Water Quality, Perception and Knowledge in China

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write this abstract later…

Contents

1 Introduction

`Copied from the thesis proposal`

Access to freshwater is something many people take for granted. Simply turning on the tap or buying a bottle of water makes it easy to underappreciated the immense value of clean freshwater. Water is essential for almost all aspects of modern civilization and is connected to all three pillars of sustainable development – environment, society, and the economy.

While water is a permanent resource, water that is usable and consumable by humans is not. Globally, only 2.5 percent of the Earth' s water is non-saline, with most of the remaining freshwater being inaccessibly located in glaciers, ice caps or permafrost. (Shiklomanov 1993)

Water scarcity, being the scarcity of availability or access to usable freshwater resources, is a significant and increasing global issue. (UN-Water n.d.) Globally, water usage has increased at a rate of 1.7 times the rate of population increase over the past century. (F.A.O. 2014) Water stress and scarcity can be caused by increased water withdrawal, population increase, and climate, amongst others. (F.A.O. 2014) Water scarcity is three dimensional, including physical, infrastructural and institutional factors. (F.A.O. 2011b) While some regions are affected more than others, every continent is affected. Four billion people experience extreme water scarcity at least one month out of the year. (Mekonnen and Hoekstra 2016)

The implications of water scarcity cannot be understated. Global water crises stemming from water scarcity are predicted to be the largest risk globally within the next decade. (World Economic Forum 2016) Since water is vital for human existence, a lack of water can be directly or indirectly related to almost any societal indicator.

One direct impact of water scarcity can come in the form of food production. Globally, 70 percent of global renewable water resources withdrawn for human use is used for agriculture. (F.A.O. 2011b) Affected by population growth and the increased consumption of more water-intensive food due partially to economic development, it is estimated that food production must increase by 70 percent to meet demand. (F.A.O. 2011b) Another impact is health. Health can be affected by the quantity and quality of water. The impacts of dehydration, water-borne diseases, and consumption of polluted water are well documented. A third impact is economic. By 2050, some regions could see a GDP growth rate decline of up to six percent due to "losses in agriculture, health, income, and property" caused by water scarcity. (The World Bank 2016)

1.1 Chinese Shortage

Water issues in China are especially prevalent. On average, China's renewable freshwater resources were 2,062 cubic meters per capita in 2014, a decrease from 4,200 cubic meters in 1962 and far less than the half of the world average in those respective years. (F.A.O. 2016) China's renewable freshwater resources are also highly location dependent. For example, only 19.7 percent of total internal renewable surface water and 30 percent of groundwater resources reside in northern China. (F.A.O. 2011a) Northern China's renewable freshwater access is only 757 square meters per capita per year, far below the water scarcity limit of 1,000 square meters per capita per year. (Zhang et al. 2010)

1.2 Chinese Pollution

In addition to the already strained water resource problem, poor water quality caused by pollution is amplifying the problem and is causing further economic, societal and environmental problems. Roughly 80 percent of groundwater resources were found to be unsafe for human contact. (Jing 2016) Economic costs attributed to poor water quality in 2003 were over 1.16% of GDP. (Wu et al. 1999)

Historically, and especially since the Opening Up and Reform era post-1978, the Chinese government has prioritized economic growth over environmental protection. In terms of water resource management, the government's investment strategies have prioritized large scale water infrastructure projects over environmentally-friendly pollution-control policies, due to a variety of political and non-political reasons. (Rogers and Crow-Miller 2017) Mao Zedong famously embraced the idea of the now-partially-completed South-North Water Transfer Project, one of the largest infrastructure endeavors in history, by saying "The south has plenty of water and the north lacks it, so if possible why not borrow some?" (Reuters 2009)

