Evaluation of current solid waste disposal site based on socio-economic and geospatial data: a case study of Wolkite town, Ethiopia

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Abstract Wolkite is a town like many developing countries, faces problems associated with poor solid waste management. The town has only one major landfill site, which is found at Gasore kebele, near to the town. However, the waste dumping in this site has been affecting the surrounding community. The objectives of this study were to evaluate the current solid waste disposal site and socioeconomic impact of the current solid waste disposal site in the study area. The data were collected through field observation, key informant interview, focus group discussion, and household survey. Geospatial data were also used to evaluate the current solid disposal site. In this study, fifty-two household and two focus group discussion were participated. The quantitative data coded and analyzed using SPSS software. The data described using descriptive statistics and qualitative data were also expressed using narrative description whereas the geospatial data were analyzed by ArcGIS. The study result showed that the landfill site is proximate to stream and river, church, mosque, rural settlement,

main road, and vegetation. The disposal site has affecting negatively to the local community; besides, the municipal waste is disposed arbitrarily on open field, roadside, dumped everywhere and solid waste disposed jointly with liquid at the landfill site, therefore, this study recommends to select suitable landfill site in the of the town.

Keywords Disposal site · Land fill · Solid waste · Wolkite

Introduction

The current challenges in developing countries is selecting the most suitable area for disposing municipal solid waste (Kharlamova et al. 2016). Increased urbanization and expanded use of disposable products in the past decades have generated greater demand for landfill space. Currently, world cities generate about 1.3 billion tons of solid waste per year (Orhorhoro and Oghoghorie 2019). This volume is expected to increase to 2.2 billion tones by 2025 (Kharlamova et al. 2016) and by 2050 to raise 3.40 billion tons annually (World Bank 2018).

An integrated system for waste disposal site selection is need to reduces the growing challenge of municipal solid waste management (Asefi and Lim 2017). Integrated solid waste disposal is a final

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functional element in the solid waste management system because disposal activities are associated with final dump of solid wastes directly to a landfill site.

Today disposal of wastes by landfilling or land spreading is the ultimate fate of all solid wastes whether they are residential wastes or residual materials from materials recovery facilities (Kaza et al. 2018). In urban centers throughout African regions, less than half of the solid waste produced is collected, and 95% of that amount is either indiscriminately thrown away at various dumping sites on the periphery of urban centers, or at a number of so-called temporary sites, generally urban waste management has been a challenge for municipalities and urban governments in the developing world, largely due to poor infrastructure, bureaucratic competence and limited institutional capacity of the municipalities (Hoorweg and Bhada-Tata 2018).

Because of growing global trend in the solid waste generation (Kaza et al. 2018) many thousand tons of solid wastes are generated daily in Africa. For example in Nigeria solid waste generation is at a daily rate of 0.43–0.66 kg/capital/day (Orhororo and Oghoghorie 2019), and overall significant increasing of solid waste generation in per capital solid waste generation rates, from 1.2 to 1.42 kg per person per day in Africa (Igbinomwanhia 2011; Hoorweg et al. 2013).

Most of the solid waste is ends up in open dumps and wetlands, contaminating surface and groundwater and posing major health hazards. When we see specifically sub-Saharan African countries, the problem that related to solid waste is very enormous. Most of sub-Saharan Africa countries solid waste generation exceeds collection capacity and scattered solid wastes in markets, residential or offices could result soil, water and air pollution, emit nauseating odor and GHG that contribute to the climate change (Kaza et al. 2018).

Most of the waste is disposed of in environmentally unsound open or controlled dumps. Waste minimization practices at all stages, some non-recoverable waste will remain, making landfills necessary (Kaza et al. 2018). For example, in Brazil, 17.9% of the collected solid waste have been recycled, and only 3.6% have been composting and the remaining waste is in open dumps or in controlled landfills instead of sanitary landfills (Paiva et al. 2013).

Higher economic, population growth and urbanization expansion rapidly in developing countries, like Ethiopia, has been resulted in many challenges of the environment (Aruna et al. 2013). Among the challenges, the continuous increase in the generation of solid waste is the main environmental challenges (Yuan and Yabe 2015). Solid waste in municipalities of Ethiopia have experienced with traditional practices of collecting, disposing and reusing solid waste, which is not aimed at promoting public health, protection of the environmental and alternative energy sources (Hailemariam and Ajeme 2014). These form of solid waste management practices are now becoming the major causes to surface and ground water pollution, decline in cities and towns cleanness (Tsega and Reddy 2013). Among the town, Wolkite is one of them and faces challenges associated with poorly managed solid waste operation.

