1 GENERAL INTRODUCTION

1.1 Health issues in the Aral Sea area

The health conditions of five million people living in the environmentally degraded Aral Sea area became public at the beginning of the 1990s.

In 1997, Médecins Sans Frontières (MSF) started a medical program in the worst affected region Karakalpakstan, Uzbekistan. Having recognized the urgent need for research into the links between environmental situation and human ill health, MSF launched an operational research program in order to encourage scientists to carry out environmental health research in the Aral Sea area. MSF also stated that well researched evidence and qualitative data were scarce. Moreover, skepticism about the validity of official data and the need for independent research was determined (Small et al., 2003; van der Meer, 1999).

The situation has not changed much since then; research evidence is still strikingly insufficient. A keyword database search in Medline for publications until April 2005 using the term 'Aral Sea' delivers 65 matches, of which 15 (23%) articles elaborate on water issues and health in general. Another 14 (22%) articles refer to studies about the flora and fauna of the region and 36 (55%) mostly recent articles are dealing with specific studies on human health. In addition, non-peer reviewed publications were hand-collected during field trips and at different conferences.

During the 1980s, high morbidity and mortality rates – especially in Karakalpakstan – led to the perception of environmental health problems as a consequence of the drying up of the Aral Sea and its implications, like the degradation of soil and water (Sharmanov, 1989) as well as changes in the regional climate. In the beginning, studies on environmental health on maternal and child health (Ataniyazova, 1995; Ataniyazova et al., 1994; Ataniyazova et al., 1995) including nutritional anemia (Morse, 1994) were carried out. As children are the most vulnerable group, some recent research also focused on children's health (Hashizume et al., 2003; Hashizume et al., 2004; Jensen et al., 1997; Kaneko et al., 2003; Kaneko et al., 2002; Khusainova et al., 2004; UNICEF, 1996).

In the Aral Sea area, the rates of tuberculosis in adults and in children (Absadykova et al., 2003; Zakharova and Piataeva, 1992) are the worst in all of Europe

and the former Soviet Union. Owing to this fact, MSF conducted the very successful directly observed short-course (DOTS) program to combat tuberculosis (Kittle, 2000; Shafer et al., 2001) and multidrug-resistant tuberculosis (Cox et al., 2004).

While infectious diseases are not necessarily related to the environmental situation, chronic diseases are associated with the environmental conditions. Hypertension, respiratory conditions, heart disease, anemia, cancer and kidney disease are considered to be linked with environmental conditions such as: high salinity of drinking waters, pesticides in the environment, dust storms and poor air quality (Small et al., 2001).

Four studies deal with excessive intake of calcium and sodium via ingestion of drinking water and renal diseases (Fayzieva et al., 2002; Kaneko et al., 2003; Kaneko et al., 2002; Riabinskii et al., 1993). Poor air quality due to airborne dust containing salts and pesticides as well as incidence of respiratory diseases are addressed by three studies (Kunii et al., 2003; O'Hara et al., 2000; Severin et al., 1995).

Due to the heavy use of pesticides during the times of the Soviet Union, soils and water are contaminated with persistent organic pollutants, which then accumulate in the food chain. Studies by MSF demonstrated that long-lasting organochlorine pesticides and their metabolites can be found in all foods of animal origin and in some vegetables such as onions and carrots. While in the vegetables only low levels were detected, fat from animal origin like sheep fat, dairy cream, eggs and edible cottonseed oil contained high levels of dioxins. “Intake estimations demonstrate that consumption of even small amounts of locally grown food may expose consumers to dioxin levels that considerably exceed the monthly tolerable dioxin intake levels set by the World Health Organization” (Muntean et al., 2003). In humans living in the Aral Sea area (Kazakhstan and Karakalpakstan) high levels of organochlorine pesticides were measured in breast milk (Hooper et al., 1997) and cord blood (Ataniyazova et al., 2001) as well as in blood (Erdinger et al., 2004; Mazhitova et al., 1998).

Since health perception is strongly associated with psychosocial factors, another research by MSF examined the contribution of the environmental disaster to the well-being of people living in Karakalpakstan. The results demonstrate that the majority of the respondents reported their health status either fair (43%) or poor (12%). In doing so, environmental conditions are commonly perceived to be the cause of somatic

symptoms and are significantly related to the self-rated health status (Crighton et al., 2003a; Crighton et al., 2003b).

