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MASTER'S THESIS

Pollution of Water and Environmental Policies in Tianjin Area: Perception of Environmental Threats by City Residents

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Declaration

I hereby declare that I have prepared my diploma thesis on the topic “Pollution of Water and Environmental Policies in Tianjin Area: Perception of Environmental Threats by City Residents” independently and I have listed all the used references.

1st May 2021 Olomouc

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Abstract

The diploma thesis deals with the perception of water quality and the risks associated with it in the Tianjin area. These are mainly water reservoirs, lakes, Hai river and its canals. First part of the thesis describes main problems related to water pollution in Tianjin. The second part reveals results of research. The research is based on the methodology of psychometric approaches to risk perception that was developed to answer questions related to risk and safety in the context of perception of the public. The psychometric questionnaire was based on questions related to word associations, quantitative judgements on water risk (scale of riskiness), water use, supplementary questions and demographic characteristics. In addition, several qualitative online interviews with city residents were conducted. The results of the research found significant differences in the perception of water quality among Chinese and foreigners – the Chinese rated the quality of water resources in Tianjin much more positively and were less afraid to use tap water for cooking and drinking than foreigners. In the question of risk assessment of individual items, it turned out that drinking river water is considered the most risky. Respondents also acknowledged a number of health problems related to use of water, of which the most common were hair and skin problems, stomach ache and diarrhoea. It also turned out that 55 percent of respondents consider environmental measures to protect water in Tianjin to be sufficient, but at the same time think that more should be done. The thesis contributes to understanding how Tianjin residents perceive the risks associated with water quality and puts them in the context of summarizing the real state of water resources in the area. In addition, it provides a basis for further research that will allow better communication of environmental risks.

Keywords: environmental problems, health problems, risk perception, Tianjin, water pollution

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Introduction

The issue of water pollution is one of China's most serious environmental problems. Although a number of environmental measures have been taken, the problem of water quality and water scarcity persists. There is a lot of research in the field of environmental sciences that examines water pollution. However, very little research is on how people perceive these environmental problems.

The diploma thesis fills this gap in knowledge. This thesis deals with the perception of water quality and the risks associated with it in the Tianjin area. These are mainly water reservoirs, Hai River and its canals.

The aim of the diploma thesis is to answer the main research question:

RQ1: *How do people in Tianjin area perceive water pollution and the risks associated with it?*

In addition to the Chinese population, there are a number of foreigners of different nationalities in Tianjin, and we can define two hypotheses regarding the difference in the perception of water pollution and risks among Chinese and foreigners. The null hypotheses assume that these differences do not exist, hypothesis 1 and hypothesis 2 claim that these differences exist:

H01: *Chinese and foreigners in Tianjin perceive water quality in the same way.*

H1: *There is a statistically significant difference between Chinese and foreigners' perception of water quality in Tianjin.*

H02: *Chinese and foreigners in Tianjin perceive risks associated with water quality in the same way.*

H2: *There is a statistically significant difference between Chinese and foreigners' perception of risks associated with water quality in Tianjin.*

This question and the related secondary questions will be answered through first-hand data:

1.1 *How do the Tianjin residents evaluate the quality of water?*

1.2 What risks related to water quality do Tianjin residents consider to be the most serious?

1.3 How do Tianjin residents perceive and trust environmental policies?

1.4 What are the feelings of Tianjin residents regarding water pollution? Are there any symptoms of eco-anxiety?

The research will be based on the methodology of psychometric approaches to risk perception. This methodology was developed by Fischhoff et al. (1978) who aimed to answer questions related to risk and safety in the context of perception of the public. This research follows psychometric method by Slovic et al. (2007). The questionnaire is based on questions related to word associations, quantitative judgements on water risk (scale of riskiness), water use, supplementary questions and demographic characteristics. The research question on eco-anxiety and feelings associated with water pollution is answered through qualitative research (structured interviews with Tianjin residents).

This research helps to understand how people view the quality of water and the environment and whether they do not underestimate or overestimate safety risks associated with the quality of water. It also helps to understand how water quality affects people's daily lives – especially their health. The information gained from the research is also important for education and helps to eliminate the negative consequences of using unsuitable water. This research could help to reveal attitudes of people to environmental policy and their trust to the government. The selection of the Tianjin region for research was inspired by a study written by Tan et al. (2015), who found that the environmental policy has a diverse effect, suggesting that in this area there may be a distorted perception of the severity of environmental problems and it is useful to further investigate the situation. The implementation of various measures does not have to be sufficient and the negative consequences of environmental policies must also be considered. An example is the research in Tianjin. The goal of the local environmental management was to ensure the protection of the Yuqiao reservoir, based on the principle of "no use, no pollution". However, the results of research show that this method of protection has led to unintended consequences related to new types of pollution. This pollution concerned the consequences of the activities of both households and production processes. One of the causes of this pollution can be considered the fact that the inability to use the water area of the population has reduced in their eyes its

usefulness, and therefore its significance. Instead of the required principle, people's behaviour has changed to "no use, no protection" (Tan et al., 2015).

From this reason, it would be important to obtain more data from this area that will contribute to the existing literature. This research will provide a more detailed understanding of how people in Tianjin perceive water and the problems associated with it. With its quantitative focus on a wider range of respondents, it will make it possible to find out whether people are aware of the seriousness of the environmental situation. Research can also popularize environmental issues and lead to other environmental measures. The thesis provides a basis for further research that would address the perception of environmental risks in other areas of China.

The thesis is structured into three chapters. The first chapter describes research background and it is divided into six sections. The first section deals with water resources in the Tianjin area. The most important rivers, reservoirs and canals are presented. The second section deals with the industry in Tianjin. It is the great development of industry without sufficient environmental measures that results in water pollution and the transformation of the landscape, which leads to the loss of water resources. The third section presents the results of research on the quality of water resources in Tianjin. This section highlights the severity of water pollution. The fourth section deals with the consequences of water pollution on the health of the population. The fifth section presents some of the environmental measures by which the government seeks to solve environmental problems. The last section of the first chapter introduces the problematic of risk perception and its relation to environmental research. The second chapter describes methods of research. The individual sections describe the method of data collection and characterize the respondents. The third chapter presents findings of research. In the first section, results of quantitative psychometric research are presented. Results of qualitative research are described in the second section. The results of the research are summarized and limits of research discussed in the final part.

1 Research background

This chapter provides background information of this research. To be specific, it introduces water resources in Tianjin, industries that affect water quality, the impact of water pollution on health and environmental measures aimed at protecting water resources.

1.1 Water resources in Tianjin

Geography and general situation

Tianjin is a municipality spreading on an area of 11,946 km^2 with the population of approximately 15 million inhabitants (Zhang et al., 2017, p. 3) that is located in the basin of the Haihe River, which has five main tributaries (South Canal, North Canal, Ziya River, Daqing River and Yongding River) (Li et al., 2018, p. 1). It is situated in a mild semi-dry and humid monsoon climate zone with an annual total precipitation of 566 mm. However, the amount of rainfall from June to August makes up 75 percent of the total annual precipitation (Zhang et al., 2008, p. 3). The major water source for Tianjin is surface water (Yue et al., 2010, p. 563). The annual per capita water consumption is 153 m^3, which is significantly lower than the Chinese national average of 455 m^3 (Gu et al., 2015, p. 1; Zhang et al., 2017, p. 3). Water resources in Tianjin are very scarce, as evidenced by the fact that per capita in Tianjin accounts for only 7 percent of the average water level per capita in China (Zhang et al., 2008, p. 3). Zhang et al. (2009, p. 392) states that in 2009 the water source per inhabitant in Tianjin was 190 m^3. However, the data from 2016 state that the amount of water per inhabitant of Tianjin decreased to 160 m^3 (Leng et al., 2016, p. 21). The world's reserves are 1000 m^3 per capita, so the amount of water per inhabitant of Tianjin is only one-fifth of the world average (He et al., 2006, p. 387).

Tianjin is considered to be one of the largest coastal area in China. It belongs to the coastal zone of Bohai Bay. In 2005, the Chinese government developed the coastal area, which include Tanggu, Hangu and Dagan wards and thus became a strong competitor in economic development for northeast China (Zhai & Suzuki, 2008, p. 552). Water resources in Tianjin are characterized by uneven distribution of water in the regions, acute water shortages and alternating periods of high and low water flow (Zhang et al., 2009, p. 317). Groundwater and surface water are the main sources of water in Tianjin (He et al., 2006, p. 390). Surface water

in Tianjin is heavily polluted and its pollution is exacerbated by insufficient and slow wastewater treatment (Leng et al., 2016, p. 22; Zhang et al., 2009, p. 317). The main source of water supply is the Luanhe River flowing from Hebei Province and a smaller amount of water is supplied from the Yellow River. In the future, however, there is a risk that the Luanhe River will not be able to meet the requirements for water supply to Tianjin (Leng et al., 2016, p. 21; He et al., 2006, p. 389). The share of water supplied to Tianjin from other areas of China together is up to 30 percent (Zhang et al., 2009, p. 392).

Main water resources

The most important rivers and canals in Tianjin include the Hai River, Yu River, Yongding New River, Ji Canal, Chaobai New River, North Canal, Beijing Pollu, North Pollu, South Pollu, South Canal, and Yinluanrujin. In the past, these rivers were a source of drinking water, but today they are heavily polluted, mainly due to industry, agriculture and rapid urbanization. The only exception is the Yuqiao Reservoir, which is considered a source of drinking water. (Meng, 2010, p. 2). The Hai River is the largest river in Tianjin, flowing from Tianjin to Dagukou and into the Bohay Bay (Meng, 2010, p. 3). The Hai River is the main flood watercourse during the Tianjin rainy season, stems from Sanchakou and flows east into the Bohai Bay, it measures 73 km long and its basin is 1,050 km long (Zhang, Xiao et al., 2018, pp. 1103-1105). It has five main tributaries: Beiyun River, Yongding River, Daqing River, Ziya River and Nanyun River, which flow into Tianjin and then to the Bohai Bay (Yue et al., 2010, p. 563). The Hai River is characterized by extremely slow flow rate. With the development of industry and agriculture there is a disruption of water quality, sediment deposition and ecological imbalance (Zhang, Xiao et al., 2018, pp. 1103-1105). Two canals, which collect wastewater, contribute to the protection of the Hai River. At present, however, this area suffers from acute water shortages, which means that wastewater is stored in the canals for a long time and sediments settle and contaminate there (Meng, 2010, p. 3). Research conducted between 1998 and 2003 showed severe pollution of the lower reaches of the Hai River and mild pollution of its upper reaches (Meng, 2010, p. 4). The Jinhe River is a major tributary of the Hai River and flows through the city center (Miao, 2018, p. 2). Another important river is Yongdingxin River that is one of the largest recipients of industrial wastewater in Tianjin. The river is 66 km long, stems in Qujiadian and flows east into the Bohai Bay (Ren et al., 2010, p. 360).

The most important canal is the Beijing-Hangzhou Grand Canal, which has a total length of 1797 km, begins in Hangzhou and ends in Beijing. It passes through the four provinces (Zhejiang, Jiangsu, Shandong and Hebei) and cities of Beijing and Tianjin. The canal bridges many important administrative regions and some harmful substances, especially heavy metal elements, have a downfall effect (Shen et al., 2020, p. 1).

There are several large lakes in Tianjin that include: Jinquan Lake, Bolong Lake, West Lake, Tianjin Lake and Guangang Lake. The important bodies of water are reservoirs. Among the most important are especially Yuqiao, Beidagang and Tuanbowa. Other reservoirs are for example Erwangzhuang, Jinquanhu, Daxing, Yuzhuanf, Yongijin, Qilihai, Daiwangtai, Xicun Yiku, Xicun Sanku, Beicun Sanku, Gaozhuang, Beitang, Beitanggang, Beitangkou, Huanggang, Chitu Yiku, Chitu Sanku, Shajingzi, Guanyangchang, Qianquan, Yadian.

Yuqiao Reservoir is a major reservoir in Tianjin, it was established in 1959, primarily for the purpose of regulating the Ji Canal. At the present, Yuqiao Reservoir is characterized by high consumption and low water quality. In addition, water has been eutrophicating since the early 1990s, and consequently the Chinese government has introduced a number of restrictions in order to protect the Yuqiao Reservoir. These restrictions taken did not seem to help, because by the beginning of the 21st century, eutrophication was already at a high level and water quality had deteriorated significantly (Tan et al., 2015, pp. 1, 8). The water quality in the Yuqiao Reservoir is gradually deteriorating, as evidenced by the fact that in 1998 the water quality met Class III, but in 2008 it was already classified as Class IV. The main reason for the pollution is the discharge of an increasing amount of wastewater (Meng, 2010, pp. 3, 4).

The Tianjin area involves three major water diversion projects: South-to-North Water Diversion, the East Route Diversion and the Luan River Diversion (Gu et al., 2015, p. 1). The Tianjin Diversion Project transfers water from the Luan River basin to the Hai River in Tianjin and provides a supply of 1 billion m^3 of water per year. The project was launched in 1983 to deal with the water supply problem of Tianjin (Zhang et al., 2010, p. 4). The Yuqiao Reservoir has been involved into the project after its completion (Tan et al., 2015, p. 8).

Another important source of water is groundwater. We are currently facing the problem of water scarcity in China, which is critical, especially in the North China. Among other things, it led to the uncontrolled use of groundwater, which caused a drop in their levels, loss of soil and salinization of the soil (He et al., 2006, p. 387). In general, groundwater levels have fallen

mainly in saltwater areas, while in freshwater areas levels have not changed much. (He et al., 2006, p. 392).

The Hai River Basin along with the Huang and Huai River Basins are called the Huang - Huai - Hai Region HHH (Yang et al., 2012, p. 323). The groundwater level in this area is still falling. In addition, groundwater quality is below standard levels in many cities in northern China and lacks a lot of minerals, nitrates and sulfates (He et al., 2006, p. 388). It turned out that the quality of groundwater was disturbed mainly in the Wuqing district of Tianjin, where the main pollutants were Fluorine and high pH value (He et al., 2006, p. 396).

Groundwater is an important water source, accounting for 30 percent of Tianjin's total supply (He et al., 2006, p. 390). However, Tianjin's groundwater resources are not evenly distributed. There are two main sources of groundwater in Tianjin: the first is in the northern part of Jixian District and the second under a huge floodplain (He et al., 2006, p. 390). The Artesian Aquifer II is a major source of groundwater in Jinghai, Ninghe, Wuqing and Baodi districts. The survey showed that its level decreased by 5 m between years 1991–1998, but up to 20 m between years 1999–2003 (He et al., 2006, p. 393).

The important thing to mention is that the city of Tianjin is facing excessive use of groundwater (Zhang et al., 2009, p. 394). Yang (2012, p. 312) states that the Hai River Basin has a water abstraction ratio of 124 percent, while the internationally recommended water abstraction ratio is 40 percent. This means that the basin pumps more water than it should. This excessive water abstraction causes a decline in groundwater levels and water depletion in the region. Shen (2020, p. 180) estimates that the Hai River Basin pumped an additional 40 billion m^3 of water. Another problem is that companies which drain geothermal water do not recycle it back, but discharge it to the drain and as a result groundwater is still declining (He et al., 2006, p. 394).

However, groundwater abstraction can cause the soil to crack, the pipes to fail and the buildings to tilt. For this reason, it is important to regularly check the status of groundwater and draw water from the excavation pits (Wu et al., 2018, p. 2). The National People's Congress (NPC) has shown that groundwater in the vicinity of Tianjin's industrial centers is contaminated with heavy metals (Shen, 2020, p. 180).

The term "thousand layers cake" of Tianjin is used to express the accumulated sand and clay that has gradually formed the hydrogeological profile of Tianjin (Wu et al., 2018, p. 2). Shen (2020, p. 178) states that China's groundwater reserves were used in 2010 as follows: 21 percent for domestic use, 18 percent for industry, and 61 percent for agriculture.

The impact of climate change on the water amount

Climate change brings uncertainty to water supply issues, while the question of future demands for water resources may be predictable (Cheng & Hu, 2011, p. 271). It is supposed that in the next decades there will not be enough water for agriculture because of increasing demands on water resources from other sectors, especially for non-agricultural uses (Cheng & Hu, 2011, p. 276).

In the recent decades, global warming has reduced water levels in northern China, notably the Yellow River, Hai River and Liao River. It is assumed that 75 percent of the water decrease in these rivers is caused by a drop in precipitation. From October to May, the runoffs of the Liao, Hai and Huai River basins are close to zero degrees, which make them very susceptible to the temperature rise and the decrease in precipitation. The results show that the the lowest amount of precipitation is the Hai River basin.

It is generally estimated that there is a 5 percent drop in water in these water sources. As for the Hai River, the decrease in rainwater is 41 percent, decrease in precipitation is 10 percent and the decrease in water resources makes up 25 percent. The decrease in water resources in this area also results in human activities. The impacts of climate change on the water are assumed to be smaller in agriculture compared with the socio-economic development (Cheng & Hu, 2011, p. 269).

1.2 Industry in Tianjin

Industry is one of the main sectors causing pollution and water scarcity. This section discusses the impact of industry on water in Tianjin. The water resources in China like water and lakes are owned by state and managed mainly by the Ministry of Water Resources (MWR) (Cheng & Hu, 2011, p. 264). During the period of economic growth of China since 1978, the government focused on economic development and the water resources management took a little interest. As the industrialization and urbanization grew in 1980s, it brought higher demands for water sources, and the water shortage problem and the reduction of water quality emerged (Cheng & Hu, 2011, p. 265; Zhang et al., 2008, p. 1). Then in the end of 1980s, the rapid pollution of water resources became very serious in many Chinese cities (Cheng & Hu, 2011, p. 267).

Tianjin is the third largest industrial city in China. Industry and automobiles are considered to be the main sources of pollution in the city (Shi et al., 2005, p. 98). Industry is a major consumer of water. The Beijing-Tianjin-Hebei area faces water shortages. Most of the water in this sector is used to produce energy from coal (Wang et al., 2018, p. 298). However, this process is characterized with high emissions (Wang et al., 2018, p. 291). As Shi et al. (2005, p. 98) mention, an industrial company burns about 15 million tons of coal and releases about 180 million tons of wastewater per year.

The Tianjin-Beijing-Hebei region forms a heavy industrial base with the largest economy in China (Leng et al., 2016, p. 3). This area is considered to be the most risky in terms of water and environmental risks. This was probably due to rapid economic growth and overpopulation of the region (Leng et al., 2016, p. 25). In addition, a new free trade area has been established in Tianjin Binhai New District, which plans to further develop its new economic activities, so the water pollution in this area is expected to increase (Zhou et al., 2015, p. 1718).

According to the results of the survey, the water consumption needed for energy production can be reduced by 15-23 percent by using certain technology sets. However, it has been found that the application of this method has caused an increase in water consumption due to the removal of pollutants (Wang et al., 2018, p. 298). Water consumption for the removal of pollutants accounted for 13 percent of the total water consumption for electricity production (Wang et al., 2018, p. 291).

As a result of an increased economic growth, there was also a demand for a better standard of living. The population in this area is increasing, as are the demands for housing, which causes the dismantling of green areas and trees, higher pollution of water and the environment, but also a higher probability of natural disasters (Zhai & Suzuki, 2008, pp. 551-552). Rapid urbanization and industrialization have caused water supply problems and made urban land impermeable to rainwater (He et al., 2006, p. 400). With a growing economy, the gap between water supply and demand has widened (He et al., 2006, p. 390).

Water-related natural disasters such as high waves or floods occur relatively frequently. Since 1949, such disasters have occurred a total of 7 times and caused great damage (Zhai & Suzuki, 2008, pp. 551-552).

Wastewater from the surrounding industries is discharged mainly into the Yongdingxin River. The industries are engaged in the production of chemicals, food and beverages, paper, pharmaceuticals, textiles or metal smelting. In addition, wastewater from Beijing travels to the

Yongdingxin River and from there it flows into the Bohai Bay and increases pollution of the sea (Ren et al., 2010, p. 360).

Heavy industry in Tianjin is very widespread, requiring high water consumption and high emissions. In addition, the share of heavy industry has increased rapidly since 1995, causing a decline in the quality of the surrounding rivers. According to Li et al. (2018, p. 4), there were about 10,000 industrial enterprises in Tianjin at the end of 1995. However, due to the insufficient and inefficient wastewater treatment, it is estimated that up to 80 percent of this water was discharged directly into the agricultural land, which caused great pollution of rivers and agricultural land.

Tianjin's economy has grown more than 24 times since 1990. Industrial production also registered a huge increase, but the amount of used industrial water increased only slightly (Meng, 2010, p. 2). Meng (2010, p. 5) states that the total amount of industrial water used in 1998 was 4 billion and increased to 9.1 billion in 2008, while industrial production increased more than 5.7 times during that time. Furthermore, the efficient use of water resources is significantly hampered by inappropriate land use (Leng et al., 2016, p. 7).

1.3 Water pollutions in Tianjin

This section deals with the pollution of water resources in the Tianjin area. In the context of research conducted on the perception of threats associated with water pollution, this section is of great importance, as it presents the results of environmental research, which represent the current state of water resources. A comparison of this real state with the perception of water quality by Tianjin residents will show whether their assessment of risks associated with it is realistic, or whether they underestimate or overestimate environmental threats. In this respect, the following chapter will also be important, which presents the main health risks associated with water pollution.

Continued economic growth and urbanization have led to increased water demands from all sectors. This also means higher water pollution and the associated lack of water. The water scarcity thus limits some water resources to the supply of drinking and industrial water. Pollution of municipal, industrial and agricultural wastewater and household wastes became one of the most serious water related issues in China (Cheng & Hu, 2011, pp. 262, 265, 276).

According to the statistics from the 2007 Tianjin Environment Protection Bureau, only 60 percent of coastal water is found to meet quality standards (Zhai & Suzuki, 2008, p. 552). A national water research MWR 2010 has shown that only 61.2 percent of the river sections, 44.2 percent of lake areas, 80.2 percent of reservoirs, and 26.2 percent of groundwater fulfills the quality criteria of drinking water sources (Cheng & Hu, 2011, p. 262).

The rivers in the Tianjin area contain large amounts of wastewater from Beijing and Tianjin municipal areas and persistent organic pollutants. Due to the lack of water, it was common here to use wastewater for irrigation and sludge application in agriculture before the Cultural Revolution. Sewage irrigation dominates the Tianjin suburban area, which covers an area of approximately 3,500 km^2. The Hai River was considered as an important source of drinking water in the area in the past, but nowadays it is extremely polluted (Shi et al., 2005, pp. 97-98).

Rivers in the northeast and southwest areas of Tianjin are polluted mainly due to industrial and agricultural production. The two canals of the Hai River are adapted to collect wastewater, which amounts to 530 million cubic meters of wastewater per year. Due to the lack of precipitation, polluted water settles in rivers, which causes the accumulation of polluted sediments and even greater pollution of rivers. Furthermore, contaminants released from water increase its pollution. The situation is also exacerbated by the inflow of polluted water from the upper stream (Shi et al., 2005, p. 98).

Heavy metals are toxic, difficult to degrade and easy to accumulate in river water, that seriously affect the ecosystem. The research showed that the main heavy metal pollutants in sediments were Cadmium and Arsenic (Shen et al., 2020, p. 1). As a result of rapid economic growth, the level of Nitrogen in water is constantly increasing, mainly through the discharge of wastewater, the application of Nitrogen fertilizers and canalization from the households (Yue et al., 2010, p. 562). Water quality is also affected by latent anthropogenic factors, mainly CSO, organic compounds, sewage and agricultural sources (Zhang, Xiao et al., 2018, p. 1115).

The research by Yue et al. (2010) examined water quality through Nitrogen isotopes. The results show that the high concentrations of Ammonium-Nitrogen (NH_4^+-N) and Nitrates (NO_3^-) were mainly in the Longfeng River, the upper reaches of the Yongding and Beiyun Rivers due to the discharge of wastewater from the factories. Higher concentrations were also measured at the Tanggu Drainage River and the Dagu Drainage River, which have been shown to receive 80 percent of the urban sewage for Tianjin. On the other hand, the

Ammonium-Nitrogen and Nitrates concentrations of the Hai River were lower in the urban part. The reason is that the sewage from the city does not flow directly into the Hai River (Yue et al., 2010, pp. 563, 565). To sum up, water near suburbs and sewage drainage in urban areas had higher concentrations of Nitrates which is caused mainly by the domestic sewage (Yue et al., 2010, p. 567).

Another research has shown that the self-cleaning capacity of the Hai River has been impaired due to the opposite trend of Ammonia and Nitrate. The Hai River has also been found to be prone to eutrophication, mainly due to Phosphorus and Nitrogen, which means that their concentrations should be monitored (Zhang, Xiao et al., 2018, pp. 1113-1114).

According to Li et al. (2018, p. 1), the main factors causing river pollution in the Tianjin area are excessive water consumption, sewage discharge and water resources. In order to reduce water pollution, it is therefore necessary to regulate the use of water resources, reduce the discharge of wastewater, and contribute to its better treatment. Moreover, authors claim that water quality in Tianjin has deteriorated rapidly, especially since 1995. Nowadays, most rivers are heavily polluted and cannot even reach the surface water standard Grade V.

The results showed that the concentration of metals in the Yongdingxin River turned out to be higher than in natural waters. An increased concentration of Copper and Chromium metals was found in the river estuary (Ren et al., 2010, p. 360). In addition, Iron and Manganese concentrations were increased at most sampling points (Ren et al., 2010, p. 362).

It is clear that Tianjin suffers from water scarcity and pollution, and the problem is constantly growing (Xiang et al., 2014, p. 391). The major sewage rivers in Tianjin in 2004 included the Dagu Sewage River, Beitang Sewage River and Jiyun River. The total amount of wastewater in Tianjin in 2004 was 486,710,000 tons, of which industrial wastewater accounted for 46.5 percent and household wastewater for 53.5 percent (Zhang et al., 2009, p. 319).

Poor sewerage networks also contribute to water pollution problems. In the process of wastewater treatment, pollutants passed through the infrastructure for treatment of companies but did not pass through municipal treatment plants. To improve water drainage, it is thus necessary to increase the rate of decontamination of municipal waste and to build and reconstruct pipeline networks (Zhang et al., 2009, pp. 319, 321).

When calculating the load of pollutants in water, we take into account the total oxygen consumption (CHSK), total nitrogen (T-N) and total phosphorus (T-P) (Zhang et al., 2009, p. 394). The amount of total chemical consumption of oxygen (CHSK) and ammonia-nitrogen

(NH_3-N) in water should be controlled (Zhang et al., 2009, p. 321). According to Purwono et al. (2017, p. 4915), wastewater contains Nitrogen and its form of Ammonia (NH_3-N) is toxic to aquatic organisms. Municipal domestic sewage sources had the largest share of discharged pollutants. The total rate of CHSK and NH_3-N was more than 50 percent, followed by industrial sources and finally point sources (Zhang et al., 2009, p. 318). The rate of total chemical oxygen consumption (CHSK) was represented in household wastewater in 49.5 percent, in industrial water in 34.3 percent and in non-point sources in 16.2 percent (Zhang et al., 2009, p. 321). According to Zhang et al. (2009, p. 394), even 133,080 tons of CHSK were emitted in 2009 and the results showed that population activity was the main source of pollution in Tianjin.

The water quality in Chinese lakes is worse than in rivers because the water in the lake circulates slowly and therefore more pollutants settle there. Yang et al. (2012, p. 314) states that of China's 44 largest lakes, up to 56 percent have a water quality grade higher than III.

Chemical analysis of the Landscape lake in Tianjin showed that the concentration of formaldehyde in the water was lower than the standard value of water quality in China but at a safe level for aquatic organisms (Zhang et al., 2017, p. 1). Formaldehyde has been used as an indicator of environmental risk because it is one of the main side products of disinfection and also easily volatilizes and accumulates in organisms. It was found that water temperature probably most affects the formaldehyde's concentration (Zhang et al., 2017, p. 7). The four elements (Mercury, Arsenic, Chromium and Cadmium) were investigated in the study. It was revealed that their concentration in the sediment was not risky in the studied lake (Zhang et al., 2017, p. 10). The average content sequence of the elements in the sediments was present in the following descending order Chromium> Arsenic> Cadmium> Mercury, of which Chromium had the highest concentration (Zhang et al., 2017, p. 4).

The water quality in the lake is mainly affected by toxic organic substances, heavy metals (Cd, Cr, Cu, Ni, Pb, Zn) and pathogenic microorganisms. The self-cleaning capacity of the lake is severely limited, which can threaten the balance of the ecosystem (Zhang et al., 2017, pp. 1, 2).

