Assessment of Environmental and Social Impacts of Gikeu Dumpsite in Othaya, Kenya

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Abstract

This study introduces and discusses solid waste management and its environmental and social impacts in the rural area of Othaya, Nyeri County, Kenya. This is done through an interdisciplinary approach by looking at the current management and use of Gikeu dumpsite, the local community's perceptions and attitude towards the dumpsite, and environmental parameters.

The results reveal a shortage of structure and struggle with enforcement of laws in the Nyeri County Government. The governmental stakeholders express their wishes of an improved situation but are struggling with the execution of their promises. The local community highly desires relocation of the dumpsite, and 79% perceives that their health is being affected. The main concerns are respiratory diseases and malaria. The environmental scope of this study proposes concern about water and soil quality on and around the dumpsite. Findings include traces of *E. coli* in two of four water samples, and NO_3^- and NO_2^- levels in soil samples reaching ranging from 0-114mg/kg and 0-24mg/kg respectively. Lastly, recommendations are given based on our findings.

Acknowledgements

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We are grateful for the opportunity to meet and work with our co-researchers Wanjohi Dennis Wachira and Asoyo Mary, MSc in Environmental Governance at the University of Nairobi, Wangari Maathai Institute. Throughout our 10 days in the field we developed a friendship that is very precious to us. We may refer to them as our Kenyan counterparts in this study.

Without our field guides and interpreters, John Murage Maina and Elizabeth Wairimu, this field work would not have been possible - we are extremely thankful to them.

Abbreviations

DES	Department of Environment and Sanitation
MCA	Member of the County Assembly
MSW	Municipal Solid Waste
NEMA	National Environment Management Authority of Kenya
NCG	Nyeri County Government
PHO	Public Health Officer
SSI	Semi-structured interview
SWM	Solid Waste Management

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1. Introduction

Solid waste management (SWM) is a common problem in developing countries. The increasing generation of waste caused by population growth, rapid urbanisation and the rise in living standards are burdening the responsible authorities. Efficient and sustainable solutions put pressure on budgets and call for organisational skills and knowledge that many authorities do not yet have. Poor, inefficient SWM is often the consequence (Guerrero, Maas & Hogland, 2013).

Poorly managed solid waste is often resulting in open, neglected dumpsites, having an impact on health and wellbeing of the nearby community. The risks of infection transmission through rodents and insects, as well as inhalation of fumes from burning waste, are just the tip of the iceberg (Ziraba, Haregu & Mberu, 2016). Apart from health impacts, areas of open waste dumping often result in social stigma for nearby residents due to the perceptions of living close to a dumpsite. Nauseating and pungent odours, insects, being able to see waste disposal close by and various other atmospheric factors leads to an unpleasant environment for the residents. Therefore the social stigma issue arises (Mosquera-Becerra, Gómez-Gutiérrez & Mendez, 2009). Moreover, pollutants and harmful substances leach through the soil and into the groundwater or nearby water bodies, causing environmental issues (Guerrero, Maas & Hogland, 2013).

In Kenya, waste is often disposed of in open dumpsites, where all sorts of waste from households, industries and health care facilities usually are dumped unsorted. This holds risks of severe contamination. The management of solid waste has for many years overburdened as well as contributed to suspected pollution of the country's natural environment (Thuo, 1998). And thus, the vulnerability of pollution of the surface and groundwater is high, as local authorities rarely consider environmental impacts in identifying solid waste disposal sites (Henry et. al. 2006; Kazuva & Zhang, 2019).

Economically, inadequately managed solid waste depresses the market for recyclable materials as most materials are dumped without being sorted and recycled. The waste ends up in landfills, while the potential of generating new value is lost. This often happens due to the lack of standards and guidelines for recycling, as well as missing access to the recycling market (Republic of Kenya, 2019a). There is, however, an informal sector consisting of “scavenging”

activities. People commonly known as “scavengers” have developed a livelihood strategy where they use dumpsites as a source of food and/or income generation. These activities can fill a gap when there is a lack of official SWM institutions, softening the impact of increased waste generation (Simatele & Etambakonga, 2015).

The rising awareness of the negative impacts on health, environment and economy encouraged the government of Kenya to implement “The Kenya Vision 2030” in 2008. This, amongst other initiatives, focuses on developing functional and sustainable waste management systems in Kenya’s largest cities: Nairobi, Kisumu, Eldoret, Nakuru, Thika and Mombasa by 2030 (Republic of Kenya, 2019a). The aim seems feasible in Nairobi (Haregu et al., 2017) and Kisumu (Sibanda, Obange & Awuor, 2017), where the government is cooperating with private companies, community-based organizations (CBOs) and non-profit, non-governmental organizations (NGOs) for waste collection and disposal, as well as recycling. Research investment and community-based initiatives in smaller cities and rural areas, however, is rare.

Environmental and social assessments of open landfills in Kenya focus mostly on the MSW of big cities. The awareness of impacts of open dumping in the rural communities is limited, and the impacts on the environment and the community living close by are often not assessed, to our knowledge. The limited research available on SWM of rural areas, here to mention Thuo (1998) or Selin (2013), are outdated and lack recognition as they are not peer-reviewed and lack timeliness.

This reflects the general situation of research on SWM in urban areas of developing countries (Guerrero, Maas & Hogland, 2013; Kazuva & Zhang, 2019; Minghua et al., 2009; Mosquera-Becerra, Gómez-Gutiérrez & Mendez, 2009; Vij, 2012), as opposed to rural areas (Anwar et al., 2018; Boateng et al., 2016; Vahidi et al., 2017). The studies on rural areas are harder to find and the papers often state that there is a need for more research.

In this study, we therefore aim to assess the SWM of Gikeu dumpsite in Othaya sub-county, to evaluate the environmental and social impacts of an open dumping system in a rural area. The assessment is attained by answering the following questions:

1.1 Main research question:

What are the environmental and social impacts concerning Gikeu dumpsite in Othaya?

1.2 Sub-questions:

1. How does the County Government of Nyeri currently manage Gikeu dumpsite?

2. How is the dumpsite used?

3. What influence does Gikeu dumpsite have on the surrounding soil and water quality?

4. What are the residents' perceived effects from the dumpsite on their health and everyday life?

5. What are the perceptions of, attitude towards and political engagement regarding the waste management system among households in Gikeu area?

2. Background

The following section outlines further information on SWM, the study area Othaya and basic theory on some of the environmental hazards on open dumpsites.

2.1 SWM in developing countries

In developing countries, municipal solid waste (MSW) generation is increasing as living standards rise. Although there is a movement towards gaining value from waste by recycling and other methods, landfills still play an important role in SWM in the world (Danthurebandara et al. 2012). Developing countries often chose landfills over other options, because they are easy to implement, cheaper and can handle fluctuations in waste amounts and categories (Seng et al., 2013).

MSW is recognised as a complex category of waste (Troschinetz & Mihelcic, 2009). However, more than half of the MSW in developing countries usually consists of organic material and thus many communities are considering increased composting (Troschinetz & Mihelcic, 2009). It has been reported that composting gives more benefit than landfills in regards to compost product, landfill life extension and greenhouse gas emission reduction. However, a full cost-benefit analysis is still yet to be conducted (Seng et al., 2013).

Overall, three methods to regain value from waste can be identified: waste-to-energy, recycling and transformation (Oliveira & Rosa, 2003). In developed countries, waste incineration is a common method to generate energy. However, it is a big investment for developing countries and mismanagement can prove great risks, such as air pollution (Troschinetz & Mihelcic, 2009).

Much of the recycling of waste in developing countries is done via the informal sector, which includes waste pickers and sorters, community-based organizations, small and micro enterprises and individuals (Republic of Kenya, 2019b). A study in the capital of DR Kongo found that scavenging activities are mostly carried out by men, and that the buyers of waste

benefit most, while children are often exploited. Possible reasons include a lack of governance and frameworks to protect solid waste collectors (Simatele & Etambakonga, 2015).

2.2 SWM in Kenya

Kenya classifies as a low-income developing country and produces an estimated amount of 22,000 tons of waste per day and approx. 8 million tons annually (Republic of Kenya, 2019a). The numbers are thought to rise rapidly alongside the steady increase in population in urban areas. Past inventories suggest that 60-70% of the waste is organic (Guerrero, Maas & Hogland, 2013; Republic of Kenya, 2019a).

Kenya is divided into 47 counties. In 2010, the Kenyan government decentralized administration of power, resources and representation, including the waste management, delegating the responsibility out to the county governments. The regional administrations have insufficient frameworks for waste management infrastructure, as they lack technologies and capacity to support sustainable waste management, as well as public awareness and county laws (Republic of Kenya, 2019a). The decentralization has overburdened the authorities with the task of implementing waste management strategies, and in 2019 no county had implemented a developed infrastructure for waste management. This has resulted in open dumping, exposing huge volumes of waste to elements, animals and scavengers, endangering the surrounding environment and residents (Republic of Kenya, 2019a).

2.3 Pollutant hazards in open dumpsites

Open dumpsites can contribute to the spreading of pollutants such as heavy metals and organic contaminants and cause environmental impacts on its surroundings. Depending on the waste collected on the dumpsite it may cause leaching of various nutrients from the decomposition of organic materials, contribute to spreading of pathogens, and more (Danthurebandara et al. 2012). Open landfills are also significant emitters of methane, leading to increased greenhouse gas concentration (Bogner, et al. 2008).

Whenever there is a release of contaminants to the environment, parameters such as soil type/ structure and weather conditions affect the distribution. Thus, heavy rainfalls favour the migration of contaminants from the surface to the subsurface, where the groundwater table

increases resulting in a lateral flow of water (hazardous when contaminated) to sinks, e.g. wells, springs, boreholes (Lapworth et al. 2017). Figure 2.1 illustrates sources of contamination, their pathways and sinks amongst which open waste dumping is one of the hazards. According to Lapworth et al. (2017), figure 2.1 further summarises the key pathways and, thus, showing that waste contaminants percolate down through the soil top layers making its path to the groundwater through root canals and cracks in the weathered and fractured basement (bedrock).

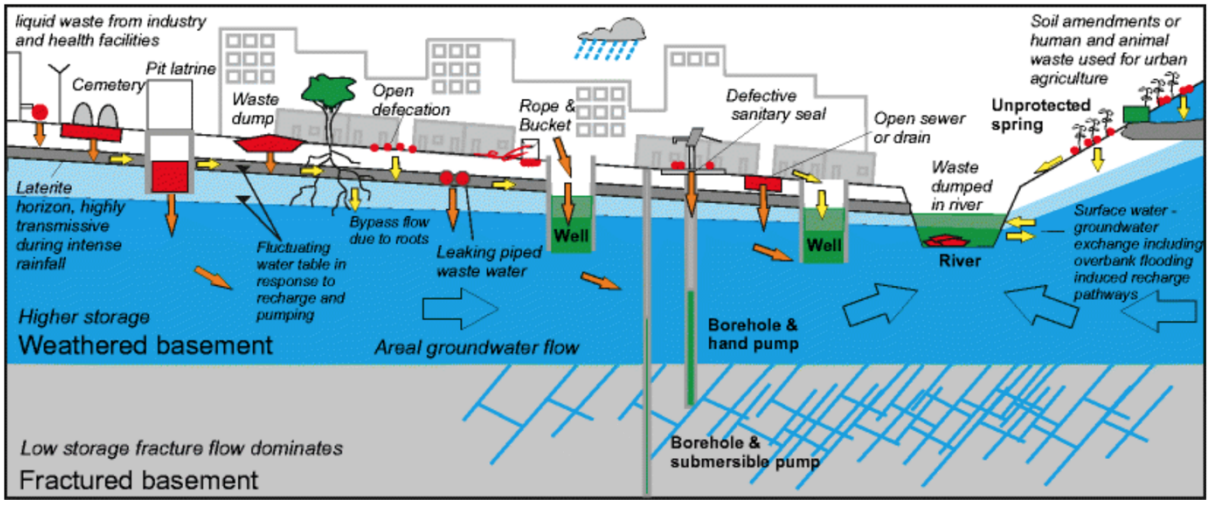

Figure 2.1. Illustration on sources of contamination, pathways and sinks (Lapworth et al. 2017).

2.3.1 Heavy metals

Heavy metals are one of the recognized problems regarding dumpsite impacts on health and the environment (Aucott, 2006). Common effects from heavy metals are potential hazards for humans, especially children (European Commission, 2002). Lead, mercury and cadmium are here used as examples, as they are tightly connected to waste mismanagement. Lead can cause impacts on the nervous system like slowing the nervous responses, but severe health effects are mostly an issue in highly contaminated areas. Mercury (methylated) can affect mental health and children's mental development. Cadmium can potentially damage kidney functions (ibid). The heavy metals can also be toxic to plants, animals and microorganisms, and negatively affect the environment surrounding landfills. Sources of heavy metals include plastics, ceramics, dental amalgam, lamps, batteries, wood preservation applications, paint and textiles (Aucott, 2006).

2.3.2 Nitrate

Although sources of nutrients such as nitrate (NO_3^-) are often linked to agriculture, levels of nitrate can also be related to leachate of solid waste disposal (Wakida & Lerner, 2005). NO_3^- is a mobile compound of nitrogen and occurs naturally in many environments. While inorganic nitrogen is essential for plants growth, NO_3^-N from excess fertilization is highly mobile and has become a common contaminant of surface -and groundwater, potentially causing algae blooms, fish kills and risks to public health (Wakida & Lerner, 2005; Russo et al. 2006).
According to the NEMA (2006), the content of NO_3^- should not exceed 10mg/L in sources of domestic water supplies in Kenya. In the soil, background levels of NO_3^-N in the upper part of mineral soils (approx. upper 30cm) typically range from 5 to 10 mg NO_3^-N per kg soil (Camberato and Nielsen, 2017). Coarse textured soils, with low water holding capacity, are generally prone to NO_3^- leaching. Clay-rich soils tend to have more moderate leachate loss (Akinbile & Yusoff, 2011; Russo et al. 2006).

2.3.3 Nitrite

When nitrates are ingested, they are reduced to nitrites in the intestinal tract (Gubta, 2000a).
Nitrite (NO_3^-) is a common intermediary form of nitrogen in at least three different oxidative or reductive biochemical pathways in water and soil. It can thus be produced by ammonia oxidation through nitrification (aerobic), by anaerobic nitrate-reducing processes and by denitrification. NO_2^- is highly toxic to human, flora and fauna and high concentrations of NO_2^- are an essential water quality concern. NO_2^- has been named as a possible cause of migraine headaches. Research likewise shows that passage of NO_2^- into the bloodstream results in irreversible alterations in the body resulting in respiratory deficiencies and respiratory infections in humans amongst others (Phillips et al., 2002, Gubta, 2000a). Especially infants are sensitive to this condition leading to the "blue-baby syndrome" (ibid.).

2.3.4 Escherichia coli

E. coli is a gram-negative bacterium of the family *Enterobacteriales*. *E. coli* are gastrointestinal bacterias and are normal and essential in the human gastrointestinal microbiota. There are, however, several harmful strains of *E. coli*, which can cause bacterial infections. Since *E. coli* normally do not live and propagate in water bodies, findings in water bodies indicate contamination with e.g. sewage (Machnicka, 2014).

2.4 Study Site

Gikeu dumpsite is part of the waste management in Othaya sub-county within the county of Nyeri, see figure 2.2. Nyeri County is located in the central highlands of Kenya and covers a total area of 3,356Km^2. It has a population of 693,558 people according to 2009 statistics but is expected to reach 840,994 in 2030 (Republic of Kenya, 2019a). The South-Central Highlands are Kikuyu land, and most people living in Othaya therefore speak Kikuyu (County Government of Nyeri).

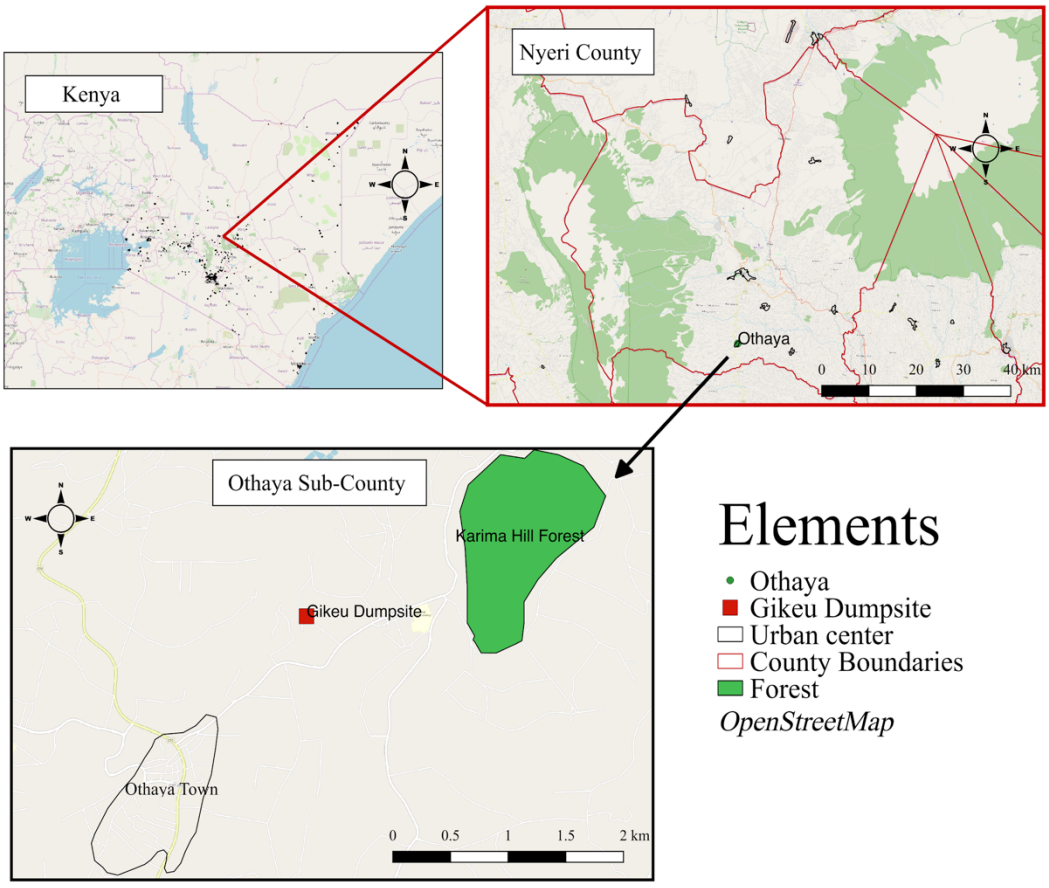

Figure 2.2. Map of Kenya, Nyeri County and Othaya. The map was created in QGIS. Source: OpenStreetMap.

The elevation in Othaya is 1846 meters above sea level, and due to its high altitudes the temperature is stable with an average temperature of 16.8 degrees C. The average annual rainfall is 1401mm. Even in the driest months, the average rainfall is above 40mm (Othaya Climate, n/d). Nyeri's water resources consist of ground and surface water from the 49 permanent rivers, and the main catchment areas of these rivers are the Aberdare Ranges and Mount Kenya. The quality of the water is good, according to the Republic of Kenya (2018) and suitable for domestic as well as wildlife, livestock and irrigation purposes. The soil texture in the area consists of mostly clayey soil according to the ICPAC GeoPortal (1997), see also figure 2.3.

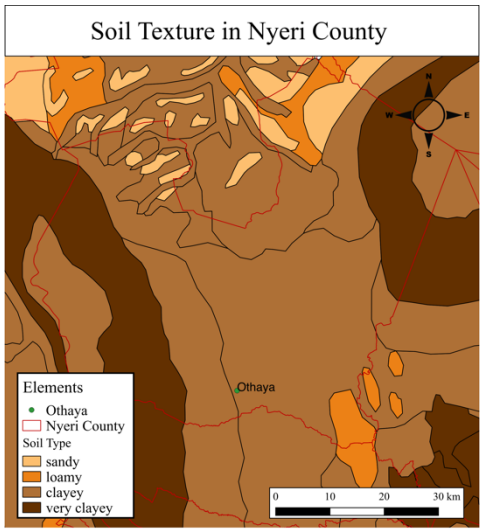

Figure 2.3. Map illustrating soil textures in Nyeri County. Kenya soil survey in 1982, revised in 1997. (ICPAC Geoportal 1997)The ma was created in QGIS.

Gikeu dumpsite is one of four official dumpsites in the Nyeri county, the other dumpsites being Karatina, Naromoro and Mweiga. The dumpsite is located approximately two kilometres outside the centre of Othaya town in a small village, Gatugi. The dumpsite is located in a low-lying area compared to the greater surroundings, making it prone to flooding (App. 2A; App. 2D).

