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Challenges of River Pollution in the Dora Community, Mutare (Zimbabwe)

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Abstract: The Dora communal lands which are home to over 2000 peasants is heavily dependent on water sources for their daily lives. This study was conducted in July, 2018 in order to examine the challenges and possible solutions to the problem of river pollution in the Dora community, Mutare. The Sakubva River is heavily polluted through human activities along its course; the Dora River is downstream of the Sakubva River and is subsequently fed polluted water by the Sakubva River. Despite the potential health hazards, impacts on livelihoods that the pollution of water bodies has for the locals who use the water, river pollution persists. A mixed methods approach specifically the use of questionnaires and water sampling results were used in the data collection process. Questionnaire data were captured, coded and entered into SPSS and then analyzed using descriptive statistics. Results were then presented using tables, graphs, statistical coefficients that were supplemented using narratives descriptions. Respondents noted odors, health problems, algal blooms, changes in color of water and accumulation of slurry as the major indicators of river pollution. Respondents also pointed out the major sources of pollution and what they think should be done to deal with these problems. The study concluded that the pollution of the Sakubva and Dora rivers has impacted gravely on the social and economic environments of the Dora communities. The research also shows that there is awareness on river pollution but there is no community involvement and assistance in dealing with problems of river pollution.
Keywords: River pollution, Causes, Challenges, Effects, Solutions, Dora Community.

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Introduction

Water is a critical factor to the integrated and cooperative socio-economic development of the SADC region. Water is an extremely basic piece of our livelihoods as each living and non-living part of the earth needs it for ordinary fundamental processes to occur. The changing of its quality in any case, mutilates or totally decimates the regular habitat and the organisms that thrive within it. Zimbabwe has 7 river catchments, which include: the Runde, Sanyati, Manyame, Gwai, Mzingwane, Save and Mazowe. Just like most nations in the SADC region, Zimbabwe is a developing country with rapid urbanization and industrialization. During the last three decades, it has experienced massive rates of urbanization, in comparison with other nations in the region (Zinyama, 1994). In order to achieve stable development, people need to balance the economic development and environment bearing capacity (Yan and Wei, 2000).

However, due focus has mainly been on development overlooking sustainable development. The most pressing issue of these developments is water pollution particularly river pollution.

It has become apparent in Zimbabwe that water pollution is a pressing issue because of the existing known effects, the rather late solutions being adopted in a bid to curb an already spreading problem. Industrial pollution of rivers was one of the first and most recognizable instances of environmental pollution. Following the industrialization and urbanization, many waterways, rivers and reservoirs suffered dramatic impacts of factory discharges, sewer bursts and beginning in the last two decades, governments made serious attempts to regulate. The main source of water pollution along the Dora River is the city of Mutare, the fourth largest city in Zimbabwe. Located within a range of mountains and hills the city now occupies about 16 700 ha of land (City of Mutare, Department of Housing and Community Services, 2002). The population of the city is ever increasingly as evidenced by the continued urban expansion into peripheral areas. It is predicted that by 2025 Malawi and South Africa will be facing absolute water scarcity, whilst Lesotho, Tanzania and Zimbabwe will be hugely water stressed (Wilson, 1990).

Forecasts are based on data on water pipe bursts and rates of water pollution. The focus of this study is the Dora communal area an area on the periphery of Mutare urban. The relationship that exists between Mutate and Dora communities cannot be overlooked because the Dora communities are highly dependent on Mutare urban for services. However, the Dora communities are on the receiving end of a bad relationship since much of the river pollution that occurs along their major source of water, the Dora River is attributed to the malpractices in the City. The Highly polluted Sakubva River which navigates through the city and the industrial areas subject to unprecedented industrial pollution and constant sewer bursts directly feeds into Dora River. The River supplies water for much of the population in the communities, livestock accounts for much of the water demand. The water supply in the Dora communities is also supplemented by boreholes and wells. The major land use activity in the area is agriculture including livestock farming and use of water from the river for stock watering.

