Background Report

Lower Olifants Community Health: Risks and Opportunities Project

CSIR

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Report documenting a full literature review of available water pollution, air quality and human health information for the study areas delivered as part of Deliverable 2 to the Department of Science and Technology on the 31 August 2012

Additional components of Deliverable 2 include:

- Research ethics application submitted
- Finalised survey and sample plan

Communities living near the Olifants River face environmental pollution risks and their health may be threatened. Sound evidence is needed to determine these health risks and identify coping strategies to best protect human health.

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1 Purpose and scope of this document

The purpose of this document is to provide a full literature review of available water pollution, air quality and human health information for the study areas included in the Lower Olifants Community Health: Risks and Opportunities Project.

This project is funded by USAID and the Department of Science and Technology. Project partners include in South Africa: the CSIR, the NOVA Institute, SANParks and in Mozambique: Eduardo Mondlane University.

2 Introduction to the Lower Olifants Project

2.1 Background to the project

Communities living near the Olifants River face environmental pollution risks and their health may be threatened. Sound evidence is needed to determine these health risks and. identify mitigation measures and adaptation and coping strategies to best protect human health.

2.2 Short project summary

Wildlife deaths in parts of the Olifants River Catchment Management Area alerted scientists to possible serious pollution problems. It is known that communities living in close proximity to this river are exposed to pollution, but to what extent and whether health problems can be attributed to this exposure is not known.

Large-scale monitoring is underway to characterise water pollution in this intense mining and agricultural area, and a human health risk assessment project in the Upper Olifants was done in 2010. Results showed that risks from exposure to high pathogen concentrations and

metal accumulation in vegetation were at higher levels than what is considered acceptable for consumption of food and water.

The Lower Olifants Project will use community surveys, focus group discussions and monitoring (of air, water, fish, fruit and vegetables) in the Lower Olifants to identify human health risks, as well as coping strategies used by communities to best protect human health.

2.3 Purpose of the project

The overall purpose of the project is to determine the extent to which water and air pollution may have an impact on the health of two communities in the Lower Olifants River Water Catchment Area, with the purpose of identifying potential human health risks and relevant coping strategies that will inform and guide locally-appropriate, sustainable solutions.

3 Overview of study areas

The Olifants Basin is a principal sub-catchment of the Limpopo River. It has its source in the north of South Africa (in Mpumalanga) and flows north-east through the Limpopo Province into Mozambique. In South Africa, significant mining, industrial and agricultural activities, including intensive irrigation schemes, are concentrated in the catchment.

The Massingir Dam and reservoir is located in the Gaza Province of Mozambique and forms part of the Limpopo River Basin, an area which covers 80 000 km^2 of Mozambican territory. The Limpopo National Park, formed in 2001, covers an area of approximately 10 000 km^2 and is located immediately north of the Massingir reservoir in the area bounded by the Olifants River in the south and the Limpopo River in the north. The Limpopo National Park also forms part of the Great Limpopo Transfrontier Park which covers an area of 35 771 km^2 and includes the conservation areas of the Limpopo National Park (located in Mozambique), the Kruger National Park (located in South Africa) and the Gonarezhou National Park (located in Zimbabwe). Massinger District includes approximately 27 750 people (both inside and outside of the Limpopo National Park), in 5 296 households of which 4 547

households were involved in agriculture, as reported in the 2006 Census (Simpson, 2007). Household size varied between 2 – 14 adults and 0 – 19 children.

The study areas broadly include Hoedspruit and Phalaborwa in the Limpopo Province (South Africa) and several communities around Massingir Dam (Mozambique). The exact study sites will be defined following a field visit on 20 August 2012, however, for the purpose of this background report, literature and information pertaining to the two broad study areas are included and reported here.

4 Need for a social component in the study

In a study such as this, where the purpose of the research is also to understand the human interaction with the natural resource as well as their responses in the form of coping strategies, it is essential to include an understanding of the socio-cultural imperatives bound up in the actions of the people in the study area. Burger *et al* (1999) for example argues that humans have dual "nature of being both part of natural ecosystems, yet developing sociological environments beyond nature". These sociological environments can be based on particular cultural or spiritual beliefs and manifested similarly through belief systems and their related rituals and practices. Belief systems are systems of shared beliefs, which may be considered as a worldview, ideology or social representation (when analysed on a group level) or as cultural model (when analysed on a level of culture) (Heidmets & Raudsepp, 2001).

It is also essential to understand that environmental problems are more than technical problems (SfAA, 2001). Environmental problems also reflect human choices made both in the past and present, by different groups or institutions and at different levels, from the local to the global (SfAA, 2001). As such, one needs to understand that these choices are shaped by particular values and relational attitudes. De Groot (2008) argues that values reflects the desirability of a certain end state, in other words a wish for a particular outcome; values are abstract and transcend different situations, for example values may span across different situations; values serve as a guiding principle for selecting and

evaluating behaviour, people and events, differently said this is how we decide what is right or wrong and good or bad; and values are ordered in a system of value priorities, for example some 'things' are more important that others (De Groot, 2008). Environmental values therefore, reflect the varied ways in which people experience, understand and care for the world around them (SfAA, 2001).