1.4 Health impact of pollution

This section presents a health problem related to polluted water. Water pollution is a serious problem in China, with around 60,000 victims of liver or stomach cancer caused by polluted water each year. The situation of urban rivers is particularly serious, of which up to 80 percent are polluted. In addition, urban wastewater treatment plants do not comply with the necessary water quality control measures. Of the total number of 4,000 urban wastewater treatment plants surveyed, a quarter did not comply with quality controls (Zhang, Xiao et al., 2018, p. 1103).

It was released that an increase in the amount of Nitrates is harmful in drinking water. It can cause methemeoglobinemia in infants, cancer of the stomach, colon, bladder, lymphatic or hematopoietic system (Yue et al., 2010, p. 562).

Iodine deficiency is undesirable for humans: it can cause endemic goitre or endemic cretinism in young children. Among them, endemic cretinism is one of the most serious diseases caused by Iodine deficiency and has a negative impact on brain development, especially on cognitive development, intellectual abilities and school development of children. Excessive Iodine in the body, in turn, causes endemic goitre and thyroid enlargement. A survey of 1,229 people found that children with elevated Iodine levels as well as children with Iodine deficiency have lower IQs. The association between excessive Iodine and low IQ turned out to be about 9 points lower (Liu et al., 2018, pp. 32-33).

Another problem is related to enteric viruses. It is a widespread group of viruses that mainly affects young children and people with reduced immunity. They are found in surface waters and cause water-borne diseases such as gastroenteritis and hepatitis. The results of the research showed a high presence of enteroviruses in the studied Jinhe River and enteroviruses were abundant mainly in the summer months (Miao, 2018, p. 1).

In the context of water pollution, it is important to mention the presence of protozoa. Research evaluating the presence of Cryptosporidium and Giardia protozoa in the recreational lake of Tianjin's largest city park confirmed that 82.7 percent of the samples contained Cryptosporidium oocyst and 98.1 percent of them contained Giardia cysts. It is known that these parasitic protozoa can cause water-borne diseases in humans and are highly infectious (Xiao et al., 2018, p. 1).

Microscopic plants such as phytoplankton, zooplankton and benthos play an important role in the aquatic environment and the life of aquatic organisms. Phytoplankton is a producer of

organic matter in water and food for zooplankton (Li et al., 2010, p. 792). The construction of ports and various water projects have been shown to disrupt the existence of plankton and reduce their abundance. In addition, water projects bring various pollutants and industrial wastewater into the water from the earth's layer (Li et al., 2010, p. 798). Plankton levels are currently particularly endangered in Tianjin's industrial areas, such as the coastal zone south of the Haihe River known as Nanjiang Petrochemical Wharf (Li et al., 2010, p. 792).

Another problem concerns the incidence of Parkinson's disease. A study of 93 patients and 186 randomized controls at Tianjin General Hospital found that drinking river water had an effect on the development of Parkinson's disease (Odds ratio was 2.12). Its origins are further strengthened by exposure to industrial chemical plants, rubber plants, rural life for more than 20 years, a positive family history, virus infections and measles (Wang et al., 1993, pp. 210-213).

Further study concerned the presence of estrogens in Tianjin waters. In the three rivers of Tianjin, which discharge wastewater from Tianjin to the Bohai Sea, research results showed the presence of high levels of estrogens (17-ethinylestradiol and 17-estradiol). This is due to the large population of China and the fact that China is the largest consumer of birth control pills in the world. Another reason is that the studied rivers flow through areas that discharge industrial, agricultural and domestic wastewater (Rao et al., 2013, p. 1168). Estrogens in the Tianjin Rivers are thought to disrupt freshwater life and hormonal functions in marine life. The presence of large amounts of estradiol may impair reproductive performance in wildlife and steroid estrogens may cause feminisation of fish (Rao et al., 2013, p. 1169). Estrogen levels in Tianjin river waters have been shown to be much higher than in European countries and Japan. The highest value was recorded for the Yongding New River (Rao et al., 2013, p. 1167).

1.5 Environmental policies

China recognizes that the issue of water – water scarcity and pollution – is a very serious problem for the country. This section presents some environmental measures that aim to improve the situation.

The water resources in Tianjin are limited and the situation is deteriorating every year. The results of research show that the difference between the amount of water and its consumption

is increasing. The predictions show that in 2025 the water consumption will achieve 3,174 billion cubic meters, that means 342 million cubic meters more than in 2017 (Tian et al., 2020, pp. 17-18).

According to Tian et al. (2020), the suggestions for more effective water usage in Tianjin include: saving water, reducing water consumption in water-intensive industries and promoting water-friendly industries, setting water consumption limits, gain knowledge of new technologies and methods and put it into the practise, collect rainwater, seawater, waste water and reuse it (Tian et al., 2020, pp. 18-19).

Due to the intervention of the central government, water pollution in China has slightly decreased. The government implemented the Special Program on Water Pollution Control and Treatment, which made it possible to control water quality between years 2008-2020 (Cheng & Hu, 2011, p. 276). Another restriction was in force from October 2017 to March 2018, when all construction projects in regulated areas in China were suspended (Wang & Watanabe, 2019, p. 209). However, water pollution is still one of the most serious environmental problems in China (Cheng & Hu, 2011, p. 276). According to Zhai and Suzuki (2008, p. 551), Chinese government is trying to apply restrictions also in order to raise its standard of living. As a potential solution of water shortage problem, new water resources need to be developed or it is planned to use alternative water resources such as seawater desalination, rainwater harvesting and reclaimed water (Gu, Chen et al., 2015, p. 1).

There are several ways how to reuse water. The first is seawater desalination. However, this process requires a lot of energy and is very expensive. The second is rainwater harvesting. This method is cheaper and relatively fast. The third is reclaimed water. It is a cheap way that has great potential in Tianjin. In order to make effective use of this method of obtaining water, it is necessary to create a plan how to realize it. According to statistics, reclaimed water represents 6 percent of total water consumption in Tianjin. The annual alternative water consumption is 1.9 billion m^3, of which reclaimed water constitutes 80 percent. (Gu, Chen et al., 2015, p. 1).

In order to protect the water in Tianjin, local governments had set up the following measures, grouped into three categories: water management, residence management and waste management. However, the results of these measures led to new types of pollution, primarily from these sources: households, extensive farming and “hurried building” (Tan et al., 2015, pp. 8, 16).

Yuqiao Reservoir is an example of implementation a governing principle known as “no use, no pollution” (Tan et al., 2015, pp. 1, 16). However, the logic of “no use, no pollution” significantly reduces the usefulness and importance for the locals which brings out a new phenomenon called “no use, no protection” (Tan et al., 2015, pp. 13, 16). This example clearly shows the importance of the perception of environmental problems by the general population. A study by Tan and colleagues shows that there is a need to better fill the gap in knowledge related to people’s understanding of environmental measures and how they perceive individual environmental threats. Thus, examining how people think and understand certain phenomena is as important as examining the phenomena themselves.

Water management deals with water-related rules, investments in infrastructures related to water, controlling salinity and supporting of water and groundwater protection (Cheng & Hu, 2011, p. 263). It is evident that the continuous climate change makes effect to the water management. It causes worsening water shortage and increasing demands for water (Cheng & Hu, 2011, p. 253). Furthermore, climate change is expected to lead to higher differences between water demands and water supplies. Control and prevention of water resources is an important aspect that would lead to an increase in the quality of water management (Cheng & Hu, 2011, p. 279).

Public opinion has been shown to have a major impact on the possible introduction of new methods of obtaining water and on water management. Hartley (2016) mentions that social background like information, knowledge, local context, age and education, all are important for perception and participation on environmental issues. It was released that people over 50 are more reluctant to use reclaimed water. On the other side, people with higher education and income are more willing to reuse water (Gu & Chen et al., 2015, pp. 1-2). Research has shown that people in Tianjin do not have sufficient knowledge about the water system and water resources in Tianjin. There is also a lack of knowledge about the available water resources (Gu, Chen et al., 2015, p. 8). The lack of public cooperation is also playing a difficult obstacle for meeting China’s environmental protection goals (Cheng & Hu, 2011, p. 276). This study is another example of the importance of researches that deal with the perception of environmental threats by the public.

Meng (2010, p. 6) shows that with a growing economy in Tianjin, water consumption increases, but the volume of fresh water consumption and the amount of wastewater discharged decrease. Meng (2010) adds that water efficiency in Tianjin has improved, as evidenced by statistics that Tianjin was the city with the best water use in China at the time.

Li et al. (2018, p. 5) states that the river has the ability to self-clean, but at the same time it must be fully hydrated. Despite the implemented projects that enable the transport of water to this area, it is obvious that this region is constantly drying up. Industrial production must also use groundwater. Lack of water hinders economic development in this area (Li et al., 2018, p. 5).

Water consumption

In 2003, the Tianjin city government introduced water consumption limits, which were divided into three categories: household, agricultural and industrial water consumption. The consumption quota per capita in the household was set at 70-120 liters per day (He et al., 2006, p. 399).

China is a major exporter, as it exports goods that require a large amount of water to produce. As a result, huge amounts of so-called virtual water are lost in this way, while the polluted water remains in China (Yang et al., 2012, p. 326). Water consumption in China in 2007 was 526 billion m^3, of which virtual water exports accounted for 11.5 percent. It has been calculated that virtual water exports in Huang - Huai - Hai Region in 2007 caused a loss of an average of 7 percent of water resources from total water consumption. In Tianjin, this share was the highest – 63 percent. In comparison, other water-scarce cities such as Beijing and Shandong had a loss rate of 17.9 and 20 percent (Yang et al., 2012, p. 323).

Total water consumption in China in 29 years (1980-2009) increased by 34 percent, but consumption increased only in the field of industrial production and households, which can be justified by rapid urbanization and population growth (Yang et al., 2012, p. 314).

Charges for water resources

Tianjin City, together with Liaoning Province, were the first to introduce a system of water resource charges in 1988, mainly for urban groundwater (Shen, 2020, pp. 34, 147). Since 2017, Tianjin has been part of a pilot project to introduce tax charges on water resources. This project was initiated in 2016 in Hebei Province and should be gradually implemented at the national level (Shen, 2020, p. 151).

Water recycling

In China, the use of recycled water spread especially after 2000 to Tianjin, primarily for industrial and public purposes. Consumption of recycled water then increased significantly after 2010 (Shen, 2020, p. 222).

Beijing and Tianjin have developed a more advanced water recycling process that provides better water quality. It is based on multi-stage purification, it is the so-called "sewage treatment effluent + coagulation + sedimentation + microfiltration + reverse osmosis + disinfection". There is also a method of recycling water with ozone technology, which is used in Tianjin and Beijing. These recycling methods are constantly being researched and developed (Shen, 2020, pp. 222, 224).

Beijing is considered as the city with the most developed water recycling system (Shen, 2020, p. 222). According to the Beijing Statistics Bureau 2010, the water recycling rate in Beijing was 59.3 percent. On the contrary, Tianjin is one of the cities with a lower recycling rate (Zhang et al., 2009, p. 394). For that reason, it is necessary to deal with the use of regenerated water. Recurrent water reuse should reduce wastewater and downstream water pollution. A plan has been developed to help to achieve a recycling rate of 56 percent recycled water (Zhang et al., 2009, pp. 391-392).

Under the Water Pollution Control Action Plan, cities including Tianjin, are encouraged to use recycled water. For example, in Tianjin since 2018, a newly built building with an area of more than 50,000 m^2 must have installed a recycled water facility (Shen, 2020, p. 232). The technology of using recycled water in 2010 was at the beginning of development, the share of recycled water in terms of full utilization was only 3 percent (Zhang et al., 2009, p. 392). Recycled water use rates are expected to reach 30 percent in Tianjin, Beijing and Hebei Province by 2020 (Shen, 2020, p. 232).

Thanks to the government efforts of the city of Tianjin, the rate of industrial water recycling in Tianjin increased from the original 40 percent in the 80s to 74 percent in the 90s. The implementation of fees for the abstraction of industrial water reduced its consumption by one third (He et al., 2006, p. 387).

Water purification

A 2010 survey showed that the construction of water conduits is fragile, with up to 30 percent of water mains dependent on water imports. According to the Tianjin Water Bureau 2010, wastewater from the primary industry does not undergo treatment, but is discharged directly

into the surface water. The data show that 82 percent of the discharged wastewater is treated by wastewater treatment plants, but only 2.92 percent is treated deep enough to be used as reclaimed water (Zhang et al., 2009, p. 394).

1.6 Risk perception and environmental problems

This research is based on methods of psychometric research. Psychometric studies in risk research help to understand how people and society perceive and manage the risks of daily life (Slovic et al., 2007, p. 81). The perception of risks was first addressed by psychologists Fischhoff, Slovic, Lichtenstein, Read and Combs (1978), who began to study what people mean that something is or is not risky and what factors lead to this perception (Slovic et al., 1982, p. 83). The basic characteristics of the risk are severity and uncertain adverse outcome. Slovic (1999, p. 689) says that "danger is real, but risk is socially constructed" (cited from Böhm & Tanner, 2019, p. 16). This definition based on psychological perception is in contrast to a technical (realistic) understanding of risk based on an examination of the probabilities of events and the extent of their consequences (Freudenburg, 1988; Renn et al., 1992, p. 138). Risk can thus be defined as the probability of catastrophic damage caused by technological or other modernization processes (Janmaimool & Watanabe, 2014, p. 6293).

Social researchers show that human risk is not just a product of probabilities but is also influenced by their values, attitudes, social influences and cultural identity (Renn et al., 1992, p. 137). How these people evaluate the probabilities and ranges of events depends on their values, attitudes, social influences, and cultural identity (Douglas & Wildavsky, 1982, p. 38; Renn et al., 1992, p. 138). Sjöberg et al. (2004, p. 7) recalls in this regard the definition by Rosa (2003, p. 56) that risk is "a situation or an event where something of human value (including humans themselves) is at stake and where the outcome is uncertain".

Many experts have different views on risk perception. Among them, Janmaimool and Watanabe (2014, p. 6294) argue that "the term 'risk perception' generally refers to natural hazards and threats to the environment or health". According to Böhm and Tanner (2019, p. 17), the perception of risk is the subjective judgment of people who are associated with a certain event or situation. Sjöberg agrees with this statement, according to him the risk is a subjective assessment of the probabilities and consequences of a negative outcome (Sjöberg et al., 2004, p. 8).

So far, four approaches to risk perception have been developed: the sociocultural paradigm, the psychometric paradigm, the interdisciplinary paradigm – Kasperson's social amplification of risk framework (SARF) and the axiomatic measurement paradigm (Janmaimool & Watanabe, 2014, p. 6294).

The psychometric model was proposed in 1978 by Fischhoff, who examined how risk perception is influenced by physical characteristics, psychological, and cognitive factors such as fear or experience (Janmaimool & Watanabe, 2014, p. 6294). In 1995, McDaniels and colleagues applied the first psychometric paradigm to environmental risk perception (Böhm & Tanner, 2019, p. 20).

In 1988, Kasperson proposed the concept of social amplification of risk. This means that risk-related events interact with other processes (psychological, social, institutional and cultural) that can increase or decrease risk perception and lead to secondary effects (Renn et al., 1992, p. 139).

Risk perception studies have revealed interesting facts. For example, experts and lay people have had different perceptions of risk. It has been shown that lay people tend to assess higher levels of risk and professionals the lower (Böhm & Tanner, 2019, p. 20). Furthermore, in general, individuals tend to have a higher risk perception for unknown events (Janmaimool & Watanabe, 2014, p. 6295).

The issue of risk perception also has its opponents from many experts, including Ropeik, who argues that the results of risk perception assessments can never be objective because experts and politicians do not fully understand ordinary people. Some of them also had reservations about the cultural approach to risk perception, as Sjöberg who argued that risk perception and cultural aspects were not closely related and that risk perception concerned real risks rather than cultural aspects (Janmaimool & Watanabe, 2014, p. 6294).

A specific example of risks are environmental risks, which are characterized by high complexity and uncertainty. They are often time-delayed and geographically distant and can cause ethical problems. They are more often caused by the behaviour of many people or groups than by a single activity (Böhm & Tanner, 2019, p. 16). The authors further argue that the risks posed by humans are perceived emotionally more intensely than the risks caused by natural disasters (Böhm & Tanner, 2019, p. 23). The perception of risks and threats associated with environmental changes is very important in the current situation, as evidenced by the current phenomenon of so-called eco-anxiety. This type of anxiety could be characterized as "eco-anxiety is a specific form of anxiety relating to stress or distress caused

by environmental changes and our knowledge of them" (Usher et al., 2019, p. 1233). A socially serious problem can be a situation where intense anxiety leads to the paralyzing of an individual who, under the influence of this eco-paralysis, are so distressed that they are unable to act (Albrecht, 2011; Usher et al., 2019). It is the issue of water and its pollution, the loss of water due to the climate change that are issues that have a major impact on everyday life.

A number of factors influence the perception of risks, including environmental ones. Emotions are important, they have a great influence on the perception of risks, for example fear increases and anger reduces the perception of risks. Fear leads to the fact that the individual perceives the situation as more uncertain, which leads to an increased risk. On the contrary, anger leads to the evaluation of phenomena as highly certain and people therefore tend to choose a lower risk (Böhm & Tanner, 2019, p. 22). Currently, to better understand risk perception, science is focusing on the importance of the emotions that evoke risks (Böhm & Tanner, 2019, p. 23).

In several studies, Sjöberg has theorized that there is a moderate relationship between risk perception and emotional responses. Emotional reactions affect risk perception and lead to emotions such as worry, fear or anxiety (Sjöberg et al., 2004, p. 26).

The communication of stakeholders depends on the determination of the acceptable level of risk. From this point of view, they represent the risks of social construction. Risk communication is considered a cultural process (Masuda & Garvin, 2006, pp. 437, 452). Authors define this as "what constitutes danger depends on 'who is speaking to whom'". Therefore, risk communication can easily lead to conflict. However, this is a controversial statement, because each group of people prefers such a communication about risk that reflects their view of risk and suits their interests (Masuda & Garvin, 2006, p. 437).

The biggest problem in risk communication is considered to be the different attitudes to risk between lay people, governments and industry (Janmaimool & Watanabe, 2014, p. 6292). It is expected that with the growing knowledge of the environment and the rising influence of the media at all levels of society, people's awareness of potential threats is also increasing and people should have a greater ability to assess the risks they face and be less affected by psychological factors such as uncertainty or fear (Janmaimool & Watanabe, 2014, p. 6293).

The research presented in the following section examines how Tianjin residents perceive the risks associated with water. In the area of environmental risk perception, studies in China are mainly focused on perception of water scarcity (Fan et al., 2019; Tan, Liu, 2017),

perception of the use of reclaimed water (Zhu et al., 2018; Chen et al., 2015; Hu et al., 2014; Tang et al., 2013) or the perception of the risk of floods (Zhong et al., 2021). As already mentioned, an important study on the perception of environmental issues in Tianjin is the study by Tan et al. (2015), who found that people perceive environmental measures differently than the government assumes, which led to a worsening of the situation. This work thus complements current research and can provide important information on water quality perceptions.

2. Methodology

2.1 Quantitative research

Psychometric questionnaire

This research is based on psychometric questionnaire (Slovic et al., 2007). Complete versions of the Chinese and English questionnaires are included in the appendix. The questionnaire has the following parts: 1) Demographics. 2-3) Questions based on word associations to "water in Tianjin". Respondents write six times association with word. Then evaluate if these associations are negative or positive. 4) Evaluation of water quality in reservoirs, rivers, and quality of tap water. 5) The question based on evaluation of sufficiency with environmental water protection measures. 6) Question focused on use of water for drinking, cooking, cleaning, showering. 7) Question focused on the use of water from natural sources. 8) Risk evaluation of 19 items: 1 = not at risk, 2, 3, 4, 5, 6, 7 = very much at risk. Respondents are asked to make quantitative judgements to several items. Some items relate to water quality and the risks associated with it, others relate to a different area to allow for comparison and a broader context (drinking tap water, cleaning face with tap water, drinking water from reservoir, drinking river water, cooking with tap water, swimming in river, swimming in reservoir, cigarette smoking, high-fat foods, alcoholic beverages, sweet beverages (coke etc.), bottled water, coffee, flooding, typhoon, automobiles, cell phones, air pollution, acid rain). 9) Question related to trust in government environmental measures. 10-11) Health issues related to water quality.

Data collection

Data were collected on a web platform for Qualtrics questionnaire surveys in the period from September 2020 to February 2021. Respondents were contacted via e-mail (personal contacts), Wechat, Facebook and Researchgate scientific social network. The main criterion for selecting respondents was permanent residence in Tianjin or living in the city for more than three years. Both Chinese and foreigners living in the city were included in the research.

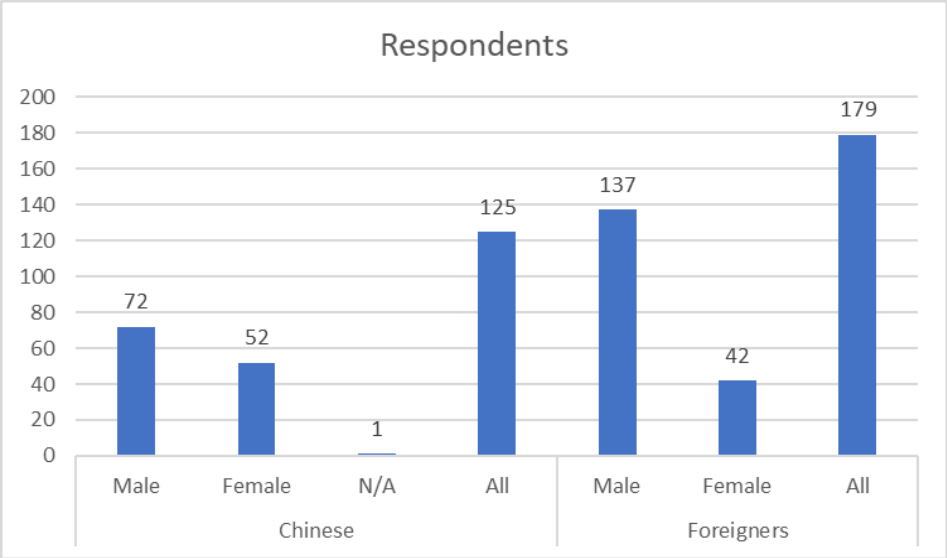
Due to the small willingness of the respondents to fill in the questionnaires, it was necessary to address the respondents individually and acquaint them with the nature and goals of the research. Many people who were asked to complete a questionnaire were reluctant to complete it. Some were afraid to click on the link due to a possible computer virus. Some

people did not understand that research was about their personal opinion and did not need any expertise on water quality. Especially people with higher education often mentioned that they could not fill in the questionnaire because they are not experts in water issues. Many people promised to complete the questionnaire, claiming to have filled it in, but in fact their answers were not recorded.

Respondents

A total of 304 respondents completed the questionnaire, of which 94 were women and 209 were men. One respondent did not report sex. 125 Chinese participated in research, including 72 men and 52 women. The total number of foreigners who filled out questionnaire is 179, of which 137 were men and 42 were women. The data are shown in the following Graph 1.

Graph 1: Respondents



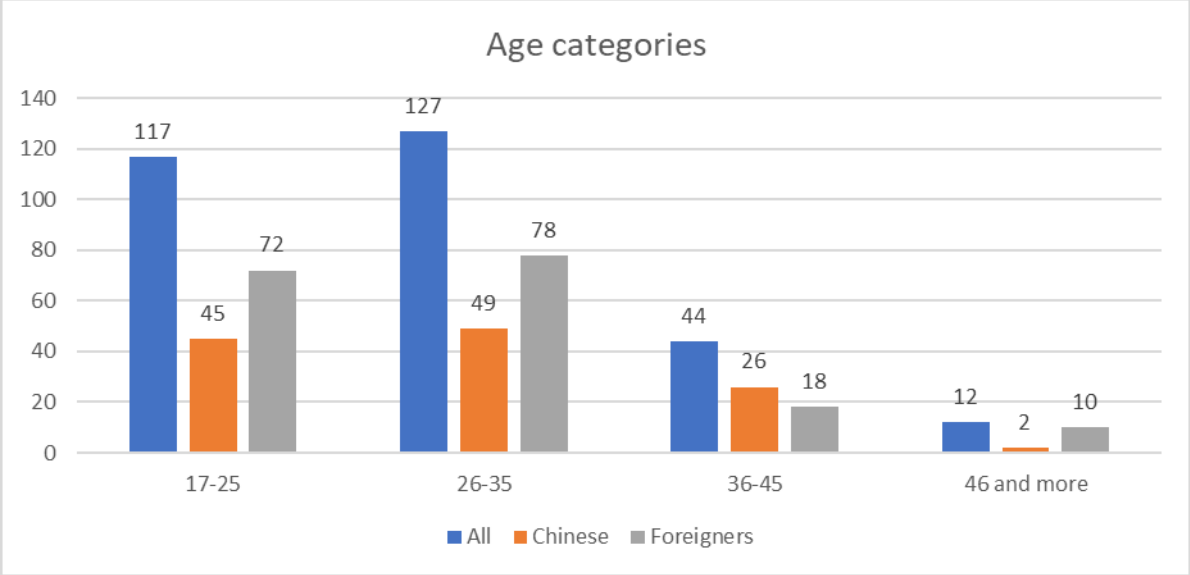
The age of the participants ranged from 17 to 60 years. The most numerous group was represented by the young generation. 127 respondents (41.78 percent) were in age category 26-35, the second largest group were respondents in the age category of 17-25 years (38.49 percent), followed by a group of respondents aged 36-45 years (14.47 percent). Respondents over the age of 46 were the least numerous (3.95 percent). The mean age of all respondents is 29.15 years. The mean age of Chinese is 29.48 years, the mean age of foreigners is 28.93 years. It turns out that both groups (Chinese and foreigners) are comparable in age. The biggest limit of the age characteristic is the weak representation of the older generation.

The age of the respondents is shown in Table 1. The age categories and frequency of ages are shown in Graph 2 and Graph 3.

Table 1: Age of respondents

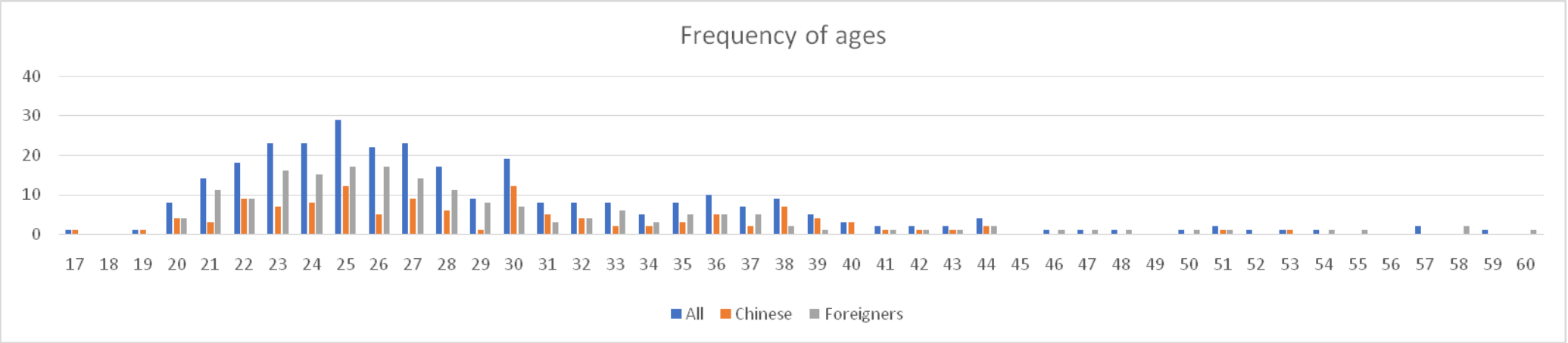
	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	17	53	29,48	6,94	48,23	122
Foreigners	20	60	28,93	7,84	61,49	178
All	17	60	29,15	7,49	56,17	300

Graph 2: Age categories

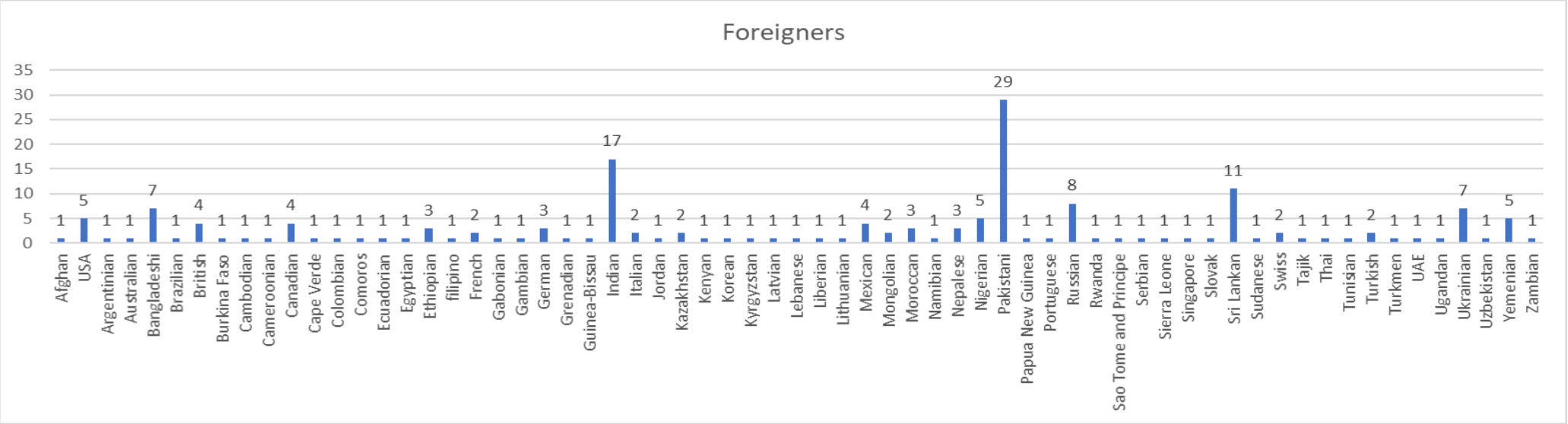


The ethnic composition of the respondents is diverse. In addition to 125 Chinese, 179 foreigners of various nationalities took part in the research. The ethnic composition of foreigners is shown in Graph 4. Respondents from Pakistan (29), India (17), Sri Lanka (11), Russia (8), Bangladesh (7) and Ukraine (7) had the highest representation. In total (in addition to the Chinese), respondents from 65 different countries participated in the research.

