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A NEED TO EXPLORE POSSIBLE MITIGATION MEASURES TO IMPROVE AIR QUALITY FOR COMMUNITIES IN CLOSE PROXIMITY TO THE WASTEWATER TREATMENT PLANT

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ABSTRACT

This review paper compiles and discusses the occurrence of odour released from a water waste treatment plant (WWTP) and its impact to those who reside relatively close to such sites .It investigates the health impacts due to emissions released and also indicates the means people use to mitigate odours. This paper used a mixed method approach based on informal interviews, questionnaires and observations from the study area. Results reveal that there are a number of health ailments (e.g. numbness of hands and feet, vision, olfactory and respiratory problems) that people present due to their close proximity to the WWTP site. The WWTP works indicated that they have tried to improve their systems however those interventions are likely not recognised by the communities exposed. The municipality involved has in the past 9 years after occupancy from the low cost housing planted what they estimate to be 1800 trees that were meant to improve the air quality however died from negligence. Therefore the only remediation method that people use to keep the odour at bay was closing the doors and windows. The methodologies applied by the people exposed to musk the odour appear to be non-efficient; this indicates a clear need to develop new effective and cost-efficient remediation approaches beneficial for human health at an extent which is in the same order of magnitude of damage caused by air pollution.

Keywords: environmental impact assessment, health impact assessment, air quality, municipality responsibility, mitigation measures

INTRODUCTION

People often suffer from the diseases of non-biological causes some of which are a result of negligence, noncompliance and environmental exposure, associated with their environment. Environmental exposures occur when people, animals and the physical environment come into contact with the hazardous substances. These substances may remain in the environment for a long time to contribute to a range of health concerns. Chemical (gaseous) emissions from

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

wastewater treatment plants (WWTP) are perceived as odour and can generate undesirable health reactions. These could affect the quality of life to those albeit intermittently exposed, although regular exposure may result in tolerance and loss of recognition of the odour (Zarra *et al.*, 2008). According to Kampa and Castanas (2008) air pollutants are associated with adverse health impacts.

Nicell (2009) indicates that the public usually reacts to objectionable odorous episodes by registering complaints with the local authorities (e.g., municipal by-law officers, police, and fire or health units), regional government agencies, and/or the personnel associated with an odour-emitting operation. The extent of odour annoyance is evident from complaint statistics collected over a number of decades. For example Nicell (2009) indicates that, the United States National Research Council Committee on Odours (1979) estimated that more than 50% of the complaints related to air pollution deal with exposures to odours. More recently, an analysis of the 25 responses to a survey of regulatory agencies in the United States of America (USA) indicated that in 1994 more than 60% of air pollution complaints were related to odours with an estimated total of over 12, 000 registered complaints (Leonardos, 1995). These complaints originated from impacts associated with a wide variety of industries and operations including agriculture, wastewater treatment works, and landfills, among others. It has been claimed that the growth in the number of complaints has risen due to the increasing number of persons that are being exposed to odours as a result of the creation of new or expanded facilities that emit odours (Nicell, 2009).

Brunner and Fellner (2007) agree that the location of any WWTP should be as far as practical from public dwelling places making it quite crucial that sufficient land (buffer zone) is set aside to allow for any future alterations that there is no offensive odour detected at the property boundary to protect citizens. It is however lugubrious that WWTP's are built in close proximity to residential areas in a number of towns across South Africa. South Africa is currently dealing with a number of diseases such as HIV/ AIDS and T.B. which can be aggravated further to those affected if proper environmental care is ignored (MHC, 2008). Generally if you are young and in a good state of health, moderate air pollution levels are unlikely to have any serious short term effects. However, elevated levels and/or long term exposure to air pollution can lead to more serious and conditions affecting human health (Morgan, 2011).

Considering South Africa's need for economic growth, the Environmental Impact Assessment (EIA) is a helpful tool to prevent development from being held back by environmental concerns. There is a requirement for comprehensive scoping (assessment identifying key issues) and emphasis on extensive public participation followed in the EIA process. When a competent authority or a developer undertakes scoping there are three key questions to be answered: What

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

effects could this project have on the environment? Which of these effects are likely to be significant and therefore need particular attention in the environmental studies? Which alternatives and mitigating measures ought to be considered in developing the proposals for the project? Therefore if the process of EIA is properly followed there are usually few awaiting surprises in the future (DEAT, 2003).