Several studies have shown that only 43% of waste is collected in the country and is properly collected and disposed of in open landfills. The remaining waste is indiscriminately disposed of in drainage lines, open spaces, street sides or is informally burned.

Wolkite is one of the swiftly urbanizing centers but has been tackled with an increasingly growing urban waste generation and solid waste disposal problems (Kiros et al. 2018). The study landfill site, which is found at Gasore kebele, categories as open landfill.

The overall objectives of this study are to evaluate the current Solid waste disposal site through proximity analysis of geospatial data from important feature and identify the socio-economic impact of the current solid waste disposal site in the study area.

Literature review

Solid Waste Management (SWM) is a challenging issue for low-income countries, affecting on the environment, health, socio-economic, aesthetics and infrastructure, because of the volume of wastes generated, disposal and treatment methods (Iyamu et al. 2020).

In all cities of developed and developing countries faced with the persistence issue of Municipal Solid Waste (MSW) management (Kokkinos et al. 2019; Oguntoket et al. 2019). According to Xiao et al. (2020), population growth, urbanization and industrialization are the main reasons for increase of waste generation

behind in China's. The swift increase of urban population has triggered a dramatic increase in municipal solid waste (MSW) generation, with consequences more observed in developing countries (Zhou et al. 2019). Approximately, 3 billion world population still deficiency of access to regulate waste disposal services, and viable solutions to SWM are some of the vital approaches still being explored (Wilson et al. 2015).

Solid Waste Management (SWM) is a challenging issue for low-income countries, impacting on the environment, socio-economic, health, aesthetics and infrastructure, due to the generated volume of wastes, treatment and disposal methods. The current global trends of waste management problems caused by population inflation, higher living standards in cities, expansion of urban areas, and changes in consumption behavior, which are resulted unsustainable methods of waste disposal, which is ultimately a result of inadequate planning and implementation (Al-Salem et al. 2018; Ghinea et al. 2016). This made it help to effectively manage the MSW because low regulating of MSW will negatively affect the natural resources and degradation of the environment (Carota et al. 2018). Managing solid waste is required to monitoring (handling and storage), collection, transport, processing and disposal of solid wastes (Srivastava 2020). These activities should be in line with principles of waste management hierarchy (Fig. 1) that seeks to

minimize waste generation, maximize waste recycling and reuse, and ensure safe and environmentally sound disposal of waste (Iyamu et al. 2020). According to Barati et al. (2017) the effort to reduce the volume of waste generated that needs to be disposed of (waste prevention). Land filling is the final choice in waste management hierarchy process and a common solution for the final disposal of wastes in lower-income countries and a large majority of community's practice subsistence land filling or open dumping as their main method of waste disposal. Recently, due to the growing urgency of urban environmental problems, solid waste management in lower income countries has attracted much attention and there is now a movement toward landfills designed to increase environmental protection (Stamps et al. 2016).

The oldest most common and popular method of solid waste disposal for many countries all over the world is landfilling. Landfills are the final repository for most of the thrown material from human and its built environments. Microorganisms subsequently degrade this discarded material in the landfill, releasing gases and a complex mixture of soluble chemical compounds in leachate (Stamps et al. 2016). Presently, increase in population growth in most urban cities has given rise to an increase in waste production along with environmental pollution through human activities. Therefore, selection of sustainable site for sanitary landfill and proper disposal of solid waste is unavoidable (Motlagh and Sayadi 2015; Sayadi et al. 2015).

Urbanization, economic development, and a rapidly growing population result in massive quantities of waste materials requiring proper management (Yuan and Yabe 2015). Therefore, an increased urbanization and expanded use of disposable products in the past decades have generated greater demand for landfill space.

Most local governments in developing countries are unable to deliver services effectively and dumping of municipal solid waste (MSW) on undesignated areas such as open dumps is a common practice, resulting in a strain on the environment. Obviously, landfill is the most cost-effective system of solid waste disposal for most urban areas especially in developing countries; Uncontrolled disposal of waste is detrimental to human health because it creates unsanitary environments that have adverse impacts on the urban residents.