In addition to having the political will and prowess to pursue economic development, Chinese leadership has also at times shown a campaign-style action to mitigate environmental pollution. One such example was the substantial air quality improvements in Beijing during the 2008 summer Olympics. (Zhang et al. 2010) However, similar outcomes regarding improved water quality have not been as positive. Analysis of water quality trends has been hampered partially due to data limitations, including public accessibility, the scope of measurement, and technological limitations including long latency peri-

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Recently, further policy has been implemented to address water scarcity and pollution issues. In 2015, the State Council released an ambitious attempt to do this, colloquially known as the "Water Ten Plan," which sets water quality-related goals to be met by 2020. (国务院. 2015) However, results so far have been mixed, with nearly half of all provinces missing their water quality targets in 2017. (Greenpeace 2017) One factor which may help this progress, and one of the goals outlined in the Water Ten plan, is the improvement of water quality sensing technology and data management.

`Below is new content`

1.3 Environmental Policy, Education and Perception

Water quality and quantity issues in China and abroad sit within the context of environmental policy, environmental education, and societies' perception of the two. (Caldwell and others 1990)

1.3.1 Environmental Policy

Environmental Policy has a long and global history, at times being documented since the 12th century.

1.3.2 Environmental Education

Environmental Education (EE) has been inexorably tied to environmental protection and policy - one of its main goals is "Awareness - to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems." ("Intergovernmental Conference on Environmental Education, Tbilisi, USSR, 14-26 October 1977: Final Report - UNESCO Digital Library" n.d.) An earlier definition was presented in 1969 from the United States, and has proved reliable and accurate since:

> **Environmental education** is aimed at producing a citizenry that is **knowledgeable** concerning the biophysical environment and its associated problems, aware of **how** to help solve these problems, and **motivated** to work towards their solution. (Stapp et al. 1969)

Progress continued with development and deployment of EE the international level, with many landmark events in environmentalism and sustain-

ability putting EE at their core, including The International Environmental Education Program (IEEP 1975), the World Conservation Strategy (IUCN 1980), 'Tbilisi Plus Ten' (1987), Our Common Future (WCED 1987), and The Earth Summit (UNCED). (Neal and Palmer 2003, p13–15)

EE also has the potential for direct and indirect positive environmental impacts. One study reviewed 105 EE studies which emphasized conservation outcomes, and found that EE programs which included and focused on ecological indicators (such as improved water quality) had outcomes with the most directness (as opposed to indirect impact categories such as community capacity building), and concluded that local aspects of regional and global problems are important for the directness of the link. (Ardoin, Bowers, and Gaillard 2020)

While there is a longer document environmental protection movement in the United States than in China, it is important to note that Dr. Stapp wrote this definition with the perspective that only 50 years had passed since much of the nation was rural and underdeveloped. It can be argued that China shares this temporal perspective today.

1.3.3 Environmental Society (Perception)

1.3.4 In China

Despite its international perception (often correct) of poor environmental protection, China does have a long history of environmental policy, with "great leaps" of progress and reform every decade or so since the political reform in the early 1970s. (Xie 2020) There is also evidence showing that environmental issues and their repercussions are deemed important by the local population. One study found that Chinese university student were more concerned about environmental risk, and deemed "environmental issues to be more harmful to health, to the environment, and to social economic development of the nation than did the American respondents.environmental issues to be more harmful to health, to the environment, and to social economic development of the nation than did the American respondents." (Duan and Fortner 2012) Furthermore, they found that Chinese students were concerned about fresh water shortage, and safe drinking water shortage more than other environmental concerns, and only less so than human population growth.