The semi-arid climate in the Dora communities coupled with the high demand and significant population growth meant that dependency on primary water sources increased. City councils are typically a major drawback with regards to water and effluent management. In high density areas sewage bursts are noticeable and the overflow of sewage at times affects water sources. This prompts various sicknesses like cholera which are lethal to individuals and animals. Eutrophication can likewise happen if the sewage water finds its way into substantial water bodies and this will choke out animals. Vegetation will likewise be affected as overgrowth causes competition for nutrients. This brings about the necessity for an assessment of the extent of challenges of river pollution in the Dora communities and the solutions that can be adopted.

Research Methods

This research was conducted in July, 2018 and it involved the use of mixed methods including both quantitative and qualitative data collection techniques. Triangulation of methods was useful because the researchers needed to get both statistical and on the ground perspectives of the impacts of river pollution on people's lives. Two main methods were employed in the collection of data, namely quantitative and qualitative. If the different research methods come to the same conclusion, the researcher could be more confident that the results are truly a reflection of what is actually happening and not a reflection of the

method of testing used to gather the data. Quantitative research methods use a standard format, with a few minor inter-disciplinary differences, of generating a hypothesis to be proved or disproved. Quantitative methods emphasize objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires, and surveys, or by manipulating pre-existing statistical data using computational techniques (Sieber, 2003). Quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon. An entire quantitative study usually ends with confirmation or disconfirmation of the hypothesis tested. Water analysis data was obtained from the environmental management Agency which has broad monitoring systems of water resources. The monitoring system is known as ambient water monitoring which involves water collection for testing on a monthly premise. The process is constant which allows for trend analysis to observe changes over time.

Qualitative methods involved the use of interviews and questionnaires. It sought to explore a wide array of dimensions of the social world, including the texture and weave of everyday life, the understandings, experiences and imaginings of the research participants, the ways that social processes, institutions, discourses or relationships work, and the significance of the meanings that they generate (Mason, 2002). Qualitative data collection methods vary using unstructured or semi-structured techniques. Some common methods include focus groups, individual interviews, and participation and observations. The sample size is typically small, and respondents are selected to fulfill a given quota (Schulman, 2005). The data collected was then analyzed in order to yield the views which are expressed in this study.

Study Area

The Dora community is a peri-urban communal land that lies between 15 to 40 kilometres from the City of Mutare. It is on the downstream of Sakubva River which feeds into the Dora River with over 2000 peasant farmers who depend on the water for domestic and non-domestic uses. The farmers are exposed to numerous health risks from polluted water. For survival, the community depends on market gardening, livestock keeping, farming and river sand extraction in Sakubva and Dora River for sale, the community is at high risk of contracting diseases and other related problems as they are in constant contact with polluted Sakubva River and Dora river water.Sakubva River. Sakubva River which is the main source of pollutants drains through Mutare City passing through industrial, residential and agricultural areas. It is polluted mainly by sewage, industrial waste and leaching from agricultural activities. Dora community constitutes Ward 5 of the Mutare Rural District Council in Manicaland Province.

Mutare is one of Zimbabwe's eight cities. It occupies the fourth position in the country's settlement hierarchy (Mapira, 2001) and has a population of 187 621 according to the last national census, which was conducted in 2012 (CSO, 2012). However, more recent municipal estimates peg the figure at 200 000 (City of Mutare Housing and Community Services department, 2018). Located within a range of mountains and hills the city now occupies about 16 700 ha of land (City of Mutare Department of Housing and Community Services, 2002). Most of the built-up area lies within the Sakubva River basin and its tributaries including the Nyapfumbi, which drains the main industrial areas. Sakubva River is a tributary of the Odzi, which in turn drains into the Save, one of Zimbabwe's major rivers. Consequently, the pollution of the Sakubva is a cause for concern at both local and national levels. The city of Mutare pollutes river water in at least three ways, namely by sewage, industrial and institutional waste (Mukokeri, 1999). Household detergents, which are fed into sewages, are a

major threat to human health and aquatic life. Downstream is the Dora River a water source for the Dora community. Sakubva River feeds polluted water into Dora River which is a primary source of water for this community.