On a similar note, investigating environmental risk requires the same consideration and incorporation of socio-cultural aspects such as belief systems, values and attitudes. Burger *et al* (1999) argues that risk assessment are both stimulated and influenced by the attitudes and perceptions of people. Wakefield *et al* (2001) note that risk is socially and culturally constructed which is rooted in the daily experience of everyday life. In addition, risks are perceived as integral to environmental beliefs and should not be seen as independent causes of behaviour (O'Connor *et al*, 1999). As a result there has been a shift towards qualitative approaches to measuring and understanding risk (Wakefield *et al* (2001).

5 Background

5.1 Introduction to environmental health

Environmental factors are the modifiable parts or impacts of pollution i.e. air, water, or soil with chemical or biological agents.; These may include solar ultraviolet and ionizing radiation; noise, electromagnetic fields; occupational risks; built environments (including housing, land use patterns, roads); agricultural methods, irrigation schemes; man-made climate change and ecosystem change. It also includes behaviour, for example related to the availability of safe water and sanitation facilities, such as washing hands, and contaminating food with unsafe water or unclean hands.

Environmental health "*comprises those aspects of human health and disease that are determined by factors in the environment. It also refers to the theory and practice of assessing, correcting and controlling factors in the environment that can potentially affect health. As used by the World Health Organization, environmental health includes both the*

direct pathological effects of chemicals, radiation and some biological agents, and the effects (often indirect) on health and wellbeing of the broad physical, psychological, social and aesthetic environment" (WHO, 2009).

The link between the environment and human health and well-being has long been acknowledged. A study by the World Health Organization (WHO) (2006) showed that an estimated 24% of global disease and 23% of all deaths in Africa (estimated at 2.4 million) were as a result of avoidable environmental hazards, with a greater tendency to impact upon the poor and most vulnerable groups in underdeveloped countries.

An estimated 33% of disease in children under the age of 5 years is believed to be due to environmental hazards. The four main diseases influenced by environmental factors include diarrhoea, lower respiratory infections, unintentional injuries and malaria. According to the WHO (2006), environmental health could be improved through simple interventions such as safe household water storage and better hygiene measures, better water resource management, the use of cleaner and safer fuels, increased safety of the built environment, and more careful use of toxic substances both in the home and workplace.

5.2 General human health impacts and risks relating to environmental pollution

Environmental pollution may be from natural sources (volcanoes, hot springs) or anthropogenic (man-made) sources (industrial emissions, pesticide use, dumping of waste). Environmental pollutants may be chemical (gases, metals) or biological (viruses, pollen). These pollutants may also transform in the environment, for example inorganic mercury emitted from coal burning will transform to the organic form, methyl mercury, in water. Humans may be exposed to environmental pollutants through inhalation, ingestion or dermal absorption. Impacts may range from slight and reversible such as a rash, to severe and irreversible such as birth defects and cancer.

5.2.1 General health impacts and risks from water pollution

The Olifants River has been described as one of the most polluted rivers in southern Africa because of the number of anthropogenic impacts that affect water quality. The sources of pollution are numerous, and include mining, coal-fired power generation, industrial activities, agriculture as well as inadequately treatment of wastewater. Water quality can have significant impact on health. The type of contamination that may occur can be typically classified into either microbial or chemical contamination. In South Africa, diarrhoeal disease is the third largest cause of death among children under the age of five, a significant proportion of which can be attributed to the ingestion of contaminated water (Steyn and Genthe 2008). Among all age groups, diarrhoea is responsible for 3.1% of total deaths in the country (Lewin et al., 2007). Fewtrell et al., (2007) quantified the health impact in countries with incomplete water and sanitation coverage and estimated that in areas where water and sanitation coverage is below 98%, between 70 and 90% of diarrhoea cases are attributable to this low access to water, sanitation and hygiene services. According to the WHO assessment (2004), achieving the water and sanitation MDG target would bring economic benefits ranging from US$3-US$34 for every US$1 invested. Additional improvements of drinking water quality such as point-of-use treatment in addition to access to improved water and sanitation would lead to a benefit ranging from US$5 to US$60 for every US$1 invested. Within the Olifants catchment, it has been calculated that the actual diarrhoeal incidence is 211414 based on 2007 data (De Lange et al 2012). This equates to ZAR 669 million for direct treatment costs and a further ZAR1.141 billion per year for the catchment for indirect costs of diarrhoea.

Microbial contamination of our water resources may arise through inadequate wastewater treatment as well as if the water resource being used for domestic purposes is inadequately treated. Industrial development represents another aspect of human activity that has left its mark on South Africa's water resources and in terms of health of the population. Many industrial processes have by-products that contain hazardous chemicals, and these are sometimes released directly into rivers or other bodies of water. Waste products disposed in landfills or slag heaps may release substances that eventually leach into watercourses as a result of poor maintenance and poorly constructed infrastructure. Modern agricultural practices add significantly to this environmental burden, as pesticides, herbicides or

fertilisers may wash into rivers or leach into ground water. It has been shown that pesticides used intensively in agricultural pest management may enter and contaminate the environment, creating a major selection pressure on the development of pesticide resistance, and possibly increasing the exposure of local communities, causing adverse health effects (Sereda et al., 2005b; La Merrill and Birnbaum, 2011). The impact of agrochemicals on human health, and particularly on childrens' health, has been reported worldwide. Some pesticides such as endosulfan, chlorpyrifos, dichlorvos, and methamidophos, are reported to be the active ingredients for developing the endocrine disruption and reproductive toxicity, therefore increasing the risk of adverse events on the human foetus (Peiris-John and Wickremasinghe, 2008).