3. Methodology

3.1 Observations

During the fieldwork, general observations of Gikeu dumpsite were made to describe the composition of waste and the physical use of the dumpsite. The observations consisted of noting the areas topography, senses of smell, material on the site, human activity, animal activity and vegetation. In the following chapters the observations will be referenced as (O).

3.2 GPS data collection and QGIS data analysis

To measure physical data, *Garmin eTrex 10 handheld GPS* was used for the collection of positioning data and measurement of features on the field site in Gatugi. Through the real-time positioning function, the horizontal accuracy of <15 meters 95% of the time was assured. Under normal conditions, the accuracy generally stays within 5-10 meters (Garmin(r)/support.garmin.com, n/d). In addition to the Garmin eTrex, our smartphones were used to track the GPS points of each household for the questionnaire. This most likely resulted in less accurate geodata, but provided the ability to use a feature of our survey tool, which generates maps disaggregated by survey responses on specific questions. For more information on the survey tool, see questionnaire section 3.4.1. For the data analysis, we used QGIS, which is an open-source geographical information system and thus supports working with geodata through core functions and online plug-ins, which enabled us to work from home (qgis.org).

The collected data files were transferred to the computer in GPX format, whereafter the files could be imported to QGIS. The area of the dumpsite was calculated by converting the tracking points to polygons, and thus, areal data could be extracted easily. The waypoints only needed to be imported, and the positioning points were then used to visualize the household and sampling locations.

3.3 Natural Science Methods

In this study we conducted simple soil and water analyses to test for nitrate, nitrite and *E. coli* levels. The soil samples were taken on, and in close proximity to, Gikeu dumpsite and the water samples were collected from the wells and water pits, see figure 3.1.

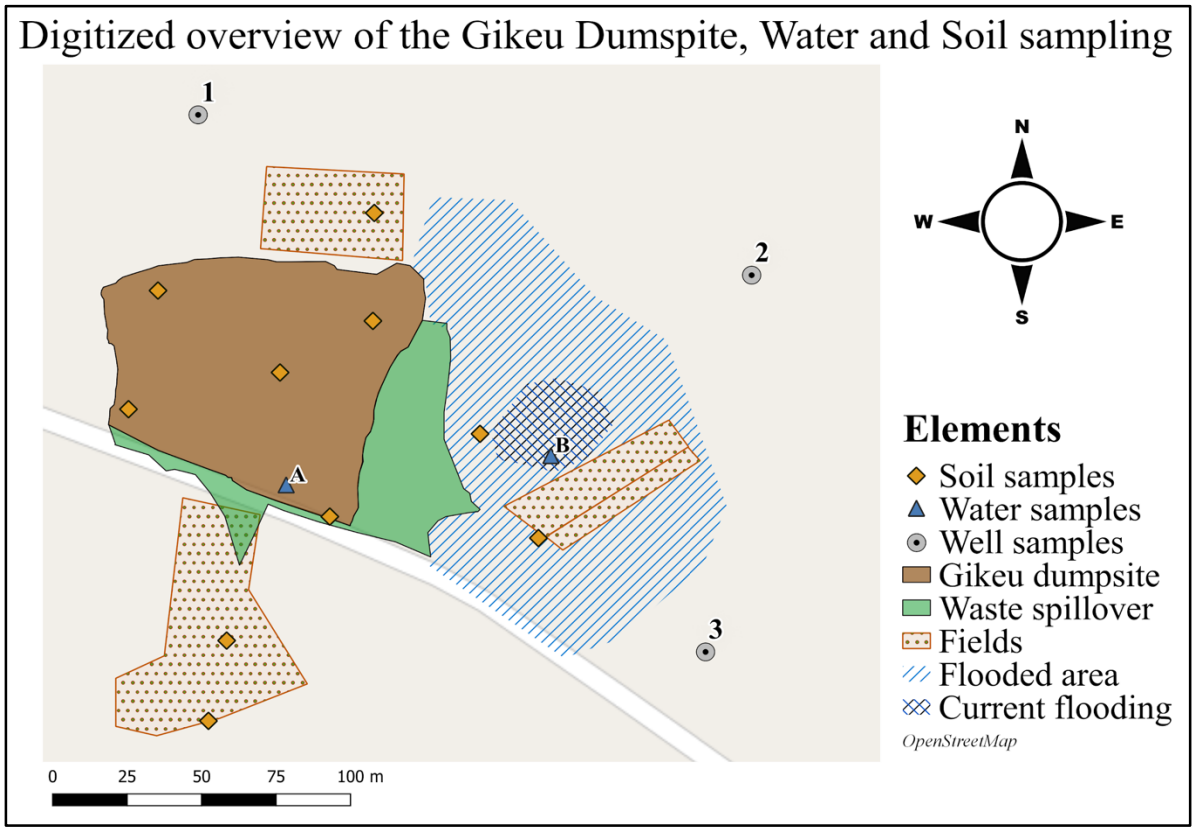

Figure 3.1 shows an digitized overview of Gikeu dumpsite and the water and soil samples conducted. The map is produced in QGIS. Source: OpenStreetMap.

3.3.1 Nitrate and nitrite levels

Concentrations of NO_3^- and NO_2^- levels were tested for wet soil samples in mg/Kg and water samples in mg/L. For analysing the samples, Macherey-Nagel Quantofix Test strips were used. The soil samples were collected in plastic zip lock bags and contained four smaller samples from a one-meter distance, to ensure a valid representation, see figure 3.2. 30ml distilled water was added to the viales and the soil samples were added up to 40 ml mark, and then shaken for 5 minutes. When the sediment was settled on the bottom of the viale, the NO_3^- and NO_2^- test could be conducted. The test strips were dipped into the vials containing the water and soil

samples and analysed according to package instructions. The strip kit contains a colour diagram, which was used to determine NO_3^- and NO_2^- levels. The Macherey-Nagel Quantofix Test strips then give a resulting concentration of NO_3^- and NO_2^- in water (mg/L).

Figure 3.2 shows soil sampling inside the dumpsite.

In order to interpret the results of the soil samples, a correction factor of 2,2 is used, based on soil texture (clay) and moisture (dry) to get values in PPM NO_3^-N for dry soils (www.waterboards.ca.gov). The following formula (1) was used, to calculate the results:

$$ppm\ NO_3 - N\ in\ dry\ soil = \frac{Test\ strip\ reading\ (ppm\ NO_3)}{Correction\ factor} \qquad (1)$$

3.3.2 *E. coli* testing

E. coli testing was conducted from water sources such as wells and water puddles. For the analysis the AquaVial Water Test Kit was used. 5 ml sample water needed to be poured into the vial provided by the testing kit and the instructions were followed thoroughly. Hereafter the samples were incubated in 20-25 degrees C for 48 hours. The results were read using the provided colour diagram, which indicates the levels of coliform bacterias. Yellow indicates 0

CFU/ml (colony forming units per ml) *E. coli* present in the sample, orange indicates 1 CFU/ml, and purple indicates higher levels.

3.4 Social Science Methods

3.4.1 Questionnaires

A questionnaire gives an essential overview of the social aspect of our research question, as well as retrieving statistical knowledge about the impacts of the dumpsite on the Othaya area. The aim was also to collect comparable data on age, gender and geographical position of the household, in order to find any correlations between the answers. It gave us a better background on which to base our interviews and inspiration for the focus group as well.

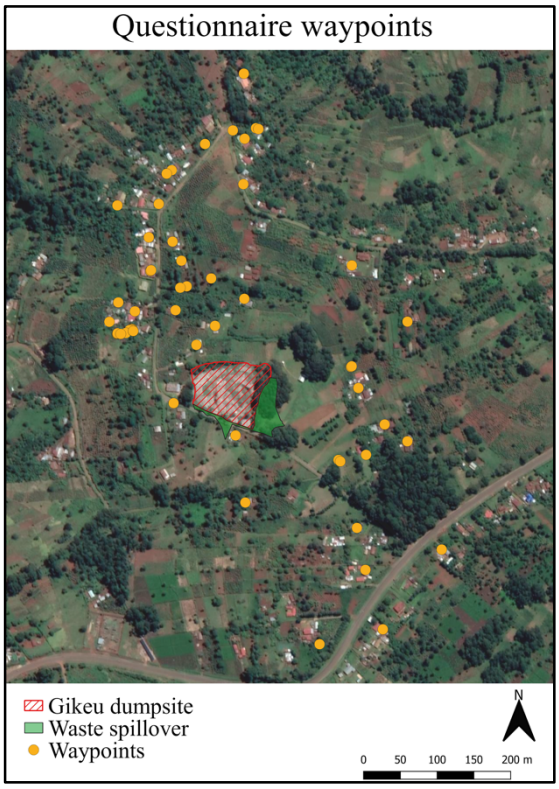

Figure 3.4. Map of questionnaire waypoints collected from GPS. The map has been created in QGIS. Source: Google Maps.

The questionnaire acted as a preliminary data collection and was used for statistical analysis. Thus, a minimum of 30 questionnaires had to be collected to ensure valid results. We conducted 34 questionnaires with households around the dumpsite, distributed over two days and two groups. Our strategy was to start close to the dumpsite and ask as many households as possible there, and then to increase the distance gradually, see figure X, a map of household GPS locations. Our guides helped identifying nearby households and introduced us to the residents. The questionnaires were mostly performed in Kikuyu by the guides and our Kenyan counterparts. The English language has some words that cannot be translated to Kikuyu, such as “recycling”. This was solved by using an explanatory sentence to describe the meaning of the word. We did a translation exercise on the questionnaire with our guides, to meet these potential issues. The length of each

questionnaire varied between 20-30 minutes, depending on the necessity of translation and the amount of elaboration by the respondents.

Our questionnaires were collected electronically on our smartphones, using the open-source data collection tool KoBo Toolbox (www.kobotoolbox.org). After all the results had been sent to the server, we used the automated reports to analyse our data and generate figures, except for the open-ended questions, which were analysed manually.

3.4.1 Unstructured interviews

Throughout our ten days of fieldwork, we spoke to several people with different perspectives on and knowledge about Gikeu dumpsite. Some of these people were identified as being key-actors, and thus the unstructured interviews served as a preparation for a SSI with them. Others included short conversations with some of our hosts and guides, children and adults we met on or near the dumpsite, as well as the official garbage collectors and employees of a private medical clinic in Othaya. The method of unstructured interviews gave us a possibility to obtain information from spontaneous meetings and subjects of relevance.

3.4.2 Semi-structured interviews (SSI)

During our first days in the field with observations and unstructured interviews, we quickly got an understanding of what key-actors were relevant to conduct in-depth interviews with (institutions, politicians, governmental positions, etc.). The list goes as follows:

1. Public Health Officer (PHO)
2. Othaya Hospital representatives
3. Unofficial recycler at Gikeu dumpsite
4. Assistant chief of Gatugi
5. Member of County Assembly (MCA)
6. Representative from National Environmental Management Authority (NEMA)
7. Protest organizer
8. Chief director of the Department of Environment and Sanitation (DES) Nyeri County Government (NCG)

Our initial thought was to conduct all SSI's after we had finished doing the questionnaires. The reason behind this was to actively incorporate the knowledge gained from the questionnaires into our interview guides. Despite this, we quickly found that scheduling appointments for interviews were mostly out of our hands, which led us to accept whenever we could get an appointment. In hindsight, this enabled us to manage more interviews within the timeline, and it also gave us time to follow leads given by the individual interviews.

Before each SSI we agreed on an interview guide (see App. 2). Each guide was fitted for the individual interview.

3.4.3 Focus Group

As a final part of our data collection, we conducted a focus group interview. The aim was to see if this format of data collection would present us with different results than the questionnaires, unstructured interviews and SSIs. The main topics of the discussion and exercises were focused around perceived impacts of the dumpsite and on solutions to meet these impacts. The target group were people from the community surrounding the dumpsite. Therefore, at the end of each questionnaire, we offered the informant to participate in the focus group. In total, 19 informants agreed to be contacted subsequently with further details. The contact was established by our guides as their local relation was thought to be beneficial in recruiting informants. 9 community members agreed to participate, of which 7 showed up.

We agreed to conduct the discussion in Kikuyu, as most of the informants did not speak English. Our Kenyan counterpart Dennis Wanjohi facilitated the meeting as he speaks Swahili, Kikuyu and English. To observe as much as possible during the discussion all group members were present. Our guides were present to translate during the discussions.

4. Results

4.1 History, management and governance of the dumpsite

4.1.1 History

Gikeu dumpsite is situated close to Gatugi village, about 1,7 kilometres from Othaya town. Geospatial analysis shows that the dumpsite area is 6941 m^2 and has an area of spillover (marked in green, see figure 4.1) which measures 2428 m^2 (cf. section 3.2). The land of the dumpsite was originally community land used for the extraction of murram (gravel) at the end of the 1970s. After some years it was converted into a slaughterhouse which after four years was moved to Othaya town by the council members of the time (App. 1; App. 2A; App. 2C; App. 2E). The land was then transferred into government property and made into a supposedly temporary dumping site in the end of 1980s with the dumping of waste from the Othaya sub-county (App. 2A). Liquid waste was dumped until approximately 2013 as well, when the nearby sewage system was built (App. 2A).

Figure 4.1. Map of Gikeu dumpsite showing the GPS track of the dumpsite and waste spillover. The geodata were used to measure the area (km^2). The map was produced in QGIS

4.1.2 Governance

In order to get an understanding of how solid waste is managed in Nyeri County, we have interviewed several actors to get an overall understanding of the waste-sector - including governance processes. Figure 4.1 shows an overview of the government system, wherein the sections marked in red indicate who we have interviewed. It shows our focus on the connection between the community and the County Government, without looking into the National Government institutions.

During our fieldwork we have had the opportunity to speak to all links in the decision-making hierarchy except for the County Executive Officer. Issues regarding waste management are dealt with at the Director level. The Director coordinates and directs all matters leading to SWM and the environment. This includes managing staff and also ensuring the adaptation of policy and regulation framework on SWM. The Director of Environment also holds the position as the Chief Officer of the same department, a situation caused by understaffing. The Director of Environment is the person we interviewed a representative from the DES. Furthermore, there is also a shortage of staff in Othaya which means that the PHO manages the position as the Sub-County Solid Waste Manager of Othaya as well (App. 2H). In figure 4.3 we have visualized the decision-making hierarchy on solid waste in Nyeri County (ibid.)

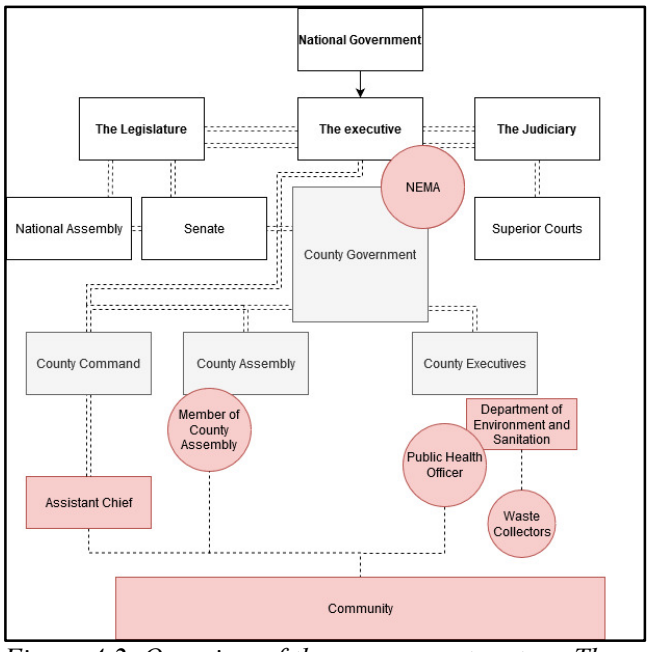

Figure 4.2. Overview of the government system. The sections marked in red indicate who we have interviewed.

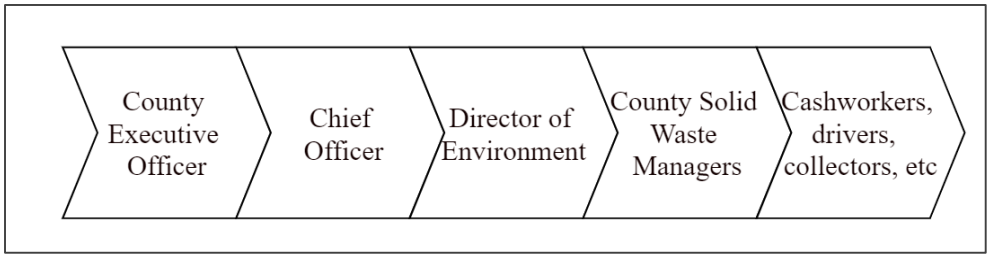

Figure 4.3. Decision making hierarchy on SWM.

Besides this decision-hierarchy we found that other actors, such as NEMA, the County Assembly and the community, have a significant influence in the governance of solid waste. These different actors; "*(...) Initially worked in isolation, but now they must work together to solve the overall issues.*" (App. 2A). The Governor has started an Environmental Committee (including the DES, NEMA, PHO, and members of the community), which shall deal with SWM related issues. This shall help to harmonize the work of the various actors (App. 2H).

NEMA has the authority to put pressure on the current state of SWM and therefore to ensure development of the sector. NEMA can also persecute the government if regulations are not met (App. 2F). However, this is not always the case, as for example with the newest national SWM strategy (NEMA, 2015) which, according to NEMA, has not been adopted by the NCG. When asked why they are not currently persecuting, despite the regulations not being met, they answered that they would rather encourage the initiatives that are being taken, than focus on the ones that are not being adapted (App. 2F).

During our interview with the DES, it was not clear who had the responsibility to actually ensure the adaptation of, for example, the national SWM strategy. As mentioned above, the Director of Environment has the responsibility to ensure implementation of policies and regulations, but during the interview it was also mentioned to be the responsibility of County- and Sub-County Solid Waste Managers (cf. Figure 4.3). NEMA underlined that they are trying to engage the County Government to adapt the national SWM strategy, but that they themselves lack the capacity to do so. This is an issue also pointed out by the PHO, as he stated that NEMA is "*very understaffed*" (App. 2F).

Furthermore, Environmental Audits (EA) have supposedly been carried out every year on Gikeu dumpsite, according to the PHO (App. 2H). According to NEMA, no EA's have been carried out, though it is planned to be carried out at the end of March or April 2020, and finished in the following financial year. The PHO explains this by pointing to a disagreement between the Government and NEMA - which he states makes the audits inaccessible to any other than NEMA. It can thus be said that issues still remain, since there are unclear regulations as to who has the responsibility within the county government to implement further SWM strategies.

4.1.2.1 Political influence on governance

The County Assembly also has a major influence in the governance regarding solid waste (App. 2E; App. 2F; App. 2H). The adaptation of the strategy depends on "the good will of the government" and on the government's budget, which are both tied to the members of the council (App. 2F). The council is in charge of the allocation of budget, which means that if a certain issue holds personal interest for the member, it will often facilitate the process of gathering finances for it (ibid.). An example of the influence from the MCA's can be seen in the issues regarding relocation. Currently there is a process of procuring new land in another region, which could enable Gikeu dumpsite to only be used as a transfer station. However, this

process is being hindered by the local member of parliament in the area, as he is against procurement. This seems like a general issue, as the procurement process has been going on for some time, but that they face political resistance each time they consider new land (App. 2A; App. 2D).

The issue also became evident during our interview with the ward MCA in Gatugi (App. 2E). He is part of the surrounding community of Gikeu dumpsite, and also stated that a relative of his died because of health effects from the dumpsite (ibid.). He has allocated 2.9 million KSH to develop solutions for Gikeu dumpsite, which will be used to fulfill the above mentioned goals for development on the dumpsite. According to him, the solutions have been identified in agreement between himself, the national government, NCG and the local community. Despite positive outcomes, the PHO sees political influence as one of the main issues in SWM, as he feels the government *"becomes beggars for the politicians"* (App. 2A).

4.1.3 Management

Nyeri county is divided into 8 sub-counties, where the solid waste is managed in different ways by the county government. Daily waste collection only happens in 3 towns; Othaya Town, Nyeri Town and Karatina (App. 2H). In these towns, there are different methods for daily waste collection, including for example kerbside collection in Nyeri Town. Kerbside collection is dependent on the predictability of the waste collection, as it has to be precise in order to keep the town clean (ibid.). According to the DES, kerbside collection also existed in Othaya Town, but because of the unpredictability of the collection frequency, they had to implement a different method, which is using waste *shambas* (collection points on the ground or partly enclosed spots) (App. 2A; App; 2H; App. 3I).