According to Harris (2009), internationally the inclusion of health within EIA has shown to be limited. Advocates of public health have been interested in the inclusion of public health in EIA for a range of reasons to protect people and the environment (Wärnbäck and Hilding-Rydevik, 2009). However for the past 20 years empirical research into EIA practice and documentation has consistently revealed lack of coverage and deficiencies in consideration of health (Harris 2009). An empirical study of 42 environmental impact statements found that more than half contained no mention of health impacts. In others, health impacts were analyzed narrowly, if all, indicating poor integration. Huang (2012), states that Health Impact Assessment (HIA) has played an important role in environmental protection in China however there's insufficient professionals in the HIA practice and there's largely a great demand for HIA with the large scale infrastructural development involved.

In general, WWTPs were not specifically designed to limit odour in the area immediately surrounding the site boundary. Many of the sites were therefore built in areas that were remote from sensitive receptors. The close proximity any proposed development to the wastewater treatment plant is a concern. The odours produced in the "noxious zone" will not stop at the fence line. This is why it is internationally recognized that in order to minimize odour annoyance a separation distance between the odour source and residential areas is required (Schauberger *et al.*, 2012). According to Du Preez *et al*., (2006) cost effective measures can be implemented at WWTP sites to control odour intensity or frequency however the community might still not recognize the efforts if odours are still being observed. Other scholars such as Nicell (2009) argue that there's a need for assessment and regulation of odour impacts. Exposure to air pollutants is largely beyond the control of individuals and requires action by public authorities at the national, regional and even international levels.

The noticeable gases that are perceived as odour released from the WWTPs can have a damaging impact on the quality of life to those who reside close by. Sulphur Dioxide (SO_2) is one of the gases released from the WWTP, that is an irritant absorbed in the nose and aqueous surfaces of the upper respiratory tract, and is associated with reduced lung function and increased risk of mortality and morbidity. Adverse health effects of SO_2 include coughing, phlegm, chest discomfort and bronchitis. According to Al-Shammirri (2004) inhalation of low levels of Hydrogen Sulphide (H_2S) can cause headaches, dizziness, nausea, cramps, vomiting, diarrhea,

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

staggering, muscular weakness and drowsiness. Prolonged exposure to 50 ppm can cause bronchitis and pneumonia. Levels of up to 250 ppm can lead to numbing of extremities and death due to respiratory paralysis. Mercury (Hg) on the other hand has long been recognized as toxic, principally targeting the kidneys, central nervous system and thyroid glands following acute or prolonged high-level occupational exposures (Holmes 2009).

The degree to which a respondent reacts to a nuisance, such as odour, depends on five factors, the so called FIDOL factors (Nicell, 2009). These are frequency (F), intensity (I), duration (D), offensiveness (O), and location (L). Here Frequency: The more often an odour is detected, the more likely it will be annoying. Intensity: very high concentrations of odours can become nauseating. Duration: a very short duration odours is likely to be less annoying than one that persists for an extended period. Offensiveness: is a subjective rating of an odour's ability to cause annoyance. Location: some odours may be more acceptable in certain areas than others.

The South African National Air Quality Management Act (AQA, 2005) requires that each Municipality develops an air quality management plan (AQMP) with the objective to systematically address air quality concerns. The National Environmental Management Act (NEMA) and the AQA, 2005 lay the legislative and regulatory framework for AQMP.The AQMP is a guiding document and the master plan prescribing for action which must get implemented to bring about a change in the air quality status. The whole process is subject to a monitoring and review exercise. The air quality monitoring network, stakeholder feedback and complaint statistics is often used in the evaluation process.

The AQMP will undergo a comprehensive process of review every five years in line with the Integrated Development Planning (IDP) review process for the Municipality. The outcome of the AQMP will be incorporated into IDP such that it has the political and financial endorsement for implementation.The outcome of the AQMP will be to achieve compliance with air quality objectives and to ensure that the ambient air media is conducive to health and wellbeing of people particularly indoor air quality. Undertaking health risk assessment and an epidemiology study phasing out the use of dirty fuels will indicate the dose response functions to any air quality improvements or degradation.