5.2.2 General health impacts and risks from air pollution

The existence of adverse effects on health from exposure to ambient air pollutants had been well established in multiple international studies (Pope *et. al*., 2002, Brunekreef and Holgate, 2002, Sears *et. al*., 2003). Observations in developing countries indicated that effects of air pollution on these nations may be greater because they are more vulnerable as a result of their nutritional status and lifestyle (Romieu and Hernandez-Avila, 2003). Long term mortality studies (studies on the causes of death) in the US, showed fine particulate matter was positively associated with all-cause, cardiopulmonary and lung cancer mortality. The association with the latter two remained even after controls for cigarette smoking, body mass index, diet and occupational exposure had been introduced (Pope *et. al*., 2002).

Recent studies have also associated particulate matter (Brook et al., 2010;Sacks,2011) as well as sulphur dioxide and nitrogen dioxide (Su et al, 2011) with cardiovascular effects, while others have linked sulphur dioxide, particulate matter and nitrogen dioxide with respiratory health effects (Curtis et al, 2006, Guaita, 2011, Ghosh et al, 2012). Studies have demonstrated synergistic effects when exposure is to more than one pollutant. This means that the effect of the pollutants in combination is greater than the sum of the individual effects. Synergistic effects were found with ozone together with other pollutants, including particulate matter (Mauderly and Samet, 2009).

5.3 Mitigating human health impacts and risks from environmental pollution

It is well known that environmental pollution (air, water and soil pollution) has a detrimental effect on human health and the environment (see sections 5.2.1 and 5.2.2). The adverse effects of environmental pollution is not only limited to health, but indirectly also influences the economy, because people cannot be productive if they are ill and they are a burden on health services. A decrease in environmental pollution will therefore have a positive impact on health.

Mitigation of environmental pollution may be through control at source, for example through the use of cleaner technologies (unleaded fuel); emissions from industries may be regulated through a licensing system that specifies the maximum levels emitted to air, water or soil, or control can be at the receiving environment through standards. These standards are maximum concentrations of pollutants allowed in air, water and soil.

Companies or authorities may use health action plans based on the significance of an impact to develop mitigation strategies. Education level and awareness campaigns may help to mitigate human health impacts from environmental pollution, because if people are educated or aware of how they may be exposed to environmental pollution and the dangers of environmental pollution to their health, they may make informed choices to reduce or eliminate exposure. For example not swim in a river contaminated with acid mine drainage or if they have to use solid fuels for cooking and heating, to use a different technique to light a fire (Basa njengo Magogo) which has proven to emit lower levels of pollution. Also to keep children away from the smoke of fires and from secondary tobacco smoke, not to dump or burn refuse and not to build pit latrines where it may contaminate groundwater.

5.3.1 General ways to mitigate against water pollution

Improvements in the quality of drinking water provide significant benefits to health. In South Africa, the primary health impact of drinking water is well recognised and has substantial enabling legislation, frameworks and strategies relating to the provision of water

services in South Africa (DWAF, 2004). The SANS 241 Drinking Water Specification is the definitive reference used in South Africa on acceptable limits for water quality parameters and provides guideline levels for a range of water quality characteristics (SANS, 2011). The Department of Water Affairs has additional information on drinking water quality sampling, analysis, assessment and treatment (DWAF,2000). The DWA makes use of the more recent initiative, namely the Blue Drop system to assess drinking water quality in the country. The Phalaborwa Municipality scored 79,2% in the 2011 assessment and was found to have inadequate monitoring. The Green Drop system assesses wastewater treatment works in the country. The Green Drop wastewater risk ranking for Phalaborwa was 50% with the highest risk area considered to be the effluent quality. This means that wastewater effluent of poor quality is entering the river and the drinking water treatment works is not up to standard to ensure a safe drinking water treatment process. Legislation exists to ensure that all South Africans have access to safe water. However, we are not always able to assess whether water is safe. There is a crucial need for scientifically sound answers to the problems of contamination of water sources with potential hazardous agents – microbial and chemical, and the assessment of the risks posed by such pollution.

The main aim of water quality guidelines is to protect public health. According to the World Health Organization (2004), the potential consequences of microbial contamination are such that its control must be of paramount importance and must never be compromised. Generally the greatest microbial risks are associated with ingestion of water contaminated with human and animal excreta. Water must, as the first line of defence, be protected from contamination by human and animal waste.