Fig. 1 Waste management in hierarchy stages *Source* Yakubu and Zhou (2019)

Locating landfill area requires multiple aspects, data, analysis and issues. These factors mainly consist of: public health issues, environmental aspects, topography of the area, hydrology, geology, drainage system and weather of the area. The availability of landfills in the area is to cover the wastes, proximity to the residential and industrial areas, the distance to and from the city, drainage system, cost and current/future land use of the area (Chang et al. 2008).

When MSW is processed in landfills, the organic material is anaerobically decomposed by methanogens, a process that releases methane to the atmosphere. When MSW is deposited in a landfill, it first undergoes an aerobic decomposition stage during which little methane is generated. Within less than a year, anaerobic conditions are established, and methanogens begin to decompose the waste and generate methane (Stamps et al. 2016).

Selecting suitable sites for landfills is one of the most difficult tasks in solid waste management. The sanitary landfill site selection must address social, environmental and technical concerns (El-Kelani et al. 2017). Landfilling includes monitoring of the incoming waste, compaction, placement of the waste and installation of landfill and control facilities (Dahal and Adhikari 2018). However, non-engineered facilities and poor management were the major problems associated with landfills. Therefore, every landfill requires appropriate design and operation to reduce socio-economic impact and negative impacts on the environment.

Materials and methods

Profile of the study area

Wolkite town is located in Guraghe zone of Southern Nations, Nationalities and Peoples Regional State (SNNPRS), Ethiopia (Fig. 2). Analysis of 30-year data from the National Meteorology Agency (NMA) (1988–2018) shows that the average annual rainfall varies from 856 to 1600 mm and the mean yearly temperature is 19.1 °C with the maximum and minimum values of 22.5 and 6.7 °C, respectively (Aneseyee et al. 2019).

It is the capital town of the zone and located at 158 km South of Addis Ababa on the way to Jimma town and 427 km from the regional capital city,

Hawassa. According to Guraghe Zone Bureau of Finance and Economic Development projection, the total population of the town during 2013/14 was 42,812. Among these 8241 were household heads. The percentage of female population was 21,116 (49.3%) and that of male was 21,696 (50.7%).

Wolkite has access road that links the town with Addis Ababa, Jimma, Woliso, Hossana and Butajira town. The area has transport infrastructure such as paved roads and gravel (unpaved) roads of 130 and 386 km, respectively, which connect rural areas and the district's city. According to Central Statistical Agency of Ethiopia (Csa 2007), total population of the town was 28,856 of which 15,063 (52.2%) were male and the rest 13,793 (47.8%) were female. In 2013, the total population size of the town is expected to be 33,877 of which male accounts 17,684 and female accounts for the rest 16,193. The population growth rate at medium variant was 2.9% (Csa 2007). The area is one of the densely populated areas in Ethiopia. Based on an Ethiopian Central Statistical Agency Csa (2007) report, the study area has an average population density of 283 people/km². The majority of the rural household's occupation in the area is subsistence farming (Aneseyee et al. 2020).

The major economic activities of the town are trade, transport, construction, agricultural products and other services. Among these activities hotel and restaurants are the major activities since the town has major transportation pass, which country cross road from capital city of Addis Ababa to boarder region of Gambella state. The physical characteristic of the housing units in the town has revealed that the majority of them are dilapidated and without the requisite services, however, there are newly emerging housing units at the center and periphery of the town. Its proximity to Addis Ababa, Jimma and Woliso towns creates good opportunity of the future development of the town.

Data collection

Socio economic data

In this study, the environmental, social and economic factors or constraints to be considered for sitting landfill sites were considered and respective data was obtained from different data sources.

Fig. 2 Map of Wolkite town

The qualitative approach was comprised key Informants Interview (KII), Focus Group Discussion (FGD) and site observation whereas quantitative approach was conducted through household survey. The HH was made to identify the attitude of the local community towards the impact of the open landfill site. The total number of household (HH) units in the Gasore kebele is 520. For the purpose of this study 10% of the total households were selected. Therefore, in this perspective, 52 HH were targeted to conduct the survey (Table 1), which are lived around the dumpsite

Table 1 The number of participants in socio economic data collection

Socio economic data collection tools		
HH	KII	FGD ^a
52	12	2 (8)

^aIn the focus group discussion (FGD), two indicates the number of cluster/group/discussion and numbers in the bracket indicate that the number of participants in one cluster or group discussion

(landfill). Thus, systematic sampling techniques was used to select the households (affected residents) within and around the waste disposal site. The systematic sampling technique (i.e. every 10th HH) were employed (Sapkota and Odén 2008), using semi-structured questionnaires. The survey was conducted by means of paper based structured, open and closed ended questionnaires to determine the socio-economic characteristics of the residents, particularly the perception of residents towards the effect of the dumpsite on the residents.