Graph 3: Frequency of ages



Graph 4: Nationalities of foreigners



2.2 Qualitative structured interview

Qualitative online interviews were also conducted with city residents focusing on their perceptions of water and environmental issues. The aim was to find out what their feelings are about the polluted water in Tianjin and whether they have eco-anxiety. The interviews took place online via the Wechat application. Some participants preferred to provide written answers or send voice messages. All participants in the interview agreed to use the interview for research purposes. The call lasted about 20 minutes. The interview was structured but respondents had possibility to freely express their opinions at any time of the interview even in cases when their answers were not related to the asked question. Respondents answered the prepared questions and supplementary questions. They also had the opportunity to comment freely on the topic. The interviews were transcribed. The following section presents excerpts from important answers concerning individual questions.

Respondents

A total of 10 interviews were conducted. The characteristics of the respondents are given in the Table 2.

Table 2: Characteristics of respondents

Number of resp.	Sex	Nationality	Relation to Tianjin
Respondent 1	male	Indian	11 years in Tianjin
Respondent 2	male	Chinese	working in Tianjin
Respondent 3	male	Nepalese	working in Tianjin
Respondent 4	male	Rwandan	student in Tianjin
Respondent 5	male	Pakistani	student in Tianjin
Respondent 6	male	Chinese	living and working in the industrial zone of the city
Respondent 7	female	Japanese	student in Tianjin
Respondent 8	male	Papua New Guinean	student in Tianjin
Respondent 9	male	Bangladeshi	student in Tianjin
Respondent 10	female	Zambian	student in Tianjin

3. Findings

3.1 Analysis and results of quantitative research

The data collected on the Qualtrics questionnaire platforms were further processed using an online calculator. The Standard Deviation Calculator (SDC, 2021) was used to calculate mean, variance and standard deviation. To determine the statistical significance of the differences between groups the One-Way ANOVA Calculator (OWAC, 2O21) was employed. Statistical significance was determined at levels $p < 0.01$, $p < 0.05$ and $p < 0.10$. In some cases, the p-value was even <0.00001. However, for clarity, only three levels of significance are used.

This section describes the results of the answers to the individual questions of the questionnaire. Question 1 on demographic data was described in the previous chapter.

Q2, Q3: Associations with water

Questions Q2 and Q3 concern associations with a phrase "water in Tianjin". The task of the respondents in the question 2 was to write 6 associations related to this phrase. In question 3, they should write how they evaluate the given association (very negative = -2, negative = -1, neutral = 0, positive = 1, very positive = 2). The results are recorded in Tables 3 and 4 (separately for Chinese and foreigners). The association categories were created on the basis of the similarities of the answers. The individual categories are arranged in the table from the most numerous category to the least numerous. The following columns show the number of responses and the average effect of the category based on the respondents evaluation.

a) Chinese

The most numerous category among the Chinese was the category *Places, water resources, rivers*, which was mentioned by 90 Chinese. More than a third of them (35) mentioned *Hai River*. The reason why the Chinese mention places and geographical names more often is probably related to the fact that they have lived in the city since birth or for a very long time, so they are more familiar with these places. Foreigners, on the other hand, know the environment less and focus on other facts.

The second most numerous category was *Amount* (41), where people stated their relationship to the amount of water. Common answers were *enough, a lot, not enough* and *little*. The overall average of the answers was relatively neutral or below zero.

For Chinese, it could be said that relatively positive associations such as *good, clean, life* prevailed, which were evaluated positively. Associations such as *tap water, taste* and *water management* also turned out slightly positively, while *drinking water* was neutral, or below zero. On the contrary, negative associations were less numerous. The most numerous were *dirty, smell, hard quality* and *pollution*.

Table 3: Associations with water – Chinese

Rank	**Association category**	**Count**	**Average effect**
1	Places, water resources, rivers (Hai River)	90 (35)	0,63 (0,31)
2	Amount (scarcity, sufficiency)	41	-0,07
3	Good	27	0,7
4	Water management	25	0,4
5	Pure, clean	25	0,8
6	Taste	23	0,22
7	Drinking water	22	-0,05
8	Dirty	20	-0,8
9	Smell	18	-0,94
10	Sceneries and views	18	0,61
11	Hard	17	-0,7
12	Quality	17	-0,35
13	Pollution, contamination	14	-0,93
14	Life	12	1,5
15	Bad, negative	10	-1
16	Tap water	10	0,4
17	Water park, swimming pool	10	0,6
18	Sea	10	0,9
19	Transport, traffic	9	0,33
20	Colour	8	-0,13
21	Neutral, normal	8	0,25
22	Weather	7	0
23	Price	6	-0,17
24	Swimming	6	0,17
25	Water	6	1
26	Effects on ecosystem	5	-1
27	Cool, cold	5	0
28	Environmental measures	5	0
29	Health impact	5	0
30	Past experience, history	5	0,6
31	Rich	4	0,5

32	Food	4	0,75
33	Useful	4	0,75
34	People	4	1
35	Organizations and companies	4	1,75
36	Positive emotions	3	1
37	Safety	2	-1
38	To waste	2	-0,5
39	Boiled water	2	-0,5
40	Bottled water	2	0
41	Buying water (shop, restaurant, hotel)	2	0
42	Showering, cleaning, bathing	2	1
43	Flooding	1	-2
44	Cooking	1	-2

b) Foreigners

For foreigners, the most frequent association is *good* (46), followed by *pollution* (41), *places* (40) and *drinking water* (36). Unlike the Chinese, foreigners rate items like *pollution, drinking water* and *dirty* much more negatively.

Associations like *places* and *amount*, foreigners mention less than the Chinese. On the other hand, *price* (21) and *showering* (19) they mention more than the Chinese. Another important category for foreigners is *health impact*, which they rated 26 times, while the Chinese mentioned it only 5 times.

Foreigners are more focused on practical things related to drinking water, showering and possible threats. This may be related to the necessary adaptation to new and unknown conditions that are different from the country of origin. This is confirmed by qualitative research, which shows that foreigners often compare the water in Tianjin with water in their country and rate it as worse.

Table 4: Associations with water – Foreigners

Rank	**Association category**	**Count**	**Average effect**
1	Good, ok	46	0,89
2	Pollution, contamination	41	-1,29
3	Places, water resources, rivers (Hai River)	40 (6)	0,25 (-0,33)
4	Drinking water	36	-0,81
5	Dirty	35	-1,2
6	Pure, clean	29	0,76
7	Health impact	26	-0,7
8	Amount (scarcity, sufficiency)	26	0,54

9	Price	21	0,62
10	Smell	20	-0,5
11	Tap water	19	-0,63
12	Showering, cleaning, bathing	19	0,37
13	Water management	16	-0,13
14	Taste	16	0,06
15	Quality	15	-0,13
16	Neutral, normal	13	0,15
17	Bottled water	12	0,25
18	Hard	11	-0,64
19	Water park, swimming pool	11	0,55
20	Availability	11	0,91
21	Colour	10	-0,2
22	Organizations and companies	10	0,20
23	Buying water (shop, restaurant, hotel)	9	1,11
24	Effects on ecosystem	8	-2
25	Bad, negative	8	-1,25
26	Cool, cold	8	-1,25
27	Safety	8	-1,25
28	Weather	8	-0,13
29	Environmental measures	8	-0,13
30	Useful	8	0,75
31	Cooking	7	-0,29
32	Recycling	7	0,86
33	Boiled water	5	0
34	Sceneries and views	4	1
35	Negative emotions	3	-1,33
36	Flooding	2	-1,5
37	Transport, traffic	2	0,5
38	People	2	1
39	Swimming	1	-2
40	Food	1	2

Q4: How do you rate quality of water in Tianjin area? 1 = very bad quality, 2, 3, 4, 5, 6, 7 = very good quality.

For this question, the respondents were asked to evaluate the water quality of three water sources: reservoirs, rivers and the quality of tap water.

1) Quality of water in reservoirs

In the case of perception of water quality in reservoirs, the mean value answered by Chinese was 4.43, for foreigners it was 3.97. Comparison of these values based on One-way ANOVA showed that this difference is statistically significant at $p < 0.01$. This means that the Chinese

perceive the state of water quality in the reservoir as better quality with great statistical significance.

Table 5: Quality of water in reservoirs

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	4,43	1,44	2,08	118
Foreigners	1	7	3,97	1,51	2,27	172
All	1	7	4,16	1,50	2,24	290

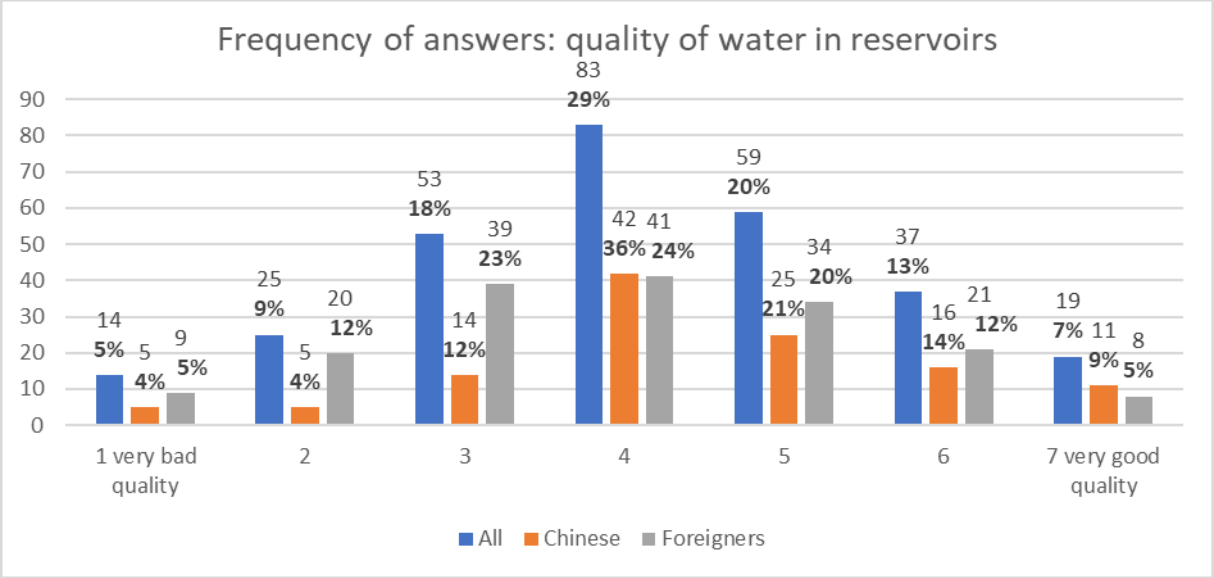
Table 6: Quality of water in reservoirs: One-Way ANOVA – comparison between Chinese and foreigners

	Chinese	Foreigners	Total
N	118	172	290
$\sum X$	523	682	1205
Mean	4.4322	3.9651	4.155
$\sum X^2$	2563	3094	5657
Std. Dev.	1.4469	1.5098	1.4997

Source	*SS*	*df*	*MS*	
Between-treatments	15.2689	1	15.2689	***F* = 6.92786**
Within-treatments	634.7483	288	2.204	
Total	650.0172	289		
The f-ratio value is 6.92786. The p-value is 0.008944. **The result is significant at p < 0.01.**				

An excessive majority of respondents (83 percent) indicated a value 4. High participation was also recorded at values 3 and 5. At higher values (4-7) there is a visibly higher percentage of Chinese versus foreigners, while foreigners make up a higher percentage at lower values.

Graph 5: Quality of water in reservoirs



2) Quality of water in river

Respondents rated water quality in rivers a little more negatively than in reservoirs. The average is 3.59, foreigners rated the quality more negatively (mean 3.24) than the Chinese (mean 4.09). According to the One-way ANOVA, the comparison of responses in Chinese and foreigners is significant at p <0.01.

Table 7: Quality of water in river

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	4,09	1,41	1,98	116
Foreigners	1	7	3,24	1,58	2,48	168
All	1	7	3,59	1,57	2,45	284

Table 8: Quality of water in river: One-Way ANOVA – comparison between Chinese and foreigners

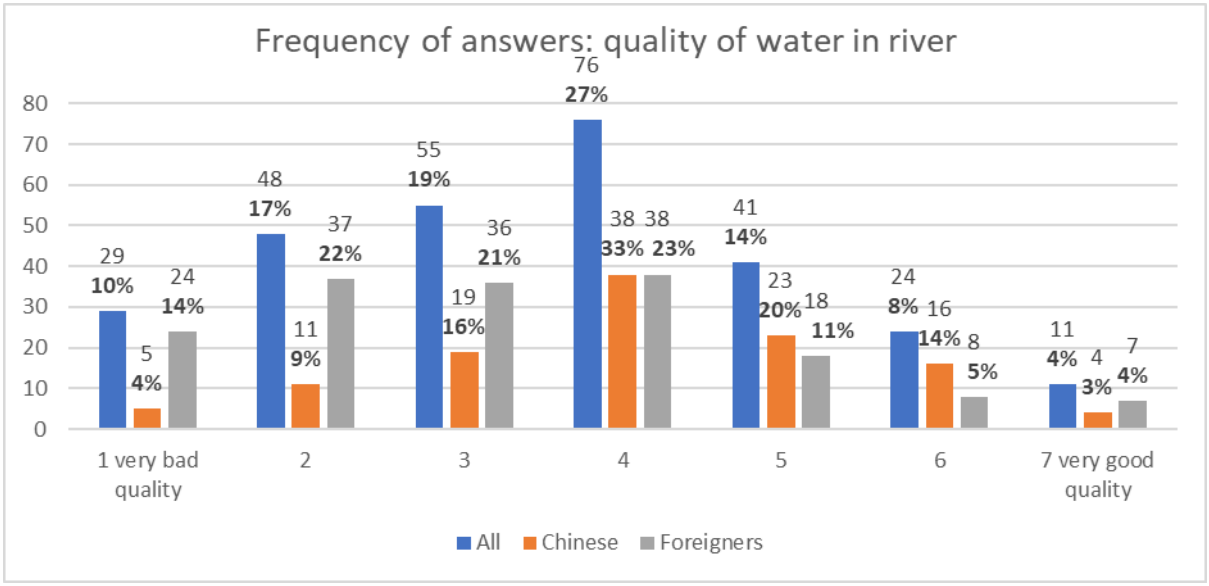
	Chinese	Foreigners	Total
N	116	168	284
∑X	475	545	1020
Mean	4.0948	3.244	3.592
$\sum X^2$	2175	2185	4360
Std. Dev.	1.4141	1.5802	1.5689

Source	*SS*	*df*	*MS*	

Between-treatments	49.6688	1	49.6688	**F = 21.65016**
Within-treatments	646.9509	282	2.2942	
Total	696.6197	283		
The f-ratio value is 21.65016. The p-value is < 0.00001. **The result is significant at p < 0.01.**				

When we look at graph 6, we observe that slightly higher values represent lower water quality (value 1-4). Value 2 was marked by 17 percent and value 3 by 19 percent of respondents. The highest representation is at value 4 (27 percent). Then the values gradually decrease. Only 4 percent of respondents considered water quality to be very good (value 7). As for the comparison between nationalities, the Chinese considered the water to be better than foreigners. At values 4-6, the percentage of Chinese prevailed.

Graph 6: Quality of water in river



3) Quality of tap water

The quality of tap water was perceived slightly positively (mean was 4.12). According to the Chinese, the quality of tap water is better (4.35) than according to foreigners (mean 3.96). The One-Way ANOVA comparison showed that the difference in their responses is significant at p <0.05.

Table 9: Quality of tap water

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	4,35	1,44	2,07	118
Foreigners	1	7	3,96	1,55	2,39	167
All	1	7	4,12	1,51	2,29	285

Table 10: Quality of tap water: One-Way ANOVA – comparison between Chinese and foreigners

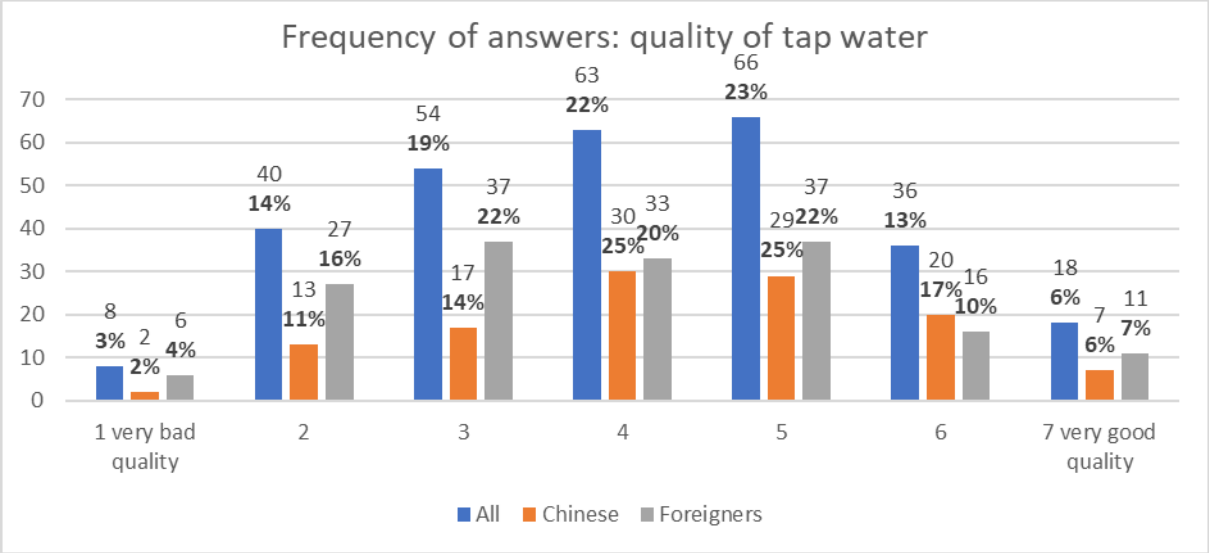
	Chinese	Foreigners	Total
N	118	167	285
∑X	513	661	1174
Mean	4.3475	3.9581	4.119
$\sum X^2$	2475	3015	5490
Std. Dev.	1.4463	1.5498	1.5174

Source	*SS*	*df*	*MS*	
Between-treatments	10.483	1	10.483	***F* = 4.61054**
Within-treatments	643.4608	283	2.2737	
Total	653.9439	284		

The f-ratio value is 4.61054. The p-value is 0.032626. **The result is significant at p < 0.05.**

Graph 7 shows the highest ratings for values 4 and 5. They were rated by 22 and 23 percent of respondents. The lowest participation was at value 1 (very bad quality) and 7 (very good quality). At lower values, we can again notice a higher percentage of foreigners. For example, value 3 was marked by 22 percent of foreigners and only 14 percent of Chinese. The Chinese, in turn, have a higher percentage at values from 4 to 6.

Graph 7: Quality of tap water



Q5: Are environmental measures to protect water resources sufficient?

In this question, respondents had to express their opinion (respectively satisfaction or dissatisfaction) regarding environmental measures. From Table 11, we can read that most respondents (69 percent) answer the question positively (options 1 and 2): 14 percent of them consider the measures to be sufficient (option 1), but most respondents (55 percent) are not completely satisfied – they choose the second option: "Yes, but more should be done". The remaining 30 percent of respondents are dissatisfied with environmental measures: 20 percent consider them insufficient (option 3) and 4 percent do not see any measures (option 4).

The mean of all answers is 2.2. From the means of the answers of the Chinese (2.31) and foreigners (2.11), we can read that the Chinese perceive environmental measures as less sufficient than foreigners. The One-Way ANOVA calculator evaluated the differences in their responses as significant at <0.05 (Table 12).

Table 11: Perception of environmental measures for the protection of water resources

Options		Chinese		Foreigners		All	
		Count	Percentage	Count	Percentage	Count	Percentage
1	Yes, it is sufficient.	8	6,45	35	20,71	43	14,68
2	Yes, but more should be done.	73	58,87	88	52,07	161	54,95
3	No, it is not	39	31,45	38	22,49	77	26,28

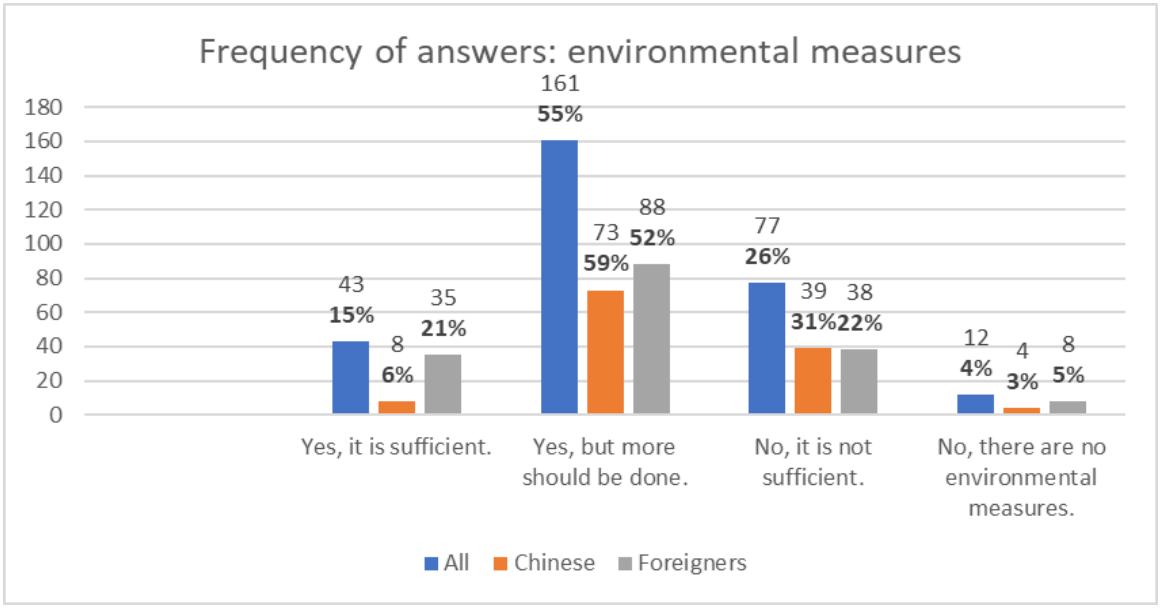
	sufficient.						
4	No, there are no environmental measures.	4	3,21	8	4,73	12	4,10
Total		124	99,98	169	100	293	100

Table 12: Perception of environmental measures for the protection of water resources: One-Way ANOVA – comparison between Chinese and foreigners

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	4	2,31	0,64	0,41	124
Foreigners	1	4	2,11	0,78	0,61	169
All	1	4	2,20	0,73	0,53	293
Comparison One-way ANOVA	The f-ratio value is 5.534. The p-value is 0.019316. **The result is significant at p < 0.05.**					

Most Chinese (55 percent) rated environmental measures as "sufficient, but more should be done" (option 2), and 52 percent of foreigners chose this option. The second most common response among Chinese was option 3 (it is not sufficient), which was reported by 31 percent of Chinese and 22 percent of foreigners. We can also note that 21 percent of foreigners but only 6 percent of Chinese considered environmental measures to be sufficient (option 1) (see Graph 8).

Graph 8: Perception of environmental measures for the protection of water resources



Q6: What water do you use for: drinking, cooking, cleaning, showering

This question focused on the use of water for routine activities, namely: drinking, cooking, cleaning and showering. As Table 13 shows, *bottled water* for drinking predominates in both groups, Chinese and foreigners. However, there are more foreigners who report *bottled water* than the Chinese. Instead of *bottled water*, the Chinese mention *tap water* much more often. We also see differences between Chinese and foreigners in the use of water for cooking. The Chinese much more often use *tap water* and foreigners use *bottled water*. In this case, approximately twice as many foreigners as Chinese report the use of *filtered water*. When commenting the water use for cleaning, the vast majority of respondents state *tap water*. The same is true in the case of using water for *showering*, with a small difference for foreigners, when ten of them also mention *filtered water*.

Table 13: Use of water

Respondents	Drinking	Cooking	Cleaning	Showering
Chinese	bottled (46)	tap (80)	tap (108)	tap (110)
	tap water (21)	bottled (15)	groundwater (2)	boiled (4)
	mineral water (21)	filtered (10)	filtered (1)	reclaimed (1)
	filtered, purified (16)	mineral (7)	pure water (1)	
	boiled water (13)	water dispenser (3)		
	water dispenser (5)	boiled (1)		
Foreigners	bottled (98)	tap (58)	tap (149)	tap (139)
	filtered, purified (25)	bottled (43)	filtered (4)	filtered (10)
	mineral water (17)	filtered (23)	reservoirs (4)	boiled (2)
	water dispenser (5)	mineral (11)	detergents (1)	groundwater (1)
	boiled water (3)	water dispenser (10)		reservoirs (1)
	tap water (2)	boiled (7)		bottled (1)

Q7: Have you ever used water directly from water sources (rivers, water reservoir) in Tianjin?

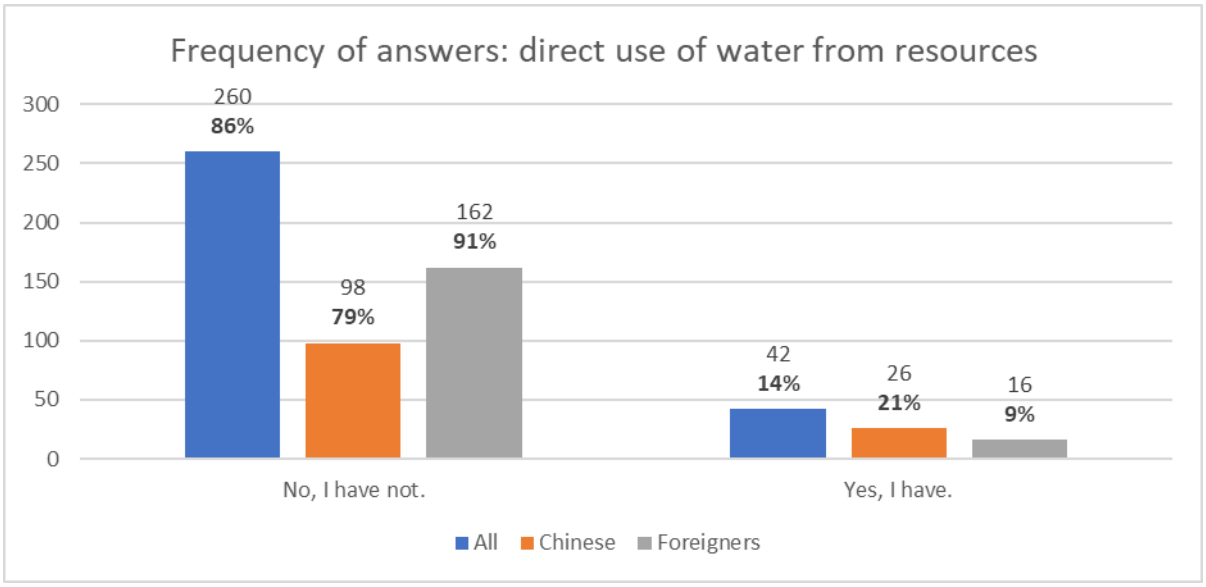
In this question, respondents were asked if they ever used water directly from water sources and had to choose from two options: "No, I have not" or "Yes, I have". In Table 14, we can see that the vast majority of them (86.1 percent) answered negatively – they stated the first option (No, I have not).