The methods used to determine whether water is safe vary according to guidelines and standards. According to the majority of international guidelines and standards, water intended for human consumption should be safe, palatable and aesthetically pleasing. This implies that the water should ideally be free of pathogenic microorganisms and other substances that may present a health risk. Similarly, guidelines exist for all other uses of water, namely agricultural water use, industrial water use, recreational water use, etc. Numerous microorganisms that may cause diarrhoea can be found in faecal-polluted water and it is impossible to analyse the water on a routine basis for all the possible pathogens

that could cause a health problem. There is conclusive evidence that simple, acceptable, low-cost interventions at the household and community level are capable of dramatically improving the microbial quality of household water and reducing the risks of diarrhoeal disease and death in populations of all ages in the developed and developing world (Sobsey, 2002)

5.3.2 General ways to mitigate against air pollution

Government mitigates air pollution through legislation such as the National Environmental management: Air Quality Act (Act 39 of 2004). This act not only controls pollution in the receiving environment, but also provides for certain industries that perform specific activities, the so called "Listed Activities," to operate under an atmospheric emission license and to comply with minimum emission standards. Listed Activities are activities believed to have a significant detrimental effect on the environment. Municipalities may implement by-laws whereby they control air pollution such as to declare certain areas as smoke-free zones.

Mine dumps are rehabilitated by planting vegetation on the slopes. At construction sites surfaces and roads are sprayed with water or chemicals to combat dust pollution. However, the responsibility of air pollution mitigation does not only lie with Government, municipalities and industries, but also with individuals. Every individual can take action to mitigate air pollution. Examples of what individuals can do are the following:

- They can use electricity wisely, and thereby reducing the need for more coal burning at coal fired power stations.
- Use renewable energy sources such as solar panel geysers
- They can make use of public transport rather than using motor vehicles
- They can refrain from starting veld fires, for example by throwing away burning cigarette butts.
- They can recycle rather than burning refuse
- They can investigate the use of natural pesticides as opposed to spraying chemicals that may pollute the air and kill plants and animals.

6 Environmental health – Mozambique, Massingir Dam

Although Africa has only about 13% of the world's population, it carries almost 24% of the world's burden of disease. Ten percent of Africa's disease burden is due to malaria, the leading cause of death among children under five years (Cooke, 2009). Furthermore, southern Africa has the highest national HIV prevalence in the world (Cooke, 2009). The main issues of Public Health in Africa are: (Cooke, 2009).

- Gender inequity
- Water and sanitation
- Food security
- Infrastructure
- Conflict issues

In a country profile by the WHO (2009a), Mozambique is classified as a low-income country where more than 50% of the population live below the poverty line and more than 80% of the poor live in rural areas. This problem is accentuated, because Mozambique often suffers from disease outbreaks, such as cholera (in 2011 there were 1279 cases of cholera with a case fatality rate of 0.3 (WHO, 2012a), and environmental disasters. Related to the latter, is food security. Here itis important to mention that cerial production in Mozambique was 43% lower in the 2011/2012 season compared with the average over the 5 years from 2007 to 2011. For South Africa thie reduction was 3%.

Despite these negative factors, the country is recovering. The economic growth rate is between 6 and 7%, the inflation rate about 10% and progress is made towards achieving the Millennium Development Goals (MDG) (WHO, 2009a). However, the burden of disease, especially malaria, HIV/AIDS, TB and the co-infection of HIV and TB as well as drug resistant TB is still a concern (WHO, 2009a).

Table 1 (Appendix A) compares statistics of Mozambique, South Africa, and the World Health Organization region in Africa as well as global, on various aspects.

In a study that investigated the relation between socio-economic parental position, namely education and occupation, and child mortality in Mozambique using data from the 1997 Mozambique Demographic and Health Survey, a partial gradient between family's social standing and child mortality was evident (Macassa et al., 2003).

A study of respiratory syncytial virus (RSV) infection among children less than 5 years of age in four countries, including Mozambique (Manhica District) and South Africa (Agincourt Health and Population field site 600 km east of Johannesburg) found that the incidence of severe RSV lower respiratory infection per 1000 child-years was 5 and 9 in Mozambique and South Africa, respectively (Robertson et al., 2004).

In a study conducted in May 2007, public health risks and benefits from interactions of humans, domestic animals and wildlife in the Limpopo National Park were assessed using a rapid appraisal approach (Simpson, 2007). The threat to nutrition due to crop damage by wildlife was identified as the most frequently mentioned public health risk. A decrease in malaria prevalence had been observed and may have been because of the spraying of homes in several villages by the Lebombo Spatial Development Initiative. Rabies was the most commonly mentioned zoonoses. Respondents in the rapid appraisal were concerned about sharing water from rivers and dams with elephants and other wildlife and felt that they may catch diseases from the water. Water was reportedly not boiled for drinking purposes and was sourced from the river, dam or boreholes.

No influence on air from wildlife was reported (Simpson, 2007). The Limpopo National Park does restrict the use of trees for charcoal and wood, which may result in reduced indoor air pollution among communities; however, as there is no alternative, this risk likely still exists. Regarding health services, village community members reported using a traditional healer, nurse or doctor, depending on the circumstance. The most commonly reported diseases were malaria (76%), diarrhoea (67%), HIV (22%) and malnutrition (21%) (Simpson, 2007). Additional symptoms and illnesses mentioned included fever, vomiting, conjunctivitis, headaches, allergic reactions, back and joint pain, asthma and wounds.

