) if and only if the ES provider secures ES provision (conditionality)" (Wunder, 2005). In theory, this Coasean approach could improve economic efficiency and environmental effectiveness as compared to Pigouvian 'governmental' approaches. For example, Engel and coauthors point out that Coasean PES schemes are ''likely to be efficient, as the actors with the most information about the value of the service are directly involved, have a clear incentive to ensure that the mechanism is functioning well, can observe directly whether the service is being delivered, and have the ability to re-negotiate (or terminate) the agreement if needed'' (Engel et al., 2008). However, although

[7] Typical examples of public goods include clean air, soil water storage that yields flood control and so on. While 'public goods' describes or characterises many ES, this is not always accurate. Some ES may be either rival (i.e. finite) or non-rival (i.e. not subject to physical consumption, or otherwise renewable), and either exclusive (e.g. if access is limited to certain groups) or non-exclusive (i.e. common pool resources). Those ES that have some degree of rivalry or excludability sometimes are considered quasi-public goods, as opposed to pure public goods (Kretsh et al., 2016).

widely cited, Wunder's definition has been criticised for being too narrow and thus excluding many payment schemes that do not comply with these five criteria (e.g. Farley and Costanza, 2010; Muradian et al., 2010). The voluntary aspect of the transaction has been particularly questioned as many PES cases involve governmental intervention and public payment schemes, and include obstacles to efficient bargaining, such as high transaction costs, power imbalances, or poorly defined property rights, making Coasean solutions in most instances impossible in practice. Vatn (2010) recognised the important role that governmental and nongovernmental organizations play in many PES projects, such as serving as intermediaries between buyers and providers. And in some cases, buyers' participation in PES may not be voluntary, because of mandatory surcharges levied on their bills, such as their water bills.

Governmental payment schemes are widely referred to as the Pigouvian concept of PES (Vatn, 2010; Van Hecken and Bastiaensen, 2010). In these kinds of scheme, governments are regarded as third parties acting on behalf of service buyers. Unlike Coasean PES schemes where direct beneficiaries pay land stewards for the provision of ES that are characterized as club goods, Pigouvian PES schemes rather focus on the provision of public goods (Schomers and Matzdorf, 2013). In effect, the great majority of PES initiatives around the world maintain a strong degree of state intervention, and even Wunder himself acknowledges that there are few "true PES" schemes conforming to the theoretical concept and his simple definition (Wunder, 2005). For example, a large number of governmental financial incentive programmes under the PES label have been widely documented in various countries, including Costa Rica, Mexico, the European Union member states, the US and China (see e.g. Schomers and Matzdorf, 2013; Shapiro-Garza, 2013).

In response to Wunder's definition and the Coasean framing of PES, Muradian et al. (2010) provide an alternative definition which is now the most widely accepted broad PES definition. They define PES as "a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources". This broader definition covers a wide range of existing PES initiatives which are excluded from Wunder's definition. In this definition, Muradian et al. (2010) acknowledge that different values and perceptions exist in the social setting where payments (or transfers of resources) occur, and that there are institutional and political economy issues inherent in PES initiatives. This social-institutional perspective argues that "the implications of information costs, uncertainties in service provision, inequities in access to resources, the high leverage of intermediaries and the broader institutional and cultural settings where PES thrive are among the key issues to consider" (Muradian et al., 2010). This approach towards PES is referred to as the "ecological economics approach" (Farley and Costanza, 2010). It is noteworthy that this definition has been scrutinized by several scholars as well. For example, Wunder (2015) argues that this definition is so broad that it could be a "one-size-fits-all term for every economic instrument in the environmental policy toolbox" such as eco-certification, subsidies, tax exemptions, co-investments and co-management agreements.

In addition to these two most representative definitions, there are a number of other definitions as well. Pointing out that many ES are associated with elements - such as carbon storage in forests - that cannot be appropriated, Karsenty (2011) propose "PES is a payment to an agent for services provided to other agents (wherever they may be in space and time) by means of a deliberate action aimed at preserving, restoring or increasing an environmental service agreed by the parties." This definition emphasizes that payments are made based on actions to provide ES rather than ES themselves. Another definition, closer to Wunder's definition, is by Engel et al. (2008), who define PES as "a voluntary transaction where a well-defined ecosystem service is bought by a buyer from a service provider if and only if the provider secures its provision (conditionality)".

3.1.2 Alternative Concepts

Since the 1990s, the term PES has been the most commonly used name for instruments that reward stewards who are able to generate positive externalities. However, at the same time, some alternative terms, such as Markets for ES or market-based mechanisms (Landell-Mills and Porras, 2002; Pagiola et al., 2002), Compensation for ES (Rosa et al., 2003), Rewards for ES (van Noordwijk et al., 2005), have also been used to describe institutional arrangements which provide incentives for people to encourage environmentally-friendly land management practices. Moreover, the term "environmental services" is often used instead of "ecosystem services". In my opinion, these two terms can be used interchangeably, although Muradian et al. (2010) consider ecosystem services as a subset of environmental services while others think in the opposite sense (see Derissen and Latacz-Lohmann, 2013)

Wunder is one of the few authors to evaluate the terms payments, markets, compensation, and rewards comparatively (Wunder, 2005). In his most recent paper attempting to revisit the definition of PES, he uses Google and Google Scholar to gain insights into how regularly different terms are used (see Table 3.1).

Table 3.1 Popularity of Key Concepts: Hits on Google Searches.

Transfer/action	**"Environmental services[8]**	**Ecosystem services**	**Total**
1 None	1,390,000	286,000	1,676,0002
2 "Payments for"	931,000	865,000	1,796,000
3 "Payments for" (Google scholar)	6120	4540	10,660
4 Payments for (no quotes)	21,200,000	1,520,000	22,720,000
5 "Compensation for"	74,000	27,900	101,900
6 "Rewards for"	70,700	111,000	181,700
7 "Compensation and rewards for"	42,000	7600	49,600
Total	23,713,820	2,822,040	41,619,862

Source: Adapted from Wunder (2014)

Wunder rejects the term "market" for the reason that markets may involve multiple actors, choices, and competition to some degree, when sometimes PES schemes are simply bilateral contracts between a single buyer such as a water company and sellers, and thus they are not pure markets (Wunder, 2005). In addition, he is doubtful whether there are true general market economies in developing countries where a wide range of such projects are carried out. He interprets "rewards" as a term carrying an "overtone of entitlement and justice for service providers being secured through a transaction: everybody who delivers a benefit should also be 'rewarded'." This leads to a concern that the term "runs the danger of raising excessive expectations" as in many cases it may be hard to find buyers for ES (Wunder, 2005). The term "compensation" refers to payment that compensates a service supplier for direct and/or opportunity costs incurred in the process of

8 Wunder uses the term "ecosystem services" to imply multiple services that cannot always be broken up into additive components, while using "environmental services" to refer to services that can be separated.

ES provision. This term may restrict compensation to those service providers suffering some costs, while those who bear no costs are not eligible for compensation. Moreover, compensation could be misleading as this term often implies that providers who bear costs try to gain more money than their costs (Wunder, 2005).

3.1.3 Eco-compensation

Beside these frequently-used terms in the international world, the term "eco-compensation" is widely used in China by both scholars and policymakers. The term seems to be directly translated from the Chinese word *"shengtai buchang" (生态补偿)* into English. The Chinese government has been making the development of "eco-compensation" a priority. In 2005 the State Council stated that the government "…should improve eco-compensation policy, and develop eco-compensation mechanisms as quickly as possible" (State Council, 2005). China's 11th Five-year Guidelines (2006-2010) called for the development of eco-compensation pilot schemes, and encouraged policymakers to quicken the pace of development of eco-compensation mechanisms, particularly intra-regional and watershed-related eco-compensation mechanisms, with an attempt to resolve funding issues regarding conservation. In a speech in 2007, a deputy director of the State Environmental Protection Administration[9] stated that eco-compensation policy is "not only an environmental and economic need, but also a political and strategic need. Financial transfer instruments between developed and undeveloped regions, between urban and rural areas, between rich and poor, between lower and upper watershed areas, between those benefiting from the environment and those contributing to environment protection, and between high-polluting industries and 'green' industries, need to be improved" (Pan, 2007). This statement shows that eco-compensation may include a broad range of economic instruments for environment protection, but could also contribute to poverty alleviation and regional development. In effect, the term "buchang" in Chinese, or "compensation" implicitly states that ES providers bear some costs associated with their stewardship to maintain or improve ES, and considers this to be a cause of underdevelopment as their environmentally-responsible activities tend to be less profitable than alternative practices.

[9] It was later elevated to the Ministry of Environmental Protection in 2008.

In spite of its common use in China, there has not been a relatively clear and widely-accepted definition for eco-compensation as yet. The China Council for International Cooperation on Environment and Development (CCICED) initiated the first official Task Force on Eco-Compensation and Policy Research in 2005. The report of that initiative describes eco-compensation as an institutional arrangement to protect environmental and natural resources, and to adjust the distribution of costs and benefits between different actors and stakeholders, mainly through economic measures (CCICED, 2007). Along these lines, Zhen and Zhang (2011) consider eco-compensation as a public regulation that aims to adjust relations between the stakeholders involved in ecological conservation through government means and market-based schemes. This notion of "public regulation" implies the important role that government plays in these eco-compensation schemes.

The National Development and Reform Commission (NDRC) refers to eco-compensation as "a type of public system or institution that brings to bear either public or private sector measures to adjust the relative benefits and costs of ecological service provision among the key stakeholders in order to realize the goals of protecting the environment; promoting the harmonious coexistence of man and nature; and comprehensively considering the costs of conservation, opportunity costs of foregone development, and the value of ecological service provision" (Zhang and Bennett, 2011). In this statement, the notion of "public system or institution" and "either public or private sector measures" indicate that in China eco-compensation tends to be a government-led or at least government-mediated institution which aims to adjust benefits and costs of ES provision, and both beneficiaries and providers of ES could be governments, organizations, enterprises, communities, and individuals. This is different from PES initiatives in other countries, as PES programmes are aimed at private landholders and local communities (Engel et al., 2008). Getting insights from PES, the Chinese government tries to facilitate "market transactions" which are based upon a Coasean approach; however, in reality the vast majority of eco-compensation schemes are operated at large scales, targeting public goods, and therefore in most cases the government must make direct monetary or in-kind payments on behalf of the beneficiaries of ES.

When it comes to the theoretical conception of eco-compensation, obviously it is similar to that of

PES. Internalisation of externalities is the key philosophy of eco-compensation. Eco-compensation is considered to be similar to a PES approach since both concepts aim to ensure the delivery of ES through making payments or compensation to ES providers. The "beneficiaries pay principle" (BPP) is the underlying principle of this. This principle has been identified in accordance with the responsibilities and roles of the stakeholders involving in eco-compensation. It is noteworthy that, according to CCICED's report, under BPP even natural resource users should pay the State, or public representatives, for using scarce resources, because of their public ownership (CCICED, 2007). However, it does not seem to make sense to put this under the umbrella of eco-compensation, because there is no need to challenge the charging for some natural resource extraction. For example, mining companies pay resource use fees after obtaining permits to extract resources by mining because mines themselves have economic value, rather than because the State acts to maintain or improve the ES of mines.

According to Xiong and Wang (2010), eco-compensation is a kind of public regulation that heavily relies on fiscal transfer mechanisms to internalise externalities and to adjust the relationship between private and social interest. Mao et al. (2002) define eco-compensation as a fiscal transfer mechanism that incentivises ES providers by increasing their incomes in order to provide positive externalities; or that penalise ecosystem damagers by incurring fines so as to internalise negative externalities.

From these two definitions, we can clearly see that they both focus on government - financed eco-compensation, and that the Fiscal Transfer Payment (FTP) approach is the most common mechanism of eco-compensation projects in China. It therefore seems that in China transactions between suppliers and beneficiaries of ES through voluntary negotiations are very unlikely to happen without government intervention, because of high negotiation costs and low willingness to pay, and FTP is probably the most practical means of carrying out eco-compensation programmes. This is illustrated by the Environmental Protection Law of 2014, stating that the central and regional governments are required to supply funding to facilitate market-based collaboration mechanism between local governments (Wang et al., 2015).

What has been mentioned above could be considered to be a narrow basis for understanding the concept of eco-compensation. The definition by Mao and his co-authors tells us that, in addition to providing incentives to encourage ES providers, eco-compensation also offers disincentives to those who damage the environment and ecosystem; this is different from PES. Eco-compensation adjusts or introduces fees, levies, fines or taxes on resource users to increase the costs incurred in damaging the environment, thereby aiming to prevent environmentally-harmful activities or punishing these unsound behaviours when they happen. These fees, levies and taxes are mainly imposed on factories, etc. The "polluter pays principle" (PPP) is therefore commonly used in China related to this practice. The underlying point of this principle is a Pigouvian approach (Pigou, 1932). In the productive process, one's actions, such as emitting pollution and using environmental resources, may cause environmental degradation and therefore harm others' welfare. Since the commodity prices will not justify the true costs of economic activities, the costs must be shared by the whole of society. In order to internalize the negative externalities, a Pigouvian approach proposes that a tax should be levied on those producers who are also the polluters, and that the polluters should compensate those who are negatively affected. In the Chinese context, PPP is mainly used as a way of targeting companies or factories that discharge pollution and damage ecosystems, in order to raise funding for environmental protection and restoration. Zhang and Bennett (2011) point out that NDRC aims to incorporate eco-compensation into 14 types of environment-related taxes and fees to generate a stable source for public eco-compensation schemes.

To be more specific, Wang (2006) asserts that eco-compensation may include five dimensions: i) Payment for Ecosystem Services, i.e. payment for providers of ecological services; ii) natural resource based compensation, e.g. restoration or creation of a wetland or habitat conservation area to offset negative impacts caused by development activities; iii) damage-based compensation, i.e. economic punishment for individuals' and enterprises' environmentally-harmful activities ; iv) development-based compensation, i.e. compensation for those who protect the environment or give up development opportunities due to conservation; and, v) conservation-based compensation, i.e. public investment in regions of important ecological value. Some of these five dimensions are quite similar in essence. For example, many have assumed that PES will contribute to poverty reduction by making payments to poor land users, and PES programmes are designed with pro-poor effects (Landell-Mills and Porras, 2002; Pagiola et al., 2002; Pagiola et al., 2005; Wunder, 2008b). More often than not, payment or compensation recipients tend to be poor land owners in upper watersheds and other marginal areas and most PES programmes often target these areas (Engel et al., 2008). Therefore, PES could be development-based compensation at the same time as being environmentally-oriented. Moreover, fines on companies who damage ecosystems may be used for restoration of natural habitants or recreation of landscape with similar ecosystem services at other places.

From the above description, we can see that the Chinese term "eco-compensation" appears to encompass both PES-like policies that involve direct payments from the government to individual and community-level suppliers of ecosystem/environmental services, as well as other government interventions, such as environmental taxes and command-and-control regulations. It is a combination of market-based instrument and government interventions. In addition, compared with the term PES, eco-compensation puts more emphasis on the institutional and political aspects of payment; eco-compensation seeks to develop frameworks of cooperation between various levels of government for the financing and sharing of costs of environmental protection and restoration.

In summary, although initially it follows the same theoretical basis as PES, eco-compensation in China has gradually become a broader concept, including PES-like policies as well as a range of other policies and types of programmes, both with and without market-based elements. There are broad and narrow ways of understanding the concept of eco-compensation. In the broad sense, eco-compensation refers both i) to the incentives to protect ecosystems and natural resources, or the compensation for the loss arising from damage to ecosystem and natural resources; and ii) to charges to the environmental polluters. In the narrow sense, it refers only to the first meaning described above, and could then be seen to be similar to PES or PES-like initiatives. In my research into eco-compensation, I will mainly focus on the broad sense of the concept, particularly since it is also widely used and recognised in this sense in China. I choose to use the term eco-compensation when describing Chinese cases, instead of PES.

3.2 A Classification Framework Based on Eco-compensation Characteristics

Similar to PES, eco-compensation schemes apply a number of approaches that differ significantly when it comes to the ES addressed, the spatial scales, buyer and seller characteristics, and the rules that govern the agreement among stakeholders. Thus, eco-compensation initiatives are not easy to review systematically. In order to make this possible, in this section I try to draw lessons from attempts to review and compare PES schemes, as eco-compensation and PES share some similarities, in spite of significant differences in some respects. There are only a few efforts to document PES characteristics systematically and even fewer efforts to compare them (Muradian et al., 2010; Sattler et al., 2013; Wunder et al., 2008). I draw from these approaches to identify relevant characteristics to help classify eco-compensation schemes, related to programme type, the ES addressed in the schemes, payment arrangements, the actors involved, actors' roles, the scale of the schemes, and possible side effects.

3.2.1 Project Types: Voluntariness

Although the first criterion of voluntariness in Wunder's PES definition (Wunder, 2005) has been criticised a lot, and in China voluntary eco-compensations programmes are rare, I still use it here as a characteristic to examine eco-compensation schemes. Following the methodology of Sattler et al. (2013), I divide eco-compensation into four groups: (a) completely voluntary for both the supply (ES sellers) and the demand (ES buyers) sides, (b) partly involuntary (demand side), (c) partly involuntary (supply side), or (d) involuntary for both sides. The detailed explanations of these are as follows.

In Type (a) - completely voluntary: the eco-compensation is voluntarily financed by the actual ES beneficiaries and the ecosystem services are provided voluntarily without government regulation. In the PES literature, this is the only ideal type that fully meets Wunder's definition of PES according to the Coasean conceptualization. This type is also considered to be PES with the most direct transfer of payments (Muradian et al., 2010). Type (b) is partly involuntary on the demand side, and here eco-compensation projects are government-funded and there is no regulatory requirement for ES providers to offer ES. As the government spends public money to secure ES on behalf of the beneficiaries without asking whether they are willing to participate, these agreements are seen as partly involuntary on the demand side. Muradian et al. (2010) categorize this type of PES as PES with the most indirect payments. In fact, PES projects falling under this type are very common (e.g. Engel et al., 2008; Muradian et al., 2010). Type (c) is partly involuntary on the supply side; here the ES providers are obliged to provide ES under certain regulations, while ES buyers voluntarily participate in the eco-compensation agreement. Finally, type (d) is completely involuntary, and here ES provision is driven by regulatory frameworks and ES beneficiaries are made to pay for ES provision through government authorityb.

In practice, sometimes there are no absolute boundaries between these four types. Imagine an eco-compensation project in which land-owners in a watershed are paid for their stewardship to secure fresh water supply to a nearby small village and a big city, with payment both from local villagers who voluntary engage in the scheme and from the city's budgets; here the city dwellers are involuntary participants. Also, it is likely that a project starts as one type and then develops into another type later on. Type (a) and (b) are based on the differentiation between user- and government-financed PES by Wunder et al. (2008) (see also Engel et al., 2008). From the perspective of efficiency, for types (c) and (d) projects, generation of ES benefits could also be expected even without compensation, as ES provision is a land-owners' duty under a regulatory a driver. Engel et al (2008) argue that paying for services that would have been provided without market-based incentives is inefficient. This is a problem of financial efficiency for the programme - money is wasted on something that is available even if no one pays for it directly.

3.2.2 Ecosystem Services

In terms of the Ecosystem Service (ES) addressed by an eco-compensation scheme, this classification framework takes several factors into account, including information on ES type, ES-related targets and whether single ES or a bundling of different ES.

Type of ES

There are a number of ways of categorising ES (e.g. Costanza et al., 1997; Costanza, 2008; de Groot et al., 2002; Fisher et al., 2008). For instance, as seen in Section 1.2.1, the widely-used method by MEA (2005) catergorises ES into provisioning services (e.g. fish, trees, and fibre), as well as regulating services (e.g. water regulation), supporting services (e.g. nutrient cycling) and cultural services (e.g. recreation and religious values). Commonly, in the international world, PES schemes are related to biodiversity, carbon, water and landscape services provision (Wunder, 2008a). In China, eco-compensation projects are designed for water management, afforestation, soil conservation, eco-agriculture and carbon markets (Bennett, 2009). Considering this research mainly focuses on water-related schemes, here three types - forest, water, and biodiversity, are used in this framework to assess whether they exist in China's eco-compensation programmes.

Biodiversity-related schemes refer to projects that are designed for single or multiple species protection as well as habitat conservation or restoration (Sattler et al., 2013). Water-related programmes cover all ES related to improvement of water quality and/or increasing water quantities. Finally, forest projects link to schemes for afforestation or forest management.

Aims regarding the ES addressed

PES programmes are implemented by paying land users to generate the desired ES. Ideally, through incentives, "additionality"- increases in provision of ES - should be achieved. This "additionality" refers to improved quality (e.g. improved water quality for drinking water supply) or/and increased quantity (e.g. increased water retention in a watershed) (Sattler et al., 2013). However, in practice, there are quite a number of PES schemes which rather aim at the maintenance of the status quo, instead of securing "additionality". In these cases PES schemes provide payments in order to prevent land owners from switching from already environmentally friendly land-use practices to other less desirable land uses. The former type of PES projects is known as an "asset-building" scheme while the latter ones are "use-restricting" projects, and costs in "asset-building" schemes tend to be much higher than costs in programs focus on retaining existing land uses. "Use-restricting" projects are sometimes criticised for paying ES which would be maintained without payment (Engel et al., 2008; Wunder, 2005).

Many authors highlight the link between poverty and environmental degradation (e.g. Fisher et al., 2008, Landell-Mills and Porras, 2002). As a result, in some cases, side objectives, such as poverty alleviation are formulated, as in the case of government-financed 'pro-poor PES' (Pagiola, 2007;

Wunder, 2008b). From a perspective of cost-effectiveness, in PES projects which incorporate poverty alleviation as a coupled policy goal, poor farmers, owning lower quality land and thus leading to lower opportunity cost, are more likely to get paid. Some authors say project designers must be careful so that these side objectives will never become more important than the effective ES provision itself (e.g. Engel et al., 2008). There are even some projects that purely aim at ES provision initially, but then turn out to be substantially hybridized with side-objectives (e.g. see Shapiro-Garza, 2013).

ES stacking and bundling

Ecosystems involve hugely complex processes in which different elements interact with others to produce services, and often such elements are also inter-connected. An ecosystem function is dependent on others (Kosoy and Corbera, 2010). In order to bring ecosystem services into the practical realm of tradeable commodities, “stacking” and “bundling” are two ways to deal with multiple ES. Here “stacking” refers to the process of separating ecosystem functions into different categories and then simply aggregating them together (Robertson, 2012). On the other hand, “Bundling” means ecosystem services are bundled together to be bought and sold in the market as a single commodity/service, and in this process individual services cannot be separated out.

While some schemes are designed to address one specific ES, some projects are carried out aiming at several ES together (e.g. Engel et al., 2008; Robertson, 2012). Bundling of ES is said to be an effective way to optimizing overall ES provision rather than maximising only one specific ES (Kosoy et al., 2008). In addition, bundling eliminates the risk that maximising provision of one service crowds out the provision of another ES (Kosoy et al., 2008). It should be noticed that there are some controversies about whether ES are considered and measured as “bundled” or as separate elements. More often than not, different services are co-produced. They may interact synergistically (so that more of one service means more of another) or may compete (such that there is a trade-off between one service and another) (Adams, 2014). Thus, unbundling a complex ecosystem into individual components can be a rather questionable process. Government-funded projects tend to embrace multiple ES while user-financed ones are likely to focus on single service (Wunder et al., 2008).

3.2.3 Payment Issues

The payment specifics of PES projects vary in terms of the payment source, mode, type, frequency, and eligibility criteria for the payment.

Several costs need to be taken into consideration when determining the amount of payment. In theory, the minimum payment needs to cover ES sellers' opportunity costs (costs that would be gained from alternative land uses) and implementation costs (actual costs for implementing the agreed measures/practices to generate the desirable ES) (Sattler et al, 2013), otherwise ES sellers are not willing to participate in PES. On the other hand, the payment must be less than the value of the benefits to the ES users, otherwise ES beneficiaries would not be happy to pay (Engel, et al., 2008). It is worth mentioning here that the true value of ES is difficult to calculate because of the methodological difficulties related to non-market valuation techniques. In practice, the payment can also be decided based on ES providers' 'willingness to accept' for the effort to deliver the services and ES buyers' 'willingness to pay'. Besides, there may be a substantial amount of transaction costs occurring when gathering information, negotiating contracts, contracting and monitoring in different stages. Transaction costs can be extremely high if PES projects involve a large number of small land-holders, and costs in the project-design phase could be higher than costs incurred in the operational stage (Jack et al., 2008; Wunder, 2008a)

Payment source

As mentioned in section 3.2.1, payments can be raised from either private or public funding sources, or both. In case of public funding, according to Gutmam (2003), government funding may be from a broad array of different sources, such as public budget funding, extra budget funding (raised through specific laws), taxes, charges, fees, fines, penalties, bank loans, debt for nature swaps, or environmental funds. When it comes to private funding sources, private investment from businesses could constitute important payments. For example, the French mineral water company Vittel finances farmers in the supply catchment to change their farming practices, attempting to address the risk of nitrate contamination of aquifer caused by agricultural intensification (Perrot-Maître, 2006). In addition, funding may come from donations of some not-for-profit organizations, such as non-governmental organisations (NGOs) and foundations.

These can be considered as somewhat intermediate cases.

Payment mode

In terms of the payment mode, drawing lessons from published work, I differentiate between input-based and output-based PES (e.g. Sattler et al., 2013; Wunder, 2005). This is linked to "conditionality" in Wunder's definition. PES schemes are often tied to proxies so that ES is easily measurable, and proxies can be actions or outcomes (Engel et al., 2008; Jack et al, 2013). The first are sometimes called area-based schemes, while for the latter the terms "result-based", "outcome-oriented", "product-based", or "performance-based" are also used (Sattler et al., 2013; Schomers and Matzdorf, 2013).

For output-based PES schemes, the payment is granted directly on the basis of ES provision in measurable quantities, e.g. measured in metric tons of water additionally withheld in a watershed (Wunder et al., 2008). However, such "output-based" payments are often impossible as the actual level of provision of many ES is very hard to measure. Alternatively, input-based schemes are established based on the foundation, often without scientific validation, that adoption of particular land management practices can deliver the desired ES. In these "input-based" PES programmes, payments are often made per hectare land that is managed under PES, or per working hour invested into the agreed management activities (Engel et al., 2008).

Output-based payments are said to have some advantages in terms of economic efficiency and environmental effectiveness. ES providers normally know better about how to best manage their lands in a low-cost way, and this will reduce costs and promote farmer innovation without prescribing specific measures (Engel, 2016, Zabel and Engel, 2010; Zabel and Roe, 2009). However, these schemes may pose some risks for the ES providers, due to the fact that ES results often depend not only on land-users, but also external factors (such as weather and natural forest fires) (e.g. Engel, 2016; Norgaard, 2010; Zabel and Engel, 2010). By comparison, input-based PES are seen as less effective, as the link between land-using activities and ES has not been well understood and might be based on assumptions that are not always supported by scientific evidence (Calder et al., 2004; Wunder et al., 2008).

Payment type, frequency and time

Payment can be paid either in cash or in kind. In-kind payments may cover materials needed to implement agreed management activities (e.g. seeds, saplings for reforestation, etc.) or food to make up for abandoned land-uses (food for farmers who have converted arable land into forests), but technical support and training for ES providers are also very common. In this context the importance of the economic incentive also matters. Monetary incentives will not always enhance intrinsic motivations for conservation, thus other kinds of incentive may play a much larger part in encouraging land stewardship (Grima et al., 2016; Muradian et al., 2013).

As far as payment frequency is concerned, payments can be one-off or periodical (e.g. on a monthly or annual basis). Usually payments are made upfront; especially considering the fact that investments are necessary before the PES can actually be implemented. In contrast, in the case of output-based schemes, payments sometimes are made after ES delivery is confirmed (Sattler et al., 2013).

Payment eligibility

To improve cost-effectiveness and efficiency, PES schemes need “targeting”. Sattler and coauthors use “horizontal schemes” and “targeted schemes” to differentiate various PES projects (Sattler et al., 2013). Targeting refers to choosing either specific regions or specific groups of providers while “horizontal schemes” use “one-size-fit-all” approach to cover all potential ES providers. Targeting is based on benefit maximization or cost and/or risk minimization. Spatial targeting tries to identify areas with the highest potential for ES provision, the highest threat of ecosystems degradation (and thus need for conservation) or the lowest costs to carry out PES (Sattler et al., 2013). Targeting across agents mean finding providers that would have the highest co-benefits after participating in the schemes, such as pro-poor PES. Basically, targeting can help to improve environmental effectiveness and economic efficiency. But it carries the risk of increasing transaction costs as a result of complex and time-consuming information gathering (Wünscher et al., 2008).

3.2.4 The Actors Involved and Their Roles

PES actors may come from the public, private and civil society sectors, as well as including cross-sectoral actors, such as scientists. They function as ES sellers, ES buyers, or intermediaries who facilitate or manage specific activities (e.g. Kosoy and Corbera, 2010; Sattler et al., 2013; Wunder et al., 2008). Actors can be individuals, groups, or institutions/organizations from these different sectors (e.g. de Groot and Hermans, 2009; Jack et al., 2008). Public actors include government (national or local), or government agencies or government-related entities, while private actors would include landowners, farmers, private companies. Not-for-profit NGOs, foundations, associations are the examples of civil society sectors.

Compared with traditional command and control approaches, PES is often seen as an approach where private initiative and the markets play increasingly important roles, although this may not crowd out government involvement completely.

ES sellers

ES sellers (or providers) are those actors whose land management practices is able to safeguard the delivery of ES (Engel et al., 2008). In general, they are land owners or land managers, who can be private individuals (e.g. farmers or forest owners), but also local communities (common-pool resources managers) or even governments (e.g. protection areas managing agencies) (Engel et al., 2008; Sattler et al., 2013). ES provision can accrue from private, common or public land[10]. In the ideal case, the land is privately-owned and the ES seller has the full and clear property rights over land. However, there are many PES schemes that are carried out on community-managed common land where property rights are less clear defined (Engel et al., 2008). It is notable that there is an ongoing debate about whether public land should be eligible for enrolling in PES, as some argue that governments should carry the responsibility for safeguarding public goods provision, and should not be paid (e.g. Tacconi, 2012). ES sellers are believed to have good information about opportunity cost of conservation activities (Ferraro, 2008).

[10] In China, communal farming ended three decades ago, but land is still owned by the state. The collective-owned land is leased to individual farmers, and farmers have the land use rights for certain periods. In most cases farmers can renew their land use rights - sometimes maybe for another patch of land - but the leasing can be totally terminated if the land is used for other purposes and there is not enough land for new leasing.

ES buyers

ES buyers can be divided into two main groups, depending on whether buyers are the direct beneficiaries of the provided ES or not. In "User-financed" PES projects, the buyers are actual users of an ES, and they can be private individuals, business companies or communities, etc. (e.g. Engel et al., 2008; Wunder et al., 2008). A telling example could be a beverage company located in the downstream part of a watershed that pays upstream land owners/managers to improve water quality (see "Payment Source" above). In other cases, buyers are third parties (typically the government, an NGO, or an international agency) acting on behalf of these actual ES users, and these projects are "government-financed" or "third-party-financed" (Wunder et al., 2008). Pagiola and Platais (2007) assert that user-financed PES programmes are particularly likely to be effective, while government-financed ones are less likely to be. However, in many cases, a government-funded project is the only feasible option. And due to economies of scale in transaction costs, it is possible that government-financed PES programmes may be more cost-effective than user-financed PES (Engel et al., 2008). Jack et al. (2008) claim that NGO-funded programmes can be used to compensate weak state institution, and they may achieve long-term benefits as NGOs are better at building trust with local communities.