Two Focus Group Discussion (FGD) were also conducted in the north and south part of the land fill for triangulation of the data and in each cluster 8 participants were involved. The participants in the FGD, were elder, youth and female representative, local administrator, and indigenous ecological knowledge persons. Moreover, the FGD were also conducted with a group of individuals who are residence of *Gasore* kebele those composed of different social and academical groups. Checklists were prepared to lead the discussions. Open and close ended structured

questionnaires were prepared based on Arabatzis et al. (2006) to obtain socio-economic data.

Additionally, twelve key informant interviews (KII) were conducted with different concerned individuals at different levels, who had a good ecological knowledge and understanding of the study area. The interviews were held with environment officer and *kebele* administrators, those selected using purposive sampling.

Likert scale values were used to code the data for collecting and analyzing of the socio-economic data (5 (very high), 4 (poses a high impact), 3 (poses a medium impact), 2 (poses a low impact), 1 (poses no impact), and 0 (do not know).

Personal observation was important to inform the facts on the ground and helps to gain relevant data, which supplement the information during gathering, analyzing and writing the data. Observation was done through transect walks. It was undertaken by visits the waste disposal site, such as the Gasore landfill site and others waste collection points in the various sources in the town. Field observations were practiced to capture the photographs and video recorded and it is the bases of the studies because it provides first-hand knowledge on the waste disposal site, socio economic status and its proximate factors impact in the study area. Besides, observation was important to record GPS location, altitude, Ground Control Points (GCP) and distance from main features to open landfill site.

Geospatial data

Data preprocessing were performed using ArcGIS software and the data were projection to the Universal Transverse Mercator (UTM) of WGS84 zone 37 N. The master plan of the municipality was obtained from digitized and geo-referenced in the Arc GIS environment. Water points, river, roads, administrative offices, water facilities, public service centers, land use/land cover, soil and administrative boundary datasets of the municipality were obtained from Ethiopian Mapping Agency (EMA) and overlaid with other data to the municipality. All these geospatial data were resampled with spatial resolution of 30 m. Digital Elevation Model (DEM) was downloaded from the United States Geological Survey (USGS) data portal (<https://earthexplorer.usgs.gov>) and it was used to derive slope and drainage patterns of the municipality. Spatial analysis tool of ArcGIS and

buffer were used to mapping each proximate data analysis. Geodatabase is created to store spatial and non-spatial information. All the data obtained from various sources were stored in the Geodatabase for further spatial analysis.

Data analysis

Interviews were transcribed and coded appropriately to facilitate understanding from the quantitative findings, observations in the form of photographic evidence from the field survey were used to either confirm or reject the quantitative findings.

Data from the questionnaire was coded and entered into a database. Statistical Product and Service Solutions (SPSS, version 20) software was used for analyses frequency and percentage among others were used to analyzing the data. Data were described using both descriptive statistics, because it allowed people's attitudes, opinions, behaviors or actions to be described and analyzed statistically. Socio-economic data those collected through observation, key informant and focus group discussion since it is qualitative data, it analyzed through the narrative description.

Results and discussion

An overview of current landfill site in Wolkite town

Regarding the landfill, the house hold, key informant and FGD stated that Gasore kebele has one official landfill site, which is 12 km far from the center of Wolkite town. The current landfill system of the municipality has been investigated to understand the impact of the landfill site to the proximate environment and livelihood of people around the area. To understand these scenario, socio-economic data, as well as onsite observation and geographic information of the area were undertaken. Moreover, proximity to important features such as streams/rivers, well points, main road, ecologically sensitive biodiversity, settlements, public centers such as churches, mosques, schools and health centers, offices and cultural sites were investigated.

The solid waste collected from Wolkite town is disposed at the final landfill site found at Gasore kebele without further characterization i.e. the solid

wastes that have been collected from different source in the Wolkite town were disposed together. As it has observed from the Fig. 3, all type of solid wastes (solid wastes and the liquids waste) like non-biodegradable plastics, cloths, bottles, etc. were mixed together. This is aggravated further impact on the environment and the local community livelihoods.