In other less busy towns, waste is collected once a week, due to a shortage of trucks and the waste generation being minimal compared to busier towns (App. 2H). The DES points out that open/illegal garbage dumping happens across the county, especially in the areas where they are not able to collect.

All collected waste in Nyeri County is dumped on 4 dumpsites, which are located in Gikeu, Karatina, Naromoro and Mweiga (App. 2H).

4.1.3.1 Gikeu Dumpsite

During the time of our research, one garbage truck was collecting waste, covering Othaya town and the sub-county's rural area. There is a waste management office in Othaya town, where

the truck driver and the team of six sweepers and nine collectors work from (App. 3I). Every morning from 8 a.m. excluding Sundays, the waste in the streets of Othaya is being swept into shambas and is then collected by the truck and transported to Gikeu dumpsite. Depending on the amount of waste generated, dumping in Gikeu is carried out one to five times a day (ibid.). The collectors take about half an hour to empty one shamba, as waste from the ground has to be swept onto a piece of plastic and then swung into the truck by two persons (cf. Figure 4.4). Their boiler suits are in good condition and they carry latex gloves for protection, sometimes however there have been injuries from handling waste. Furthermore, there has been recognition towards the risks for the people residing near the dumpsite since it is open and accessible for everyone (ibid.).

Figure 4.4. Waste collectors collecting waste in Othaya Town.

4.2 Use of the dumpsite

The conducted research has shown that activity on and around the dumpsite is common. The dumpsite seems to play a part of most of the residents' everyday life, since more than 80% of our questionnaire respondents pass the dumpsite a few times a week, and 60% even stated passing it every single day (see figure 4.5). None of the respondents earned an income from the dumpsite, while 9% dumped their own waste there, but they didn't see this as a positive factor.

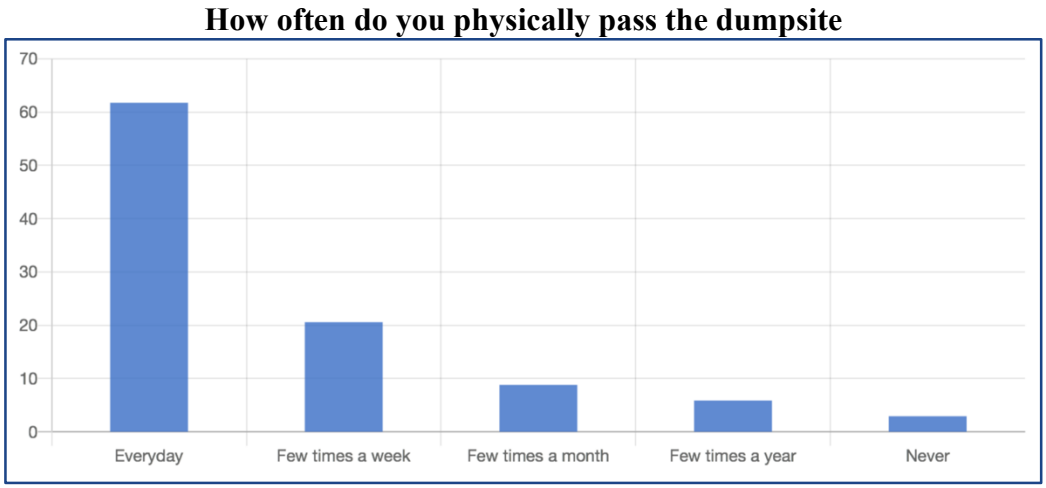

Figure 4.5: Questionnaire results on "How often do you physically pass the dumpsite?". The results were directly obtained from the Kobotoolbox application.

The road passing the dumpsite is the main access to the main road for households located on the eastern side of the dumpsite. The same road is used by the lorry when dumping waste, increasing the neighbours' contact with operational activities of SWM (App. 3G). The waste was accumulated in the northeastern corner of the site and had been flattened elsewhere which allowed plants to grow and soil to be visible in certain areas (App. 2E). In relation to that, one of the active uses of the dumpsite was people searching for edible plants. It was proposed that these plants originate in food waste from restaurants in town, and examples included African Nightshade, pumpkin, amaranth, tomato and potato. It was rumoured that some of them were being sold on the market (App. 1).

Categories of waste found on the dumpsite included food waste, many types of plastic (wrapping, wine bags, bottles, CD's, styrofoam, condoms), metal (wrapping, capsules, cans, electrical wires, computers, car wheels), hygiene products (diapers, feminine hygiene),

clothing (shoes, wigs), rubber (doormats, tyres), glass, carton and paper, mattresses, leather, chemicals (nail polish, lighters), and medical waste (syringes), cf. figure 4.6 (O).

Figure 4.6 shows the variability of waste categories on the dumpsite

It has also been mentioned by the residents how they sometimes have experienced activity from the dumpsite late in the evening and cases of smell at around 11 p.m., which was implied as sewage being dumped on the site (App. 4). Medical waste is also suspected to be dumped, coinciding with our findings of syringes (O). Furthermore, The Othaya Public Hospital owns an incineration facility, as ordered by the Ministry of Health, which is also being used by some smaller clinics in town (App. 3H). Yet, according to the informants from the hospital, private waste handlers collect waste from clinics that lack the capacity of disposal, in which case the waste is possibly being dumped on dumpsites (App. 2B).

Figure 4.7. Herding on the Gikeu dumpsite.

Other active uses of the dumpsite included herds with grazing animals (cf. Figure 4.7), children playing or walking on the site and recycling activities. The recycling activities taking place are based on an initiative by one resident, and have no connection to the official management of the dumpsite. Likely because of that, in addition to the residents' negative attitude towards the dumpsite in general (cf. 4.4), these activities seem to be rejected by the residents and the local MCA. According to observations and interviews with this recycler, he is experiencing hostile attitudes. The recycler is earning an income from collecting recyclable materials and transporting the materials back to the producers with a lorry. He has also involved a few children to help collect and process the materials (App. 2C). About 8-10 tons of recyclable materials per month are needed for the recycler to make an income. According to the waste management strategy of Nyeri county (Republic of Kenya, 2019b), activities of this kind are described as the informal sector, which should be encouraged and supported. This statement stands in contrast to our findings.

The current activities on the site are possible due to the lack of fencing and management of activities. Despite this, plans are in the pipeline in order to meet some of the issues regarding the dumpsite, which are to be implemented before 13th of june, 2020 (App. 2A). These plans include fencing the dumpsite to control entry and to improve the site visually, to make better roads around the site, to create a transfer station where the dumpsite is now located to recycle materials, to bury the waste that cannot be recycled, to provide mosquito net for the community

and to get proper equipment for workers (recyclers and waste collectors). There is, however, reason to put these plans in question, as the community have experienced promises like the above many of times, without them being realised, which has led to great dissatisfaction with the current management (App. 1; App. 4).

4.3 Environmental impacts

In this paragraph, the test results from nitrate (NO_3^-) and nitrite (NO_2^-) levels in the soil samples will be reviewed alongside an analysis of their spatial distribution.

4.3.1 Soil sampling

Figure 4.8 illustrates the spatial distribution of $NO_3^-$and NO_2^-. NO_3^-concentrations were found on and around the dumpsite with varying concentration levels, with the highest concentrations located on the dumpsite in the upper right, lower right and lower left corner with 114 mg/kg, 45 mg/kg and 45 mg/kg respectively. Around the dumpsite, the soil sample from a cultivated maize field in the commonly flooded area showed an equally high value of 45 mg/kg. All other values are equal or below 11mg/kg NO_3^--N. NO_2^- concentrations were only found on the dumpsite, however, they seem to coincide with the highest concentrations of nitrate. For NO_2^-, the highest concentrations are likewise located on the upper right, lower right and lower left corner on the dumpsite with 24mg/kg, 3mg/kg and 3mg/kg respectively.

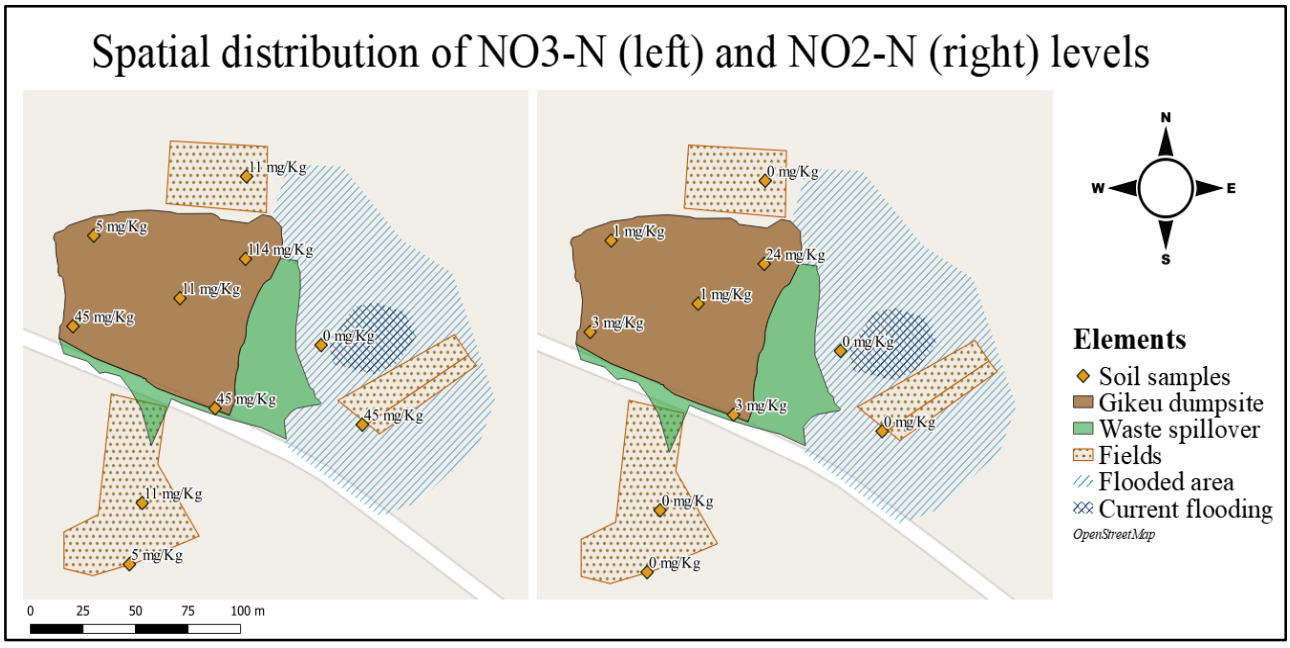

Figure 4.8: Map showing the spatial distribution of NO_3^- *and* NO_2^- *concentration levels in and around Gikeu dumpsite.*

4.3.2 Water sampling

The questionnaire results indicated that around 23% of the respondents use wells as a source of water for drinking and/or irrigation. Figure 4.9 illustrates the locations for testing of water samples for *E. coli* traces, nitrate and nitrite concentration. It further shows the direct distance from the dumpsite. Results in figure X show that well (2) and the water pit on the dumpsite (A) tested positive for traces of *E. coli* bacteria, thus exceeding the guidelines proposed from NEMA. The well (2) is located at a direct distance of approx. 110m from the western borders of the dumpsite and is used for irrigation purposes.

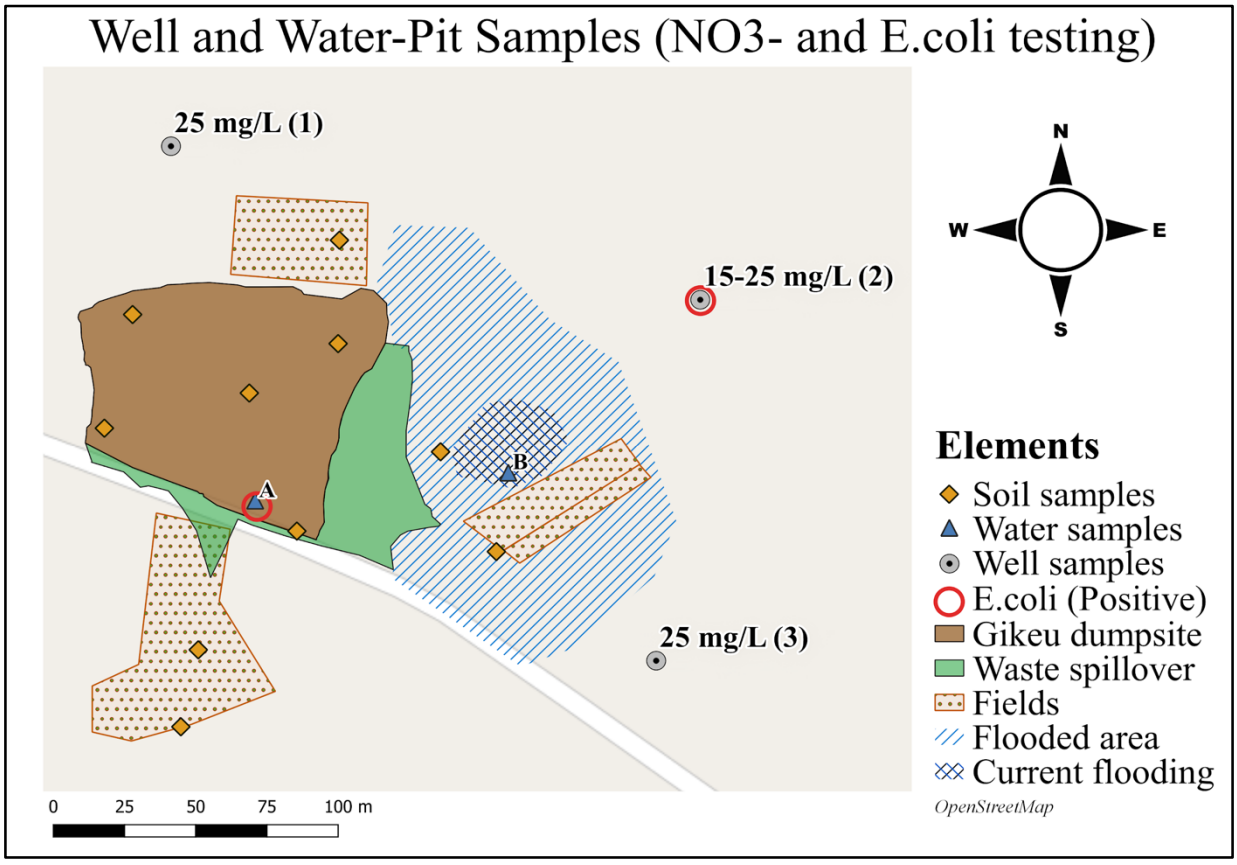

Figure 4.9. Results from the tests of nitrate concentration and E. coli for the water samples.

The water sample taken from wells (1) and (3) did not test positive for *E. coli*, neither did the water samples taken from the flooded area (B), between the dumpsite and the church. All well water samples (1, 2 and 3) showed a NO_3^- concentration between 15-25 mg/L, however neither the flooded area nor the water pit on the dumpsite showed concentrations of NO_3^-. All 5 water samples did not contain nitrite.

All well samples do exceed NEMA's guidelines of 10mg/L NO_3^- for domestic water supply, and should not be used for drinking purposes in order to avoid compromising health risks. The NO_3^-N and NO_2^-N levels in the soil indicate that organic sources of waste contribute to higher contents than usually seen in uncultivated soils (5-10mg/Kg NO_3^-N) (Camberato and Nielsen, 2017). The residents (sample QM, App. 1A) use the water from well (2) for irrigation purposes and this water tested positive for E. coli. Therefore the usage of the well should hereby be stopped immediately in order to avoid health risks that are directly linked to *E. coli*.

4.4 Perceived effects on residents

4.4.1 Resident demographics

The neighbors that were present at their homes during our research constituted a division of 62% female respondents and 38% male respondents. The mean age of the respondents was 56 years, with a standard deviation of 18 years. Primary school was the highest level of education for almost half of our respondents, while around a third had attended secondary school (cf. Figure 4.10).

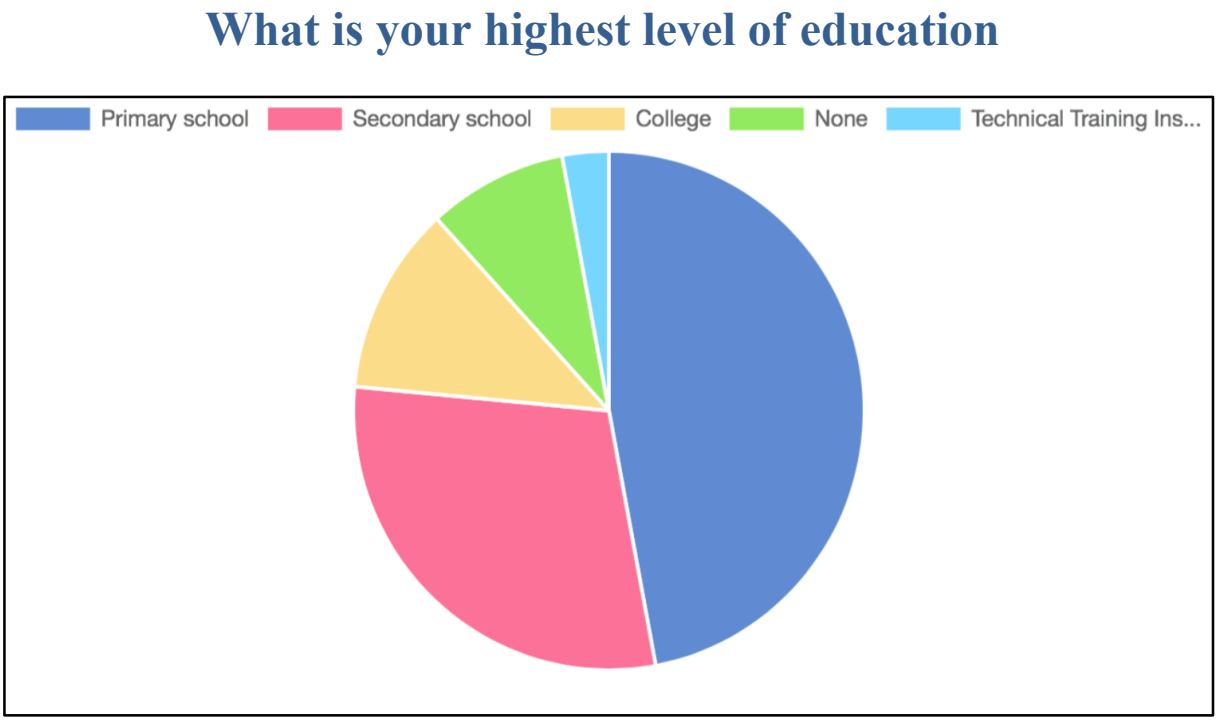

Figure 4.10. Questionnaire results on "What is your highest level of education". The results were directly obtained from the Kobotoolbox application.

4.4.2 Impacts on everyday life

On average, the respondents have lived at their location for 43 years, which is longer than the dumpsite has existed. 41% stated that they were born here. This means most respondents have experienced the neighbourhood before and after the establishment of the dumpsite. Furthermore, the consensus among questionnaire respondents was a negative attitude towards the dumpsite, as 94% said they were bothered by it, and 97% said that they couldn't see any positive factors (see figure 4.11).

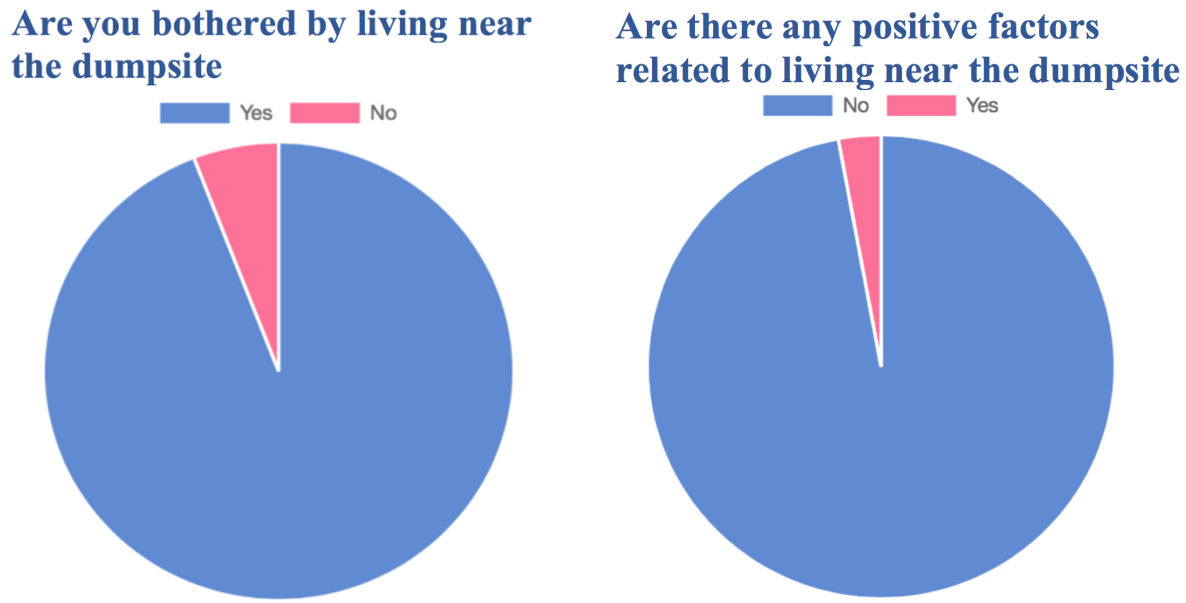

Figure 4.11: Questionnaire results on "Are you bothered by living near the dumpsite?" and "Are there any positive factors related to living near the dumpsite?". The results were directly obtained from the Kobotoolbox application.