Intermediaries

In theory, as long as two actors can reach a one-to-one transaction agreement, an intermediary is not essential for a PES project; for example, a landowner in an upstream region can negotiate directly with a downstream water user. However, in reality, because of large number of actors being involved in a practical PES scheme, especially the projects implemented at a large spatial scale, transaction costs for actors are likely to be very high without mediation by an intermediary. In this respect, intermediaries are in a position to help bring down the overall costs of a scheme (Vatn, 2010). Moreover, usually ES buyers do not have enough technical knowledge and capabilities to evaluate the feasibility and effectiveness of PES schemes. Therefore, intermediaries can be necessary for many reasons, e.g. to function as a mediator, or assisting through contract negotiation, resolving disputes, monitoring or verifying ES delivery and so forth (for intermediaries' roles at different stages, see Table 3.2). Intermediaries can also play important roles in building trust among buyers and sellers (Wunder, 2008).

Table 3.2 Intermediaries' Roles, Aims and Functions in PES

Roles	Associated aims	Key functions/activities
Scoping and scheme design	- environmental protection and conservation goals; - spatial targeting and coverage; - cost-effective budget allocation; - socio-economic development and poverty reduction in some locations	1. stakeholder mapping; 2. activate stakeholder consultation; 3. wider stakeholder engagement and public awareness raising; 4. gather and analyse hydrological and other relevant data; 5. feasibility studies including identification and estimation of ecosystem service 'flows', and identification of management activities; 6. spatial planning and targeting, scenario modelling, technical appraisal and advice to scheme financiers; 7. draft scheme protocols 8. if necessary, action to clarify or even establish property rights (e.g. land titles for smallholders or communities); 9. initial advice for ES providers; 10. negotiations facilitation and conflicts resolution; 11. design of payment mechanisms and contracts 12. development of management plans and approaches for monitoring.
B. Scheme administration	- deliver scheme objectives; - minimise transaction costs; - monitor and verify ES delivery and reporting.	1. identify, recruit, organise and further advise ES providers; 2. pro-active assistance and support with scheme eligibility requirements and cost reduction; 3. support to ES providers to build the capacities needed for the interventions desired by ES buyers; 4. price setting, funds allocation, contract administration and payments; 5. monitoring of ES provision (or required 'inputs') and enforcement of contracts; 6. negotiation of revised, replacement or new agreements; 7. maintaining communication; 8. social capital and trust building;

Roles	Associated aims	Key functions/activities
		9. engagement and partnership working with other government agencies and civil society organisations; 10. continued data gathering, analysis and knowledge sharing; 11. exceptionally: acting as a 'wholesaler' of ES; 12. monitoring and evaluation of scheme outcomes and reporting.
C. Representation and mediation	- social equity; - scale for lower costs and impact; - dispute resolution; - wide scheme acceptance and support; - additional funding	1. represent resource-poor ES providers; 2. promote inclusiveness and ES provider participation; 3. coordinate collective bargaining by ES providers; 4. assess seller compliance with regulation and agreements for ES buyers; 5. achieve scale-dependent advantages and coordinated impact; 6. public awareness raising and promotion of the scheme's worth to society; 7. leverage further and complementary sources of funding
D. Knowledge generation and exchange	- facilitate scheme operation; - reduce transaction costs; - influence policy.	1. generate and share information about and between ES providers and buyers; 2. local information hub; 3. public information dissemination; 4. demonstrating and communicating outcomes and practices; 5. feedback to policy cycle and wider agenda; 6. lobbying of politicians and policy makers; 7. co-production of technologies and policy options
E. Building social capital and trust	- facilitate scheme operation; - reduce transaction costs; - build local institutions	1. build social capital: communications, networks, partnerships, knowledge exchange; 2. build trust between parties; 3. establish transparency and good governance; 4. maintaining broad-based acceptance that scheme operation and outcomes are fair and equitable

Source: Adapted from Cook et al. (2017)

For example, in the case of the “UpStream Thinking Project” in Southwest England which aims to use improved farm infrastructure and land management practices to enhance raw water quality and manage water flows, the Westcountry Rivers Trust, an environmental charity, acts as an intermediary, both co-innovating programme design and being a broker between local farmers and South West Water company (Cook et al., 2017).

3.2.5 Status

Setting up PES projects involves a number of stages and can be very time-consuming; furthermore, projects may be adjusted according to changing environmental, socioeconomic and political contexts. Normally, after careful technical design, projects will be negotiated and piloted at a small scale. If they go through the testing stages, they are more likely to turn out to be eventually carried out, and to be sustained in the longer term through continued funding (Bohlen et al., 2009; Sattler et al., 2013). This is especially true for government-funded projects. In other cases, a number of PES projects are abandoned for several reasons, such as lack of funding or insufficient participation (Grima et al., 2016). There are also some very successful PES schemes that have been developed into improved follow-up stages, such as Mexico’s National Programme for Hydrological Environmental Services (PSAH) (Wunder et al., 2008). For the multi-level classification attempted here, I draw the following categories: testing/pilot, ongoing, finished/completed, and abandoned/failed.

3.2.6 Scale in Space and Time

The scales of space and time for PES implementation need to be considered carefully since they influence outcome (Kinzig et al., 2011, Sattler et al., 2013). In this chapter, I differentiate between local, regional and national approaches for the spatial scale and between long-term (>5 years) and short-term (<5 years) contracts for the time scales.

Spatial scale

PES projects need to be designed at a range of spatial scales because ecosystem processes happen at a confined scale and should be managed accordingly. Spatial distribution can be characterized by the directional flow of the ES and the geographical extent across which benefits accrue

(Costanza, 2008; Kemkes et al., 2010). For instance, climate regulation services are omni-directional and benefits arise at a global scale, and thus the international mechanism, Reducing Emissions from Deforestation and Forest Degradation (REDD+), to reduce emissions is paid by developed countries to developing countries (Dietz et al., 2003). Water supply and water regulation services are “directional-related” - flowing from upstream to downstream, and should be manged at regional (catchment) scales.

Time scale

The duration of a project is mainly determined by how long the funding is available (Wunder et al., 2008). It is said that long-term contracts might be preferable as they bring higher security for the ES providers to gain the additional income. Long-term contracts may also increase the permanence of the scheme, and long- and mid-term projects are more likely to be successful (Nsoh and Reid, 2013; Grima et al., 2016). But this does not necessarily mean that short-term PES projects are not without advantages. In the pilot stage, PES projects are usually agreed on a short-term basis to allow flexibility to accommodate improvements or abandonment (Engel et al., 2008). Flexibility is also needed when environmental and socioeconomic conditions change in such a way that PES effectiveness or/and efficiency needs to be improved (Jack et al., 2008).

3.3 Selection of Eco-compensation Cases

The framework outlined in section 3.2 was then applied to derive an analysis of a sample of eco-compensation cases in China. The detailed description of the methodology of case retrieval has been given in section 2.3.1 of Chapter 2. 19 cases in total have been selected in this research. General information on the cases is provided in Table 3.3, and details of each case are given in an Appendix (Appendix 1) after this dissertation. However, it should be noted that there are more eco-compensation schemes being carried out in China, but due to the lack of enough information on some cases to make meaningful analysis, these cases have not been included in this study (for more cases on watershed eco-compensation in China, see Wang et al., 2016).

Table 3.3 Summary of the 19 Eco-compensation Schemes in China

No.	Case Name	Location	Services	Buyers	Sellers	Scale	Since	Payment source
1	Sloping Land Conversion Programme	25 Provinces	Water Forest	Central government	Private land owners	Large	1999-	Central government
2	Natural forest Protection Programme	17 Provinces	Water Forest Biodiversity	Central government	State-owned forest farms	Large	1998-	Central government
3	Miyun Watershed Programme	Hebei Province	Water	Downstream government	Private land owners	Regional	2006-	Municipal government
4	Hebei Major Watersheds Programme	Hebei Province	Water	Downstream government	Upstream government	Regional	2009-	Provincial and municipal government
5	Liao River Programme	Liaoning Province	Water	Downstream government	Upstream government	Regional	2008-	Provincial and municipal government
6	Lake Tai Programme	Jiangsu Province	Water	Downstream government	Upstream government	Regional	2007-	Municipal government
7	Min River	Fujian Province	Water	Downstream and Provincial government	Upstream government	Regional	2003-	Municipal government
8	Xinan River Programme	Zhejiang and Anhui Province	Water	Downstream and central government	Upstream government	Regional	2011-	Central government and upstream government
9	Shayin River Programme	Hehai Province	Water	Downstream government	Upstream government	Regional	2008-	Municipal government

No.	Case Name	Location	Services	Buyers	Sellers	Scale	Since	Payment source
10	Qingshui River Programme	Guizhou Province	Water	Downstream government	Upstream government	Regional	2009-	Municipal government
11	Lake Lashi Programme	Yunnan Province	Water Biodiversity	NGO and World Bank	Private land owners	Small	2007-2009	Donations and citizens
12	River Jinhua Programme	Zhejiang Province	Water	Downstream government	Upstream government	Regional	2000-	Municipal government
13	River Xiaoqing Programme	Shandong Province	Water	Downstream government	Upstream government	Regional	2007-	Municipal government
14	River Dawen	Shandong Province	Water	Downstream government	Upstream government	Regional	2008-	Provincial and municipal government
15	River Dong Headwater Programme	Jiangxi Province	Water	Downstream government	Upstream government	Regional	2009-	Provincial government
16	Pingwu community-based scheme	Sichuan Province	Water Biodiversity	NGO	Private land owners	Small	2009-	Donations to NGO
17	He Nan Major Rivers Scheme	Henan Province	Water	Downstream government	Upstream government	Regional	2010-	Municipal government
18	Wasteland Conversion Programme in small watershed	Shanxi Province	Water	government	Private land owners	Regional	1980-2005	In-kind payment from harvest on cultivated land
19	Jiaquan Watershed Programme	Guangdong Province	Water	Beverage company	Private land owners	Small	2014-	Private company

While most of these cases (n=17) are implemented targeting watersheds (be they large or small), there are two cases (No.1 and No.2) associated more with forest management. I include them in my examination of water-related eco-compensation cases mainly because they were firstly initiated to control soil erosion and thus to mitigate flood risks.

In general, based on the full sample of cases, classification results can be summarized as follows (see Table 3.4):

1) Only 16% (Nos. 16, 18, 19) of the eco-compensation cases are completely voluntary (Coasean type PES), with the rest of the cases being involuntary (included as Pigouvian type PES);

2) While all the cases in this research are water-related, three of them (Nos.1, 2, 11) also concern biodiversity, among which two are forest management schemes (Nos.1, 2);

3) Mostly, water quality improvements are the aim of these programmes, while one programme is designed for both quality and quantity purposes (No. 3);

4) Only 1 case (No.19) is funded by private money. The rest are either supported by an NGO on behalf of donors (Nos. 11, 16) or are publicly funded;

5) 53% of cases (Nos.1, 2, 3, 7, 11, 12, 15, 16, 18, 19) are paid based on management activities (input-based);

6) Government actors play dominant roles in eco-compensation, followed by NGOs and, rarely by private companies from the market sector. Even when governments are not buyers or sellers (Nos.11, 16, 19), they still serve as intermediaries;

7) ES sellers are mostly governments or governmental agencies, while only a quarter of ES sellers are private land users (Nos. 3, 11, 16, 18, 19);

8) As ES buyers, it is again mainly government entities that provide this function, followed by civil society; private company's role is rather limited;

9) The vast majority of eco-compensation is rather small-scale (local or regional level), with only two large-scale cases (Nos.1 and 2);

10) Contracts within eco-compensation agreements are generally relatively long-term (>5 years).

Table 3.4 Classification of Eco-compensation Cases

Eco-compensation characteristics	**Specifications**	**Number (total=19)**	**Percentage of total %**
Project voluntariness	Voluntary	2	11
	Partly involuntary (supply)	0	0
	Partly involuntary (demand)	2	11
	Involuntary	15	78
ES type	Water	19	100
	Biodiversity	3	16
	Forest	2	11
ES purpose	Quality	17	89
	Quantity	3	16
	Both	1	5
Pay source	Private	1	5
	Public	18	95
	Both	0	0
Pay mode	Input-based	10	53
	Output-based	9	47
PAY eligibility	Horizontal	18	95
	Targeted	1	5
Actors	Market (companies)	1	5
	Government	19	100
	NGO	2	11
ES sellers	Government	14	74
	Private Land owners	5	26
ES buyers	Government	16	84
	Market	1	5
	NGO	2	11
Spatial Scale	Local	3	16
	Regional	14	74
	National	2	11
Time Scale	Long term(>5y)	17	88
	Short term(<5y)	2	12

3.4 Eco-compensation and Its Features

Amongst China's many eco-compensation projects, the Natural Forest Protection Programme (NFPP) (No.2 in Table 3.3) and the Sloping Land Conversion Programme(SLCP) (No.1) are two of the largest similar initiatives in the world, with substantial environmental benefits having been achieved in forest and grassland management since 1998 (Liu et al., 2007).

The Natural Forest Protection Programme aims at protecting non-commercial forests through paying for collectives and individuals who are forest managers in order to encourage them to plant and take good care of forests. Initially, in 2001, a pilot project was implemented in 11 provinces as a trial, covering 685 counties (enterprises) and 24 national reserves. Guangdong, Fujian, Zhejiang and other provincial governments have allocated budgets to their local governments for pilot projects. After 2001, and finally by 2004, the programme was in full operation throughout the country, with payment delivered to key state-owned non-commercial forest, scattered woodland and shrubland in areas of desertification and soil erosion (Zheng and Zhang, 2006). Similarly, in response to the 1998 flood in the Yangtze River Basin, the central government initiated the Sloping Land Conversion Programme in 1999, with particular emphasis on western provinces. This programme was developed with the aim of converting around 14.67 million hectares of cropland into forests, of which 4.4 million is on land with slopes above 25°; and with an additional target of afforesting a roughly similar area of wasteland by 2010. This project has been carried out in more than 2000 counties across 25 provinces in China (Bennett, 2008).

Meanwhile, because of the demonstration effect of these two national programmes, increasingly, local policy-makers have considered eco-compensation as an effective way of realising the task of environmental protection, especially for river basin water quality management. Therefore, in some developed provinces such as Zhejiang, Fujian, Guangdong, etc, eco-compensation projects between the upper and lower reaches of rivers are now being carried out through provincial financial transfers or negotiation between municipalities (Zhang et al., 2010). Since central governmental funds are mainly distributed to areas with highly-important ecological benefits, such as key ecological function zones, natural reserve zones and so on, local governments take actions to make the most of eco-compensation mechanisms with the hope of improving watershed environments and providing clean and sufficient water. This type of eco-compensation programme, which has become dominant in China, includes the example of compensation from Beijing to the water source areas of the Miyun reservoir (No.3 in Table 3.3); compensation from upstream of Dawen River to the Dongpei Lake in Shangdong province (No.14); payment from Guangdong

Province transferred to the Dongjiang headwaters (No.15); compensation in the Xin'an River(No.8); the mode of "off-site" development between Jinhua and Pan'an in Jinhua river[11] (No. 12); and subsidies from downstream to upstream in the Min River and the Jiulong River in Fujian province (No.7), and many others (Zheng and Zhang, 2006; Zhang et al., 2010; Zheng et al., 2013). In the above cases, usually with the help and coordination of upper-level governments, local governments play a key role in negotiation and in defining the payment planning. Compensation funding is mainly through financial transfer payments, resource taxes, and other subsidies. Because the property rights of natural resources such as water, forestry and land are owned by the state in China, compensation is mainly paid by governments. However, this centralization may introduce inefficiencies, may distort "pricing", and could lead to high transaction costs.

It is worthy of note that in a wide array of literature, scholars, both in China and abroad, categorize water rights trading as eco-compensation (Li et al., 2007; Zhang et al., 2010; Zheng and Zhang, 2006). The most illustrative example is the water-rights trade between Dongyang and Yiwu in Zhejiang Province, and this has been followed by various cases all over the country. In Hei River in Gansu Province, water rights quotas are distributed to households according to their number of livestock and farmland area. Water users are encouraged to save and sell surplus water at a market regulated price and under government guidance (Zheng and Zhang, 2006). In my view, it is inappropriate to consider water trade as an eco-compensation programme because most cases have nothing to do with environmental purposes. In eco-compensation programmes, the goods that payments target can contribute directly to improvement of the environment and ecosystems. Water is sold as commodity for drinking, irrigation or production, without direct environmental consideration in water trading. water rights trade cases are excluded in this research. The main reason why Chinese scholars consider water rights trading projects as eco-compensation without careful examination is because, more often than not, local government officials claim these projects as eco-compensation schemes. This echoes the facilitation of eco-compensation innovations by Chinese leaders and different pilot projects (policy experiments) across the country

[11] The Jinpan Development Zone in Jinhua City, Zhejiang Province, restricts industrial development in upstream Pan'an County while compensating for this by offering off-site development options downstream.

in forestry, grasslands, wetlands and river catchments, which shows the diffusion of innovation. However, the casual including of water rights trading as eco-compensation schemes suggests policy makers and scholars alike in China should dig more deeply into the meaning of eco-compensation, so that the concept is not misused.

Particular features of eco-compensation in China that are important to consider are those noted in the following sections, which are structured to mirror the section themes of the theoretical discussion in Section 3.2.

3.4.1 Project Types: Voluntariness

In Wunder's definition of PES, despite frequent criticism, the criteria of "voluntariness" is very important (See Section 3.1.1). When it comes to eco-compensation projects in China, most of the cases listed in Section 3.3 could be questioned regarding being voluntary for watershed service buyers and providers.

Project 19 is a completely voluntary eco-compensation programme which also meets the ideal definition by Wunder. In this case, the real ES beneficiary - a mineral water company - voluntarily proposes to pay to farmers in the upstream region for their management practices to improve water quality, and ES providers are not forced to enrol into this programme.

There are three more projects in which ES providers' participations are voluntary (Nos. 11, 16, 18), but situations for ES buyers vary. For Project 11, the real ES beneficiary of the abandoned scheme (the project has not been in operation after design) was supposed to be citizens and tourists in an old town in the downstream area. It was proposed to be funded partly by surcharges on citizens' water bills and tourists' entry fees to the town and partly by NGO donations. As a result, the project would be involuntary on the demand side. When it comes to Scheme 16, the beneficiaries of water services are villagers in the downstream and biodiversity could benefit far more people beyond the project's area. However, since the project is fully financed by donations, those beneficiaries do not contribute to the project. For this end, I consider the NGO here as the service buyer voluntarily taking parting in the project. For Project 18, ES providers are farmers who voluntarily participate, through an auction process, to manage collectively-owned wasteland to reduce soil erosion or desertification. Beneficiaries of this project are local people. A feature of this project is that ES providers are not paid directly by local people or local governments on behalf of their villagers, but they generate incomes by selling products, such as non-timber forest products on their managed land. I consider this as an alternative way of governments paying on behalf of ES beneficiaries, as otherwise villagers can share income if the collectively-owned lands are managed collectively. Hence, this project is involuntary on the demand side.

For other government-led projects, they are neither voluntary on the demand side nor voluntary on the supply side. For the demand side, ES beneficiaries pay for ES provision through government authorities, although they may not realise their contribution, public funding for eco-compensation are derived from their bills[12] and/or tax-paying.

In terms of ES provision in these eco-compensation projects, there are regulatory frameworks to set water quality requirement.

3.4.2 Ecosystem Services

Since the focus of this research is water-related eco-compensation schemes, the cases analysed here are those designed with the aim of generating water services, although some of them are carried out targeting other services as well.

Type of service

All the cases are targeted directly or indirectly at water services. Among them, Cases 1, 2 are mainly designed to improve forest coverage, with the belief that increase in forests in the upper region of river basin will increase water yields, and mitigate flood risks. In addition, there are two cases (Nos.11 and 16) that generate biodiversity as well. The former one aims to protect the wetland which inhabitants a large number of birds, and in the latter one farmers co-manage the forest reserve which is home of pandas and other endangered species.

Aims regarding the addressed ES

[12] In China, citizens' total water bills are composed of water companies' costs to exact, purify and provide water; water resource fee set by government and sewage treatment fee.

Almost all the cases are implemented to generate additional ecosystem benefits, with only Case 2 aiming at the maintenance of the status quo. In Case 2, state-owned forest farms are given subsidies to stop timber harvesting.

In addition, poverty reduction is often said to be an important side product of eco-compensation projects. In China, upstream regions are normally less well-developed than their downstream counterparts. Increasingly, policymakers consider eco-compensation as a mechanism that can adjust the relative benefits and costs of ecological service provision among the key stakeholders, which implicitly or explicitly indicates an upstream governments' aim of lessening its financial burden for environmental protection and thereby allocating more budgets into flourishing regional development. However, the centralized and top-down nature of eco-compensation may render these projects unproductive in achieving this goal. For example, there is a hidden aim in the SLCP to encourage farmers to change their labour supply from traditional agriculture to non-farming industries. With a labour surplus unleashed from agriculture and engaging in better-paid jobs, it is expected that the outcome of poverty reduction will increase. However, Li et al. (2011) conclude that the SLCP has not increased the transfer of labour towards non-farming activities at their survey location as the government had expected. At the same time, as mentioned in the previous section, normally the payments to the upstream jurisdiction are much lower than the opportunity costs. Consequently, it is difficult to say whether many water eco-compensation projects with the objective of boosting regional development are effective in this end. In order to maximize the benefits to the poor while at the same time securing environment conservation targets, better spatial targeting should be taken into consideration in the design phase of eco-compensation projects.

ES stacking and bundling

As discussion in the sub-section of ES types indicates, some projects in Table 3.3 (Nos. 1, 2, 11, 16) are carried out aiming at several services together. Those projects above are designed to generate more than one ES provision. A scheme which is worth noting is Miyun (Case 3). Although from Table 3.3 it seems that water is the only service, the programme is designed to both improve water quality and increase water quantity. The remaining projects are targeting one single ES - water quality. The water service in China's eco-compensation projects is not a "bundled" service as it only includes water quality and both quality and quantity, as in the Miyun case, rather than covering overall water services including fish production, flood protection, recreation and so on.

It is worth mentioning that design of eco-compensation schemes involves a process of creating socially-necessary abstractions to facilitate commodification of ES. As a part of this process, whether adding several ES together or only selling one particular type of ES is not unproblematic. For multiple-service projects, the relations between different services are ignored. For example, changes in forest cover in SLCP (No.1) may reduce nutrients, chemical outflow rates and runoffs and thus will affect water-related services.

3.4.3 Payment Issues

Payment source

Most eco-compensation cases in China are government-sponsored, with the Cases 11 and 16 being supported by NGOs. Case 19 is the only case which is funded by a private company, yet this project is still in the early stage, and piloting at a very small scale, so the environmental impact may be minimal. Therefore, the private drinking water company may not only want to see if the idea works but also hopes to build its reputation. This implies that there is an additional benefit to the payment-provider that is "hidden" in the eco-compensation transaction; the latter acts as an uncosted advertisement.

Payment mode

In China, both input-based and out-based eco-compensation schemes exist. For Cases 1, 2, 3, 16, 18, 19, sellers are paid based on their management practices, regardless of environmental outcomes. For other projects, payments between upstream and downstream governments are outcome-oriented.

In either case, monitoring is very important to ensure the delivery of services, and the compliance. For example, in the SLCP (No.1) the generation of services is linked to land retirement activities.

According to State Forestry Administration (SFA) (2003), measures explicitly indicating the delivery of services include the targeted total land area for retirement (14.67 million hectares), the area of retired land on slopes greater than 25° (4.4 million hectares), the division of this area in different regions and in terms of tree types to be planted, and the required survival rates of the trees planted on retired land. 75% of the retired area is to be planted with timber product species, while the other 25% is to have orchard crops or trees with medicinal value across all regions (SFA, 2003; cited by Bennett, 2008). Nevertheless, no baseline against which to evaluate these gains is presented. A series of inspections by various levels of government is conducted to make sure that farmers comply with requirements. Village officers regularly inspect sites to make sure implementation is functioning well, which is followed by formal evaluation by township and county governments to determine whether land passes inspection. In some random cases officials from higher-level government and/or even the SFA itself carry out some inspections as well. In terms of water programmes, delivery of services is thought to be on the basis of water quality. Unlike "input-based" projects where payments are made for certain land management practices, these water projects can be considered to be "output-based". In the design phase, a certain level of water quality is targeted and is the only indicator of performance. Generally, water quality baselines are set up with no additional effort since water quality is required to be monitored regularly in China even in the absence of eco-compensation mechanisms. With water quality data, it is relatively easy to tell whether the upstream complies with the eco-compensation contracts. It is worth noticing that there is now an increasing trend of sanctions for non-compliance. For example, in the Ziya River in Hebei Province (No.4), if the upstream jurisdiction fails to secure the provision of clean water, fines will ensue. This is less likely to happen in a voluntary PES project as service providers may not be willing to participate if they know there is a risk that they may need to pay rather than being paid.

Payment type

Payment in China's eco-compensation programmes has been both in cash and in kind. For example, in SLCP (No.1) compensation payment to farmers who convert sloping and degraded cropland is composed of i) an annual in-kind subsidy of grain, ii) a subsidy in cash, and iii) free seedlings, provided to the farmer at the beginning of the planting period. Although in official documents there are no estimates of participant opportunity costs, it is believed that the amount of the annual in-kind grain subsidy is determined based on estimated grain yields on crop land, which means in practice the SFA has incorporated the concept of opportunity cost into project design (Bennet, 2008). Moreover, providing famers with seedlings implicitly shows that the cost of converting land is taken into accounted to some extent. Until 2004 when the subsidy was made wholly in cash, the subsidy structure had not been changed. Besides this, technical assistance for implementation is provided and taxation on profits from economic forestry products planted under SLCP is waived (SFA, 2003). In general payment is high, with the annual grain subsidy at 2250 kg/ha in the Yangtze River Basin, and 1500 kg/ha in the Yellow River Basin respectively, plus 300 CNY/ha per year in cash; grain subsidy is higher than the yield (Xu et al., 2004).

For water eco-compensation projects, payments for the upstream government are, more often than not, much lower than the opportunity costs of the upstream land uses from alternative activities since the opportunity cost of an entire region may be drastically high. For this reason, the supply side and the demand side need to come to an agreement by negotiation, usually with the coordination of an upper level government body. These payments often are monetary payments. Usually, payments are transferred directly between sellers and buyers. However, sometimes, both the upstream and downstream make deposits with upper-level province or national government at the beginning, with the funding allocated to relevant parties after monitoring. Hebei Province Watershed Project (No.4) is this type.

Payment mode

In terms of payment mode, in addition to cash compensation, a series of innovative in-kind compensations have arisen. The “off-site” development zone is a telling example of this type of scheme (No.12). In the Jinhua River, in order to compensate for the upstream county’s loss because industrial development is restricted for the sake of clean water, a development zone which is run under the supervision of the upstream county has been set up in the downstream county (Zheng and Zhang, 2006). It is worth mentioning that this “off-site” mode is suspected to generate a “leakage” effect which is argued to hamper the efficiency of these projects. Leakage (or “spillage”) means that, with the aim of ensuring service delivery, land users relocate their activities that damage environmental service provision to areas outside the geographical zone of PES intervention (Robertson and Wunder, 2005). This in turn may lead to overestimation of the environmental benefits attained from PES and eco-compensation projects.

Other payment modes include policy payment, material payment, and human resource payment. Policy payment is a common mode in which the upper-level government compensates the lower-level government through preferential policies; this mode is frequently used in underdeveloped areas. For example, in Xinan River Eco-compensation scheme (No.8), in addition to cash payment arrangement, the China Development Bank approved a loan of 10 billion CNY with relatively low interest rate to the upstream government, a large portion of which is used to develop high-tech industries (Xinhua News, 2012). Material payment is when service providers are compensated directly with equipment, labour and so on. Human resource payment refers to free technical consultation, guidance and training. Generally, in all of these projects, the payments, irrespective of what kinds, are paid annually.

3.4.4 Actors and Their Roles

One distinctive feature of China's eco-compensation is the pivotal roles that governments play in programmes, whether as buyers, sellers or intermediates. These government-led programmes run according to the following principle: "The developer shall be responsible for protection, the impairer shall be responsible for restoration, and the beneficiary and the polluter shall be responsible for payments" (State Environmental Protection Administration (SEPA), 2007). Here those who pay and receive are not only limited to individuals, but collective entities as well.

Sellers

In a very different manner to PES where service providers are mainly private land owners, in most cases in China governments are paid for their efforts to take a series of actions to improve/maintain water quality in China's eco-compensation projects, although in some projects, such as SLCP, farmers are paid directly for their effort to convert farmland (on slopes above 25°) into forests (Bennett, 2008), In total, there are 6 cases (Nos. 1, 3, 11, 16, 18, 19) where payments are delivered to private land users for their direct involvement in these projects. For other cases, governments or state-owned forest farms in Case 2 are sellers of ES.

Since negotiations usually take place between upstream and downstream governments, sometimes under political pressure from a government at a higher level, payment may be much lower than the costs of providing the ES.

Buyers

Although outside China there are instances where the public sector is a big purchaser of ecosystem services (e.g. Costa Rica's Payments for Environmental Services programme (Pagiola, 2002)), governments as buyers as a strategy to replace or complement a conventional regulatory approach is still a main characteristic of eco-compensation.

Of all the Chinese cases in Table 3.3, only 3 cases (Nos. 11, 16, 19) are financed by NGOs and the private sector rather than the government. It is worth mentioning that Case 19, which is supported by an international beverage company which has a factory in that watershed, is the only case where a private company serves as the buyer.

All the other cases are funded by various levels of governments. In the SLCP (No.1) and NFPP (No.2) projects, central government buys the services of forests management, paying farmers directly or as collective entities. In a typical watershed eco-compensation project, one government, as service buyer, makes payment to another government through a fiscal transfer system, although sometimes the payment is delivered further to land-users, such as farmers in the upper region of Miyun Watershed in Case 3. Although government funding may be financed by compulsory water fees levied on actual water users, it is not clear which cases are operated under this model because it is very difficult to trace the original sources of the funding. And even when water users contribute to the funding, they cannot decide whether to participate in these projects, and cannot influence how these projects are designed and carried out.

It is understandable that in China this kind of government-led project at regional and national levels may be the only option. More often than not, eco-compensation projects, with ambitious goals, cover a large number of service providers and beneficiaries. As the numbers of service providers and beneficiaries increase, setting eco-compensation mechanisms through negotiation between these two sides may become difficult and transaction costs can be very high. Additionally, due to the public-goods nature of some services, it is possible that actual users are prone to become free riders. Given these characteristics, government involvement may be the only way that eco-compensation projects can be implemented, but they are likely to be inefficient.

Intermediaries

In China, upper-level governments often function as intermediaries by providing legal and policy frameworks, encouraging pilot projects at lower-level and coordinating negotiation between buyers and sellers. In addition to formulating payment policy, upper-level governments also participate in the payment activities, including the determination of the environmental objectives, payment criteria, monitoring and fund allocation.

Cases Nos. 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18 all involve upper-level governments as intermediaries. NGOs engage in Cases 11, 16, 17 as intermediaries.

In addition, scientific communities play important roles in intermediating eco-compensation as well. For example, academics in the Reseach Centre for Eco-Environmental Science, Chinese Academy of Science, provide technology support to IUCN for targeting areas with high potential of drinking water provision (Interview 29, 2014). And that led to proposal of the Jiaquan Watershed project (No. 19).