The current study was done in Northern KwaZulu-Natal province of South Africa within the Majuba municipality in a town called Newcastle. The KwaMathukuza low cost residential settlement that is situated in close proximity to a wastewater treatment plant.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

OBJECTIVES OF STUDY

This study intended:

- To investigate the impact the WWTP may have on the health of people who reside close to the site as receptors.
- To determine what strategies if any, that residents use to mitigate the odours.

RESEARCH METHODOLOGY

The Data Collection Methods

In this study a mixed method approach applying a qualitative and quantitative method to collect data was used. A mixed method approach was chosen because the researcher concurs with scholars (Creswell, 2009 and Mnguni, 2012) who argue that mixing methods strengthen research findings, in that each approach is validated by the other when used together.

In this study a human receptor level of odour nuisance was determined by using a questionnaire survey, whereby the receptor could describe the degree of odour nuisance based on his or her experience of the odour exposure over time. The researcher developed items integrating FIDOL factors in the questionnaire, which was piloted prior to data collection.

This questionnaire was administered to respondents included 85 residents living within five kilometers and ten residing beyond five kilometers from the WWTP. Respondents included both genders between the age group 18 – 65 years. The participants were selected based on their availability and willingness to participate in the study. Consequently a non-probability sampling was used where the researcher applied convenience sampling. With convenience sampling, the samples are selected because they are accessible to the researcher. The researcher further used the probability sampling after identifying the population and applying a random process to decide on each individual's probability.

A stratified sampling technique was applied to divide the entire target population into different subgroups, or strata, and then randomly selected the final participants proportionally from the different strata. This type of sampling is used when the researcher wants an adequate amount of participants from each class in the final sample. The researcher only used this method with the questionnaires that were meant to be administered to residents in the envisaged area as the expected sample size was larger. This method quite greatly improved the efficiency of the sample plan. In order to conduct this sampling strategy, the researcher defined the population first, listed down all the members of the population and then selected members to make the sample.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

A separate questionnaire was also developed which sought to explore municipality employees who worked in the WWTP, only two of the employees in the high hierarchy and 10 healthcare givers' perceptions regarding the odours released from the WWTP. This questionnaire probed information about health of the community, their perception of the gases released from the WWTP as well as EIA meetings and processes related to the construction of the RDP houses. Semi-structured interviews were also used in this regard to further probe views of municipal officials on the subject. It is important to note that the presence of odour could only be evaluated from the receptors through only the olfactory system.

The researcher also used historic meteorological data (wind speed, wind direction, temperature, and rainfall) to determine the atmosphere downwind of the odour source for the dynamics to recognizing the odours character.

Questionnaire design and validation

The questionnaire was validated by utilizing the panel of experts. In this regard, ten respondents participated as a panel of experts and were given a questionnaire to scrutinize each instrument and determine its appropriateness for the research. This enabled the face and content validity of the instrument to be determined. The questionnaire given to the panel of the group of ten people was designed to address two fundamental questions, through which the validity of the instruments would be established. These questions were:

a) Does the instrument question what they ought to be? Given that each section of the instrument was meant to assess something specific skills the panel was meant to determine therefore whether the instrument meet the specified standards.
b) Is the instrument suitable for the purpose it is designed for? In this instance the main focus was on the conceptual background of the instrument as per propositional knowledge given in (see Table1).

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

Table 1: Questions used in the questionnaire given to the experts and reasons for their inclusion

Question	*a) The questions are easy to understand*
Reason for inclusion	Here the panel had to determine whether the overall language used in the probes was suitable for the respondents.
Question	*b) The time allocated to each question is appropriate*
Reason for inclusion	Since each question was to be performed over a specified period of time, the panel had to give their opinion as to whether the time allocated for each instrument was adequate.
Question	*c) The test is appropriate for the envisaged respondent*
Reason for inclusion	The panel also had to assess the content of the instrument and suggest in their experience whether they thought that a typical individual would have enough conceptual knowledge to respond to the instruments.
Question	*d) Other positive comments*
	e) Other negative comments
Reason for inclusion	The panel of experts was also asked to forward any other inputs by critiquing the probes. This was to cover any loop-holes that the questions in the questionnaire were not covering.