When asked an open question about the negative factors concerning the dumpsite, the two main reasons turned out to be mosquitoes and smell, followed by illness and children playing on the dumpsite (see figure 4.12). The concern about mosquitoes correlated with the concern about malaria, which is elaborated on in the section concerning perceived health effects (cf. section 4.3.2).

What are the negative factors related to living close to the dumpsite

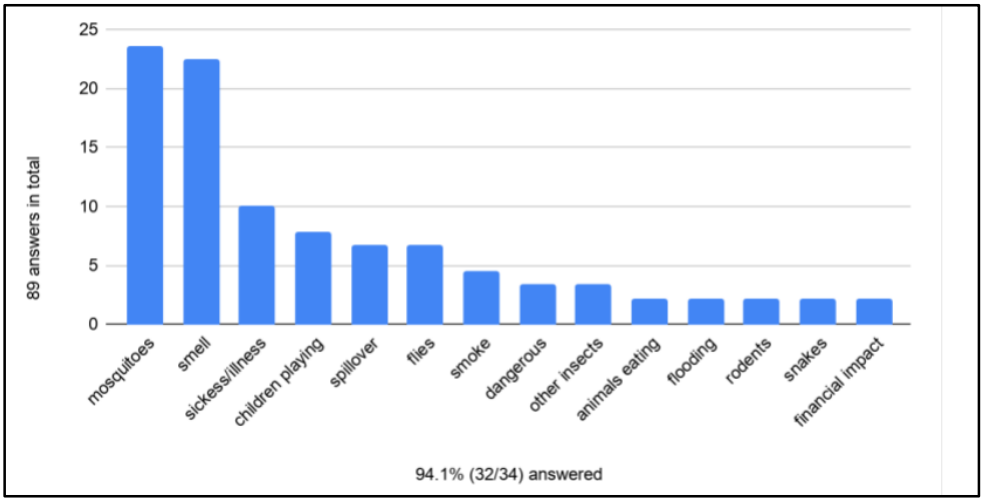

Figure 4.12. Normalized questionnaire results on open question "What are the negative factors related to living next to the dumpsite [If any].

Furthermore, the issue of smell was supported when we asked specifically how often people experienced smell from the dumpsite, to which 79% answered everyday. We also asked how often they experienced noise and smoke. According to the participants, smoke was of no great concern to the residents, and they explained that there was no official burning of waste anymore. However, the PHO stated that he gets daily complaints about fires, and lists this as the second-most common complaint after mosquitoes (App. 2A.). He thinks that the fires happen because the dumpsite is open for everyone, but did not go into detail, except noting that they might be strategic/intentional. The MCA however said that fires were caused by the drying of garbage and people walking around on the dumpsite smoking cigarettes (App. 2E). Lastly, garbage collectors told us that the banks have previously burned their papers on the dumpsite and the fires spread and burned for a long time.

There were mixed results concerning noise. Most respondents said they never experienced any, but one third said everyday. However, when we analyse the geographical distribution of these answers (see figure 4.13), we can see that all households located immediately around the dumpsite do experience noise, while those located further away do not.

Figure 4.13. Spatial distribution of noise complaints. The data were obtain directly from the Kobotoolbox application.

4.4.3 Perceived health effects

The vast majority (79%) of our respondents felt that their physical health is affected by living close to the dumpsite. The most commonly mentioned results were respiratory issues such as chest pain, lung irritation, nasal blockage and asthma. Another common issue was malaria, mentioned by 22% of questionnaire participants. In our interview with representatives of the Othaya Public Hospital, we were informed that they had had very few cases of malaria during the last years. In contrast, in the later conducted focus group (cf. Figure 4.14), it was indicated that cases of malaria might be more widespread. A participant who had contracted malaria a few weeks before the focus group meeting explained that most people prefer private clinics for treating malaria, as the cost of medicine is roughly the same, while waiting time is hugely reduced at the private clinic. Furthermore, the participants said that it is not something people like to talk about too much (App. 4).

Figure 4.14 shows the focus group. Residents of Gikeu are discussing the dumpsite.

12% answered that living next to the dumpsite was related to stomach issues. We found *E. coli* in 2 of 4 of our *E. coli* samples, one of which was a water well used for irrigation of vegetables (c.f. section 4.3). We cannot know if these findings are related, but *E. coli* can cause stomach issues, like diarrhea. The other sample that tested positive for the *E. coli* was taken from inside the dumpsite, in a small water pit, in which for example diapers were seen. We were informed about diapers being spread by dogs from the dumpsite to the households (App. 4), and this might also be a source to the spreading of *E. coli* and other intestinal bacterias. The two samples that tested negative for the *E. coli* were from the flooded area and from another water well. Physical injuries and headaches were not mentioned by many respondents as being a health effect from the dumpsite.

Apart from physical health, we also attempted to get some insight into perceived effects on mental health. Instead of using medical terminology, we identified some mainly emotional indicators of affected mental health and asked if the respondents related any of them to living next to the dumpsite (see figure 4.15). Almost half of them answered that they had sleeping difficulties - many explained in person that this was due to the smell, which was strong at night. Almost the same amount of respondents said they felt worried, and many explained that this was related to the children playing on the dumpsite, as well as neighbours or family members falling ill.

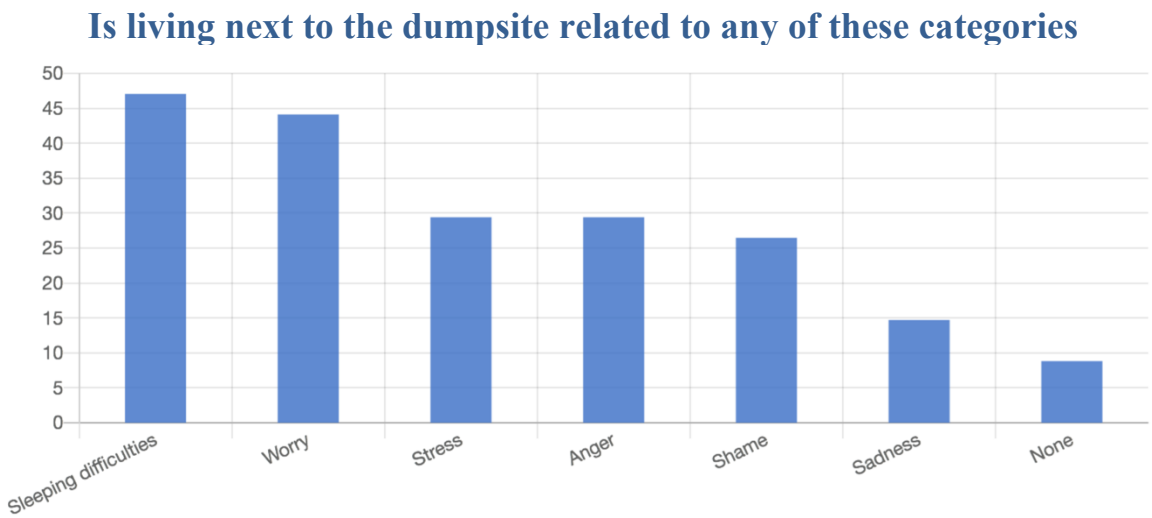

Figure 4.15. Questionnaire results on "Is living next to the dumpsite related to any of these categories?". The results were directly obtained from the Kobotoolbox app.

The issue of children playing on the dumpsite was one result that was repeated continuously (O; App:1 App. 3A; App. 4). It was said that the children eat expired products dumped on the site, get severe cuts from the glass shards and that they play with used condoms. Furthermore, people walking past said they experienced cuts from the glass, and that tires often get punctured (App. 4).

Although it wasn't mentioned as much as some other issues, the dumpsite also has some economic consequences derived from health issues. Apart from medical treatment of, for instance malaria, many of the residents have a problem with sickness in farm animals, especially lymph disease in cows (App. 4). The reasons are believed to be the stray dogs roaming the dumpsite, contracting ticks and other insects, and thereby passing sickness onto the farm animals.

4.5 Attitude and perception of the dumpsite

Due to intensification of the impacts from the dumpsite, the elders and the local people have since a few years back, expressed their grievances to the Assistant Chief of Gatugi and the County Government (App. 4; App. 2G). These intensifications happened as the former dumpsite in Nyeri Town closed, which caused waste from there to be dumped both in Karatina and in Gikeu. As the grievances of the community were not met, demonstrations began as a way to reach the council. As the PHO explains;

"*The community heard about Nyeri, and someone informed the media that the Nyeri waste will be taken to Othaya and Karatina. When they heard that, the members of xx began to mobilize their community to block access to Gikeu and Karatina*." - (App. 2A).

During these demonstrations, a trench was dug to block the road going into the dumpsite, which impeded waste-collection for 3 months in the area (App 1; App. 2G). This caught the attention of the County- and National Government, and as a result, a public meeting was held with the outcome being the promise of a fence and other improvements. At the same time the residents received mosquito nets as a precaution of malaria, which was of great concern to the residents due to the recent flooding in 2019. The number of mosquito nets handed out was rather small (20 nets), and were made for baby-cots (App. 1; App. 4), or as the Assistant Chief stated "for

children and pregnant women" (App. 2D). Contradictingly, the MCA stated that *all* households had received the mosquito nets (App. 2E). Furthermore, the nets only alleviate the issue of mosquitoes in the night time. The dumping from other areas has stopped, presumably as a result of a public meeting (App. 1; App. 2E; App. 3I), although NEMA stated that waste from Nyeri Town is possibly still being dumped at Gikeu dumpsite (App. 2F).

This shows that the needs of the community have been very poorly met and accounted for over a period of time. This has led to a minimal trust from the community in the implementation of the solutions presented by the government. Even the few remedies that have been carried out at this point are met with little enthusiasm. For example, one participant asked sarcastically what use she could get out of the provided mosquito nets - *"should I walk around on her farm wearing a mosquito net?"* (App. 4).

This dissatisfaction is also evident in the data collected during the questionnaires. Here, 65% and 29% of the questionnaire-respondents answered that they were, respectively, '*very unsatisfied'* and '*unsatisfied'* with the management of the dumpsite. No one gave a positive answer regarding the management (App. 1). Their dissatisfaction was mostly due to the location, the lack of management, and unfulfilled promises made by the council government.

During the focus group, we wanted them to discuss possible solutions for the current impacts, but the participants were unwilling to discuss any other solutions than relocation. Furthermore, when one of the village elders started talking about the benefits of the dumpsite, he was silenced by the other participants (App. 4). Despite this, when presented with the open question in the questionnaire about solutions to the current management of the dumpsite, a lot of different solutions were presented, many of them being fencing, recycling and making the dumpsite profitable for the surrounding community (App. 1). This can indicate an openness towards other solutions than just relocation, but this openness is only present when asked individually. When some of the same people were gathered in the focus-group, they did not, as a community, want to discuss any positive aspects or other solutions. The impression was, though subjective, that they were afraid positive statements would maintain the situation as it is. This presents a big issue in regards to managing the dumpsite, as there seems to be distrust, which is also reinforced within the community, towards the management that would take more actions or radical approaches to fix.

5. Discussion

5.1 Reflection on methods

Some limitations of this study should be acknowledged. As foreign students coming to a new country and culture, not speaking the language and without a complete understanding of the political system, biases might affect our results. We may have misinterpreted statements through translation or as a result of cultural differences. These misinterpretations can have misled or changed our findings, although precautionary measures were taken (cf. section 3.4.1). We were aware of the potential source of bias, and tried to identify words or questions that could lead to any potential misinterpretations before the interviews commenced. For example, we substituted some of the medical terms. 'Insomnia' was replaced by 'sleeping difficulties' and 'depression' by 'sadness'.

The informants might also have personal or political interests in the dumpsite situation, and might have been strategic and biased when responding. For example, the residents might have deliberately exaggerated the negative health effects of the dumpsite, as they may think that this would trigger action. Moreover, the politicians might have exaggerated their plans for the dumpsite to place themselves in a good light.

No representatives of the department were able to meet us in person during our fieldwork. Therefore, the PHO offered to pass on our questions to a relevant person in the department, and then verbally give us the answers. As he passed on the answers, we asked follow-up questions. Therefore, it is important to note that a lot of the information we found on the DES' waste-management comes from the PHO himself.

Observing the case as foreigners can also provide some benefits. A lack of ulterior motives can make our assessment more objective. We have intentionally tried to stay impartial, but acknowledge that it is possible that wishes for a certain outcome may have affected the results.

Furthermore, the lack of equipment and resources made some restrictions. The environmental analysis would benefit from measuring more parameters, such as an analysis of air quality. It was initially planned to measure the heavy metal content of the soil sample, but circumstances made this analysis impossible to carry out and had to be limited to the analyses carried out in the field. Looking at the existing literature, there is a plethora of assessments of heavy metal

levels concerning open dumpsites. Many show high levels of toxic metals, especially lead and chromium (Aucott 2006, Budihardjo et al. 2014). Results of high levels of heavy metals could have given some more validation and enforcement to the assessment.

The *E. coli* test results were obtained using a simple test in the field. Further testing of the water samples should be conducted for higher reliability. Furthermore, the test was supposed to be incubated in 20-25 degrees C for 48 hours. We did not have access to an incubator, and the temperature in the room where the tests were placed was not stable. The incubation time might thus be prolonged or decreased and the results may have been affected.

Other reliability-related insecurities are related to the strip tests for NO_3^- and NO_2^-. The instructions for the test states that the reading accuracy is ± ½ coloured field of the scale. Furthermore, it is important to note that in this research paper we did not conduct soil texture analyses; we used a generalized soil texture map of Kenya. A generalized map has limitations as it is broad and excluding smaller areas with individual soil characteristics. This needs to be noted as the solutions with soil samples settle at different rates, ranging from 5 minutes to 24 hours, indicating difference in grain sizes. Additionally, the calculation method in general is very simplistic, based on general values for soil textures and weight. The soil on the dumpsite had a darker colour compared to the very reddish surrounding soil, which could indicate high soil organic matter content (Senecahs.org). The occurrence of soil organic matter alters structural conditions and the bulk density of soils (Chaudhari, 2013). Therefore, it can be assumed that the NO_3^- N and NO_2^- N results could therefore introduce bias. With more time on hand, testing of NO3-, NO2- levels and traces of pathogens (*E. coli*) on groundwater and leachate from the dumpsite could have given more conclusive results and could be linked to health risks and perceived effects.

5.2 Reflection on results

Our main methods to gain knowledge on perceived health effects were the focus group and questionnaires. It would give our assessment more significance and relevance if we also had the possibility to gain knowledge on actual and direct health effects of the dumpsite, from either medical records or a health assessment of for example asthma cases in the local community.

There is a possibility of respiratory issues arising from smoke or decomposition fumes from the dumpsite. However, it is important to keep in mind that respiratory problems are a

widespread issue in many developing countries (Aït-Khaled et al. 2001). The Othaya Public Hospital informed us that at their facilities, Upper Respiratory Tract Infection was the most common diagnosis for patients below 5 years of age, and the second most common for patients above that age. They also said that many patients believe they have asthma, while actually, they have something less severe.

Respiratory diseases have also been linked to high levels of NO_3^- and NO_2^- in drinking water sources. Existing research shows that there is a possible correlation between the nitrate concentration in drinking water and acute respiratory tract infections (Gubta, 2000a, Russo et al. 2006). However, the research focuses on test results based on water sources (mg/L) and can therefore not directly be linked to our findings. It is, therefore, necessary to evaluate the linkage between NO_3^- level in our samples of (clayey) soil and groundwater pollution. Akinbile & Yusoff (2011) found that spatial patterns of soil NO_3^- levels and NO_3^- levels in well waters were similar, indicating that wells around the dumpsite are at risk of polluted groundwater from leaching. Clayey soils have a high water-holding capacity, and thus contribute to less leachate of pollutant hazards to the groundwater (Akinbile & Yusoff, 2011). However, research suggests that soil cracks in heavy clay soils from swelling and shrinking encourage vertical movement of water and leaching of dissolved nutrients (Bronswijk, 1991; Malingweni et.al 2019). Groundwater pollution with NO_3^- is therefore likely, and health risks need to be considered. However, a direct link of soil NO_3^- content and potential content of NO_3^- mg/L in groundwater and wells cannot be made in this study. It is also important to note that seasonal variations in climatic conditions alter leachate rates. The test results were taken and analysed in March, which is one of the drier months (Lapworth et al. 2017; Othaya Climate, n/d).

There was some apparent bias from the community in favor of relocation. Repeatedly, during our fieldwork, we heard the sentence: "Relocation is the only solution we will accept" (App. 4). It is striking how ingrained this has become in the residents' collective mind. As they exclusively gained progress and attention after their protests, it might imply that extreme measures are more likely to work. Furthermore, none of the neighbours of the dumpsite gain anything from the dumpsite (App. 1), and so they have no incentive to wish for it to be kept there. In other research, communities around dumpsites had a more positive attitude towards waste if they gained an income from it (Selin, 2013). Community participation like self-help groups can also provide an improvement, but take time to implement (Muller et al., 2002).

Research has shown that landfills can have considerable impacts on land value in the surrounding area (Danthurebandara et al., 2012) and this, in addition to the known and suspected health impacts and social stigma, are all reasons why people don't want a dumpsite near their homes. Despite the clear cry for relocation from the households near Gikeu dumpsite, this solution does not seem to be the easy way out (cf. section 4.1). It seems that the government cannot exclusively decide on a location that they seem fit, but must succumb to the power of politicians. Furthermore, relocation is that it is one of the most costly ways to close a dumpsite, it is hard to transport the waste, remove the smell and clean up the old site (ISWA, 2016).

The level of recycling is still low in the case of Gikeu dumpsite, as there is only one recycler. A reason behind this could be the stigmatization of the concept of *scavenging*. Changing this word may help with using the workforce constructively to reduce environmental damage. Scavengers collect waste and turn discarded objects into valuable substances, often providing an income for the poor (Nyathi et al., 2018). Adding to that is the feeling from the residents of not being respected by the county government, and the recycler making an enterprise of something that is a nuisance to the residents, benefitting him more than the community.

As the waste management in Kenya is influenced by institutional deficiency (NEMA, 2015), a possibility to sustain constructive long-term management in line with the county's policy could emerge through collaboration between the public and private sector. This might also lessen unemployment using relatively few resources. Furthermore, it is suggested that establishing new formal waste systems without taking already existing informal systems into account might turn out as counterproductive (Andrianisa et al., 2016). The formalization of the informal sector is also mentioned in the national policy on waste management (Republic of Kenya, 2019a), and thus has the governmental support to be realised.

Solutions to the current issues will be carried out in the near future (App. 2A, 2E, 2F), however we were unable to gather many written-down statements on the implementation of the presented solutions, despite asking for these repeatedly. Without affirmative documents, an overview of the verbal agreements was difficult to obtain, and it was not always clear to us when and in what order the plans will be carried out, and who is responsible for what. Despite this, the plans presented seemed quite aligned between the different responses, which indicates some legitimacy.

5.3 Further research

Further research on solid waste management on Gikeu dumpsite is desirable, due to the limited time period in the field. This led to snapshot data as it was not possible to conduct data on seasonal variabilities or development over time. Moreover, this study found that environmental assessments on pollution and health effects might alleviate incentives from the government towards a better management. An extensive assessment of pollutant hazards like heavy metals surrounding open dumpsites can contribute with valuable information to the existing research on this topic. The analysis of heavy metals should include the levels of heavy metals in the nearby water bodies, especially in wells used for irrigation and drinking-water purposes, groundwater and in plants growing on and nearby dumpsites. An investigation on more in depth effects on physical and mental health related to the dumpsite would bring more relevance and reliability to the research. Lastly, an assessment on attainable SWM solutions that are suited to the specific circumstances and resources at hand can be made in order to improve the management system and living standards of the residents affected by Gikeu dumpsite.