One of features of many of these eco-compensation projects is that the roles of buyers and sellers are not fixed, with the upstream and downstream local government playing either role. A telling example is Xin’an River Project (Case 8). A threshold is defined to decide the direction of the payments. If the water quality is better or the pollutant flux is lower than the threshold, the upstream and downstream local governments will become sellers and buyers, respectively.

However, if the water quality is worse or the pollutant flux is higher than the threshold, upstream governments are treated as polluters and have to pay penalties to downstream governments. In this case, it is important for the upper-level government to act as an independent authority, and set threshold, organise monitoring, and determine the payment amount.

3.4.5 Status

The Jiaquan Project (No. 19) was designed and started in 2014, and this project is still at its early pilot stage operated in a small scale to testify its feasibility and effectiveness. With wider stakeholder mapping and robust monitoring, it could be rolled out in the whole watershed in the future. The Lake Lashi Project (No.18) was halted after the initial study during 2007-2009 for unknown reasons. This suggests possible difficulties in running eco-compensation schemes. Project 18 also terminated after more than 20 years' successful implementation. The SLCP (No.1) first started in 1999 and in 2007 extended into the second stage to emphasise the management of forests planted in the early stage. In 2014, the government decided to continue the project, with several changes, such as from top-down approach to bottom-up voluntary participation, allowing farmers to grow under-forest products and so on (NDRC, 2014). This implies that for long-term success, policy-makers and project managers need to adjust eco-compensation projects to accommodate new needs. All the other projects in Table 3.3 are at the ongoing stage.

3.4.6 Scale in Space and Time

Spatial scale

The physical, biological and chemical components of ecosystem services, as well as interactions among these components, which underpin and determine the ecosystem functions and services, are distributed at a certain spatial scale. Accordingly, eco-compensation projects are designed to be carried out at a certain spatial scale.

In China, the SLCP and NFPP have been implemented at a large scale, throughout the country. Most other eco-compensation cases are rolled out within a single watershed or several major watersheds in certain jurisdiction. To be specific, Miyun Watershed case (No.3) is running in a single watershed which is located in parts of Beijing Municipality and Hebei Province. Similar cases include Case Nos. 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19. Of these cases, Lake Lashi Programme, Pingwu Community Based Scheme, and Jiaquan Watershed Project (No.11, No.16, and No.19 respectively) operate at a small scale, only in a single county or even across a few villages; while the remaining cases span several cities. In addition, there are some cases covering more than one major watershed; Cases 4, 17, 18 fall under this group.

Time scale

Most of the cases in this research are long term, with only 2 cases (Nos. 11 and 19) running less than 5 years. In terms of Jiaquan project (Case 19), the short time frame is because it was started in 2014, and is still in the pilot stage, and its future depends on outcomes for adjustment or abandonment (Interview 29, 2014). Case 11 was terminated soon after the initial study stage, and indeed it has never been fully implemented. The reason for this is unknown. Long-term projects can bring a strong sense of security for ES providers, with officials expressing their worries about certainties of projects as some schemes' contracts are renewed annually (Interview 18, 2015).

3.5 Summary

In China, the term "eco-compensation" is used to refer to a market-based institution in which ecosystem services providers are paid for service delivery. But sometimes those entities (public or private) that are responsible for ecosystem management may be considered as polluters and get penalised if they fail to deliver desirable result. The government plays a dominated role in eco-compensation, be it as buyers, sellers or intermediaries; and both buyer and seller can be different governments in a simple project. Only in some cases are individual land users directly involved, sometimes in government-led projects while on few occasions in privately-funded or NGO-supported schemes. Water quality and in some cases water quantity are the main focus of China's water-related initiatives, with forestry and biodiversity being coupled with water services in some initiatives. As this chapter has shown, the most common schemes are government-funded, and the service providers can be either a government or land-users. The next two chapters will examine in more detail two cases of each category – an intra-government water quality management scheme in Chapter 4 and a project paying upstream farmers for both quantity and quality purposes in Chapter 5.

Chapter 4 Politics of Scale in Eco-compensation: the Xin'an River Case Study

4.1 Introduction

PES systems are not created in an institutional vacuum; rather, an appropriate institutional setting is essential for the success of PES programmes (See Section 1.5 in Chapter 1 for more details). Likewise, the wider institutional setting of eco-compensation, especially in the context of river basin management, cannot be ignored. Water moves continuously through the hydrological cycles of evaporation and transpiration, precipitation, and runoff on the earth, and usually this naturally connected material is abstracted, used, and discharged across jurisdictions by competing parties to fulfil various ends. In order to solve the problems associated with competition among stakeholders effectively, the political context behind eco-compensation schemes needs to be considered carefully. Often in a water resource management regime, these stakeholders and their different interests and power relations are nested in different scalar units or at multiple 'levels'. However, challenges related to spatial scales and multiple levels of governance are not uncommon in the realms of environmental governance and management. This can be largely attributed to two factors: (1) levels of government and administration typically do not fit the biophysical boundaries of resources or ecosystem, and (2) conflicts also exist between the traditional nested hierarchies of national political-administrative systems. One telling example of this issue is water governance as water flows across and within certain spatial scales, and efforts to manage water can happen at as high as supranational or national scale, and downwards to regional or local levels. Consequently, the "scale" in water resources management gives rise to heated discussion (e.g. Lee and Moss, 2014; Moss and Newig, 2010; Swyngedouw, 2000).

It is against this background that this chapter analyses the introduction of an eco-compensation scheme in Xin'an River Basin as a process of scalar reconfiguration. This chapter focuses on scalar configurations produced by eco-compensation, and the power process around this. This chapter aims to explore how classic upstream-downstream conflicts of water quality management can not only be examined by the asymmetries between the territorial jurisdictions within the river basin, but also can be interpreted by scalar politics in a hierarchical form of institutional administration as well. Drawing on the concept of politics of scale and the processes of rescaling regarding environmental governance, I seek to answer the following research questions: (1) how does the political context of institutional arrangement affect water quality management in China? (2) how does the politics of scale play out in the rescaling process to address this problem? Doing so, this chapter helps to add new depth and reveal the hidden politics of eco-compensation in a broad river management context.

4.2 Theoretical Approach

"Problems of fit, interplay and scale", which was first introduced in the Science Plan of the Institutional Dimensions of Global Environmental Change (IDGEC) (1999), strongly impacts the effectiveness of institutions which govern environmental management (Young, 1999). And thereafter, these analytical dimensions have been widely used to study environmental governance systems and their performance in complex social and environmental settings (e.g. Moss 2010).

According to IDGEC, problems of fit arise due to mismatch between political-administrative systems and bio-physical systems. It is worth mentioning that, in spite of negative consequences, these misfits are inevitable as there are often political, economic and social forces supporting existing mismatches (Folke et al., 2007).

4.2.1 Problems of Institutional Interplay

In complex societies, a number of well-defined institutions rather than a single institution organise around an array of different functions and spatial domains. One institution can be embedded, nested and overlapping with other institutions. As the number and complexity of individual institutions continues to increase, the likelihood of interplay between or even among different institutions rises accordingly.

Institutional interplay is considered as a major force affecting whether environmental regimes can produce sustainable results, and in to order to address environmental problems, Young (2002) points out that managing institutional interplay needs more effort rather than trying to choose a "proper" level of social organisation at which new governance structures are devised.

Two main forms of interplay - namely vertical interplay and horizontal interplay - provide useful insights to analysis problems of institutional interplay. The first of these refers to interplay among institutions across different levels of social organisation, and the second refers to interplay occurring among institutions at a specific scale of social organization (Young, 2008). Interaction between organisations at global, national and local levels to address global environmental problems such as climate change is a telling example of vertical interplay. An example of horizontal interplay occurs in the Water-Energy-Food Nexus - water security, energy security and food security are inextricably connected and actions in one sector more often than not have impacts on others.

When it comes to river basin governance systems, vertical interplay may arise across the traditional jurisdictional scales, but also across institutions designed in accordance with the biophysical scale (basin and sub-basins) as well. Linkages, interactions or interplay of complex institutional structures at various scalar dimensions and levels are common. Rules at local level may only focus on particular functions, while rules at a larger scale may coordinate those local rules to facilitate the achievement of the system's ultimate goals. Moreover, issues of horizontal interplay among various water sectors are also important.

Furthermore, vertical and horizontal interplay interact with each other. For example, horizontal interplay of various regional regimes (e.g. county level) may depend on how similar arrangements function and interact at higher levels (e.g. provincial level).

Problems of institutional interplay are quite common across the world, and may lead to duplication, redundancy, and conflict among institutions and organisations. In spite of wide acknowledgment of negative consequences, these problems are not easily solved as changes are resisted by interest groups and jurisdictional and functional fragmentation make solutions too costly (Young, 2003).

There are a number of taxonomies of institutional interplay used for a range of different purposes (e.g. see Stokke, 2001), and both vertical and horizontal institutional interplay may be classified into both unintentional interplay and intentional interplay. Unintentional interplay may occur when an institution aiming to address one particular problem affects the biophysical or socioeconomic systems in which other institutions operate. Interplays may also result from deliberate political interventions seeking to purse collective goals. The occurrence of unintentional interplay may trigger exercise of intentional interplay as actors could take advantage of opportunities provided by unintentional interplay, or seek to avoid the side-effects accompanied with unintentional interplay.

Intentional interplay between actors, through tight collaboration, shared understanding of problems and co-production may be used as a remedy for problems of fit resulting from mismatch between socioeconomic-political systems and the biophysical system.

4.2.2 Problems of Scale

In terms of water management, water flows across and within certain spatial scales, and thus efforts to manage water, such as flood management, water supply and wastewater treatment, may all happen at different scales. A large number of human activities to abstract, distribute, use and discharge water for different purposes may affect both the quality and quantity of water, with these social-economic activities organised by different institutions at different scales. Water management practices can occur at a high level such as supranational or national scale, or at a low level such as local levels. To be more specific, water-related problems such as climate change may be best addressed at a global scale while de-centralization of water supply management, participation, and demand a lower level of water governance.

There are different meanings of scale in geography's various subdisciplines. The beginning of the scale debate dates back to the 1980s in human geography, focusing on scalar configuration in the global economic system (Smith, 1982). At that time, scale, as a more fixed concept, referred to the levels in a nested hierarchy. Later scholars in very different disciplines, particularly political ecologists, moved this debate towards the relational aspects of scale, focusing on the issue of scale and power (e.g. Swyngedouw, 1999, 2004, 2000).

Scales evolve relationally within hierarchies, and Brenner (2001) points out that "The meaning, function, history and dynamics of any one geographical scale can only be grasped relationally, in terms of upwards, downwards and sidewards links to other geographical scales situated within tangled scalar hierarchies and dispersed inter-scalar networks." The process-based approach to scale leads us to pay attention to the mechanisms of scale transformation through social conflict and political-economic struggle.

Rangan and Kull (2009) argue that "scale is central to the production and representation of spatial-temporal difference, and the means by which change - be it ecological, social, or economic - is made political", and the production of scale is a fundamental part of the activities and movements involved in the production of space, time and power to "articulate relations, controls, and representations of social and biophysical landscapes". This implies that power dynamics act within particular scalar configurations.

Environmental problems of scale arise when there are mismatches between biophysical processes, administrative structures and procedures and socioeconomic activities (Moss and Newig, 2010). These include problems of scalar fit (problems of finding the 'optimal' scalar level in order to address collective problems), problems resulting from a reconfiguration of scalar levels (rescaling) and generalising insights between different scalar levels (problems of upscaling and downscaling) (Moss and Newig, 2010).

4.2.3 Problems of Scalar Fits

Misfits between different scalar dimensions (levels in a hierarchy) usually happen between biophysical dimensions and resource management dimensions. The problem of fit was introduced by Young (2002; 2005), stating that "the effectiveness of social institutions is a function of the match between the characteristics of the institutions themselves and the characteristics of the bio-geophysical systems with which they interact." It is worth noting that mismatches between biophysical and administrative scalar units are inevitable. However, this does not necessarily mean that the problem of fit should be taken for granted. In contrast, the environmental governance process should improve this mismatch by facilitating institutional arrangements.

4.2.4 Finding the Optimal Scale for Water Management

One way to address this problem of misfit is find the 'optimal' scalar level, either in the administrative or the biophysical system, in order to address collective problems.

As far as the administrative dimension is concerned, some argue that scaling water resources management at the national level through centralised coordination, command and control has advantages (Lebel et al., 2005). However, an opposite picture emerges from research trying to understand the different performance of water management and environmental governance in unitary governments and federal countries. For example, Moss (2003) finds that in a federal country, such as Germany, introducing River Basin Management under the European Union Water Framework Directive at the national level poses significant challenges to existing institutions. At the same time, Doyle et al. (2013) observe that federal environmentalism in United States causes particular states and federal agencies in different social and environmental settings to interpret a unified national policy in different ways, and to produce very different outcomes in some arenas. Comparing water quality management in the Rhine in the European Union with that of the Zhujiang in China, da Silveira and Richards (2013) conclude that in the European case polycentrism and the variety of incentives at different levels have enhanced the adaptive capacity while institutional dynamics in China renders water quality management less adaptive. In his study of hydro-politics in China, Moore (2014) similarly asserts that inter-jurisdictional water conflicts are likely to pose growing difficulties for the Chinese political system. It can be seen therefore that water management in a centralised system does not always work perfectly.

Scholars studying common resources management do consider the effectiveness and legitimacy of polycentric and multi-level systems of environmental governance in a broader governance context. While some argue these forms are favourable, others point out that nested hierarchies of decision making can impede smooth policy implementation and increase transaction costs (Armitage et al., 2009; Ostrom et al., 1999; Tsebelis, 1995).

Orienting water resources management around the river basin is widely accepted by various water-related experts as the appropriate unit of water governance on the basis that it represents the physical hydrological unit. However, the notion of river basin management has been challenged for several reasons. Firstly, the river basin scale is ambiguous as hydrological processes are extremely heterogeneous, complex, dynamic and multi-scalar, which means that their natural states are questionable (Jakeman et al, 1993; cited by Budds and Hinojosa, 2012). Watershed boundaries are also defined and redefined by people, and are thus partly subjective. For example, the surface water boundary in a river basin does not coexist precisely with its groundwater boundary, and in practice, hydrologists always determine a watershed’s boundary following surface flows. Even if this boundary-drawing method were not debatable, a river basin can be as large as a river like Yangtze River covering over 1700,000 km^2 (Varis et al., 2014) or can be as small as the catchment of a pond. In addition, a large river basin can be delineated into several sub-basins based on administrative needs or contestable scientific norms (e.g. Varis et al (2014) divide China's continental territory into 21 river systems instead of the widely accepted 9 water resource planning units). Secondly, river basins and water flows are not fixed but can be modified through hydraulic infrastructure, economic development and water policies, and thereby rendering watershed boundaries inherently dynamic (Budds and Hinojosa, 2012). Thirdly, there are issues of authority, that is, issues of tasks and responsibilities for a new organization. In other words, a river basin corresponds poorly with political-administrative jurisdictions, which in turns leads to a river basin organization being weak or even having no authority over local and regional government. River basin committees or councils’ collaborative capabilities with other sectors that are crucial for water management, such as urban planning, regional development, agriculture, industry, will also face challenges (Lee and Moss, 2014). Lastly, structuring water management using biophysical boundaries carries the risk of encouraging water managers to focus on physical rather than socio-economic aspects of water management (Moss and Newig, 2010).

In addition to trying to find an optimal unit to minimize negative repercussions arising from the problem of fit, Cohen and Davidson's (2011) notion of watersheds as "problem-sheds"- meaning that watersheds frequently impact on, and are impacted by, factors beyond their boundaries - highlights the necessity to explore water governance in a broad context. In fact, water governance, including its forms, mechanisms and practices, is always embedded into broader socio-political contexts which have their roots in different economic, social and cultural realities (Meadowcroft, 2002). Therefore, the elaboration of modes of water management and environmental governance must be examined in the existing political economy of broader political and administrative forms.

On the basis of insights gained from the above discussion, we can see that establishing the perfect spatial fit between different scalar dimensions is not as easy as it might be imaged to be, and Lee and Moss (2014) argue that there is no perfect spatial fit. However, this does not necessarily mean that spatial fit is not important to water resources management any longer, nor that it is time for us to abandon a basin-level governance method. But it does urges us to reflect in a more nuanced manner about the problems of spatial fit. As well as putting too much emphasis on considering a river basin as a whole unit, we also need to think of informal collaboration between agencies with a river basin.

On either the administrative or biophysical scalar dimension, it is also important to recognise that optimal scalar levels are constructed, de-constructed and re-constructed according to the dominant interests concerned with particular water management problems.

4.2.5 Problems of Rescaling

Environmental governance is affected by scaling and rescaling processes which relate to the social production of scale and its impact on the distribution of power (Moss and Newig, 2010). The process of scaling and rescaling occurs when actors trying to mobilise certain problems across spatial scales. Social groups may choose to frame problems and then promote solutions accordingly at a particular scale to meet their own interests, perceptions and policy beliefs (Gupta, 2007). Gezon argues that "projects of scale-making occur as people negotiate the extent of their political influence and material impact of the decisions they make" (Gezon, 2005: 147–48). In this sense, scale-making is about which tasks should be promoted at which specific level of governance according to actors' choices.

Different from the meanings of scale in a hierarchy, "scale" here is no longer only considered to be fixed in a pre-given territorial administrative unit and their subordinate levels. Instead, relational "scales" can be understood as spatial concepts of socio-political dynamics whose continuous contestation and restructuration express a ''social struggle for power and control'' (Swyngedouw, 1997). The reconfiguration of authority at new spatial levels is a result of actors' ability to work across scales or levels to meet their own purposes. The power relations are renegotiated and reconfigured (Moss and Newig, 2010). Thus, scale is the "outcome of socio-spatial processes that regulate and organise social power relations" (Swyngedouw, 2004). In other words, power is embedded in and reproduced by the process of scaling - agents enact and transform power relations through their actions and structures enables and constrains human actions (Leitner and Miller, 2007: 118).

"Rescaling" is a very useful analytical lens to investigate how people and places influence each other. However, rescaling practices entail complexities and difficulties, and thus scalar practices sometimes struggle and do not always succeed. For example, the case of Franco's transformation of the hydraulic environment in Spain (Swyngedouw, 2007), seeking to transform Spain's environment and achieve nationalist homogenization, failed partly because Franco's political agenda was unsuccessful. The capacity to control and capture resources, information and knowledge from different levels varies greatly among stakeholders, and therefore different interested groups possess variable abilities to make use of alternative scales of regulation and decision-making. A successful rescaling process may not only move an existing task to a different scale in a hierarchy but could also set a new process with different spatial-temporal and institutional features.

Scaling upwards occurs when problems will never be effectively solved by actors at a low scale. Often environmental problems need to be addressed in this way, because impacts of some physical processes spread widely. For example, for river basin management, downstream jurisdictions may rescale the task of water quality management upwards to the entire basin with the aim of controlling water pollution. Other reasons of scaling up include to enhance understanding of the problem, to improve governance, to promote domestic interests, and the desire to promote extraterritorial interests (Gupta et al., 2007).

At the other end of spectrum, downwards scaling is preferred to enhance understanding of local causes and impacts, to avoid liability for impacts elsewhere, to empower local rights and to bypass national governments (Gupta, 2007; Gupta et al., 2007).

In rescaling processes, whether state's power is really weakened is still debatable. Rescaling transforms power relations by creating spaces, and by changing institutions, decision making processes and social actors', including state's roles (Cohen & Bakker, 2014). In some cases, there is a restructuration of state's roles in regulation and service provision, shifting from government to governance (e.g. Bakker's study on water privatisation in England (Bakker, 2003; 2005). But it is not uncommon that state still retain real power. Swyngedouw (1997; 2007) vividly details how state's important roles, through exercise of social, political, and economic powers at a given geographical scale, play out in transformation of ecological processes. Scott (1998) says state creates new institutions, appealing to wider local interests, to promote development and management, and in this system states have a far more powerful voice than local actors in defining how scale is represented in a series of policies, laws, or media campaigns, and sometimes even in threats and the exercise of force. Clearly state's roles cannot be ignored in rescaling process.

4.2.6 Problems of Upscaling and Downscaling

The process of defining problems at a specific scale can have huge impacts in addressing environmental problems, as it identifies issues, identifies resources and stakeholders, finds best solutions, and promotes policies (Bruyninckx, 2009). Thus politicians often tend to expand successful solutions from one level to others to bring more benefits to more people over a wider geographical area more quickly (Lovell et al., 2002).

However, these endeavours are not easy, given that there are differences among contexts, power dynamics at other levels. Clark (1985) suggests a simplistic scale-dependent perspective is rather risky, and it is unrealistic to believe causal explanations, variables and generalisations relevant to one scale can do full justice to others.

However, transferring scale is argued to be possible and success is contingent on a number of similar factors across different levels. These factors include the nature of the environmental resource, the nature of the problem in terms of distribution of costs and benefits, the nature of the science and knowledge, the formal legal framework, the contractual environment and the values and beliefs (cultural contexts) (Gupta, 2008).

These thoughts lead this chapter to explore how the rescaling process happens by implementing eco-compensation in the Xin'an River. This case lends us an excellent opportunity to study the politics of scale in water management, since as our following study will show, the proposal, design and finally the implementation of an eco-compensation project is embedded in a process of struggle in which various actors at different geographical scales apply strategies in order to pursue their own interests.

4.3 Political Economy of China's Water Governance

Before the "opening-up" policy and reform in 1978, China's political economy was a highly planned system, with complex affairs completely planned and controlled by the central government under the leadership of the Communist Party of China (CPC). In order to facilitate the central government's control, the governance structure in China was organized in a hierarchical form with province and municipal-level administrative units both being responsible for each lower level and responsible to each higher level. Kornai (1980) used a metaphor of father and sons in a traditional family to describe the relationship between central and local governments under this mechanism of "vertical control" (cited by Long and Ng, 2001), which means the centre had unchallenged power and control over different localities' social and economic activities. Despite this, during this pre-reform period, there were instances in which provincial governments mis-reported statistics with the aim of claiming larger budgets from the central government (Lardy, 1975). However, there was no obvious central-local divergence at that time.

Due to the economic stagnation before 1978, some Chinese leaders at national level decided to carry out a series of economic reform and openness policies to boost the economy, such as introducing market mechanisms, and devolution of power to local governments. Throughout the 1980s important administrative and fiscal responsibilities were devolved to regional and local governments, which in turn enhanced local authorities' autonomy over trade, foreign investment, land use, budgeting and expenditure (Chien, 2010). In spite of these massive efforts at economic decentralisation, political power was still firmly centralised, with the CPC's complete control of administration and legislation. This phenomenon of 'economic decentralization to the local' along with 'political centralization under the party' is described as 'asymmetric decentralization' by Chien (2010). Although recent decentralisation and regional autonomy policies in China encourage local initiatives and incentives, the vertical control system successfully prevents local governments from being truly granted political autonomy. This absolute retention of power in the centre can be largely attributed to two reasons. Firstly, the central CPC leaders have a cadre management system, according to which they can appoint, promote and in rare cases dismiss leaders at subordinate levels. Moreover, higher leaders at sub-national levels have to serve in other jurisdictions periodically for the purpose of preventing them from building powerful networks with local leaders and social elites (Moore, 2014). Secondly, in the late 1980s, an evaluation system targeted at cadres was introduced in order to facilitate central polices and regain control of local officers' activities. In accordance with this performance evaluation system, a local leader was likely to be sanctioned if he/she failed to fulfill his/her responsibility to meet specific pre-negotiated targets according to various terms, such as economic measures, social development indicators and so on (Chien, 2010). These two mechanisms substantially limit the ability of local government officers to develop local priorities which are not compatible with central ones.

Yet despite strong top–down control in a politically centralised country, this vertical control system is not without its downsides. Eaton and Kostka (2014) point to the problem of the high rate of rotation of leading cadres in local governments over relatively short periods (e.g. 3 or 4 years), which hinders implementation of the top-down policies. Because of the short time horizon of the local officials, they tend to choose "quick, low-quality" projects that do not result in improved environmental outcomes in the long run in order to deliver visible "political accomplishments" (*zhengji*). Another significant factor is that horizontal relationships between different jurisdictions are not considered important, which makes local interests often compete with each other and render inter-jurisdictional cooperation almost impossible. These situations have been greatly exacerbated by the process of economic reform, under which revenue sharing and expenditure-allocating powers have been progressively transferred to sub-national levels of government. During the fiscal decentralisation period, there have been growing numbers of local enterprises, which significantly provided incentives for local governments to generate revenue streams and boosted economic growth (Qian, 2012). This fiscal decentralization has created a growing problem of central control. Yang (1997) argues that once local governments are given possession of fiscal revenue streams from their economic development, they will pursue local interests. Moreover, the share of total revenue transferred to the central government fell sharply from 39% in late 1980s to 22% in 1993 (Dabla-Norris, 2005). A tax reform in 1994 was initiated by the central government in order to rebalance tax sharing between central and local governments, with a shared tax as well as separate national and local taxation systems. This tax reform can also be considered as a process of redistribution of central-local power. However, several problems still exist after the recentralization of tax revenues in 1994. First, there is no formal, legal assignment of expenditure responsibilities to the sub-provincial level, which may cause higher-level governments to shift financing responsibilities to the lower-level. For instance, in 2002, the share of local governments in total budget revenue was about 45% (compared to 78% in 1993, see above), but they shared around 70% of total budget expenditures for the provision of education and health services, unemployment insurance, and social security (Dabla-Norris, 2005). In terms of water-related investments, about two-thirds of expenditure came from local government (Chen, 2010). Second, richer regions can gain much more revenue than their poor counterparts since manufacturing and service sectors contribute more value-added tax (VAT) and enterprise income tax levied on local state-owned enterprises and foreign-financed enterprises (Dabla-Norris, 2005). Consequently, this will reinforce uneven development in different areas. Not surprisingly, this will leave less advanced regions to implement national and provincial policies selectively in the light of local priorities, particularly with very limited budgets for large volumes of different tasks. Actually, even some of the richest regions also witness this trend. For example, Skinner et al (2003) find that in Huzhou Municipality, a wealthy city in Zhejiang Province which is famous for the prosperity of its private enterprises, local governments have to increase the education fees collected from households and local industries in order to provide basic education, which should have been free according to national regulation.

It is important to note that in this hierarchical form, there are several administrative sectors which represent national government in order to facilitate different functional ends, such as water resources management, education, commerce and so on, with corresponding units at each lower territorial level. This administrative system hence gives rise to two types of political relationship - direct leadership relations involving binding orders (*lingdao guanxi*) and professional relations with non-binding instructions (*yewu guanxi*) (Mertha, 2005). Through recent attempts to recentralise a number of key bureaucracies partially, which are directly controlled by the functional administrative superiors, including the Administration for Industry and Commerce (Mertha, 2005), most functional departments now only have the former *lingdao guanxi* with its direct superior at the same level - for example, a Ministry only has this kind of leadership relations with State Council (central government) - while they are professionally instructed by counterpart functional units at higher levels. In China's political system, officials of regional or local bureaus (functional departments) are often appointed by local governments at the same administrative level, rather than by administrative superiors at higher levels. For example, the director of a municipal Water Resources Bureau is appointed by the municipal government, rather than the provincial Bureau. This leadership is often described by the Chinese as "leadership along a 'piece'," or *kuaishang lingdao*, whereas professional relations with non-binding instructions are called "leadership along a 'line'," or *tiaoshang lingdao*. As we can see, a local bureau is dually led by local government, politically at the same level, as well as by a bureau professionally at a higher level. According to Lieberthal (1992), this situation where authority in China is fragmented by function and by territory in the process of policy making and implementation is called "fragmented authoritarianism".

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In theory, "line" administration is designed to make sure that higher-level government policies are implemented smoothly and uniformly. “Piece-” or *kuai*-based leadership relations help local governments achieve a degree of independence from external influence, improve adaptability to local conditions in the policy implementation, and facilitate co-ordination between functional departments (Mertha, 2005). However, in reality, this fragmented regime is unable to escape from its own limitations. The first and the most negative point is that this structure inevitability provides opportunities for the expansion of local protectionism, arising from a local governments' adaptation of national decrees in order to purse its own interests, sometimes even at the expense of central governments' initial intentions. This is mainly because these local bureau's directors are appointed by local government and staff, and the personnel's' salaries come from local expenditures. This *kuai*-based management contributes to the inefficient implementation of national policies. Second, government functional organs at one level are politically ranked at the same level as regional government at a level lower, which makes them lack the authority to ensure every policy is running smoothly. For example, in 1990s, although the State Environmental Protection Administration (SEPA, now the Ministry of Environmental Protection(MEP)) required Jiangsu province to meet prescribed levels of water quality as it flowed into neighbouring Zhejiang province, downstream water quality did not improve accordingly (Moore, 2014).

This process of economic decentralisation which grants local government considerable autonomy and *de facto* power, together with the complicated dual leaderships reflected in the “line” and “piece” approach, casts a significant negative influence on water management and environmental governance, particularly on water quality management as a synthesis of these two tasks. Giving priority to economic growth by local governments in order to generate revenue streams, consistently trying to avoid expensive investment in water quality improvement projects due to competing demand on limited financial resources, and lacking co-ordination and cooperation among functional administrative units and different jurisdictional regions are the main reasons for continuous water degradation in the country (da Silveira, 2014; Xie et al., 2009).

There is a series of laws and regulations in place with regard to water management and environmental protection in China. Four laws, including the Water Law and the Water Pollution Prevention and Control Law (WPPCL), and several administrative regulations, such as the

Regulation of River Channels and the Regulation on the Administration of the License for Water Drawing and the Levy of Water Resource Fees have been set in place at the national level.

China's Water Law, Water and Soil Conservation Law, and WPPCL involve important articles in respect to water quality management; however, while WPPCL is carried out by the MEP, the other two laws claim that the Ministry of Water Resources (MWR) holds responsibility related to protection of water resources and soil conservation. This overlapping of responsibilities echoes the Chinese saying of 'taming the water with nine dragons' (*jiulong zhishui)*, which means nine or more ministries involve in the water governance system. To be more exact, in addition to the two main ministerial agencies - MWR and MEP - responsible for water body protection and preventing pollution from industrial and municipal sources, non-point agricultural sources pollution issues and sewage treatment facilities are dealt with the Ministry of Agriculture and the Ministry of Housing and Urban-Rural Development respectively. Moreover, a number of other ministries are also involved in water quality affairs. It is also worth mentioning that sometimes the National Development and Reform Commission (NDRC) plays an important role in the process of approving plans, and budgets assigned to their implementation. This, in turn, makes collaboration between different actors difficult and the whole system inefficient.

Besides the horizontal fragmentation between Ministries with different responsibilities, vertical fragmentation of China's water governance has its disadvantages as well. The most notorious one is possibly that water management is still primarily conducted on the basis of administrative boundaries rather than biophysical boundaries. The Water Law after revision in 2002, establishes the river basin management principle by saying "the state shall exercise a water resources management system of river basin management in conjunction with jurisdictional management". The law gives the MWR main responsibility for the unified administration and supervision of water resources management throughout the country, and seven River Basin Commissions as agencies for MWR have been set up in order to implement river basin management. Although the Water Law recognizes the legitimacy of River Basin Commissions to develop basin-wide water resource development and water allocation plans, these organisations' bureaucratic rank is lower than that of provincial governments. As a result, they lack sufficient capability to mediate conflicts of interests between individual provinces. Moreover, commissions are just regional agencies of the MWR, rather than truly integrated river basin management agencies, which in most federal systems are platforms gathering all shareholders and eliminating conflict through integrating land use and water resource planning mechanisms (Shen 2009).