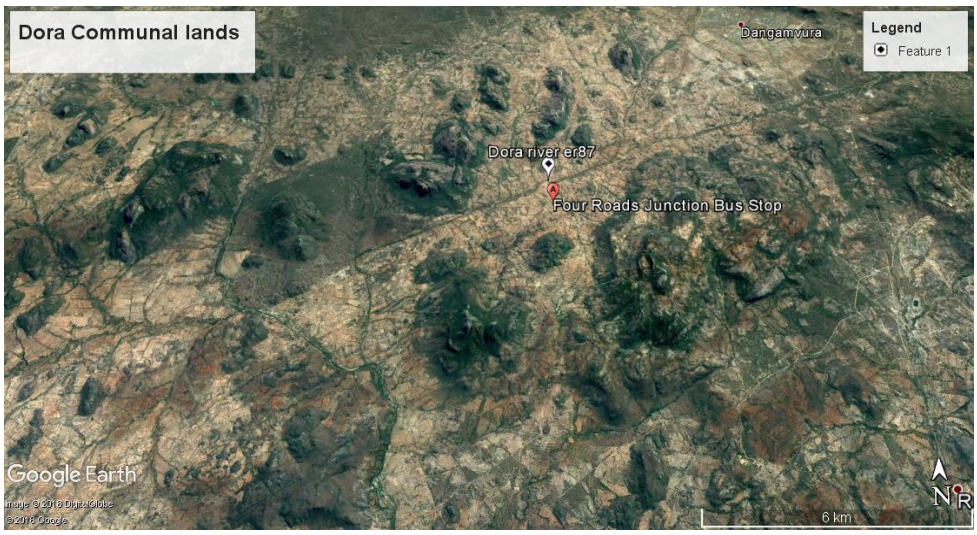

Figure 1. An extract Map of Dora communal lands

Discussion and Analysis of Results

This study quantified major water, nitrogen and phosphorus flows into Sakubva and Dora rivers, through a water quality monitoring study. The results showed that wastewater effluent is the major source of nutrients in the rivers. The rivers are hypertrophic and it has to be concluded that the current situation is not sustainable. The Dora River is a major source of water supply for the Dora communities and neighboring communities and *eutrophication* would affect water treatment, aquatic life, and irrigation systems. Questionnaires were also used to dwell more on people's perceptions and feelings and what they think should be done. Information on how their livelihoods have been affected by the ongoing pollution was established through physical and chemical parameters which were measured to establish the extent of water pollution in the Sakubva and Dora Rivers to determine how it affects the water quality suitability for various uses. The parameters examined during the study were pH, dissolved Oxygen, dissolved oxygen, temperature, manganese, iron, E. conductivity, Nitrates, Phosphates (Table 1). Water samples were collected for points ER8, ER10, ER12, ER13, ER87, ER88 along the Sakubva and Dora River respectively. ER8, ER10, ER12, ER13, are all points along Sakubva River; ER86 and ER88 are all points within the Dora River in the Dora Communal lands.

Table 1. Classification of risk SI 6 of 2007 (EMA standards)

Classification	Risk	Reason for classification
Blue	Safe	Complies with blue standards
Green	Low hazard	Waste meets green or blue permit conditions not being met
Yellow	Medium hazard	Waste meets yellow standards
Red	High hazard	Waste meets red standard

In line with EMA Organizations which seek to discharge their waste on land or in natural water courses, are obliged to apply for /permission from the Environmental quality

department of EMA (Masocha and Tevera, 2003). Failure to do so constitutes a crime. Permits 'attract penalties, which are based on the degree of risk that the waste poses to the environment' (Mapira, 2007:90). In its classification, EMA uses four categories TABLE which includes: Blue (Safe), Green (Low Hazard), Yellow (Moderate Hazard) and Red (High Hazard).