5.6 Recommendations

In the following paragraph we aim to give recommendations that relate to our findings and supplement the future plans of the NCG. The recommendations were presented for the different stakeholders for the different stakeholders during the feedback meeting on Othaya.

Note that these recommendations do not argue against relocating the dumpsite, but aim to improve the current situation.

5.6.1 Recommendations for governmental stakeholders

- Possibilities of relocation should be researched and considered thoroughly.

- Signs of ‘no trespassing’ should be installed. The signal in itself can have an effect and violation of the sign should be followed by a penalty. Recyclers would have to obtain permission or licence to do the recycling activities serving a function according to national and county policies.

- Environmental audits are an important tool in identifying the most constructive way to meet policy requirements, and provide important and official data on the current conditions of a certain function. The 2010 Constitution of Kenya in Article 42 states: *"Every person in Kenya is entitled to a clean and healthy environment (...)"* (1) and *"provide compensation for any victim of pollution and the cost of beneficial uses lost as a result of an act of pollution and other losses that are connected with or incidental to the foregoing."* (3.e). Making audits should thus be provided, and compensation of health issues and economic losses related to the dumpsite should be compensated.

- The existing laws that apply to dumping should be enforced.

- Improvements of the communication between the governmental institutions should be made and clarifications of the different responsibilities seems to be in need. Knowledge sharing of successful experiences should be shared among executives and representatives between the sub-counties.

- Since Gikeu dumpsite is located in a water catchment area, a drainage system can be a long-term solution. Polluted water can be connected to the nearby sewage system as a prevention from pollution of the water sources and agricultural land.

- The informal sector should be supported in ways that comply with the three dimensions of sustainability; environment, society and economy. An example of this could be to organize the community in self-help groups to become more involved with the dumpsite and find some benefit from it.

5.6.2 Recommendations for the community

- It should be communicated to children that the dumpsite is dangerous and a health risk. This can be done by parents, but also schools.

- The political engagement in the community should stay strong, as it has proven to be helpful in gaining momentum for change.

- The short-term solutions provided by the government should not be rejected, rather they should be seen as a path to a long-term solution.

6. Conclusion

Many of the people residing close to Gikeu dumpsite have been living there for most of their life and have been very affected by the many years of living in its vicinity. Many of the residents associate the area with discomfort, nuisance and constant risk of injuries and diseases. The most common perceived health effects were respiratory issues and concern about malaria due to the dumpsite was common. Some of the residents answered that they had stomach issues, which can possibly be connected to findings of *E. coli* in water sources on and around the dumpsite. The contaminated water sources should not be used in order to avoid compromising health risks.

All well water samples exceeded the national guidelines for NO_3^- in domestic water supply. Health risks from groundwater pollution with NO_3^- need to be considered and the tested water sources should not be used for drinking purposes. NO_3^-N and NO_2^-N levels in the soil indicate that organic sources of waste contribute to higher contents than usually seen in uncultivated soils.

Throughout this study it became apparent that improving the situation at Gikeu dumpsite is a present matter amongst the Nyeri County Government, as plans have been conducted and different practical measures have been taken.. Despite this, the community is feeling unheard by authorities, as promises have been made several times without being met. A sentiment of anger has arisen and protests towards the management have taken place. The lack of resources within the governmental institutions, the political influence and the distrust from the community has prolonged the current state of the dumpsite and made alignment between the desires of the different actors difficult.

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Appendix 1 - Questionnaire

Question	*Answer format*
Practicalities Hello, we are students working together from the Universities of Copenhagen and Nairobi We are doing research about the Gikeu dumpsite. We are looking into the management and the use of the dumpsite, as well as the effect that it has on the people living near the dumpsite. Is it okay if we ask you some questions? It will take about 20 minutes. If you don't want to answer some of the questions, it's fine.	
GPS CODE	
Age	Number
Gender	F / M
How many people are living in your household	Number
How long have you been living in this location?	Appr. number of years
What are the main reasons you live in this location?	Agriculture Family Born here Work Preference Availability Other:

	[Can select more than 1]
What is your highest level of education?	Primary school Secondary school Technical training institute College Bachelor Master PhD None
Physical experiences	
How often do you physically pass the dumpsite?	Every day A few times a week A few times a month A few times a year Never
Are you bothered by living near the dumpsite?	Y/N
If YES, what are you doing about it?	Open
Are there any positive factors related to living next to a dumpsite?	Y/N If yes, what?
Are there any negative factors related to living next to a dumpsite?	Y/N If yes, what?
Are there any activities on the dumpsite?	Children playing Herding and grazing Other

Do you experience any noise from the dumpsite?	Every day A few times a week A few times a month A few times a year Never
Do you experience any smell from the dumpsite?	Every day A few times a week A few times a month A few times a year Never
Do you experience any smoke from burning of waste on the dumpsite?	Every day A few times a week A few times a month A few times a year Never
Are you earning an income from objects on the dumpsite?	Y/N
If yes, how much would be your approximate monthly income	1-1000 1001-10000 10001-20000 20001-30000 Above 30000
Is this your main source of income?	Y/N
Do you know anyone earning an income from objects on the dumpsite?	Y/N If yes, how many?
Health effects	
Do you think your physical health is being affected by the dumpsite?	Very unaffected Unaffected Neutral Affected Very affected
If affected or very affected	Respiratory issues

Is living next to the dumpsite related to any of these categories?	- Lung irritation, nasal blockage, asthma, chest pain Headache Nausea Physical injury (skin burns, cuts etc.) Stomach issues None Other (specify) [Can select more than 1]
Is living next to the dumpsite related to any of these categories?	Sleeping difficulties Stress Sadness Worry Anger Shame None [Can select more than 1]
Management of the dumpsite	
Do you sort any of your waste?	Y/N If YES, how?
How do you get rid of your own waste?	Burning Garbage pit Municipal garbage collection Dumping it somewhere else Dumping it at the dumpsite Toilet pit I don't know Other (specify)
To what extent are you satisfied with the waste management?	Very unsatisfied Unsatisfied Neutral Satisfied Very satisfied

What are you specifically unsatisfied with regarding the management?	Open
If unsatisfied, do you have any ideas for how the council can improve the management?	Open
Do you know of any active community group(s) involved in the improvement of waste management?	Y/N
Do you know about any protests against waste dumping in the area?	Y/N
What do you think were the reasons for the protests?	open
Which of these do you see as the most suitable possibility for improvements of the situation? (select max. 3)	- Waste reduction - Relocation of dumpsite - Management should be changed - Recycling must be increased - Other
Thank you for your answers!	
Do you have any questions for us?	
Would you approve of potential/prospective further contact?	Number/contact info

1A - Observations

Code	Household observations	Stories
Q1	A lot of trees around the house. A lot of flies and mosquitoes.	Children are the ones burning the waste on dump site.
Q2	A lot of trees and mosquitoes. Not as many flies but some.	Earlier they used the manure from dump site as soil fertilizer

		but then the medical waste came and they stopped. - Smell is worst at night. - Government has sprayed against mosquitoes.
Q3	House is right next to dump site.	Dogs bring trash to farm and she has to bury it.- Dead animals are brought to the dump site. - Children take syringes and play with them. - Council has promised fence. - Less smoke in later years. - Smell worst in evening and morning. - Council brought mosquito nets but only 20 (for 300 neighbours) and only for baby cots. - Son has inhaler because of asthma. - Friends make fun because she lives "on the dump site". - Children eat rotten fruit from dump site. - Had a well but the frogs came from dump.
Q4	-	Most smell in the evening. - More smoke before, now it has almost stopped.
Q6	Close to sewage plant, lots of smell.	Border point, not affected.
Q7	We interviewed two people in same household together. Big household. 4 houses. Green area. Not very close to dump site.	County government receives funding to have dump site here. - Expired food is dumped and kids eat it. - Kids blow up condoms on dump site. - Smoke is to blame on the people here, not county. - Suspecting that people pick vegetables on site and all it in town. - The mosquito net problem.
Q8	Close to dump site. Lots of trees.	Dogs come here with trash and

	Not fenced. - He seemed afraid to answer.	the cows get sick by eating it.- Waste from fruits (e.g. mango season) smells more. - Most smell when raining. - Last year fire on site and firemen came.- does not feel ashamed / worried because he does not own the dump site.
Q9	Near dump site.	Husband is very sick (fever) because of dump site. - Cockroaches and rats bc dump. - Glass recycling is bad because of cuts. - People from the bank burn waste at site. - Hospital waste is dumped.
Q10	-	Group of 4 ppl who should pressure the county.
Q11	House on top, a bit the other way of dump site.	The woman fell and was injured by glass from dump site. - No pesticides from council to fix the problem.- A girl lost or disabled her arm because of glass on dump site. - Many people have died. - Area was supposed to be a slaughterhouse but they think it became dump site due to corruption.
Q12	-	Kids playing with condoms. - More smell in the evening. - Dead animals are put on the dump site. - Meeting group recently in the neighborhood. They had one responsible for complaining to the council, but they came back and had changed their mind.
Q13	-	People take the plants and give to animals.

Q14	-	Feels at risk of infection.
Q15	-	Passes the dump site on a motor bike. - Gets smell at night.
Q16	-	Experiences smell, mostly during rain. - Mainly worried about the neighbours who live close to site. - She doesn't know any place where recycling helped with issues like smell, so unsure if it's good.
Q17	-	Experiences smell, especially during rainy days. - Not so much affected but fears for his neighbors.
Q18	-	The smell makes it hard to sleep. - Had seen a child admitted to hospital for long time due to dump site injury. - Says no one cares about the environment.
Q19	-	Falls ill more often due to dump site.
Q20	-	Some people dump raw sewage. - Can't release his dog due to fear of eating trash.
Q21	-	Not bothered because she has lost hope. - Not affected now but previously was. - Smell when it rains. - Sleeping difficulty due to smell.
Q22	-	Wish the county would make the dump site profitable (to benefit all).
QB	waste in garden. Dogs are spreading waste to household. A lot of mosquitoes and flies.	truck dumps in farms when it’s stuck. Found dead dogs on Gikeu. Have a well, but don’t use it due to contamination and it smells.

QC	flies and mosquitoes.	don't use well due to contamination. Stomach issues. Scavengers for expired foods.
QD	-	worried because some people have died due to dumpsite. Seen children playing on dumpsite. When it's burning it's inhabitable.
QE	mouse and slug in well. Farm land gets flooded. Very close to dumpsite.	sickness from malaria
QF	mosquitoes and bad smell.	-
QG	-	got mosquito net from NEMA, but not enough. Animals feeding on dumpsite.
QH	-	malaria incidents. Wife has asthma because of the air.
QI	lives on other side of main road and not close to dumpsite.	before she used the church in the dumpsite area, can't use it anymore. Frogs from the Gikeu comes to garden.
QJ	other side of main road. Mosquitoes, flies and frogs.	-
QK	house on other ads of main road. Mosquitoes and flies.	she says she has flu because of Gikeu. Frogs comes. Don't bring guests to house because of the dumpsite and shame.
QL	water sample from well is tested. House QE.	-
QM	water sample from well is tested. Flooded area near well. Use water for irrigation. E.coli is found in water.	-
QN	near dumpsite. She has flu	waste is dumped in her garden where food is grown. She wants

		medicines.
QO	living very close to dumpsite. She had lump on her chest, a tumour that was operated - but she didn't know that it was because of dumpsite.	fires/smoke last for a very long time.

1B - Questionnaire open questions

Question: 10

If you are bothered by living close to the dump site, what are you doing about it?

88.2% (30/34) answered

30 answers in total

66.6% (20/30): demonstrations/protests

26.6% (8/30): nothing

3.33% (1/30): herbal medicine against illness

3.33% (1/30): complain to garbage collectors

Question: 12

What are the negative factors [related to living close to the dump site]?

94.1% (32/34) answered

89 answers in total

23.6% (21/89): mosquitoes

22.5% (20/89): smell

10.1% (9/89): sickness/illness

7.8% (7/89): children playing on dump site

6.7% (6/89): waste on my property

6.7% (6/89): flies

4.5% (4/89): smoke

3.4% (3/89): sharp/dangerous objects

2.2% (2/89): animals eating waste

2.2% (2/89): flooding

2.2% (2/89): rodents

2.2% (2/89): snakes

2.2% (2/89): financial constraint/impact

1.1% (1/89): ants
1.1% (1/89): cockroaches
1.1% (1/89): frogs

Appendix 2 - Semi-structured interviews

List of interview persons:
(All interviews have been conducted during the period from 27th February 2020 to the 11th of March 2020)

A. Public Health Officer (PHO)
B. Othaya Hospital representatives
C. Unofficial recycler at Gikeu dumpsite
D. Assistant Chief of Gatugi
E. Member of County Assembly (MCA)
F. Representative from NEMA
G. Protest organizer
H. Chief Director of Department of Environment and Sanitation

2A - Public Health Officer

Interviewguide
Introduction of us
Introduction of him and his work
Background information on dumpsite
How has the dumpsite changed/developed during the last 40 years?
How are the logistics regarding the dumpsite, for example number of garbage trucks collecting waste in the area?
How is waste managed in the county/region?
Are there recorded health implications caused by the dumpsite?
Questions regarding his responsible areas:
How long have you been working with the Gikeu dumpsite?
What are you responsible for regarding the dumpsite?
Do you face any waste management related issues?
Who is responsible for waste management related issues?
Do you face any other issues regarding the dumpsite?
What are your plans for improving the dumpsite?

Interview

Where/when: Othaya Sub-County office, 11:00, 02-03-2020
Attendees: Nele, Mary, Teresa, Prof. David, Dorette, James

Present as sanitation service, involved in budget making for solid waste management of the county. Advising the county on the budget for waste management.

How has the dumpsite changed/developed during the last 40 years?

It started in the late 1970'ies. Area used to get construction material from nyeri, and then left as open pit. Then the municipal council requested members of othaya to dump their waste. That time also dumping of sewage. The sewage system is only 7 years old in othaya, therefore, until recently, liquid waste was also dumped.

The area lies low compared to surrounded area = water collection area, therefore flooding when raining.

How are the logistics regarding the dumpsite, for example number of garbage trucks collecting waste in the area?

They recently bought one bulldozer, to manage and even out the area.

They have two garbage trucks, but one is broken at the moment. When its fixed it will help remove the pressure from neighbouring counties. They need moving trucks.

How is waste managed in the county/region?

Where does the waste come from in the Gikeu dumpsite? Urban area of Othaya (plus small centres), and the tee farm.

In Othaya, waste is collected everyday. In rural markets, waste is collected once a week, but because of the unpredictability of when the waste-trucks come, the people dump waste everywhere. They have tried to solve this with the construction of waste shambas.

"Waste from Nyeri town goes to Karantina"

Are there recorded health implications caused by the dumpsite?

They never had any sort of health investigation.

The interviewed had discussed that the vegetation should be removed, the area is not good for bulldozing, and the area is very poisonous. Anything that grows inside the dumpside is a health concern. But there are two main complaints:

1. mosquito breeding
    - Vegetation surroundings also provided good nature for mosquito
    - The county Spray around the dumpsite, but the effect is minimal because of the open area, and they need to reduce the use of chemicals
2. Fires of the dumpsite: daily complaint
    - The fires come because of lack of control of entry to the dumpsite

Do you face any waste management related issues?

- Community is not enlightened
- Governance
- Enforcement:
    - officers are intimidated by the officials; therefore, they have stopped enforcing laws (on waste), and they are understaffed.

- Also, there are no environmental laws. Not domesticated their own issues. Using public health laws instead – through the 13 officers working here. People think there are no laws, they can pollute as much as they want.
- Culture issue.
- NEMA is so understaffed.

Do you face any other issues regarding the dumpsite?

Land values go down with dumpsite in area – local member in the county (MCA) assembly has area close by. Therefore the interviewed thinks the fires where very strategic, and implies that the MCA had organized people to start fires.

He says that the issue the MCA was raising was very important – as a politician he raised the right questions, and therefore the county government tried to find a solution with him.

He says that in the time of uproar, there was "SO much noise coming from this area".

At the same time, a major project in Nyeri was happening; needed to make it more a relaxed city, poorly planned, and therefore they removed the dumpsite in Nyeri and made a bus stop instead. Therefore a new dumpsite had to be created in the nearby region, but the people were resistant towards it, and the resistance spread "like a bonfire".

"The community heard about nyeri, and someone informed the media that the nyeri waste will be taken to othaya and Karatina. When they heard that, the members of xx began to mobilize their community to block access to Gikeu and Karatina. After some time, the demonstrations at Karatina subsided".

What are your plans for improving the dumpsite?

The governor has it intervened, and will carry out these changes on Gikeu dumpsite before June 13th:

- fence, to control entry
- Better road, so vehicles know exactly where to dump
- Transform dumpsite to transfer station where waste can be recycled
- Bury the waste that cannot be recycled
- Get proper equipment for workers

The Health Officer explains it in steps:

1. First step is investment: lightning, security man at the dumpsite, construct a house with toilets
2. Second step: transfer station (2020, from july to June next year)

End notes:

The PHO states; "You really want to do something, but there are so many obstacles".

He also says that he has removed nuisance and conflict with community.

2B - Othaya Public Hospital

Interviewguide
Introduction of us (making clear that we might ask questions about sensitive topics/confidential patient information)

- Do you experience any pattern in cases of people living close to the Gikeu area?
- Are there special issues with asthma cases in the area?
- If yes, are they linked to the dumpsite?
- We have seen a lot of cases of lumps on people living close to the dumpsite - what does such lumps usually signify and what could be the causal relations?
- Where does the Hospital dispose of their waste?

Interview
Where/when: Othaya Public Hospital, XXX.
Attendees: Medical superintendent, PHO, Deputy nurse officer, Medical officer, XXXX

Fires cause poor circulation at night - they have been lit intentionally (PHO)
The facility does not have a system to categorise patients based on the areas where they come from. It receives patients from Othaya town, neighbouring towns and also neighbouring counties. However, there are no specific cases of illness noted from the Gikeu and Karima areas. Information on patients and diseases can be obtained from a government information portal. No overview of cases in Gikeu - no records. Someone who might know something more about the health cases in the Gikeu area: Disease surveillance officer.
No major diseases in the hospital like epidemics.
Asthma: maybe also just a common cold - because the word spread that this happened at the dumpsite: psychological.
Othaya is not a malaria endemic zone and only less than 10 cases of malaria have been confirmed in the last year in the whole hospital - some with a history of travel to other areas prone to malaria infections.
Stomach issues:
High water table in the area - as depending on topography.
E.coli possible from dumpsite but a lot due to the house flies and cockroaches. Usually diapers should be disposed of in the pit latrines or the toilet but they end up on the dumpsite.
Diarrhoea is a common issue all over so it cannot be isolated to one cause and thus cannot be related to stomach issues affecting the people living close to the dumpsite.
From the interview it was indicated that the waste from Othaya town is solid in nature, not the industrial or chemical waste and therefore the contamination of the wells may not necessarily be from the dumpsite.
We have noticed lumps on people living around the dumpsite, what could be the cause?

Tumor could be cancerous but they could also be swellings on joints and limbs. Cancerous lumps could however not be connected to the dumpsite as much as smoking can also be a contributing factor only results in a risk of lung cancer.
The Othaya hospital has a waste incinerator for handling medical waste as guidelines from the ministry of health oblige. Other health facilities are supposed to use incinerators as well but lack capacity to do so. Currently private waste handlers collect and some might be the people who dispose of in the surrounding dumpsites. Othaya hospital is planning to buy waste from the health facilities and implement a Recycling System. They are currently working on technicalities and to figure out a prize per kg or similar system that they deem fit. Information on how the private hospitals dispose their waste can be obtained from the sub county.
There is a clear lack of enforcement of existing guidelines on how private clinics handle their medical waste. The management shall endeavor/work towards digitizing their hospital records to enable easy access to information.

2C - Unofficial waste recycler at Gikeu dumpsite

Interviewguide
Introduction of the recycler
How long have you been recycling waste at Gikeu?
What is the waste composition at Gikeu?

- Is there any electronic waste?
- Is there any medical waste?
- What is the percentage of biowaste?
- Etc.

Are there any other categories that would make sense to recycle?
What are your preferences in an optimal recycling scenario?
What is your relation with the MCA/the government?
Are you aware of the future plans for the site and do you think they would improve the situation?
Would you be comfortable with us mentioning your work?
Do you experience any health issues?
What do you see as the differences between Karatina and Gikeu?