Table 14: Direct use of water from water sources

Answers		Chinese		Foreigners		All	
		Count	Percentage	Count	Percentage	Count	Percentage
1	No, I have not.	98	79.03	162	91.01	260	86.1
2	Yes, I have.	26	20.97	16	8.99	42	13.91
Total		124	100	178	100	302	100

Using Graph 9, we can notice the difference between Chinese and foreigners: 91 percent of foreigners state this option, but there are slightly fewer Chinese – 79 percent. If we look at the second option (Yes, I have), we notice that more Chinese report having experienced direct use of water from water sources, while the percentage of foreigners reporting this option is 12 percent less. Overall, this means that the Chinese consider the use of water directly from water sources to be more natural than foreigners, who are obviously more afraid of it.

Graph 9: Direct use of water from water sources



Q8: Rate riskiness of each item. 1 = not at risk, 2, 3, 4, 5, 6, 7 = very much at risk

This question is focused on the evaluation of the perceived riskiness of individual items related to water quality. Other items are also included, which provide a comparison with other risks, such as other environmental risks (flood, typhoon, air pollution) or health risks (cigarette smoking, alcohol, sweet beverages). The results of the items used for comparison are compared with the results of the study by Slovic et al. (2007).

1. Drinking tap water

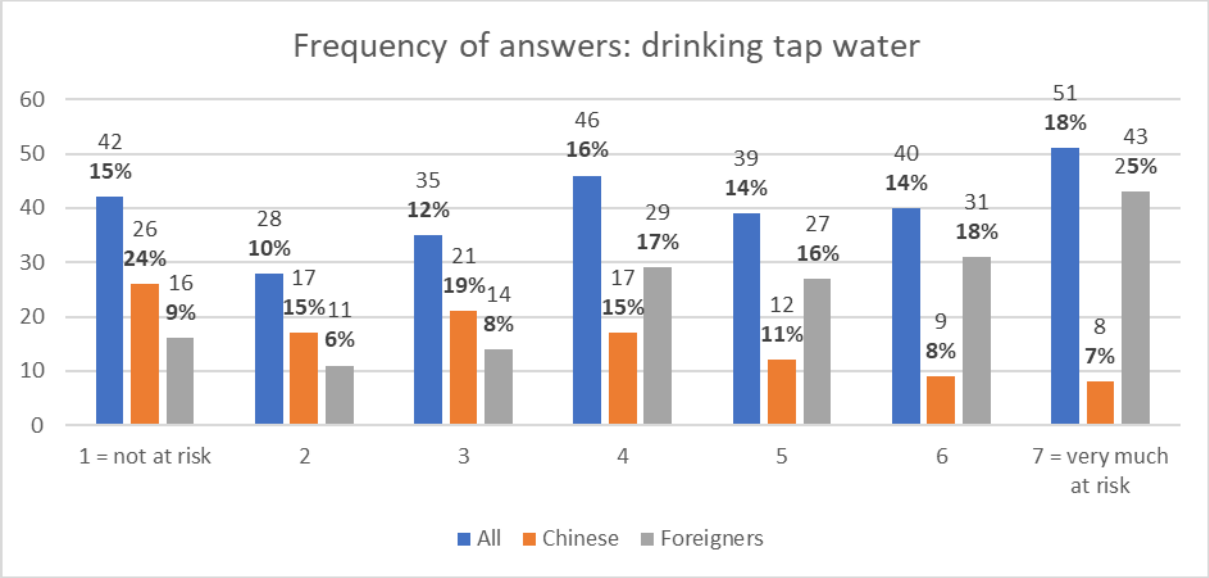
The first item evaluated drinking tap water (see Table 15). The total mean risk is 4.20. There is a statistically very significant difference between the perception of the risk of drinking water by the Chinese (mean 3.28) and foreigners (mean 4.78). Comparison based on One-way ANOVA showed that the result is significant at p <0.01.

Table 15: Drinking tap water

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	3,28	1,87	3,51	110
Foreigners	1	7	4,78	1,93	3,71	171
All	1	7	4,20	2,04	4,17	281
Comparison One-way ANOVA	The f-ratio value is 41.24581. The p-value is < 0.00001. **The result is significant at p < 0.01.**					

This significant difference is also evident from the percentage of response rates (see Graph 10). While 25 percent of foreigners rate tap water as very much at risk (value 7), only 7 percent of Chinese rated this risk value. In contrast, the item not at risk (value 1) was marked by 24 percent of Chinese and only 9 percent of foreigners.

Graph 10: Drinking tap water



2. Cleaning face with tap water

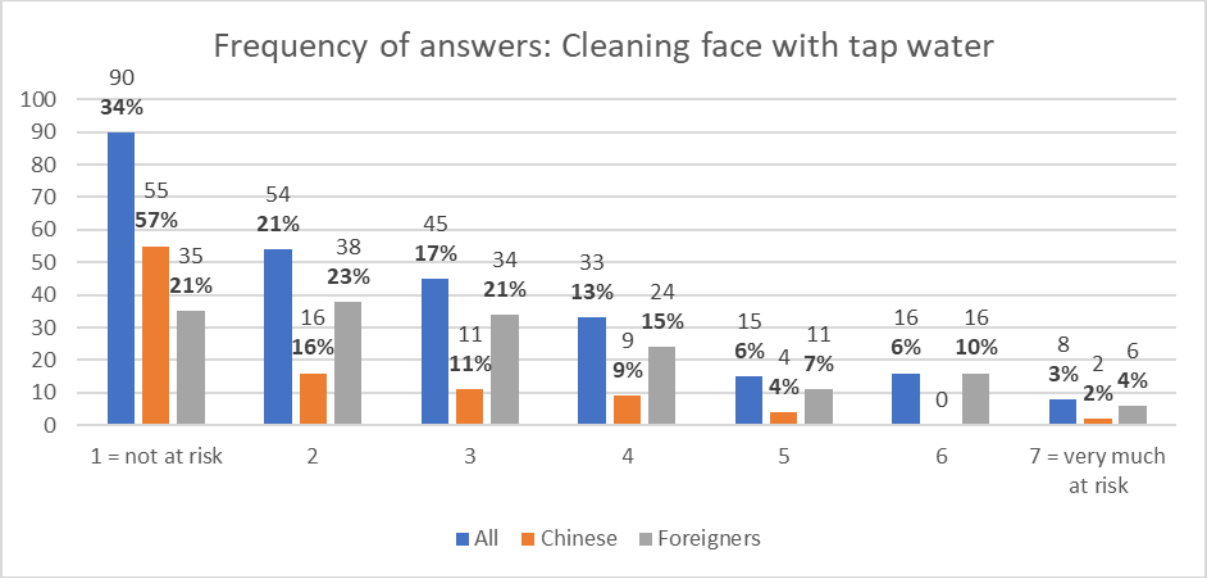
When we look at the Table 16, we notice that the Chinese consider cleaning face with tap water to be less risky (mean 1.96) than foreigners (mean 3.06). The p-value is <0.00001, which means that the difference is statistically very significant. The mean of all answers is 2.65, which means that they are inclined to take a small risk.

Table 16: Cleaning face with tap water

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	1,96	1,39	1,94	97
Foreigners	1	7	3,06	1,72	2,96	164
All	1	7	2,65	1,69	2,86	261
Comparison One-way ANOVA	The f-ratio value is 28.4869. The p-value is < 0.00001. **The result is significant at p < 0.01.**					

For this item, we can also notice a descending graph 11, which expresses a gradually declining level of risk among respondents. Most respondents (34 percent) rated value 1 (not at risk). At the same time, there is a significant difference between the answers of the Chinese and foreigners. While up to 57 percent of Chinese indicated this value, only 21 percent of foreigners did so.

Graph 11: Cleaning face with tap water



3. Drinking water from reservoir

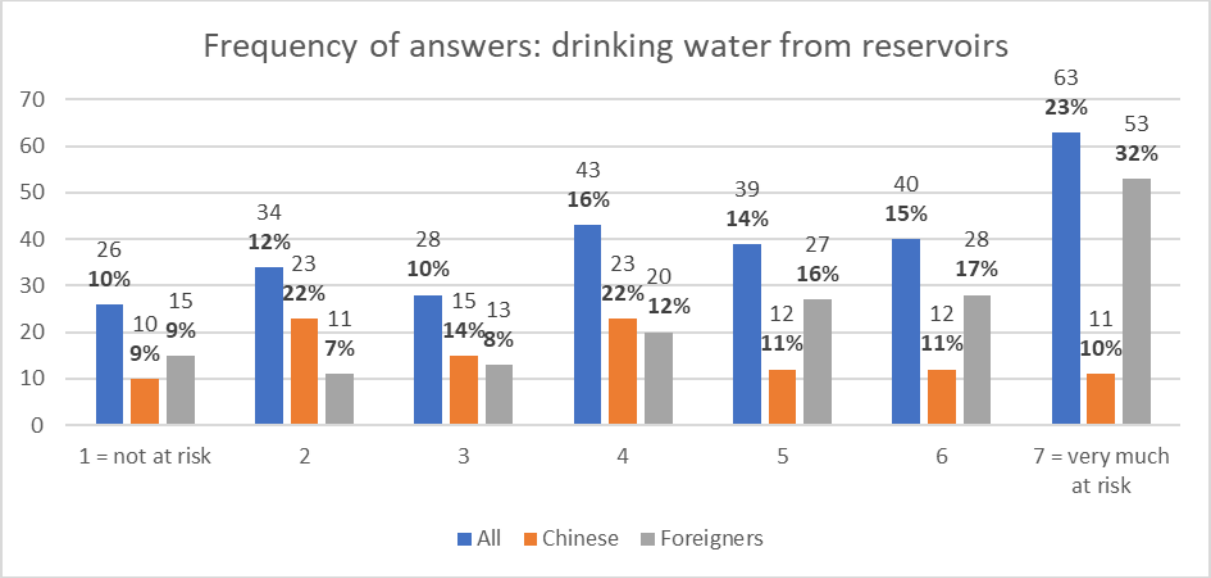
This item shows a higher risk of answers in both groups, but the Chinese have a lower level of risk. The overall mean is 4.49, of which 3.79 for Chinese and 4.97 for foreigners. The difference appears to be statistically very significant at p-value <0.00001 (Table 17).

Table 17: Drinking water from reservoir

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	3,79	1,82	3,32	106
Foreigners	1	7	4,97	1,97	3,90	167
All	1	7	4,49	2,01	4,02	273
Comparison One-way ANOVA	The f-ratio value is 24.31302. The p-value is < 0.00001. **The result is significant at p < 0.01.**					

Most respondents rated value 7 (very much at risk), of which 32 percent were foreigners and only 10 percent were Chinese. The first option was represented by 10 percent, of which 9 percent were Chinese and the same percentage of foreigners (Graph 12).

Graph 12: Drinking water from reservoir



4. Drinking river water

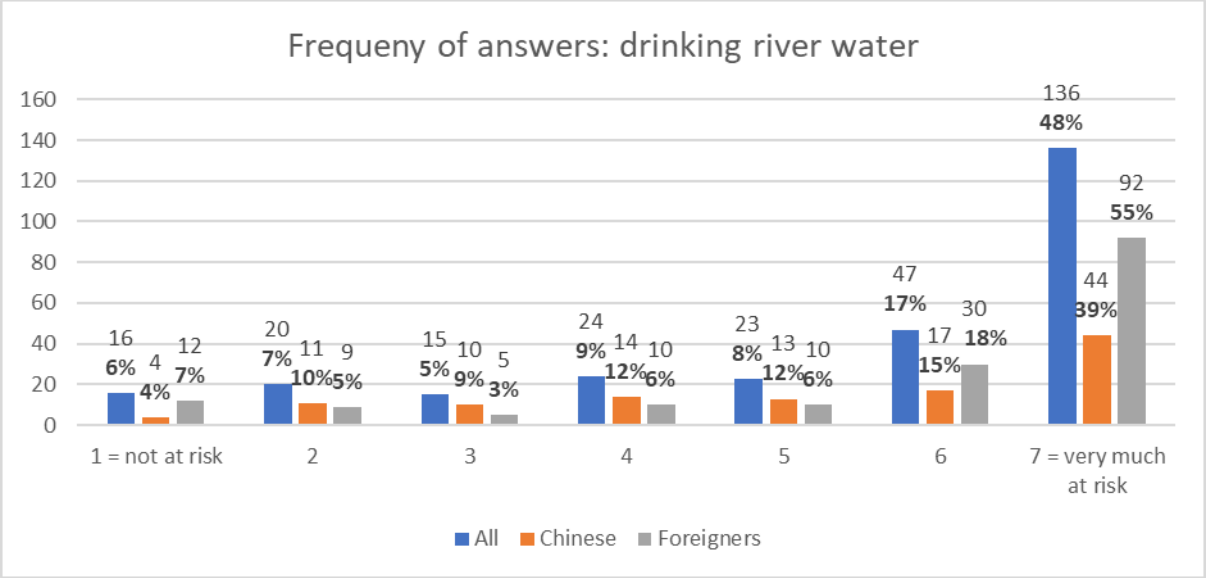
This item represented high risk for the respondents, the mean is 5.5 (Table 18). For foreigners, the mean response was higher (mean 5.71) than for Chinese (mean 5.19). The result is significant at p <0.05.

Table 18: Drinking river water

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	5,19	1,89	3,59	113
Foreigners	1	7	5,71	1,92	3,67	168
All	1	7	5,50	1,92	3,70	281
Comparison One-way ANOVA	The f-ratio value is 4.86381. The p-value is 0.028241. **The result is significant at p < 0.05.**					

Graph 13 shows a significant predominance of responses expressing the highest risk. Almost half of the respondents (48 percent) indicated the highest risk (value 7). When we look at the differences between Chinese and foreigners, the Chinese have chosen a lower risk. For example, at values 2-5 the Chinese predominate, but at values 6-7 foreigners have a higher representation. The highest risk (value 7) was chosen by 55 percent of foreigners and 39 percent of Chinese. On the other hand, the lowest value was rated by 7 percent of foreigners and 4 percent of Chinese.

Graph 13: Drinking river water



5. Cooking with tap water

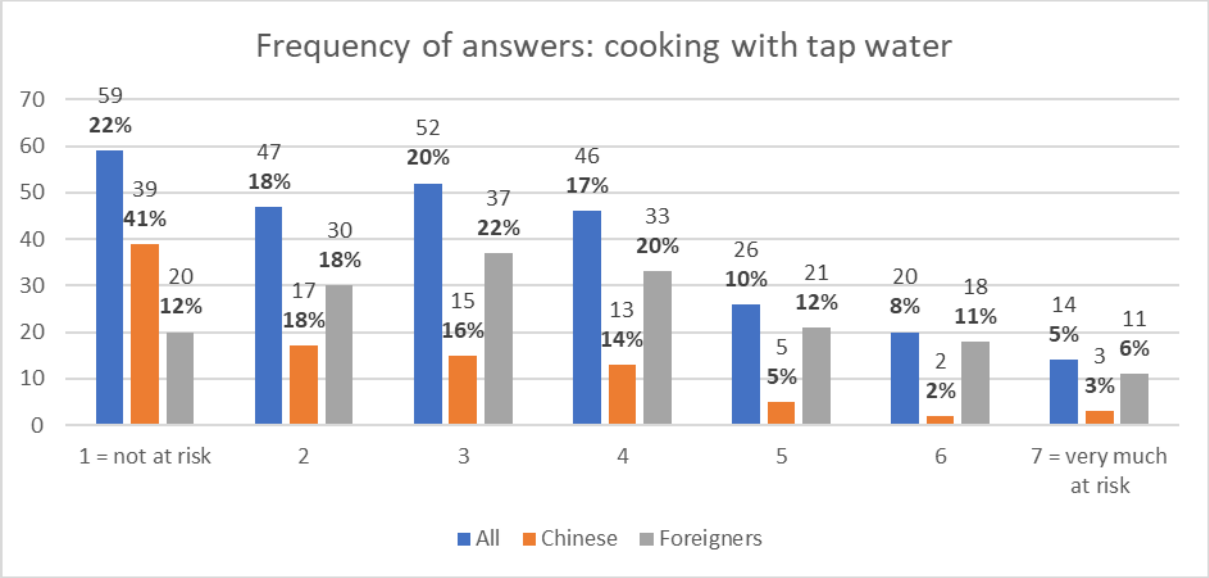
The average response rate for this item is 3.19 (Table 19). It turned out that the Chinese perceive cooking with tap water as a less risky activity than foreigners. Means are 2.43 for Chinese and 3.61 for foreigners. The result is significant at p <0.01. The claim that Chinese are less afraid to use tap water for cooking than foreigners was also confirmed in the previous question 6, where many more Chinese than foreigners reported this fact.

Table 19: Cooking with tap water

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	2,43	1,60	2,56	94
Foreigners	1	7	3,61	1,72	2,96	170
All	1	7	3,19	1,77	3,14	264
Comparison One-way ANOVA	The f-ratio value is 29.71478. The p-value is < 0.00001. **The result is significant at p < 0.01.**					

Graph 14 on a scale of 1-7 shows a gradually declining level of risk. The most numerous category is the value 1 (lowest risk), which was reported by 22 percent of respondents. There is an extremely high percentage of Chinese (41 percent), while this value was marked by only 12 percent of foreigners. Only 5 percent of respondents rated the highest value of risk (value 7), that is marked by 6 percent of foreigners and 3 percent of Chinese.

Graph 14: Cooking with tap water



6. Swimming in river

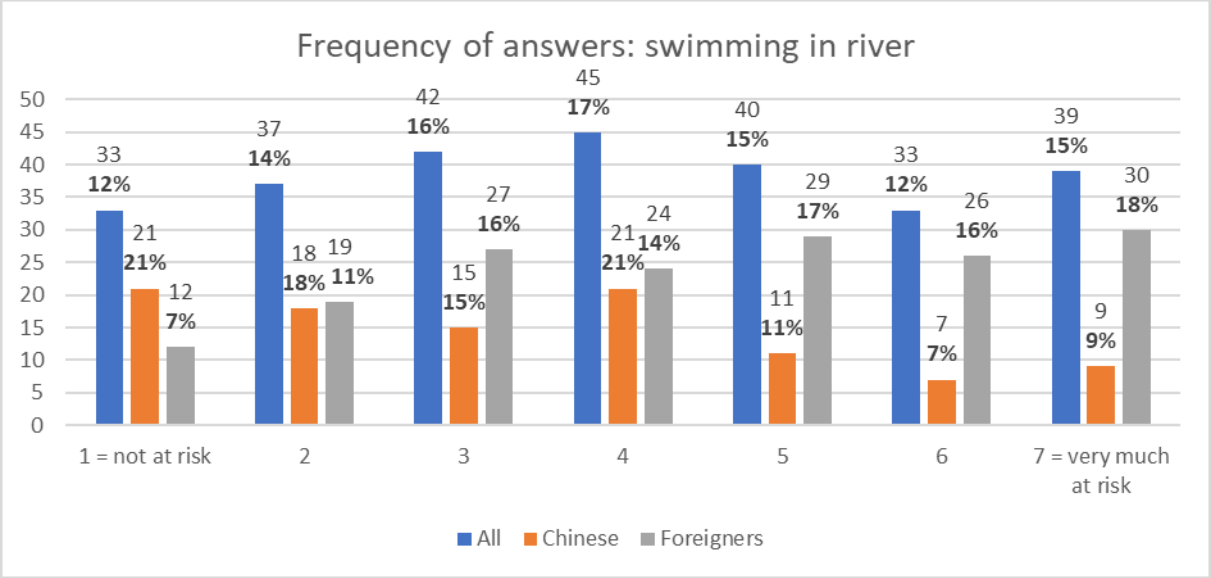
Swimming in the river is considered by the respondents to be a medium risk (mean 4.03), for the Chinese the risk is lower (mean 3.92) than for foreigners (mean 4.42). As shown in Table 20, the result of the One-way ANOVA comparison is significant at p <0.01.

Table 20: Swimming in river

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	3,92	1,87	3,51	102
Foreigners	1	7	4,42	1,87	3,50	167
All	1	7	4,03	1,94	3,75	269
Comparison One-way ANOVA	The f-ratio value is 18.91131. The p-value is 0.000019. **The result is significant at p < 0.01.**					

Graph 15 shows a relatively even representation of respondents' answers for all values 1-7, the frequency of responses for each value ranges from 12 to 17 percent. The Chinese had a higher percentage at values 1-4, while at values 5-7, foreigners already prevailed. 15 percent of respondents indicated the highest risk (value 7). Foreigners predominated here (18 percent) compared to the Chinese (9 percent).

Graph 15: Swimming in river



7. Swimming in reservoir

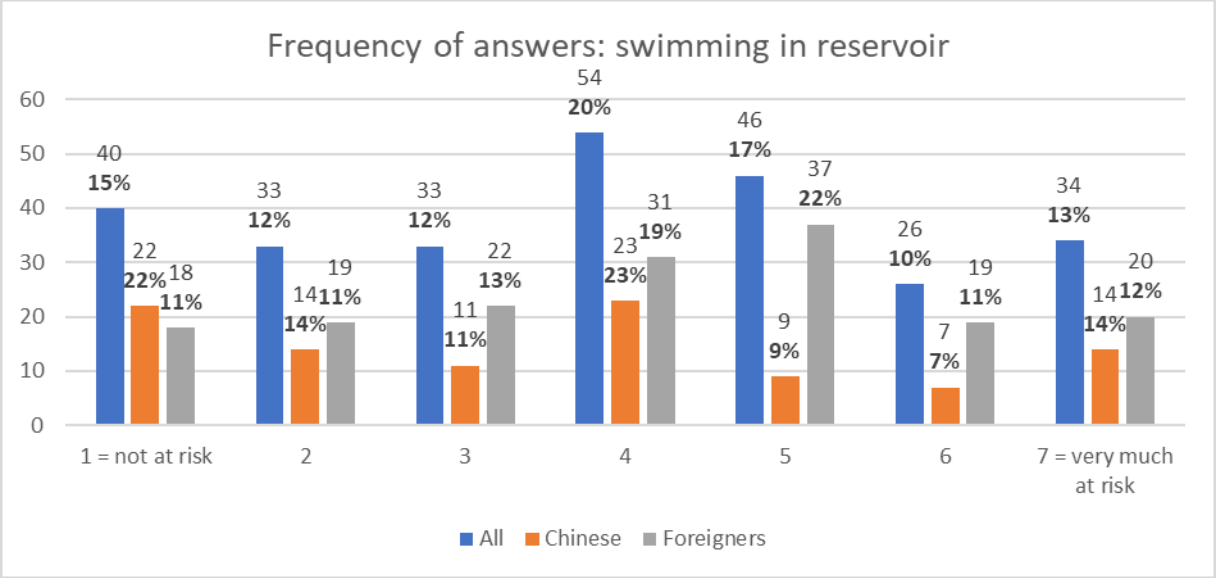
The results for this item show that swimming in reservoir represents approximately a medium risk for respondents (mean 3.93). Compared to the previous item (swimming in river), the risk perceived by respondents is slightly lower. A comparison of means has shown that foreigners perceive swimming in reservoir at greater risk (mean 4.13) than Chinese (mean 3.60). According to the One-way ANOVA comparison, the result is significant at p <0.05 (Table 21).

Table 21: Swimming in reservoir

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	3,60	2,03	4,12	100
Foreigners	1	7	4,13	1,82	3,32	166
All	1	7	3,93	1,92	3,68	266
Comparison One-way ANOVA	The f-ratio value is 4.74577. The p-value is 0.030255. **The result is significant at p < 0.05.**					

Graph 16 shows that frequency of answers is relatively even, where none of the values 1-7 is represented by less than 10 percent. The highest frequency of answers is present at value 4 (20 percent) and at value 5 (17 percent), but value 1 (15 percent) is also relatively numerous. Most Chinese rate value 1 (22 percent) and value 4 (23 percent). Most foreigners give a value of 5, while only 9 percent of Chinese state the same.

Graph 16: Swimming in reservoir



8. Cigarette smoking

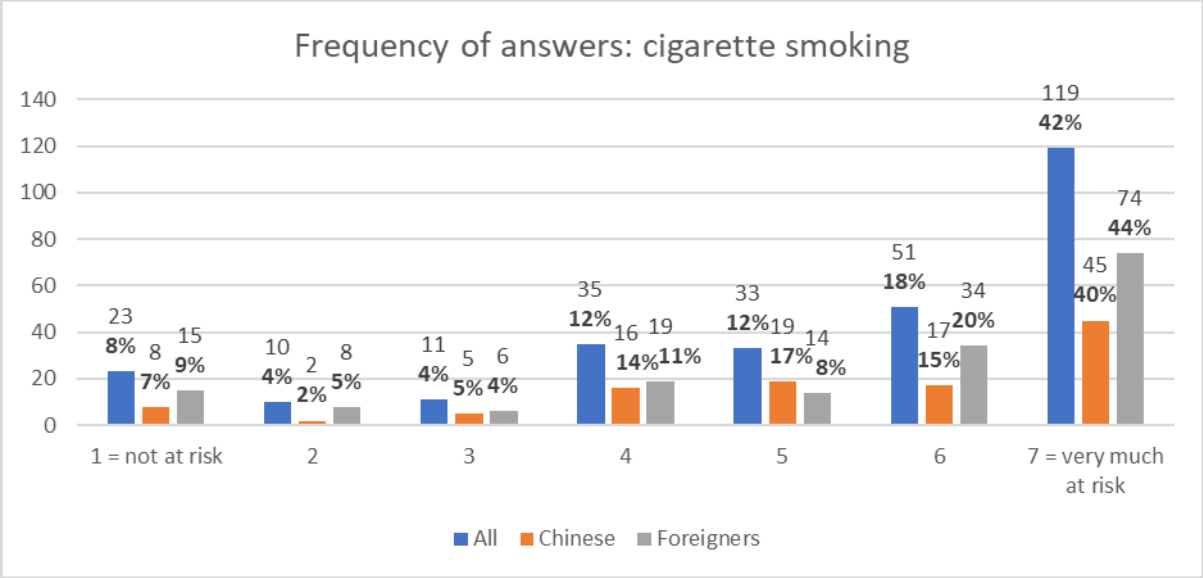
For cigarette smoking, the average response rate is 5.38, which signifies a higher risk. The means of responses for Chinese and foreigners are almost identical, the difference between them is only one hundredth. Thus, the result of compared responses of Chinese and foreigners is not significant at p <0.10 (Table 22).

Table 22: Cigarette smoking

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	5,38	1,80	3,23	112
Foreigners	1	7	5,39	1,97	3,87	170
All	1	7	5,39	1,90	3,62	282
Comparison One-way ANOVA	The f-ratio value is 0.00192. The p-value is 0.965061. **The result is not significant at p < 0.10.**					

Respondents tended to give higher values, with values 4 to 7 predominating, of which the highest frequency of responses is value 7 (42 percent). The differences in the representations of Chinese and foreigners are not significant in any of the values. The highest risk (value 7), for example, is indicated by 40 percent of Chinese and 44 percent of foreigners (Graph 17).