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China's political situation does not negate the impact that society can have on environmental policy. One study found that Chinese civil society organi-

zations (CSOs) work in similar ways to those in more liberal and democratic countries. (Teets 2018)

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Multiple factors drive environmental perception. One study found that "age, percentage of time spent on farming and social network are the main determinants of awareness" and perception of water scarcity in the Guanzhong Plain, Shaanxi Province, China. (Tang, Folmer, and Xue 2013)

2 Literature Review

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This research proposal looked at many publications covering a broad range of related topics, some of which are outlined below:

- (Mekonnen and Hoekstra 2016) analyzed the current situation of water scarcity worldwide and found "two-thirds of the global population (4.0 billion people) live under conditions of severe water scarcity at least 1 month of the year," with nearly half living in China and India alone.
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- (Araral and Wang 2013) look at water governance, water insecurity, and its related research. They find that a second-generation research agenda on water governance, including a focus on incentive structures and other multi-disciplinary approaches, is required.
- (Kahn, Hanjra, and Mu 2009) looks at the effects that water management has on crop production and food security in China. They conclude that water management affects many aspects of China's development, it also affects food pricing and security globally.
- (Araral and Wang 2013) looks at the relationship between water resource management and droughts in China and find that demand-side management can be more effective in meeting the challenges imposed by increasingly-severe droughts.
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- (Bai and Imura 2001) look at sustainable urban water resource management with a case study analysis of Tianjin, China. They suggest that a

holistic, systems approach to water management is key for sustainability.

- (Lu 2014) looks at the importance of full project life-cycle cost analysis in addressing water challenges, particularly with wastewater treatment facilities, concluding that there are serious inefficiencies currently.
- (Rogers and Crow-Miller 2017) take more of an overview approach in synthesizing literature regarding the politics of water in China. They find that there are serious gaps in the literature regarding hydropolitics in China.
- (Webber, Crow-Miller, and Rogers 2017) look at the infrastructure side of water resource management in China with a review of the South-North Water Transfer Project. They find that this project is emblematic of the engineering-heavy approach often taken in China and will pose serious risks to regional governance and have serious environmental impacts.
- (Jin, Andersson, and Zhang 2016) looks at air pollution control policies in China with a retrospective perspective. They break down the history of air pollution policies into three phases, and conclude, amongst other takeaways, that there's a continuously increasing demand for quantification of all aspects regarding air pollution, including air quality, source identification, atmospheric modeling, and health risk assessments. These conclusions have the potential to be analogous to future water policy.
- (Hofstedt 2010) looks at the implications of domestic and international stability stemming from China's water scarcity and the government's current plans to address it. They argue that many of the options to alleviate water scarcity (increase water pricing, remove the requirement to be self-sufficient in grain production, increased efficiency of water usage in agriculture) all have serious downsides, and can have serious negative effects on political stability domestically and internationally.
- (Ward and Loftis 1986) looks at water quality monitoring and improvements (at the time) in data collection. They argue that increased data collection itself is not enough to affect the management of water resources; data analysis and reporting are also very important, and that understanding why monitoring water quality is important in the design process of water quality monitoring itself.
- (Glasgow et al. 2004) looks at the emerging technology surrounding real-time remote monitoring (RTRM) and concludes that this technology will have a progressively-larger impact and importance for monitoring water quality.
- (Shirode et al. 2018) and (Abubaker et al. 2018) look at the emerging

technology of an Internet of Things (IoT) based water quality monitoring system. They show that this kind of system can address some of the limitations of manual, lab-based water quality testing (time-consuming, costly, etc.), and their real-time monitoring capabilities offer a large potential for improved water quality monitoring.

3 Methodology

3.1 Data Sources

The main analysis of this thesis center around two data sets, described below.

3.1.1 Chinese General Social Survey (CGSS)

This national survey, originally launched in 2003, aims to monitor and document relationships between quality of life (in both individual and collective scope) and social structures, both in urban and rural environments. (“Home-中国综合社会调查” n.d.) One of the main benefits is its longitudinal design, however this feature is not utilized in this thesis, which will be discussed later. The survey has been conducted nearly annually since 2003, with a major redesign conducted in 2010. Thus, surveys conducted prior to 2010 are referred to as “Cycle II” while surveys conducted in 2010 or later are referred to as “Cycle II.”