Table 1 lists the questions (in *italics)* used in the questionnaire given to the panel of experts and motivate for their inclusion. For each question, the panel had to give a closed response on a 4-point Likert scale (i.e. strongly agree, agree, disagree and strongly disagree), as well as an open response where they had to justify their choice in the closed responses.

Data collection and analysis

The survey method research was employed for this particular social study. This research method encompasses respondents to answer the questions administered through interviews or questionnaires, thereafter the researcher describe the responses given. In order for the survey to be both reliable and valid it is important that the questions are constructed properly, meaning that they should be clear and easy to comprehend. Another consideration is to include open ended, closed ended or rating scale questions which all have their set of advantages and disadvantages. Open ended questions allow for a greater variety of responses from participants but are difficult to analyze statistically because the data must be reduced in some manner. The closed ended questions on the other hand are easy to analyze statistically but they limit the responses of the participants. The Likert type scale on the other hand is easy to analyze statistically but also limits the respondent's response (Jackson, 2009).In all, responses should be analyzed to identify the most prominent trends, relationships and patterns.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

The descriptive research methodology was employed by the researcher to formulate rational and sound conclusions recommendations for the study. The use of descriptive research methodology is an opportunity and flexibility to fuse both quantitative and qualitative data giving the researcher greater options in selecting the instrument for data-gathering (Leahey, 2007).The researcher used this kind of research to obtain first hand data from the respondents so as to formulate rational and sound conclusions and recommendations for the study.

The WWTP is in the north west of KwaMathukuza area. The area is characterised by the highest frequency of (in decreasing order) North West(NW),North (N), North East (NE) and South West (SW) winds especially during the warm months of August to January. Therefore the direction of wind is directly from the WWTP to KwaMathukuza. The wind speeds recorded over a five year period are generally low, 3.0 – 4.0 m/s having a frequency of less than 15.0 % and occurring only in September.

RESULTS

Perceiving the odour

In this study, the majority of respondents (56.1%) who live in close proximity to the WWTP further indicated that the odour is perceived more during the day, 12.1% respondents were more sensitive to the odour at night and 15.2% of respondents indicated their sensitivity towards the smell when it's windy, 10.6% indicated that they are more affected during the day whereas 3.0% are more sensitive to the odour when it rains, 1.5% in cold days and 1.5% did not give a valid response (Figure 1). There appears to be a relationship between odour and meteorological conditions. The influence of weather such as wind direction and wind speed, temperature and rainfall can all affect the concentration of odour from the WWTP.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