Table 2. ER8 Sakubva River at Grants service station (Environmental protection Unit, EMA Mutare)

Parameter	Recording
dissolved oxygen saturation%	77.5
E. Conductivity uS/cm	254
Iron mg/I Fe	0.39
Biological oxygen demand mg/l	17.53
manganese mg/I Mn	0.58
pH	7.55
phosphates mg/I P	0.13
Nitratesmg/I N	10.9
Band class	Red

Phosphates and nitrates are the causes of eutrophication in many rivers, results for phosphates and nitrate tests results were obtained from the environmental management agency for ER8 which is upstream of Sakubva River before the water reaches Dora River. The phosphate levels are in the green band in reference to EMA standards, a reading of 0.13mg/IP was recorded. The green class is considered to be telling of low environmental hazard and if left unmonitored the situation could be acerbated. However, these phosphate levels in huge concentrations downstream can still pose a great deal of problems for the Dora communities downstream as evidenced by the blue-green algae, principally *Microcystis aeruginosa* and *Anabaena* sp, upstream of Dora River. Nitrate levels of 0.77mg/N which is in the blue band of less or equal to 10 were recorded. According to SI 6 OF 2007 this is the sensitivity range. SI 6 OF 2007 notes that sensitive areas are areas which may in the near future if not protected contain a nitrate level of more than 10mg/N which may in turn cause eutrophication of a river. In all rivers, TP was higher than the limit of 0.03 mg/l required for avoiding excess plant growth in rivers and streams according to OME Guidelines (OME Guidelines, 1991). The overall band class for ER8 is a strong Red class pointing towards strong pollution levels.

Table 3. ER 10 Sakubva River Bridge to NOIC refinery (Environmental protection Unit, EMA Mutare)

Parameter	Recording
dissolved oxygen saturation%	26.9
E. Conductivity uS/cm	379
iron mg/i Fe	1.01
Biological oxygen demand mg/l	55
Manganese mg/I Mn	0.52
ph	7.64
phosphates mg/I P	1.01
Nitrates	0.98
Band class	Red

The pH of the Sakubva river ER10 sampling station was found to be acceptable within the limits of WHO guidelines (≥ 6.5 and ≤ 9.5). The BOD for ER10 is comparatively high, exceeding the maximum threshold for BOD (50mg/l) and set by the EPA and being in the yellow class according to EMA standards which is not ideal for bolstering aquatic life such as Fish.

The high values of BOD at the sampling site indicate that the water has a low potential to support aquatic life. ER10 is the last sampling station before the Sakubva River flows into the Dora communal lands. The colour of the water at this sampling point is blackish, subsequently the Dora River is fed this polluted effluent affecting the nutrient balance and affecting aquatic life.

Although bacteriological tests on faecal coliform count of the water were not carried out due to financial constraints mere observation showed a high feacal content count. Faecal coliform count gives an indication of pollution being caused by human waste (Rangwala *et al.,* 2007).

The Dissolved oxygen levels are also comparatively low in relation to EMA and EPA standards standing at 26%. Oxygen usage in water systems takes place through microbiological processes which are particularly important in relation to Biodegrading of organic matter, DO mass balance and Dissolved oxygen depletion (Hvitved-Jacobsen *et al.,* 2010). In reference to the tests conducted by EMA on 20/06/2018 ref 183264-287 ER10 was given an overall red class which suggests that pollution is of high hazard to the environment, human beings and animals downstream in the Dora communities.

Table 4. ER12 Sakubva River after Gimboki sewage plant (Environmental protection Unit, EMA Mutare)

Parameter	Units	Recording
Biological Oxygen Demand	Mg/l	7.76
Dissolved Oxygen	Saturation %	27.1
E. Conductivity	Us/cm	326
Iron	Mg/I Fe	0.39
Manganese	Mg/I Mn	0.35
Nitrates	Mg/I N	11.43
Ph		7.84
Phosphates	Mg/I P	0.40
Band Class	-	Red

ER12 is a sampling point soon after the Gimboki sewage treatment plant, the plant processes raw sewage and assimilates it back into the environment through direct discharge into the Sakubva river. The output water of the plant has a bearing on the quality of the water in the Dora river. The saturated dissolved oxygen levels are also alarming at this point being as low as 27.1 which according to EMA standards is in the yellow band ≥30, the phosphaste levels of 0.40 mg/l P are also enough to promote overgrowth of plants downstream in the Dora communities.