7 Environmental health - South Africa, Phalaborwa

South Africa is considered a middle-income country. In a country profile by the World Health Organization (2009b), it was stated that South Africa has one of the strongest economies in Africa. More than 90% of the population has access to piped water and nearly 80% to improved sanitation and about 80% of the population is able to reach a health facility within an hour. Despite these positive statistics, the life expectancy at birth in the country is not higher than 60 years (WHO, 2009b), mainly due to HIV/AIDS and TB, because South Africa has the third highest TB and the fifth highest drug-resistant TB burden in the world. In fact, the mortality profile for 2000 shows a quadruple burden of disease, since HIV/AIDS, chronic diseases, poverty-related conditions and injuries all contributed substantially. The leading causes of death were, after HIV/AIDS, which contributed 30%, cardiovascular diseases that contributed 17%, infectious diseases (10%), malignant neoplasms (8%) and injuries 12% (Bradshaw, *et. al*., 2003). However, South Africa is making huge efforts in addressing the nation's health issues of which the main challenges are the large burden of infectious diseases such as HIV/AIDS and TB and the growing burden of non-communicable chronic diseases, such as diabetes and heart diseases (WHO, 2009b). Although these diseases are not considered to be environmental diseases, they make people more susceptible to environmental pollution.

Statistics presented in Table 1 (Appendix A) indicate how South Africa compares with Mozambique, the World Health Organization region in Africa as well as globally on several socio-economic and health indicators.

Madanire-Moyo et al., (2012) investigated the relation between fish parasites (in Mozambique tilapia fish) and water quality in dams in Limpopo. They found that unpolluted water had a higher number of parasite species and a higher number of parasites than polluted water. This finding proofs that aquatic systems are affected by the quality of water, which in turn are negatively affected by man-made activities.

In malaria areas in South Africa, including in the Limpopo province, DDT is still sprayed indoors to control malaria. Barnhoorn et al., (2009) conducted a study in Limpopo, where

they analysed tissue from locally caught fish, domestic chickens and wild birds (land and water birds). All of these animals are consumed by communities as a source of protein. DDT residues were found in all of the tissue samples as well as in water samples. Since the study area is also a malaria area, DDT pollution may be present in the environment.

Analyses of water samples from the Olifants River catchment area in Mpumalanga, showed that dissolved sulphate levels exceeded threshold levels for aquatic ecosystem health and at some monitoring stations also the level for human consumption. At the Loskop dam it was also found that sulphate levels increased seven-fold since the seventies, apparently due to pollution from the Little Olifants River catchment. These findings raised a concern for possible copper-sulphate levels in the Olifants River near Phalaborwa, due to activities at the copper mine, as copper sulphate is toxic to aquatic life (De Villiers and Mkwelo, 2009). Samples that were taken from the lower Olifants River and lower Selati Rivers near Phalaborwa during the period April 1990 to February 1992, already showed the influence of the mining activities on the quality of water in terms of sodium, fluoride, chloride, sulphate, potassium, total dissolved salts and metal concentrations (except strontium) (Seymore et al., 1994).

The influence of the copper industry and mine in the Phalaborwa area was also illustrated in a study by Grobler and Swan (1999), who investigated chronic copper poisoning in ruminants within the Phalaborwa area of the Kruger National Park. They found chronic copper poisoning in impala and the occurrence of high copper concentrations in buffalo. They also found that the faecal concentration of copper decreased with distance from the industry. Van Niekerk (2006) analysed liver samples from Impala near Hoedspruit and did not find elevated levels of copper

7.1 Populations likely to be affected

The banks on the South African side of the lower Olifants river (taken as the section of the river flowing through the lowveld, i.e. east of the Abel Erasmus pass) is relatively sparsely populated. Between the Abel Erasmus pass and the Mozambique border there are only six

populated areas or sub-places (according to the Census 2001 subdivision) that lie within one kilometre of the river. These are: Ga-Mabin, Tshwenyane, Dingapong, Diputhi, Finale and Namakgale NU. This is shown in Figure 1. All these sub-places fall within the Maruleng Local Municipality except Namakgale NU which is part of the Ba-Phalaborwa Local Municipality and Tshwenyane which falls under the Greater Tubatse Local Municipality.