Interview
Where/when: at the dumpsite, 06-03-2020, 10:00-11:30
Attendees: Anna, Dennis, Mary, Teresa, Dorette, Recycler & Recycler's friend

The recycler starts off with reading an article he has written for our interview.
He states the positive uses a dumpsite presents for all the different waste-components.

Plastic can be used for making ventilation for houses.

- How: melt the plastic, mix with sand & paper
- Need: sand, fireplace, mixing-facilities, manpower

Carton and brownpaper can be sold to tissue & recycling companies and
Carton and bownpaper can also be used to make egg-trays

- How: mix with water and mold to make egg-tray
- Need: machinery and a shed to keep materials dry

Bones can be used to make food for cows and goats as they are rich in calcium and also for kitchen utensils

- How: sorted & cleaned bones can be grinded

Charcoal can be used to make firebricks which are good for domestic use as they are smokeless

- How: charcoal is grinded and mixed with water

Organic waste can be used as organic fertilizer

- How: should be collected from the source, then dry and grind it
- According to Kihara, 70% of the waste at the dumpsite is organic waste

Broken glass can be sold to make new bottles or used to make windscreens and tables

- How: broken glass put into cement bags and transported to nairobi

Remarks:
The next step is to make the dumpsite commercially viable, to make a commercial hub at the dumpsite.
According to the recycler, if these steps above are implemented, the dumpsite will after two-three years not be necessary - only the medical waste and the diapers, which should be incinerated.
The way forward, according to the recycler, is therefore to get help from the government & NGO to create a Dumpsite Commitee with 15-20 members and with the recycler as the chairman, where local youths are employed, in order to create income to the surrounding community. He thinks this will help the community embrace the dumpsite, as they will get something out of it themselves.
In order to get the Dumpsite Commitee started, the recycler sees it best to start out with making the ventilations. To do that he will need:

- A sorting place
- A fireplace (which should be metallic to boil the plastic
- A big steel table
- Molds and 2-3 spades
- Steel for molds
- Lubricants like oil
- Bags
- Manpower (provided by members of the community)

The recycler has been in contact with the MCA, who since last august has promised to take his work to the government. The recycler hasn't heard anything yet from him.

The recycler also states, that the dumpsite is a hazard, and that we are now seeing it at a "good time", because it in other seasons looks (and smells) really bad.
In Karatina, the fencing has already begun (he is showing us a picture of it), and it is a matter of time, before it will begin in Gikeu. In Karatina, they already have a Dumpsite Committee which is working. The K-Committee is supported by a NGO with boots and uniforms. He says that they are "ahead of us" in Karatina. They are called the Scavenger Self-help group on Facebook.
When we ask if the fence will be the right solution to meet the issues of the dumpsite, the recycler says that the fence will improve the eyesight and it will help guide the trucks to dump at the right place.

About the medical waste, there is still some being dumped, but mostly it is taken to Othaya, according to him. Only some of the small private hospitals-waste can find its way to Gikeu Dumpsite.
About the electronic waste, he says that it's only the outsides of the electronics (plastic shells) that are being dumped. The inside, like the wires, steel and metals can be sold elsewhere and are therefore not dumped (Note: we found some wires and electronics after the interview on the dumpsite, so this is not always the case).
The recycler has been doing this for the last two years. He is not concerned about his health, as he is not experiencing health-implications. He only experiences small cuts on his hands from the glass-breaking. He wears gloves and a gas-mask during work.
Endnote: Two men on a motorbike drove by as we held the interview and yelled at Kihara that he shouldn't promote the positives of the dumpsite, as they are afraid that that would lead to no relocation of it. They yelled in quite a hostile way.

2D - Assistant Chief of Gatugi, Thuti

Interviewguide

- What is your role in the community?
- Can you describe the problem concerning the Gikeu dumpsite for us?
- What do you think of the protest?
- We heard that the promise of a fence has been renewed many times, but nothing has happened so far. Do you know why it keeps getting postponed?
- How are you collaborating on this issue with the county government?
- Do you know anything about the promise of the mosquito nets to residents?
- What do you see as the ideal outcome of solutions?
- There are many empty houses surrounding the dumpsite, do you know what happened there?

Follow up questions:

- Who was at the meeting?

- What are the specific problems?

Interview
Where: Assistant Chiefs office, 05-03-2020.
Attendees: All

Described his role as an administrator-linking the local community and the national government and vice versa, he's a contact person.
He is aware of the problems of Gikeu dumpsite but says the docket is not under his jurisdiction but works closely with county government and national government to find solutions.
His main concerns are about school children picking and playing with used condoms, eating expired stuff from the supermarket, and people getting sick as a result of pollution.
A lot of meetings (about 7) have been held to hear grievances and look for possible solutions, nothing has materialised.
He confirms that about 20 mosquito nets have been distributed to the people living close to the dumpsite for children and pregnant women.
He understands there is a budgetary allocation of Kshs 2.9M for fencing the dumpsite but says the procuring process delays the fencing.
There is a process to procure land at Kieni that will serve as the main dumping site for the entire Nyeri county so that Gikeu will be used as a waste sorting area (transfer station). Unfortunately, the Kieni area member of parliament is against it.
About deserted homes by the dumpsite, he says a team of 5 people had been selected to follow up on that issue. The 5 are led by the area chief and some elders.
He, however, thinks the idea of the MCA's proposal of fencing the dumpsite would not be sustainable and the only solution would be to make Gikeu a transfer station and dump the waste at Kieni.

2E - Member of County Assembly, Nyeri County

Interviewguide

- Introduction of you
- What is your engagement in the Gikeu dumpsite?
- What do you think are the issues/problems of the dumpsite?
- What do you think are possible solutions?
- Why are you passionate about the dumpsite?
- Do you know what caused the fires?
- How has the dumpsite developed?
- Have the protests on the Gikeu dumpsite been helping/successful?
- Do you foresee any significant changes/development on the management of the dumpsite?

Interview

Where: at the dumpsite, 02-03-2020, at 16:00
Attendees: Nele, Teresa, Mary, Ruben

Has been an area MCA since 2017, gave a brief history of the dumpsite citing that the locals were duped, the dumpsite would be there temporarily, but that has not been the case. According to the MCA, the entire Nyeri county's waste was dumped at the Gikeu dumpsite. He found the dumpsite in a pathetic state, this made him organize demonstrations as the people he represents were severely affected. He says that people have died because of the dumpsite, including his relatives. He went ahead and dug a trench by the road, together with the community, so that garbage trucks wouldn't pass. This paralysed waste collection for 3 months in the entire Othaya sub-county.
The demonstrations drew both county and national governments attention. A public participation meeting was called. They resolved that the dumpsite would only take in waste from Othaya sub-county.
He states that he has made sure that every household close to the dumpsite has a mosquito net. He also states that there has been constant spraying of mosquito larvae especially during the rainy season.
His plans are as follows;

- ❖ Fence the dumpsite because it has already been allocated (stone fence)
- ❖ Have a gate
- ❖ Light up the dumpsite
- ❖ Every home should have mosquito nets
- ❖ Build sanitation
- ❖ A guard to monitor the activities in the dumpsite
- ❖ In future he would wish to put up a recycling plant and an incinerator (he wants the government to initiate a economical project regarding waste recycling)

He states that he has agreed with the national government, Nyeri county government and with the local community on these points. He also states that the minister of environment has ensured 2.9 million Kshs for the Gikeu dumpsite only, in order to achieve these points.
The fires on the dumpsite were, according to the MCA, caused by the drying of garbage and people walking around on the dumpsite smoking cigarettes.

2F - NEMA-representative (National Environmental Management Authority)

Interviewguide

- Can you tell us about the work that NEMA is doing in Nyeri county?
- What are your functions/responsibilities, locally?
- Have you been working with the dumpsite in Gikeu?

Environmental knowledge/data regarding dumpsite

- What are the impacts of the Gikeu dumpsite?
- Is there an impact assessment available?
- EIA or EA report done for the Gikeu dumpsite
- How do you assess the impacts of the dumpsite?
- Do you have sufficient resources for doing this work?

Politics

- Which locations are using the Gikeu dumpsite?
- Do you foresee any significant changes/development on the management of the dumpsite? If so, which?

Interview
Where/when: Nyeri, 03-03-2020, 14:00.
Attendees: Teresa, Nele, Anine, Dorette

- *Can you tell us about the work that NEMA is doing in Nyeri county?*

- NWI

NEMA: county director in environment, they supervise and coordinate environmental issues. Thus, having more practical approaches in NEMA.
They consist of 3 technical officers (her included) and one driver. They all have common interests but different backgrounds. She couldn't talk for the others however she has her first degree in forestry, 2nd degree in ….
NEMA coordinates and supervises the Gikeu dumpsite – not specific but in general. The NSWMS strategy supposed to be adopted by the counties, however it has not worked. Supposed to be domesticated, however, Nyeri County has not done that: no county governments has adopted these as of now. Engaging them to adapt, own capacity is lacking,

they might require some but depends also on the good will of the government. It also depends on budget of the government: purely a county affair to budget – gather finances.
Requirements 10 minimum: Collection all the way to disposal - she wanted to send them our way. It entails: Zone collection areas, labeling the categories of waste, fancing, manned dumpsite, compacting

- *What are your functions/responsibilities, locally?*

NEMA has some small influence in pressuring the government. Currently Nyeri town has no dumpsite – either Karatina or Gikeu. Pressure from NEMA resulted in finding another dumpsite (transfer station, only recycling and separation) – with recycling, composting, incineration plant. Identified the peace of land within Nyeri, plant to fence the area, compacting machines.

- *Have you been working with the dumpsite in Gikeu?*

Issues are very general, no real research. Address a general problem of solid waste management. NEMA has not conducted research of environmental assessments. They depend on experiences. Only on personal initiative for gathering environmental knowledge/data regarding dumpsite.

- *What are the impacts of the Gikeu dumpsite?*

Impact assessments are carried out by private consultants who are licensed. NEMA orders the impact assessment. They want to audit the impact assessment for Gikeu – is a new thing. End of march or April in the next financial year that starts in June. County government level. – start this year as it is already ordered.

- *Is there an impact assessment available?*

Gikeu: they want to do an impact assessment for the fencing.
They do an audit: environmental and socio-assessment of what had been happening

- *EIA or EA report done for the Gikeu dumpsite*

No

- *How do you assess the impacts of the dumpsite?*

Impact assessments are carried out by private consultants who are licensed. NEMA orders the impact assessment. Issues to solve:

- Littering
- Hazardous waste management/dumping
- Burning
- Blockage of drains

- *Do you have sufficient resources for doing this work?*

Issues are very general, no real research. Address a general problem of solid waste management. NEMA has not conducted research of environmental assessments. They depend on experiences. Only on personal initiative. Biggest issue:
Governance issues: structures, do they have the manpower to do it (resources), priorities.
Political will: MCA in charge of budget, is it an issue to them? Personal initiative. The county assembly decides what to do with the budget after the government afsætter a budget. Politics.

- *Which locations are using the Gikeu dumpsite?*

NEMA has some small influence in pressuring the government. Currently Nyeri town has no dumpsite – either Karatina or Gikeu. Pressure from NEMA resulted in finding another dumpsite (transfer station, only recycling and separation) – with recycling, composting, incineration plant. Identified the peace of land within Nyeri, plant to fence the area, compacting machine.

- *Do you foresee any significant changes/development on the management of the dumpsite? If so, which?*

There might be changes because they advise the Gikeu dumpsite to adopt: they ordered and got approved a fence – might be happen any time. Environmental assessment is in the pipeline: the moment they get the license they will start the assessment. May not tap the leachate. Compacting they will do.
Compost: Sell it to farmers.
Waste separation: taking place on site at karatina. The transfer station, sorting at the site. Encouragement of sorting at source but it is another challenge. Private operators can engage the households to sort, manage and dispose their waste. Not much embraced to sort at source.
Environmental laws: Management regulation, framework.
Persecution: On the liquid waste.
Putting pressure with facts.

2G - Protest organizer

Interviewguide

- Can you give a brief history of the community surrounding the dumpsite?
- Can you give a brief history of the mobilization regarding the dumpsite?
- Who are the members/leaders of the active community group?
- Is the community group still active?
- Who organized the protests?
- What is the reason for the protests?
- How many protests has there been?
- How many people have approx. been joining the protest?
- We have seen a lot of empty homes surrounding the dumpsite, do you know the reason why they are empty?
- What is the balance between what the leaders provide and what the community needs?
- Is there any progress in this regard?
- What is the leaders view of the community?
- Has the protest led to an improvement?
- Do you see the upcoming improvements (like the wall) as proper solutions?
- Are there any better solutions

Interview
When/where: at protest organizer's house, 05-03-2020, 10:00.
Attendees: Mette, Anine, Dennis, Mary, Nele, Anna, Teresa, John, Mr. Kenda

Interviewed was born here, 83 years old, has been a part of the protests.

- *Can you give a brief history of the community surrounding the dumpsite?*

Council took land from the community. The land contains Maram (?), building material for constructing roads. Before the maram was taken, the land was cultivated. Approx. 30-40 years ago, they started dumping waste on the site.

- *Who are the members/leaders of the active community group?*

There are no community groups, but the community meets once in a while to talk about different issues. Only people from the area participate in the protests.

- *Who organized the protests?*

People from the community. No one in particular.
What is the reason for the protests?

- The community complains because of the lack of a fence, children can freely enter the site.
- Also, the community feels that the place is theirs.
- The community wants the dumpsite to be moved to where there are no people around.
- Waste is coming from everywhere, even Karatina and Nyeri.

How many protests has there been, and how many people have been joining?
He can't remember.
We have seen a lot of empty homes surrounding the dumpsite, do you know the reason why they are empty?
The interviewed implies, that they left the houses because of the dumpsite (mosquitos).

- *What is the balance between what the leaders provide and what the community needs?*

The community needs the dumpsite to be replaced. Politicians bring empty promises, according to interviewed. "That is why people are very annoyed".
The MCA comes to talk to us and then leaves again without doing anything – the community is not satisfied with the work of the MCA. The MCA is on the side of the community, but he is not heard by the council. But all of them (politicians, government) say that the fence will come, but it doesn't (in the experience of the community). The chief says that the community should not protest. "The chief is on the government's side".
During elections, the dumpsite is used as a political topic, where a lot of promises are made, but nothing happens.

- *Has the protest led to an improvement?*

Nothing.

- *Are there any better solutions?*

The interviewed makes it very clear that the only solution is to move the dumpsite.

Note: Every time the group presents the interviewed with the solutions that have been promised by the MCA and the Government, he interrupts saying: nothing happens, whatever they promise, it doesn't happen.

2H - Director of Environment

Interviewguide
Introduction of us
Introduction of you
What are you responsible for regarding waste management in the nyeri county?
How is waste managed in the county/region?
How is the structure of decision-making regarding waste-management in the county?
What do you see as the main issues?
Is there an impact assessment available?
Do you foresee a significant development regarding waste management during the next 5 years in Nyeri County?
Is there anything else, you think could be of importance for us to know?

Interview
Where/when: Department of environment and sanitation, Nyeri, 03-03-2020.
Attendees: Nele, Anine, Teresa, Dorette and PHO

Interview by the PHO, as the Director was not available for an interview with us. Therefore, we handed our questions over to the PHO for him to ask the Director, and then he verbally passed on her answers to us. As he passed on her answers, we asked follow-up questions, and therefore it is important to note that a lot of the answers below are coming from the PHO himself, and are not necessarily the answers the Director would give.
Introduction of the Director
She is the director of environment, and also the chief officer in the department of environment and sanitation. Therefore, she has 2 roles.
As the chief officer she manages human resources. As the director of environment she manages the coordination and direction of all matters leading to environment and solid waste management.
What are you responsible for regarding waste management in the nyeri county?
She is responsible for ensuring the policy and regulation framework on solid waste management in Nyeri, and also managing staff in ensuring that they achieve the goals laid out by the government.

- She initiated training on environment and enforcement (trained in Nairobi)
    - Training on EIA and EA
    - 7 trained staff members have been certified to do EIA and EAs

- Collaboration with the private companies (for example NEMA) in risky areas; government can only assess areas that are not risky – not allowed by NEMA

How is waste managed in the county/region?

There are 8 sub-counties. The daily waste collection only happens in 3 sub counties (Othaya, Nyeri, Karatina). In these towns, there are different methods for daily waste collection. In nyeri: Kerbside collection. Kerbside collection is dependent on the predictability of waste collection – has to be precise, otherwise the town gets very dirty. Kerbside collection has existed earlier in the other areas, but because of the unpredictability of the trucks, they found a different method: waste *shambas*. Containers will be implemented in the next financial year.

Also, open/illegal garbage dumping happens across the county, especially in areas where they are not able to collect waste. In other towns than the three mentioned, waste is collected once a week. This is because the waste generation is minimal, in that the smaller towns are not as busy as the 3 mentioned cities, and also because a shortage of trucks.

Machines: Normally collect waste by "side loaders" + skid-loader (container), open trucks with cover to ensure waste not being blown off, tractors.

All waste dumped into 4 dumpsite: Gikeu, Karatina, Naromoro, Mweiga.

How is the structure of decision-making regarding waste-management in the county?

The decision go through these people:

1. County executive officer (the policy maker)
2. Chief officer (administration, financial management, human management (interviewed))
3. Director of environment (coordination of technical support in the department (interviewed))
4. County Solid Waste Managers (implement departmental policies and regulations (also done by the sub-county heads – there is supposed to be a sub-county solid waste manager, but shortage of staff. Therefore PHO has this role in Othaya)
5. The guys who the real job, cashworkers, drivers, etc.

Normally issues are dealt with at the director level (interviewed)

What do you see as the main issues?

1. Political interference: Enforcement of environmental regulations – there is not a lot of space to do as you wish.
2. Lack of resources: Influenced by politicians. Therefore, government becomes beggars for the politicians.
3. Getting a proper land to solid waste management: Communities have not allowed waste dumping in their land.
4. Members of community: Not understanding their responsibilities and roles of waste management. Find the government as enemies.

Is there an impact assessment available?

No, there were no rules to do EIA when the dumpsite was established. NEMA came into force in 1999.

For the 4 new dumpsite-areas, EIA are in to be accepted from NEMA – if they are accepted, local persons will be chosen to manage the new dumpsite-areas.

Do you foresee a significant development regarding waste management during the next 5 years in Nyeri County?

There is a lot of hope. Waste management has been moved to another service in government, where it is not competing. There have been investments such as the purchasing of garbage trucks, training of officers and the purchasing of a supervision vehicle. Education of communities in urban-and rural areas. Collaboration with the private sector:

1. National police training college: The community service has to be used in regard to waste management (environmental management and conservation) like repainting, collecting garbage, signage of warnings/where people should collect their waste

National environmental act is very punitive. Therefore, the county government will make new regulations and policies of their own. They started this work july last year; now the cabinet has adopted them, but they are still not implemented (for a reason I, Teresa, could not understand).

The Governor has started An Environmental Committee (including NEMA, The Public Health office, and members of the community). Two meetings before June 30. One meeting of responsibilities, second one is review of what they have achieved.

Harmonization of various actors (like NEMA and county government) – initially walking in isolation, but now they must work together to solve the overall issues.

Endnotes:

Things PHO states:

- PHO says audits have been carried out every year at Gikeu dumpsite, but they are "with NEMA".
- Says there is a disagreement between NEMA and the government
- "First time that the community been involved so much in the project"
- At the moment there is a waste-management strike in Nairobi

Appendix 3 - Unstructured interviews

List of interview persons:
(All interviews have been conducted during the period from 27th February 2020 to the 11th of March 2020)

A. Unofficial recycler of Gikeu dumpsite
B. Our guide, Elizabeth
C. Boy at the dumpsite
D. Host family of group members
E. Assistant Chief of Gatugi
F. The MCA
G. Lorry driver
H. Private medical clinic in Othaya town
I. Lorry collectors

3A - Unofficial recycler of Gikeu dumpsite

Where/when: At the dumpsite, 28-02-2020.