Given that the economic decentralisation gives local governments much autonomy and economic power, jurisdictions seek to fulfill their own interests, having no obligation to consider negative environmental externality of their self-centred activities. This tendency is enhanced by the financial reform, which means most investments related to pollution control measures are a burden on the local budgets. However, governments in the upper reaches cannot prevent places downstream enjoying clean water (non-exclusivity), and lower reaches do not need to share any water quality improvement expenditure incurred upstream (free-riding). More often than not, pollution control is not a priority in local governments' budgets. Wang (2002) remarks that this situation is characterized by "a close relationship to local economies and local-benefit thinking on the part of some local governments."

This chapter therefore includes an empirical case study that seeks to explore how eco-compensation schemes may impact power dynamics of this water management system.

4.4 Eco-compensation in Xin'an River

The Xin'an River originates from the southern part of the Huangshan Mountain in Huangshan City, Anhui Province, and flows into The Xin'an River Reservoir in the Municipality of Hangzhou, Zhejiang Province (Figure 4.1). It is the third longest river in Anhui, exceeded only by the Yangtze River and the Huai River passing though Anhui Province. The main stream is 359km in length, covering a total area of 11674 km^2. Around 60% of the river basin is located in Anhui Province where the upstream of the river is 242.3 km long and has 54 tributaries, with areas of 5,820 km^2 and 620 km^2 in Huangshan City and Xuancheng City respectively (NDRC,2013). It is widely accepted in academia and the policy domain that the upstream basin covers 7 counties of Huangshan and one of Xuancheng while the downstream territory includes 2 counties of Hangzhou (see Table 4.1). The Xin'an River basin is located in the northern part of the subtropical region and has a humid monsoon climate. As a result, precipitation is abundant. To be more exact, the average annual rainfall from 1956 to 2000 was 1,786 mm and the total precipitation was 11.5 billion m^3; the upstream region is where most of the precipitation occurs. The average runoff in the river basin is 12.67 billion m^3, constituting over 60% of the total amount of runoff flowing into the Xin'an River Reservoir - Hangzhou's drinking water source - which was created by a dam constructed in 1959 in the downstream reach of the basin (NDRC, 2013).

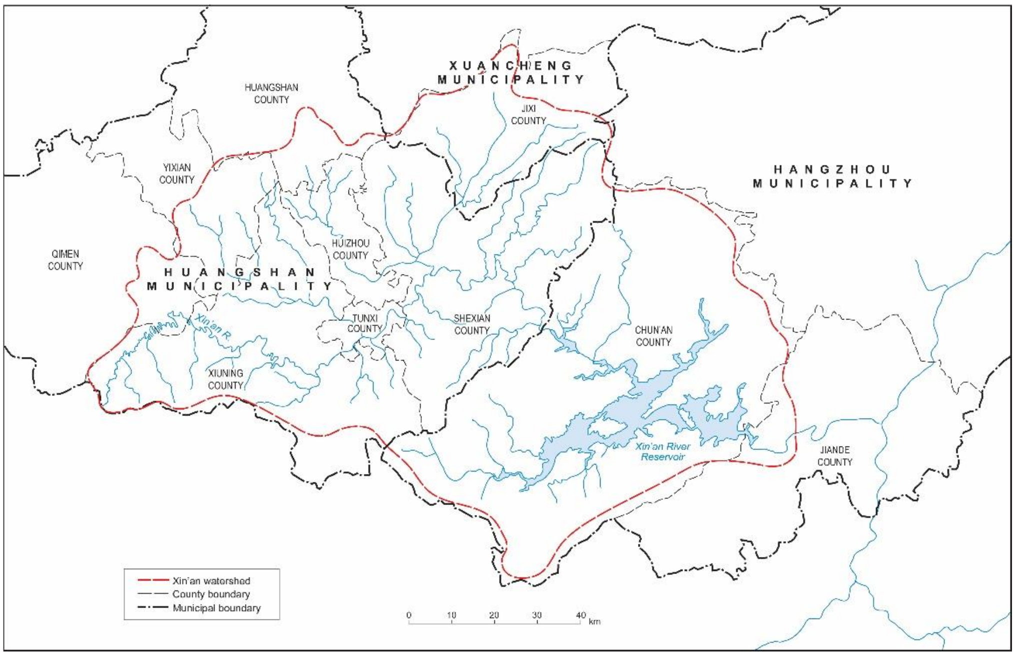

Figure 4.1 Location of Xin'an River

Source: Produced by Stickler, P.

Even though it is a trans-province river, there is no formal river management organisation specially created to mediate water issues. In fact, Xin'an River is located in the region where the Tai Lake Commission (one of 7 River Commission) is responsible for implementing water-related laws and regulations and dealing with water resources management matters, particularly with regard to water quantity. This could include inter-provincial water allocation, drought contingency management, flood control, pollutant carrying capacity calculations and so on (Shen 2009). However, Tai Lake Commission's bureaucratic rank is only as high as that of municipalities, and it is thereby inefficient in coordinating the various stakeholders for negotiation when conflicts occur, especially when it involves water quality issues since this needs to work closely with environmental protection bureau at provincial level.

Upstream regions rely heavily on traditional agricultural activities, and increasingly a flourishing tourism industry. In spite of rapid development, industries in the upstream are much less developed compared with the downstream counterparts. This can be illustrated by the per capita GDP (2010), which in the upper reaches varies from 15,115 CNY to 28,766 CNY, compared with 25,907 CNY and 37,201 CNY in the downstream (see Table 4.1).

4.4.1 Increasing Conflicts over Water Quality Management

As industries are under-developed in the upstream region, industrial point discharge is not serious and domestic sewage, soil erosion and agricultural non-point pollution are more detrimental to water quality. But overall, water quality in the Xin'an River is good. In the upper reach, measurements taken by Huangshan Municipal Environment Monitoring Centre of 24 water quality parameters–including COD_{Mn}, NH_3-H and TP - at 8 water quality monitoring sections in 2010 showed that the overall water quality was well above Grade III[13] (NDRC, 2013). To be more exact, only the monitoring result at one section was classified as Grade III while all the others were classified as Grade II. This is much better than the average water quality situation across China as a whole - according to the 2010 China Water Resources Quality Report only around 35% of monitored river status were of Class II or better (MWR, 2010). When it comes to water quality in the downstream reaches, measurements for these three indexes at 12 water quality monitoring sections in 2010 show that 8 of them were Grade II and the others were Grade I. Moreover, the parameter TN is measured as well, since it is useful to identify the degree of lake eutrophication. However, the result in terms of TN was not as good as the other three indexes, indicating the overall downstream water quality was only Grade IV or V. The concentration of TN fluctuated from 0.82 to 1.01 mg/l and was highly likely to cause eutrophication (NDRC, 2013).

In spite of this, there was a generally increasing tendency for all these parameters in the upstream during the period from 2006 to 2010, seeing COD_{Mn}, NH_3-H and TP varying between 0.9 and 3.36 mg/l, 0.13 and 0.95 mg/l and 0.025 and 0.12 mg/l respectively. Similarly, the main parameters had crept up slightly from 2006 to 2010 in the downstream as well.

[13] For details of the Chinese water quality classification system, see 1.1 in Chapter1.

Table 4.1 Basic Socio-economic Characteristics of Jurisdictions Located inside the Xin’an River Basin

									Composition of GDP (%)									
	Area in the Baisn[14] (km^2)	Land Area (km^2)	Population			Per capita GDP(CNY)			2000			2005			2010			
			2000	2005	2010	2000	2005	2010	Agr	Ind	Tert	Agr	Ind	Tert	Agr	Ind	Tert
Upstream																		
Huangshan[15]	5,856.07	9,807	1,468,600	1,469,000	1,480,500	5,591	10,909	20,846	23	31	46	16.4	35.9	47.7	12.7	44.1	43.2
Tunxi	249	249	149,303	160,563	174,273	5,733	9,547	23,434	20.2	27.9	51.9	12.5	36.2	51.3	5.9	34.8	58.3
Huizhou	424	440.7	97,287	99,088	100,446	4,473	9,536	22,825	31.5	34.6	33.9	18.8	44.2	37.1	11.3	62.1	26.6
Shexian	2236	2,236	502,263	493,286	485,798	4,456	8,675	16,331	20	39.5	40.5	16.8	43.6	39.6	15.4	47.4	37.2
Huangshan	289.95	1,775	162,000	161,044	162,500	7,259	13,480	28,766	26.1	13.4	60.5	19.4	22	58.6	12.9	34.7	52.4
Xiuning	1,952.74	2,151	273,740	272,654	274,027	4,121	7,556	15,115	37.7	24.2	38.1	27.6	33.2	39.2	21.7	39.9	38.4
Yixian	453.38	857	97,422	95,641	95,742	4,060	7,700	16,545	35.1	31.1	33.8	27.4	36	36.6	18.1	45.6	36.3
Qimen	251	2,257	185,000	187,080	187,691	4,804	8,576	17,067	26	33	41	11	61.8	27.3	13.4	40.5	46.1
Xuancheng[16]	880.76	12,340	/	2,735,600	2,783,600	/	9,749	21,028	/	/	/	21.5	36.8	41.7	16.8	47.2	36
Jixi	880.76	1,126	/	176,600	177,200	/	8,947	18,905	/	/	/	26.5	38.9	34.6	21.2	48.4	30.4
Downstream																		
Hangzhou[17]	4,715.7	16,596	6,215,800	6,516,800	6,891,200	22,201	38,858	86,642	7.3	51.6	41.1	5.5	53	41.5	5	50.8	4.2
Chunan	4,452	4,452	449,235	452,539	454,286	7,400	15,000	25,907	26.4	38.3	35.3	22.4	37.9	39.7	18.5	42.5	39
Jiande	263.7	2,321	5,130,000	507,128	510,194	13,132	19,450	37,201	15.1	57.4	27.5	15.9	55.2	28.9	11.2	56.4	32.4

[14] For river basin area in each jurisdiction, figures were taken from Xin’an River Water Resources Management and Environment Protection Plan (NDRC, 2013).

[15] For Huangshan City and counties within it, the figures were taken from Huangshan Statistical Yearbook, 2001, 2006 and 2011 respectively.

[16] For Xuancheng City and Jixi County, the figures were taken from Xuancheng Statistical Yearbook 2006 and 2011 respectively. The figures for 2000 were not available since the jurisdictional boundary was adjusted in 2001 and data were only available from 2002.

[17] For Hangzhou City and counties within it, the figures were taken from Hangzhou Statistical Yearbook, 2001, 2006 and 2011 respectively.

The average concentration of TN during that time was 0.88 mg/l, which means that water in the Xin'an River Reservoir almost degraded to Grade IV based on the index of TN. This will lead to serious problems if the declining quality trend cannot be reversed as the downstream water will be unsuitable for the purpose of a drinking water supply then. The total sewage discharge in the river basin had a 12% increase in the 5-year period to 83.99 million tonnes, of which domestic sewage constituted over 56%. In 2010, the values of the total nitrogen load and total phosphorus load were 7,170 tonnes and 763 tonnes respectively. The run-off of fertilizer and pesticide excessively applied to agricultural activities contributed 68.9% and 80.8% of these overall discharges respectively. At the same time, total ammoniacal nitrogen load was around 3,165 tonnes, with sewage from growing urban settlements and agriculture accounting for 49.4% and 38.1% of total discharge (NDRC, 2013). Excessive application of fertilizer and pesticide to boost productivity in agricultural sector, and a low rate of treated urban wastewater in the sparsely urbanised region have contributed to the gradual deterioration of the river's water quality. The situation was considered likely to get even worse if no measures are taken in the near future.

Given the deteriorating trend of water quality in Xin'an River, especially in the lower reach containing the Xin'an River Reservoir, Hangzhou City (which depends on the Xin'an River Reservoir for drinking water sources) has consistently asked the upstream region to take various actions to improve water quality. This basin-wide proposal is mainly based on the fact that water continuously flows across political boundaries, and land-use activities, industrial pollution and sewage in the upstream will result in negative outcomes in the whole basin. Because of the highly fragmented institutional structures, coordination over hydro-conflicts regarding water quality issue is usually impossible in China. Indeed, after an outbreak of blue algae in part of the Xin'an River Reservoir in 1998, representatives of the Zhejiang Province in the subsequent year submitted a proposal during the National People's Congress (NPC), asking the upstream Anhui Province to improve the cleaning of floating rubbish in the Xin'an River (Interview7, 2014). However, no progressive achievement had been made, although the former National Environmental Protection Bureau (now MEP) did organise a coordination meeting between the two provinces.

4.4.2 Negotiating an Eco-compensation Project

Huangshan City then argued that the downstream would enjoy the benefits of water pollution control measures in the upstream, but had not shared any of the cost; that is to say, that the costs and benefits of water quality management were unequally shared by the two parties. One local officer even used the compensation policy for affected people in the Xin'an River Dam construction to justify this claim.

> "People in upstream had sacrificed too much last century when the dam was built in the lower reach. Forcibly relocated people only got very little compensation then, and a large portion of them became poor due to the resettlement and are still very poor today. The costs were borne by them but hardly any benefits were shared with them." (Interview 7, 2014)

This upstream-downstream conflict, or "politics of position" (Lebel et al., 2005) is exacerbated by the substantial economic disparity between the two cities. The GDP per capita of Huangshan City is less than a quarter of the level in Hangzhou City, and much less than the two downstream counties which are among the least developed counties in Hangzhou (see Table 4.1). The upstream claimed that this divergence could be largely ascribed to their endless efforts, which were environmental friendly but less economically profitable, to protect water quality. It was said that from 2000 the estimated annual forgone cost due to turning down a number of large-scale industrial enterprises had been around 2billion CNY (Interview 4, 2014). Finally, Anhui submitted a proposal to the central government, hoping to establish an eco-compensation scheme which reflects the "beneficiaries pay principle" to provide monetary incentives for water quality management and to compensate for opportunity cost. To support its position, the government asked the China Institute of Water Resource and Hydropower Research (IWHR), a leading water-related research organization which regularly advises on water policies, to conduct a consultancy programme. In the unpublished report, IWHR highlights the rhetoric that treating water as economic good will contribute to effective water management and water has inherent values due to its scarcity (IWHR, 2006). Moreover, it suggests that fiscal transfers between administrative boundaries should be introduced, considering costs to manage water of good quality, opportunity costs, and benefits which healthy water brings to both ecosystems and humans.

China's central authority has been playing a proactive role in creating momentum towards eco-compensation, with the aim of finding new ways to finance environment protection and conservation efforts. This enthusiasm embodies a narrative of ecological modernization, holding a perspective that environmental concerns and economic growth are not mutually exclusive, and that sustainable development could be achieved through the internalization of environmental impacts via market-based solutions (Yeh, 2009). Even though a number of large public payment schemes have been carried out nation-wide, such as SLCP, there were only small-scale eco-compensation projects at the prefecture or municipal levels before the case described in this chapter (Zheng and Zhang, 2006). Essentially, the central government has always been eager to develop intra-regional and watershed-related eco-compensation projects to resolve funding issues and to mediate intra-jurisdiction relations (Bennett, 2009). Under such circumstances, the proposal from Anhui drew considerable attention from the central government, particularly during 2005-2007 when a member of the NPC's Environment and Resources Committee proposed to designate the Xin'an River Basin as a watershed where a pilot trans-provincial eco-compensation scheme would be carried out (Wen, 2013). Thereafter, NDRC announced the Xin'an River Basin as the region for the first pilot eco-compensation project for trans-provincial watershed management in the country.

However, even though the two parties had agreed to take part in the eco-compensation programme, several divergences still existed at that time since eco-compensation design is a complex process and involves many different steps. A highly contested one is about what performance measures and baselines would be used to examine whether the eco-compensation project is effective. Normally, there are two different types of performance measure: 1) Payment would be made directly conditional on the ES provided; however, such 'output-based' payments are often hard to achieve since ES is high complex, but simplified yet relatively validated "proxy" or "indicator" variables need to be developed. 2) Most PES programmes and eco-compensation base payments on adoption of particular land uses, e.g. payment are made based on per hectare of forest conserved (Engel, et al., 2008). In the Xin'an case, ES is simplified into water quality largely because in the Chinese contexts water pollution and water scarcity are the two main problems that lead to water crises, though linking changes in water quality to changes in multiple ecosystem goods and services is still challenging (Keeler, et al., 2012). Additionally, baselines need to be constructed to see if the eco-compensation scheme can bring sufficient environmental additionality, which will, in turn, reassure buyers that the requisite services are indeed being provided. In this case, if water quality improves, the project is effective and payment is made to the upstream. However, water quality cannot be defined by measurement of only one parameter. Rather, there is a range of chemical, physical, and biological components that determine water quality, and several variables must be measured to provide a general indication of water quality. Thus, how to determine a reasonable baseline is very crucial for this project. In the process of negotiation, initially, the MEP proposed that the baseline could be the average pollutant concentration during 2008-2010 of four quality indexes, namely $COD_{Mn,}$ NH_3-H, TP and TN, with each being given the same weight. However, there is no evidence suggesting why they determined to set up the baseline in this manner. Not surprisingly, this gave rise to some contestation. For the upstream, they argued that due to climate change there was likely to be a decreasing trend in rainfall, and this in turn may mean less runoff in some years. As a result, water quality may experience an unexpected degradation even though efforts to tackle water pollution had been made. Considering this, finally, a parameter $p=\sum_{i=0}^{4} s\ w_i\ {}^{c_i}/_{c_{i0}}$ was adopted to assess if the water quality met the desired target (Cheng, 2013). In this parameter, i ranging from 1 to 4 refers to the above-mentioned four water quality indices, c_i is the average concentration of the water quality index which is monitored at the boundary river section in each year; c_{i0} is the baseline of the water quality index; and w_i is the weight of each water quality index which is equal to 0.25. S, equal to 0.85, was introduced to allow for possible rainfall decreases). If $p \leq 1$, the downstream would pay the upstream 100 million CNY per year as a reward for managing water quality protection.

Although the downstream jurisdiction contended that, using this parameter, even if water quality deteriorated slightly they still had to make the payment, this performance measure method has not been changed. To be more precise, if p=1, the ratio between pollutant concentration and baseline concentration is about 1.18, which means an 18% increase in pollutant concentration is acceptable in this project. It is also noteworthy to mention that, under this water quality assessment method, it is possible that the overall water quality may still improve if deterioration for some indexes happens, as this deterioration could be offset by improvement for some other indexes.

The downstream pays to the upstream if the negotiated target is achieved, which is based on the "beneficiary pays principle", and offers economic incentives to those who contribute to environmental protection and conservation. However, in theory, a clear and enforceable sanction for non-compliance is important as this will ensure that payment made by "buyers" in an eco-compensation project justify the environmental additionality created by these schemes. This is especially vital in the case in this research, as one problem of environment management is that China's national policies are relatively strict, but pollution enforcement depends highly on municipal and county governments (Tilt 2007). Although, in 2007, the central government added environmental outcomes as a criterion in the officials' performance evaluation system, a number of implementation problems still exist, such as excessive focus on measurable criteria, the manipulation of reported results, and trade-offs with other career enhancing norms, such as economic growth and employment (Ongley, 2009). In order to ensure the upstream will comply according to the eco-compensation agreement and thus bring about desirable environmental outcomes, a non-compliance sanction was imposed - if the water quality has not met the required level, the upstream would pay 100 million CNY to the downstream as a penalty. However, it is understandable that a lot of PES and eco-compensation projects do not establish non-compliance sanction measures, because it is possible that potential providers of ES will not be willing to take part in PES or eco-compensation schemes as they might be punished if they fail to produce acceptable outcomes.

It is necessary to mention that, in either case, the central government allocates 300million CNY per year to Anhui Province for flexibly adopting both conservation practices and pollution abatement technologies to ensure the water quality. Here, the central government's stance can be understood as a way of allocating budgets to facilitate negotiation.

Since the payment between the upstream and downstream provinces is dependent on the result of water quality, monitoring of water quality is crucial in this project. A detailed water monitoring plan has been formulated by the National Environmental Monitoring Centre (NEMC) affiliated to the MEP (Cheng, 2013). To be more exact, water sampling at the boundary river section is jointly conducted by staff from upstream and downstream on a monthly basis under the coordination of the NEMC. Each sample is split into two sub-samples to be analysed by the two provinces individually, and the average of the two results is used for water quality assessment. If the two parties have any dispute on the monitoring data, they can turn to NEMC for final arbitration. In practice, ever since October 2012, the two provinces have further collaborated to collect water and analyse water samples jointly. In addition to the monthly manual monitoring, a national automatic water quality monitoring station at the same river section provides reference data six times per day.

Besides the eco-compensation contract, an equally important element is the Upper Xin'an River Basin Water Resources and Environmental Protection Planning prepared by NDRC. The planning outlined various targets for environmental protection and conservation in the upstream, such as that water quality at the boundary section would be kept at Class I or Class II, as the total load of COD and NH_3-H would meet government's requirement. Besides water quality management, it applied a holistic approach for river basin management, aiming to address various aspects, such as soil erosion control, forest management, water consumption control, irrigation efficiency improvement. Moreover, it divided the river basin into different functional zones and identified where should be prioritised for water quality management. Not only did the plan set certain management targets, it also gave a detailed implementation process, listing specific measures and projects (NDRC, 2013).

4.5 Discussion and Conclusion

On the basis of the above analysis of the political economy of China's water management regime, a detailed description of the problems existing in the Xin'an River Basin and the proposal and negotiation of the PES project, some in-depth discussions around scalar issues in the Xin'an eco-compensation project can be made.

4.5.1 Political System Affects the Rescaling of Water Governance

The first research question asks how the political system in China affects water governance through the introduction of eco-compensation. The insights from the Xin'an case show that the existing political economy of the broader political and administrative contexts matters. The analysis in section 4.3 shows that the final setting up of eco-compensation can be directly attributed to the political economy of the water governance regime. Eco-compensation can be seen as a step towards rescaling water quality governance to meet multiple stakeholders' different needs. In fact, China's "fragmented political system" and the process of "economic decentralization to the local" has affected the introduction of eco-compensation in the following major respects: fiscally and economically and politically.

Firstly, from a political perspective, although the Chinese government has created a set of environmental laws and regulations to address its environmental problems, it is widely cited that an implementation deficit is a major problem that allows the environmental situation to remain serious (Johnson, 2009; da Silveira, 2014; Shen, 2009) And as many scholars believe, the main culprit is China's "authoritarian but fragmented political system" (Lieberthal, 1992; Moore, 2014; Shen, 2009; da Silveira and Richards, 2013).

In the Chinese political system where a top-down exercise of political power occurs in a "vertical control" manner, the central government relies on its sub-governments at the lower levels to exercise its agency and power. In order to retain control over the local officials' actions, a cadre management system and an evaluation system targeting at cadres has been constructed. Having evidence showing high tangible economic development outcomes increases a cadres' possibility of promotion (Wu et al., 2014). On the contrary, if he/she fails to fulfill his/her responsibility to meet pre-negotiated specific targets in various terms, a local leader is likely to be sanctioned (Chien, 2010; Moore, 2014). However, these two vertical control systems are never perfect, especially when urging local cadres to address environmental problems in line with the central policies. In this target responsibility system, more often than not, targets related to economic growth, such as the amount of GDP growth overtake those of other areas (da Silveira, 2014). Although later, the higher authorities have added environmental outcomes as a criterion in officials' performance evaluations (Ongley, 2009), one can easily imagine that a number of implementation problems exist. Interestingly, using data from 287 cities for statistical analysis, Wu et al. (2014) find that a city government's spending on environmental improvements is actually significantly negatively related to the odds of its party secretary or mayor being promoted. In Xin'an River Basin, there are strong incentives for the upstream cadres to promote economic development since those regions are relatively poor. Meanwhile, actually the water quality remains broadly acceptable despite a declining trend. As a result, it is difficult for them to improve water quality in such an economic situation.

Besides this, China's bureaucratic matrix of "leadership along 'piece' and 'line'" is notorious for making facilitation of certain governmental functions rather inefficient. In terms of water management, it is still mainly conducted on the basis of administrative boundaries rather than at the basin level. Each jurisdiction seeks to fulfill its own ends, without considering the consequences of its actions for downstream jurisdictions. A number of ministries are involved in the water environment governance system, among which are the two main Ministerial agencies - MWR and MEP - that are responsible for water body protection, and for preventing pollution from industrial and municipal sources. With many Ministries mediating the water quality problem, a lack of co-ordination and cooperation among these functional administrative units renders management activities inefficient. The problem can be exacerbated as these professional functional units only have a non-binding relationship with local authorities, which makes them lack the authority to ensure every policy is running smoothly. For example, even though officials of the MEP and its six regional supervision centres conduct environmental supervision talks with local officials, MEP does not have a primary say over personnel appointments (Huang, 2015). In the Xin'an River Basin, there is no formal river management organisation specially created to mediate water issues. There is a Xin’an River Basin Water Bureau which has been set up by the upstream jurisdictions, aiming to accommodate managerial needs in its jurisdiction. All the staff and daily running of this organisation are fully funded by the upstream. In fact, Xin’an River is located in the region where the Tai Lake Commission is responsible for implementing water-related laws and regulations and dealing with water resources management matters, particularly with regard to water quantity rather than quality management. However, Tai Lake Commission’s bureaucracy is only ranked as high as municipalities, and thereby it is inefficient at coordinating various stakeholders for negotiation when conflicts occur. It can be seen that a basin-based agreement should be established, but not necessarily a River Basin Commission in this river basin, as it would compete with the existing purposes of a number of other organisations.

Secondly, in terms of the fiscal and economic aspects, although local authorities have been given autonomy in an array of fields to generate revenues, it is a commonplace that no adequate budget is available for implementing local water and environmental governance in the less developed regions. This has echoed other research, which highlights the important role of fiscal decentralization and the allocation of water-related revenues to river basin offices for their performance, in China and some other countries alike (Houdret et al., 2014; Moss and Newig, 2010; da Silveira, 2014).

In China, local governments are prone to avoid expensive wastewater treatment investments and pass on pollution problems to downstream neighbours. The governments in the upstream areas, which are often under-developed regions, tend to have less financial means available to respond to water quality management challenges. This situation is even worse when considering the fact that these regions are likely to attempt to develop industrial activities, which may cause degradation of water quality, in order to generate revenues to meet budgets for numerous other activities. With increasing pressure from the downstream to maintain/improve water quality at/to a standard suitable for drinking and other uses, the upstream authorities’ limited budgets are deemed insufficient enough to finance water quality management, which would require investing in and running wastewater treatment facilities, controlling soil erosion and so on. In Xin’an River Basin, before the introduction of its eco-compensation project, there was no financial transfer from upstream to downstream and water quality management was mainly self-supported economically by the upstream despite some spending allocated by the central government for certain projects. It is obvious that the budgets of local authorities were insufficient for the required management tasks. It is reported that during the nine-year period from 1996 to 2004, the upstream had invested around 4.34 million CNY for water pollution prevention and control, comparing to the 2.5 billion CNY investments in 2012 alone after implementing the project (IWRH, 2006; Ma and Du, 2015). It is understandable why the upstream were so proactive in proposing the PES project, arguing that the downstream was a “free-rider” enjoying the benefits without making any contribution.

Since the tax reform in order to rebalance tax sharing between central and local government in the 1990s, more tax revenues have been collected by the central government. Before that the central government did not have a separate tax collection regime and local governments were considered as agents executing tax collection duties on behalf of the central government. The tax reform, a process of redistribution of tax revenues between central and local, carried out a national taxation arrangement as well as a local one, with limited revenues running into local governments’ pockets (Dabla-Norris, 2005). In the meantime, financing responsibilities for different levels of government had not changed much. The fact that in 2002, with roughly 45% of total budget revenues, local governments shared around 70% of total budget expenditures is a telling example of the shifting of financial responsibilities from higher-level governments to their lower-level agents (Dabla-Norris, 2005). In terms of water-related investments in Xin’an River Basin, no exact figure on how much the central and local contributed respectively, yet it can be seen that the central government had only contributed about 26 million CNY on soil erosion control management towards a total cost of 100 million CNY before 2004 (IWHR, 2006).

Overall, the analysis shows that the governance context is highly influential, both in terms of its political nature and in its financial aspects. It is the “fragmented authoritarianism” and the mismatch between the responsibility and budgets that give rise to the inefficient water quality management system. As a result, an eco-compensation project was designed and finally carried out to help to reduce these inefficiencies.

While it seems that progress in eco-compensation has tightened the central control over local-level environmental management, and has increased budgets at the local level, it is nevertheless too early to say that eco-compensation is a panacea for transboundary water management in China's context.

4.5.2 Politics of Scale in Eco-compensation

The second research question is how the politics of scale plays out in setting up a new eco-compensation institution to address the spatial misfit in water quality management in the Xin'an River Basin. The project, with several contested points in almost every process of the proposal development, negotiation and implementation, confirms that introducing eco-compensation is not a merely a technical issue, but is rather inherently political.

From the description in section 4.4.2, it is interesting to see that the less developed upstream region has successfully mobilised spatial scales as part of a struggle to gain financial rewards and support from both the downstream and central government.

Having been arguing that the cost and benefit of water quality management was unequally shared by the two parties for a long time, the upstream government had been trying hard to propose an eco-compensation scheme at national congress annual meetings. This strategy resonates with Hüesker and Moss's (2015) observation of "scale jumping" in which actors at one particular geographical scale mobilise claims by moving to another scale. Obviously, simply mobilising the narratives emphasising that provision of water of good quality should be paid for by those who enjoy the resources is not enough to fulfill the upstream's region purpose. One important element for the upstream jurisdictions' success is to find alliances who share similar values and beliefs. Academics from IWRM - a leading water-related research organization which regularly advises on water policies - finished a consultancy report which highlighted that fiscal transfers between administrative boundaries should be introduced in the Xin'an River Basin. A deputy chief engineer in IWRM, who was a member of NPC's Environment and Resource Committee Board, drafted a proposal to NPC for setting up a pilot eco-compensation programme in the Xin'an River Basin. This is considered to be an important reason why the proposal from the upstream region could finally get attention from the central government (Interview 5, 2014). These academics are key practitioners who provided the scientific and discursive support that can make a proposal possible.

It is noteworthy to mention that besides the financial transfer from downstream, the upstream also had been trying to mobilise scale to get additional financial supports from the central government. As discussed in Section 4.3, after the 1994 tax reform, limited revenues went into local governments' pockets, whilst financing responsibilities for different levels of governments had not changed too much. So this necessitated the upstream jurisdiction's strategy to rebalance the central-local relations in terms of financial aspects.

The way in which water quality parameters determine the direction of financial flows between upstream and downstream jurisdictions also shows the upstream's government's ability to influence the outcome of contestation and conflict. Successfully mobilising the argument that the fluctuation and uncertainty of rainfall and water flow in different years may affect water quality, a coefficient (which is 0.85) was introduced to calculate the water quality parameter. As a result, as shown in Section 4.4.2 even if the water quality deteriorated slightly, it is possible that the parameter P is still smaller than 1. This would lead to payment from downstream to upstream despite water quality deterioration.