Graph 17: Cigarette smoking



9. High-fat foods

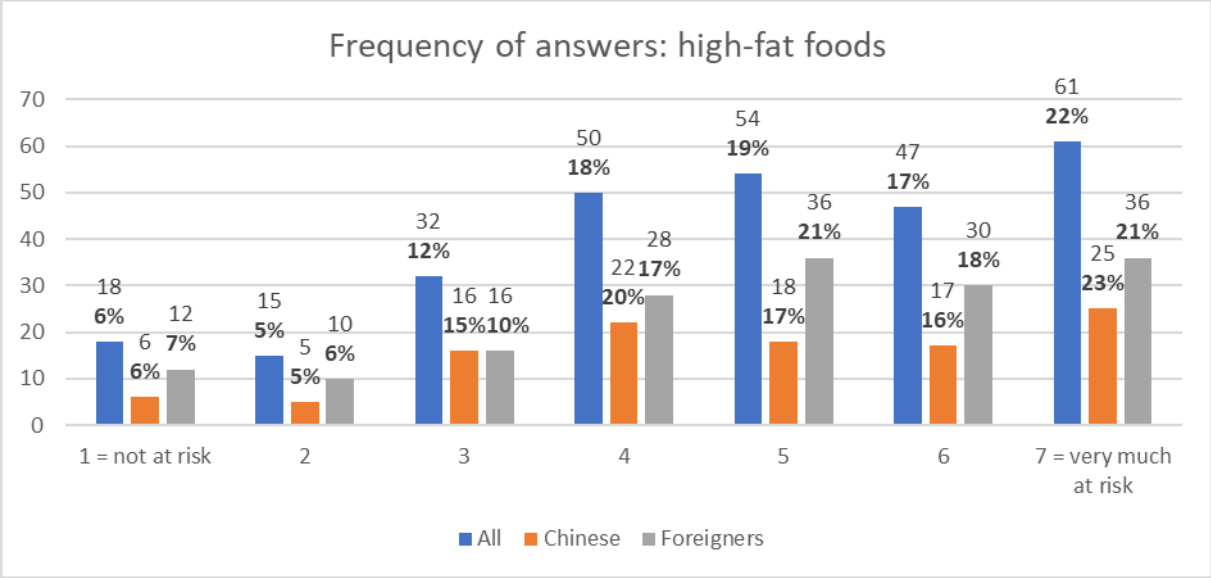
In Table 23 we can see that the mean of all responses for high-fat foods is 4.78. It is interesting to compare the means of Chinese and foreigners, which are almost equal. Therefore, the One-way ANOVA comparison is not significant even in the comparison p <0.10.

Table 23: High-fat foods

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	4,76	1,76	3,10	109
Foreigners	1	7	4,79	1,79	3,22	168
All	1	7	4,78	1,78	3,17	277
Comparison One-way ANOVA	The f-ratio value is 0.01217. The p-value is 0.912232. **The result is not significant at p < 0.10.**					

Graph 18 shows an increase in the frequency of responses from value 3 to 7. Value 7 has the highest frequency of responses (22 percent) and value 2 the lowest – only 5 percent. The representation of Chinese and foreigners' answers does not differ significantly in any of the values. The highest risk (value 7) was indicated, for example, by 23 percent of Chinese and 21 percent of foreigners.

Graph 18: High-fat foods



10. Alcoholic beverages

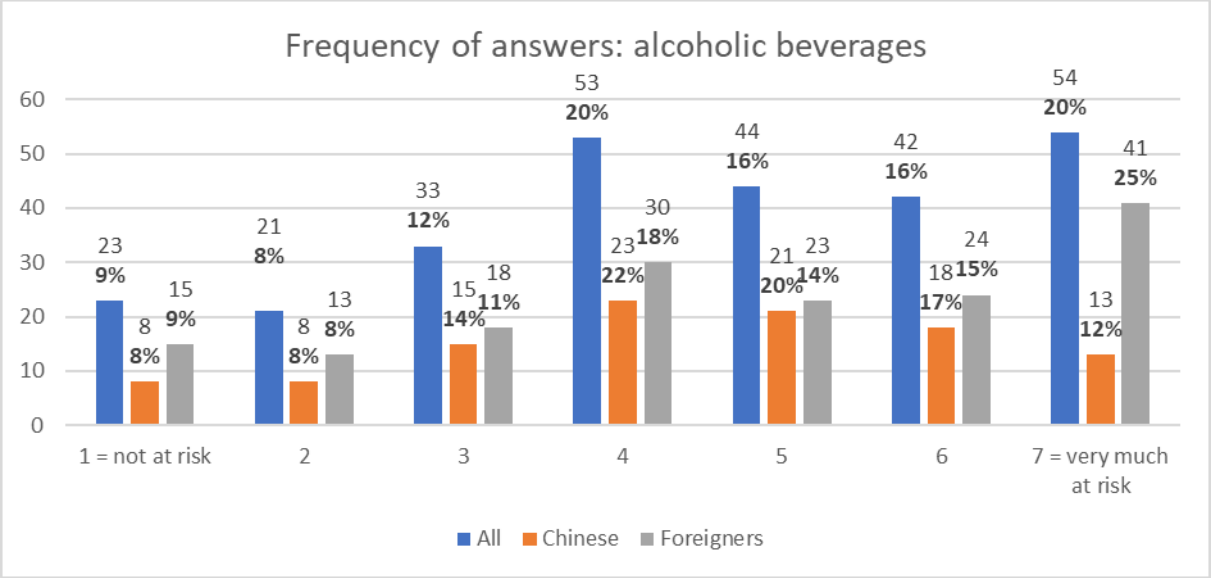
According to the results, the mean perceived riskiness of alcoholic beverages is 4.54. A comparison of the means of the responses for Chinese and foreigners shows that the difference is minimal. The mean for Chinese is 4.39 and for foreigners it is 4.64. The result according to One-way ANOVA is therefore not significant at p <0.10 (Table 24).

Table 24: Alcoholic beverages

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	4,39	1,71	2,95	106
Foreigners	1	7	4,64	1,95	3,82	164
All	1	7	4,54	1,87	3,49	270
Comparison One-way ANOVA	The f-ratio value is 1.18055. The p-value is 0.278221. **The result is not significant at p < 0.10.**					

When we look at the Graph 19, we find that the higher frequency of responses is at higher values (4-7). Values 4 and 7 are represented by 20 percent and values 5 and 6 by 16 percent. Differences in the percentages of Chinese and foreigners are minimal for these values. However, a more significant difference can be observed in the highest value of risk (value 7), which was indicated by 25 percent of foreigners but only 12 percent of Chinese.

Graph 19: Alcoholic beverages



11. Sweet beverages (coke etc.)

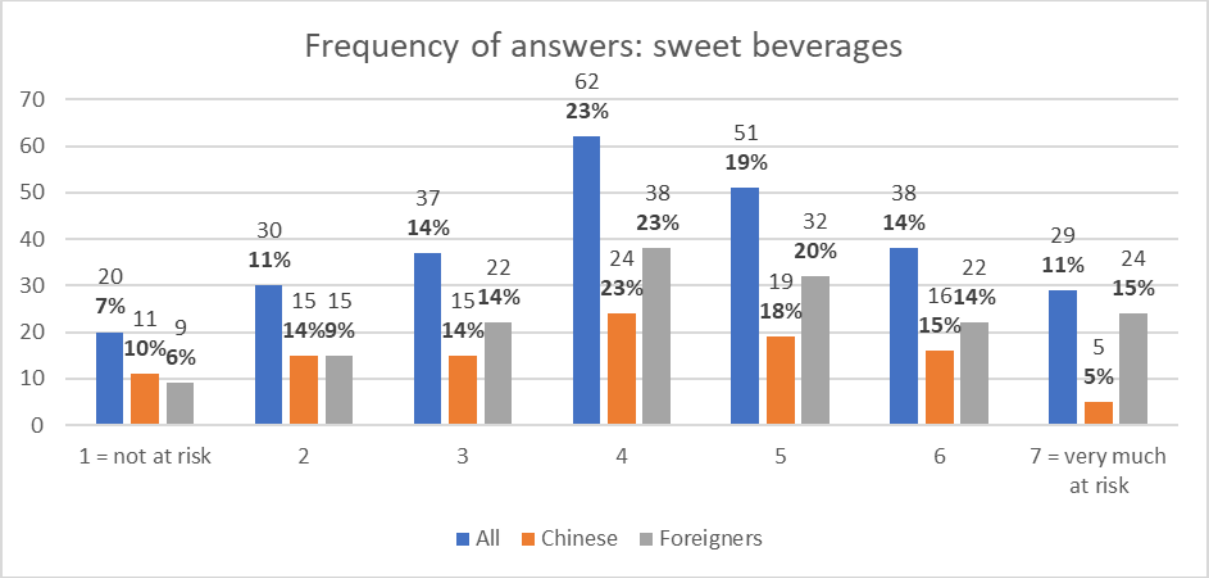
Sweet beverages represented a medium risk for respondents (mean is 4.21). The mean was lower for Chinese (3.89) than for foreigners (4.43). Comparison with One-way ANOVA gave statistical significance at p <0.05 (Table 25).

Table 25: Sweet beverages

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	3,89	1,69	2,86	105
Foreigners	1	7	4,43	1,70	2,90	162
All	1	7	4,21	1,72	2,95	267
Comparison One-way ANOVA	The f-ratio value is 6.39648. The p-value is 0.012015. **The result is significant at p < 0.05.**					

The frequency of responses was most represented at values 4 and 5. For other values, the frequency of responses in both the range 1-3 and the range 6-7 is decreasing. The percentage of Chinese and foreigners in some values (3-6) was the same or differed only minimally. The most significant uniqueness was value 7, which was marked by 15 percent of foreigners but only 5 percent of Chinese (Graph 20).

Graph 20: Sweet beverages



12. Bottled water

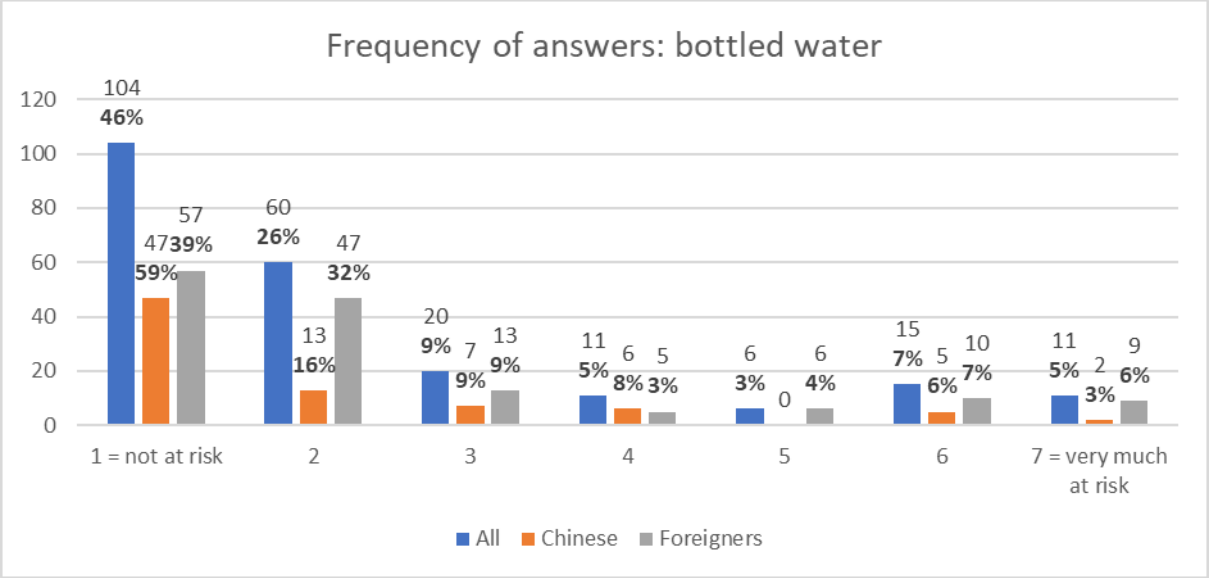
Table 26 shows that respondents consider bottled water to be a low risk. The overall average is 2.31, the average of the answers of the Chinese (2.02) is slightly smaller than that of foreigners (2.47). A comparison of the answers of Chinese and foreigners shows statistical significance at p <0.10.

Table 26: Bottled water

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	2,02	1,61	2,60	80
Foreigners	1	7	2,47	1,84	3,38	147
All	1	7	2,31	1,77	3,15	227
Comparison One-way ANOVA	The f-ratio value is 3.26715. The p-value is 0.072016. **The result is significant at p < 0.10.**					

The most represented categories are the values of the lowest risk, namely value 1 (46 percent) and value 2 (26 percent). The following values are represented below 10 percent. Most Chinese (59 percent) responded with the lowest risk rating. This value was also marked by most foreigners (37 percent) (Graph 21). It could be said that this item is perceived by both groups, Chinese and foreigners, alike. However, fewer respondents (227) answered this item than usual, so the results may be a bit skewed.

Graph 21: Bottled water



13. Coffee

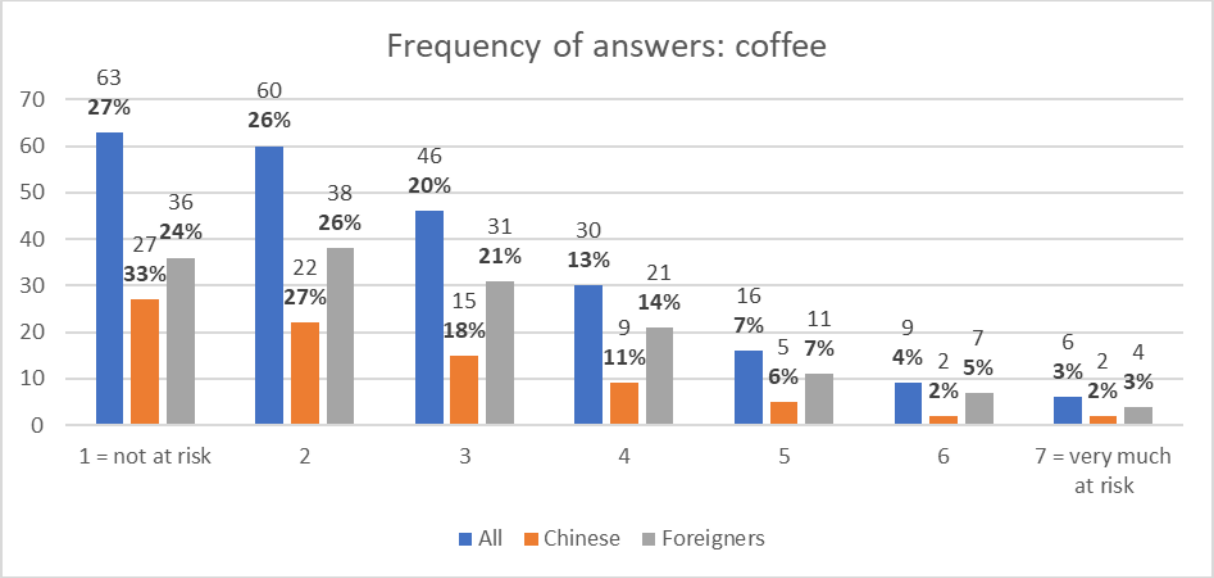
According to the results, coffee is considered low risk, the overall mean response is 2.68. The mean response rate of the Chinese was a bit higher than that of foreigners. The difference between Chinese and foreigners' answers was evaluated using One-way ANOVA as statistically not significant at p <0.10 (Table 27).

Table 27: Coffee

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	2,48	1,51	2,27	82
Foreigners	1	7	2,80	1,58	2,49	148
All	1	7	2,68	1,56	2,43	230
Comparison One-way ANOVA	The f-ratio value is 2.2457. The p-value is 0.13537. **The result is not significant at p < 0.10.**					

Graph 22 has a decreasing character of the frequency of responses (values 1-7). Most respondents rated the value corresponding to the lowest value of risk (value 1), it was marked by 33 percent of Chinese and 24 percent of foreigners. Other low risk values are also significant – values 2 and 3. The frequency of responses continues to fall and the last value, which represents the highest level of risk (value 7), was marked by only 3 percent of respondents.

Graph 22: Coffee



14. Flooding

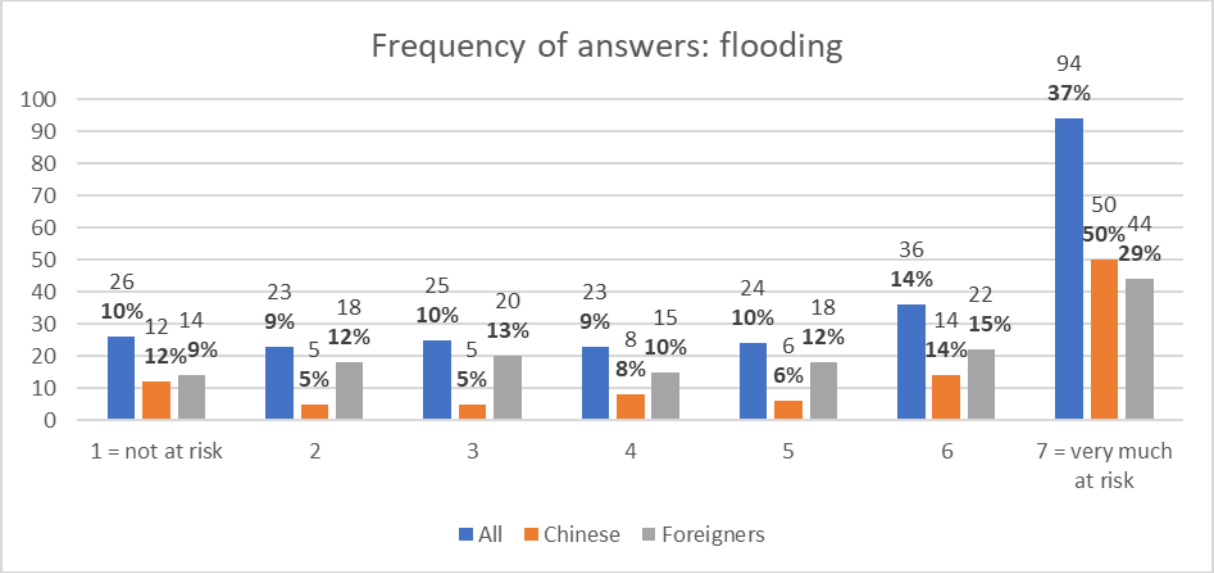
The flooding item was assessed by the respondents as relatively risky. The mean response is 4.91. The mean was higher for the Chinese (5.33) than for foreigners (4.64). The result is considered statistically significant at p <0.05 (Table 28).

Table 28: Flooding

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	5,33	2,16	4,68	100
Foreigners	1	7	4,64	2,09	4,36	151
All	1	7	4,91	2,15	4,61	251
Comparison One-way ANOVA	The f-ratio value is 6.4057. The p-value is 0.011992. **The result is significant at p < 0.05.**					

Most respondents (37 percent) rated flooding as the highest risk (value 7). If we look at the ethnic differences, the value of the highest risk was marked by exactly half of the Chinese and 29 percent of foreigners. For other values, the Chinese had a lower share, except for the value of 1, where they had a predominance of only 3 percent. The second highest proportion had a value of 6 (14 percent), the other values each had a maximum representation of 10 percent (Graph 23).

Graph 23: Flooding



15. Typhoon

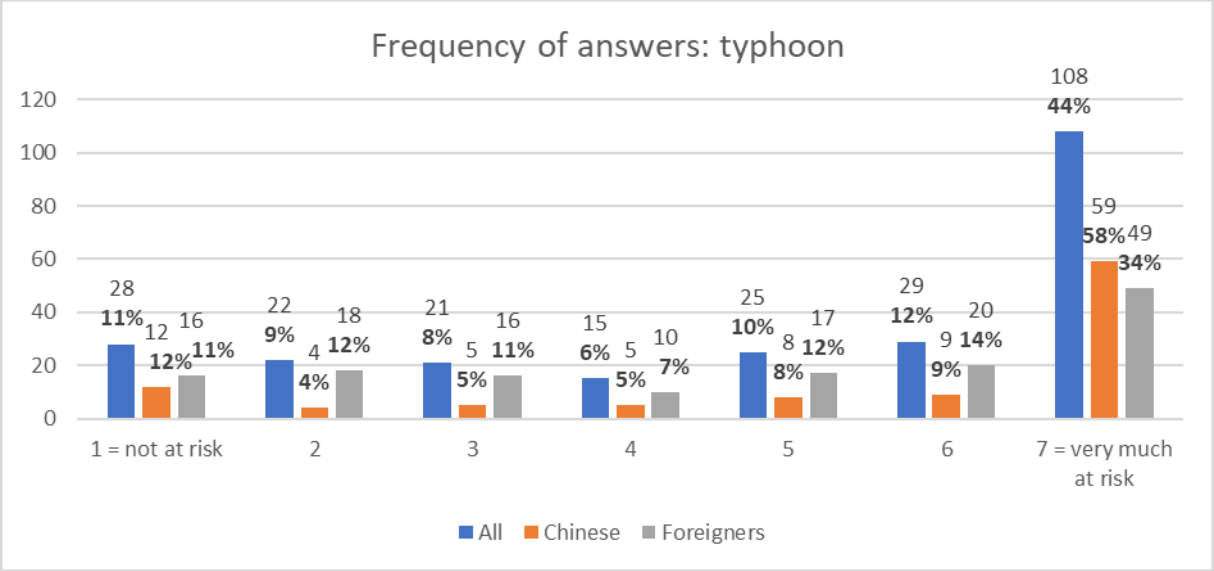
An interesting research item was a typhoon, where almost half of the respondents stated the highest level of risk (value 7). The overall mean turned out to be relatively risky 5.04. For the Chinese, the mean was higher (5.51) than for foreigners (4.71). According to the One-way ANOVA comparison, the result is significant at p <0.01 (Table 29).

Table 29: Typhoon

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	5,51	2,15	4,62	102
Foreigners	1	7	4,71	2,18	4,77	146
All	1	7	5,04	2,20	4,86	248
Comparison One-way ANOVA	The f-ratio value is 8.04726. The p-value is 0.004937. **The result is significant at p < 0.01.**					

Graph 24 shows a high value of 7 (44 percent), the other values are relatively evenly represented with a maximum value of 12 percent. The percentage of Chinese and foreigners at value 7 is 58 percent for Chinese and 34 percent for foreigners. For other values (2-6) foreigners predominated and for value 1 there was one percent more Chinese (12 percent) than foreigners (11 percent).

Graph 24: Typhoon



16. Automobiles

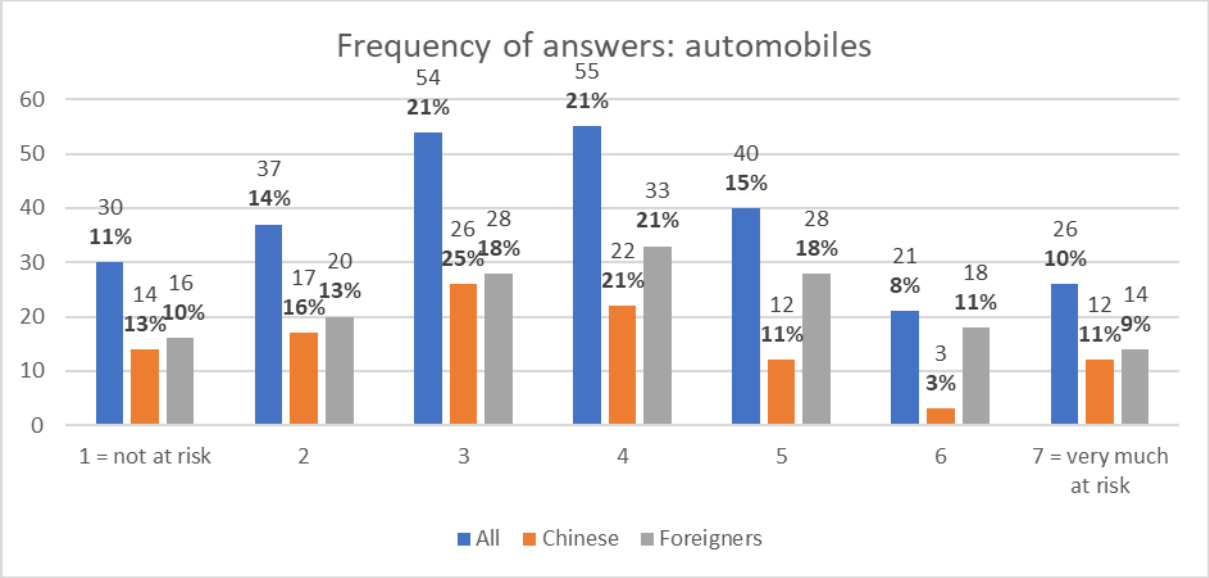
The respondents perceive automobiles as medium risk with an overall mean of 3.78, which is lower for the Chinese (mean 3.55) than for foreigners (mean 3.94) (Table 30). The result is significant at $p < 0.10$.

Table 30: Automobiles

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	3,55	1,77	3,12	106
Foreigners	1	7	3,94	1,74	3,04	157
All	1	7	3,78	1,76	3,10	263
Comparison One-way ANOVA	The f-ratio value is 3.09658. The p-value is 0.079629. **The result is significant at p < 0.10.**					

Respondents tended to give values in the middle of the risk scale. The highest frequency of responses is at values 3 and 4, both have 21 percent. At values 1-3, the Chinese have a higher percentage, at value 4 the percentage is balanced and at values 5-6 the representation of foreigners already prevails. At value 7, the Chinese representation predominates by two percent (Graph 25).

Graph 25: Automobiles



17. Cell phones

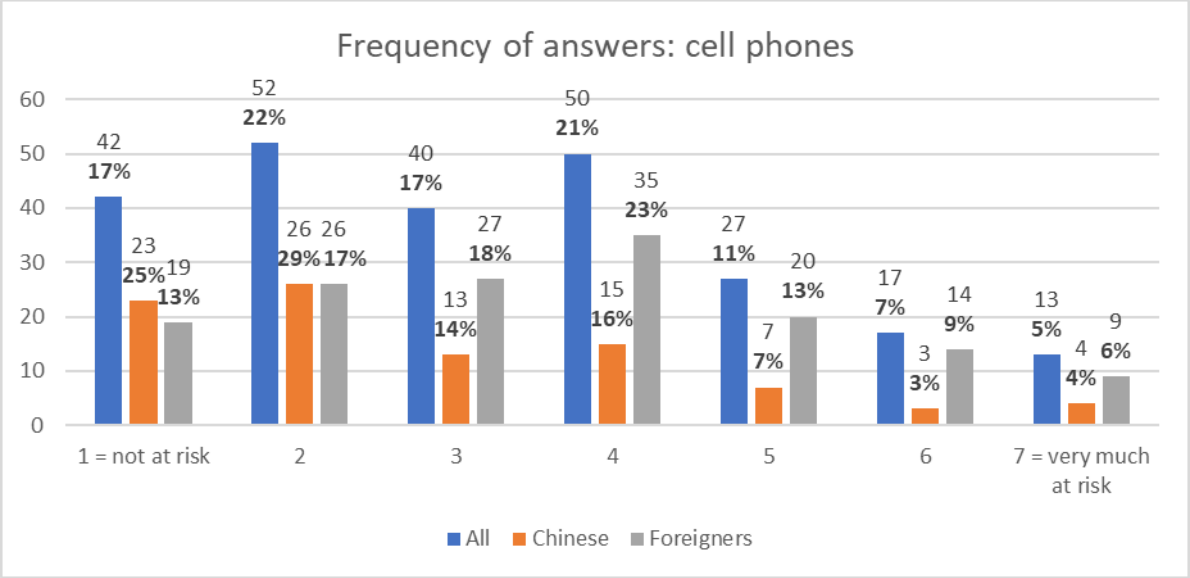
The results show that mobile phones are perceived as a medium high risk – the mean is 3.29. The Chinese perceive them less risky (mean 2.80) than foreigners (mean 3.59). The result of the One-way ANOVA comparison appears to be very significant at p <0.01 (Table 31).

Table 31: Cell phones

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	2,80	1,65	2,73	91
Foreigners	1	7	3,59	1,70	2,89	150
All	1	7	3,29	1,73	2,98	241
Comparison One-way ANOVA	The f-ratio value is 12.41161. The p-value is 0.000511. **The result is significant at p < 0.01.**					

The highest proportion of responses are values of 1-4 and then the proportion gradually decreases (Graph 26). Most respondents rated value 2 (22 percent) and 4 (21 percent). From a value 3 towards higher values, we can observe an increasing proportion of foreigners compared to the Chinese. In other words, Chinese referred to lower risk values. For example, at value 1, the proportion of Chinese is 23 percent and foreigners 15 percent, but at value 4, foreigners are represented by 23 percent and Chinese at only 17 percent.