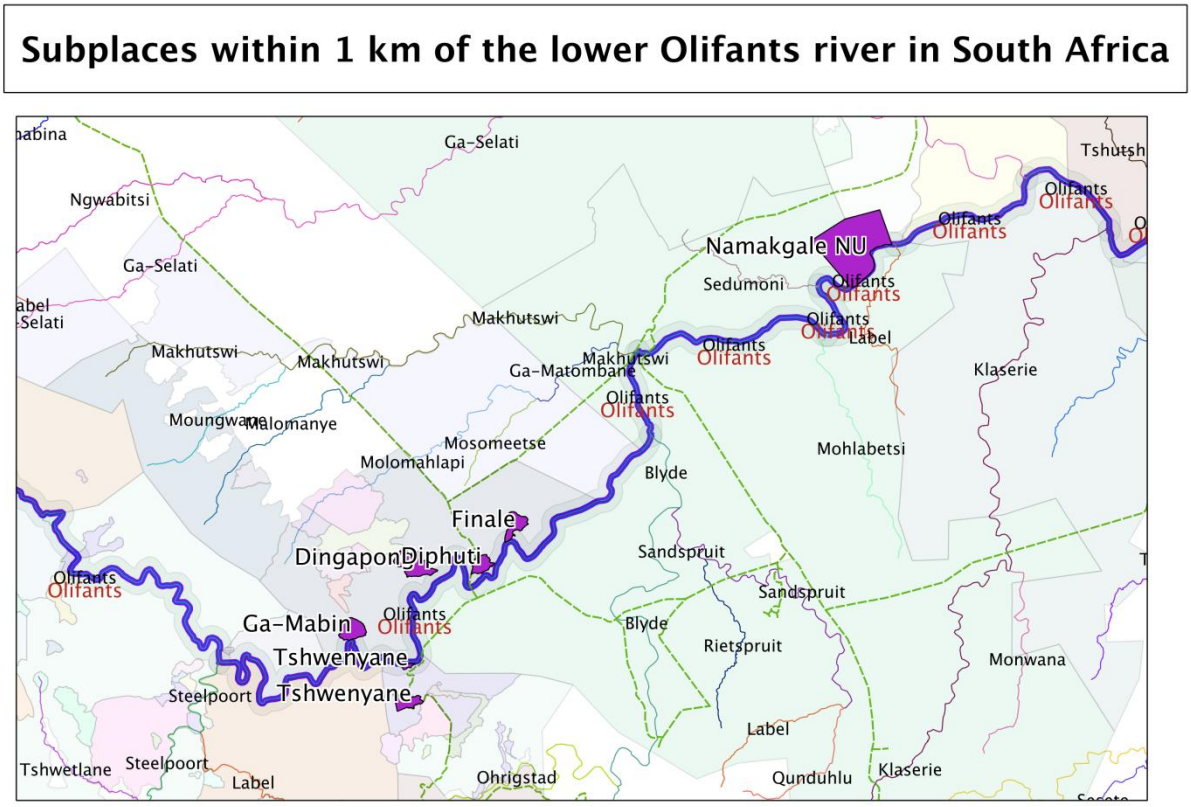

Figure 1: Populated sub-places within 1 km of the Olifants River (in purple)

Tshwenyane is split between a smaller northern portion adjacent to the Olifants River and a larger area about 3.5 km south which is higher up on the Abel Erasmus Pass. The northern portion of Tshwenyane is of interest to the project.

The proportion of Dingapong that is closer than one kilometre to the river is very small. This makes the site less interesting from the point of view of this research project. Namakgale NU is sparsely populated and has a very small population (140 households in 2001). For this reason Namakgale NU is also not a preferred study site.

This leaves four potential study sites, namely Ga-Mabin, Tshwenyane, Diputhi and Finale, that all have substantial populations living within one kilometre of the lower Olifants River.

7.2 Potential exposure to indoor air pollution

The total number of households in all six these sub-places were 2870 according to the 2001 Census. Table 2 gives the results of the 2001 Census for the main energy carrier used by the household for cooking (categories with less than 10 responses are not shown). The mostly rural character of these areas can be seen in the fact that 90% of households reported using wood as main energy source for cooking in the 2001 Census. The very high incidence of domestic wood use makes it likely that a substantial proportion of the population may be exposed to dangerous levels of air pollution.

Table 2: Household main energy source for cooking for sub-places within 1 km of the lower Olifants River. (StatsSA 2001)

Municipality	Main_Place	Sub-Place	Electricity	Gas	Paraffin	Wood	Total
Maruleng	Mametja	Dingapong	36	8	13	787	853
Maruleng	Mametja	Diphuti	92	0	11	611	718
Maruleng	Mametja	Finale	0	3	0	428	431
Maruleng	Mametja	Ga-Mabin	17	8	0	441	469
Greater Tubatse	Sekhukhuneland	Tshwenyane	0	0	0	259	259
Ba-Phalaborwa	Ba-Phalaborwa	Namakgale NU	47	21	7	65	140
TOTAL			192	40	31	2591	2870

7.3 Potential exposure to polluted water

Although sub-place level data were not available at the time of writing of this report, indications from the municipal level data that were available (the 10% sample from households of the 2001 Census) are that there are potentially substantial sections of the population who may potentially be exposed to waterborne pollutants. Approximately 38% of households in Maruleng and 40% of households in Geater Tubatse used water from a dam, pool or other stagnant source or from a river or stream as main source of domestic

water. Table gives the results of the question "What is this household's MAIN source of WATER for domestic use?" from the 2001 Census per municipality.

Table 3: Main source of domestic water. Households from the 2001 Census (10% sample)

Municipality	Regional / local water scheme	Bore hole	Spring	Rain-water tank	Dam/ pool/ stagnant water	River or stream	Vendor	Other
Greater Tubatse	35%	19%	2%	1%	8%	31%	2%	2%
Maruleng	44%	12%	2%	0%	17%	21%	1%	2%
Ba-Phalaborwa	82%	7%	1%	0%	8%	1%	1%	1%

Ba-Phalaborwa Local Municipality

Ba-Phalaborwa Local Municipality (LM) has a geographical area of 7461.6 km^2 and constitutes more than 27% of the Mopani District Municipality in the Limpopo Province (IDP, 2012-2017). There are four towns, 23 villages and 109 farms in the LM (IDP, 2012-2017). The town of Phalaborwa is considered as the provincial growth point (IDP, 2012-2017). The area is a gateway to the Kruger National Park and the Transfrontier Park through to the coast of Mozambique. The warm climate (temperatures range between 23 and 35˚C) and close proximity to the parks attracts tourists, and in the process creates jobs. Job opportunities have decreased since the copper mine in this mineral-rich area, which used to be the biggest contributor to the local GDP, has been scaling down. This may have a considerable impact in a LM where the unemployment rate is 38.8% (IDP, 2012-2017).