The vested interests and power struggles linked to this rescaling process are also obvious when it comes to the important role of eco-compensation for the central government to tighten control over its local agents on water quality management. As shown in Section 4.3, for a long period of time, local authorities have gradually been able to implement national polices selectively. Due to the serious water pollution problems across China, the central government has a comprehensive set of environmental protection laws, regulations, and standards in place in order to address water quality problems. However, there is a significant implementation gap in practice. Although Article 4 of WPPCL says that "local government above county level should take all appropriate measures for water pollution prevention and control and be responsible for water quality in their jurisdictions", there is no clear statement about the level of water quality that should be achieved (WPPCL, 2008). This could partly explain why in China 17.7% and 20.9% of monitored water sections have water quality worse than Class V and Class IV to V respectively (MWR, 2010). Not surprisingly, China's central government wants to change this ambiguity, at least in the Xin'an River. In accordance with the eco-compensation agreement, the upstream government must attain a specific water quality requirement in order to get the PES payment from downstream. Otherwise, it will be penalised by being levied a fine. More importantly, the Upper Xin'an River Basin Water Resources and Environmental Protection Plan prepared by NRDC has outlined various targets for environmental protection and conservation in the upstream, such as water quality requirement, total pollutant load control, water abstraction limits and so on.

China has long been criticised for lacking a proper water quality data-sharing mechanism among its different responsible departments, and within regions (Liu, 2016). Even worse, contradictory findings in official figures published by different parties are not uncommon. For example, water quality published by Guangzhou Municipal Environment Bureau was not consistent with that of MEP (Southern Daily, 2013). A private conversation with one interviewee, revealed that once, "*a water quality monitoring staff member from downstream secretly sampled water in the upstream of Xin'an River*", confirms the level of distrust between them over the accountability for water quality data (Interview 9, 2014). A number of reasons can be identified for this phenomenon, such as the use of different monitoring locations, varied methods of sampling and so on. As can be seen in Section 4.4.2, in the eco-compensation project the politics of scale was mobilised when the central government regulated water quality monitoring to provide reliable data to determine whether the upstream would be rewarded or penalised. It is questionable whether this would improve the everyday practice of monitoring staff when they sample and analyse water quality in other locations in the region, yet this process still provides some useful insights on how to monitor water quality in transboundary rivers.

The analysis on how the politics of scale in an eco-compensation plays out in the Xin'an River Basin echoes the idea of considering scale as a process rather than merely as a fixed property or outcome (Swyngedouw, 20004). Reaching an agreement to set up PES, without doubt, is a result of negotiation by different parties often with competing positions over the appropriate scale of water governance. But from the Xin'an River project we can tell there are further negotiations over the detailed design of eco-compensation. As Section 4.4 highlights, conflicts, contestations and negotiations are indispensable parts of the concrete processes and practices of eco-compensation. Essentially, the very process of negotiating eco-compensation is also the process of struggling for the command of scale, defining relative empowerment and disempowerment and finally shaping new orders. This corroborates Swyngedouw's (2004) claim that politics of scale is about "a careful negotiation of the tensions, conflicts, and contradictions", and this is true even in a centralised country.

Chapter 5 Political Economy, Water and Eco-compensation: The Case of Miyun Catchment and Beijing's Water Supply

5.1 Introduction

As discussed in Chapter 4, it is important to consider the broad social and political contexts in which PES and eco-compensation projects are carried out. One important element is to interrogate the politics and power relations that determine the mode of environmental governance (such as a government-dominated command-and-control method, or a market-based commodification process), and how these governance modes reshape new socio-ecological configurations. From a water management perspective, usually the social and political dimensions include how narratives with regards to water availability or scarcity are framed, the roles that water plays in social struggles, and how water is managed and controlled to pursue wider economic benefits (see (Bakker, 2003a, 2003b, 2007; Swyngedouw, 2007, 2009). However, very few studies have shown how water-related PES projects, not to mention eco-compensation initiatives, exemplify these important issues (for an exception, see Rodríguez-de-Francisco and Budds, 2015).

This chapter draws on the case study of an eco-compensation programme in the Miyun Reservoir Watershed. Under this scheme, farmers in the upstream regions are paid to convert from growing rice using irrigation methods to less water-intensive crops, such as corn. In addition, financial rewards are used to encourage farmers to apply less fertiliser with the aim of improving water quality. Thus farmers on the land surrounding the reservoir are being encouraged to change land management practices to deliver more water of better quality to the Miyun Reservoir which supplies Beijing with drinking water. This chapter examines the process of framing of environmental problems, and its impacts on the establishment of water conservation goals in the Miyun Reservoir Watershed. Using this case, this chapter aims to show empirically how an eco-compensation project to increase water yields and reduce nutrient pollution reinforces the differential influence of upstream and downstream people over water usage. To this end, a political ecology perspective could provide useful insights for the analysis, because it pays attention to the social relations and power dynamics involved in environmental issues and related policy initiatives.

5.2 Theoretical Approach: Political Ecology and Water

Political ecology is an approach representing an explicit alternative to the traditional "apolitical" ecology which ignores the significant influence of political-economic forces behind environmental change. Broadly speaking, the term "combines the concerns of ecology and a broadly defined political economy. Together this encompasses the constantly shifting dialectic between society and land-based resources, and also within classes and groups within society itself" (Blaikie and Brookfield, 1987: 15).

Following Bryant and Bailey's definition (1997), political ecologists' accounts towards social-environmental interactions believe that environmental change and ecological conditions are the outcome of political processes. In essence, research problems are approached with three fundamental and linked assumptions. To be more specific, political ecologists "accept the idea that costs and benefits associated with environmental change are for the most part distributed among actors unequally . . . [which inevitably] reinforces or reduces existing social and economic inequalities . . . [which holds] political implications in terms of the altered power of actors in relation to other actors" (Bryant and Bailey, 1997: 28–29).

Political ecologists are interested in unfolding the social power asymmetry in socio-ecological processes and how power relations produce winners and losers. As a result, political ecological research deals with questions such as: What are the root causes of environmental degradation? Who benefits from certain conservation policies and who loses? And is there any resistance as a result of local land use transitions? (Robbins, 2004: 11).

The concept of geographical scale is a useful analytical lens to answer these questions. Political ecologists follow a mode of explanation, emphasising that local resource use decisions are influenced by political economic processed at multi-scales. Researchers examine decisions at many levels, from the very local, where individual land users make complex decisions such as cutting trees and ploughing fields, to the international level, where world leaders sign the 2016 Paris climate change agreement to reduce emissions.

Political-ecological explanations tend to be highly integrative and multidisciplinary, and researchers come from a diverse array of backgrounds, from political studies, sociology, geography, development studies and more. However, whatever their backgrounds, they follow a same mission - to understand the condition and change of social/environmental systems, from a point of view of power relations. Political ecology, often very critical, tries to find flaws in mainstream conservation approaches, reveal unintended outcomes borne by marginalised groups, and show these dominate accounts themselves may exacerbate environmental changes. Further, political ecologists attempt to provide alternatives - better, less coercive, less exploitative, and more sustainable ways address mismanagement and exploitation (Robbins, 2004:.12). In this sense, political ecology tries to integrate the arguments or narratives in ecological struggles and to document livelihood alternatives in the face of change.

In Robbins' introductory book (2004), he characterises diverse work on political ecology in relation to five major themes which are summarised in Table 5.1. Additionally, the diversity of political ecology research also results from smaller, differing arguments addressing, among many issues: (1) the possibility of community collective action; (2) the role of human labour in environmental metabolism; (3) the nature of risk-taking and risk-aversion in human behaviour; (4) the diversity of environmental perceptions; (5) the causes and effects of political corruption; and (6) the relationship between knowledge and power (Robbins, 2004: 24)

Among these issues, the integration of local ecological knowledge and mainstream scientific knowledge regarding ecosystem dynamics is an increasingly important topic. Under the lens of political ecology, conservation intervention that fails to take enough account of historical and geographical specificities, local conditions, and local knowledge is problematic. Pielke notes the importance of understanding the "complex interface of science and decision making in which science is 'co-produced' by various sectors of society, and separation of 'facts' and 'values' cannot be achieved" (Pielke, 2004).

Table 5.1 Five Theses of Political Ecology

Thesis	What is explained	Relevance
Degradation and marginalization	Environmental conditions (especially degradation) and the reasons for their change	Environmental degradation, long blamed on marginal people, is shown in its larger political and economic context
Conservation and control	Conservation outcomes (especially failures)	Usually viewed as benign, efforts at environmental conservation are shown to have pernicious effects, and sometimes fail as a result.
Environmental conflict and exclusion	Access to the environment and conflicts over exclusion from it (especially natural resources)	Environmental conflicts are shown to be part of larger gendered, classed, and raced struggles and vice versa.
Environmental subjects and identity	Identities of people and social groups (especially new or emerging ones)	Political identities and social struggles are shown to be linked to basic issues of livelihood and environmental activity.
Political objects and actors	Socio-political conditions (especially deeply structured one)	Political and economic systems are shown to be underpinned and affected by the nonhuman actors with which they are intertwined.

Source: Adapted from Robbins (2004: 14)

Scientific knowledge both embeds and is deeply embedded in social practices, identities, norms, conventions, discourses, instruments, and institutions and all these elements are "social" (Bixler, 2013). This point highlights that, from a political-ecological perspective, it is necessary to interrogate carefully how the social and economic practices frame ecosystem dynamics in any scientific investigation, and thus how conservation policies are prescribed. Increasingly, scholars have explored how stakeholders are embedded in their political and ecological context and how this shapes their various knowledges and understanding of ecosystem dynamics (Bixler, 2013; Budds, 2009; Forsyth, 2003).

One strand of critical environmental science is increasing the recognition and validity of local ecological knowledge, which consists of knowledge, practices, and beliefs regarding ecological relationships that are gained through extensive personal observation of and interaction with local ecosystems, and are shared among local resource users (Charnley et al., 2008). However, these studies tend to engage overly with questions of power, struggle and representation while overlooking the connections of these struggles to the biophysical environment (Walker, 2005). In line with this argument, a number of studies make a shift to show that many supposedly factual explanations of environmental problems are highly problematic since they overlook biophysical uncertainties (e.g. Budds, 2009; Forsyth, 2003). Forsyth's (2003) work in particular interrogates the dominance of environmental science as an authoritative source of physical environmental explanations. He argues that much political ecology work has failed to take a sufficiently critical stance towards the validity of environmental science explanations of the natural environment, neither considering how they are shaped by socio-political factors nor examining the politics with which those explanations have been mainstreamed. For example, using a case in La Ligua river basin, Chile, Budds (2009) has questioned the production of hydrological assessment and its use to inform water allocation decisions which produced uneven impacts on farmers within different regions of the river basin. In a similar vein, Mehta (2005) analysis of water scarcity in Kutch, India indicates that drought is not merely a biophysical phenomenon, but also a socially constructed problem to justify controversial schemes such as large dams, which allows for simplistic portrayals of property rights and the social-political reason of resource conflicts.

Despite the flourishing political ecology literature, water has seemed to fail to gain serious attention from political ecologists. In Robbins's influential book (2004), which provides a full history of the development of political ecology, water is not even included. However, especially over the last few years in the wake of the development of the water crisis, a growing number of political ecologists has focused on water, especially on water provision (e.g. Bakker, 2003a, 2003b; Loftus, 2009; Rodríguez-de-Francisco and Budds, 2014; Swyngedouw, 2007, 2009). Political-ecological perspectives on water provide useful insights into the relationship between transformations of the hydrological cycle at local, regional and even global scales, and social, political, economic and cultural power relations (Swyngedouw, 2009). Political ecologists call for interdisciplinary approaches to study water by insisting that biophysical and social dimensions cannot be separated in the process of hydro-social configuration (Bakker, 2003a).

Water scarcity has been one of the prevailing themes in studies about the political ecology of water. Various responses to address this crisis are complicated by the contradiction between those perceptions and agendas which regard water as a public good and a basic human right, and those which value water more as a profitable commodity. This reflects the question of who is entitled to what quality and quantity of water and who - private or public sector, should control, manage and provide water. Calls for universal water rights are underpinned by the belief that a human being needs to have access to at least a minimum volume of a sufficient quality of water in order to sustain bodily metabolisms and social reproduction (Swyngedouw, 2009). However, this has not prevented a growing neoliberal trend of privatisation in the domestic water supply sector both in developed and developing countries (Bakker, 2003a).

Bakker's work, in particular, although mainly focused on England and Wales, suggests a nuanced approach to the complexities of privatisation (Bakker, 2003, 2005). For consumers, the privatisation reveals a shift from policies prioritizing inter- and intra-regional equalization (emphasis on social equity) towards policies prioritizing economic efficiency (emphasis on economic equity) in water charging (Bakker, 2005). Her claim that water is an 'uncooperative commodity' unveils the conflicts between private water companies and governments. However, water privatisation does not necessarily lead to negative ramifications. Instead of simply linking negative environmental consequences to privatisation, by analysing the role of the state - in Bakker's case, the UK Environment Agency - in seeking ecological safeguards for local water supplies, she argues that water company privatisation is a process of re-regulation rather than de-regulation (see also Kinnersley, 1988) . This practice raises the necessity to consider the role of the state and the intricacies of "real" regulation in analyses of resource management.

From a different perspective, Budds and McGranahan apply a more nuanced approach towards privatisation experiences in Asia, Africa and Latin America (Budds and Mcgranahan, 2003). Rather than trying to generate polarised attitudes towards public and private water supply, they argue that private sector investments, like large public infrastructural works, are unlikely to achieve the Millennium Development Goals of doubling the number of people with necessary access to water and sanitation by 2015. In fact, neither publicly nor privately operated water companies seem well-suited to serve the needs of low-income households for adequate water and sanitation, and this is because many of the obstacles to water provision in urban poor areas cannot easily be addressed, regardless of whether water and sanitation utilities are publicly or privately operated. For example, land tenure is still a barrier preventing informal settlers from having access to water service provision, even when these people are officially within the service area of the private operator. Sometimes, private sector involvement can open new areas for corruption. Budds and McGranahan (2003) provide a solid conclusion that private sector participation in water and sanitation services will not lead to adequate water and sanitation access to deprived households in the global south. They also claim that public utilities may encounter many of the problems that arise with privatization, while sometimes reforming public sector utilities can equally achieve many of the strengths of private sector participation.

More political ecological literature on the question of privatisation has focused on analysing concrete cases of water privatisation in a range of different locations. Loftus and McDonald's work in Buenos Aires develops an agent-centred approach to understanding the political ecology of water privatization (Loftus and McDonald, 2001). In this paper, the politicised environment is an outcome of the interactions of a number of key actors, from the state to business. Arguing that a coalition of international forces has depicted a myth of the "Buenos Aires model" which claims that water privatization had reduced water tariffs and improved water provision, and has then tried to replicate this in a range of other locations, the authors try to show how this model was shaped more by economic ideology than good sense, how it has contributed to a new wave of corruption, and how, in the process, it has reinforced both social and environmental inequalities within South American cities.

The privatisation wave represents a new battleground for capitals to gain profitable investments, described by Harvey as "accumulation by dispossession" to support capitalism survival (Harvey, 2003). This point has been brought forward in recent years from privatisation to finalisation as a broader array of investors and new forms of financial techniques have entered the global water industry. Using a Spanish company, AGBAR, as an example, March and Purcell (2014) shows finalisation allows AGBAR to re-direct its accumulation strategy from ownership-based operation into provision of water services and knowledge intensive solutions. The entrance of new financial players has huge impacts on ownership, regulation, the right to water, community life and sustainable development. For example, large-dams financing by a diverse of public and private investors in the Mekong River Basin enables private actors to gain short term capital returns while leaving pubic actors responsible for providing guarantees and mitigating social and environmental impacts (Merme et al., 2014).

More political ecologists draw out the role of politics and power in shaping water flows and infrastructural developments in cities. Although touching on the topic of privatization, Kaika's work takes a view of relations between water privatization and social power in Greece (Kaika, 2003). It examines how drought during 1989 and 1991 was mobilised as an effective discursive vehicle to facilitate a state-led neoliberal political-economic agenda which led to water privatization. Swyngedouw's work in both Spanish and Ecuadorian contexts applies a similar lens on social power on water (Swyngedouw, 1997, 2007). Swyngedouw reveals the fundamental relationships between water and social power that shape the city of Guayaquil: flows of water, both physically and socially, embody myriad social struggles and conflicts, and these flows narrate stories about the city's own structure and development. Swyngedouw shows how the history of the urbanisation process of Guayaquil can be understood as simultaneously a political-economic and a political-ecological process: in a city where around a third of the inhabitants have no access to piped potable water, water is unsurprisingly subject to intense social struggles for control and/or access, and the mechanisms of exclusion from, and access to water drive the ecological frontier outward as the city expands (Swyngedouw, 1997). Also touching socio-natural inequalities, Rusca et al. (2017) illustrate, through the case of water supply in Lilongwe, Malawi, that networked water supplies, discursively constructed as 'reliable', 'good' and 'safe' provide poor quality water for the poor household as a result of area prioritisation in city planners' everyday decision-making process.

Within Swyngedouw's work, and especially in his writings on the politics of scalar territorial reconfiguration in Spain, he presents a path-breaking analytical framework for exploring how social power is reshaped by water. In the Spanish context, he shows how the scalar politics developed within Franco's period was produced, contested and reproduced in transformations of the hydraulic environment (Swyngedouw, 2007). Remaking of the Spanish hydraulic techno-natural landscape, through a huge dam-building project, was predicated on uniting various territorial coalition while eradicating regionalism, and mobilising discursive, symbolic and material processes. Swygnedouw's work attempts to demonstrate the ways in which the relationship between water and social power are mutually constitutive, thus dismissing Wittfogel's (1957) environmentally deterministic claim that the distribution of irrigation water is the primary cause of the formation of coercive political power. Kaika's research on Athens (Kaika, 2006) is also consistent with Swygnedouw's study (1997). The construction of a large dam to water and sanitize Athens, one of the most important aspects of the production of the city as a modern western metropolis, has shed light on the complex relationship between materiality and representation in the efforts to tame nature.

For Loftus, recent political ecological contributions, and the work of Swyngedouw and Kaika in particular, seem to share an interest in the role that water plays in the production and reproduction of power (Loftus, 2009). Trying to dig deeper, he calls for more efforts to understand the consolidation of power within liberal capitalist societies, and the attendant processes of subjectification. Using the case of water utilities and consumers in the South East of England, Loftus and his colleague argue that the water meter becomes an important mediator which serves to discipline households' behaviours, shape practices, and foster new thought forms associated with the political rule of finance, turning water consumers into governable and predictable subjects (Loftus et al., 2016). Earlier, by engaging with the work of Antonio Gramsci, he suggests a rethinking of political ecology of water by recognising how thoroughly embedded water is in everyday life. Drawing on his research in Durban, South Africa, Loftus reveals that the provision of water there is more directly shaped by the commercialisation of bulk-water supplies and the need for the supplier to find new opportunities for profitable investment. Surprisingly, the role of private water companies in water provision is rather insignificant (Loftus, 2009). In additional, he suggests that feminist ideas should not be overlooked in political ecologies of water. To be specific, most families in Durban rely on women to get enough daily drinking water, while in the few instances that men are prepared to carry out water work, it is to sell their labour to make money. Therefore, the situated knowledges of women open up conditions of possibility for radical change that may not be possible from the socially produced positions of men.

Recent years, "water grabbing" has attracted the attention of political ecologists. Mehta et al. (2012) define water grabbing as "a situation where powerful actors are able to take control of, or reallocate for their own benefits, water resources already used by local communities or feeding aquatic ecosystems on which their livelihoods are based". And Houdret (2012) uses water grabbing to describe the reallocation of water resources that produces increased ecological and socio-economic marginalization of local farmers.

Together, these perspectives suggest the need to adopt a critical stance towards water provision and management. However, so far political ecology studies on water have concentrated on how relations and struggles among different citizen groups in urban or peri-urban areas produce uneven water access; little attention has been paid to uneven distribution of water between urban and rural regions - except where dams are built to supply water to urban regions and industries, depriving rural people of their use of natural floodplain irrigation (e.g. Adams, 1992). Furthermore, there is little literature on the particular ways in which political ecology can address questions of water equity and water management in centralised economies like that of China. The Miyun case can provide some useful insights in this regard. Coupled with critical studies of environmental science, this chapter will show how policy makers have sought to divert water from upstream farmers in order to meet the increasing demands of urbanisation and economic growth in the city of Beijing.

5.3 Miyun Watershed and the Beijing Water Crisis

The Miyun Reservoir, the largest artificial lake in Asia, was built in the northeastern part of Beijing in the late 1950s (see Figure 5.1). The initial multiple purposes of this reservoir were flood prevention, electricity generation, agricultural irrigation and aquaculture, and to supply drinking water to the rural region of Beijing as well as Langfang county in Hebei province and Tianjin municipality (Beijing Forestry Society, 2015; Peisert and Sternfeld, 2005). There are two rivers flowing into the Miyun Reservoir: Bai River and Chao River. In the early days, the urban region of Beijing Municipality relied on Guanting Reservoir, another reservoir built in 1952 that later became so polluted that water was not suitable for drinking even after treatment; groundwater reserves were also used for drinking water supply. In the 1990s, Beijing's government decided to cease using Guanting water for urban supply, and then the Miyun Reservoir became the main drinking water source for Beijing (Peisert and Sternfeld, 2005). The reservoir has a storage capacity of around 4.4 billion m^3, and supplies between 60% and 80% of Beijing's urban drinking water needs. The Miyun Watershed has a total area of 15,788 km^2, with around two thirds of this in Hebei Province. The watershed and Beijing lie on the North China Plain where the average annual rainfall is only 549 mm and varies significantly between seasons (Li and Emerton, 2012).

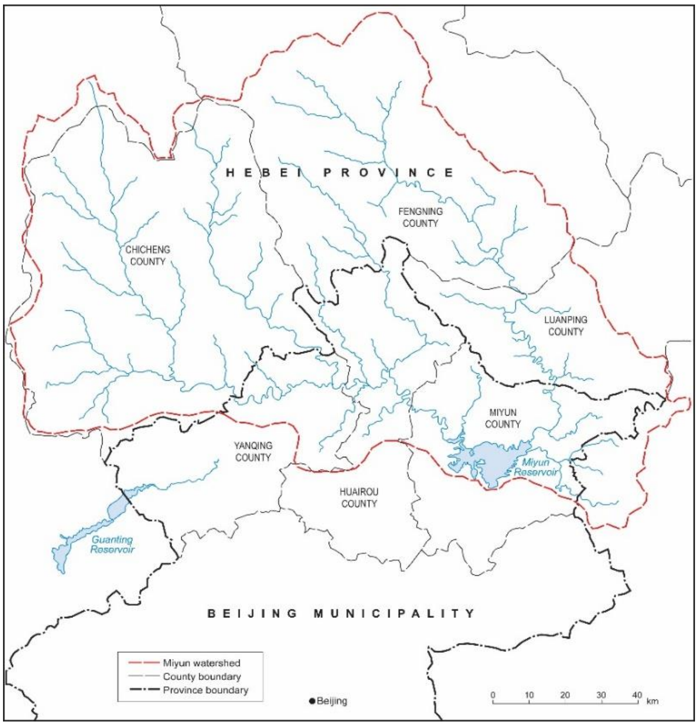

Figure 5.1 Miyun Watershed

Source: Produced by Stickler

While Beijing has become the political, economic, cultural and scientific centre of China, the city and its rural hinterland have expanded to cover a total area of 16,800 km^2, with around 1,400 km^2 in the central urban area. The total population has expanded to around 21.5 million, compared to 14 million in the early 2000s (Beijing Stastical Bureau, 2015; Peisert and Sternfeld, 2005). This rapid socio-economic development has not come without ecological costs, and a water crisis is one of these. Beijing has been under severe water stress in recent decades from the viewpoint of water supply quantities. From 1956 to 2000, the average annual available freshwater resource was around 3.8 billion m^3 and the average water resource per capita was less than 300 m^3. In 2008, the amount of annual available freshwater per capita was just below 220 m^3, which is equal to only about a tenth of China's average and 2.7% of the global average (Beijing Municipal Bureau of Statistics, 2015). Beijing has become increasingly dependent on groundwater supply. Between 1980 and 2002, the groundwater table in the urban area declined by about 11.78 m, creating a funnel of emptied aquifers stretching across an area of 2,200 km^2 (Peisert and Sternfeld, 2005). From 1999 to 2007, Beijing experienced one of the most severe water crisises in its history, with an average annual precipitation at just 428 mm. By the end of 2003, the worst year, the amount of water stored in Miyun Reservoir had declined to 723 million m^3 from 2,800 million m^3 in 1999 (Ma, 2011).

Beijing Municipality is also not immune to water quality degradation; in fact, more than 40% of the monitored river courses in Beijing have been classified as Grade V or worse every year since 2007 (Qi and Zhao, 2016). From the early 1970s, pollution by untreated sewage from upstream cities, as well as discharges from small rural industries, and fertilizers and pesticides washed out from agriculture land caused serious water quality deterioration in Guanting Reservoir. Despite years of effort, little was achieved to improve the reservoir's severe eutrophication problem and eventually this compelled the government to stop extracting water from there for urban supply. Water quality in Miyun Reservoir is much better, but it is still vulnerable to pollution from upstream economic activity, especially excess fertilizer application in the catchment area (Regele, 2008). The total nitrogen concentration, which averaged 0.76 mg/l in 1987-1988, had risen to 3.28 mg/l in the period of from 2003 to 2005. Total phosphorus currently ranges from 0.017 to 0.076

mg/l (Zheng et al., 2013). In order to avoid the trajectory of Guanting, Beijing adopted new environmental programmes aimed at reducing the pollution accumulation in the Miyun.

In order to increase the quantity and quality of incoming water to Miyun Reservoir and reduce agricultural pollution in the upstream region, since 2001, Beijing and Hebei Province have jointly initiated a series of regional collaboration activities, one of which is in the form of an eco-compensation programme. Rice cultivation through flood-irrigated paddies was thought to be one of the root causes of both decreased water yield and high nutrient loads in the Miyun Reservoir. In 2006, Beijing signed a “rice-to-dryland conversion” agreement with Chengde and Zhangjiakou, two municipalities in Hebei with land in the Miyun Reservoir watershed, to pay an average of 450 CNY per mu every year (15 mu=1 ha) for land that was converted from rice to dryland cultivation. In 2008, the Beijing government increased compensation to 550 CNY per mu per year to ensure that participation in the eco-compensation would not reduce household income. Instead of growing rice, the vast majority of farmers chose to grow corn. By 2010, households upstream of Miyun Reservoir had converted all 103,000 mu of rice fields to dryland crops. In addition, farmers are required to apply less fertilisers under this project.

5.4 Urbanisation and Water Management

5.4.1 Burgeoning Capital, Growing Demand

After 1949, the year when it became the capital of the People’s Republic of China (PRC), Beijing was planned by the Communist Party to be the political, cultural and industrial centre of China. In the early years after establishment of the PRC, the Communist Party considered the consolidation of power as a priority. As a result, a large number of military personnel and civil servants in various government ministries were transferred into Beijing. Moreover, economic development was thought to be beneficial for the legitimacy of the government (He et al., 2015). For these reasons, each year hundreds of thousands of people migrated to the city; coupled with organic population growth and territorial expansion, the population tripled from 2million in 1949 to 6.3 million in 1958. In the next twenty years, the population increased to 10 million in 1980 and 14.56 million in 2003 (Cheng and Liu, 2015), and most recently to 21.5 million in 2015. Accordingly, the boundary of Beijing was expanded several times during the 1950s. For example, at first the Miyun County was administered by Hebei Province, but later it was transferred to Beijing, and the city took over management of the Minyun Reservoir. The area of Beijing had expanded from 707 km^2 to 16,807 km^2 by 1958, and the urban area region had expanded as well. The population growth has led to a significant increase in domestic water consumption. To be specific, people used only 8 million m^3 of water in 1949 to meet domestic needs, but this figure grew to 350 million m^3 in 1980 and 1.48 billion m^3 in 2010 (Yang et al., 2012). Similarly, the territorial expansion, especially including rural counties where agriculture constituted a large proportion of the economy within the new administrative boundaries, boosted agricultural water consumption. That was exacerbated by construction of reservoirs and canals so that farmers could gain access to irrigation water more easily. After the construction of Miyun Reservoir, agriculture usage was 1.97 billion m^3 in 1961, and that rose to 3.2 billion m^3 in 1980 (Yang et al., 2012). In the following years, as a result of de-agriculturalisation, there has been a declining trend in agricultural water usage, decreasing to just 1.5 billion m^3 in 2000 and to 0.6 billion m^3 in 2016 (Beijing Water Authority, 2016).

Before 1949, Beijing’s industry was predominantly by light industry, most of which involved small family-owned workshops (Li et al., 2012). Although there were some voices by Chinese urban planners arguing that Beijing should not be an industrial city, experts from the Soviet Union insisted that Beijing should be developed as an industrial city, arguing that Beijing’s working class only accounted for 4% of the population, compared to a quarter of that in Moscow (He et al., 2015). In 1949, The People’s Daily, the official newspaper of the CPC, published an editorial with the title “Turning the consumer city into an industrial base”. The editorial said “In old China, a semi-feudal and semi-colonial country, the big cities such as Beijing where the ruling class lived were mostly consumer cities. These cities’ existence and prosperity were based on exploitation of workers and villages. In PRC, we cannot allow this phenomenon to continue in Beijing. To do this, we should recover and develop industrial production” (The People's Daily, 1949). The CPC also hoped that Beijing’s industrialisation would serve as a showcase, encouraging industrialisation and urbanisation across China (He et al., 2015). After 1949, Beijing ramped up its efforts to develop heavy industry, aiming to turn Beijing into a modern industrial city in 3 to 5 years. That industrialisation process was particularly furious in the "great leap forward" period when Chinese leaders unrealistically planned to catch up with Britain within 15 years. During that time, a large number of gigantic plants depending heavily on water, such as steel, oil and brewing took shape (Zheng, 2006). Consequently, there was a substantial increase in industrial water usage. For example, water usage by industry was only 30 million m^3 in 1949, but climbed to 640 million m^3 in 1964, reaching 1.36 billion m^3 in 1980 (Yang et al., 2012).

In the 1980s Beijing was deemed the political, cultural and international centre, while the authorities no longer mentioned Beijing's position as an industrial centre (Beijing Municipal Government, 1994). After that, the central government tried to turn Beijing into a city where international events such as the Olympic Games and Asia-Pacific Economic Cooperation Summit are held, a home of headquarters of large Chinese state-owned enterprises and multinational corporations' regional offices, and a place where high-end professionals work. Moreover, it was planned to be a technology and innovation hotspot, becoming the "Silicon Valley" of China with more than 70 universities and 400 research institutes (Zhao, 2013). In recent years, Beijing has become one of most important financial centres in China mainly because participants in high-level financial activities are concentrated in Beijing, the centre of financial policy decision-making, in order to have rapid access to information, especially rumours (Zhao, 2013). All these aspects make Beijing a magnet for people. During the period 2010-2015, it is estimated that a net migration of over 3 million people flowed into Beijing (Qi et al., 2012).

5.4.2 Managing Waters in the Early Days

Beijing's urbanisation and development history can be seen as a history of struggle for water. Historically, Beijing's residents mainly depended on groundwater for domestic purposes. At that time, Beijing had an apparent abundance of clean groundwater, given its relatively small population. In addition, those people who lived close to rivers and lakes tended to get surface water to use for their convenience from these sources (Lu et al., 2015). Before 1949 there was only one water plant in Beijing, serving a very limited number of urban dwellers, and with poor reliability. Instead, the vast majority of households and institutions got their water from wells manually. Beijing had not experienced water scarcity for most of the time before 1949 (Lu et al., 2015). Rather, it was a city with sufficient water, which is perhaps indicated by the large number of places called *Hai* (*海, sea*) and Hu (*湖, lake*).