Recently there have been problems with Gimboki sewage power plant, issues related to capacity, performance and efficiency. Gimboki treatment plant has an operating capacity of 41 Megaliters per day but it receives a projected 90 megalitres per day which is way beyond

its capacity. The plant is not operating at full capacity because of the obsolete infrastructure, out of the sixteen aerators only one is operating. Constant power cuts also play a role because the motors pumps are electrically powered, the sludge cannot be pumped so it is spread on the leeward side of the treatment plant where it is washed into Sakubva River. The sludge contains organic material and nutrients that have an agricultural value but also some pollutants in the form of heavy metals, organic contaminants and pathogens. The raw sludge, generated from different steps in the wastewater treatment process, is unstable and contains high amounts of water. Jordan, 1984 noted that treatment plants are expensive to maintain, this is particularly with the case of developing countries, where due to poverty, municipal budgets are often under strain. The poor outlet water from the treatment plant affects the people downstream in the Dora communities to a larger extent.

Table 5. ER 86 Dora River at Four roads

Parameter	Units	Recording
Biological Oxygen Demand	Mg/l	15.51
Dissolved Oxygen	Saturation %	52.9
E. Conductivity	Us/cm	403
Iron	Mg/I Fe	0.86
Manganese	Mg/I Mn	0.70
Nitrates	Mg/I N	0.10
Ph		7.34
Phosphates	Mg/I P	0.03
Band Class	-	Red

ER 86 is a sampling point within the Dora Community, the river is primarily used for domestic and agricultural purposes. The community is highly dependent on agriculture and livestock keeping however the progressive pollution of the Dora River by upstream activities along the Sakubva River has since seen the water quality being compromised.

The Dora River receives the bulk of wastewater treatment plant effluent from Mutare via upstream rivers such as Sakubva River. Non-point source export of nitrogen and phosphorous ffom the local agricultural activities and urban agriculture contributes to the nutrient content on the Dora River. The Dissolved oxygen levels are minimal at 52.9 percent hence fisheries are constantly being affected, most fish are sensitive to DO levels of below3 mg/l (Weich and Lindell, 1980; Mara, 1996).

DO is not one of the critical parameter in determining water suitability for agricultural use, as said by Hopkins *et al*., (2007), however DO levels influence the rate at which aquatic plants grow, which have implications on agricultural operations, such as clogging of pipes and *eutrophication* of irrigation water. The high organic content in the Dora River often taints the water with a distinctive taste hence the people in the community have resorted to the use of boreholes and wells as primary sources for drinking water.

The overall band class for ER 86 is red class which is a high environmental hazard and telling of possible eutrophication in the near future. *Eutrophication* of water bodies is undesirable because of deterioration of water quality, interference with most of the beneficial uses of water, and corresponding economy losses. Observations at sampling point ER 86 showed evidence of the presence of alga blooms, odors and a blackish color in the water. Ideally mere

observation showed that the water is highly polluted further cemented by the overall band class of red as observed in the laboratory results (ER 8617/10/17 REF 175948-958).

Table 6. ER87

Parameter	Units	Recording
Biological Oxygen Demand	Mg/l	55
Dissolved Oxygen	Saturation %	27.8
E. Conductivity	Us/cm	157
Iron	Mg/I Fe	0.32
Manganese	Mg/I Mn	0.08
Nitrates	Mg/I N	0.96
Ph		7.51
Phosphates	Mg/I P	0.02
Band Class	-	Red

ER 86 is a sampling point at the confluent of Sakubva and the Dora River; it is the point where the Sakubva River Drains into the Dora River with all the pollutants accumulated through its flow from the City of Mutare.

The overall band class for this point is Red with extremely low Dissolved oxygen content; further more BOD levels are in the yellow band which implies low potential to support aquatic life.

Biological oxygen demand (BOD) indicates that there is organic overload of the effluent and shows how much oxygen the effluent or water requires to be stable. Using this indicator, and comparative analysis of all the sampled points (they all lie in red band class) it can be concluded that both the Sakubva and the Dora River are *eutrophic* or have the potential to become *eutrophic*. Ideally the rivers can therefore not support aquatic life.