Graph 26: Cell phones



18. Air pollution

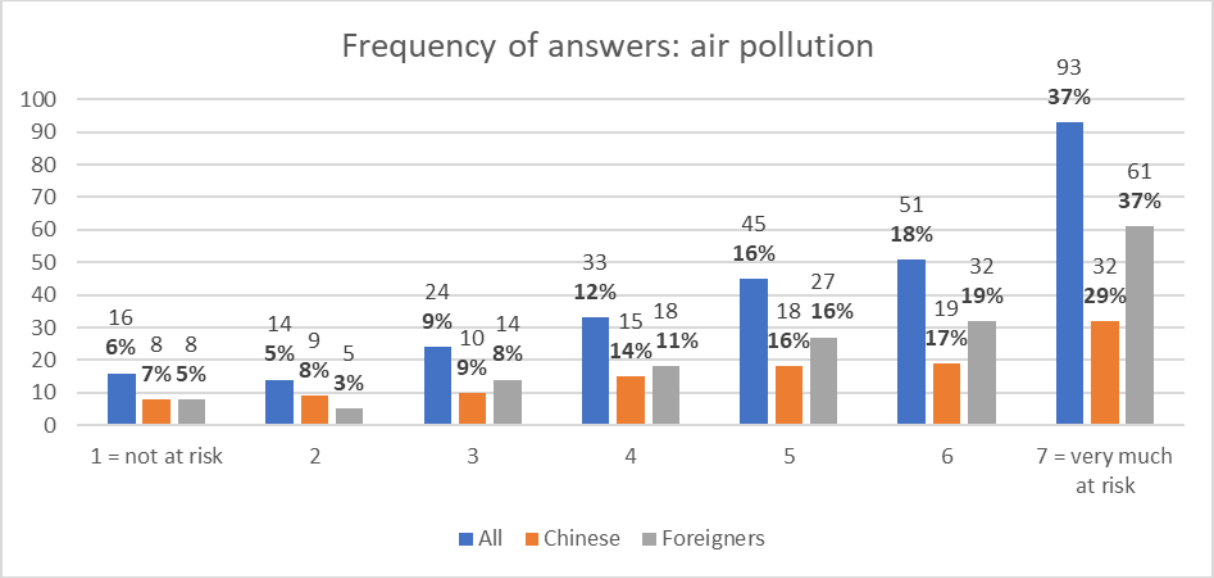
Air pollution was rated as risky with an overall mean of 5. In Table 32, we can see that the Chinese rated air pollution as less risky environmental factor (mean 4.90) than foreigners (mean 5.37). One-way ANOVA calculator calculated that the difference between the perception of Chinese and foreigners is statistically significant on a scale of $p < 0.05$.

Table 32: Air pollution

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	4,90	1,92	3,69	111
Foreigners	1	7	5,37	1,74	3,03	165
All	1	7	5,18	1,83	3,35	276
Comparison One-way ANOVA	The f-ratio value is 4.38939. The p-value is 0.037081. **The result is significant at p < 0.05.**					

The highest amount of respondents (37 percent) indicated the highest level of risk (value 7). The share differed in the representation of Chinese (29 percent) and foreigners (37 percent). The values of the representation of Chinese and foreigners decrease with a decreasing numerical scale (values) – the lowest risk was indicated by only 6 percent of respondents (Graph 27).

Graph 27: Air pollution



19. Acid rain

Respondents rated this item as risky. The overall average of the responses was 5.16. The Chinese rated acid rain as a more risky phenomenon than foreigners, but the difference is very small (mean of Chinese is 5.3 and mean of foreigners is 5.07) and according to the comparison of One-way ANOVA it is not statistically significant even in the comparison at level p <0.10 (Table 33).

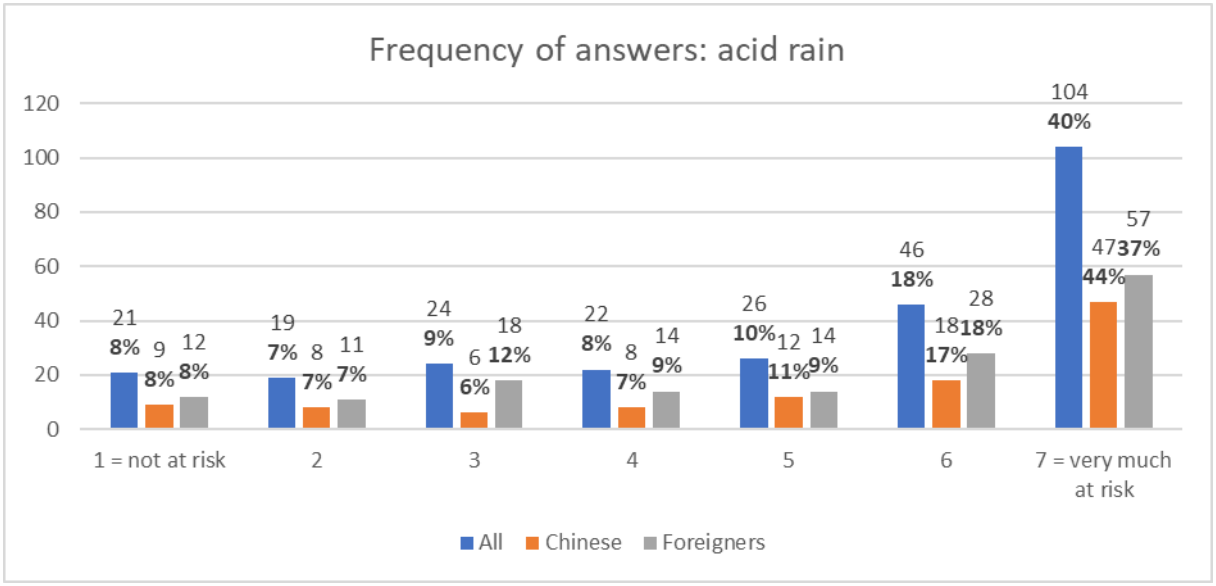
Table 33: Acid rain

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	7	5,30	2,03	4,12	108
Foreigners	1	7	5,07	2,03	4,11	154
All	1	7	5,16	2,03	4,12	262
Comparison One-way ANOVA	The f-ratio value is 0.77511. The p-value is 0.379454. **The result is not significant at p < 0.10.**					

Graph 28 shows that the most respondents (40 percent) rated this item as high risk (value 7). It was marked by almost half of the Chinese (44 percent) and 37 percent of foreigners. There is also a significant decrease – the value 6 was marked by only 18 percent of respondents.

Other values are represented by only 10 percent or below. The lowest risk level (value 1) was indicated by only 8 percent of respondents.

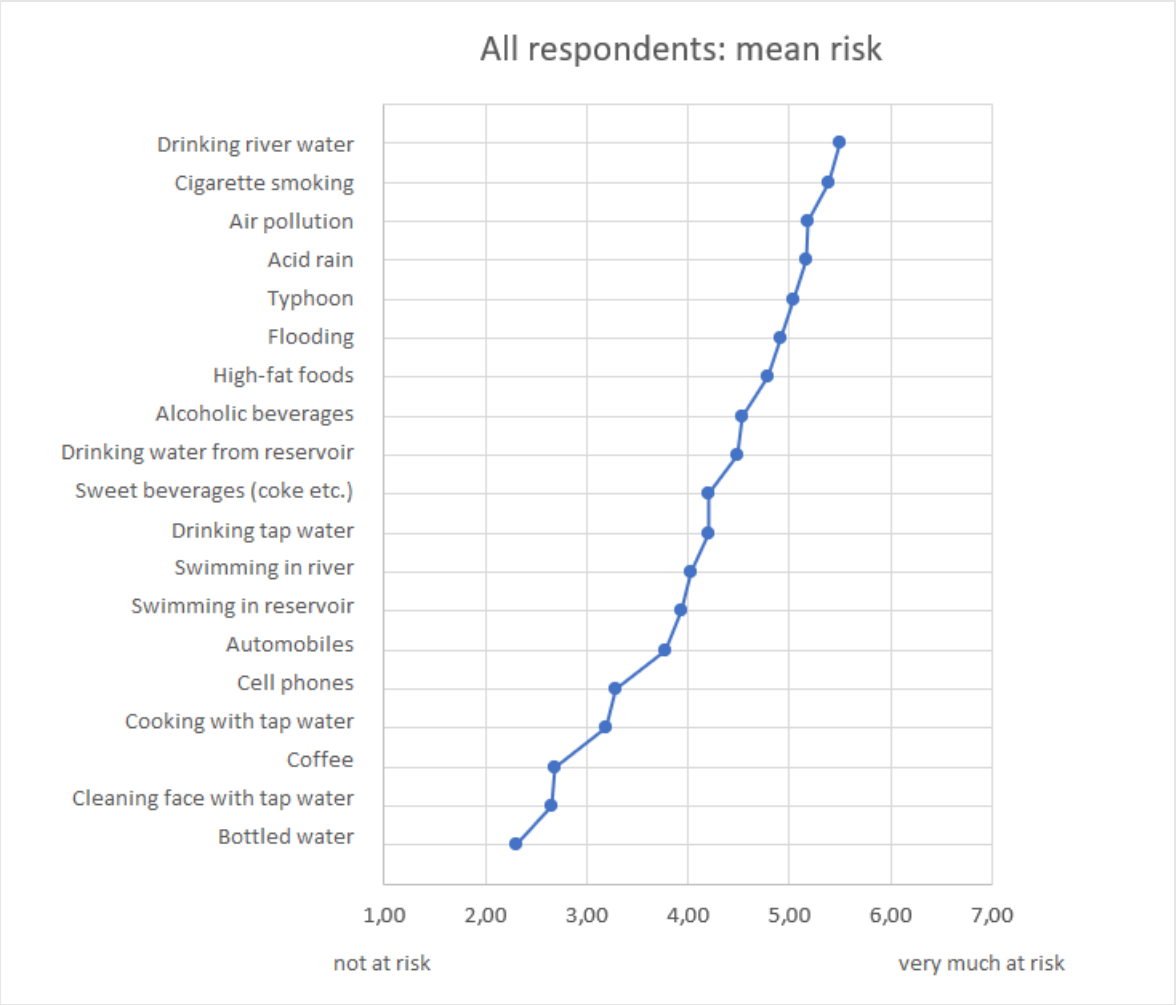
Graph 28: Acid rain



All respondents: mean risk

Graph 29 on a scale of 1-7 shows the degrees of risk for all examined items. The risk values of individual items on the numerical scale are the result of the calculated mean risk of each examined item. The results showed that the least risky item is *bottled water*, followed by *cleaning face with tap water* and *coffee*, with an overall risk level not exceeding value 3. *Drinking river water* proved to be the most risky. *Typhoon, acid rain, air pollution* and *cigarette smoking* also have a high risk level (above value 5).

Graph 29: All respondents – mean risk

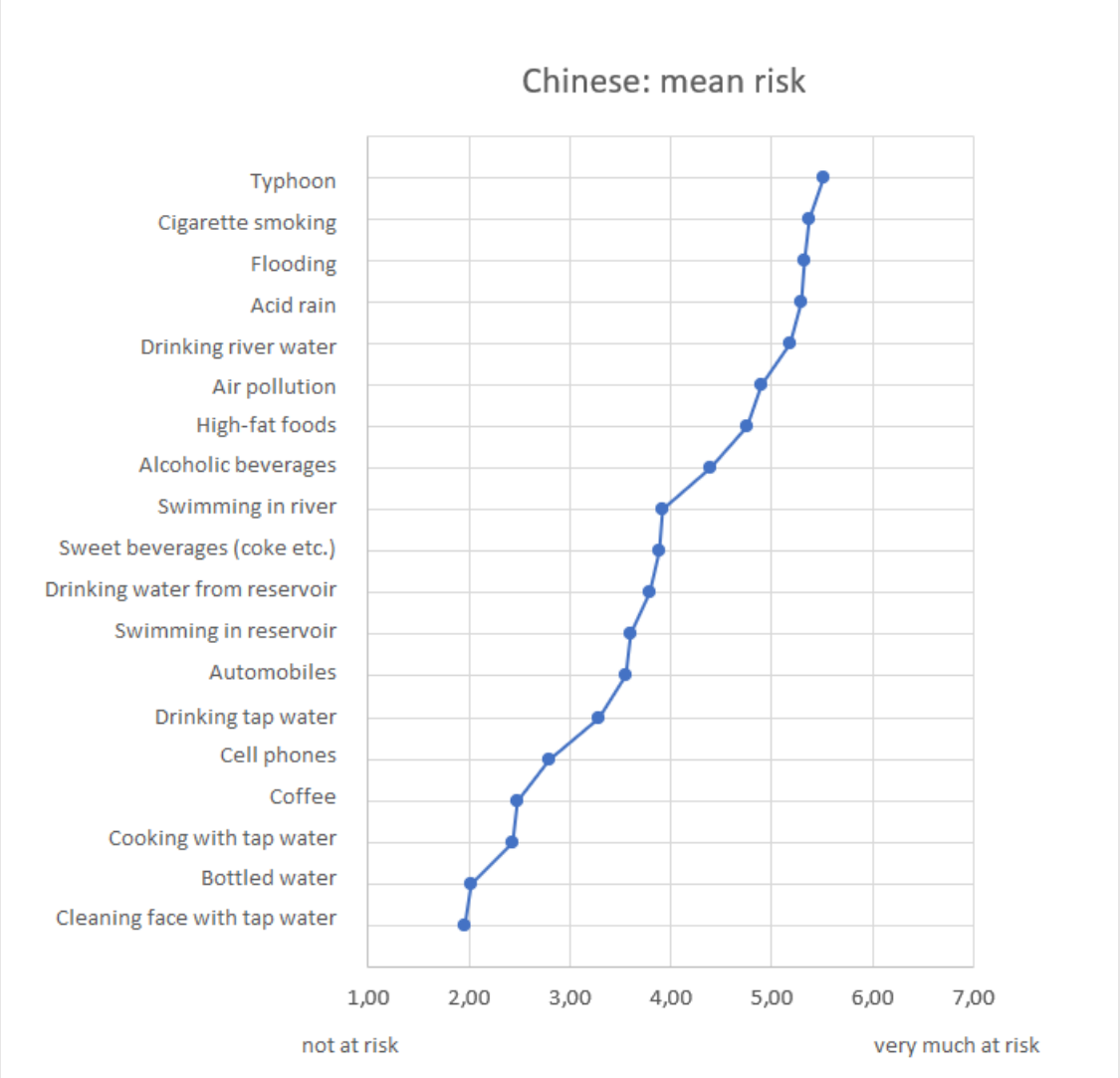


Chinese: mean risk

Chinese perceived *cleaning face with tap water* as the least risky, followed by *bottled water*, *cooking with tap water*, *coffee* and *cell phones*. This evaluation turned out to be quite similar to the evaluation of all respondents in Graph 29. However, *cell phones* and *cooking with tap water* were among the least risky for Chinese (below value 3), while in the overall evaluation in Graph 29, they represented a higher risk.

On the other hand, Chinese described *typhoon* as the most risky phenomenon. Interesting item is *air pollution*, which represented a much lower risk for Chinese than in the Graph 29 of all respondents and in Graph 31 of foreigners.

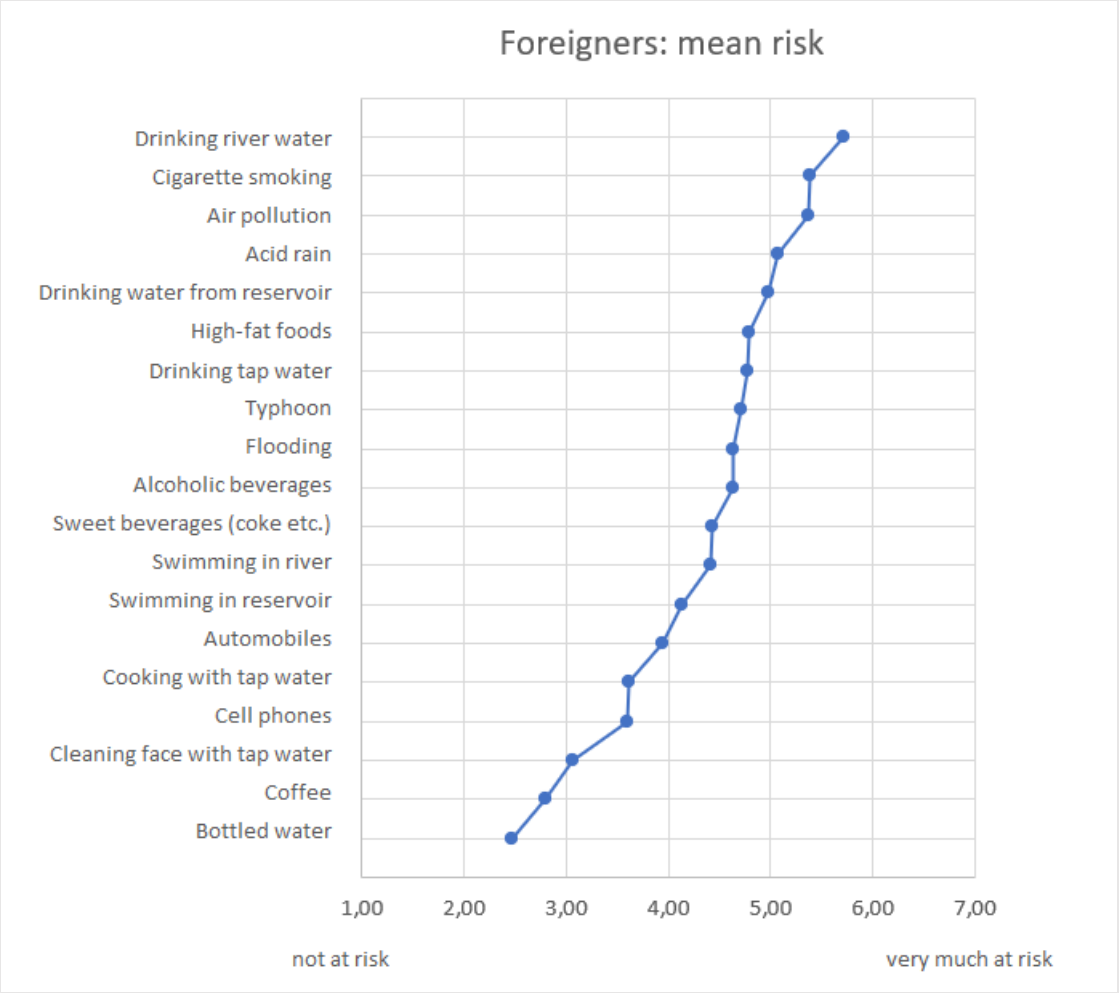
Graph 30: Chinese – mean risk



Foreigners: mean risk

For foreigners, *bottled water* and *coffee* present the least risks, and *cleaning face with tap water* is also among the smaller risks. On the other hand, *drinking river water* was confirmed to be the most risky (as in the case of Table 29, which concerns all respondents). Among the riskier items (above value 5) are again included *cigarette smoking*, *air pollution* and *acid rain*. *Drinking water from reservoir* is perceived here more risky than in the Graph 29. *Typhoon* and *flooding* are perceived by foreigners at a much lower risk compared to the Chinese. On the contrary, foreigners consider *air pollution* to be a more serious risk than the Chinese.

Graph 31: Foreigners – mean risk



Q9: How do you feel about efforts of the following institutions in regard to water protection? 1 = very negatively, 2 = negatively, 3 = neutral, 4 = positively 5 = very positively

In this question, respondents were asked to respond to the role of three government institutions (universities and scientists, Chinese government and local government) in relation to water protection. They should choose from options 1-5, which represent very negative to very positive perceptions.

Universities and scientists

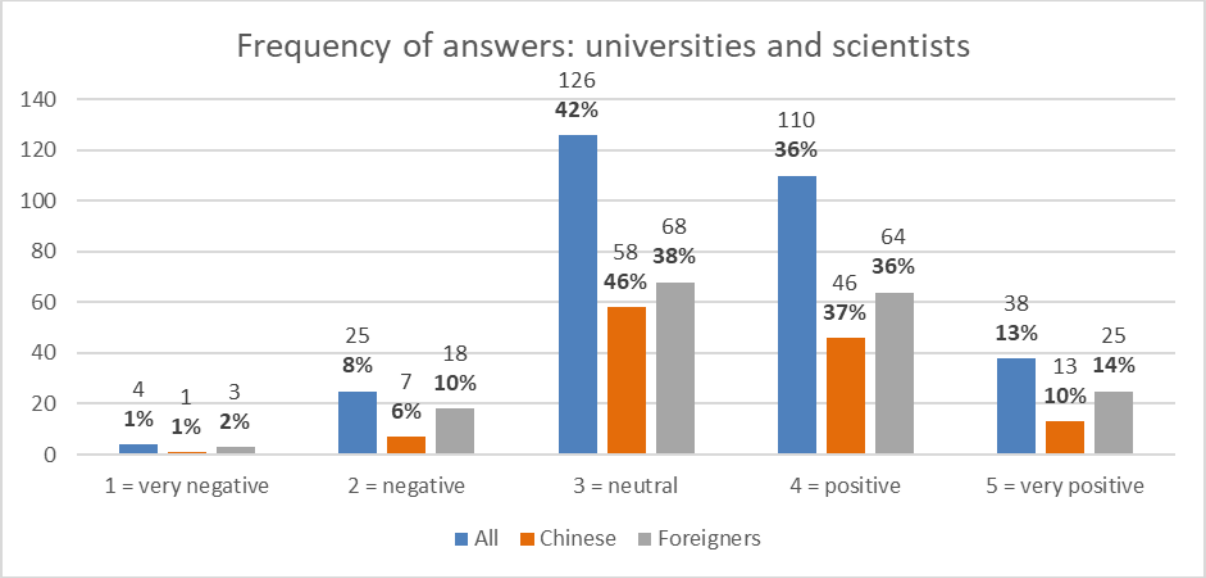
The results showed that the respondents perceive this item rather positively (mean is 3.5). The average response rate was almost the same for Chinese (mean 3.5) and foreigners (mean 3.51). One-way ANOVA calculator evaluated the result as not significant at p <0.10 (Table 34).

Table 34: Universities and scientists

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	5	3,50	0,79	0,62	125
Foreigners	1	5	3,51	0,91	0,93	178
All	1	5	3,50	0,86	0,75	303
Comparison One-way ANOVA	The f-ratio value is 0.00026. The p-value is 0.987237. **The result is not significant at p < 0.10.**					

According to Graph 32, most respondents responded neutrally (42 percent). This option was chosen by more Chinese (46 percent) than foreigners (38 percent). 36 percent of respondents rated this item positively and only 13 percent rated it very positively. Only a minimum (8 percent) reacted negatively and only one percent reacted very negatively.

Graph 32: Universities and scientists



Chinese government

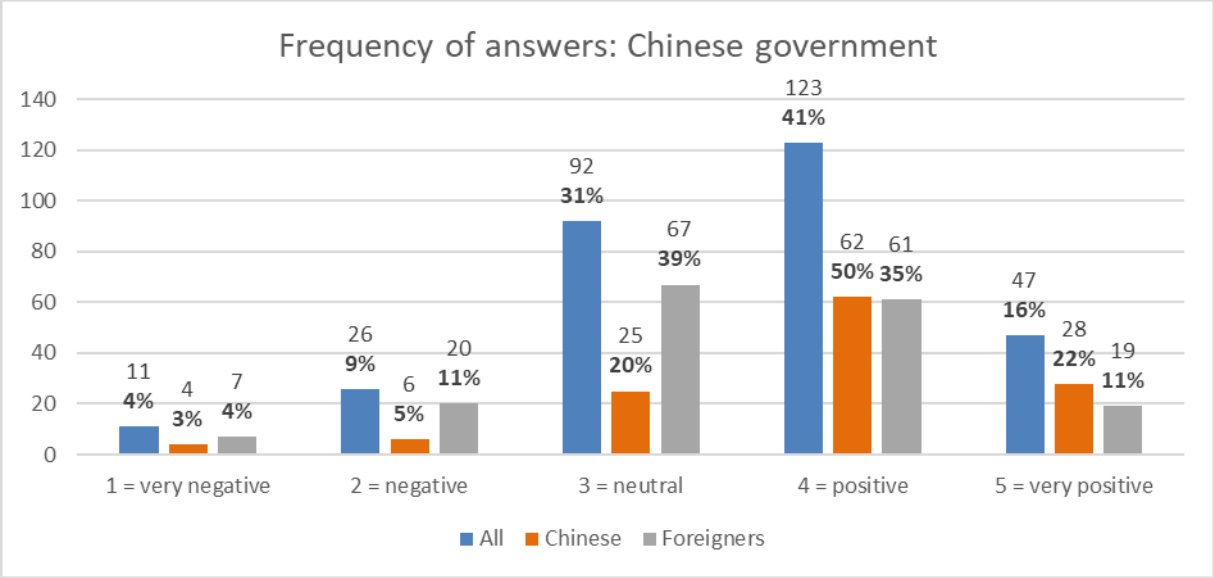
Chinese government is perceived by respondents very similarly to universities and scientists. The mean of the answers is 3.57. The Chinese reacted a little more positively (mean 3.83) than foreigners (mean 3.37). One-way ANOVA evaluated the difference as significant at p <0.10 (Table 35).

Table 35: Chinese government

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	5	3,83	0,94	0,88	125
Foreigners	1	5	3,37	0,96	0,92	174
All	1	5	3,57	0,98	0,95	299
Comparison One-way ANOVA	The f-ratio value is 0.00026. The p-value is 0.987237. **The result is significant at p < 0.10.**					

Most respondents (41 percent) rated this item positively (value 4). There were more Chinese (50 percent) than foreigners (35 percent). 31 percent reacted neutrally, most were foreigners (39 percent), Chinese were only 20 percent. Only 13 percent of respondents reacted negatively (values 1 and 2). 16 percent of respondents rated this item as very positive, with a larger percentage of Chinese (22 percent) and foreigners at only 11 percent (Graph 33).

Graph 33: Chinese government



Local government

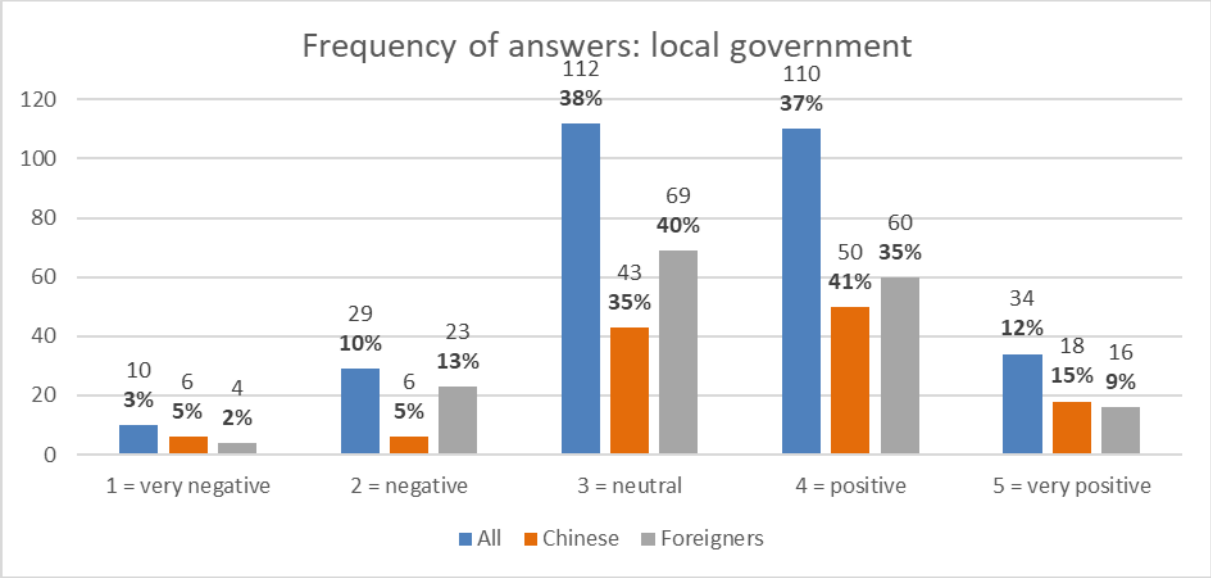
Respondents' mean (3.44) is very similar to the previous two items. The Chinese rated local government a little more positively than foreigners. The mean for Chinese was 3.55 and for foreigners 3.35. The One-way ANOVA comparison was significant at p <0.10 (Table 36).

Table 36: Local government

	Min.	Max.	Mean	Std Deviation	Variance	Count
Chinese	1	5	3,55	0,96	0,93	123
Foreigners	1	5	3,35	0,91	0,82	172
All	1	5	3,44	0,94	0,88	295
Comparison One-way ANOVA	The f-ratio value is 3.22706. The p-value is 0.07346. **The result is significant at p < 0.10.**					

The percentage of respondents is significantly predominant here for the values 3 (neutral) and 4 (positive). For 38 percent of respondents, the evaluation is neutral and for 37 percent it is positive. Both values have a higher proportion of foreigners than Chinese. More Chinese (15 percent) than foreigners (9 percent) rate this item very positively. Negative ratings (values 1 and 2) are represented together in only 13 percent of respondents (Graph 34).