> "The groundwater table was just a few metres underneath the surface, and the water was very clean and easy to extract. In the 1950s, road frost boils were not uncommon in Beijing because of groundwater table rising. In some places, water could be available if you dig 2-3 metres." (Interview 19, 2014)

During that period, the main water problem was regular flooding during summer. For example, such events were recorded in the 1930s and 1940s (Wu, 2013). In order to minimise the negative impacts caused by flooding, after the establishment of the PRC, the municipal government built a total of 83 reservoirs, including Miyun Reservoir and Guanting Reservoir. At the same time, major rivers and their tributaries were dredged, and river banks were reinforced. In addition, flood diversion projects and sediment reduction projects were built, with some pumping stations being constructed (Wu, 2013). One reason for this infrastructure construction was to control water originating from outside Beijing to serve urban development. Before 1949, in spite of scattered lakes and small rivers, there was no major river running through the urban region. After 1958, five major rivers emerged as a result of reservoir construction and the dredging of water courses, with only Beiyun River originating within Beijing's territory while the other four were from Hebei Province. Since then, these rivers significantly improved Beijing's surface water resources, with an average annual quantity of 17.72 billion m^3 which is three orders of magnitude greater than in 1949 (Zhu, 2008).

5.4.3 Quenching the Thirst by Other's Water

While flooding was managed well - although floods still did happen occasionally in the 1950s - and water was diverted into the city, Beijing encountered its first water shortage in the 1960s after a short period of balanced water supply and demand (Ma, 2011). In 1960, there was only 61mm of precipitation from January to June, which was less than the average for this six-month period. In 1965, the urban water supply was under stress. During the period, the Guanting Reservoir, the only water supplier to urban Beijing, almost dried up due to the dry weather and the decreasing surface water inflow. As a result, there was not enough water supplied to Beijing for agricultural and industrial production. Accordingly, the central government approved the Jing-Mi (Beijing-Miyun) water transfer project, which would divert water from Miyun Reservoir to the urban area of Beijing.

During the period from 1970-1972, Beijing had its second water shortage crisis - the amount of water storage in the Guanting and Miyun Reservoirs decreased so fast that they only supplied water to the urban areas in the Beijing and Tianjin regions (Ma, 2011). Farmers had to turn again to groundwater for agriculture. There were nearly 40,000 wells being used for irrigation then, with an estimated 1.76 billion m^3 of water being extracted. In addition, another 268 wells were used to obtain water for water plants; and about 2,500 wells were used to meet the demands of industrial production(Lu et al., 2015). This brought serious groundwater depletion as a result. At that time Beijing started to plan a water transfer project from Hebei. Specifically, engineers planned to build a dam on the Luan River in Hebei Province and then transfer water stored in the reservoir to the Chao River which runs into Miyun Reservoir. That plan was eventually abandoned for financial reasons (Interview 22, 2014).

At the beginning of the 1980s, drought occurred in seven consecutive years. During that event, the average annual precipitation decreased to 498 mm, almost reaching the lowest recorded level in history, which was an average of 492 mm in the 1857 to 1870 drought. By the end of July in 1981, the total water stored in the Guanting and Miyun reservoirs was only 0.5 billion m^3. Even worse, the groundwater had been over-extracted chronically, to an unsustainable degree. In response, the State Council decided that the Miyun reservoir would no longer supply water to Tianjin (Interview 19, 2014; Ma, 2011). At the same time, the Beijing government asserted that the water in Miyun Reservoir would, first and foremost, be used to supply domestic water and irrigation water for vegetables, followed by industrial production, with absolutely no water provision for other agricultural purposes (Zhu, 2008). In addition to that, from 1986 about 0.1 billion m^3 of water was transferred to Miyun Reservoir every year from Baihepu Reservoir, which had originally been designed to supply irrigation water to rural regions of Beijing (Fu and Li, 2012).

> "When Miyun Reservoir was initially built, water there was provided for agricultural irrigation and domestic uses in the rural areas of Beijing, Lafang of Hebei Province and Tianjin. Around 210,000 workers, students, teachers, soldiers, civil servants, and most importantly farmers from Hebei, Beijing, and Tianjin were involved in the construction. In spite of the labour contribution from Heibei and Tianjin, in future the people there will not get access to water of Miyun Reservoir as was initially the case, because it now quenches the thirst of Beijing." (Interview 22, 2014)

The latest water shortage event was from 1999 to 2007, with an average annual precipitation of 428 mm. The amount of water storage in the two main reservoirs also continued to decrease during this period. By the end of 2003, the amount of water in Guanting and Miyun Reservoirs was 211 million m^3 and 723 million m^3 respectively, which meant they had reduced by around 320 million m^3 and 2,120 million m^3, compared to the values in 1999 (Ma, 2011). In the meantime, the Yongding River course, the main river running through Beijing, was frequently dry. For example, from May to August in 2001, the rainy season in Beijing, Yongding River was dry for 58 days in total. Similarly, between July and August in 2003, no surface water had run into the Guanting Reservoir for 20 days in total. To address the problem, Beijing had begun to consider transferring water from other places again. In 2003, under the coordination of the Ministry of Water Resources, 50 million m^3 of water from Cetian Reservoir of Shanxi Province was transferred to Beijing (Interview 22, 2014; Lu et al., 2015).

> "Transferring water from Cetian was said to be an innovative and effective way to address Bejijing's water shortage. After that, every year about 60 million m^3 to 90 million m^3 of water from Cetian has been transferred to Beijing. One high profile expert said that they had no choice but to transfer water around Beijing before the completion

> of the Eastern Route of the South-to-North Water Transfer Project (SNWTP) which would transfer water from the downstream of Yangtze River. One of the major tasks of Beijing Sustainable Water Resources Planning in the 21st Century (2000-2005) was to identify alternative water sources in neighbouring provinces which could be transferred to Beijing." (Interview 22, 2014)

In subsequent years, water has been transferred to Beijing from a number of reservoirs in Hebei Province. To be exact, Huliu Reservoir, Youyi Reservoir and Yunzhou Reservoir have transferred 13 million m^3, 10 million m^3, and 12 million m^3 of water respectively each year to Beijing since 2005 (Interview 22, 2014).

Hosting the 2008 Olympic and Paralympic Games placed additional pressure on Beijing's limited water supply and added pressure to improve water resource planning and management. When the Olympic bidding process starting in the 1990s, Beijing committed to ensure an adequate supply of safe drinking water during the Games, and improve water quality of the city's water supply reservoirs. In addition, Beijing municipality had planned to develop man-made lakes and streams, fountains, and new aquatic parks (UNEP, 2009). Before the Games, Beijing signed the "rice-to-dryland conversion" eco-compensation agreement with Chengde and Zhangjiakou, two municipalities in Hebei with land in the Miyun Reservoir watershed. As mentioned in Section 5.1, farmers are paid to grow less water-intensive crops and use less fertiliser under this eco-compensation scheme. But that could not guarantee there would be enough water in 2008, so the authority also considered transferring water again. Originally, the Middle Route of the SNWTP was to be completed before 2008 for the Olympic Games. However, due to the difficulty of the massive forced resettlement of 300,000 local residents caused by the Danjiangkou Reservoir in Henan Province (the water source of this route), the project was substantially delayed to 2014 (Interview 27, 2014). Accordingly, in 2008, Beijing transferred 0.25 billon m^3water from four reservoirs in Hebei Province to ensure sufficient supply of water for the Games. Not surprisingly, this continued for several years after the Olympics (Lu et al., 2015).

It is worth noting that the most important water transfer project supplying the Beijing region is the SNWTP. Currently, two routes, the Eastern Route and the Middle Route, are transferring water from the downstream and mid-stream of the Yangtze River to Beijing (See Table 5.2 for more information). This project's primary justification lies in its promise to remove water resource constraints on economic development in northern China; however, controversies around environmental, ecological and social impacts are often heard. For example, the Eastern Route is badly affected by pollution, and needs investment in 426 sewage treatment plants. Similarly, the middle route will also cause long-term environmental impacts as a result of new dam and canal construction, as well as the sheer scale of the displacement of 300,000 residents (Moore, 2014).

It can be seen from this summary that Beijing has long been controlling and transferring water from neighbouring regions which are under serious water pressure as well, and further, even from the Yangtze River. All these are aimed to underpin the economic development of Beijing.

Table 5.2 Summary of Eastern and Middle Route of SNWTP[18]

	Eastern Route	**Middle Route**
Water transfer Capacity (billon m^3)	14.8	13
Primary canal length (km)	1156	1241
Primary water use	Agricultural, domestic, industrial, navigation	Domestic, industrial, agricultural
Estimated cost (billion US$)	9	10
Construction start date	2002	2003

Adapted from Moore (2014)

> "As the capital city of China, Beijing has the political power to transfer water from other places, even though that is against the wishes of officials and residents who live in those water supplying regions. Those people have no choice but to comply with Beijing's political order, but Beijing's residents have not experienced the inconvenience caused

[18] It should be pointed out that the water transfer capacity does not imply Beijing will get all of this water. Actually, the Eastern Route supplies water to the provinces of Jiangsu, Anhui, Shandong and Hebei and the municipality of Tianjin; and the Middle Route provides water to the provinces of Henan and Hebei and the municipalities of Beijing and Tianjin. However, after completion of the Eastern Route, cities along the line were very reluctant to buy water from the project, partly because water price from SNWTP is higher than local water price.

by limited water provision at certain hours in Hebei. Those people's daily life and livelihoods are compromised" (Interview 25, 2014).

5.4.4 Rice-to-Dryland Conversion Programme

This programme differs from most of China's other water-related eco-compensation projects since individual farmers are directly involved. Most other programmes, as reviewed in Chapter 3, are government-to-government based, although the sell-side government may then pay individual land users for environmentally-friendly activities as one of a basket of measures to deliver ecosystem services. In contrast, in the Miyun project, thousands of householders are directly engaged as core agents during the project implementation period. Thus, this programme can be considered to be an important departure from the conventional centralised water management methods, employed in China and illustrated in Chapter 4.

The programme was initiated in 2005, upon the request of Beijing municipality, with the intention of saving water and improving or at least maintaining water quality. Agriculture is the sector with the biggest water usage in the North China Plain, especially in Hebei Province, putting extra pressure on water shortage and causing negative environmental impacts such as rapid groundwater table decline by over extracting for irrigation (Liu et al., 2001; Yang et al., 2015). Rice is the most water intensive key grain, and in Hebei, and China more generally, it was commonplace that harvested paddy rice is irrigated. So replacing rice with less water intensive crops such as corn could potentially consume less water. Agriculture is also a leading source of pollution in many countries, with pesticides and fertilisers often being washed into adjacent rivers. In theory, encouraging farmers in the upstream to use less pesticide and fertiliser has the potential to reduce certain types of pollutant load to the Miyun Reservoir. Zheng et al (2013) estimate the programme could increase water yield by 18.2 million m^3 per year and reduce TN and TP by 10,360 and 4,340 kg per year respectively. However, this is just based on simple assumptions; so far no rigorous quantitative evaluation of the programme's environmental impact has been undertaken, and to do so would be difficult.

The project was first agreed on a 3-year timeframe (2005-2008) for the 2008 Olympic Games and thereafter Beijing, and Zhangjiakou and Chengde Municipalities in Hebei Province, extended the programme for another 2 years. But the programme is still being implemented although in the past few years there have been rumours every year that it would not be extended (Interview 12, 2015). The fact that now the subsidy agreement is signed once a year causes a sense of uncertainty among farmers and officials alike in Hebei. As of 2010, 103,000[19] mu of rice had been converted into dryland crops in the upper watershed of the Miyun Reservoir (Zheng et al, 2013).

The programme is primarily paid for by Beijing government, with the programme funds coming from the Beijing Finance Bureau. It is not clear whether income from water bills contributes to these funds (450 and 550 CNY per mu before and after 2008 respectively). All paddy rice fields falling into the programme area have had to be converted, irrespective of the farmers' willingness. However, there were some patches of land that could not been converted because they were located in the bottomland or riverbed along rivers where soil was saturated or covered with shallow water. The process of targeting paddy lands was conducted by a bottom-up approach, starting with the village leaders counting paddy lands in their villages and informing the townships of this, followed by subsequent upwards transmission through counties and finally to the cities (Interview 12, 2015). There are contradictory studies of these subsidies. While some argue that the amount of subsidy does not fully compensate for the economic losses (Bennett, 2009), others estimate that the payment (550 CNY per mu) is equivalent to 1.2 times the difference between incomes from rice and corn (Zheng et al., 2013). Due to the large number of participating households, it is difficult to say if there are instances when subsidies belonging to farmers go into local government officicals' pockets. But it is not unreasonable to mention the issue of transparency. For example, in Luanping County of Zhangjiakou City village leaders in one village overstated the area of paddy lands and then claimed extra subsidies for non-existent household names in 2007 and 2008 (Procuratorial Daily, 2011).

[19] In 2008, 80,000 mu of paddy fields in the upper watershed of Guanting Reservoir had been converted as well, but here I do not include it as the focus is the Miyun project.

Compliance with the programme is monitored by a series of inspections conducted by various levels of government. These generally involve frequent inspections by village officials, followed by formal evaluation by township and county governments. In addition, every year staff from Beijing Resources Bureau and their counterparts in Hebei carry out joint inspections, to confirm that all fields in the scheme are growing unirrigated crops, but it is hard to inspect regarding fertiliser use.

5.5 Discussion and Conclusion

As Section 5.2 has shown, the relationship between water and the nature of state and associated power relations have been hotly debated (e.g. Kaika, 2003, 2006; Molle et al., 2009; Swyngedouw, 1997, 2007, 2014; Wittfogel, 1957). In this section, the Miyun case is considered in the context of these debates.

5.5.1 Power, Water and Urbanisation

The urbanisation process and development of Beijing is simultaneously a process of urbanising water. The ecological conquest of water is an indispensable component for expansion and growth of the city. It is not surprisingly that social power relations are associated with this process. The political, social and economic aspects cannot be separated from the ecological ones in understanding the urbanization process, especially in Beijing where there is a constrained water supply. During that process, certain mechanisms of getting access to and imposing exclusion from water, sometimes even pushing the water frontier outwards beyond the municipal territory, are infused with power relations.

As the capital, Beijing not only has higher de facto political status, it is more economically powerful. On the contrary, cities in Hebei Provinces are far less developed. In 2005, Asian Development Bank (ADB) revealed in a report that there is a large "poverty zone", including 3,798 poor villages and 32 poor counties[20], around Beijing in Hebei Province (The Economist, 2006). All the three counties carrying out the eco-compensation project are state-level

[20] These villages and counties have lower level of income per capita than that set by The State Council Leading Office of Poverty Alleviation and Development

poverty-stricken counties. The situation has not changed so much, and the contrast between the project counties and neighbouring rural counties of Beijing is still very stark. For example, the income per capita in Fengning County in 2015 is 6152 CNY, less than a third of 19183 CNY in Miyun County (Fengning Statistic Bureau, 2016; Miyun Statistic Bureau, 2016). It is clear that those farmers participating in the eco-compensation scheme are economically and politically marginalized, and therefore their bargaining power is very limited as they hardly have any fallback position. It is impossible for them to say no to the financial compensations that Beijing offers them in return for water.

As explained in Section 5.4, hundreds of thousands of military forces, civil servants and citizens were relocated into Beijing, to sustain the regime of the CCP, and the city's administrative boundary was expanded to include rural regions to boost agricultural production; huge development of heavy industry also supported the imaginations of modernization and state-building as a powerful communist country. These inevitably led to growing water consumption, for agricultural, industrial and domestic usage. The material dimension of these development has been preconditioned on an incessant flow of water, which was exemplified by the large infrastructure building, such as dams (the Miyun and Guanting Reservoirs amongst many others), and water diversion projects from these dams to the urban area of Beijing during the 1960s and 1970s. Indeed, this infrastructure embraced a state-centric "hydraulic mission" (Molle et al., 2009), and itself can be considered symbolic of the projects of modernization and nation-building (Kaika, 2006, Swyngedouw, 2007). This phase may also resonate with Wittfogel's (1957) thesis of oriental despotism highlighting the interplay between regime formation and megaprojects of water infrastructure. Channelling water into the growing city, by means of building dams in and beyond Beijing in order to harness water, is a way of gaining access to and controlling water in the upstream region. As mentioned in Section 5.4, when Miyun Reservoir was built, the county of Miyun where the dam was located was administrated by Heibei Province, but later transferred to Beijing as a result of the jurisdictional expansion. In the 1970-1972 drought, the Miyun Reservoir ceased supplying water to Hebei Province, ensuring the downstream region could have enough water. Consequently, the upstream water users have been excluded from using water in the reservoir as used to be the case. As documented in Section 5.4, from the late 1980s onwards, Beijing has been transferring water from reservoirs in Shanxi and Hebei Provinces, especially in the 2000s, not to mention the two routes of SNWTP which channels water travelling over 1000 km to Beijing. Webber et al. (2017) assert that the SNWTP embodies a "technopolitical regime" in which political goals are enacted. Although other small-scale water transfer events have not involved massive new infrastructure, such as pipes and channels, as in the SNWTP, the redistribution of water which allows water to flow into Beijing constitutes a flow of political power as well. Water becomes subjective to the city's power in order to sustain the city's life, form and metabolism. Water has been tamed, managed, channelled and redirected in order to support the city's growth and expansion, and attempt to increase urban water supply outside cities is commonplace (Kaika, 2003, 2006). This is acute in the case of Beijing, with water elsewhere being channelled to support the vision of establishing Beijing as global metropolis with a focus on modern services, as well as a high-level international exchanges city and political, economic, cultural and scientific research centre. Although the Miyun eco-compensation project does not represent an infrastructure project, it is still part of water controlling endeavours which are fused with power relations and political goals. This demonstrates that water rights as well as benefits of use are reallocated to powerful players, here the urban domestic water users.

5.5.2 Excessive Agricultural Water Use Leads to Decreasing Water?

A fundamental insight from a political ecology perspective is that nature is not given, but is socially constructed - it is conceptualized and framed in particular ways (Robertson, 2006; Fernandeza et al., 2014). One political dimension of the Miyun project is manifest in a discursive realm, where central policy discourses serve to frame problems and thus enable particular solutions (Foucault, 1980; Milne and Adams, 2012). While water and ecosystem services are often taken for granted in PES schemes, or in this case, in eco-compensation projects in China, it is worth paying attention to how these are understood.

Beyond the fact that the Beijing-Hebei region is located on the North China Plain, where water resources are scarce compared with the average figures for China, irrigation in Hebei Province, the upstream region of several of the main rivers of Beijing, is undoubtedly considered as the main culprit for water shortage in the Miyun Reservoir. That claim is often based on the belief that in Hebei Province agricultural water accounts for nearly 70% of total water consumption (Wang and Li, 2014). In a report produced by Tsinghua University for the Ministry of Water Resources, it is stated that "more and more water is used in the upstream areas, and in recent years, inflow water to Miyun Reservoir is decreasing at a worrying rate. If Zhangjiakou continues to use agriculture water at a similar rate, we will have no water at all one day. Currently irrigation infrastructure in the upstream is very poor, if one day dams are built there to retain water for agricultural use, where should we get water? Water use efficiency in Beijing is much higher, so Beijing should rank ahead of Hebei when it comes to water allocation" (Li, 2009). The use of water in agriculture is invariably described as wasteful, the blame being put on traditional irrigation which wastes large amounts of water. Farmers are also blamed for not having the appropriate irrigation practices, sometimes as irrational and even "backwards" water users.

It is true that agricultural irrigation in the Miyun Reservoir Watershed constitutes the largest water consumer, with agricultural water usage accounting for as much as 80% of total water consumption in some counties (Interview 13, 2015). However, the claim that the agricultural sector is the root cause of decreasing water inflows of the Miyun Reservoir is far more oversimplified. Water evaporates from oceans, rivers, lakes and ground, or transpires from plants, moves in the atmosphere and then returns to the ground through precipitation. Once it reaches the ground, some may move into the atmosphere again while some penetrates and becomes ground-water, with that remaining becoming as surface runoff. This complex biophysical process affects how much surface water is produced. But the hydrological cycle cannot escape from being affected by anthropogenic activities; for example, climate change is projected to result in more precipitation in some regions (IPCC, 2014), land use change such as agriculture and deforestation could affect evaporation and transpiration, dams regulate natural flows, water is extracted for agricultural, domestic and industrial purposes, to name a few influences. All these factors contribute to the availability of surface water. That means that decrease of inflow to the Miyun Reservoir in the 2000s may be attributed to several reasons. Hence it is important to dig deeper to unearth the whole picture of the situation.

While irrigation is blamed for causing declining surface runoff, it is surprised to find that the annual agricultural usage has experienced a decreasing trend since 2001 in the upper Miyun watershed, four years before the eco-compensation programme was implemented. To be exact, the amount of water for agriculture dropped from around 0.12 billion m^3 in 2001 to less than 0.1 billion m^3 in 2005 in the upstream region (Li and Li, 2008). Although the water usage data in Statistical Yearbooks is often said to be inaccurate, being estimated in-house by staff, the trend is believed to be accountable (Interview 13, 2015). Since the 1990s, the land use cover in the upstream has undergone a significant change - while agricultural land and grassland have decreased the area of forest and woodland has risen significantly. From the late 1970s onwards, the Chinese central government has initiated a series of afforestation schemes in the upstream region, such as the Three-North Shelter Forest Programme which is implemented to prevent desertification and sandstorms in northern China, the Soil Erosion Control Programme in Beijing and Hebei and so on. As a result, the forest coverage in the Miyun watershed has increased. For example, in the Chao River Basin, a sub-basin covering about 40% of the total Miyun Watershed, the area of forest land increased from 2450 km^2 in 1978 to 3098 km^2 in 1999 and then to 3789 Km^2 in 2009, with the coverage reaching over 75% (Yang et al., 2014). There is a similar trend in the whole basin, with nearly 8000 Km^2 of forests out of 11880 Km^2 of the upper Miyun watershed in Hebei (WatershedConnect, 2013). Although these forests are helpful for anti-desertification and water erosion control (Li and Emerton, 2012), and forests are often believed to be able to regulate flood flows, enhance water quality and improve water yields, the relationship between forests and water is far more complicated and trade-offs exist. While increased forest coverage may indeed reduce nutrients, and increase water yields, there are also other factors such as topography, the forest type or land-use and preventive infrastructure that can influence the complex physical process, and these can increase the uncertainty between the afforestation-water outcome relationship (Muñoz-Piña et al., 2008; Kosoy et al., 2007). In fact, the forest ecosystem is a major user of water. Tree canopies reduce groundwater and stream flow, through interception of precipitation and evaporation and transpiration from the foliage. Forests represent a potential water loss in the catchment because atmospheric moisture derived from forest- related evapotranspiration may travel with wind and, as a result, rain takes place beyond the basin (Ellison et al., 2017). In semi-arid and arid regions, the evaporation of forest land is higher than that of other land use types, including agriculture (Yang et al., 2014). At the same time, the influence of interception may reduce stormflow response precipitation after event (FAO & CIFOR, 2005). As long ago as 1956, Law (1956) showed that the practice in the UK of surrounding reservoir with forest was potentially misguided as the water yield was reduced by the increased transpiration loss from trees. These factors are believed to contribute to the decreasing water quantity in the Miyun River Basin. Yang et al (2014) investigated the rainfall-runoff relationship in the Chao River Basin by using the daily rainfall and runoff series data from 1973 to 2010. The result of a Hydro-Informatic Modelling System model shows that that land coverage change can reduce annual runoff by as much as total upstream water usage on average during the 1998-2010 period. Evidences by Li and Li (2008) and Zheng et al. (2013) suggest similar trends in the whole Miyun watershed.

This evidence does not seek to dismiss the fact that the agriculture sector uses most water, but to provide useful insights into the possibility that agriculture is not the root cause of decreasing runoff in the basin. This shows how the problem of water shortage was being framed in the case of Beijing, and thus suggests why the eco-compensation project was initiated. In particular, the focus of the implementation of the eco-compensation scheme entirely centres on requiring farmers to grow less water-intensive crops, as an exercise of power and control which can be easily effected in China where political order can prevail over many other considerations. That is a contrast to common situations when water users on the upstream side of a river are able to appropriate more than their share of the water while leaving those in the downstream water deprived. This eco-compensation scheme can be interpreted as a form of “water grabbing” (Mehta et al., 2012), instances when powerful actors are able to take control of or relocate water resources which are used by local communities for livelihoods to fulfill their own interests. Compensation for income losses caused by growing less water-intensive crops instead of higher valued rice is used to legitimate the exercise of water grabbing. Neither does this deny the necessity of improving water use efficiency in the Beijing-Hebei-Tianjin region where water availability per capita is low. But surely there are other effective ways. For example, improving irrigation infrastructure is said to be very useful because a very high proportion of dams and canals in the upstream were built in in 1970s and water losses from leaking cannot be neglected (Interview 12, 2015). Also, changing irrigation schedule - supplying water only at times when irrigation is necessary, and rolling out water-saving technologies, especially drip irrigation can be solutions (Barnett et al., 2015).

5.5.3 Good water quality upstream, poor water quality in Beijing

The river basin scale is often considered to be an appropriate unit of water resources management, in spite of some criticisms (see 4.2.4 in Chapter 4). While Beijing tries its best to ensure water security, including using its political power to reshape water management practices in its upstream regions, as well as in the waterscape of Hebei and even the Yangtze River Basin, it is doing relatively poorly in relation to its downstream areas.

While the eco-compensation programme and other measures such as transferring water from reservoirs in Hebei were initiated to increase water in the Miyun Reservoir, outflowing water from the reservoir to urban rivers does not increase accordingly. Fu and Li (2015) found that from the construction of Miyun Reservoir to the early 2000s, the Chaobai River downstream runoff exhibited a sharp decline and it has stayed at a low level since then. As a result, it is hard to maintain the components, functions, and processes of healthy aquatic ecosystems, and water quality is poor with heavy metal pollution and fragile ecosystems (Zhang et al., 2005).

Although in the eco-compensation project Beijing authority is paying upstream farmers to reduce fertilizer use, in addition to growing less water-consuming crops, ostensibly to improve water quality, the city itself has a very bad record of maintaining water quality with its own territory. In 2016, of the 2545.6 km watercourses in Beijing being monitored, 52.8% were classified at between Grade I to Grade III, while 38% were worse than Grade V. Actually, there was no surface water of Grade I in Beijing. Only 5.2% and 4.4% of the monitored watercourses were classified as Grade IV and Grade V respectively (Beijing Water Bulletin, 2016). This implies a rather bi-model distribution of quality, which is explained below. And the years of 2010 to 2015 saw similar situations for water quality in river courses in Beijing, although there is a suggestion of a small improvement as the percentage of Grade I to III increases slightly, and that of worse than Grade V decreases (see Figure 5.2). However, water quality varies significantly from region to region. Most of the river courses classified as Grade II or Grade III are in the rural upstream area of the city where water is heavily protected and much less densely inhabited. On the contrary, as water runs close to the peri-urban regions and downstream from Beijing to the south, water quality deteriorates substantially (see Figure 5.3).

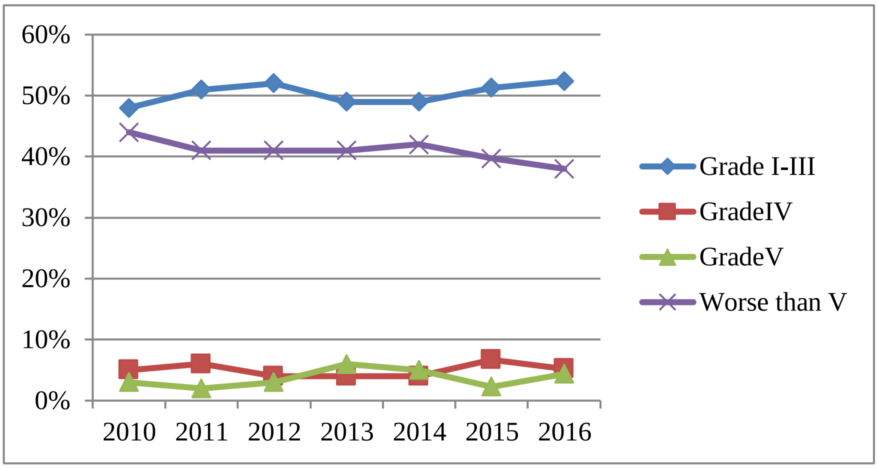

Figure 5.2 Surface Water Quality of Beijing, 2010-2016

Source: Produced by the author, data from Beijing Water Bulletin, 2010-2016

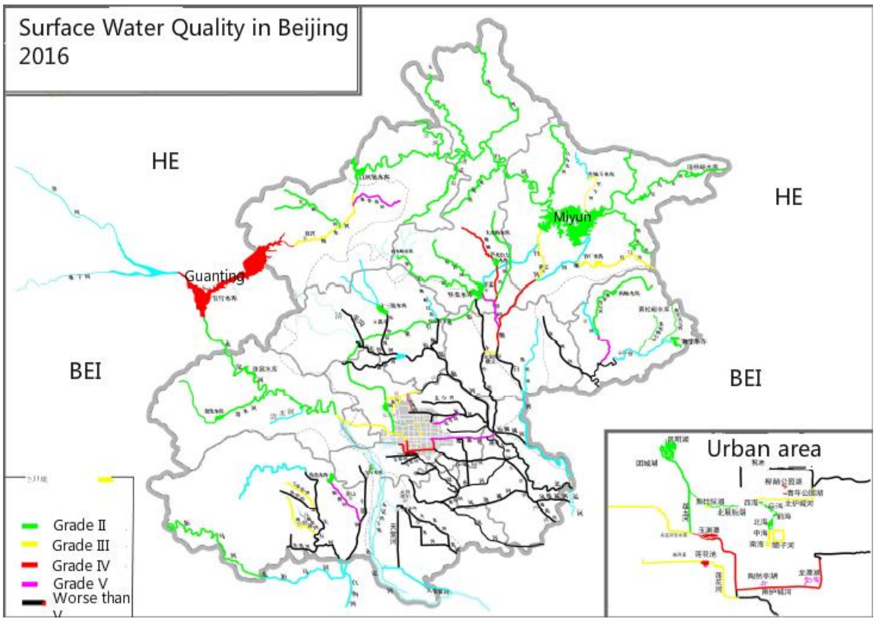

Figure 5.3 Surface Water Quality of Beijing in 2016

Source: Adapted from Water Bulletin 2016

The bimodal quality distribution thus reflects the fact that water quality is good upstream from Beijing, and very poor downstream; thus, regardless of the water quality effects of farmers, Beijing itself is a major polluter. Interestingly, from Figure 5.3 we can see that overall water quality in the central city is better than that of the surrounding per-urban regions, especially in the western areas. The reason is that the sewage treatment system is well-deployed and well-run in the central city. In 2016, nearly 98% of sewage was properly treated before being discharged into the rivers in the central urban region, while this figure was less than 90% for the whole municipality (Beijing Water Bulletin, 2016). The situation was worse before 2016, with less than 80% of sewage being treated before 2010 (See Table 5.3).