Ba-Phalaborwa Local Municipality's main water source is the Olifants River, because the groundwater in the area has a low yield and is of a poor quality (IDP, 2012-2017). The poor quality is due to contamination from poorly planned developments, pit toilets, cemeteries and dumping of waste (IDP, 2012-2017). Abstraction of water for developments, the mining sector and the agricultural sector puts pressure on the availability of water, while alien vegetation and the siltation of surface water due to erosion, exacerbate the problem. The

quality of surface water in the area is also not good, due to, amongst others, poorly managed sanitation facilities. About 20% of households (nearly 7 000) in the LM do not have any toilet facilities (IDP, 2012-2017). About 8% or 3000 households in the LM do not have access to electricity and 33% of households (11 240 households) have no refuge removal.

The Ba-Phalaborwa LM does not monitor any air pollutants and thus have no data available on air pollution (IDP, 2012-2017). However, there are sources of air pollution such as mining, a phosphate producing plant, brick works, other light industries, an airport, motor vehicles and about a third of all households in the LM still use wood for cooking and heating, (Only 60% of households have access to electricity) (IDP, 2012-2017).,

The total population of the LM was 127 307 in 2007, of which 41625 were below the age of 15 and 6800 above the age of 60. These individuals (at least 48425) are considered more vulnerable to environmental pollution. The 33 792 households had, on average, 3.8 individuals per household, thus no overcrowding. Houses mostly (88.1%) consist of a brick structure on a separate yard (IDP, 2012-2017).

There is currently (2011) only one public hospital situated in Phalaborwa, with 100 beds, five doctors and 187 nurses, that have to provide service to the entire LM (IDP, 2012-2017). There are however, also 10 clinics and four mobile clinics in the LM (IDP, 2012-2017).

The LM is situated in a malaria area and has four malaria control centres. AIDS, TB and Malaria are the diseases of main concern in the LM.

Maruleng Local Municipality

The Maruleng LM, situated in the Limpopo province within the Mopani District Municipality, is approximately 3247 km^2. Hoedspruit, which lies about 74km south of Phalaborwa is considered to be the administrative and economic centre of the LM. The South African air force is also based in Hoedspruit (IDP, 2009-2013). The area is part of the “tourism valley” and there are 70 lodges, 10 guest houses and 10 resorts in the LM. In addition to tourism, the area is dependent on agriculture and citrus, mango, vegetables, tomatoes, avocados and

onions are crops produced (IDP, 2009-2013). Pesticides are being used by the farmers and this contributes to the pollution of air and water.

There are 33 rural communities within the Maruleng LM and no refuse removal service is delivered to them. There is also no licensed landfill site in the whole of the LM. As can be expected, burning of waste is a major source of air pollution and waste is also illegally dumped in river water (IDP, 2009-2013). There are 24 589 households and 95769 people in the Maruleng LM. About 65% of the households have access to RDP standard water, 90% of the population have access to electricity and about 50% to sanitation (IDP, 2009-2013). About 40% of the population is below the age of 15 years and 4% above 65, forming an age-related vulnerable population of 44%. In the order of 10 000 individuals are unemployed and more than 70% of the households have to survive on less than R 800 per month (IDP, 2009- 2013). The unemployment rate is most probably related to the fact that almost one third of the population has no schooling. Because the people in the LM are so poor, walking is their main form of transport (IDP, 2009-2013).

Housing in the Maruleng LM consists mostly (about 90%) of brick houses on separate stands and as far as access to health care is concerned, it is evident that more than 70% of the population in the Maruleng LM lives within 20 km from a health facility. The LM houses one hospital and nine clinics (IDP, 2009-2013). The prevalence of HIV/AIDS in the LM is estimated at about 27%, which is about 4% higher than for the District Municipality. Other diseases prevalent in the area are diarrhoea, pneumonia, TB, malaria and sexually transmitted diseases.

8 Summary and conclusions

From the World Health Organization statistics it is clear why Hasselt and Chapman (2012) came to the conclusion that the under-capacitated health sector and the continuous struggle with infectious diseases that become drug resistant, such as HIV and TB, are contributing to the fact that “the Southern African Development Community (SADC) health sector is not sufficiently prepared for the adverse public health impacts of climate change,”

despite the fact that Africa is considered the most vulnerable to climate change, because it can hardly cope with the current .

Malaria, cholera and malnutrition, are climate sensitive diseases that are already a concern in the SADC region. It seems (from the WHO 2012 stats) that the burden of these diseases is higher in Mozambique compared with South Africa.