Graph 34: Local government



Q10: Have you ever experienced health problem related to use of water?

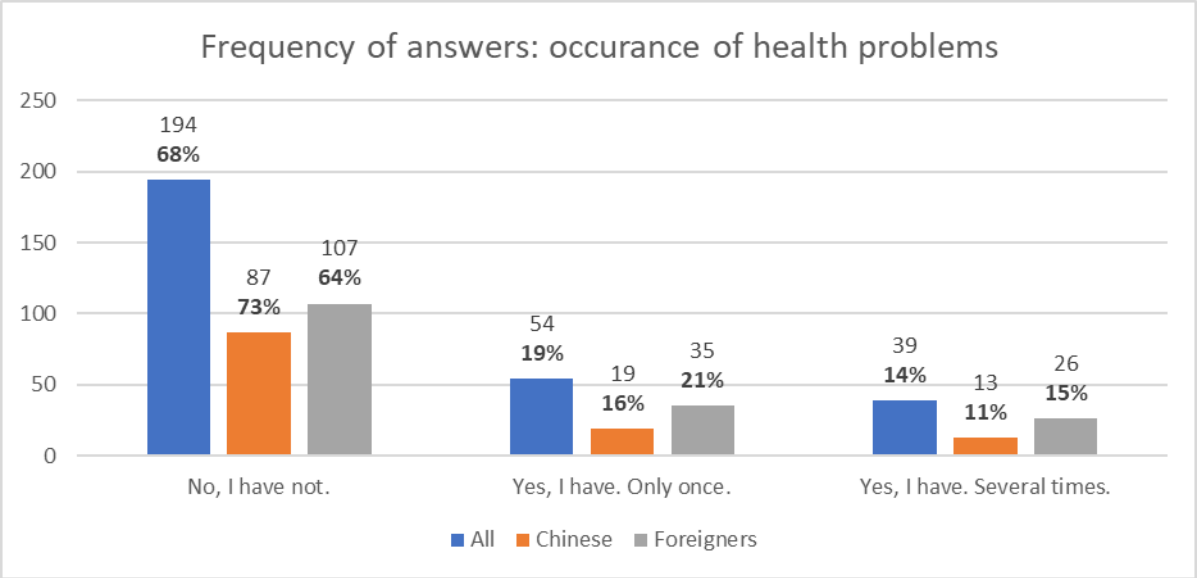
In this question, we focused on whether the respondents had already encountered health problems associated with the use of water. They could choose from three options: 1. No, I have not. 2. Yes, I have. Only once. or 3. Yes, I have. Several times.

The results showed that approximately two-thirds of respondents (67 percent) did not experience any health problems. About one-third (32 percent) have already experienced some water-related health problems, of which 18.8 percent have experienced it only once and 13.6 percent have suffered more than once. Looking at ethnic differences, a quarter of Chinese (25 percent) admitted to a water-related health problem, of which 15 percent experienced it only once and 10 percent more than once. There are slightly more foreigners who admitted a health problem – 35 percent (20 percent of them suffered only once and 15 percent more times). The increase in the occurrence of health problems among foreigners compared to the Chinese is therefore 10 percent, which is not much, but due to the relatively small sample of respondents, the data may be skewed (Table 37, Graph 35).

Table 37: Occurrence of health problems

Answers		Chinese		Foreigners		All	
		Count	Percentage	Count	Percentage	Count	Percentage
1	No, I have not.	87	73,11	107	63,69	194	67,6
2	Yes, I have. Only once.	19	15,97	35	20,83	54	18,82
3	Yes, I have. Several times.	13	10,92	26	15,48	39	13,59
Total		119	100	168	100	287	100

Graph 35: Occurrence of health problems



Q11: If you have experienced health problem related to use of water, what kind of problem it was?

In the last question, the respondents had to verbally list the health problems they encountered. The answers were divided into two groups (Chinese and foreigners) and then classified into categories related to the relevant health problems.

Among the most common health problems in foreigners were problems with hair, skin, stomach and diarrhoea. In relation to hair, foreigners most often cited *hair fall* (14). Furthermore, they mentioned *hair problems* three times and *hair breakage* and *hard hair* only once. The second most frequently mentioned problem was related to the skin. In connection with this problem, some foreigners generally mentioned *skin issues* (8), others were more specific: *rashes* (3), *dry skin* (2), *urticaria* (1), *skin pores* (1), *skin irritation* (1), *skin colour*

change (1). Another frequently mentioned problem was associated with the stomach. They most often mentioned the *stomach ache* (4), the *upset stomach* (5), which in 4 cases was caused by tap water. *Food poisoning* (1) and *gastrointestinal diseases* (1) are also mentioned. *Diarrhoea* was mentioned in 11 cases. In four of them, the presence of diarrhoea was associated with tap water drinking. One participant mentioned diarrhoea in connection with loss of appetite.

Other problems have occasionally been reported, such as *body itchiness*, especially after taking the shower. In one case, this symptom was accompanied by minor allergies. Other problems were rather more individual, e.g. *teeth, eye redness, bacteria infection, sickness, nausea, vomiting*. Regarding the *teeth*, respondents mentioned *yellow discoloration of teeth* and *bad for enamel*.

As we have read in question 2 (water related associations in Tianjin), the Chinese did not attach much importance to health impact associations (only 5 people mentioned it). In this question, we can confirm a significant difference in the perception of health problems between Chinese and foreigners. Unlike foreigners, the Chinese mention them only minimally. They are either used to minor health problems and do not consider it necessary to mention them or do not bother them at all.

The presence of water-related health problems in Chinese is also very limited in this matter. The Chinese mention *skin issues, kidney stones* and *diarrhoea* in only two cases. In connection with skin issues, they state "skin is allergic to Tianjin rain" and "using tap water can cause eczema". In *kidney stones* they wrote "drinking boiled water caused kidney stones in family members". Individually, *gallstones, yellow teeth* and *urinary system problems* occurred. They do not report hair problems at all.

However, unlike foreigners, the Chinese usually noticed other water problems, which were not directly related to health problems, but could cause them. The most mentioned problem concerned *water quality* (21 times), half of which concerned *water pollution*. Others mentioned e.g. "water is not healthy anymore", "the problem of water purification", "bugs found in bottled water", "fluorinated water, contains chemicals", or "the quality of drinking water in high-rise buildings is prone to problems".

Another problem was related to the *use of tap water* and was mentioned 10 times. The Chinese stated that "tap water has a big peculiar smell", "poor quality", "quality of tap water is the same after boiling", "contains sediments" or "poorly maintained water pipes".

The three associations concerned *drinking water*. They mentioned "excessive levels of Escherichia coli in drinking water", "tap water in Tianjin is hard and difficult to drink" and "drinking tap water directly".

The last group were the so-called *positive associations*, which were mentioned only twice. They stated here "water is clean and the discharge and treatment of sewage meet international requirements". The second says: "Chinese people have been used to heating and drinking water since ancient times, so in Tianjin, there is basically no negative news about the quality of water".

In this question, it is clear that the Chinese were dominated by negative associations. However, it is interesting that the Chinese wrote these *water problems* in the last question but did not mention them in the second question concerning associations to "water in Tianjin". These so-called water associations they mentioned here may have been so important for them that they wanted to mention it in this last question.

The reason why the Chinese did not mention health problems may be that they do not consider health problems to be important, especially minor health problems to which they may be accustomed, and on the contrary, foreigners pay more attention to them. The second possibility may be that they misunderstood this question.

Table 38: Health problems related to use of water

Chinese	**Count**	**Foreigners**	Count
Skin issues (rashes, urticaria)	2	Hair (hair fall, hard hair)	19
Kidney stones	2	Skin issues (rashes, urticaria)	17
Diarrhoea	2	Stomach (stomach ache, food poisoning)	15
Gallstones	1	Diarrhoea	11
Teeth (yellow teeth)	1	Body itching	2
Urinary system	1	Teeth (yellow teeth, bad for enamel)	2
		Eye redness	1
		Bacteria infection	1
		Sickness	1
		Nausea	1
		Vomitting	1

3.2 Analysis and results of the qualitative research

Based on the thematic analysis of transcripts of the interviews, several emergent themes were identified. These topics were repeated throughout the interviews and form meaning categories to which the respondents attached great importance. The four basic themes are eco-anxiety and fears of the future, tap water and related health problems, pollution, and involvement in environmental activities.

Eco-anxiety and fears of future

Most of the respondents expressed that they are affected by the eco-anxiety phenomenon – they were mainly concerned about the current and future development of the environmental situation. People in Tianjin are affected by *"worry about industry pollution"* (Respondent 2, China) or anxiety about *"water and wood resources"* (Respondent 6, China). Increasingly, they are forced to *"go through this phenomenon"* (Respondent 8, Papua New Guinea). It turns out that poor environmental standards also have direct effects on physical health and lead to a reduction in quality of life.

> *What I feel actually is that water quality is not good. I feel, when I breath, that environment is worse. It is dry. I feel that situation is getting worse than the situation for years ago.* (Respondent 3, Nepal)

> *Yes, I actually breath the air and from time to time you get a notification from the weather forecast telling you that the air is heavily polluted, please avoid going out.*
> *I think about these things like: if I am affected by a cancer or some weird disease, it might be because of this. This means that the pollution is so bad that you cannot see where you are going. It is foggy, it is like all you can see, is a white smog.* (Respondent 10, Zambia)

It is important to realize that the deteriorating environment is also related to the lifestyle that our society prefers. In the middle of our own activities, we stop being interested in life around us and forget about important values:

Yeah, I do feel eco-anxiety, mainly because of changing lifestyle and modernizing and consumerism way of thinking, we don't think and care much about our environment and animals as such, which we should have concern about. (Respondent 7, Japan)

This careless treatment of nature can even result in disaster:

Yes. The environment tends to be stable. But on the other hand, human makes it unstable through destroying the nature. Due to this imbalance, I am afraid there will be time, when we – human being, will face a great disaster. (Respondent 9, Bangladesh)

For some respondents, eco-anxiety was too strong a word, but they mentioned that they have worries:

Well, I don't feel anxious, but definitely worried looking at the current situation of the ecology. It seems to me that it has changed a lot for the worse. Disturbance in the ecological system is the most problematic, resulting from the industrialization. (Respondent 1, India)

Eco-anxiety also arises from the possibility of comparing the water status in Tianjin with the water status in the home country, as shown in the following excerpt from the interview. It is this possibility of comparison and previous experience that is one of the factors why foreigners perceive water pollution in Tianjin as more serious than the Chinese. Previous experience is one of the factors influencing risk perception (Janmaimool & Watanabe, 2014).

Yes, I mostly experience eco-anxiety when I am having a glass of water straight from the tap (not in Tianjin but in my country Papua New Guinea). Because in contrast, I have seen that natural supplies of fresh drinking water in Tianjin are not so existent. And all the drinking water that the masses consume is through artificial water purification methods. (Respondent 8)

The influence of previous experience on the perception of environmental risks is also documented by the following statement:

I believe that most foreigners in China especially in Tianjin and probably across China are anxious and careful of the quality of water they consume. Most have lived off water sold in the shops for drinking. (Respondent 8)

It is necessary to emphasize that most respondents linked their concerns about environmental issues to water quality. They mentioned the accumulation of plastic waste in the oceans and that "*it makes the life of the ocean being into a living hell"* (Respondent 9, Bangladesh).

However, some also acknowledged other environmental concerns – air pollution – that has already been mentioned (Respondent 10, Zambia). Others perceived as important problems of the whole environment, not only water related problems (respondents 3, 7, 10):

My worries are not related only to water, as water is not enough for good life. I worry not only about good quality of water, but about whole environment. (Respondent 3, Nepal)

Yeah, life depends completely on water. Water has to be pure. I would say water is part of my worry, but water is not the only cause of worry, because other factors contribute too. (Respondent 7, Japan)

Yes, but it is also air pollution – both of them are bad. We don't cook using water from the tap. We cook with the bottled water. (Respondent 10, Zambia)

As a result, the emotional experience of environmental problems means that many respondents see Tianjin's future regarding the environment pessimistically. They think that the situation is deteriorating every year and the measures are not sufficient (respondents 2, 4, 8, 10):

It is never gonna be any better in the future. (Respondent 2, China)

Pessimistically because the water and air pollution is getting worse. (Respondent 4, Rwanda)

I would say I am more pessimistic than optimistic, but I also open to the possibilities of science and innovation to improve the water quality in Tianjin and across China. (Respondent 8, Papua New Guinea)

I am pessimistic. China is greatly moving towards a zero energy, consumption, zero water waste. But China is still on a long way from evolving where the water is safe. For example, technologies are moving fast, but they are still young and there is a cost for moving this fact. The water pollution is a wide product of side effect of Chinese industry and companies. So they must find a way that is environmentally less diverging. If they don't, next generations will be repairing the steps they are taking now. (Respondent 10, Zambia)

Despite the concerns expressed by respondents, we can also find optimistic expectations for the future. Five respondents are optimistic about the future of water quality in Tianjin – according to them, water-related problems can be solved (respondents 1, 6, 7) and the government contributes to improving the situation by implementing various environmental measures (respondents 3, 9).

I would rather see future of water quality in Tianjin optimistically. It can be solved. (Respondent 1, India)

Government in Tianjin do some good initiatives, some measures. I am optimistic. (Respondent 3, Nepal)

Yeah, I am optimist about water in Tianjin, improvement can be done in tap water regarding pH levels, and other impurities, also to make it drinkable. That would help to make it top quality. (Respondent 7, Japan)

Tianjin is a heavily industrialized region. So, it's easy to pollute water. In the recent past, the prospect was not up to the expectation. But nowadays, the local government is focusing a lot on water issues. I believe, with the development of new chemical techniques and the efforts of the policy makers, it will be possible to sustain water

demands, recycling from every corner and saving water from being wasted as much as possible. So, I am optimistic. (Respondent 9, Bangladesh)

Tap water and health problems

Another important topic is the quality of tap water and health problems caused by its consumption or washing in it. Apart from *"lack of water"*, the poor quality of tap water is described as the "*biggest problem of Tianjin"* (Respondent 2, 5, 9).

I think that the biggest water problem in Tianjin is that you cannot drink the tap water. You have to go to a certain place to find the filtered water or you have to buy it. I think it is the biggest problem of the whole country. (Respondent 5, Pakistan)

As I said, I think the only thing I can mention here is they can only improve tap water to drinkable water, to make the top quality. I can only tell about water quality in the area I was living in, which was Qixiantai lu, things which I have mentioned here is about this particular area. (Respondent 7, Japan)

Tianjin residents are aware of the poor chemical properties of tap water and the possible consequences of that.

There is a lot of sulphur ions in the water. So, we must be careful because that is why many people experience kidney stones. All of that signifies that water quality is terrible. We use distilled water for drinking but we don't use distilled water for cooking. (Respondent 10, Zambia)

Well, I think, there's some problem with pH level of water, it seems to some foreigners that the bathing water is not good as they observed a lot of hairfall compared to their own country. So, I think it might have some water related problem because this has been a complaint for so many foreigners. (Respondent 1, India)

Drinking water is also financially expensive. While some respondents believe that this problem can be solved in the future, for example thanks to technology (Respondent 9), others are more sceptical about the government (Respondent 2).

> *I think the price for the usage of water should be decreased and I believe it's possible due to the high progression of science and technology.* (Respondent 9, Bangladesh)

> *The tap water in Tianjin is worse. But the government is selling the water to the people. They still don't care of quality of the water. It is bad. But still the government, they are just selling. Even the pure water still has something bad. But I trust the pure water more than the tap water. I think that bottled water is expensive. But you have no choice. You have to live. Tianjin is only for work. I don't like this city.* (Respondent 2, China)

Regarding water-related health problems, five respondents mentioned health problems. Fortunately, the respondents did not experience any serious health problems, only minor and short-term ones. These included hair fall and hair damage (respondents 1, 9), stomach ache and diarrhoea caused by drinking tap water (respondent 2), respondent 8 admitted throat pain and voice loss also caused by drinking tap water.

> *Just the hair fall damage and quality of hair, for me I didn't have any hair issues because I am a boy.* (Respondent 1, India)

> *Sometimes I felt like the excessive chlorine caused hair fall.* (Respondent 9, Bangladesh)

> *Yes, I had health problems many times. I felt bad after drinking water, I had stomach-ache, I had also diarrhoea. So, I don't drink tap water. Yes, my friends who live in the same building had health problems caused by drinking water. I am worry about my health and my friends too. They don't drink tap water.* (Respondent 2, China)

> *The only time I experience a health problem relating to water is when I drank the water without knowing it was from the tap. My throat ached and I think I lost my voice as well. That is why I am always concerned about the quality of water that I consume in China because I am cautious of my health.* (Respondent 8, Papua New Guinea)

Furthermore, respondent 10 mentioned, in addition to hair dandruff, rashes on the body caused by showering in tap water and emphasized the importance of using a water filter, which solved her problems.

> *When I arrived to Tianjin, I washed my hair the first day I came. By the end of the week, I had big chunks of dandruff that I have never experienced and I had rashes on my body as well. After I used the water filter, my skin went back to normal, but my hair was still suffering from the heavy chemicals. So I stopped washing my hair with the water from the tap. Instead, I used distilled water to wash my hair. So, I just experienced skin reactions and my roommate had the same problem. My friend experienced ear inflammation last week.* (Respondent 10, Zambia)

Respondent 3 admitted that his friends suffered from stomach ache caused by canteen water.

> *Actually, I didn't have health problems because of water. But my friends, they had experienced problem, stomach ache. It was related to canteen. I am worry about my lungs. I worry more about air pollution. I don't have actually experience related to drinking water.* (Respondent 3, Nepal)

Four respondents did not suffer from any water-related health problems (foreign respondents 4, 5, 7 and Chinese respondent 6).

Pollution

Another important topic that intersected with the answers to the questions is the issue of pollution. Several respondents had the opportunity to compare with other countries and mostly mentioned that water was better in their home countries.

> *Yes, there are differences between Tianjin water and water abroad. The pure water is quite different in Tianjin. Mongolia has better water. In any other city it is better water quality than in Tianjin.* (Respondent 2, China)

I am from a rural area of Bangladesh. We have access to water through deep tube-wells. The quality and taste of water there is better than that of Tianjin in many ways. But, the water of Tianjin had much less iron than that of Bangladesh, which is a good thing according to me. (Respondent 9, Bangladesh)

I think the quality of the water abroad is much better than quality of water in China. But I would not say that Tianjin water is very bad. I think it's just so-so. (Respondent 5, Pakistan)

In this comparison, one of the respondents stated that he found the water in Tianjin better.

Yeah, I did compare, but I think water in Tianjin was better than other places water. (Respondent 7, Japan)

Some mentioned the influence of industry on water, as well as concerns about aquatic animals, and consequently of humans.

The water supplied itself is heavily recycled and it is very high in chemicals. There is high level of water pollution, mostly due to construction and industry, it is not human population themselves who pollute. They do take care of the environment, but it is the heavy industry that damages the water. (Respondent 10, Zambia)

For me I think the biggest water problems in Tianjin are water contamination by man-made problems such as sewage and poorly disposed rubbish. In fact, I have actually experimented on the quality of water. Once I filled a litre of water in a clear see through container and left it for over a week. After a week had elapsed I saw that the collected water had changed its colour from a colourless liquid to having a slightly yellow colour. This is why I am so anxious about using water in Tianjin and also in other parts of China. (Respondent 8, Papua New Guinea)

River too dirty and many Chinese do go there to fish, so I little worry if they do sell those fishes on cheap market. (Respondent 4, Rwanda)

Some city residents considered air pollution to be a more serious problem and commented on possible health effects. Frequent smog and difficulty breathing meant that the problem of air pollution was a more visible problem for them than water pollution.

> *I think the only big problem about Tianjin is air pollution, water pollution is not much in home setting as far as I have experienced, because they do clean storage tanks time to time.* (Respondent 7, Japan)

> *I never compared it, but I feel that water in Tianjin is not good. I perceive more air quality. As we know, the water is provided from sources, rivers and I never felt problem. But I am not satisfied with environment. Environment is to dry. I think that when we breathe that, it makes out lungs so dry. And water, I think, is also not good here. Also tap water is not quite good. In my country water was of good quality, but here, the water is not enough good.* (Respondent 3, Nepal)

> *There are some problems with air, because we work and live in an industrial zone.* (Respondent 6, China)

Involvement in environmental activities

Environmental problems and the feelings associated with them lead some Tianjin residents to think about the environment as a whole and the possibilities of their own involvement. The most respondents expressed their interest in environmental issues (respondents 2, 3, 5, 7, 8). A smaller number of them described their involvement in environmental activities that contribute to environmental protection, such as recycling, waste sorting or tree planting (respondents 1, 6, 10).

> *Yes, it is an important issue to me, the ecology and the environment play a vital role in our day-to-day basis. The purity of the environment, the fresh air, the plants, all play vital role in providing fresh oxygen to our lungs. Planting more trees has always been key to me, in my university as well we planted few saplings whenever we got chance.* (Respondent 1, India)

My answer is yes, I am interested. Tianjin doesn't have water. All the water is from Hebei province. Haihe river is from Bohai Bay. The water is reducing year by year. (Respondent 2, China)

Yes, it is important for me, because I really want to help. Environment is really important, we should help. (Respondent 3, Nepal)

Yeah, I am very interested in environment because I think it's an important part in our lives. (Respondent 5, Pakistan)

Many people are interested in ecological issues, as a common people here, in daily life we sort out trash and throw the trash into different trash bins according to the principle of' recycling: "toxic", "kitchen garbage" and "others". (Respondent 6, China)

Yes, I'm interested in environment, I think it is very important because in the end this affects our life altogether, mother earth is everything, we need to protect her. I'm not involved in any sort of environment activity as of now. (Respondent 7, Japan)

I am interested in the environment and its ecology. I believe they are crucial. It is in environment that we gladly source our supply of water and food. So, this is why I reckon that the environment and its ecology are important. (Respondent 8, Papua New Guinea)

Some foreigners mentioned that their environmental involvement concerns the countries they come from rather than Tianjin, where they live for work or further education.

In China I am not involved but in Zambia I am an active member of Zambia Institute of Architecture that is a non-profit organization and we are finding an environmentally friendly ways of designing and constructing the buildings. (Respondent 10, Zambia)

It is clear that people are interested in the environment and are aware of its importance for life on this planet. However, it is much more difficult to come up with an initiative that would

lead to environmental protection. Government communication and an appropriate discussion of environmental risks will be important to support environmental initiatives.

Conclusions

Answers to research questions and confirmation of hypotheses

The aim of this diploma thesis was to answer the research question how do people in Tianjin area perceive water pollution and the risks associated with it. Research shows that Tianjin residents are aware of the seriousness of the environmental problems associated with water quality.

Answers to a question about water quality in reservoirs, rivers and tap water showed that Tianjin residents rate water quality as average. The Chinese and foreigners were most optimistic in their assessment of water from reservoirs, followed by tap water and finally river water. It should be noted that this issue did not concern the drinking of water from these sources. In the case of risk assessment of drinking different types of water, tap water was considered the least risky.

A comparison of the answers to these questions for Chinese and foreigners through One-way ANOVA confirmed hypothesis H1, that there is a statistically significant difference between Chinese and foreigners' perception of water quality in Tianjin. Foreigners perceive water in reservoirs, rivers and tap water as of lower quality with great statistical significance (reservoirs $p < 0.01$, river water $p < 0.01$, tap water $p < 0.05$).

Differences in water quality perceptions were also reflected in the open question based on associations. While positively evaluated associations predominated among the Chinese, for foreigners the associations were more negative. In addition to pollution, foreigners also mentioned health impact more often.

There are also a number of risks associated with water. Tianjin residents consider drinking river water (mean 5.50), flooding (mean 4.91), drinking water from reservoir (mean 4.49) and drinking tap water (mean 4.20) to be the most risky. A comparison of individual risk items for Chinese and foreigners on the basis of a One-way ANOVA makes it possible to confirm the H2 hypothesis that there is a statistically significant difference between Chinese and foreigners' perception of risks associated with water quality in Tianjin. For all items related to water (drinking tap water $p < 0.01$, cleaning face with tap water $p < 0.01$, drinking water from reservoir $p < 0.01$, drinking river water $p < 0.05$, cooking with tap water $p < 0.01$, swimming in river $p < 0.01$, swimming in reservoir $p < 0.05$, bottled water $p < 0.10$), except of flooding, foreigners consider the given risk item to be more risky. For some risk items compared, the

p-value was even <0.00001 (drinking tap water, cleaning face with tap water, drinking water from reservoir and cooking with tap water).

Another part of the research question concerns trust in environmental policies. Respondents rated trust in universities and scientists, Chinese government and local government. The means of the respondents' answers for the examined items were very similar, of which the highest confidence was expressed by the Chinese government (the average was 3.57). The differences between the perceptions of Chinese and foreigners were significant for local government and Chinese government, where p <0.10. For Chinese government, the means of responses were 3.83 for Chinese and 3.37 for foreigners. This signifies that the Chinese government is perceived more positively by the Chinese than by foreigners.

Qualitative research made it possible to describe the emotions and feelings of Tianjin residents regarding the environment. It identified four important topics to which respondents attached the greatest importance. The four basic themes are eco-anxiety and fears of the future, tap water and related health problems, pollution, and involvement in environmental activities. Qualitative research helped to understand the respondents' feelings about their experience with water. Some felt eco-anxiety due to water pollution and poor quality of tap water. Concerns have also been raised about other environmental issues. Interviews with foreigners provide an explanation for one of the reasons why foreigners consider Tianjin water to be more risky. This is a comparison of previous experience with water in their home country with water in China of poorer quality. It was this comparison that was often a source of anxiety. This influence of previous experience on the perception of environmental threats is in line with previous research. The quality of tap water was described as a major problem by Tianjin and some respondents faced health problems. An interesting fact is that several respondents are more concerned about air pollution. The problem of water quality is more hidden – the use of tap water, which has already been purified, does not affect emotions as much as polluted air. In the interview, respondents expressed their interest in environmental issues, some described how they contribute to environmental protection. It also turns out that although interest in the environment can be great, it does not automatically mean that people are willing to change something in their behaviour and that they are able to develop some initiative to protect nature.

Summary

There are several important water sources in Tianjin, such as Hai River, Yongdingxin River, Yuqiao Reservoir or Beidagang Reservoir. However, the growing urbanization and industrialization in the 1980s caused higher demands of water and thus a reduction in its quantity and quality. Due to the acute shortage and limited amount of water resources, water is supplied to Tianjin mainly from the Luanhe river from Hebei province and a smaller amount is also distributed from the Yellow River.

One of the main sources of water pollution in Tianjin is considered to be industry, especially heavy industry, which is also its largest consumer. However, the water problems in Tianjin also concern inefficient wastewater treatment, with an estimated 80 percent of this water being discharged directly into the agricultural land. Wastewater from the surrounding industries is mainly discharged into the Yongdingxin River.

Several studies confirmed the insufficient quality of water, from a chemical point of view it was mainly an increase in the amount of Nitrates and Iodine, as well as the presence of enteroviruses, protozoa or estrogens in the water. As a result, China is trying to implement a number of measures that would help to improve the situation. For example, in 2008–2020, the government introduced a Special Program on Water Pollution Control and Treatment, which enabled water quality control. However, forecasts are not optimistic – water consumption is estimated to reach 3.174 billion cubic meters in 2025, which is 342 million cubic meters more than in 2017.

Perceptions of environmental risks provide important information for understanding people's attitudes and safety, as well as future government actions. The research showed that foreigners perceive the overall situation as more serious. It was possible to assess what risks the Tianjin residents perceive as the most serious. The research results also identify a number of health problems caused by poor quality of water, mainly the hair and skin issues, stomach ache and diarrhoea.

Limits

Due to the online conduct of the research, most respondents were in the lower age category. In the future, it will be necessary to focus on the elderly population. Data from the elderly population can be particularly important in the context of health issues, as they are the longest exposed to polluted water.

The characteristics of the respondents are also influenced by the choice of communication channels for the distribution of questionnaires. In follow-up research, it will be necessary to involve more possible means of communication or to carry out a questionnaire survey directly in Tianjin.

The data can also be skewed by the fact that people may not have to answer questions honestly. Many Chinese were afraid to complete the questionnaire. It was even more difficult to conduct interviews, where in the case of a recording, there may be concerns about an anonymity. The Chinese may have tended to overestimate confidence in the government and evaluate water quality more positively.

In the future research, it would be good to examine the length of stay of foreigners in Tianjin. The foreigners included in the research stayed in Tianjin for more than 3 years. It would be interesting to know if people who live in Tianjin longer, will perceive the risks as less serious than those who live there for a shorter period of time.