The CGSS is conducted by face-to-face interviews, which on average require 90 minutes to complete. (“Implementation-中国综合社会调查” n.d.) The survey consists of a questionnaire, which is composed of three modules (beginning in Cycle II):

```
  {table} CGSS2010 Components and Description  :name: cgss2010-components
<!-- ~ put table here -->
```

Module	Frequency	Dimensions	Variables	Coverage	Comments
Core	Annual	11	152	All participants	
Background Variables	Annual		71	All participants	

Module	Frequency	Dimensions	Variables	Coverage	Comments
Social Change Trends	Annual		81	All participants	
Topic	Annual (5 year rotation)			All participants	Either one or two topic modules per year.
Additional				1/3 - 1/2	Coverage depends on quantity of other questions and demand

(“Questionnaires-中国综合社会调查” n.d.)

The Environmental Module (“环境(ISSP)” or “L部分”) is of particular interest in this analysis. (“调查问卷-中国综合社会调查” n.d.) It asks 25 questions and sub-questions, most of which are directly or indirectly related to the environment. There are several interesting questions which ask things related to environmental protection, importance, perception and knowledge.

Talk about specific questions, etc.

The published data is in the form of a Stata file, which consists of 11783 rows (respondents) and 871 columns (variables).

3.1.2 Blue City Water Quality Index Ranking (WQIR)

The second data set was compiled by the author from a report from the Institute of Public & Environmental Affairs, a non-profit environmental research organization based in Beijing. (“About IPE” n.d.) The report, the Blue City Water Quality Index 2019, compiles various surface, drinking. and ground water quality data published by various government agencies and assigns a score (their proprietary Blue City Water Quality Index Score (BCWQI)) and publishes the results at a sub-provincial level (second administrative level, or “admin 2”). (Jun, Sunan, and Haijin, n.d.) The methodology and conversion to the government’s is provided. This report was chosen as the basis for this data set since it was the most comprehensive data the author could find with the closest publication date to the CGSS. The difference in time of the two data sets is discussed in the section. In the appendix of this report, the BCWQI for each second administrative level, including the city name, province, and ranking, is included. This data, in a table in the PDF report, was exported into a

comma separated value (.csv) file for later analysis.

3.2 Analysis

Analysis for this thesis was conducted using the general-purpose computer programming language Python. To allow for accessibility, readability, and reproducibility, the primary data analysis medium was a Jupyter notebook (Kluyver et al., n.d.), a document format which allows for text and code to be read and execute in an easy-to-read format, which was hosted on GitHub, to allow for accessibility. (Rynearson 2020) This was chosen after initial data analysis was conducted in a more traditional Python file, which was less collaborative and more cumbersome.

The two main data sets were loaded into the Jupyter notebook and reviewed for initial analysis, beginning with the CGSS2010. Then, after reviewing the data, it was cleaned and processed in several ways:

3.2.1 Choosing Appropriate Questions

Demographic Questions The thesis proposal and hypothesis were created before the author reviewed the data set, and before the author was aware of the environmental module of the CGSS. While many variables were deemed interesting, several variables were initially selected for broader analysis:[1]

“ ‘{table} Relevant CGSS2010 Demographic Components :name: cgss2010-demographic

```
| Code | Variable (English)             | Variable (Chinese) | Importance
|------|--------------------------------|--------------------|--------------------
| s41  | Province                       |                    | Location of the indi
| a2   | Gender                         |                    |
| a3a  | Birth year                     |                    | Age of respondant
| a7a  | Highest level of education     |                    | Link to perception a
| a8a  | Personal total income          |                    |
| a15  | Subjective personal health     |                    |
| a62  | Family total income            |                    |
| a91  | Rural / agricultural household |                    |
As evident, not all of the variables were utilized, for several reasons.

#### Environmental Questions
```

[1] Translated from Chinese into English.

```
The CGSS includes many demographic data on each respondent. Of which, the following