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10 Appendices

Table 1 World Health Organization statistics on Mozambique, South Africa, The WHO African region and global

World Health Organization (WHO). 2012. World health statistics 2012. ISBN 978 92 4 156444 1

Demographic and Socio-economic

Risk factors	Mozambique	South Africa	WHO African Region	Global
Population (2010)	23 301 000	133 000	836 970 000	6 860 318 000
Population % <15 (2010)	44%	30%	42%	27%
Population % >60 (2010)	5%	7%	5%	11%
Annual growth rate % (2000 – 2010).	2.5%	1.1%	2.4%	1.2%
% in urban areas (2010).	38%	62%	38%	50%
Crude death rate per 1000 people (2009)	15.3%	13.3%	12.3%	8.4%
Literacy rate among those >15 years (%) (2010).	55%	89%	63%	84%
% Population living on <$1 a day (2009).	60%	17%	43%	23%
Cellular subscribers per 100 people (2010).	31%	100%	48%	78%
Life expectancy at birth (2009).	49	55	54	68
Infant mortality rate 2010 MDG no 4	92	41	75	40
Under 5 mortality (2010) MDG no 4	135	57	119	57
Percentage of children <5 who died from the following in 2010:				
AIDS	10%	28%	4%	2%
Diarrhoea	9%	5%	11%	10%
Measles	1%	1%	1%	1%
Malaria	19%	0%	15%	7%
Pneumonia	15%	11%	17%	18%
Injuries	3%	4%	4%	5%

Maternal mortality/100 000 live births	490	300	480	210
Specific mortality per 100 000 cases AIDS (2009) Malaria (2008) TB among HIV negative people (2010)	 325 171 49	 627 0.2 50	 160 94 30	 27 12 15
Morbidity incidence (new cases) per 100 000 AIDS (2009) Malaria (2009) TB (2010)	 581 32978 544	 773 32 981	 217 217537 276	 39 33 327 128
Prevalence (existing cases) per 100 000 AIDS (2009) TB (2010)	 5 985 491	 1118501795	 295850232	 502 178
Infectious diseases: cases Cholera (2010) Malaria (2010) Measles (2010) Rubella TB	 7 430 1 522 577 2 321 70 43 558	 No data 3875 No data No data 354data	 109 549 189dat 811 186 675, 2 754 1 380ta94	 317 528 23 572a138 327 305 76 025 5 7535a44

Health care service delivery

Risk factors	Mozambique	South Africa	WHO African Region	Global
Antenatal care coverage (%) (2011)	No data	No data	43%	55%
Births attended by skilled health personnel (%) (2011)	55%	No data	48%	69%

Immunization coverage for measles among 1-year-olds (%) (2010	70%	65%	76^	85%
Children aged 6–59 months who received vitamin A supplementation (%) (2010)	No data	No data	59%	46%
Treatment-success rate for smear-positive tuberculosis (%) (2009)	No data	No data	80%	87%

Risk Factors

Risk factors	**Mozambique**	**South Africa**	**WHO African Region**	**Global**
Population using improved drinking-water sources (%) (2010)	47%	92%	63%	89%
Population using improved sanitation (%) (2010)	18%	79%	34%	63%
Population using solid fuels (%) (2010)	95%	15%	77%	41%
Low birth weight newborns (%) (2010)	16%	No data	13%	15%

Nutritional status

Risk factors	**Mozambique**	**South Africa**	**WHO African Region**	**Global**
Children < 5 Stunted (2011)	44%	24%	No data	27%
Children < 5 Under weight (2011)	18%	9%	No data	16%

Children < 5 Over weighted (2011)	4%	No data	No data	7%
Prevalence raised fasting blood glucose (adults ≥25 years) (%) (2008)	8%	12%	8% (male) 9% (female)	10% (male) 9% (female)
Prevalence of raised blood pressure among adults aged ≥25 years (%) (2008)	46% (female) 41% (male)	35% (female) 41% (male)	Female (35%) Male (38%)	25% (female) 29% (male)
Alcohol consumption among adults aged ≥15 years (litres of pure alcohol per person per year) (2008)	2.3	10.2	No data	No data
Prevalence of smoking any tobacco product among adults aged ≥15 years j(%) (2009)	2% (female) 18% (male)	8% (female) 24% (male)	3% (female) 17% (male)	36% (female) 8% (male)
Prevalence of current tobacco use among adolescents aged 13–15 years (%)	7 % (female) 13 % (male)	20 % (female) 29% (male)	13 % (female) 20 % (male)	11% (female) 18% (male)

Health workforce and infrastructure

Risk factors	**Mozambique**	**South Africa**	**WHO African Region**	**Global**
Physicians (per 10 000 people) (2010)	0.3	No data	2.2	14.2
Environmental & public health workers (per 10 000 people) (2010)	No data	No data	0.3	No data

Hospital beds and Psychiatric beds (per 10 000 people) (2011)	7 and 0.2	No data and 2.2	No data and 0.6	30 and 2.5
Median availability of selected generic medicines (%) (2009)	Public: no data Private: no data	Public: no data Private: 2.2	Public: no data Private: 0.6	Public: 30 Private: 2.5
Total expenditure on health as % of gross domestic product (2009)	5	9	7	9
Private expenditure on health as % of total expenditure (2009)	27%	56%	51%	41%