The relationship between Sakubva and Dora rivers

One of the aims of this study was to pin point the sources of pollution in the Dora communal lands. Sakubva River is the main source of pollutants for the downstream communal lands in the Dora area.

The Graph below shows a comparison in the nitrate and phosphates levels between the Dora and Sakubva River, the sharp decline in the nutrient levels towards the Dora River proves that the Sakubva River is responsible for polluting the Dora communal lands.

The Dora River can still be protected from further nutrient pollution with proper pollution control measures. Urban agriculture should be stopped, industries should be penalised for polluting the Sakubva River, industries should treat their waste before discharging it and the Gimboki sewage treatment plant has to operate at full capacity to avoid disposal of pre-treated waste water into the Sakubva River.

Other parameters like Dissolved oxygen concentration showed variations at the different points along the rivers this can be attributed to turbulence, temperatures, and atmospheric pressure and/or biological activities at the various points along the Canal, as suggested by Chapman (1996).

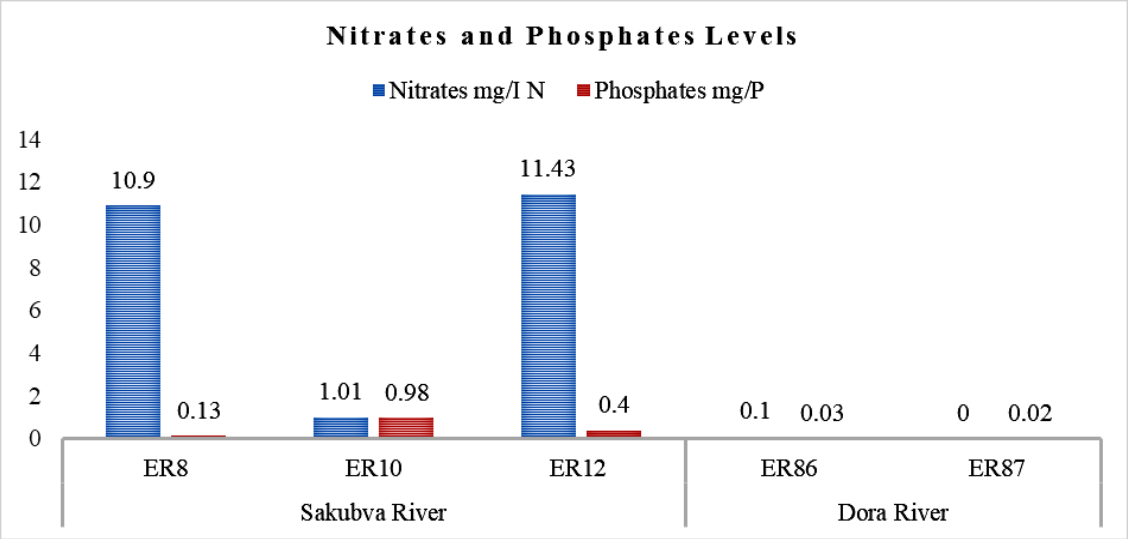

Figure 1. Graph showing the difference in Nitrate and phosphates levels between Sakubva and Dora River

A total of 16 respondents which accounts for 53.3% of the sampled population were of the opinion that the water from the Dora River affects their livestock and agricultural produce. Toxicity elements in water affect agricultural produce, accumulation of nutrients in plant roots affects the growth thereby reducing yield. Due to climatic variations between seasons water from the Dora River is used for irrigation purpose to supplement during poor rainfall seasons. Livestock is also affected, mysterious deaths of livestock especially cattle, goats, donkeys and sheep in the area were some of the major concerns. Livestock mortality is disastrous to the community, cattle and donkeys are the main sources of draft power in Dora communal lands, hence their death affects agricultural produce. Some of the respondents purported that they noticed parasitic worms in cattle excreta which they attributed to be caused by water from the Dora River. Thirteen of the respondents which accounts for 43.3% of the sampled population were not sure if the water from the Dora River affects their livestock and agricultural produce.