References

Albrecht, G. (2011). Chronic environmental change: Emerging “psychoterratic” syndromes. In: I. Weissbecker (Ed). Climate Change and Human Well-being (pp. 43–56). New York: Springer

Böhm, G. & Tanner, C. (2019). Environmentl Risk Perception. In Steg, L., & De Groot, J. I. M. (Eds.). *Environmental Psychology: An Introduction* (pp. 15–25). Hoboken: Wiley.

Chen, W., Bai, Y., Zhang, W., Lyu, S., & Jiao, W. (2015). Perceptions of Different Stakeholders on Reclaimed Water Reuse: The Case of Beijing, China. *Sustainability*, 7(7).

Cheng, H., & Hu, Y. (2011). Improving China’s water resources management for better adaptation to climate change. *Climate Change*, 112:253–282. 10.1007/s10584-011-0042-8

Douglas, M., & Wildavsky. A. (1982). *Risk and culture.* Berkeley: University of California Press.

Fan, Y., Tang, Z., & Park, S. C. (2019). Effects of Community Perceptions and Institutional Capacity on Smallholder Farmers’ Responses to Water Scarcity: Evidence from Arid Northwestern China. *Sustainability*, 2019, 11(2), 483.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978). How Safe is Safe Enough? A Psychometric Study of Attitudes Towards Technological Risks and Benefits. *Policy Sciences*, 9(2), 127–152.

Flynn, J., Burns, W., Mertz, C. K. & Slovic, P. (2006). Trust as a determinant of opposition to a high-level radioactive waste repository: Analysis of a structural model. *Risk Analysis*, 12(3), 417–429.

Freudenburg, W. R. (1988). Perceived risk. real risk: Social science and the art of probabilistic risk assessment. *Science*, 242(4875), 44–49.

Gu, Q., Chen, Y., Pody, R., Cheng, R., Zheng, X., & Zhang, Z. (2015). Public perception and acceptability toward reclaimed water in Tianjin. *Resources, Conservation and Recycling*, 104(Part A), 291-299. http://dx.doi.org/10.1016/j.resconrec.2015.07.013

Hartley, T. W. (2006). Public perception and participation in water reuse. *Desalination*. 187 (1–3), 115–126. 10.1016/j.desal.2005.04.072

He, X., Liu X., Zhang L., and Jin G. (2006). The Challenge of Managing Groundwater Sustainably: Case Study of Tianjin, China. *International Review for Environmental Strategies*, 6(2), 387 – 402

Hu, X.-J., Xiong, Y.-C., Li, Y.-J., Wang, J.-X., Li, F.-M., Wang, H.-Y., & Li, L.-L. (2014). Integrated water resources management and water users' associations in the arid region of northwest China: A case study of farmers' perceptions. *Journal of Environmental Management*, 145, 162–169.

Janmaimool, P., & Watanabe, T. (2014). Evaluating Determinants of Environmental Risk Perception for Risk Management in Contaminated Sites. *International Journal of Environmental Research and Public Health*, 11(6), 6291–6313. 10.3390/ijerph110606291

Leng, S., Zhai, Y., Jiang, S., Lei, Y., & Wang, J. (2016). Water-environmental risk assessment of the Beijing–Tianjin–Hebei collaborative development region in China. *Human and Ecological Risk Assessment: An International Journal*, 23(1), 141–171. 10.1080/10807039.2016.1229119

Li, K., Liu, X., Zhao, X., & Guo, W. (2010). Effects of Reclamation Projects on Marine Ecological Environment in Tianjin Harbor Industrial Zone. *Procedia Environmental Sciences*, 2, 792–799. 10.1016/j.proenv.2010.10.090

Li, R., Bao, J., Zou, D. & Shi, F. (2018). Influence factors analysis of water environmental quality of main rivers in Tianjin. IOP Conference Series: Earth and Environmental Science, 108, 042032. 10.1088/1755-1315/108/4/042032

Liu, H., Lam, L. T., Zeng, Q., Han, S., Fu, G. (2008). Effects of drinking water with high iodine concentration on the intelligence of children in Tianjin, China. Journal of Public Health. 31(1). 32-38. 10.1093/pubmed/fdn097

Liu, S.-S., Chen, S.-Y., Yao, M., Zhang, Q.-H., & Wu, J.-J. (2014). Water quality of Tuanpowa reservoir and Qilihai marshes in Tianjin area. *Wetland Science*, 12(2), 257–262.

Masuda, J. R., & Garvin, T. (2006). Place, Culture, and the Social Amplification of Risk. *Risk Analysis*, 26(2), 437–454. doi:10.1111/j.1539-6924.2006.00749.x

Meng, W., Li, H., Hao, C., & Mo, X. (2010). Water Environment Protection with Rapid Economy Development in Tianjin of China. 2010 4th International Conference on Bioinformatics and Biomedical Engineering. 10.1109/icbbe.2010.5515495

Miao, J., Guo, X., Liu, W., Yang, D., Shen, Z., Qiu, Z., Chen, X., Zhang, K., Hu, H., Yin, J., Yang, Z.,Li, J., & Jin, M. (2018). Total coliforms as an indicator of human enterovirus presence in surface water across Tianjin city, China. BMC Infectious Diseases, 18(1). 10.1186/s12879-018-3438-5

OWAC (2021). One-Way ANOVA Calculator, Including Tukey HSD. In Social Science Statistics (online). Available at: https://www.socscistatistics.com/tests/anova/default2.aspx

Purwono, Rezagama, A., Hibbaan, M., & Budihardjo, M. A. (2017). Ammonia-Nitrogen (NH_3-N) and Ammonium-Nitrogen (NH_4^+-N) Equilibrium on The Process of Removing Nitrogen By Using Tubular Plastic Media. *Journal of Materials and Environmental Sciences*, 8 (S), 4915-4922

Rao, K., Lei, B., Li, N., Ma, M., & Wang, Z. (2013). Determination of estrogens and estrogenic activities in water from three rivers in Tianjin, China. *Journal of Environmental Sciences*, 25(6), 1164–1171. 10.1016/s1001-0742(12)60149-1

Ren, H., Liu, H., Qu, J., Berg, M., Qi, W. & Xu, W. (2010). The influence of colloids on the geochemical behavior of metals in polluted water using as an example Yongdingxin River, Tianjin, China. Chemosphere, 78(4), 360–367. 10.1016/j.chemosphere.2009.11.018

Renn, O., Burns, W. J., Kasperson, J. X., Kasperson, R. E., & Slovic, P. (1992). The Social Amplification of Risk: Theoretical Foundations and Empirical Applications. *Journal of Social Issues*, 48(4), 137–160. 10.1111/j.1540-4560.1992.tb01949.x

Roeser, S. (2012). Moral emotions as guide to acceptable risk. In Roeser, S. et al. (Eds.), *Handbook of risk theory: Epistemology, decision theory, ethics, and social implications of risk* (pp. 819–832). Dordrecht; London: Springer.

Rosa, E. A. (2003). The logical structure of the social amplification of risk framework (SARF): Metatheoretical foundation and policy implications. In N. K. Pidgeon, R.E., & Slovic, P (Eds.). *The social amplification of risk* (pp. 47–79). Cambridge: Cambridge University Press.

SDC (2021). Standard Deviation Calculator. In Calculator.net (online). Available at: https://www.calculator.net/standard-deviation-calculator.html

Shen, D. (2020). Water Resources Management of the People's Republic of China. *Global Issues in Water Policy*, 26, 1-465. 10.1007/978-3-030-61931-2

Shen, L., Gan, Y., Li, C., & Wang, C. (2020). Pollution Level and Ecological Risk Assessment of Heavy Metals in Riverside Sediments of the Grand Canal (Beijing, Tianjin and Hebei section). *Bulletin of Environmental Contamination and Toxicology*. 10.1007/s00128-020-02957-z

Shi, Z., Tao, S., Pan, B., Fan, W., He, X. C., Zuo, Q., Wu, S. P., Li, B. G., Cao, J., Liu, W. X., Xu, F. L., Wang, X. J., Shen, W. R., & Wong, P. K. (2005). Contamination of rivers in Tianjin, China by polycyclic aromatic hydrocarbons. *Environmental Pollution*, 134(1), 97–111. 10.1016/j.envpol.2004.07.014

Sjöberg, L. (2001). Limits of knowledge and the limited importance of trust. *Risk Analysis*, 21(1), 189–198.

Sjöberg, L., Moen, B.-E., & Rundmo, T. (2004). Explaining risk perception. An evaluation of the psychometric paradigm in risk perception research. *Rotunde publikasjoner*, 84. ISBN 82-7892-024-9

Slovic, P. (1999). Trust, emotion, sex, politics, and science: surveying the risk-assessment battle field. *Risk Analysis*, 19(4), 689–701

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1982). Why Study Risk Perception? *Risk Analysis*, 2(2), 83–93.

Slovic, P., Peters, E., Grana, J., Berger, S., & Dieck, G. S. (2007). Risk perception of prescription drugs: Results of national survey. *Drug Information Journal*, 41(1), 81-100.

Tan, H., Luo, J., Orderud, G. I., Zheng, Y., & Pan, J. (2015). The Pollution Caused by Protection: The Unintended Consequences of the Local Governance of the Urban Drinking Water Source Protection in Tianjin, China. *Chinese Journal of Urban and Environmental Studies*, 3(3), 1-20. 10.1142/S2345748115500256

Tan, Y., & Liu, X. (2017). Water shortage and inequality in arid Minqin oasis of northwest China: adaptive policies and farmers' perceptions. *Local Environment*, 22(8), 934-951.

Tang, J., Folmer, H., & Xue, J. (2013). Estimation of awareness and perception of water scarcity among farmers in the Guanzhong Plain, China, by means of a structural equation model. *Journal of Environmental Management*, 126, 55-62.

Tian, Y., Li, C., Yi, Y., Wang, X., & Shu, A. (2020). Dynamic Model of a Sustainable Water Resources Utilization System with Coupled Water Quality and Quantity in Tianjin City. *Sustainability*, 12(10), 4254. 10.3390/su12104254

Usher, K., Durkin, J., & Bhullar, N. (2019). Eco-anxiety: How thinking about climate change-related environmental decline is affecting our mental health. International Journal of Mental Health Nursing, 28(6), 1233–1234

Wang, C., Li, Y., & Liu, Y. (2018). Investigation of water-energy-emission nexus of air pollution control of the coal-fired power industry: A case study of Beijing-Tianjin-Hebei region, China. *Energy Policy*, 115, 291-301. 10.1016/j.enpol.2018.01.035

Wang, L., & Watanabe, T. (2019). Effects of environmental policy on public risk perceptions of haze in Tianjin City: A difference-in-differences analysis. *Renewable and Sustainable Energy Reviews*, 109, 199–212. 10.1016/j.rser.2019.04.017

Wang, W., Fang, X., Cheng, X., Jiang, D., & Lin, Z. (1993). A Case-Control Study on the Environmental Risk Factors of Parkinson's Disease in Tianjin, China. *Neuroepidemiology*, 12(4), 209–218. 10.1159/000110319

Wu, Y.-X., Lyu, H.-M., Shen, J. S., & Arulrajah, A. (2018). Geological and hydrogeological environment in Tianjin with potential geohazards and groundwater control during excavation. *Environmental Earth Sciences*, 77(10). 10.1007/s12665-018-7555-7

Xiang, N., Xu, F., Shi, M.-J., & Zhou, D.-Y. (2014). Assessing the potential of using water reclamation to improve the water environment and economy: scenario analysis of Tianjin, China. *Water Policy*, 17(3), 391–408. 10.2166/wp.2014.054

Xiao, S., Zhang, Y., Zhao, X., Sun, L., & Hu, S. (2018). Presence and molecular characterization of Cryptosporidium and Giardia in recreational lake water in Tianjin, China: a preliminary study. Scientific Reports, 8(1). 10.1038/s41598-018-20902-3

Yang, H., Zhang, Z., & Shi, M. (2012). The Impact of China's Economic Growth on its Water Resources: A regional and sectoral assessment. In Mckay, H., & Song, L. (Ed.) *Rebalancing and Sustaining Growth in China* (pp. 309-328). ANU Press. 10.22459/RSGC.07.2012.14

You, X., & Zhang, C. On improvement of water quality of a reservoir by optimizing water Exchange. *American Institute of Chemical Engineers Environ Prog*, 37, 399–409.

Yue, F., Liu, X., Li, J., Zhu, Z., & Wang, Z. (2010). Using Nitrogen Isotopic Approach to Identify Nitrate Sources in Waters of Tianjin, China. *Bulletin of Environmental Contamination and Toxicology*, 85(6), 562–567. 10.1007/s00128-010-0156-0

Zhai, G., & Suzuki, T. (2008). Public willingness to pay for environmental management, risk reduction and economic development: Evidence from Tianjin, China. *China Economic Review*, 19(4), 551–566. 10.1016/j.chieco.2008.08.001

Zhang, C., Liu, W., Su, Z., & Wang, L. (2010) Index system and method for assessing water environment security of Luan River - Tianjin Water Diversion Project. *4th International Conference on Bioinformatics and Biomedical Engineering*, 1-5. 10.1109/ICBBE.2010.5515083

Zhang, X. H., Zhang, H. W., Chen, B., Chen, G. Q., & Zhao, X. H. (2008). Water resources planning based on complex system dynamics: A case study of Tianjin city. Communications in Nonlinear Science and Numerical Simulation, 13(10), 2328–2336. 10.1016/j.cnsns.2007.05.031

Zhang, Y., Liu, Y., Niu, Z., & Jin, S. (2017). Ecological risk assessment of toxic organic pollutant and heavy metals in water and sediment from a landscape lake in Tianjin City, China. *Environmental Science and Pollution Research*, 24, 1-11. 10.1007/s11356-017-8906-8

Zhang, Z., Fang Y., Xin X. (2009). Investigation and Assessment of Water Pollution and the Study of Water Pollutants Reduction Countermeasures in Tianjin. In Zhang, H., Zhao, R, Zhoa, H. (Ed.) *River Basin Research and Planning Approach. International Symposium of HAI Basin Integrated Water and Environment Management* (pp. 317-322). Beijing.

Zhang, Z., Xiao, L., Ji, M., & Wang, C. (2018). Assessment of the spatial–temporal variations on the water quality of stagnant Haihe River, Tianjin, North China. *Water Science & Technology Water Supply*, 18(3), 1103–1116. 10.2166/ws.2017.178

Zhong, S., Cheng, Q., Zhang, S., Huang, C., & Wang, Z. (2021) An impact assessment of disaster education on children's flood risk perceptions in China: Policy implications for adaptation to climate extremes, *Science of the Total Environment*.

Zhou, L., Zhou, H., & Fan, L. (2015). Environmental Risk Assessment of Enterprises from Key Industries in Tianjin Binhai New District. Advances in Engineering Research. International Conference on Applied Science and Engineering Innovation (ASEI 2015). 10.2991/asei-15.2015.340

Zhu, Z., Li, A., & Wang, H. (2018). Public perception and acceptability of reclaimed water: the case of Shandong province, China. *Journal of Water Reuse and Desalination*, 8(3), 308–330.

Appendices

Appendix 1: Research questionnaires for quantitative research

Chinese questionnaire

English questionnaire

Appendix 2: Questions for qualitative research

Chinese questionnaire

研究者想询问您，是否愿意参加与天津市水污染有关的环境威胁及环境政策研究。
参加这项研究是匿名的，完全是自愿的。如果您决定不参加，这对您没有任何负面影响。请注意，如果您决定参加，您可以随时停止参加，并且可以决定不回答任何特定问题。
提交这此表格即表示您已经阅读了研究说明，您已年满18岁，并且您同意所述条款。
如果您有任何疑问或者想要这封知情同意书的副本，请通过veronika.vasekova01@upol.cz跟我联系。
感谢您的参与！
Veronika Vaseková

	是	不
1. 我同意参加这项研究。我了解这项研究的目的和性质，我是自愿参加的。我了解我可以随时退出研究，而且不会受到任何惩罚或承担后果。	○	○
2. 我同意将这次访问所产生的数据，用于该主题研究人员的学位论文和有关其出版物。	○	○
3. 开始填写调查表，表示您同意参与研究。	○	○

Q1: 请在这此表格中填写您的个人资讯。

您在天津居住已满三年以上?	
国籍	
年龄	
性别	
教育	
职业	

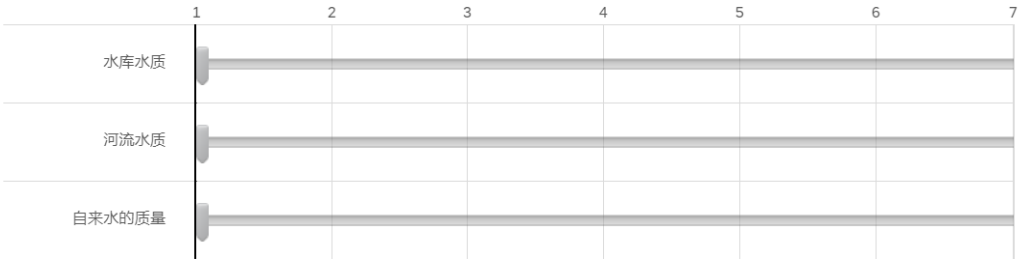
Q2: 在每一行中填写“天津的水”让你产生的联想。

天津的水	
天津的水	
天津的水	
天津的水	
天津的水	
天津的水	

Q3: 对上一个问题的每个项目评分。

	非常负面	负面	中性	正面	非常正面
关联1	○	○	○	○	○
关联2	○	○	○	○	○
关联3	○	○	○	○	○
关联4	○	○	○	○	○
关联5	○	○	○	○	○
关联6	○	○	○	○	○

Q4: 您怎么评价天津地区的水质？ 1 =质量很差，2、3、4、5、6、7 =质量很好



Q5: 保护水资源的环保措施是否足够?

- ○ 是的，足够了。
- ○ 是的，但还有更多工作要做。
- ○ 不，这还不够。
- ○ 不，没有环境措施。

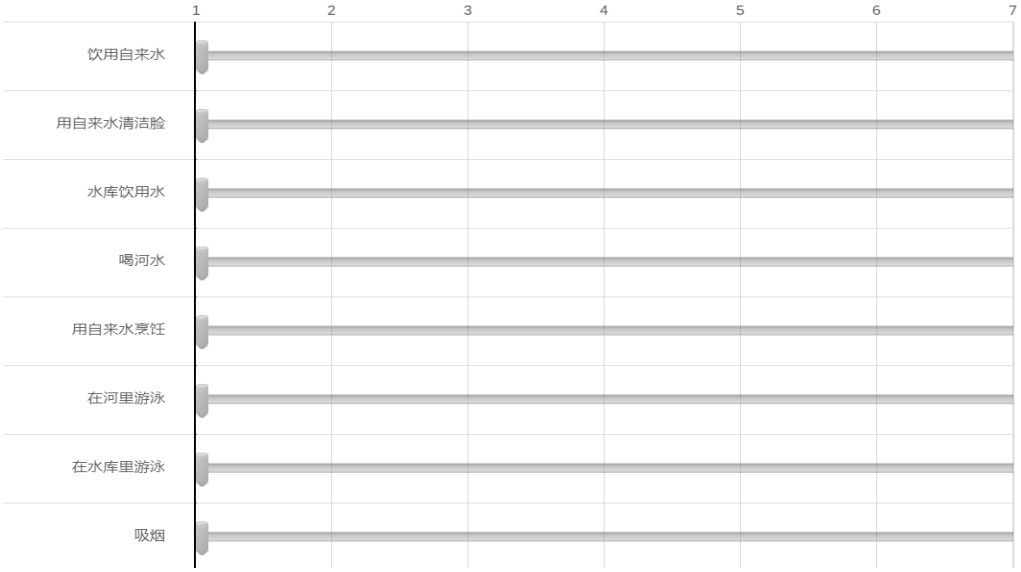
Q6: 您使用什么水：

喝	
煮	
清洁	
淋浴	

Q7: 您是否曾经直接使用天津的水源（河流，水库）中的水?

- ○ 是的，我有。
- ○ 不, 我没有。

Q8: 评价每个项目的风险。 1 =没有危险，2、3、4、5、6、7 =非常危险



Q9: 您怎么看待这些机构在水保护方面的努力?

	非常负面	负面	中性	正面	非常正面
大学和科学家	○	○	○	○	○
中央政府	○	○	○	○	○
地方政府	○	○	○	○	○

Q10: 您是否曾遇到与用水有关的健康问题?

- ○ 是的，我有。好几次。
- ○ 是的，我有。只有一次。
- ○ 不，我没有。

Q11: 如果您遇到了与用水有关的健康问题，那是什么问题?

English questionnaire

The researcher requests your consent for participation in a study about perception of environmental threats related to water pollution in Tianjin and environmental policies. Participation in this study is anonymous and completely voluntary. If you decide not to participate there will not be any negative consequences. Please be aware that if you decide to participate, you may stop participating at any time and you may decide not to answer any specific question. By submitting this form you are indicating that you have read the description of the study, you are over the age of 18, and that you agree to the terms as described.

If you have any questions, or would like a copy of this consent letter, please contact me at veronika.vasekova01@upol.cz.

Thank you in advance for your participation!

Veronika Vaseková

	Yes	No
1. I agree to participate in the research study. I understand the purpose and nature of this study and I am participating voluntarily. I understand that I can withdraw from the study at any time, without any penalty or consequences.	○	○
2. I grant permission for the data generated from this interview to be used in the diploma thesis and researcher's publications on this topic.	○	○
3. By starting the questionnaire you agree to participate in the research.	○	○

Q1: Please fill your demographics in this form.

Are you Tianjin resident at least for more than 3 years?	
Nationality	
Age	
Sex	
Education	
Occupation	

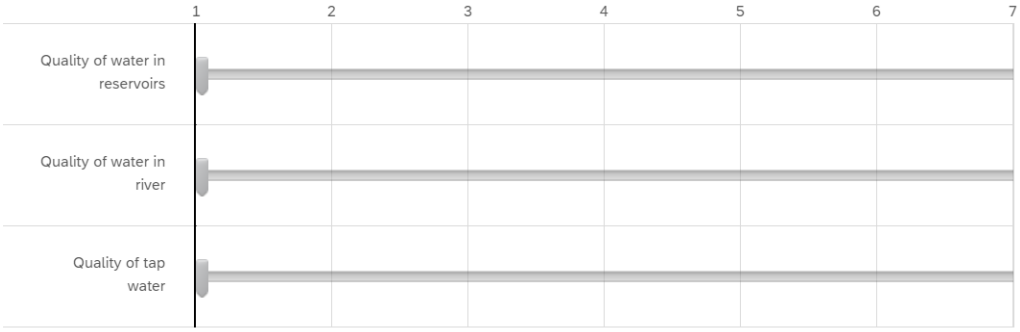
Q2: Write six associations in each line.

1) Water in Tianjin	
2) Water in Tianjin	
3) Water in Tianjin	
4) Water in Tianjin	
5) Water in Tianjin	
6) Water in Tianjin	

Q3: Rate each item from previous question.

	Very negative	Negative	Neutral	Positive	Very positive
Association 1	○	○	○	○	○
Association 2	○	○	○	○	○
Association 3	○	○	○	○	○
Association 4	○	○	○	○	○
Association 5	○	○	○	○	○
Association 6	○	○	○	○	○

Q4: How do you rate quality of water in Tianjin area? 1 = very bad quality, 2, 3, 4, 5, 6, 7 = very good quality



Q5: Are environmental measures to protect water resource sufficient?

- ○ Yes, it is sufficient.
- ○ Yes, but more should be done.
- ○ No, it is not sufficient.
- ○ No, there are no environmental measures.

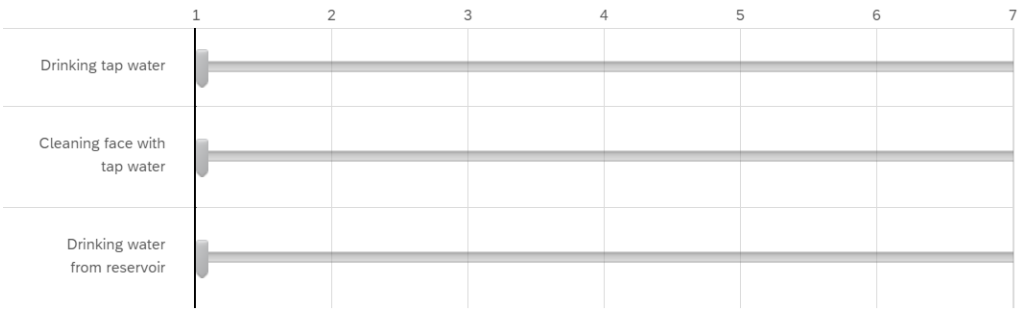
Q6: What water do you use for:

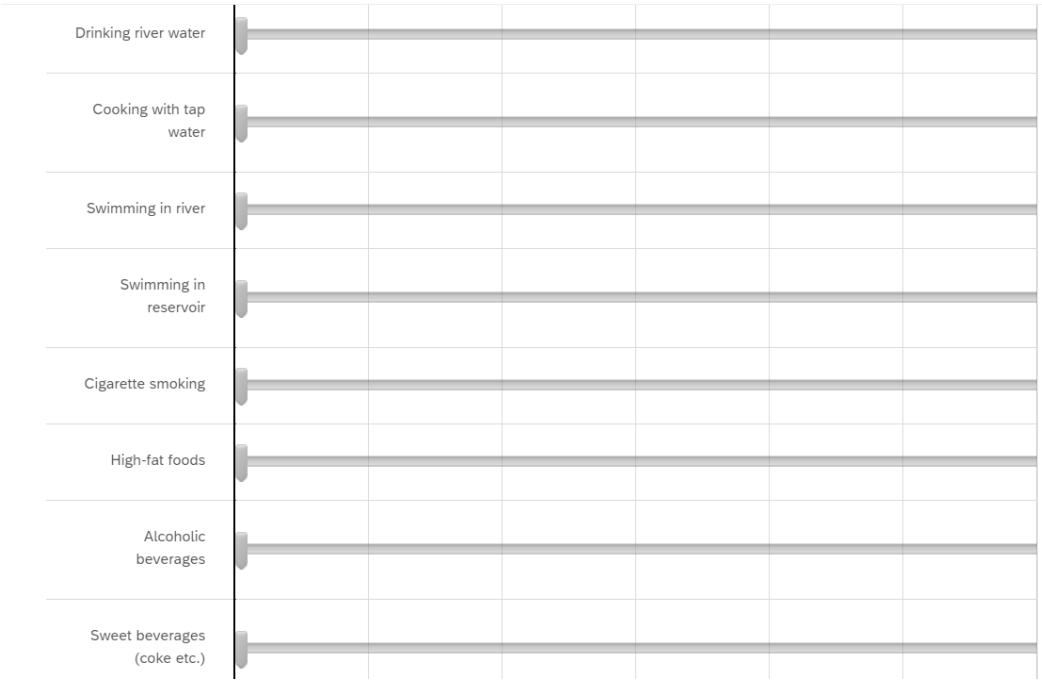
Drinking	
Cooking	
Cleaning	
Showering	

Q7: Have you ever used water directly from water sources (rivers, water reservoir) in Tianjin?

- ○ Yes, I have.
- ○ No, I have not.

Q8: Rate riskness of each item. 1 = not at risk, 2, 3, 4, 5, 6, 7 = very much at risk





Q9: How do you feel about efforts of the following institutions in regard to water protection?

	Very negatively	Negatively	Neutral	Positively	Very positively
Universities and scientists	○	○	○	○	○
Chinese government	○	○	○	○	○
Local government	○	○	○	○	○

Q10: Have you ever experienced health problem related to use of water?

- ○ Yes, I have. Several times.
- ○ Yes, I have. Only once.
- ○ No, I have not.

Q11: If you have experienced health problem related to use of water, what kind of problem was it?

Appendix 2: Questions for qualitative research

1) Are you interested in the environment and the ecology of the environment? (Is it an important issue for you, are you involved in any way?)

2) What do you think are Tianjin's biggest water problems?

3) At present, there is talk of the so-called phenomenon of eco-anxiety, which is related to the anxiety of the devastation of the environment. Do you feel something similar?

4) Are these worries related to water quality?

5) Have you ever had the opportunity to compare the quality of water abroad with the quality of water in Tianjin? What are the feelings of water quality in Tianjin?

6) How do people around you perceive water quality?

7) Are you looking at the future of water quality in Tianjin optimistically or rather pessimistically?

8) Have you ever had health problems that were caused by water? Or someone around you? Are you worried about your health?

9) Do you want to say something else that you consider important about the water in Tianjin?