Further human health concerns refer to a lack of health and hygiene education among the population and water issues (van der Meer, 1999). For the period since the independence, official data show a strong decline for all acute intestinal infections. In contrast to official data, at the same time there was important anecdotal evidence that prevalence and incidence of diarrheal diseases in the Aral Sea region are among the highest in the former Soviet Union. In a randomized intervention study by (Semenza et al., 1998) – using household drinking water chlorination – revealed the suspected high incidence of diarrheal diseases in Karakalpakstan. So far, for Uzbekistan this is the only study into the relation between diarrheal diseases and the risk factor water. Needs assessments and feasibility studies within the framework of the 'Rural Water Supply Program' and the 'Water Supply, Sanitation and Health Project' revealed an urgent need for improvements in water supply, sanitation and hygiene (Harris and Manila, 1998; Kudat et al., 1995; Oldham, 1999; Oldham, 2000; Oldham et al., 1999). It was, however, beyond their focus to establish causal relationships.

The development of strategies for a sustainable improvement in water-related health needs to be tailored to cultural demands. This requires a full understanding of links between water supply, sanitation – primarily human excreta management –, health-related behavior, domestic hygiene issues and disease outcomes. This study provides a comprehensive insight into common local practices and establishes a knowledge basis for the development of adapted holistic management strategies.

1.2 Implications of freshwater demand in the Aral Sea Basin

At present, 69% of the global freshwater resources are utilized for agricultural needs (UNESCO, 2003). In the future, food production – for the world's increasing population – will demand even more water allocation to the agricultural sector (Falkenmark and Lannerstad, 2004). As a result of political changes implicating administrative restructuring like the formation of new states, water is increasingly becoming a contentious issue especially in regions situated downstream. The rivers Amu Darya and Syr Darya as well as the Aral Sea have become international waters since the independence of the Central Asian Republics. This impedes water management on a

river basin scale and creates water problems – because of the enormous water demand needed for irrigated agriculture – being worst in the downstream countries, namely Turkmenistan and Uzbekistan (SIWI, 2000). Freshwater shortage is regarded to be responsible for about 70% of the developmental problems in Central Asia (Severskiy, 2004).

One of the instruments to overcome struggles for water is the 'Convention on the Protection and Use of Transboundary Watercourses and International Lakes' ('Water Convention'). As water is essential to human health not only in terms of food production, but also for drinking water purposes and other domestic needs, the 'Protocol on Water and Health' ('London Protocol') was adopted under the Convention in 1999. The 'London Protocol' addresses water-related diseases in the European region with a holistic approach including prevention, control and reduction of water-related diseases by means of safe drinking water supply, adequate sanitation and basin wide protection of national and transboundary watercourses (WHO, 2001). So far, the Republic of Uzbekistan has signed neither the Convention nor the Protocol.

Water issues continue to dominate international environment protection and developments agendas. Thus, the Millennium Development Goal No. 7 targeting environmental sustainability includes halving the proportion of people without access to safe drinking water by 2015 (United Nations, 2000). Although the water needed to cover drinking water demands and domestic hygiene purposes amounts only to 8% of the annual global water consumption (UNESCO, 2003), in 2002 still about 1 billion people had no access to a safe drinking water supply.

Progress towards achieving the Millennium Development Goal on access to water supply and sanitation is monitored by the Joint Monitoring Program on Water Supply and Sanitation of WHO and UNICEF. The terminology used in the Joint Monitoring Program on Water Supply and Sanitation report has to be clarified: first, how is 'drinking water' defined; second, how do you measure 'access'; and third, what is the difference between 'safe', 'basic' and 'improved' drinking water supply and sanitation? Drinking water is defined as water used for drinking, hygiene and other domestic purposes. Access to safe drinking water and improved sanitation is measured by the percentage of population using an improved water source or an improved sanitation facility (WHO and UNICEF, 2004). It is important to be aware that the term

'safe water supply' does not imply hygienically safe water neither in the sense of microbiological quality nor of chemical water quality. It refers solely to accessibility and type of source.

According to this report (WHO and UNICEF, 2004) for 2002, a total of 89% (97% urban, 84% rural) of the Uzbek population had access to a safe drinking water supply and 53% (85% urban, 33% rural) had a household connection to the drinking water supply network. The coverage with improved sanitation was 57% (73% urban, 48% rural). Since safe drinking water supply and sanitation are two sides of the same coin, only improvements in both facilitate substantial health benefit (Anonymous, 2004). This is also addressed by Millennium Development Goal No. 7 with the aim to cut the proportion of people without access to improved sanitation by 50% until 2015. Due to these inseparable linkages, progress in meeting Millennium Development Goal No. 7 contributes at the same time to the health-related Millennium Development Goals. However, still about 2.6 billion people worldwide lack improved sanitation (WHO and UNICEF, 2004) and 1.6 million deaths are directly attributed to unsafe water supply, sanitation and hygiene (SIWI, 2005).