Table 5.3 Sewage Treatments in Beijing, 2006-2015

Year	1	2	3	4	5
	Sewage produced ($10,000\ m^3$)	**Sewage treatment capacity ($10,000\ m^3$/day)**	**Sewage treatment rate (%)**	**Untreated ($10,000\ m^3$)**	**Untreated if on full capacity ($10,000\ m^3$)**
2006	129138	331	73.2	34609	8323
2007	129820	348	76.2	30897	2800
2008	132095	329	78.9	27872	11864
2009	136511	356	80.3	26892	6571
2010	141651	365	81.0	26917	8426
2011	145543	369	82.0	26198	10712
2012	152010	389	83.0	25842	10208
2013	155317	393	84.6	239189	11872
2014	161548	425	86.1	22455	6423
2015	164217	440	87.9	19870	3740

Source: Columns1, 2 and 3 from Beijing Statistics, 2016; Column 4= Column 1*(1-Column 3/100); Column 5=Column 1- Column2* 365

It can be seen that although the amount of sewage increased gradually, as treatment ability and treatment rate improved, the total amount of sewage without treatment decreased. But it is interesting to see that if treatment facilities had been operated at their maximum capacity, the amount of untreated wastewater which was discharged into rivers should have been much less. That is to say, some treatment plants were not being run properly. Moreover, in Table 5.3 during the period from 2009 to 2013, even if sewage had been treated at full capacity, the amount of untreated wastewater would have increased, which implies that construction of treatment facilities could not keep pace with sewage growth. These figures can only indicate the overall picture, but situations are more worrying for peri-urban regions, especially in the southern part of Beijing (Interview 19, 2014). Actually, in some areas the problem of direct sewage discharges is very serious. It is reported that, while the sewage treatment rate was 83% in the central city, the rate was less than 35% in rural areas. Only 681 out of 3111 villages outside the central districts have been provided with sewage treatment facilities, with some of these plants not running on a regular basis. It is found that about 30% of treatment facilities at village level were not running completely or only running from time to time (Xinhua News, 2016).

> "In recent years, the southern part of Beijing has been developing very rapidly. Due to relatively lower house prices there, a large number of residential blocks have been and will continue to be built. However, sewage treatment facilities and sewage pipelines have not been fully constructed accordingly; therefore, sewage can only be discharged directly into the river. For example, in Jiugong of Daxing County, we have to set up temporary treatment facilities. More than 60,000 tons of waste water is produced every day, but the temporary station is only able to deal with 45,000 tons. And this temporary measure cannot compete with standardised plants, it is only used to reduce the level of pollutants, even after treatment the sewage still cannot reach the official standard. (Interview 16, 2015)"

One of the reasons the eco-compensation project is introduced is to improve water quality to Miyun Reservoir, where the water is sent to treatment plants before delivery to households. But when it comes to drinking water, a fair proportion of residents in Beijing choose to buy bottled water or barrelled water, fearing that tap water is not clean. China measures its treated tap water against 106 indices, according to the National Drinking Water Standard (NDWS). However, there are reports that only about half of drinking water meets the standard in a nationwide survey of more than 4,000 water-treatment plants, carried out by the Ministry of Housing and Urban-Rural Development (Gong and Liu, 2013). The NDWS is very strict on paper, in reality, it is not strictly applied in a lot of water plants, especially in less developed regions. However, in terms of drinking water treatment, Beijing sticks to the NDWS firmly - the Beijing Waterworks Group (BWG) publishes the measured results for the 106 indices on its website. It is one of few cities in China which use advanced treatment technology, such as membrane treatment and ultraviolet disinfection, rather than conventional methods (e.g. sedimentation, filtration and disinfection) (Interview 19, 2014). But citizens in Beijing are still very concerned about tap water. The first impression about tap water is the hardness. Hard water does not cause health problems, but water in Beijing is so hard that it feels very starchy, tastes bad and one can immediately find white flakes floating on the surface. As a result, most people decide to get their drinking water from bottled water and barrelled water. In Beijing, it is common to see billboards with "shuizhan" (水站, water station), meaning barrelled water can be bought there; or to see delivery workers carrying barrelled water on tricycles to nearby residential communities. It is interesting to note that during the Beijing 2008 Olympic Games additional facilities were installed in the Olympic village and venues to reduce water hardness (UNEP, 2009).

No matter how clean water it is at the treatment plants, it still has to run a long distance through pipes to peoples' taps. Hard water is not harmful to people's health, but polluted water could be. Old pipelines are where contaminants arise. BWG claims it tests water quality along the pipe network and publishes results quarterly on its website. It only tests 7 indices, including chlorine, turbidity, colour, smell, total colony count, total coliform bacteria and $COD_{Mn.}$ According to the website, all the water tested meets the NDWS. Since 2016, every quarter the Beijing Environment Protection Bureau (BEPB) has started testing drinking water quality at water sources, water plants and water taps. It is interesting to find that, in all four quarters, there are instances when tap water fails to meet the NDWS, although the failure rates were very near to 1% (BEPB, 2016a, 2016b, 2016c, 2016d). It should be noted that BEPB tests 42 indices for tap water regularly, far more than that of BWG in the pipe networks. Among the results failing to meet the NDWS, sometimes chlorine and turbidity exceeded the limits, but in one sample the concentration of Fe almost amounted to twice the limit. In 2016, more than five residential communities were seriously affected by tap water pollution, with water turning black and smelling bad. Some people were treated in hospital after drinking polluted tap water (Caixin News, 2016). A further reason why tap water may be polluted is that it is normal to have water storage tanks on top of multi-storey buildings so that people on the top floors can get water easily during peak periods. These tanks are rarely cleaned and replaced, so they provide opportunities for secondary pollution.

It is clear that water quality management is mainly characterised by focusing on upstream management while ignoring the huge environment impact the municipality exerts. Moreover, although farmers who participate in the eco-compensation scheme are required to use less fertilisers to improve the water quality in the Miyun Reservoir which is an important drinking water source, the state-owned water company cannot always supply city-dwellers with drinkable water of good quality even the water quality in the Reservoir has already meet the national standard. From a river basin management perspective, these findings shed light on, water management through eco-compensation can be rather selective.

Overall, it shows that in situations, when incompatible interests among water users regarding forms of access to what quantity of water and what level of water quality at which place, powerful actors are in a position to legitimate their “water control” (Mollinga, 2008) by eco-compensation. It further suggests that the manipulation of the physical flow and quality of water and the guiding of the human behaviour which is part of water use through institutional arrangement, eco-compensation here, is rather political.

Chapter 6 Conclusion

China has been undergoing rapid economic development over recent decades, becoming the world's second-largest economy. However, this remarkable success has not come without significant environmental cost. Since the economic reforms in the late 1970s, China's environmental problems, such as biodiversity loss, air and water pollution, have exacerbated. Facing these challenges, China's government, at various levels, has been actively seeking new methods to reverse the deterioration. Under these circumstances, Payments for Ecosystem Services (PES), an increasingly favoured mechanism in which land users are deemed to be "providers" of ecosystem services and thus get paid in cash or in kind by the "users" of such services, has caught Chinese policy makers' attention. PES is especially widely applied for conservation purposes in developing countries, mainly because policy makers, international development organisations and conservation NGOs consider the mechanism as an effective way of reconciling development and conservation objectives. In China, a wide array of projects referred to as "eco-compensation" is being carried out. In terms of the type of services eco-compensation aims to deliver, water-related schemes have gained particular support in watershed management. This is not only because China's water quality and quantity problems are so severe - it is reported that water scarcity and water pollution cost China 1.3% and 1.0% of its Gross Domestic Product (GDP) respectively (Zhang and Bennett, 2011) - but also because water problems can be felt by people in their everyday life. How China resolves its water crisis is of fundamental importance to the country's continued development. Eco-compensation is seen as part of a new series of evolving environmental management frameworks, and how it works can provide useful lessons to address other environmental problems.

There is a wide range of studies on PES schemes from various perspectives (e.g. Engel et al., 2008; Kosoy and Corbera, 2010; Landell-Mills and Porras, 2002; Muradian et al., 2010; Pattanayak et al., 2011; Wunder, 2005, 2008). However, in English-language scholarship there are few attempts to document China's eco-compensation schemes, especially those targeting watershed services (except Wang et al., 2016). Even among the research reported in the Chinese language, most papers tend to focus on valuing how much the payments should be in the project design stage while little attention has been paid to social aspects of eco-compensation, particularly those schemes which already have been carried out for a period of time. This is partly because eco-compensation projects are still in their early stages. This in turn suggests greater demand for further detailed empirical research in this area, which could provide useful lessons for policy makers and eco-compensation practitioners alike. Another motivation for this research is to see how mainstream concepts, theories, and analytical perspective in western social science scholarship could bring new insights to Chinese cases; and whether China's practices could enrich PES studies. By presenting first an overview of water-related eco-compensation initiatives and then two detailed empirical case studies, I attempt to make a contribution in terms of bridging these gaps.

To begin with, the thesis has sought to clarify several terms used in PES and eco-compensation by reviewing relevant concepts. I then employed an analytical framework based on the literature to characterise PES schemes, and used this to analyse important features of 19 water-related eco-compensation schemes in China, including voluntariness, ecosystem services, payment issues, actors and their roles, current status, spatial scale and time frame. In doing so, it has not only provided a broad picture of China's eco-compensation schemes, but also has helped to determine, at least partly, which cases should be chosen for in-depth analysis.

When examining eco-compensation schemes in China, it is vital to understand how broad social and political factors play out at various stages of development and implementation. Failure to do so would result in asserting that eco-compensation is a purely technical solution. However, in both PES and water management practices, there is evidence suggesting in some instances that they can be highly contested and political (e.g. Chéné, 2009; Vatn, 2010), and thus taking an "apolitical" stance will lead to distorted or incorrect conclusions. As a result, through the lens of political ecology, I have tried to unearth how power relations play out in the two cases. The first of these is the Xin'an River eco-compensation project, in which the upstream and downstream governments reach eco-compensation agreement to protect water quality under the coordination of the central governmental agencies. The second is Miyun upper watershed eco-compensation scheme, in which the downstream city pays farmers in the upstream to grow crops consuming less water instead of irrigated rice, and no longer to apply fertilisers as much as before.

In the first case study, before touching on the details, I first briefly examined China's broad political system and water management institutional setting. That helps us to understand why water quality management in trans-boundary river basin faces significant challenges in China, a country with a one-party authoritarian regime. Employing the perspective of scale, the thesis examines the interests and conflicts of different governmental actors at different scales, and how this has affected the negotiation process and design of the eco-compensation.

In the second case study, using a political ecology framework, I explored how the circulation of water is embedded in social power relations, through which arise the urbanisation of water in Beijing and the eco-compensation programme. To achieve this goal, the case study examined the history of the urban use of water and interrogated the causes of decreasing water inflows from the upstream, and the water quality situation in the city of Beijing and its citizens' taps. By doing this, I have shown how the growing city, as the capital of China, has consistently sought to gain water from beyond its boundary. It has also revealed how the city selectively framed agricultural water use as the main problem, and thus initiated the eco-compensation accordingly. At the same time, I have shown that the city ignores its own environmental impacts on water quality and sometimes fails to provide safe drinkable water even though the water quality in the upstream is good. For these reasons, I argue that eco-compensation schemes in China can be political as well.

This final chapter is arranged as follows. First, it lists the main findings from each chapter in this thesis. It then considers the implications of these findings for China's both eco-compensation and PES more generally. Next, it examines the relationship between eco-compensation and political power. Finally, this chapter discusses the limitations of this dissertation, before suggesting wide implications of this thesis for China's eco-compensation projects and Beijing's water management in the future.

6.1 Main Findings

As Chapter 1 discussed, water can provide a broad range of ecosystem services; water quality is an indicator of the result of some intermediate services such as water purification, and at the same time, it is a driving factor which affects other services such as food provision. Chapter 2 mainly discussed research methodologies and offered some reflections on this. It is worth mentioning that the end of that chapter noted that China's social science, including human geography, lags well behind that in the western world, despite the fact that several fields in science now can compete with the USA. This can be explained by several factors, including significantly less government funding for social science, less promising careers for students with social science and humanities background, the government's censorship on academic freedom, the instrumental nature of the research conducted by many social scientists, and social scientists' unwillingness or inability to learn and apply Western theories. By giving some examples, I suggested four possible ways for Chinese human geographers to engage with Anglophone geography. To be specific, Chinese geographers can 1) use western methods and theories to examine China's contexts straightforwardly, 2) apply and improve western theories if applicable, 3) develop localised theories which might not be replicated in western contexts, and 4) build more widely-applicable methods and theories.

Chapter 3 focused on reviewing the characteristics of eco-compensation in China. This chapter began by examining some terminologies regarding PES and eco-compensation. According to Wunder's definition (2005), PES involves voluntary transactions where a well-defined ecosystem service is bought by a buyer if and only if the provider secures the provision of such service; this has been subject to criticism. The voluntary nature of PES has been particularly questioned, as governments are involved as direct buyers in many PES cases. In addition to PES, alternative terms such as Markets for ES, Compensation for ES and Rewards for ES are terms that are also used. When it comes to China's eco-compensation, on various occasions, "public institution" or "public regulation" appears in government documents, and that indicates eco-compensation tends to be government-led. It is clear that in some instances eco-compensation is identical to PES in other countries, but more often than not, it also involves direct payment from governments to public entities such as other governments and state-owned forest management companies. This is in stark contrast to PES which relies on individual land users or communities as a means towards decentralisation of resource management. In essence, this kind of government-government (or government-related entity) eco-compensation is just an alternative way of funding environment protection or conservation using the rhetoric of market environmentalism, without the reduction of state's involvement. It is not uncommon to see that, in addition to providing incentives to ES providers, eco-compensation also offers disincentives to those who cause environment damage. In that sense, environmentally-harmful activities are punished. In practice, service providers are penalised if they fail to deliver a certain level of environmental/ecosystem services, and this often happens in upstream-downstream water quality related projects. Under these circumstances, the role of the upstream region is not fixed - it could be considered as a service provider conditioned on acceptable water quality and will receive payment from the downstream region, or otherwise it could be the polluter and be required to compensate the downstream region for poor water quality. This indicates that eco-compensation does not only adopt market-based elements in PES, but also has strong government interventions, sometimes still relying on conventional command-and-control methods.

As Chapter 3 showed, the majority of water-related eco-compensation projects are not voluntary. For the three schemes of the 19 reviewed in which participants can determine whether to take part in or not, two are small scale NGO-led projects while the other is a government-led water conservation project in which land users are encouraged to bid to participate. Other services, including biodiversity and forest, are bundled with water services in some eco-compensation projects. It seems that policy makers and project managers are more interested in using eco-compensation to address water quality problems, with water quantity being considered together with quality concerns in the Miyun Watershed initiative. Public funding from government is the main the source of payment, and there is only one project funded by a private beverage company, designed to improve water quality in its abstraction area. Moreover, sometimes NGOs tend to finance eco-compensation, as well as providing technical support. Payment is made conditional on either certain land management activities which are thought to be able to lead to improved environmental status (input-based); or outcomes of those land-using practices (output-based). These two kinds of payment arrangement are almost equally prevalent in China. Government actors play leading roles in eco-compensation projects, in most cases with different governments as both buyers and sellers of ecosystem services. Governments' roles are not limited to this; besides, they often serve as intermediaries in various stages, fulfilling different functions such as project design, daily administration and so on. Although governments are usually service sellers, private land users are involved and are paid in some schemes. The vast majority of eco-compensation is rather small-scale (local or regional level), with only two large-scale forest management projects being rolled out nationally. In terms of project length, contracts within eco-compensation agreements are generally relatively long-term (>5 years), but there is a project that is on hold after the project design and thus it has not been carried out so far.

Chapter 4 explored the "hydro-politics" issue in eco-compensation; in this chapter relationships are mainly assessed between different governmental agencies at national and subnational levels, by using the concept of scale. This chapter at first analysed China's political system and water governance regime, and I argued that China's poor water quality status is partly attributed to the fragmented political and water management regimes. In spite of the Communist Party's tight control of administration, local officials are still able to implement national policies selectively and flexibly. They are more likely to choose do things which can show accomplishments in a short time in order to gain promotion. This was compounded by a tax reform which saw significant revenue being retained by the central government while financial responsibilities are still left with sub-national governments. With limited budgets and multiple tasks, local governments have strong incentives to develop the local economy to increase revenue, while tending to spend less on things such as environmental management which normally would only show effects in the long term. Moreover, the Chinese political system puts considerable emphasis on vertical control, yet cooperation between different jurisdictions is often hard to achieve and local governments often compete with each other to further their own interests. Even worse, China's functional governmental departments at lower levels are dually led by local governments and their parenting organisations at higher levels. They are politically affiliated with local governments, which means their main leaders are appointed by, and their general and administrative expenses are provided by, local governments. Departments at higher level are only in a position to give professional support and have no mandates over their lower level counterparts or governments. The river basin is generally believed to be an appropriate scale at which water management takes place, but this "fragmented authoritarianism" (Lieberthal, 1992) is incompetent to coordinate multiple stakeholders in upstream and downstream for that. Water quality management especially takes the brunt, with the upstream usually ignoring its environmental impact on the downstream, and water quality being managed by multiple departments.

Chapter 4 also explores how central and provincial governmental agencies use eco-compensation as an opportunity to fulfill their own interests, and explained what effects the eco-compensation can have on the power relations at different scale. It does so by analysing the negotiation process and details of the Xin'an River Scheme. As the downstream jurisdiction had long requested the upstream to improve water quality, the upstream mobilised the idea of eco-compensation upwards to the central government, requiring the downstream government to share the costs. To do so, the upstream asked a leading water research institute to conduct a consultancy project to justify the idea, and submitted a draft bill to Congress which won support. The central government was keen to use eco-compensation as a means to enforce water protection at local levels, especially in the river basin as a whole. This chapter showed that the negotiation process was highly contested, with the focal point being the performance measures used. In PES and eco-compensation schemes, performance measures are important, as payments are made on the basis of certain indicators, such as the level of water quality that should be achieved. By mobilising the narrative that climate change would lead to less precipitation, the upstream argued that water quality might worsen even if pollutant load was reduced. Because of this tactic, a discount coefficient was applied in the water quality parameter. This allowed the upstream to be able to receive payment even if the water quality degrades to a certain extent; constituting a favourable term for the upstream. In order to control the upstream tightly in terms of water quality management, the scheme applied a non-compliance sanction method - if the upstream fails to meet the water quality target, it will have to pay the downstream for environmental damage. Also a detailed water monitoring plan was set up to avoid data manipulation. Furthermore, a comprehensive water management plan was developed by the central government, setting various long-term goals. I argued in this chapter that the implementation of eco-compensation, resulting from the struggles and strategies of different actors at different scales, created a shifting power dynamic, with reconfigured authority and responsibilities for water quality management spanning different levels.

Chapter 5 focused on the how eco-compensation was selectively framed as a solution to support the megacity of Beijing, and examined initially the recent history of urbanisation of water in the city region. The chapter found that since it became the capital, harnessing water has been an integral part of Beijing authority’s task. This not only represents a “hydraulic mission” of the government in the early years, but has also supported the burgeoning population and economic activities in order to realise the modernisation of the city. However, these were underpinned by controlling and diverting water from elsewhere, rendered successful by Beijing’s political status. Besides traditional engineering methods, eco-compensation became a new way of controlling water by forcing upstream farmers to grow less water intensive crops. Furthermore, the chapter reveals that, by blaming upstream farmers as irresponsible water users, the project designers selectively interpreted agricultural water users as the main cause of decreasing water flows, while disregarding massive land use change in the upstream. Actually, significant afforestation activities happened during recent decades in the upstream region to stop desertification and sandstorms, and evaporation within these forests is probably higher than that from other land use types, including agriculture. There are several studies suggesting that this change can reduce annual runoff by as much as total upstream water usage (Li and Li, 2008, Zheng et al., 2013; Yang et al., 2014). Moreover, the chapter found that even though upstream farmers participating in eco-compensation schemes are discouraged from using fertilisers ostensibly to improve water quality in the Miyun Reservoir, water quality deteriorates significantly in the lower reaches of the basin more because of pollution generated within the city; and that the authority has not done enough to provide drinkable water. The chapter has showed that policymakers were using the eco-compensation to appropriate water legitimately from marginalised farmers. In terms of using eco-compensation to manage water, policymakers in this case determined who should have particular qualities of water, and what the quality of water should be.

6.2 Eco-compensation and power in China

China's water-related eco-compensation mechanism, which in theory tries to draw lessons about marketisation of environment from the concept of PES, is interpreted and designed with alternative meanings by local policy-makers in the course of implementation. Projects are mainly directed by governmental actors, sometimes through mediation by superior agencies. Given difficulties and transaction costs of organising the public on the demand side, it is not uncommon for local authorities to act as a buyer on behalf of its citizens. Although this may not differ greatly from PES more generally, which in many cases also involve little free market exchange, a more evident feature is that in most of the projects examined in Chapter 3, money is paid to upstream governments conditional on good water quality outcomes, which is very rare in PES where securing ecosystem services come from individual land managers. But it is noteworthy that several, albeit few, eco-compensation projects target individuals.

From a socio-institutional perspective, the reshaping of market-based rhetoric into eco-compensation with its own characteristics is deeply rooted in the local social-political realities of the Chinese water management institutions. Although China is as an authoritarian country, some decentralisation processes have happened in the past, significantly shifting the responsibility of environmental management to local authorities. However, lack of adequate budgets makes local regions reluctant to improve or maintain good water quality, especially in the less developed upstream regions. Therefore, the mainstream market-based discourse that tries to internalise externalities is interpreted as a solution to redistribute water management costs among upstream and downstream governments. This is compounded by the Chinese central government's determination to address water pollution issues. As a result, the popular globalised narratives about PES as an effective solution for conservation has sparked considerable interest in Chinese policy domains.

The influence of social-political dynamics on eco-compensation has been well illustrated in the

Xin'an case. The initiation of Xin'an eco-compensation is intrinsically connected to the original power relationships among China's fragmented regime which does not fit well with river quality management. The central government and its Ministries cannot effectively compel its sub-national governments to protect the environment, especially in the case of water quality management in trans-jurisdiction rivers, and the less developed upstream regions were reluctant to improve or maintain good water quality given that they would bear all the financial burdens.

At the same time, promoting government-to-government eco-compensation as a promising policy tool opens new opportunities for various actors to realign their power relations in the existing power structure, often through highly contested processes and by deploying various strategies. It is clear that both the central government and upstream governments have tried to influence the outcome of negotiation which would lead to the reconfiguration of power dynamics. In the Xin'an eco-compensation project, the processes can be seen in the scale jumping of the upstream government to the Congress, claiming it should be compensated. These struggles are also manifest in establishment of water quality targets, introducing non-compliance sanctions, outlining monitoring details, and developing river basin management plans and so on. The process of struggles can further be seen in actors' strategies, such as the upstream's mobilising the "climate change" narrative to influence the water quality target. Actors' contestations and strategies were organised as a result of existing power structures, and these actors mobilised according to their agendas, generating new power configurations to meet their own needs. Eco-compensation not only reshaped the central-local relationship, but also altered the upstream-downstream relationship. These produce new power relations among the upstream government, downstream government and higher-level government (including the state itself), but in a more balanced way. To be more specific, upstream governments get new funding streams for protecting water, meanwhile downstream government can enjoy better water, and the higher-level government gains tighter control over local water quality management.

This tighter control can be largely attributed to the regulatory component in many government-to-government eco-compensation projects - if an agreed water quality outcome is not achieved, the upstream government will be punished, paying fines to the downstream government. While in theory monitored and enforced conditionality is key for effective PES projects, in practice sanction for non-compliance is hard to enforce or not severe enough, usually terminating future payment, even if enforced. In the Chinese context, non-compliance penalties are possible thanks to the fact the seller side of an eco-compensation scheme is the downstream government that assumes a certain degree of responsibility of environmental protection under regulatory framework. This further suggest that eco-compensation in China is a hybrid mechanism combining an old state-centric command-and-control approach with market-based rhetoric, rather than a neoliberal policy tool.

The illustration of how eco-compensation, under the mask of a market-based framing, unfolds in practice, indicates that the often-assumed pure technical fix for environmental governance is heavily embedded in the socio-political dynamics. These broad factors play a vital role in shaping how market solutions are interpreted, designed and implemented in China. Meanwhile, the politicised process, involving contestation and conflict, shows that different actors in the socio-political dynamics try to break apart existing power relationships and reconfigure them. The study therefore echoes with the wider claim that PES cannot operate in an institutional vacuum, and that power dynamics among different agents cannot be ignored (e.g. Milne and Adams, 2012, Rodríguez-de-Francisco and Budds, 2014, Rodríguez-de-Francisco and Boelens, 2016). This makes an important contribution to understand the political nature of state-led eco-compensation among different state actors in a highly authoritarian regime. At the same time, this more explicit illustration of the role of power dynamics in an authoritarian context perhaps shed light on the political dimension of PES more generally.

But some rather more mixed insights emerge from the government-to-individual Miyun case. This programme was designed to gain control of water by limiting upstream farmers' access to water, in order to reduce agricultural water use to support the needs of the growing downstream city. This has also been embedded within socio-ecological dynamics. The cause-effect framing without careful scrutiny of the complex drivers of water scarcity in the watershed is illustrative of power dynamics in this project - overlooking how massive state-led afforestation in the upstream (to prevent sandstorms) may affect water availability was inherently political and power-related. The social construction of problems and particular solutions may thus strengthen the power asymmetry between downstream policy makers and upstream land-users. This sheds light on the fact that projects with individual participants are likely used by powerful funders to gain control over resources, compared to government-to-government projects in which power dynamics lead to more balanced reconfiguration without obvious winners and losers.

6.3 Need for Future Research

Inevitably, there are some limitations to the arguments put forward in this thesis. First, in terms of the overview of eco-compensation, the findings are based a limited number of schemes. The cases that I chose are relatively well-known and have sufficient primary or secondary information for me to draw out key conclusions. It is important to examine these schemes, however, since by focusing on them, certain aspects of eco-compensation projects in China are revealed; but the number of schemes which I have explored is still small compared to the many projects which are implemented in a large and diverse country, especially at county or lower levels. Therefore, conclusions generalised from these may have pitfalls.

Second, in terms of the two specific case studies, although the Xin'an River case represents the government-government style (the most common one) while the Miyun Case represents the government-individual type, complementing each other nicely, each of them has its own contextual background which might not be replicated elsewhere. To be specific, in the Miyun case, Beijing is the capital of China, and thus enjoys unparalleled political status over the upstream region. In the Xin'an case, it is the first trans-provincial boundary eco-compensation case; as a result, the design of the project involves high-profile mediation from the national level agencies. Actually, these two points have significant implications for how each project was designed. Therefore, the two cases undoubtedly provide useful insights, yet conclusions arising from them should not be taken too far or extrapolated without care to other localities.

Third, for the two case studies, I focus on just the negotiation and design phases. I did not follow the power struggles and conflicts in the implementation period. An important area of future research would be to carry out detailed studies of how different actors react. For example, from the perspective of farmers' "everyday politics" (Kerkvliet, 1990), involved in contestation over day-to-day water use and management, I could explore how farmers in the upper Miyun Watershed use water in order to increase corn yield to make up the loss arising from not being able to grow rice, and how that might affect the water quantity. In addition, in the Xin'an River case, further study on what measures the upstream government has taken to ensure improvement of water quality would be worthwhile, to investigate how the power relations play out in that process. Moreover, there is a need for in-depth studies of cases in order to examine what kinds of economic and institutional elements do work in eco-compensation and what not, and why.

6.4 Policy Suggestions

China's eco-compensation schemes indicate that policy-makers there are willing and determined to try innovative approaches to address environmental problems, drawing lessons from world-wide experience. While these projects are gaining momentum in China, policy-makers and practitioners must be cautious that eco-compensation fetishism may not always lead to desirable results and there are a number of challenges.

As PES schemes are often questioned over the purity of their "market-based" nature, this critique is even more acute for eco-compensation in China. As this thesis shows, eco-compensation projects depend heavily on government's involvement. While governments' roles should not be dismissed, participation of individuals and, if possible, private firms needs to be encouraged. Given the scale of most water-related projects, government-government negotiated projects are practical in Chinese's context, helping to bring down transaction costs. However, individual land-users' management practices have significant impact on delivery of environmental benefits, and therefore their roles could be incorporated into eco-compensation projects. As in the Sloping Land Conversion Programme, in which farmers are paid for converting farmland into forests, money can be channelled to land-users to incentivise their stewardships in other water-related eco-compensation projects after upstream governments get eco-compensation payments. For example, in the Xin'an River project, a wide range of measures can be adopted, such as converting arable land into grassland or woodland, in-field and riparian buffer strips, ditch management and so forth, with farmers being directly paid accordingly. Without participation of individual entities, eco-compensation takes the risk of turning out to be redistribution of revenues between state agencies and hence working like the command-and-control subsidies which eco-compensation intended to replace. This "old wine in new bottles" scenario should be avoided.

In spite of numbers of projects, eco-compensation is still in its early stages, and policy-makers, practitioners and scientists must work out a comprehensive, but practical, approach to design and implement eco-compensation projects. It goes without saying that many steps, such as identifying tradable ecosystem services, enlisting prospective buyers and sellers, and negotiating agreements are important and sometimes challenging. However, based on the two specific case studies in this research, it seems that extra attention should go to technical aspects of eco-compensation. To be specific, robust scientific links between management practices and environment benefits should be assessed, and baselines, representing the likely future status of environmental outcomes without eco-compensation interventions, need to be established. PES projects, particularly water-related ones, are often criticised for poor assumptions and weak causal links between land use and ecosystem services (de Lima et al., 2017). China's eco-compensation is no exception to this, although this weakness can be partially attributed to the complexity of biophysical processes and limited understanding about these processes. Therefore, more research is needed to improve on this challenge for scientific and practical grounds alike. In addition, baselines are critical to measure whether additionality has been achieved and to what extent. In the Xin'an case, the possible impact of climate change, which may lead to less precipitation and further affect water quality, was mobilised by the upstream government to influence the negotiating process. Careful validation of this argument and the associated baseline projection were absent in that negotiation, resulting in possibly favourable terms for the upstream. As a result, these technical issues are crucial for successful eco-compensation implementation.

As for most of the water-related eco-compensation programmes, their performance is generally measured by water quality. Notwithstanding that water quality plays an important role in maintaining healthy ecosystems and ecosystem services, this recommendation suggests that water-related eco-compensation programmes should be more ecosystem-based instead of focusing on only a few water quality indexes. Fully understanding the complex ecosystem process is still challenging today, yet it would be a good starting point to develop a broader range of indicators which can assess the status of aquatic ecosystem more accurately. An ecological framework developed by the Ministry of Water Resources (2010b) to assess river health could be incorporated into eco-compensation schemes; doing so will compel local governments to pay attention to various aspects of aquatic environment in addition to its chemical quality. Factors such as river continuity, water flow, number and species of fish and flora could also be considered in the future.

Policy-makers should be aware that eco-compensation is not a policy panacea for water problems, both of quality and quantity. Over-reliance on eco-compensation might lead to ineffective outcomes. For example, in the Miyun eco-compensation project, paying farmers to restrict their access to irrigation water is very likely lead to a drop-in crop production, as there are numerous studies demonstrating that under a given agro-climatic situation the relationship between water consumed and crop production is linear (Howell, 1990; Perry et al., 2017). This is also true for government-government initiatives, as the opportunity cost of environmental protection and conservation for a government could be much higher than the payment it receives or the penalties it pays. Therefore, eco-compensation could be applied as one of a diverse group of possible solutions, rather than as a silver bullet which is assumed to address any problem. In addition to eco-compensation, traditional command-and-control regulations, integrated conservation and development projects, environmental taxes and subsidies, pollution permit trading, among many others, can be tried in different social-ecological systems. For example, the new “River Chief System” and the “Environmental Audit System” require that the main officials at provincial, city, county and township levels should assume major responsibilities for addressing water problems in their jurisdictions, and officials can be punished or even be sacked for serious environmental damage (China Daily, 2017). Traditionally, there is no incentive to encourage officials to address environmental problems rather than economic developments; such sanctions may alter the attitudes of those responsible for environmental improvement.