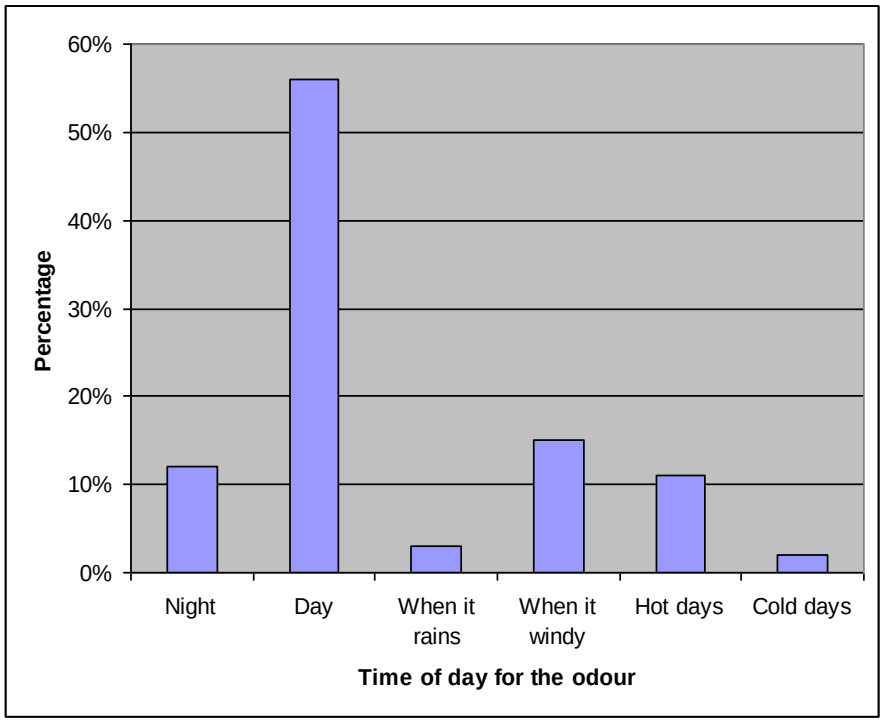

Figure 1: The time of the day in which most receivers are sensitive to odour

The odour in this regard was described by the respondents as a skunk or rotten eggs. A survey of the area (kwaMathukuza) showed no other possible source of these gases except the WWTP. These gases lead to an unpleasant odour which probably affects the health of the residents as well as the environment in general. The results indicate that 97.0 % of respondents have smelt the bad odour that is probably released from the WWTP. This includes all respondents (n=10) who reside more than five kilometers from the WWTP. A majority of the respondents described the odour as strong to very strong**.**

The heath impact of gases in neighboring communities

The potential negative effects of gases released from the WWTP on the health of the community were also investigated. According to the healthcare givers who participated in the study, people who are exposed to gases (odours) were "most likely to suffer from allergens, sinusitis, nausea and lung diseases" (e.g. Respondent #16). To start with, the researcher asked the respondents (residents) if they perceive the WWTP and the gases released as hazardous. Seventy two percent of respondents indicated that the odour (gases released from the WWTP) possibly causes health problems to humans. A further 74.0% indicated that they believe the gases probably affect their lungs. This was based on the fact that at least 57.0% of the respondents indicated that they visit

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

the health facilities at least once in a month. About 40.0% of the respondents that reside five kilometers away from the site visited the health facility on a monthly basis. About 50.0% of respondents from five kilometers away indicated that they consult the public clinic the most and 40.0% go to the public hospital whereas 10% can afford to visit private doctors. In KwaMathukuza 51.5% people indicated that they consult mainly the clinics when they are sick and 39.4% visit hospitals whereas a minor shortfall of 6.1% visits the doctors and 3% never gave clear indication to the institution they consult (Figure 2).