Waterborne sewerage causes in turn new environmental and health concerns by converting freshwater into enormous amounts of fluid waste, which has to be safely disposed. Otherwise, "beyond the direct impact to human health, in the end, pollution of freshwater, food insecurity, destruction and loss of soils, loss of biodiversity, destruction of the ozone layer and global warming is occurring" (Esrey, 2000).

The people living in the Aral Sea area, in particular on the south sea shore, face serious water quantity and water quality problems in agriculture as well as with water for human consumption and other domestic purposes. Urgently needed sustainable water management concepts must not only consider public health aspects of these water problems, but also focus the priorities on the mutually public health impacts of drinking water supply and sanitation as well as on potential interventions.

1.3 The German-Uzbek Khorezm project

The German-Uzbek Khorezm project 'Economic and Ecological restructuring of Land and Water Use in the Region Khorezm (Uzbekistan)' financed by BMBF is an interdisciplinary pilot project in development research, carried out under the auspices of

the UNESCO. The project includes several studies based on an interdisciplinary approach incorporating environmental, economic and social aspects. The common factor joining these studies is the resource water and its utilization for agriculture and drinking purposes as well as its socio-economic effects. Each of these water utilizing sectors requires a specific water quantity and quality and in turn has an impact on the resource. Overstretching water use in one sector affects quality and quantity demands of the same or another sector. For example, leaching of the saline agricultural land needs a high amount of water, which is then lacking during the irrigation period. Additionally, surface waters and herewith source waters for drinking purposes become contaminated with agricultural chemicals. Although, unsustainable land and water use on a small scale – like farm or household level – also has an impact on water quality issues, it is often neglected.

Only a balanced utilization of the scarce resource water on all scales (household, farm, regional, national, international) can create a satisfactory situation for all stakeholders and mitigate the ecological, economical and socio-economical problems in the region. Therefore, the interdisciplinary research approach of the project addresses water issues on those different scales. Randomized surveys and participatory approaches are applied on household and farm level. Projects referring to the regional scale use study sites along two transects in Khorezm, which intersect seven out of ten districts. The national and international scale is addressed by studies on legal-administrative reorganization.

1.4 Research objectives

The interrelations between water supply, sanitation, hygiene and diarrheal diseases are rather complex. Research objectives studying these links can only be met using an interdisciplinary approach. In this observational study, the incidence of diarrheal diseases and the risk factors such as water supply, sanitation, and hygiene are analyzed using a combination of quantitative and qualitative methods. The main objective of this study is to measure the association between diarrheal disease and the risk factors on household level.

Specifically, the study aims to:

1. Create active monitoring data on the incidence of diarrheal disease
2. Identify risk factors for diarrheal disease
3. Identify health-related behavioral habits

In view of these objectives, the following research questions are posed:

- What is the population at risk?
- How is the knowledge status on causes, prevention and treatment of diarrheal diseases among the population?
- What is the drinking water source quality?
- What is the point-of-use drinking water quality?
- How is drinking water collected, treated and handled?
- What is the status of domestic sanitation?
- What is the status of food hygiene?
- What is the status of domestic hygiene?
- What kind of health care seeking behavior is prevailing?

2 STUDY AREA AND DATA MINING RESULTS

2.1 Introduction

A brief introduction into the regional geography of Uzbekistan is followed by results from the data mining on demographic, health and water issues. In order to facilitate better comparability of the data, results are narrowed down from the national level to the Aral Sea region and finally to the Khorezm level. Where possible, comparisons are made with other Central Asian Republics (CAR) or with the European Union (EU).

Uzbekistan is a landlocked country in Central Asia. The country extends over 447,400 km^2 and includes the southern part of the Aral Sea. Desert covers about 70% of the country and about 11% are arable land; the latter is mostly situated in river valleys along the course of the rivers Amu Darya, Syr Darya and Zarafshan. A predominantly (semi-) arid climate with long, dry, hot summers and cold to moderate winters is one of the restricting factors in agricultural production. Uzbekistan is rich in natural resources and exports gas, petroleum, heavy metals and precious metal.

Since 1991, Uzbekistan has been an independent republic with a presidential democracy. The Supreme Assembly adopted the Constitution in December 1992.

Administratively, Uzbekistan consists of 12 provinces (Uzbek *viloyat,* Russian *oblast*), the autonomous Republic Karakalpakstan and its capital Tashkent. Each province is further divided into administrative districts named *tumani* (Uzbek) or *rayoni* (Russian). The study area, Khorezm *tuman,* is located about 400 km south of the Aral Sea and borders on Karakalpakstan.