```{table} Relevant CGSS2010 Environmental Components
:name: cgss2010-env
<!-- ~put table here -->
```

Code	Question (English)	Question (Chinese)	Response Types	Importance	Utilized?
l1a	In your opinion, in terms of the current situation in our country, which of the following issues is the most important?				
l1b	like l1a, but 2nd most important				
l6a	In your opinion, in terms of the current situation in our country, which of the following issues is the most important?				
l6b	How serious are env. problems facing China?				
l7a	Which is most important env. issue in China?				
l7b	Which has greatest impact on you/family?				
l8a	Knowledge of causes of environmental problems from ?l7				
l8b	Knowledge of solutions of environmental problems from ?l7				
l12a	In order to protect the environment, to what extent are you willing to pay a higher price?				
l12b	like l12a, but with higher taxes				
l12c	like l12a/b, but with willingness to lower living standards				
l137	Environmental issues directly affect my daily life				
```

Code	Question (English)	Question (Chinese)	Response Types	Important	Utilized?
l14d	How do you think the pollution of rivers, rivers and lakes in China is harmful to the environment?				
l15a / b	see question, about statements of responsibility for environmental protection (individuals/companies, government, etc.)				
l16c	In terms of solving environmental problems in your area, how do you think the local government has done in the past five years?"				
l20e	Do you often save water or reuse water specifically for environmental protection?				
l2409	In the domestic water pollution report, the water quality of Category V (5) is better than that of Category I (1)				

As evident, these questions include questions related to the environment in general, perceptions of the local, national and global environment, water, and knowledge of water quality issues.

Other Survey Questions Many more survey questions were included in the main and additional module sections. Many of these relate to social satisfaction, political involvement, and future aspirations. Future analysis could be done with many of these questions, but were not within the scope of this analysis.

3.2.2 Geographic Alignment

The two data sets are of differing geographic precision. The CGSS2010 (and all CGSSII data sets) include data on the province of where the respondent resided. Based on the structure of the data, it is assumed that more precise geographic information is included, however the CGSS publishing team chooses

only to release the provincial information.

This is different than the WQIR2018 data, which is published at the sub-provincial level (admin 2). Thus, for comparative analysis, the mean water quality per province was calculated (more on this below).

3.2.3 Procedure

Once the data sets were loaded and reviewed for importance and quality, initial data analysis was conducted. Due to the author's limited experience with Python, multiple versions of the analysis were conducted in order to gain working knowledge of Python and of the data set.

For provincial comparative analysis, the data was sorted by province `s41` and grouped into visual and numerical approaches of looking for differences between provinces. Several functions were created which allowed the author, and users, to see provincial comparative analyses on any question by inputting the question code. Either quantities of responses or their mean value would be output, as well as a heatmap for quick comparison. This initial analysis helped the author validate the main variables that were analyzed, which are discussed later.

Then, the WQIR2018 data was loaded. An initial plot was created to see the distribution of water quality per sub-province, sorted by province. Histograms were added to visualize the distribution of water quality measurements and values.

`{figure} ../wqir2018.svg :name: wqir2018-vis WQIR2018 distribution per province.`

From the previous steps, a subset of questions were created. The subset `cgss_strict`, which include only variables s41, l14d and l2409 were used for further initial analysis for simplicity.

Within these subsets, some values were revealed to be outside of the acceptable range (negative numbers). Since the origin or reason behind these values could not be determined, they were discarded. This lead to further discrepancies in the number of values depending on the province.

Once invalid values were removed, the two data sets were merged on their shared province values. This was done in two separate ways, which allowed for different analysis.

1. **On Provinces**: The mean water quality per province was added to the mean value per province of each analyzed variable. This allows for simpler data analysis, but loses some individual demographic data (gender, income, age, education, etc.).