In addition to main disposal site of Gasore, another small new disposal site is emerging, which is found near to “*Arisema*” church of Wolkite town, at ‘*Adise Hiwot kebele*’ (Fig. 4). The local community stated that, the city municipal has been selected this area (site) due to the area is affected by huge gully and gorge, therefore, the municipal office plan to fill the gorge using the collected solid wastes from the town. This may result generation of GHG, soil and water pollution and unpleasant odor that affect the surrounding community health, soil and water pollution.

Based on our FGD and KII, the remaining solid wastes that were not arriving at the disposal site, which were uncollected and dumped in unauthorized areas such as open fields, ditches, sewers, streets and many other available spaces in the city (Fig. 5).

The proximity of the landfill site to important features

Proximity analysis is done in the form of the buffer as well as nearness feature analysis to determine the distance between the landfill site and important

features such as a river, public centers, biodiversity, boreholes, and road. However, based on Thiessen polygons, buffering, point distance and near feature analysis results it is within environmentally significant wetlands and biodiversity or public infrastructures such as church and road, i.e. it is within less than 0.5 km of the buffer zone in contradiction to the recommendations based on Bahrani et al. (2016).

Stream and river

The analysis shows that surface water (i.e. *Wabe* River and pond) is located within a 500 m radius of the current landfill site. The surface water buffer analysis was done to prevail in the situation (Fig. 6). Permanent River (i.e. *Wabe* River) is located very near to the current landfill site (i.e. within 500 m buffer zone). This is contradiction to various environmental health standards. According to Yuan and Yabe (2015), waste disposal areas should not be in the vicinity of rivers, lakes, or swamps, where the underground water level is high. It is the fact that, major rivers have a higher discharge and greater downstream influence, as a result, landfill should not be sited within the flood-plains of major rivers. Multi-ring buffer analysis is done to determine proximity to the road and other features (Fig. 7). Main and pedestrian roads are within 100 m of the radius, that implies the site is the cause of public health problems.

Fig. 3 Disposal site at *Gasore* Source (Researcher)

Fig. 4 Deposal site found near to *Aresema church/Adise Hiwote kebele*

Fig. 5 Uncollected solid waste and dumped in unauthorized site

Fig. 6 Proximity of current open solid waste disposal site from streams and rivers

Proximity to rural settlement, church and main road

Ersay and Bulut (2009) stated that rural settlements should not be allowed within a 3000 m radius of landfill site. According to Pearce and Turner (1994) also indicated that distance from settlements to be 3000 m, 500–2000 m, 3000 m multi-ring buffers. But the landfill site of Wolkite municipality is located within 600 m buffer distance of rural settlements in contradiction to the standard and above-mentioned literatures (Figs. 8, 9).

Moreover, groundwater point or pond is located within a 1500 m radius from the landfill site and religious centers such as mosque and church are located in the vicinity. According to FGD report, the church is inaccessible to residents from the opposite side of the road because it is causing different diseases when they cross across the pedestrian road

overlapping with the site. Moreover, they claimed that it was causing social detachment as they are not meeting due to bad smell across the road.

Even though accessibility to the road is one of the factors required for the transportation of waste from waste sources to the landfill site, it is not recommended to be very near to the main roads. But the current open landfill site of the municipality is within 100 m buffer distance from the main road. The pedestrian road is passing through the site where solid and liquid waste is disposed of. Moreover, agricultural land is found nearer to the landfill site, where cereal, vegetative crop and eucalyptus plantations were dominant in the study area. Bee farm, and biodiversity is also located within 100 m buffer distance. Forest nursery and grown-up vegetation are also found within the proximity of landfills. The topography of the area has a gently sloping surface with a slope greater than

Fig. 7 Features in buffer of 100, 500 and 1000 m distance from the landfill site

5%. Moreover, wildlife such as monkeys, apes and other species are observed in proximity to the site.

Impact of the current landfill system

Demographic characteristics of the respondent

The socio-demographic characteristics of respondents shows that 32 (44.4%) of the respondents are female and 20 (27.8%) are male (Table 2). The finding of socio demographic data analysis showed that 55.8% of the respondents were living 250–500 m distance from the solid waste disposal site, 28.8% are living within 100–250 m radius of the disposal site and the remaining 15.4% are within 500–750 and greater than 750 m. Majority of the respondents (76.9%) were resided around the study area for over 7 years, 19.2% of the respondents were live around 4–6 years and the remaining 3.9% of the respondents were living 1–3 years in the current residence.