In addition, emphasis is also needed to address the multi-faceted and complex root causes of water crisis. For example, in Miyun Reservoir's case, managing Beijing's water scarcity should not only concentrate on increasing water supplies; perhaps more importantly, Beijing authority should take necessary steps on the demand side. Water tariff reform, water pollution management, new technologies including rainwater harvesting and wastewater recycling, and improvement of agricultural water use efficiency could all help alleviate Beijing's water stress.

In the end, a depoliticised attitude towards eco-compensation is likely to be unwarranted, and policy makers should give more emphasis to the process of policy design. As both case studies show, the often-assumed technical mechanism is highly contested and part of a broader structure of power interplays. Since social groups may influence the design of projects, the roles of broader economic, social and political factors cannot be neglected. More attention should be given to studying and understanding how these factors contribute to the outcomes of eco-compensations so as to avoid possible policy failures.

6.5 Contributions of this research

This thesis demonstrates, first through a review of 19 eco-compensation cases and then using two detailed case studies, how market-based environmental management mechanisms work in China. The research has important implications.

The review reveals what kinds of programme are labelled as "eco-compensation" in China. It shows that most eco-compensation schemes, which are often considered identical to PES without interrogation, do not follow a pure market logic. As chapter 3 reveals, most eco-compensation projects rather reflect governmental intervention. Although there are PES projects which are paid by government subsidies in other countries, a distinct aspect of eco-compensation in China is that these initiatives often involve transactions between one level of government and another. This reveals that the top-down approach is still prevalent in China. However, this does not suggest that eco-compensation projects are different from PES altogether. Some small-scale projects, sometimes supported by NGOs or private company, are very similar to PES. The thesis shows that the framework which is used to analyse PES can be used to characterise eco-compensation as well. This illustrates that exchanges between researchers and practitioners across different countries can broaden the diversity of market-based environmentalism.

Perhaps the dominance of state actors in China's eco-compensation can be partly explained by its broad political contexts. The thesis exemplifies that eco-compensation might be influenced by political power. Different government agencies, both at the same and different levels in a hierarchical government try to promulgate eco-compensation as a way, using different strategies, either to gain financial benefits or greater control over lower level counterparts. The power relations both shape and are shaped by eco-compensation. It also shows that, under the mask of the market, eco-compensation can be used to control the allocation of scarce resources, by framing both problems and solutions. These findings imply eco-compensation projects may be political. Therefore, the broader contexts of environmental policy tools cannot be ignored.

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Appendix 1: More information on 19 Eco-compensation Schemes

Case 1 Sloping Land Conversion Programme

A severe Yellow River drought in 1997 and devastating floods in 1998 in the Yangtze River Basin and Northeast China spurred Chinese policymakers into action. In response to these disasters, the central government initiated the Sloping Land Conversion Programme in 1999, with particular emphasis on west China. It is the largest land retirement programme in the developing world, with the target of converting around 14.67 million hectares of cropland to forests (4.4 million of which is on land with slopes greater than 25°) and an additional “soft” goal of afforesting a roughly equal area of wasteland by 2010. Pending successful completion, it could thus represent a 10–20% increase in China's national forest area and roughly a 10% decrease in cultivated area. The programme has been implemented in more than 2000 counties across 25 provinces in China - a wide area containing huge ecological and economic heterogeneity - and involves the participation of tens of millions of rural households. It has a total budget of 337 billion CNY (over US$40 billion), over 50 billion CNY of which has been spent so far, and over 7.2 million hectares of cropland had been retired by the end of 2003.

Overall, the SLCP targets a wide array of environmental services. Upper Yangtze and Yellow River Basin watershed services are the main focus of the programme; the 2003 plan particularly emphasizes retirement of sloping cropland in these watersheds, reporting that China has some 6.07 million hectares of cultivated land with slopes greater than 25°, and that some 2 billion tons of silt are released into the Yangtze and Yellow Rivers annually, with two-thirds of this coming from sloping cropland. At the same time, however, the 2003 plan's wording indicates that forest ecosystem services and timber value, forest rehabilitation, and landscape restoration are also important targets. Timber value, in particular, is an important goal, since 75% of the planned enrolment area is to be planted with timber-producing forests (which are termed in China's state forestry system as, ironically, “ecological forests”), as compared with 25% for orchard crops or trees with medicinal value. SLCP also has the stated goals of poverty alleviation and assisting farm households to shift to more sustainable structures of production. Added to this, it is said argue that an additional hidden aim of the programme has been to subsidize the ailing State Grain Bureau.

Under the SLCP, the State Forestry Administration plans to convert around 14.67 million hectares of cropland, 4.4 million of which is estimated to be on land with slopes of 25° or above. Subsidies for SLCP to 2003 have been both in cash and in kind. The programme stipulates that farmers who convert degraded and highly sloping cropland back to either "ecological forests" (timber-producing forests), "economic forests" (orchards, or forests with medicinal value) or grassland will be compensated with 1) an annual in-kind subsidy of grain, 2) a cash subsidy, and 3) free seedlings, provided to the farmer at the beginning of the planting period

No rigorous quantitative evaluation of the programme's environmental impact exists at present. Instead, the explicit measures of environmental services are the targeted total land area for retirement, the portion of this that is to be on slopes greater than 25°, tree types to be planted, and the required survival rates of the trees planted on retired land. The low survival rates for programme-planted trees found in the 2003, however, suggest that achieving programme goals has been difficult.

Source: Bennett, 2008; Scherr et al., 2006; Xu et al., 2010; Zhang et al, 2010.

Case 2 Natural Forest Protection Programme

This programme was initiated in 1998 in response to major floods in the upper and middle Yangtze River watershed and the Songhua and Nen Rivers in Northeast China, which were caused by over-logging in state forest areas. The pilot phase of the programme was started during 1998–2000, while full implementation begins from 2000.

The NFPP covers key forest areas in 163 public forestry departments, 734 counties and 17 provinces in the upper Yangtze River watershed, upper and middle Yellow River watershed, and in northeast China and Inner Mongolia. The total forest area targeted is 1.023 billion mu (68.2 million ha), 846 million mu (56.4 million ha) of which are natural forests, accounting for 53 percent of China's natural forest area.

The plan aims to reform the state forest sector in terms of the economic and environmental sustainability of forest resource management, both for timber production and ecological conservation. Specific goals include protecting current forests, reducing consumption of forest resources, reducing commercial logging, increasing forest cover and laying off with redundant workers on public-owned forests.

Under the NFPP, central government pay subsidies to participating bureaus and local forest authorities for various environmental and social tasks. For all programme areas, 10,000 CNY/person/5,700 mu (380 ha)/year is paid for forest management. In the Yangtze River upper watershed and the Yellow River upper and middle watershed, subsidies for afforestation/reforestation are paid as follows: reforestation via mountain closure - 70 CNY/mu (4.67 CNY/ha), disbursed equally in 5 years; aerial seeding afforestation - 120 CNY/mu (8 CNY/ha) for near mountain areas, 50 CNY/mu (3.3 CNY/ha) for remote mountain areas; manual afforestation - 200 CNY/mu (13.3 CNY/ha) for the upper Yangtze River watershed, 300 CNY/mu (20 CNY/ha) for the upper and middle Yellow River watershed. In all programme areas, 12,000 CNY/person/year from central government will be paid for educational purposes, 15,000 CNY/person/year will be paid for public security, and for health expenditures (i) 6,000 CNY/person/year and (ii) 2,500 CNY/person/year will be paid for (i) upper Yangtze River watershed and upper and middle Yellow River watershed programme areas and (ii) northeast China and Inner Mongolia programme areas, respectively. In all programme areas, dismissed workers will be compensated with 3 times of previous year's average salary. Subsidies are also provided for forest nursery establishment, elderly care, forest fire prevention, and technical support.

Reports indicate that the forest ecology in programme areas has improved; forest resource

consumption has been reduced by a total of 426 million m^3 since the programme began, while forest volume has seen a net increase in 460 million m^3. Waterborne siltation in Hubei Province's Yichang section of the Yangtze River has been reduced by 30 percent in comparison to 10 years ago, with a rapid decrease of 10 percent annually. Inspections by the Shanxi Provincial Water Bureau have found that flow-through siltation load in the Yellow River has been reduced by 200 million tons/year. In upper watersheds of the Yangtze River, Giant Panda numbers have increased by 1000 to more than 1590. In northeast forest areas, the northeast tiger has been spotted after many years of no sightings. Populations of Golden Monkeys and other national level-one protected species are also continuously increasing. Source: Bennett, 2009
Case 3 Beijing- Hebei Miyun Watershed Eco-compensation In order to improve quality and quantity of Beijing's water supply, cooperation between Beijing and Hebei Province has been developed regarding water quality and quantity in both Miyun and Guanting reservoirs. As part of this, Beijing and Hebei initiated the "Paddy to Dryland" programme in 2005. Under this programme, the two parties pay farmers in two stages (2005-2008 & 2008-2010) to convert 183,000 mu (12,200 ha) of rice paddies to corn and other low water-use crops in Chengde and Zhangjiakou Municipalities, the upper watersheds of the Miyun and Guanting Reservoirs respectively. Initially the plan called for Hebei to convert 103,000 mu (6867 ha) of paddy fields in the upper watershed of the Miyun reservoir before 2008 to increase water supply for Beijing Olympics. Later it was extended to the upper watershed of the Guanting reservoir, converting 80,000 mu (5333 ha) of paddy fields after 2008. Actually 71,000 mu (4733 ha) of paddy fields had been converted in the upper watershed of the Miyun reservoir by the end of 2007, while the upper watershed of the Guanting Reservoir converted 14,400 mu (960 ha) of paddy fields ahead of schedule by 2007. Under this arrangement, Beijing Municipality provided payment to farmers at the rate of 450 CNY/mu (6,750 CNY/ha). This has been increased since 2008 to 550 CNY/mu (8,250 CNY/ha). The responsible departments of both parties have jointly carried out inspection in the implementing stage.

From 2005-2010, 100 million CNY was funded by Beijing Municipality for water resource environmental management and water-saving technologies in the upper watersheds of the Miyun and Guanting reservoirs. Out of this, 22 million CNY was allocated in 2006, with an additional 2 million in 2007. Projects include water-saving irrigation on 10,000 mu (666.7 ha) land in the watershed of the Bai River in Zhangjiakou's Chicheng County, Hei River headwaters management in Chicheng County, water-saving and seepage prevention on 10,000 mu (666.7 ha) land in the Sanggan River watershed in Yangyuan County, management of pollution water from sheep slaughter houses in Xuanhua Area, integrated pollution management project in Chengde's Fengning County, a rural village domestic garbage landfill project, the conversion of 10,000mu (666.7 ha) of paddy fields to dryland and water-saving irrigation projects in the Han River watershed in Luanping County, and the implementation of 7 water pollution management projects in Yangfang, Xuanhua Area. It is reported these programmes have so far saved 19.5 million m^3 of water and increased cross-border water flow by 13 million cubic metres annually.

In addition, both Hebei Province and Beijing Municipality jointly apply to the central government to increase Hebei Province's area for public benefit forests under the Forest Ecosystem Compensation Fund (FECF), and to increase support of state-owned forest farms in order to protect water.

Source: Bennett, 2009; Zhang et al., 2010; Zheng et al., 2013

Case 4 Hebei Eco-compensation in 7 Major Rivers

In 2008, an eco-compensation scheme was set up within the Ziya watershed, a main watershed covering 5 cities. After one year of implementation, the average concentration of Chemical Oxygen Demand (COD) in the Ziya River had decreased by 42.8%, and the average concentration of ammoniacal nitrogen was 13.7% lower. Hebei Province then decided to expand the eco-compensation scheme to all 7 major watersheds, covering 201 river reaches in 56 rivers.

COD and ammoniacal nitrogen are monitored every month, and results are used to calculate how much cities need to pay to the provincial government that will allocate the money later.

Given the monitoring result for COD, when the quality of the inflow water to a city meets the required standard (or there is no inflow), if the monitoring result for COD at the outflow exceeds the standard by less than 0.2 times, the city has to pay 300,000 CNY in total; if the result exceeds by 0.2 times to 0.4 times, the city has to pay 600,000 CNY; if the result exceeds by 0.4 times to 0.6 times, the city has to pay 900,000 CNY; and if the result exceeds the standard by even more, payment is calculated in line these trends. When the water quality at the entry section fails to meet the standard and the water quality continues to deteriorate, if the monitoring result of COD at the outflow exceeds the standard by less than 0.2 times, the city has to pay 600,000 CNY; if the result exceeds by 0.2 times to 0.4 times, the city has to pay 1.2 million CNY; if result exceeds by 0.4 times to 0.6 times, the city has to pay 1.8 million CNY; and payment is increased along with this trend when results are even worse.

Likewise, payment based on concentration of ammoniacal nitrogen is calculated in a similar way but at a different rate. To be more exact, when the water quality in the inflow to a city meets the standard (or there is no entry water), if the monitoring result for ammoniacal nitrogen at the outflow exceeds the standard by less than 0.5 times, the city has to pay 300,000 CNY; if the result exceeds by 0.5 times to 1 times, the city has to pay 600,000 CNY; if the result exceeds by 1.0 times to 1.5 times, the city has to pay 900,000 CNY; and if the result is beyond these levels, payment is calculated in line with the above trends. When the water quality of the inflow fails to meet the standard and the water quality continues to deteriorate, if the monitoring result of ammoniacal nitrogen at the outflow exceeds the standard by less than 0.5 times, the city has to pay 600,000 CNY; if the result exceeds by 0.5 times to 1.0 times, the city has to pay 1.2 million CNY; if result exceeds by 1.0 times to 1.5 times, the city has to pay 1.8 million CNY; and payment is increased along with this trend when the result is even worse.

Payment is delivered to the provincial government, with 50% allocated to water environment protection projects province-wide, while the remainder is transferred to downstream city.

Source: Hebei Provincial Government, 2009

Case 5 Liaoning Liao River Eco-compensation

In 2008, Liaoning Province issued a notice regarding cross-section water quality assessment in Liao River watershed. This programme encompasses 14 provincially administered municipalities, and 27 main river channels and tributary sections are monitored for water quality. Using the targets stipulated in national and provincial pollution control plans, this programme targets COD, with participating cities being penalised for failing to achieve pollution control targets, which are paid to the next downstream municipality to defray the added water pollution management costs. For each 50% that water quality surpasses targets, the penalty is 500,000 CNY for river sections in the Liao River main channel and 250,000 CNY for river sections in the tributaries, with monthly assessments being conducted by the provincial Environmental Protection Bureau. The programme, which began in 2009, also stipulates that the provincial government will legally pursue and prosecute the authorities responsible for those river sections that consistently fail to achieve targets, or are the source of severe pollution disasters. In the first year, 7.75 million CNY of penalties were collected from seven cities.

Source: Liaoning Provincial Department of Environmental Protection (2007); Wuhan Municipal Development and Reform Commission, 2010

Case 6 Jiangsu Lake Thai Eco-compensation

Jiangsu Province has set up a wide range of programmes to manage Lake Thai. At first, water pollution emissions rights trading was piloted in 2007. Initial prices have been set at 2,600–4,500 CNY/ton for COD and 2,245 CNY/ton for sulphur dioxide (SO_2).

Then a cross-district water quality management plan was developed in the Thai Lake watershed, whereby upstream pay downstream penalties to offset added water pollution management costs based on the amount by which water quality entering the lower zone exceeds target quality levels. The following penalty rates have been set: 15,000 CNY/ton of over-target COD, and 100,000 CNY/ton of over-target ammonia nitrogen and total phosphorous. The money is partly used to

create rewards to encourage good environmental management. For example, villages will be funded at 20,000 CNY per village, primarily to subsidize the costs of management of industrial pollution sources, household wastewater and garbage collection, and husbandry wastes in villages. In addition, to manage industrial pollution, the provincial Finance Bureau has a budget of 320 million CNY/year to award those industrial enterprises which have good record of pollution control or reducing major pollutants. Source: Jiangsu Provincial Government, 2007; Zhang et al., 2010
Case 7 Fujian Min River Watershed Eco-compensation To manage the Min river, in 2005 the Fujian provincial Environmental Protection Bureau and the provincial Finance Bureau drafted the Min River Watershed Protection Special Fund Management Plan. The plan covers the 36 counties, cities and municipalities in the Min River watershed. Cities in the lower watershed of the Min River provide the upper watershed cities - Nanping and Sanming - with an annual special-purpose ecological environment protection fund of 10 million CNY. Sanming and Nanping each have to raise 5 million CNY annually as matching funds. If these upper watershed areas create pollution for lower watershed areas, they are responsible for paying compensation to lower reaches. In addition, Fujian Province's Development and Reform Commission and Environmental Protection Bureau will also finance 15 million CNY annually for integrated management in the whole watershed. Polluting industries will also have to pay emission fees, in accordance with assessed damages. The detailed management plan includes 104 projects, such as pollution management in aquaculture, poultry and husbandry operations, the Fuzhou City Hongmiaoling Garbage Incinerator Electrical Power Plant, and township and city environmental protection key water source protection projects. This plan also formally incorporates watershed protection and water pollution prevention targets into the performance evaluations of government officials, setting up a system for environmental performance evaluations for municipal and county government officials, as well as a system for investigating pollution damage responsibility. Source: Bennett, 2009; Zhang et al., 2010, Zhen and Jin, 2006

Case 8 Zhejiang-Anhui Xin'an River Eco-compensation

The Xin'an River originates from the prefecture of Huangshan City in Anhui Province and flows 359 km with a catchment of 11,674 km^2 into the Xin'an River Reservoir, which covers 573 km^2 and is a vital drinking water source in Zhejiang Province, particularly the provincial capital, Hangzhou City.

In March and September 2011, the Ministry of Finance and the Ministry of Environmental Protection successively issued the Implementation Plan for starting the Water Environment Compensation Pilot Project in Xin'an River Watershed. The basic principle to be followed in the project is that responsibilities shall be clearly defined to enable all parties to assume their responsibilities; the local governments will play a principal role while the central government will fulfill its duties of supervision and management; compensation will be made based on the monitoring results to facilitate pollution control. The Xin'an River Watershed Water Environment Compensation fund was established jointly by the central finance and Anhui and Zhejiang, with the central finance contributing 300 million CNY while Zhejiang and Anhui each contributed 100 million CNY. According to the Plan, the Ministry of Environmental Protection will organize Anhui and Zhejiang to jointly monitor the inter-provincial water quality and assess the water quality at a cross section at the provincial border to provide the basic standard. If the water quality provided by Anhui is better than the basic standard, Zhejiang will provide a compensation fund of 100 million CNY to Anhui. On the other hand, if the water quality provided by Anhui is worse than the basic standard, Anhui will provide a compensation fund of CNY 100 million to Zhejiang. If the basic standard is met, neither side will provide compensation payments. The 300 million CNY contributions from the central finance will be allocated as a directional compensation to Anhui.

The programme also specifies that the compensation fund will be used especially in water environment protection and pollution control in Xin'an River Watershed. The scheme uses the average water quality of the three years of 2008 to 2010 of Xin'an River as the basic standard for

water quality assessment. The water quality indicators include potassium permanganate index (COD_{mn}), ammonia nitrogen (NH_4-N), total phosphorus (TP) and total nitrogen (TN). The Jiekou cross section on the provincial border is the specified monitoring cross section subject to monthly monitoring. The water quality monitoring results are to be verified by China National Environment Monitoring Center (CNEMC) and provided to the Ministry of Environmental Protection and the Ministry of Finance as the basis for watershed compensation assessment. Source: Chapter 4 of this thesis; Cheng, 2013.
Case 9 Henan Shayin River Eco-compensation The main idea of this programme is a two-way compensation scheme combining both a "penalty for exceeding the limit" and a "reward for reaching the target". The indexes monitored by the Environmental Protection department are COD and ammoniacal nitrogen. The fund is used for river basin pollution control and compensating cities which complete the water protection target. The compensation fund which were withheld under this programme amounted to 65 million CNY in the first half of 2009, and then it declined to 18 million CNY as water quality improved. By March 2010, the water quality targets at all sections had been achieved with the help of this scheme. Source: Henan Provincial Finance Bureau, 2009; Guangming News, 2010.
Case 10 Guizhou Qingshui River Eco-compensation This programme was proposed by Environmental Protection Department of Guizhou (EPD), Guizhou Provincial Financial Department and the Water Resources Department of Guizhou Province (DWR), and was approved in 2009 and formally launched in 2011 by Guizhou Provincial Government. The Qingshui River runs from Qiannan Municipality to the downstream Qiandongnan Municipality in south-eastern Guizhou Province. If the upstream Qiannan has river water which is worse than the specified quality standard at the section bordering downstream Qiandongnan, Qiannan will have to pay a compensation levy to the Provincial Government (30%) and to Qiandongnan Municipal Government (70%) at the following rates: Total phosphorus: 3600

CNY/ton; and Fluoride: 6000 CNY/ton. Guizhou EPD is responsible for monitoring the water quality, and Guizhou DWR is responsible for monitoring the water quantity. Guizhou Financial Department is responsible for levying the compensation. Upstream Qiannan compensated downstream Qiandongnan 5.5 million CNY in 2010 in the pilot phase of the programme. Water pollution in the Qingshui River has been reduced significantly since the programme was implemented. The total phosphorus concentration at the bordering water section has decreased from 15.23 mg/l in 2008 to 5.98 mg/l in 2014, and the fluoride concentration decreased from 3.03 mg/l in 2008 to 0.98mg/l in 2014 according to the monitoring data of the Guizhou EPD.

Source: Guizhou Provincial Government, 2011; Guizhou Provincial Department of Environmental Protection, 2015.

Case 11 Yunnan Lake Lashi Eco-compensation

This is a pilot research project in Lijiang Municipality, Yunnan Province, targeting both watershed ecosystem services and biodiversity. It has not yet been launched. It is supported by international donors and expertise, and in particular funding from Conservation International (CI) and the World Bank, also with fees charged to tourists for visiting Lijiang old city and the Laishihai Nature Reserve. Funding is to be used to compensate upper watershed farmers adjacent to or near Laishi Lake for changing their land use practices.

Laishi Lake is a key part of the Lijiang Basin, from which water runs through and around Lijiang old city, which are an important part of the city’s charm as a tourist destination. The Laishi Nature Reserve was set up in 1998 to preserve the Laishihai wetland, accommodating a wide range of birds. Land-use practices adjacent to and near Laishi Lake thus have important impacts on both watershed ecosystem services as well as biodiversity, key beneficiaries of which are the tourists to the area. In 2005 alone, about 4 million tourists visited Lijiang old city, out of which around 50,000 domestic and 15,000 international tourists visited the Laishihai Nature Reserve.

Based on the research work for the pilot study, which examined opportunity costs of different land-use scenarios and the willingness-to-pay of tourists for the local watershed and biodiversity services, it was recommended that PES could be partially funded by charging an entrance fee to the Laishihai Nature Reserve of 8 CNY for domestic tourists and 40 CNY for international tourists, with an additional entrance fee to Lijiang old city of 0.4 CNY for domestic tourists and 2 CNY for foreign tourists. These charges would be used to compensate farmers' income losses caused by land-use changes made to reduce their impact on the Laishi Lake watershed as well as on its migratory birds. The project also plans to help farmers to shift to longer-term and sustainable alternative livelihood strategies, including organic farming and mixed systems of cropping, horticulture and husbandry. However, the programme was temporally halted after initial study from 2007-2009, but it is said that the project will be restarted soon by the NGO CI.

Source: Bennett, 2009; Dixon, J. & Xie, J.,2007

Case 12 Zhejiang Jinhua River Eco-compensation

Yuandong Township is located in the origin of Jinhua River, and Fucun Township is located downstream. Rural livestock and poultry farming from Yuandong Township is the main water pollution source. In 2004, Fucun and Yuandong officially signed an ecological compensation agreement, in which Fucun pays 50,000 CNY each year to Yuandong. According to the agreement, Yuandong commits to not develop industries which could cause serious harm on water quality. The compensation is mainly used for water conservation and management. There are five small reservoirs in Yuadong Township. The township government promised to protect the water quality, avoids water pollution caused by fish farming, and promoted to reduce the pollution of the existing livestock and poultry farmers.

Source: Li et al., 2007.

Case 13 Xiaoqing River Eco-compensation

In order to improve water quality for the South-North Water Transfer Project, an eco-compensation pilot project in the lower section of the South-North Water Transfer Project and the Huaihai River and Xiaoqing River watersheds began in July 2007. In 2007, 28.6 percent of the section of the Huai River watershed in Shandong Province did not satisfy environmental protection targets, and 95.8 percent of South-North Water Transfer Project in Shandong failed to meet the project's water quality demands; in the Xiaoqing River only 4 percent of section met these demands. The Xiaoqing River is a key area of the South-North Water Transfer Project and Shandong Province's "Two Lakes One River" (Nansi Lake, Dongping Lake and Xiaoqing River) Watershed. To improve water quality, a total of 69 counties in 12 cities took part in the pilot scheme. Each city contributed funds according to their total amount of sewage emissions, multiplying the MEP's pollutant management cost per unit of pollution. At the same time, Shandong provincial government provided additional matching funding no less than the city/county-level contributions. Provincial contribution was used to dealt with non-point source pollution and soil and water conservation, and loans were sourced from the World Bank and foreign governments.

As part of the project, farmers in regions with high environmental benefits were paid to convert farmland and aquaculture operations back to wetland along the river. Farmers who participated in this "Conversion of Farmland/Aquaculture to Wetland" programme were paid for two years. For years one and two, farmers were reimbursed for 100 percent and 60 percent of their lost net income of the year just before participating in the program. For industries that satisfied government pollution standards, 50 percent of the water pollution management fees were reimbursed. For participants in the "Further Improve Industry" project, plants were rewarded, with 50% of sewage charges reductions being given back.

Source: Bennett, 2009; Shandong Provincial Government, 2007

Case 14 Shandong Dawen River Eco-compensation

Dawen river watershed covers two cities, namely Laiwu and Taian, and the river finally flows into Lake Dongping which adjusts the water from South-to-North Project. In 2008, Shandong Provincial government and the two municipal governments agreed to set up an eco-compensation project under which a total of 20 million CNY was withheld at first. According to the agreement, the funding allocation is determined by the water quality situation, and the baseline is the average of the previous year's COD and ammoniacal nitrogen. If the water quality at the monitoring section in Laiwu improves, Taian pays Laiwu. Otherwise, Laiwu needs to pay penalties to Taian.

If the water quality improves in Lake Dongping, the provincial government pays Taian; otherwise Taian has to pay to the provincial government. The COD and ammoniacal nitrogen of the Dawen River cross section in 2008 decreased by 14.9% and 51.1% respectively from the previous year; and the COD and ammonia nitrogen content of Lake Dongping were 13.3% and 10.8% lower, respectively, than that of the previous year.

Source: Dazhong Daily, 2009

Case 15 Jiangxi Dong River Headwater Eco-compensation

Jiangxi Province invested 14.2 billion CNY during 2005–2010 in projects surrounding ecological protection of the Dong River source areas. This was invested in 9 large programmes:1) afforestation, 2) soil erosion management, 3) restoration of mines, 4) eco-friendly agriculture, 5) flood prevention and protection of drinking water supplies, 6) integrated management of agricultural run-off pollution, 7) eco-tourism, 8) resettlement of rural households away from fragile ecosystems), and 9) establishment of a system of protective monitoring and information management.

These 9 major projects aimed to improve water quality to surpass the national Class II standard, increase forest coverage rate in the Dong River headwaters area to 85 percent, and increase integrated soil erosion management area to 14.55 million mu (970,000 ha).

The programme was mainly carried out in Anyuan County, Jiangxi Province. By 2009, 390 million CNY had already been spent in the first phase of the project. Specific management measures include integrated management of the 33 waterways in the watershed, a garbage processing plant, a sewage treatment plant, management of mining waste and management of animal waste. The project aimed to develop 1.737 million mu (115,800 ha) of “closed mountain reforestation”, 240,000 mu (16,000 ha) of SLCP area, establish 6 different nature reserves and establish 8 areas for the rehabilitation and management of water-protection ecosystems. 45,000 mu (3,000 ha) of mining area was reclaimed to arable land. In the headwater region, the plan would encourage 30,000 households to shift to a standardized “pigs, wetlands and horticulture”

model, would reinforce and remove old reservoirs, rebuild and build 10 reservoirs, resettle 330,000 households out of the headwater regions. In addition, 5 pilot projects were developed to manage organic waste resources from husbandry, poultry and aquaculture. Source: Bennett, 2009; Zhang et al., 2010.
Case 16 Sichuan Pingwu Community Co-Management Eco-compensation This project was initiated by the NGO, Conservation International, with a water fund of 300,000 CNY coming from donations from the American company 3M. At first the NGO gave support to farmers in a small village called Shejiashan for managing forest and water conservation. The project has expanded to 4 local communities and the hotel chain Marriott International donated USD 60,000 to support the project for public relation purposes. Households are fully subsided to install solar panels to reduce their dependence on wood for cooking. In addition, farmers are trained to develop alternative livelihoods such as bee breeding in order to reduce intensive farming. They also help to monitor the biodiversity there. Source: Shanshui Conservation, 2009.
Case 17 Henan Major Rivers Eco-compensation Henan Provincial government set up an eco-compensation programme covering 18 cities with 4 major watersheds. Under this project, municipal governments have to try their best to meet water quality targets, and water quality is measured weekly based on COD and ammonia nitrogen. Compensation is calculated as following :1) when the target value of the concentration of COD is less than or equal to 40 mg/l or the ammonia concentration is less than or equal to 2 mg/l, compensation for a single index is calculated by multiplying the difference (monitoring value - target value) by the weekly water volume compensation standard; 2) when the target value of the concentration of COD is over 40 mg/l or the ammonia concentration is more than 2 mg/l, compensation for a single index is calculated by multiplying (monitoring value - target value) by weekly water volume by a compensation standard by 2; here the compensation standard is determined by considering the cost of pollution management, and is 2,500 CNY/ton for COD and 10,000 CNY /ton for ammonia concentration. In addition, for the cities which provide a drinking

water source, if the overall percentage of times of meeting weekly water quality targets in a year is over 90%, they are paid by the downstream cities which drink their water. The amount of payment is calculated by annual drinking water usage volume multiplied by 0.06 CNY/m^3. Source: Henan Provincial Government, 2010
Case 18 Shanxi Wasteland Management Eco-compensation This wasteland development policy, also known as the “Four Wastelands” policy (*sihuang zhengce* - the four wastelands are waste flatland, waste mountains/hills, waste gullies and sandy wastes), began in the 1980s. Back then, as part of the household responsibility system reforms regarding agricultural land rights, villages began to informally contract out wasteland for development by farmers. The Water and Soil Conservation Law of the P.R.C. (1991) formalized the contracting and development of wasteland; and added stipulations that the contractor is responsible for reducing soil erosion on the contracted wasteland and farming on land with slope over 25° is not allowed. The law also states that all trees planted as part of land rehabilitation, as well as the fruits there from, belong to the contractor as rewards. Up to 2004, more than 380,000 households had participated in these schemes. And this project has finished. Source: Bennett, 2009; Li et al., 2007.
Case 19 Guangdong Jiaquan River Eco-compensation In 2014, Danone China joined a pilot project on protecting water sources of its beverage company implemented by the International Union for the Conservation of Nature (IUCN). The project targets the Jiaquan Watershed in Guangzhou, Guangdong Province, and involves working with local stakeholders to sustainably manage water resources, ensuring healthy ecosystem services. Currently the project is in the pilot phase, covering around 2000 households of 4 villages. Farmers are subsided to plant vegetable, tea and herbal medicines instead of citrus and eucalyptus. This change of crops can reduce soil erosion and the usage of fertilisers. Source: IUCN, 2014