Slurry harvesting

The escalating prices of fertilizer, has turned dried slurry to become an alternative among the villagers particularly those who live along the river (about 33.3% of the sampled population). The conversion of thick viscous wastewater into solid is greater than would be the case with thinner wastewater. Such an activity is usually done on sandy or rocky surfaces where the liquid byproduct is allowed to seep and allow a solid residue to be harnessed and left for drying. Water cress is also thriving in the dirty water and is a locally available source of relish with some possible health hazards like the catfish which are increasing in the population which is adapting to the river conditions including hibernating in the mud. There is bio-accumulation of chemicals in their body which have not been assessed, the nutritional value of such food is questionable though no nutritional assessment has been done.

Recommendations

Several recommendations can be made concerning river pollution in Mutare.

- This study has identified the importance of public engagement in changing the future of the Dora community, responsible authorities such as EMA and the City Councils will act if sufficient public concern is generated. There is a need for projects on the

Dora Community to be translated and communicated to the public, the community engagement presents a platform to make this a possibility.

- The faecal contamination reported in this investigation exhibits the high levels of pollution. Previous contamination had been linked to industrial activities, but the study demonstrated significant levels of pollution from Gimboki sewage plant. It is attributed to identified damaged infrastructure becoming worsened by the current economic situation. The pollution faced by the Dora community is believed to be under threat by further urbanization in combination with an unreliable sewer system. There is a risk that identified under-performing infrastructure will become overwhelmed and deteriorate further. There is need to channel the few available resources towards the expansion of the Gimboki sewage treatment plant.
- The polluter pays principle is not effective since pollution is still on the rise since its formulation in 2002. It has proved to be ineffective in curbing pollution in the country, many organisations and industries find it cheap to pollute than to pre-treat effluent before discharging it into the Sakubva River. There is need to introduce economic instruments in pollution control. Incentives and subsidies are some of the instruments that can be used.
- It is common knowledge that the leading causes of *eutrophication* are phosphorous and nitrates. A number of specific measures can be adopted to deal with nutrient problems from sewage effluents. Legal instruments relating primarily to the control of point sources of nitrate and phosphate from sewage works. The nutrient control measures there in should comprise a requirement to add tertiary treatment (nitrate and phosphate removal) to plants which discharge into "sensitive areas"(EMA notes them as areas with the potential to become *eutrophic*). It has to be decided to concentrate on phosphate removal for treatment plants discharging to inland waters and nitrate removal for treatment plants where the effluent enters marine waters (representing the critical elements for *eutrophication* in the respective situations).
- Sakubva River has proven time and again to be polluting the Dora River waters through the unsanctioned activities that occur along the river as it drains through the city of Mutare. This study has demonstrated that the situation has persisted for the last decade. Continued support is needed, the people of the Dora community have to be educated and provided with alternate water sources especially during the dry seasons. With regards to the formation of solutions to combat this damaged community there is a need to conduct an ecological impact assessment to understand the implications of the localised pollution on biodiversity and wildlife productivity.

Conclusions

This study argues that river pollution has impacted on the livelihoods of the Dora community and has brought more problems than benefits to the community. Through the many analysis and questionnaire data, we can prove that there are high levels of pollution. Mutare city is the main source of pollutants. This relationship between Mutare urban and the Dora communal lands cannot be overlooked. Urbanization and industrialization have exacerbated the level of water pollution. Conversely, Water pollution causes more losses in economics and health, and it affects the livelihoods of the Dora people.

Urbanization and industrialization have been consequential, there has been an increasing pressure on the environment with pollution from human activities increasing and threatening the welfare and livelihoods of the Dora community. A number of natural resources have been affected and water is one of them. The levels of pollution have reached unprecedented levels measures have to be taken.

The industries and local authorities overlook that the protection of the environment is a precondition of all development. So the second focus of this dissertation is to suggest the government to pay more attention to the environmental protection, and strengthen the related policies on discharging polluted water without treatment, involve communities in resources management and help those affected. The government also needs to improve the technology of pollution treatment and shift industry structure. Development which compromises health and livelihoods is baseless.

About the Authors

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