- Kihara is doing unofficial recycling
    - Mainly glass
        - Broken into pieces in order to take a bigger quantity
        - Boys help with breaking the glass
        - Need 8-10 tons at a time to make a profit
        - ~ 8 tons per month
        - When a truck is coming with building-material and loading it off here, Kihara pays the lorry (truck) to take his glass back to Nairobi to "Consol"
        - If he hires a truck by himself, it costs xxxx
- Also different sorts of plastics are recycled
    - Need a compressing machine/tool, in order to compress the plastic – without it, he needs to gather a lot of plastic in order to make it profitable
- Cartons
    - More profitable when dry – hard to keep dry when its raining, the cartons get wet and loose value
    - à needs a shed to keep the cartons dry
- Companies will pay money to buy recycled goods because it's cheaper to make new stuff from it

- The county keeps saying they will “look into” funding for i.e. shed, but nothing happens
- Many people at Karatina dumpsite
    - Might be fenced and then people will come to Gikeu dumpsite
    - In karatina, neighbours have embraced the dumpsite – they see the benefits from it
- Around Gikeu dumpsite, the people are hostile towards activity regarding the dumpsite
    - Kihara was the first to profit from the dumpsite in Gikeau, and is today the only one profiting from the dumpsite. He also works on Karantina dumpsite, but there are many others there

3B - Questions asked by a group member to our guide, Elizabeth

Where/when: Near the dumpsite, 28-02-2020.

- Our guide, lives near the dumpsite.
- Many ppl like the dumpsite because it keeps the city clean
- Some ppl don’t like smell, flies etc
- People in the county throw trash over the street, in their own small garden-dump, in toilet pit, etc.

3C - Questions asked by a group member to the little boy walking around the dumpsite

Where/when: At the dumpsite, 28-02-2020.

- Says garbage trucks are coming 1-2 times a day

3D - Questions asked by group members to their host

Where/when: 28-02-2020.

- Moved away from the Gikeu dumpsite 20 years ago, both because of the need for a bigger house but also because of the bad smell from the dumpsite
- Back then, sewage waste was also dumped there
- Says they live “far away” from the dumpsite now, even though they (in our perception) still live close (between 500m-1000m away from the dumpsite?)
- They don’t think about the dumpsite anymore

3E - Assistant Chief of Gatugi

Where/when: 28-02-2020.

- Talking about the political issues surrounding the dumpsite
- Something about the title deed: the church gave him the title deed (a copy), and he said that the church is not usable.
- He acknowledges the problem of the dumpsite and says that the people are aware of the issue.
- He says that the Nyeri council has promised many times to improve the management of the dumpsite, but they haven't done what they promised.
- I can’t remember anything - please help

Interview with the area MCA-Reuben (concerning the church)
The church has requested him to help them sell land to the sub-county council or better still let the sub-county have that land and relocate them to a better place. Since they cannot use it due to constant smell and flooding.

3F - Lorry driver

Where/when: At the dumpsite, 02-03-2020.
Dumping at the Gikeu dump site is normally done depending on the amount of waste. On average they make two trips daily . When the waste is too much, the trips may even be five on one day.
Waste is collected only from Othaya town and his duty is only to drive but works with three people who help to load the waste into the lorry and to guide on the best points to dump the waste on the dumpsite. Most of the waste collected is only from Othaya town dumping spots and from the market area. Medical waste is collected and taken to Othaya Hospital for incineration .The challenge experienced the state of the dumpsite when it rains and the truck gets stuck in the waste, making it difficult for proper dumping of waste.

3G - Private medical clinic in Othaya Town

Where/when: Othaya town, 04-03-2020.
Assistant has been working there for a few months. Says that there is a private person that takes the medical waste, but doesn't know where to. She says that the waste is not being dumped on the street shambas.
The doctor says that the medical clinics in Othaya have had a meeting, every Friday a person collects the medical waste and takes it to Othaya Hospital to be incinerated.

The doctor say that Othaya Hospital has an incineration facility.
He showed us a box for the needles to be handled safely.

3H - Interview with Lori driver/collectors

Where/when: In Othaya town, 04-03-2020.
Amount of workers:

- 1 driver
- 9 collectors
- 6 cleaners/street sweepers

Time schedule: They work from 8am to 5pm from Monday to Friday. Sweepers start sweeping streets from 8am to about 11am and then the truck collects the waste together with the collectors.
They collect waste in Othaya town every day except Sunday and only half day Saturdays. Only once a day in the rural areas, and only one rural area a week, which means they choose which one to go to.
They only dump at Gikeu. They say only they are dumping there, no Lorrys from Nyeri/Karantina. They only have one Lorry. Before they had two, one is being fixed, and they could collect waste from every restaurant.
They have many collection points, called “shambas”. Everyone brings waste to the points. They take everything to the Lorry, don’t collect any especially dangerous waste in a special way.
About 50% of the waste is organic waste they think.
When it rains the Lorry sometimes gets stuck and has problems because of flooded roads. They then sometimes dumps on the road.
Apparently there are some people from the bank burning their papers and the fires spreads and burns for a long time.
They got new uniforms in February, and they say that a new Lorry is on its way (but might take years…).
They say they sometimes get injuries.

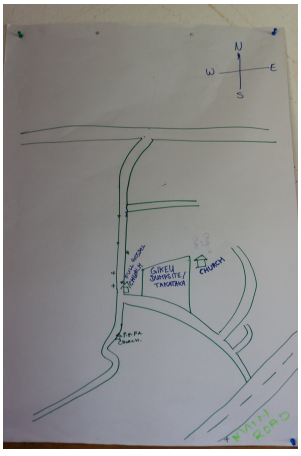
Appendix X - Focus group

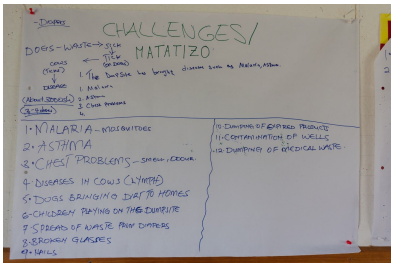
Where/when: Assistant Chief of Gatugi's office, 06-03-2020, 14:00-16:00.
Attendees: all group members
Facilitator: Dennis Wanjohi
Language: Kikuyu

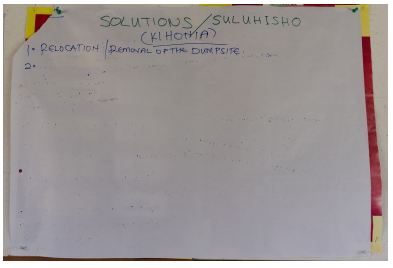
Questions should be conversation-starters.

1. Exercise to get the conversation started: drawing where they live on a map
2. Let them discuss and write down challenges concerning living next to the dumpsite.
3. Next they will rank the problems
4. Let them discuss and write down solutions to their perceived problems to see what problems are left unsolved
5. What solutions could be implemented to resolve the remaining problems?

7 participants showed up.
We had a prayer in the beginning.
The focus group was conducted mainly in Kikuyu, with the interpreters John and Elizabeth translating continuously. Dennis, the facilitator, also presented summaries of each section in English.
Everyone presents themselves with the name and saying that they are a "neighbour to the dumpsite".
The first exercise was to have the participants mark their house on the map. It was a superficial map, missing some small streets. They were told not to focus so much on details but to try their best. It got everyone talking and interacting, which was what we had hoped for.







Statements: *history*

- The Gikeu dumpsite was originally community land. It was used to extract maram (gravel), then it became a slaughterhouse which lasted for 4 years, still under community land. There has been different council members during different times, and it was a council member who took the slaughterhouse to the Othaya town. After that, the land was made into a dumpsite, temporarily, but never left.
- After some years it started to smell when the elders and others talked to the county council about it.
- Anecdote: A man has brought many wives to live with him but they have all ran away because of the smell and the circumstances of the dumpsite.
- Promises have always been the same but nothing happened. Only after digging the trench, something happened.
- The trench was made as a protest for waste being dumped from other sites and the ones coming with the truck setting fire to some of the waste.
- The protests stopped because of promises of a fence, and because they felt bad for their neighbors in Othaya.
- The promises started coming after the protests
- One participant says that relocation is the only solution she will tolerate. She started to use a walking stick long before it is normal to do so, and she is convinced that it is because of the effects of the dumpsite. She tried to make a fence of trees towards her property for the smell, but it has not worked.
- The dumpsite has been there for around 25 to 30 years.
- 400 people living in the surrounding area
- The councillors that have been during the time have all come from the area.
- One person (who is an Elder) says there are only two possibilities: to relocate the people living near the dumpsite, or to relocate the dumpsite.
- They also think they should get some kind of compensation.
- Same participant who only tolerates relocation asks what she should do with the provided mosquito nets, as she cannot wear them in the day time.
- Some people do not have the money to connect to the sewage systems. It's said that there is sewage being dumped during the night from around 11pm to 12pm. Some people experience a bad smell coming at the time.
- Every home around the area has a graveyard for people who have died because of the dumpsite
- It's a problem the expired products are lying around. A story about some men finding expired beers died from drinking it as they were poisoned by the alcohol. Children also eat expired products.
- The spreading of waste is also a problem, and dogs spread a lot of waste. It creates a problem for the cow grazing close to the site as ticks will be attacked to the dogs and then easily be transferred to the cow which makes it sick. The treat the cow for lymphs, 3-4 doses of treatments, 3000 shilling each makes up to 12000 shilling. The insurance don't cover the expenses as well as there are no guarantees that the cow will recover.

- Diapers are a big problem as they don't really degrade.
- Broken glass and nails are also a big problem, since children get injuries and it often punctuates tires of cars on the road.
- People are afraid of malaria. The treatment is 2000 shilling. The private hospitals are more efficient than public hospitals. One participant was misdiagnosed with pneumonia when he went to get a test in a private hospital at the cost of 1500 shilling and was diagnosed with malaria.
- They also want the flooded church to be relocated. It was bought back when there wasn't much flooding.
- Often when they go to churches in the area, they cannot pray or concentrate because of the stench.

General problems:

- Mosquitoes
- Sickness
- Smell
- Wells contaminated
- Asthma
- Respiratory
- Diseases in cows
- Children playing on the dumpsite
- Spread of diapers
- Broken glasses
- Nails

Consensus: ALL PROBLEMS HAVE EQUAL WEIGHT.

Solutions:

- Relocate dumpsite to Nyahururu where government has some land.
- No dogs allowed.
- Change of diaper use to nappies.
- Overall goal is relocation.
- The responsible has to make the place into something he/she would like it to be if they themselves were living close to a dumpsite.
- Two options, either relocate people or relocate dumpsite
- Relocated where: area on the other side of nyeri town, government owned, sparsely populated, it could be a good place to go.
- They don’t have to propose, the government owns a lot of land, so they should know themselves
- They seem to want a fence, as they say they would have dug another trench immediately if the elder hadn't assured them that the fence is coming.

Officially they only want the relocation.

Own notes on solutions from the content

- Allocate a new church to the people or land to build a new church.
- Dig up plastic to prevent flooding? It was stated that there were not floodings before the dumpsite.
- Close contact with an authority person, MCA or guard to keep control.

Appendix 5 - Synopsis

Assessment of environmental and social impacts of the Gikeu dumpsite in Othaya

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1. Introduction

Solid waste management has become a common problem in developing countries. The increasing generation of waste caused by population growth, rapid urbanization and the rise in living standards are burdening authorities that are mostly seen as responsible for the waste management. Efficient and sustainable solutions put pressure on budgets and call for organizational skills and knowledge that many authorities do not have. Thus, these kinds of solutions often fail to be implemented (Guerrero, Maas & Hogland, 2013).

Poorly managed waste is often resulting in open, neglected dumpsites, which has an impact on the health and wellbeing of the nearby community, where risks of infection transmission through rodents and insects, as well as inhalation of fumes from burning waste are just the tip of the iceberg (Ziraba, Haregu & Mberu, 2016). Apart from impacts on health, areas of open waste dumping often result in social stigma for nearby residents due to nauseating and pungent odours, insects, view and various other atmospheric factors (Mosquera-Becerra, Gómez-Gutiérrez & Mendez, 2009). Environmental issues arise, where pollutants and harmful substances leach through the soil and into the groundwater or nearby water bodies (Guerrero, Maas & Hogland, 2013). Economically, inadequately managed solid waste depresses the market for recycled materials, which end up in landfills instead of generating new value. This often happens due to a lack of standards and guidelines for recycling, as well as missing access to the recycling market. Only 10% of the garbage in Kenya is recycled, according to the Republic of Kenya (2019). Furthermore, the recyclable materials are often sold at the dump site for an overly low price (Republic of Kenya, 2019).

Kenya classifies as a low-income developing country and produces, according to the Republic of Kenya (2019), an estimated amount of 22,000 tons of waste/day and approx. 8 million tons annually. The numbers are thought to rise rapidly alongside the steady increase in population in urban areas. In Kenya, waste is generally not separated, thus all sorts of waste from households, industries and health care facilities are dumped unsorted and (possibly) contaminated. This overburdens as well as contributes to pollution of the country's natural environment and despite the efforts to reuse and recycle, the quantity of waste generated remains high and is still increasing (Republic of Kenya, 2019). Past inventories suggest that 60-70% of the waste is

organic, which when dumped contributes to greenhouse gas emissions from methane (CH_4) (Guerrero, Maas & Hogland, 2013). The rising awareness of the negative impact on health, environment and economy encouraged the country to implement "The Kenya Vision 2030" in 2008, which amongst other initiatives focuses on developing functional and sustainable waste management systems in the largest cities: Nairobi, Kisumu, Eldoret, Nakuru, Thika and Mombasa by 2030 (Republic of Kenya, 2019). The results seem feasible. In Nairobi (Haregu et al., 2017) and Kisumu (Sibanda, Obange & Awuor, 2017), the government is cooperating with private companies, community-based organizations (CBOs) and non-profit non-governmental organizations (NGOs) for waste collection and disposal, as well as recycling. This has helped alleviate some of the pressure on the government.

In 2010 the Kenyan government decentralized waste management, delegating the responsibility out to its 47 counties. According to the Republic of Kenya (2019), the regional administrations have insufficient frameworks for waste management infrastructure, due to a lack of technologies and capacity to support sustainable waste management, as well as public awareness and county laws. The decentralization thus seems to have overburdened the authorities with the task of implementing waste management strategies. In 2019 no county had implemented a developed infrastructure for waste management, resulting in open dumping, exposing huge volumes of waste to elements, vectors and scavengers and furthermore endangering the surrounding environment and residents (Republic of Kenya, 2019).

In Othaya, waste is dumped on the Gikeu dump site, which is located approximately two kilometres outside the centre of Othaya town. Gikeu is one of few official dumpsites in the Nyeri county, and waste from the county capital of Nyeri (estimated population between 50.000 - 140.000 [World Population Review / Kenya National Bureau of Statistics]) was dumped there after the Nyeri Town dump site closed, resulting in protests from Othaya residents in the summer of 2019 (Standard Digital). Another dumpsite in the county is located in Karatina, where town officials have given the county government an ultimatum to stop using their dumpsite before March 31st 2020 or "face the wrath of residents" (Kenya News Agency), an indicator of heated tensions concerning waste management in the area. To our knowledge there are no other official dumpsites used.

Generally, it seems that although there is some growing awareness in Kenya to improve waste management in the big cities, there seems to be a knowledge gap due to lack of research and initiatives in the waste management and impacts of open landfills in rural communities. The limited research that is available is often outdated or not peer-reviewed. Especially the research conducted prior to the impactful 2010 decentralization, might provide interesting historical perspective, but not much timeliness and present relevance. An example of such a source is Thuo's masters thesis on waste management in Othaya (Thuo, 1998). Other studies lack recognition as they are not peer-reviewed, such as Selin's bachelor's thesis on waste management in the rural settlement Mutomo (Selin, 2013). Even sources like these are hard to find, leading us to believe that awareness of the impact of open dumping in the rural communities, as well as their perceptions and opinions about the dumpsite and its effects, are often not assessed. Neither are the effects of open dumping on the environment and people living in the area are not documented adequately.

In this study we, therefore, aim to assess solid waste management of the Gikeu dump site close to Othaya town, in order to evaluate the environmental and social effects of an open dumping system and the opportunities for regionalized waste management.

1.2 Research Question

Main research question:

What are the environmental and social impacts concerning the local dumpsite in Othaya?

Sub-questions:

1. How does the council in Nyeri currently manage the Gikeu dumpsite?

2. How is the dumpsite used?

3. What are the residents' perceived effects from the dumpsite on their health and everyday life?

4. What are the perceptions of, attitude towards and political engagement regarding the waste management system among households in the Gikeu area?

5. What influence does the Gikeu dump site have on the surrounding soil and water quality?

2. Methodology

For this study we aim to take an interdisciplinary approach that incorporates both social and natural science methods. The social science methods will be used to answer the social part of our research question, while the natural science methods will shed light on the environmental part. This will highlight the different ways in which the Gikeu dump site has an impact on the area. Merging, comparing and complementing the social- and natural science methods' results will give a deeper understanding of the impacts and a more holistic picture of the situation. The environmental assessment can be used to give a context to the results from the social assessments conducted, and the other way around.

2.1 SOCIAL SCIENCE METHODS

For all social science methods we are aware of our position as students from a Western university and carefully consider the questions asked and discussing topics that would be unclear for Othaya residents and other people of interest. For instance, we initially thought about asking about allergies in the questionnaire, but realized that participants might not know how to answer this. Sensitive subjects are also of consideration, for example income related questions or themes perceived as private or intimate. We are also concerned that questions about health might lead participants to think that we expect them to answer that they *do* notice effects on their health, or in general give answers that the respondents think we want to hear. This is a risk that is hard to avoid but we will try to signal that we are interested in truthful answers.

Questionnaire

With the questionnaire we seek to understand which impact the Gikeu dumpsite has on households in the Othaya area. Specifically, we wish to gain quantitative insight on perceived effects on health and everyday life for our research subquestion 3, as well as the perceptions, attitudes and political engagement mentioned in research subquestion 4. We will also collect comparable data on age, gender and geographical position of the household, in order to find any correlations between answers. Data from the questionnaire will be essential in to get an overview of the social aspect of our research question, as well as retrieving statistical knowledge about the effects of the dumpsite on the Othaya area. It will give us a better background to base our interviews on and possibly give us some inspiration for the PRA/Focus Group.

The questionnaire will act as a preliminary data collection and will be used for statistical analysis. Thus, a minimum of 30 participants has to be collected to ensure valid results. However, we seek to undertake 50 questionnaires. The questionnaire will be presented to one adult (over 18 years old) member per selected household in the rural area around the dumpsite, as well as Othaya Town (see figure 1). The gender of the respondents is sought to be distributed as equally as possible. In the rural area, we will look at the geospatial data to determine the reach of nuisances from the dumpsite. Here, and also in Othaya Town, we will try to randomize the selected households as much as possible, in order to get data from all parts of the area. The data

collection will be equally divided between the two areas, ensuring a valid representation of the results. Each questionnaire should not exceed 10 minutes.

The questionnaire will be translated by our interpreters and we will try to test it amongst ourselves, our Kenyan counterparts and perhaps the families we will live with. With this test we wish to identify clarity, comprehensiveness and acceptability of the questionnaire, as described by Rea & Parker. A preliminary draft can be found in the appendix.