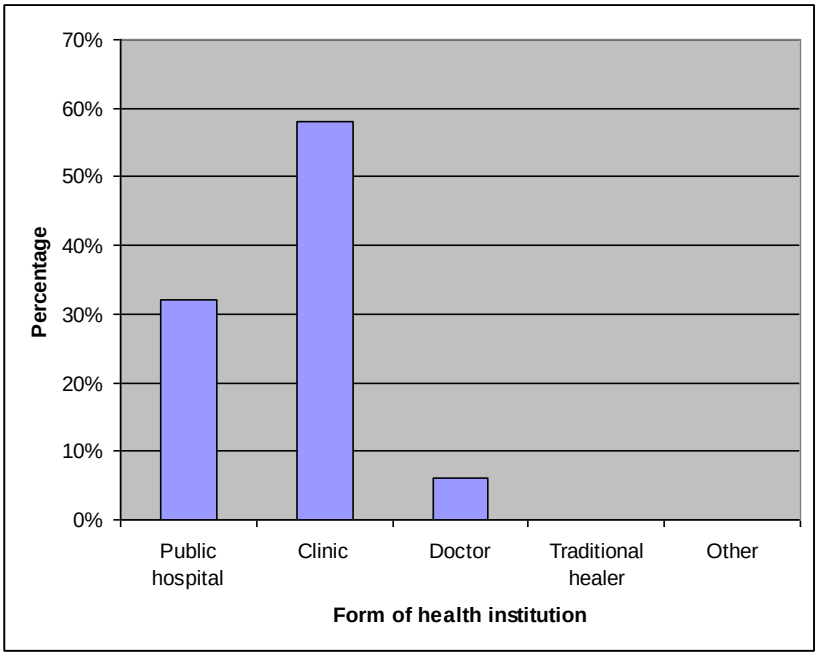

Figure 2: Health institutions consulted the most by residents in the area

Previous research has identified common ailments related to gases released from WWTP (Zarra *et al.*, 2008). Data revealed that 10.0% of the respondents indicated to have suffered a miscarriage. However there was no evidence suggesting that residing in close proximity to the WWTP increases the chances of miscarriages. Results did however indicate that a significant number of people suffer from headaches, vision, olfactory and breathing problems. The researcher further discovered that there was a significant correlation between trouble of concentrating with numbness of hands and/feet and tingling of hands and/feet. Memory problems also had a significant correlation between the numbness of hands and/feet; the tingling of hands and/feet and swelling of feet and ankles. Furthermore, it emerged that there is a significant correlation between the shortness of breath, regular cough, asthma, wheezing of chest, redness of eyes and the tightness of chest. The study also found that the effect of the WWTP affects even those communities who reside beyond five kilometers from the WWTP. The researcher also

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

found qualitative data which shows that many of the children in the area had teary looking, discoloured red eyes.

Odour Perception

The official indicated that they do try to limit the odour at operational level however complaints still arise. Municipality officials (i.e. respondent # 7) indicated that they strongly believe that "the health of people who reside at the site is severely compromised not only due to odours and gases which are harmful to people's health but also due to possible contamination of aquifer by pathogens (microorganisms)" that are released in the cemetery bed. (A cemetery is located within five kilometers from the research site).

Respondent #7 also highlighted that the lack of a border fence between the houses and the WWTP puts local children and livestock at risk. Another municipality official (respondent #8) further indicated that they had officially "planted approximately 1800 trees" in KwaMathukuza to try and "mitigate air pollution in the area and to provide people with access to a cleaner environment however those trees were neglected and many of them died". By inference, the official acknowledged that the WWTP was causing air pollution which could affect the environment and the health of local communities. From observation the researcher could only see less than twenty trees along the main road of a species Arecaceae (palm trees).

Mitigation measures to reduce odour impact

A majority of the respondents (i.e. 78.0%) indicated that they mainly shut their doors and windows if the odour becomes too invasive. The researcher further found that 3.0% of respondents believe that the infestation of flies and mosquitoes in the area is related to the odour. Many of the respondents were despondent when asked about the response of the municipality to their plea for help. Fifty one percent of the respondents indicated that they have not attended any meetings with the municipality in general, while 46.0 % have. To this effect, 62.0 % of the respondents indicated that they report environmental problems to their local council (not the municipality), 15.0 % report to municipality and 3.0 % choose not to report. In this regard, 60.0 % of the respondents indicated having reported odour related complaints while 21.0 % have not.

Sadly 36.0 % of the respondents indicated that their complaints and request are never resolved. To this end, 68.2 % of the respondents believe that the WWTP has negative effects on their lives while 36.0 % said the WWTP has negative effects on the environment.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

DISCUSSION

Sakawi *et al.,* (2011) indicated that weather is one of the environmental components which influence the frequency and the intensity of odour perceived by sensitive receivers. The influence of weather such as wind direction and wind speed, temperature and rainfall can all affect the concentration of odour from the WWTP. Findings reveal that the wind direction is towards the residential area in the NW direction. The close proximity to the WWTP makes residents in the site more susceptible to the effects of gases released and the primary routes of targets include inhalation, eye and skin contact. The situation is worsened by the emissions of fugitive volatile gases from the WWTP that are carried by wind directly towards the residential area, which are located downwind from the plant.

The hazardous chemicals released from the WWTP are not safe. It was noted that the WWTP plant offers vaccination shots to its employees to strengthen their immune systems from communicable diseases, but the same was not done for those residents who are a mere 290.0 m away from the facility. There are an alarming number of respondents who indicated that they experience numbness of hands and/or feet. While a great number of respondents also reported sight (vision), nasal (olfactory), breathing and contact (tingling fingers and/toes) problems.

Literature indicates that mercury is a potent neurotoxin that affects peripheral nerve function (Wang *et al.,* 2012). The numbness of hands and/or feet including the tingling of hands and/or feet could be an indication that the respondents are subject to contamination by Hg or any other chemical which have similar effects. While at the same time H_2S could likely be the threat as it also affects the central nervous system. This could not be verified since the research did not have the appropriate tools to measure the gases released at the WWTP.