2. **On Individuals**: The mean water quality per province was added to the individual response values. This makes the analysis slightly more complicated, but allows for comparison across the demographic data mentioned above. However, it should be noted that it runs the risk of providing a false sense of improved precision, and the mean water quality of the province may not accurately reflect the local situation of the individual.

3.3 Interviews

3.4 Limitations

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4 Water Quality, Perception and Knowledge in China

4.1 Draft Outline

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  - Chinese Shortage
  - Chinese Pollution
- Literature Review
  - Sub-sections
- Scope and Significance
- Methodology
  - Data Sources
  - Analysis
  - Interviews
  - Limitations
- Analytical Framework
- Analysis
  - Main Analysis

  - Comparison
  - New Developments
- Discussion and Recommendations
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5 Introduction

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- (Rogers and Crow-Miller 2017) take more of an overview approach in synthesizing literature regarding the politics of water in China. They find that there are serious gaps in the literature regarding hydropolitics in China.
- (Webber, Crow-Miller, and Rogers 2017) look at the infrastructure side of water resource management in China with a review of the South-North Water Transfer Project. They find that this project is emblematic of the engineering-heavy approach often taken in China and will pose serious risks to regional governance and have serious environmental impacts.
- (Jin, Andersson, and Zhang 2016) looks at air pollution control policies in China with a retrospective perspective. They break down the history of air pollution policies into three phases, and conclude, amongst other takeaways, that there's a continuously increasing demand for quantification of all aspects regarding air pollution, including air quality, source identification, atmospheric modeling, and health risk assessments. These conclusions have the potential to be analogous to future water policy.
- (Hofstedt 2010) looks at the implications of domestic and international stability stemming from China's water scarcity and the government's current plans to address it. They argue that many of the options to alleviate water scarcity (increase water pricing, remove the requirement to be self-sufficient in grain production, increased efficiency of water usage in agriculture) all have serious downsides, and can have serious negative effects on political stability domestically and internationally.
- (Ward and Loftis 1986) looks at water quality monitoring and improvements (at the time) in data collection. They argue that increased data collection itself is not enough to affect the management of water resources; data analysis and reporting are also very important, and that understanding why monitoring water quality is important in the design process of water quality monitoring itself.

- (Glasgow et al. 2004) looks at the emerging technology surrounding real-time remote monitoring (RTRM) and concludes that this technology will have a progressively-larger impact and importance for monitoring water quality.
- (Shirode et al. 2018) and (Abubaker et al. 2018) look at the emerging technology of an Internet of Things (IoT) based water quality monitoring system. They show that this kind of system can address some of the limitations of manual, lab-based water quality testing (time-consuming, costly, etc.), and their real-time monitoring capabilities offer a large potential for improved water quality monitoring.

7 Methodology

7.1 Data Sources

The main analysis of this thesis center around two data sets, described below.

7.1.1 Chinese General Social Survey (CGSS)

This national survey, originally launched in 2003, aims to monitor and document relationships between quality of life (in both individual and collective scope) and social structures, both in urban and rural environments. (“Home-中国综合社会调查” n.d.) One of the main benefits is its longitudinal design, however this feature is not utilized in this thesis, which will be discussed later. The survey has been conducted nearly annually since 2003, with a major redesign conducted in 2010. Thus, surveys conducted prior to 2010 are referred to as “Cycle II” while surveys conducted in 2010 or later are referred to as “Cycle II.”

The CGSS is conducted by face-to-face interviews, which on average require 90 minutes to complete. (“Implementation-中国综合社会调查” n.d.) The survey consists of a questionnaire, which is composed of three modules (beginning in Cycle II):

```
  {table} CGSS2010 Components and Description  :name: cgss2010-components
<!-- ~ put table here -->
```

Module	Frequency	Dimensions	Variables	Coverage	Comments
Core	Annual	11	152	All participants	
Background Variables	Annual		71	All participants	
Social Change Trends	Annual		81	All participants	
Topic	Annual (5 year rotation)			All participants	Either one or two topic modules per year.
Additional				1/3 - 1/2	Coverage depends on quantity of other questions and demand

(“Questionnaires-中国综合社会调查” n.d.)