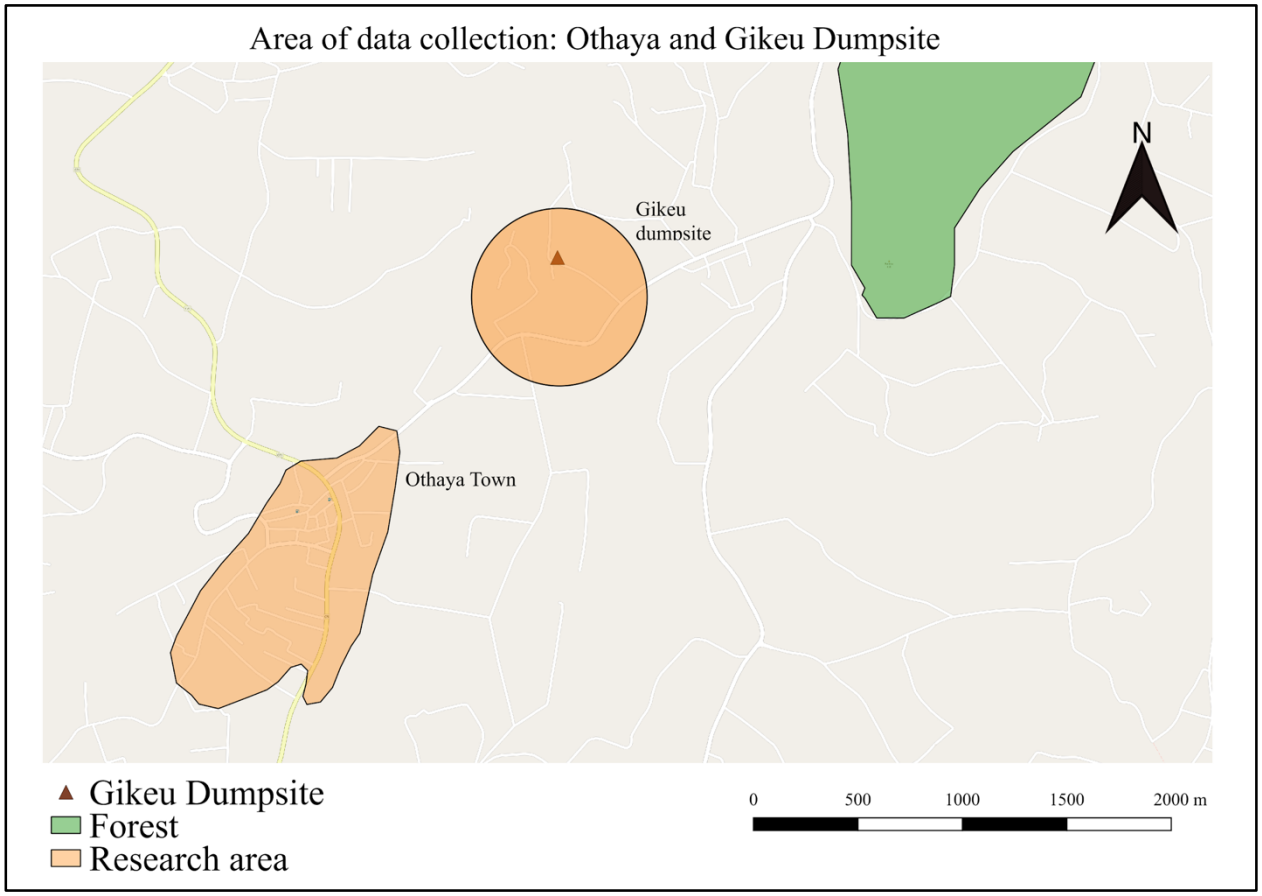

Figure 1: Research area for questionnaires (own preparation)

Interviews

Semi-structured interview

The conduction of qualitative semi-structured interviews in this study serves the purpose of gaining information about the initiatives and standpoints of the Nyeri council to answer sub-question 1 (cf. Research Questions). An interview guide will be established as a guide to the

interviewer, however the focus is on encouraging a conversation, with questions being open-ended. During the first days of data collection through questionnaires, we hope to gain an emerging impression of the area in order to clarify how interactions between local authorities in Othaya town and Nyeri county are carried out.

It is important that all interviewing group members are familiar with the interview guide and its purpose, so that they know what the intention of the questions and listed topics are. This will help in going beyond the exact written-out questions and adapt the interview to the individual situation. The same goes for our interpreter, with whom we will discuss the interview guide prior to conducting any interviews, in order to prevent any misunderstandings in the field.

Unstructured interview

The approach of qualitative unstructured interviews contributes to gain unofficial information concerning how often waste is being dumped, besides the official initiatives of the council. Informers could be residents, waste collectors and scavengers who are identified during the field trip if this information is found. This could also be described as Participant Observation, as we will observe the interviewee closely and take notes on their reactions post-interview. Despite the spontaneous nature of the method, we will still focus on asking non-leading and direct questions.

Focus Group

From our preliminary questionnaire and through talking to people in the area where we live, we will identify individuals who would be interested in being contacted for a focus group. We hope that we can get in contact with some community members who show political engagement, preferably from a variety of genders, ages and classes. This way we will get a group that has some consensus on the political aspect, while also representing different demographics and thus maybe being able to present different angles. These individuals will be invited to participate in a focus group, where we will try to collect some qualitative data on dissatisfaction with the waste management and ideas for future solutions. Due to the political tensions in the area, we have reason to assume that there is dissatisfaction and that we will be able to identify politically

engaged community members. However, if this proves not to be the case, the objective of our focus group might change.

One of us will be assigned the role of the moderator, and be responsible for leading the discussion in the direction that we expect, and intervening if they think that some participants' voice is not being heard. Non-verbal communication from this person's side might also help encourage quiet participants to communicate. Another group member will take notes on the conversation, while a third one will observe the participants' body language and interaction within the group, as emphasized by Grønkjær, Crespigny & Delmar (2011). The order of the questions can be changed by the moderator during the focus group.

Participatory methods

We would also like to conduct participatory mapping to create a community "waste" map. More specifically the result would be a mixture of a transect map and mobility map, as described in INTRAC (2017). The participants would be Othaya residents and the purpose of the Participatory Learning and Action (PLA) is to create a map showing the waste logistics, to identify how waste moves from Othaya homes to the Gikeu dumpsite or possibly illegal dumping sites. The map should include points where waste is collected/dumped apart from door-to-door collection, points in the town where there might be a lot of trash, illegal dumping points and if possible the routes of the waste trucks.

2.2 NATURAL SCIENCE METHODS

The connection between pollution from the dumpsite and the perceived health effects can contribute to a bigger understanding of the whole impact of the dumpsite. The distance from, and topographical location of, households regarding the dumpsite's location can give a context and connection between perceived health effect and attitudes' toward the dumpsite. Furthermore, an assessment of the connection of perceived health impacts and the water sources used can also contribute an interdisciplinary insight.

The natural science methods will be used to gain indications of the impacts of the dumpsite on the surrounding environment. Gaining insight in the environmental impacts will, when compared to the results of the assessments of the social impacts, give a more holistic understanding of the challenges regarding the dumpsite. Testing the soils and leachates surrounding the dumpsite, and the nearby water bodies for various pollution parameters can contribute to documenting and increase the understanding of the potential risks for people and nature.

Various parameters can be tested as indicators of pollution. Limitations of cost, time and access to equipment restrain the possibilities of parameters to assess and the choice of methods. The following methods are considered feasible in the context of the SLUSE-course, and they may produce valuable information and a better comprehension of the situation.

Soil texture classification (Danish classification system)

Soil classification will be undertaken as it gives context to other parameters and the effects of pollution. Knowledge of the soil classification of the surrounding area can reveal some information about the flow of pollution through the soils. We will most likely use plastic gloves during this assessment, due to the risk of dangerous substances.

Heavy metal content and pH level testing

Heavy metals from open landfills might contribute to environmental pollution. The main sources of heavy metals in landfills are urban waste, electronics, plastic, batteries and paint (Tahiri et al. 2017). In order to conduct research on heavy metal pollution we aim to take soil samples, leachate samples on the dumpsite as well as samples at a nearby water source, like the Thuti river. The soil sampling approach is yet to be determined as we want to consider the topography in the area, as online maps (*elevationmap.net*, see figure 2) suggest that the dumpsite is located on a sloped area. It could therefore be interesting to take samples upslope and downslope. However, we need to consider that we don't know the area and the current conditions yet, thus obstacles like flooded areas or temporary wetlands may be in our way. We aim to take between

10 and 20 samples of soil and water. The heavy metal analysis will be done at the University of Copenhagen after the return from Kenya.

The pH level is an important parameter to consider, as it affects the solubility of compounds, such as toxic chemicals and heavy metals. The effect of pH on the speciation of heavy metals is of great significance to the migration and transformation of metals (Zhang et al., 2018). pH testing will be done together with the taking of soil and water samples for heavy metal contents, to accompany the research, thus, variations of pH conditions in the system can be leading to further conclusions on the migration and distribution of heavy metals. According to Appel & Ma (2002) pH is the main factor in affecting the adsorption characteristics of heavy metals, thus controlling the solubility of hydroxides, carbonates, and phosphates of heavy metals. Furthermore, the pH also affects the hydrolysis of heavy metals in sediments and organic matter, dissolved clay surface charge changes, and the formation of ion pairs (Appel & Ma, 2002).

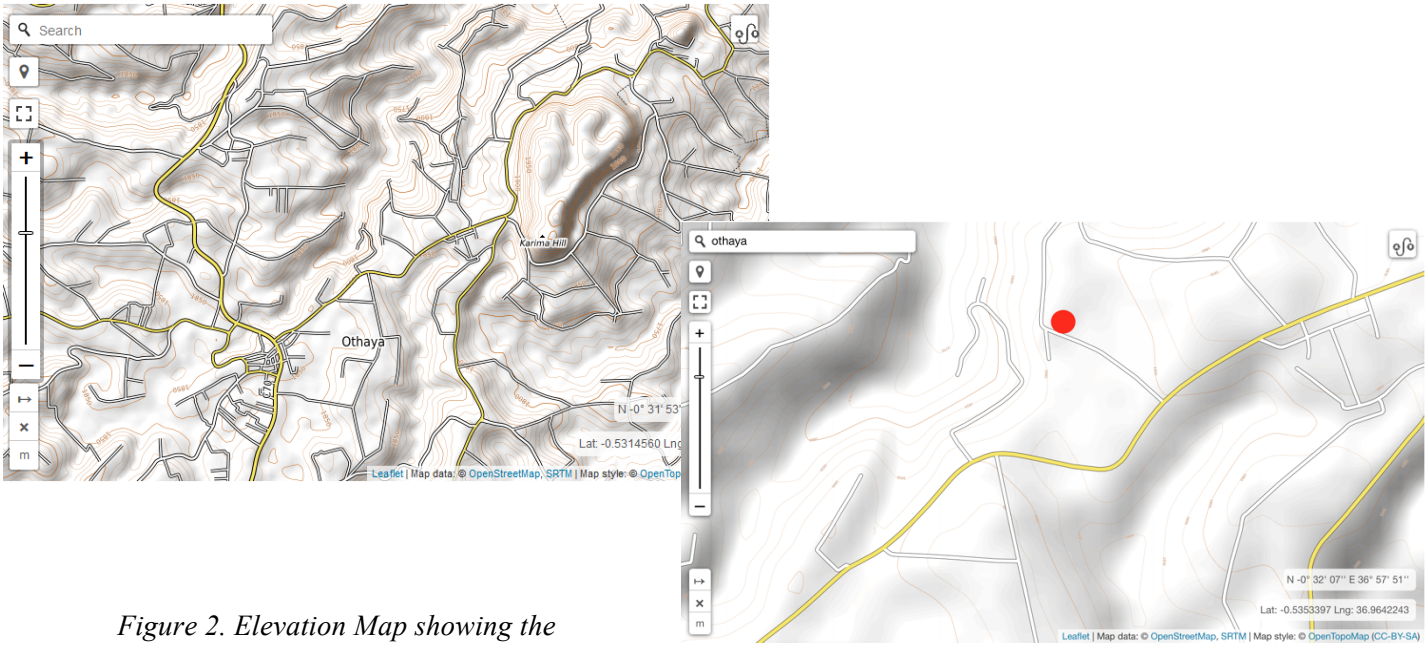

Figure 2. Elevation Map showing the approximate position of Othaya and the Gikeu dumpsite. Maps from: elevationmap.net/gitugi-mahiga-othaya-ke-1003265757

Strip tests

Strip tests of nitrate levels and E.coli will be conducted to research the water quality surrounding the landfill. By taking samples from the leachate on the dumpsite as well as samples from a water source nearby we seek to explore the potential leaching of nutrients, as compounds can flow from the waste with the water running through the dumpsite. Floodings of the area might also contribute to the spreading of the waste to the surroundings and to the nearby water streams. Nitrate is a compound of nitrogen and occurs naturally in many environments. However, it is a common surface water and groundwater contaminant that can cause health problems in infants and animals, while it also contributes to eutrophication of water bodies. Sources of nitrate are often linked to agricultural sources but can also be related to leachate of solid waste disposal (Wakida & Lerner, 2005).

Electric conductivity

The conductivity of dissolved salt content provides an insight in the amount of leached salts in waste and will be a part of assessing the mineral pollution in wastewater and water samples of the surrounding water source (Tahiri et.al, 2017). Further tests will include the concentration of sodium chloride (NaCl) and potassium chloride (KCl), which will go hand in hand with the testing of electric conductivity.

GPS

Documenting the geographical location of households and sample locations will be valuable information in the further assessment of the results. The connection between locations and results might contribute to a better understanding of the impacts of the dumpsite, and might reveal possible correlations.

We will use GPS data to map a variety of data. The GPS device used is a Garmin etrex 10, with reported accuracy of approx. 3m varying with the satellite constellation.

- Household locations for our questionnaire.
- Household locations for PRA.

- Location of our soil, leachate and water samples.
- Ground truthing (observations of e.g. waste dumping, smell), area of waste dump.
- Map the dumpsite area

3. Time Schedule and Collaboration with Counterparts

List of tasks

- Questionnaire
- Interviews
- PLA
- Soil sampling
- Water sampling

Put number of people on tasks

Time Schedule

Date	**Activity**
T, 27th of February	Meeting with Kenyan students at Wida Highway Motel
F, 28th of February	**Morning**: Travel to Othaya **Afternoon**: installation **Evening**: starting field work by assessing the surroundings and dumpsite
S, 29th of February	**Morning**: Testing questionnaire with the interpreters (all) **Afternoon**: Starting questionnaire (in 2-3 groups) **Evening**: Status meeting, evaluation on the day and on the questionnaire (all) Unstructured (short) interviews performed continuously the following days

S, 1th of March	**Morning**: Church Service **Afternoon**: Soil sampling and water testing of the surrounding areas of the dumpsite (all) **Evening**: Gathering (and maybe analysing) on the data gathered from questionnaires = status on what we are missing regarding questionnaire and how to reach this in the following day (all)
M, 2th of March	**Morning**: Finishing questionnaire work (in same groups as before) **Afternoon**: Finishing soil and water sample/collection (together or in several groups depending on how much is left) **Evening**: Prepare PLA and focus group questions
T, 3th of March	**Morning**: Africa Environment Day/Wangari Maathai Day **Afternoon**: Preparing interview and focus group **Evening**:
W, 4th of March	**Morning**: (if possible) Preparation for interview, including interpreter (all) **Afternoon**: (if possible) Interview with council employee (2-3 people) **Evening**:
T, 5th of March	**Morning**: **Afternoon**: (if possible) PRA (all?) **Evening**:
F, 6th of March	**Morning**: **Afternoon**: (if possible) Focus group (three members) **Evening**:
S, 7th of March	**Morning**: **Afternoon**: **Evening**: Dinner Party for all students
S, 8th of March	Holy Day (Sunday)

M, 9th of March	**Morning**: Feedback meeting in Othaya **Afternoon**: **Evening**: Mette's birthday!
T, 10th of March	**Morning**: Departure from Othaya **Afternoon**: Closure of field work at Wangari Maathai Institute, University of Nairobi **Evening**:

We are in contact with our Kenyan counterparts and have shared our research questions and planned methods with each other. While they are focusing on the political and socio-economic aspect, they are open to contributing to the natural science methods that we have planned to use. They had the idea to talk to garbage collectors, which we think will be interesting if it is possible. In their first proposal draft they suggested they would like to get 100 participants for the questionnaire but we aren't sure whether this is possible. Once we meet in Kenya we will figure out the details of our collaboration.

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5. APPENDICES (including data matrix)

Data matrix

Research questions	**Sub-questions**	**Data required**	**Methods**
Social impacts	*How does the council in Nyeri currently manage the Gikeu dumpsite?*	Knowledge of the resources available, the current regulations and the Council's main challenges of waste management. Knowledge of the responsibilities, actions and plans of the Nyeri council.	Semi-structured interviews with Nyeri Council, preferably a representative from Othaya.
	How is the dumpsite used?	Knowledge of who is using the Gikeu dumpsite and how often waste is being dumped. Knowledge of unintended activity on and around the dumpsite.	Unstructured interviews with: - Garbage collectors - Neighbours - Protesters - Maybe factories/hospitals The Preliminary Questionnaire. Participatory mapping of dumping logistics (PLA).

	What are the residents' perceived effects from the dumpsite on their health and everyday life?	Quantitative knowledge about the perceived effects of the dumpsite on the Othaya area. Knowledge of the perceived physical and mental health effects from the dumpsite.	The Preliminary Questionnaire: Gather information from the nearby residents of the dumpsite
	What are the perceptions of, attitude towards, and political engagement regarding the waste management system among households in the Othaya area?	Knowledge of political engagement/resistance/opposition due to discontent towards the management. Knowledge of the perception of the county waste management. Knowledge of possible local ideas for improvement.	The Preliminary Questionnaire. Unstructured interviews with interesting/politically engaged residents. Focus group.
Environmental impacts	*What influence does the Gikeu dump site have on the surrounding soil and water quality?*	Knowledge of the content of heavy metals in the soil surrounding, and the leachate of, the dumpsite. Knowledge of the content of heavy metals, E.coli and	Testing content of heavy metals in soil, leachates and water streams. Testing for *E-coli* in leachate and nearby water bodies.

		nitrate in the water streams near the dumpsite. Knowledge of how the location of the dumpsites' could contribute to the spreading of compounds.	Testing pH in soil, leachate and water streams with pH-meter. Testing nitrate levels in water streams and leachate. Soil texture analysis. <u>Potential methods</u>: miniSASS GIS-analysis of water flow from dumpsite.

First draft of questionnaire

Our background information:

Location of dumpsite, location of respondent in relation to dumpsite, observations on household location (vegetation, size of house, altitude/slope, roads nearby, other possible sources of pollution in area).

Purpose:

- Understand the impacts by distance
- Cover which factors are noticed
- Well being level
- Own perception of the management - awareness, who, what, why

While we are there:

- Locate household (mark waypoint GPS)
- Observe vegetation, tall trees, closed/open,

To-do:

- DO A TEST WITH INTERPRETER!
- Number the questions
- Format nicely in different document

Practicalities ● Presentation of us ● The purpose of the questionnaire ● Timeframe ● If you don't want to answer some of the questions, it's fine.	
Question	***Answer format***
Age	Number
Gender	F / M
How long have you been living here (in this exact spot)?	Appr. number of years
What are the main reasons you live in this location?	Agriculture Family

	Work Preference Availability Other: [Can select more than 1]
What is your occupation or livelihood activities?	Open
Physical experiences	
How often do you think about living next to a dumpsite?	Every day A few times a week A few times a month A few times a year Never
Are there any positive factors related to living next to a dumpsite?	Y/N If yes, what?
Are there any negative factors related to living next to a dumpsite?	Y/N If yes, what?
How often do you physically pass the dumpsite?	Every day A few times a week A few times a month A few times a year Once or twice Never
Do you experience any sounds from the dumpsite?	Every day A few times a week A few times a month A few times a year Once or twice Never

Do you experience any smell from the dumpsite?	Every day A few times a week A few times a month A few times a year Once or twice Never
Do you experience any smoke from the dumpsite?	Every day A few times a week A few times a month A few times a year Once or twice Never
Have you seen scavengers on the dumpsite?	Every day A few times a week A few times a month A few times a year Once or twice Never
Have you seen children playing on the dumpsite?	Every day A few times a week A few times a month A few times a year Once or twice Never
Any other activities on the dumpsite?	Open
Health effects	
Do you think your physical health is being affected by the dumpsite? (1 = not at all, 5 = very much)	1-5
If you answered more than 1: Is living next to the dumpsite related to any of these categories?	Respiratory issues - Lung irritation, nasal blockage, asthma, chest pain Headache Nausea Physical injury (skin burns, cuts etc.) Weight loss

	[Can select more than 1]
Is living next to the dumpsite related to any of these categories?	Sleeping difficulties Stress Sadness Fear Worry Anger Shame None Other: [Can select more than 1]
Do you think there is an issue with stigmatization regarding living next to a dumpsite?	Y/N
Management of the dumpsite	
Do you sort any of your waste?	
How do you get rid of your own waste?	Open
How often do you experience that there is management activity on the dumpsite (trucks)?	Every day A few times a week A few times a month A few times a year Never
To what extent are you satisfied with the involvement of the council?	Very unsatisfied Unsatisfied Neutral Satisfied Very satisfied
Do you have any ideas for how the management system can be changed?	Open
Which of these do you see as the most suitable possibility for improvements of the situation? (select max. 3)	- The council must take more responsibility

	- The inhabitants must reduce their waste generation - Relocation of the dump site - The organic waste must be used as compost - More recycling - More work force - Waste collection fees - Systematization of scavenging - None of the above
Have you heard about any of these concepts in the context of waste?	- Reduce - Reuse - Recycle - Replace - Composting [Can select more than 1]
Do you know about any protests against waste dumping in the area?	Y/N
What do you think were the reasons for the protests?	
Thank you for your answers!	
Do you have any questions for us?	
Would you approve of potential/prospective further contact?	Number/contact info

SEMI-STRUCTURED INTERVIEW - GUIDE

What do we want to find out?

- Knowledge of the resources available, the current regulations and the Council's main challenges of waste management.

- Knowledge of the interactions between local authorities in Othaya town and Nyeri county (ex. communication).
- Knowledge of local ideas for improvement.