The researcher found poor follow up at the site, residents were succumbing to atrocious living conditions and from their report “the municipality was doing little to attend to the residents’ needs”. The municipality had decided to plant trees to curb the odour only in 2011 which is 9 years later since the houses were built. Sadly many of the trees died because the local municipality expected the people to take care of the trees which didn’t happen.

A critical observation in this instance is that there appears to be poor communication between the municipality which administers the WWTP and the community at KwaMathukuza. This means the EIA measures to address environmental and social hazards such as proper and efficient auditing do not take place properly. The municipality indicated no plans to improve air quality or availability of any system monitoring to safeguard the environment.

Based on the researcher’s analysis environmental auditing, which is an important tool for providing an account of post-development EIA activities was in this instance not followed.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

Auditing would include regular meetings between environmental management officials, municipalities and communities to determine if certain projects (such as the WWTP) are causing harm to the community. One would expect that, since the EIA recommendations were not implemented in KwaMathukuza, regular meetings would be held between the relevant authorities and the community to ensure that the livelihood of the society is not compromised, especially because complaints are laid yearly at most.

The researcher further agrees with Kakonge (2013) who indicated that lack of transparency on how to mitigate and monitor the environmental impact of projects has resulted in widespread frustration, thus also causing inconsistencies in EIA quality and an EIA process that can be difficult to understand. This study highlighted a large gap between legislation and practice. The current researcher found that there is still a gap for much research in the sphere of HIA and how improvements can be made in order to improve the legal and administration system, a sustainable development strategy and public participation in environmental governance. If the scoping process had been done accordingly an alternative site would have been chosen for development. The status quo of the odour impact would also be limiting the development footprint in the area whereby even though the area is faced with such discrepancies, the municipality revealed further house construction in the area.

It may largely be possible that South Africa is using the less improved systems that hardly reduce odour problems from the source. The important question is what can be done now? There's a need to: explore coping strategies to deal with the odours, environmental education, explore possible ways to improve air quality for those who are heavily impacted. Evidently there's no universal standard or policies that cover the best distance at which human settlements should be based in relation to the WWTP.

It would be of great importance that the municipality involved follows the AQMP for an improved and integrated decision making framework for air pollution management at the local government level and to move towards reduction in air pollution to meet health based air quality standards. This will be achieved by establishing an Air Quality Management System; Controlling chemical and fugitive emissions and Strengthening the auditing and permitting system.

According to Mnguni (2012) humans have the ability to influence their world by using intelligence, knowledge and skills to solve social problems. However it all lies with developing a discipline specific thinking ability and therefore reflect disciplines they are specialized in, for their roles as adults within society. Understanding the history and relevance of scientific discoveries is one of the best ways to ensure that the environment is managed accordingly to promote social transformation.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

CONCLUSION

Although health impact alone cannot be regarded as an accurate representation of what is experienced in reality. It can give a relative indication of the impact that the released gases have on the surrounding area. The justification for this prioritization was based on data emerging from the health study undertaken and record of public complaints. It is clear from the results shown that there lies a need for improvement. The poor integration of EIA suggests a need to adopt various frameworks and enforcement to correct the inconsistencies in implementation. The WWTP odour emissions are posed as nuisance and health hazards to humans; this suggests a need to explore possible mitigation measures to improve air quality for that in close proximity to the WWTP, particularly because there are inconsistencies throughout the world.

REFERENCES

AL-SHAMMIRRI, M. 2004 Hydrogen sulfide emission from Aardiyah sewage treatment plant in Kuwait. *Desalination* , 170:1-13.

CRESWELL, J.W. 2009 *Research design, qualitative, quantitative, and mixed methods approaches*. Thousand Oaks: Sage publications.

DONOHUE, M. 2008 Causes and health consequences of environmental degradation and social injustice. *Social Science and Medicine*, 56(30):573-587.

DU PREEZ, P., WEBSTER, N. AND JOUBERT, J. 2006 Odour Modelling at wastewater treatment works. A case study. Report for Nelson Mandela Metropolitan Council by Ninham Shand Consulting Services, Webster Environmental Associates, Inc.

DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM (DEAT) 2003 National Environmental Management Second Amendment Bill, 2003, Explanatory Memorandum, Republic of South Africa R.S.A.

ZARRA, T., NADDEO, V., BELGIORNO, V., REISER, M. AND KRANET, M. 2008 Odour monitoring of small wastewater treatment plant located in sensitive environment. *Water Science and Technology*, 58(1): 89-94.

BRUNNER, P. H. AND FELLNER, J. 2007 Setting priorities for waste management strategies in developing countries. *Waste Manage Res*, 25: 234-240.

JACKSON, S.L. 2009 *Research Methods and Statistics: A Critical Thinking Approach* 3rd edition. Belmont: Wadsworth.

GIVENS, J.E AND JORGENSON, A.K. 2013 Individual environmental concern in the world polity: A multilevel analysis. *Social Science Research*, 42:418-431

HARRIS, P.J., THOMPSON, E.H.S., HARRIS-ROXAS, B. AND KEMP, L. 2009 Human health and wellbeing in environmental impact assessment in New South Wales, Australia: Auditing health impacts within environmental assessments of major projects. *Environmental Impact Assessment Review* , 29(5):310-318.

HUANG, Z. 2012 Health impact assessment in China: Emergence, progress and challenges. , 32(1):45-49.

KAKONGE, J. 2013 *Improving Environmental Impact Assessment (EIA) Effectiveness Some Reflections*. Retrieved from: http://www.globalpolicyjournal.com/blog/05/03/2013/improving-environmental-impactassessment-eia-effectiveness-some-reflections on 2 May 2012.

LEONARDOS, G. 1995 *Review of odor control regulations in the USA, in Odors, Indoor and Environmental Air*. Proceedings of a Specialty Conference of the Air and Waste Management Association. Bloomington.

MINISTRY OF HEALTH OF CHINA (MHC) 2008 *The statistical bulletin of public health development in China*. Retrieved from: (http://www.moh.gov.cn/publicfiles/business/htmlfiles/mohwsbwstjxxzx/s8208/200904/40250.htm) on 15February 2013.

MNGUNI, L.E. 2012 The relationship between the Grade 11 Life Sciences curriculum and HIV and AIDS behavior transformation of students. PhD Thesis, University of Pretoria, Pretoria.

MORGAN, R.K. 2011 Health and impact assessment: Are we seeing closer integration? *Environmental Impact Assessment Review*, 31(4):404-411.

NICELL, A.J. 2009 Assessment and regulation of odour impacts. *Atmospheric Environment*, 43:196-206.

SAKAWI, Z., MASTURA, S., JAAFAR, O., AND MASTURA, M. (2011). Sensitive Receivers Responses on Odour Annoyance of a Neighbourhood Open Landfill Site. Journal of Applied Sciences in Environmental Sanitation, 6(2), 191-199.

SCHAUBERGER, G., PIRINGER, M., JOVANOVIC, O. AND PETZ, E. 2012 A new empirical model to calculate separation distances between livestock buildings and residential areas applied to the Austrian guideline to avoid odour nuisance. *Atmospheric Environment*, 47:341-347.

ISSN: 2455-6939

Volume:04, Issue:01 "January-February 2018"

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (U.S. EPA). 2008 Guidelines for sewage works; Ontario ministry of the environment.

WANG, Y., GOORICH, J.M, WERNER, R., GILLESPIE, B., BASU,N. AND FRANZBLAU, A. 2012 An investigation of modifying effects of single nucleotide polymorphisms in metabolism-related genes on the relationship between peripheral nerve function and mercury levels in urine and hair. *Science of The Total Environment*, 417: 32-38.

FRANZBLAU, A. 2012 An investigation of modifying effects of single nucleotide polymorphisms in metabolism-related genes on the relationship between peripheral nerve function and mercury levels in urine and hair. *Science of The Total Environment*, 417: 32-38.

WÄRNBÄCK, A AND HILDING-RYDEVIK, T. 2009 Cumulative effects in Swedish EIA practice — difficulties and obstacles. *Environmental Impact Assessment Review*, 29: 107-115.