The Environmental Module (“环境(ISSP)” or “L部分”) is of particular interest in this analysis. (“调查问卷-中国综合社会调查” n.d.) It asks 25 questions and sub-questions, most of which are directly or indirectly related to the environment. There are several interesting questions which ask things related to environmental protection, importance, perception and knowledge.

Talk about specific questions, etc.

The published data is in the form of a Stata file, which consists of 11783 rows (respondents) and 871 columns (variables).

7.1.2 Blue City Water Quality Index Ranking (WQIR)

The second data set was compiled by the author from a report from the Institute of Public & Environmental Affairs, a non-profit environmental research organization based in Beijing. (“About IPE” n.d.) The report, the Blue City Water Quality Index 2019, compiles various surface, drinking. and ground water quality data published by various government agencies and assigns a score (their proprietary Blue City Water Quality Index Score (BCWQI)) and publishes the results at a sub-provincial level (second administrative level, or “admin

2”). (Jun, Sunan, and Haijin, n.d.) The methodology and conversion to the government’s is provided. This report was chosen as the basis for this data set since it was the most comprehensive data the author could find with the closest publication date to the CGSS. The difference in time of the two data sets is discussed in the section. In the appendix of this report, the BCWQI for each second administrative level, including the city name, province, and ranking, is included. This data, in a table in the PDF report, was exported into a comma separated value (.csv) file for later analysis.

7.2 Analysis

Analysis for this thesis was conducted using the general-purpose computer programming language Python. To allow for accessibility, readability, and reproducibility, the primary data analysis medium was a Jupyter notebook (Kluyver et al., n.d.), a document format which allows for text and code to be read and execute in an easy-to-read format, which was hosted on GitHub, to allow for accessibility. (Rynearson 2020) This was chosen after initial data analysis was conducted in a more traditional Python file, which was less collaborative and more cumbersome.

The two main data sets were loaded into the Jupyter notebook and reviewed for initial analysis, beginning with the CGSS2010. Then, after reviewing the data, it was cleaned and processed in several ways:

7.2.1 Choosing Appropriate Questions

Demographic Questions The thesis proposal and hypothesis were created before the author reviewed the data set, and before the author was aware of the environmental module of the CGSS. While many variables were deemed interesting, several variables were initially selected for broader analysis:[2]

“ ‘{table} Relevant CGSS2010 Demographic Components :name: cgss2010-demographic

```
| Code | Variable (English)             | Variable (Chinese) | Importance
|------|--------------------------------|--------------------|--------------------
| s41  | Province                       |                    | Location of the indi
| a2   | Gender                         |                    |
| a3a  | Birth year                     |                    | Age of respondant
| a7a  | Highest level of education     |                    | Link to perception a
```

[2]Translated from Chinese into English.

```
| a8a  | Personal total income          |                    |
| a15  | Subjective personal health     |                    |
| a62  | Family total income            |                    |
| a91  | Rural / agricultural household |                    |
As evident, not all of the variables were utilized, for several reasons.

#### Environmental Questions
The CGSS includes many demographic data on each respondent. Of which, the following

```{table} Relevant CGSS2010 Environmental Components
:name: cgss2010-env
<!-- ~put table here -->
```

Code	Question (English)	Question (Chinese)	Response Types	Important?	Utilized?
l1a	In your opinion, in terms of the current situation in our country, which of the following issues is the most important?				
l1b	like l1a, but 2nd most important				
l6a	In your opinion, in terms of the current situation in our country, which of the following issues is the most important?				
l6b	How serious are env. problems facing China?				
l7a	Which is most important env. issue in China?				
l7b	Which has greatest impact on you/family?				
l8a	Knowledge of causes of environmental problems from ?l7				
l8b	Knowledge of solutions of environmental problems from ?l7				
l12a	In order to protect the environment, to what extent are you willing to pay a higher price?				
```