2.2 The desiccation of the Aral Sea and its ecological effects

The Aral Sea is fed by two rivers: the Amu Darya (water flux 78 km^3/year) and the Syr Darya (37 km^3/year) (FAO, 2003). Both are transboundary watercourses whose river heads are situated in the Pamir Mountains and the Tien Shan, respectively. They belong to the countries Tajikistan, Afghanistan, Turkmenistan, Uzbekistan, Kazakhstan and Kyrgyzstan. The waters of the Amu Darya and the Syr Darya have been extensively exploited by the bordering countries for decades (Létolle and Mainguet, 1996). Upstream countries prefer management strategies promoting hydro-power generation, whereas the needs of ‘downstreamers’ are predominantly irrigation (Rost, 2004).

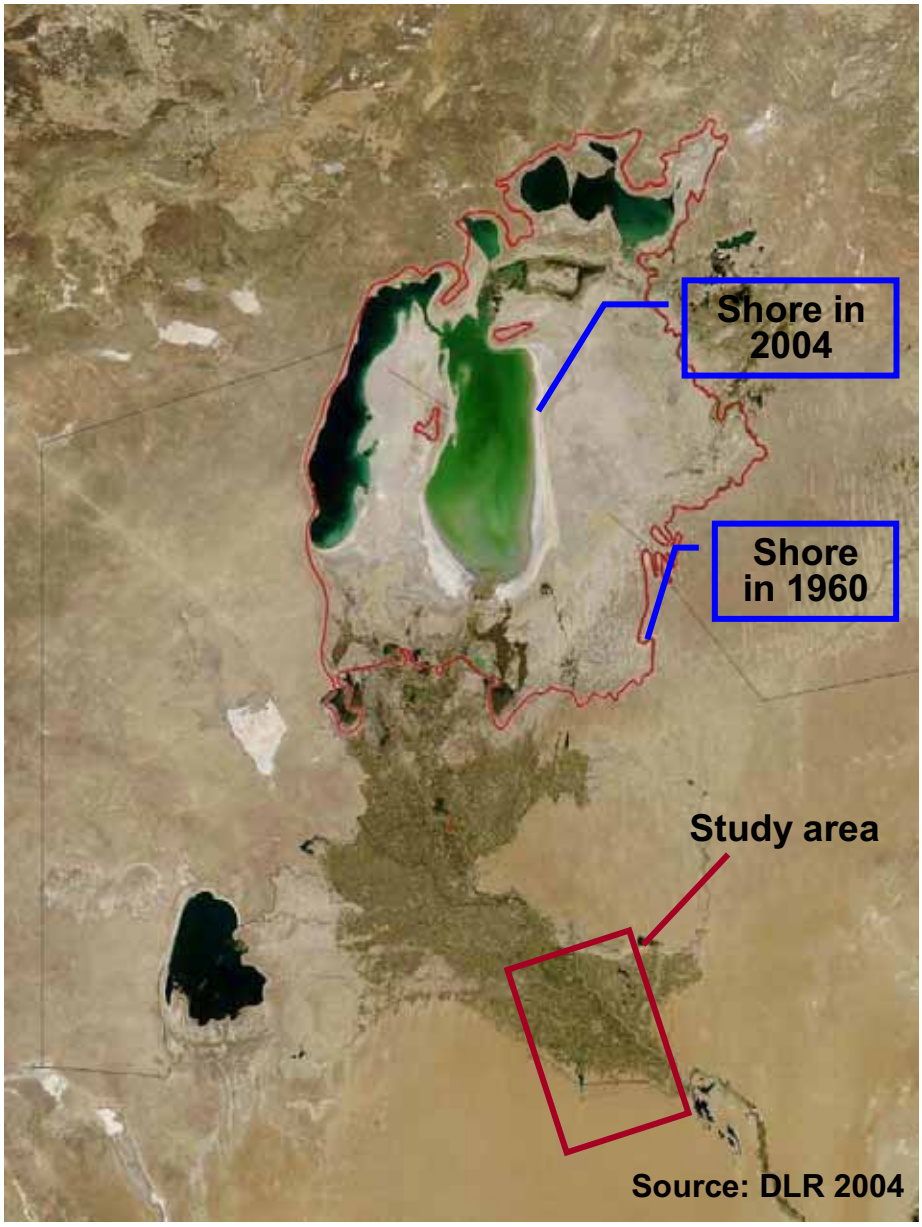

Figure 2.1 Location of study area

The lake has lost 80% of its volume and more than 50% of its surface (Hoffmann, 1997) and is still shrinking. Today, both feeder rivers seep away before reaching the former forth-largest inland water body on earth. The increasingly frequent storms triggered off by the changed regional climate blow out and deposit salty toxic dust over hundreds of kilometers causing secondary damage (Usmanova, 2003).