Code	Question (English)	Question (Chinese)	Response Types	Importance	Utilized?
l12b	like l12a, but with higher taxes				
l12c	like l12a/b, but with willingness to lower living standards				
l137	Environmental issues directly affect my daily life				
l14d	How do you think the pollution of rivers, rivers and lakes in China is harmful to the environment?				
l15a / b	see question, about statements of responsibility for environmental protection (individuals/companies, government, etc.)				
l16c	In terms of solving environmental problems in your area, how do you think the local government has done in the past five years?”				
l20e	Do you often save water or reuse water specifically for environmental protection?				
l2409	In the domestic water pollution report, the water quality of Category V (5) is better than that of Category I (1)				

As evident, these questions include questions related to the environment in general, perceptions of the local, national and global environment, water, and knowledge of water quality issues.

Other Survey Questions Many more survey questions were included in the main and additional module sections. Many of these relate to social satisfaction, political involvement, and future aspirations. Future analysis could be done with many of these questions, but were not within the scope of this analysis.

7.2.2 Geographic Alignment

The two data sets are of differing geographic precision. The CGSS2010 (and all CGSSII data sets) include data on the province of where the respondent resided. Based on the structure of the data, it is assumed that more precise geographic information is included, however the CGSS publishing team chooses only to release the provincial information.

This is different than the WQIR2018 data, which is published at the sub-provincial level (admin 2). Thus, for comparative analysis, the mean water quality per province was calculated (more on this below).

7.2.3 Procedure

Once the data sets were loaded and reviewed for importance and quality, initial data analysis was conducted. Due to the author' s limited experience with Python, multiple versions of the analysis were conducted in order to gain working knowledge of Python and of the data set.

For provincial comparative analysis, the data was sorted by province `s41` and grouped into visual and numerical approaches of looking for differences between provinces. Several functions were created which allowed the author, and users, to see provincial comparative analyses on any question by inputting the question code. Either quantities of responses or their mean value would be output, as well as a heatmap for quick comparison. This initial analysis helped the author validate the main variables that were analyzed, which are discussed later.

Then, the WQIR2018 data was loaded. An initial plot was created to see the distribution of water quality per sub-province, sorted by province. Histograms were added to visualize the distribution of water quality measurements and values.

`{figure} ../wqir2018.svg :name: wqir2018-vis WQIR2018 distribution per province.`

From the previous steps, a subset of questions were created. The subset `cgss_strict`, which include only variables s41, l14d and l2409 were used for further initial analysis for simplicity.

Within these subsets, some values were revealed to be outside of the acceptable range (negative numbers). Since the origin or reason behind these values could not be determined, they were discarded. This lead to further discrepancies in the number of values depending on the province.

Once invalid values were removed, the two data sets were merged on their

shared province values. This was done in two separate ways, which allowed for different analysis.

1. **On Provinces**: The mean water quality per province was added to the mean value per province of each analyzed variable. This allows for simpler data analysis, but loses some individual demographic data (gender, income, age, education, etc.).
2. **On Individuals**: The mean water quality per province was added to the individual response values. This makes the analysis slightly more complicated, but allows for comparison across the demographic data mentioned above. However, it should be noted that it runs the risk of providing a false sense of improved precision, and the mean water quality of the province may not accurately reflect the local situation of the individual.

7.3 Interviews

7.4 Limitations

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8 Water Quality, Perception and Knowledge in China

8.1 Draft Outline

- Abstract
- Introduction
  - Global Shortage
  - Chinese Shortage
  - Chinese Pollution
- Literature Review
  - Sub-sections
- Scope and Significance
- Methodology
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  - Analysis
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- Analytical Framework
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- Discussion and Recommendations
  - Discussion
  - Recommendations
- Conclusion
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