Impact of solid waste disposal site

Poor waste disposal site poses a several challenges to the well-being of the city residents, particularly those living adjacent the dump sites. According to Kimani (2007) lack of effective municipal solid waste management can result in environmental health hazards and environmental impact. Analysis of the collected data in the study area showed that the current open solid waste disposal site has an impact on the natural resource, socio economic condition as well as health of the community found around the landfill site.

Environmental impacts

According to Vaverková et al. (2018) leachate from the landfill is a potential source of environmental pollution, particularly a toxic effect on water sources, soil, animals or plants. The data analysis revealed that the solid waste in the landfill site was existed very near

Fig. 8 Proximity to rural settlement church, main road

to the river, all waste was being washed into the river even during the dry season, because it was a mixture of solid and liquid waste. Moreover, during rainy season flood and liquid waste was causing all waste to be washed into the river. The rainfalls on landfill sites might be make organic and inorganic constituents dissolve, forming highly toxic chemicals leaching into groundwater. This can result in serious contamination of the local groundwater. Even more dangers, this mixture usually create a high biological oxygen demand, meaning it can quickly de-oxygenate water. If or when these noxious chemicals reach rivers or lakes, it could result in the death of aquatic life (Newton et al. 2019). The study result show that 65.4% of the household have exposed with water contamination (pollute river) from dumping site, which indicated severe environmental problem, whereas 28.8% respondents indicated that water contamination to the household was moderate and 9% of the

respondent's minor contamination to the household (Table 3). According to Aneseyee et al. (2020) the solid waste is promoting wildlife and human disease transmission by creating a favorable condition for reproduction of harmful insects and reptiles, bacteria and virus.

There is also spreading dust and filth in and around the solid waste disposal site that blows to the community. The household survey indicated that 48.2% of the participants was severe and the remaining 36.5 and 17.7% of the respondents indicated moderately and minor respectively, effect for the spreading dust and filth. Based on the FGDs report explained that the dust was more sever to the community, those who live near to the damping site.

KII participant indicated that uncontrolled release of methane by anaerobic decomposition of waste from the dumping site. This was also supported by household participant with 51.9, 32.7, 15.4%, as moderate,

Fig. 9 Buffers of 100, 200 and 500 m on main road

severer and minor, respectively, (Table 4), for release of methane by anaerobic decomposition. The decomposition of organic materials in open waste dumping site produces methane, which can cause fire, explosions and significant contribution to the climate change and global warming.

Information generated from KII also indicated that burning of solid waste at the dumping site triggered air pollution due to smoke release to the air. Burning this also supported by household survey, which indicated that majority of solid waste burning (73.1%) cause the problem as sever and the remaining 26.9% as moderate. Uncontrolled burning of waste in open dumpsite could result air pollution and increase GHG which has been known to contribute to climate change. Burning waste is usually an environmentally poor waste management option that releases a hazardous mixture of cancer-causing compounds and other toxic substances into the environment.

According to Kabite (2011) the development of a landfill site means the loss of approximately 30–300 species per hectare. The study analysis indicated that solid waste dumping site has an impact on ecology and biodiversity. Bee farming was located adjacent to the dumping site, various vegetation, nursery sites, and community forest. The investigation also indicates changes also occurred in local species, with some mammals and birds being replaced by species that feed on refuse, such as rats and crows.

Socio-economic impacts

The FGD analysis revealed that the solid waste dumping site was affecting the church service, due to the bad odor. Church ceremony participant getting difficulty to attend the whole church program, especial on Sunday, since on Sunday, church service locally called “*Kidase*” means pray service carry out for

Table 2 Socio-economic characteristics of the respondents

Characteristics	Classification/range	Frequency	Percent (%)
Gender	Male	20	27.8
	Female	32	44.4
Age (year)	18–27	7	13.5
	28–37	16	30.8
	38–47	22	42.3
	> 48	7	13.5
Marital status	Single	13	25.0
	Married	38	73.1
	Divorce	1	1.9
Family size	1–3	6	11.5
	4–6	25	48.1
	> 7	21	40.4
Education level	Not schooling	7	13.5
	Primary	23	44.2
	Secondary	7	13.5
	Preparatory	11	21.2
	Diploma and above	4	7.7
Occupation	Farmer	26	50.0
	Governmental employer	9	17.3
	Trader	3	5.8
	Unemployed	14	26.9
Religion	Muslim	22	42.3
	Orthodox Christian	30	57.7
Distance from dumping site (m)	100–250	15	28.8
	250–500	29	55.8
	500–750	4	7.7
	> 750	4	7.7
Length of residence time (year)	1–3	2	3.9
	4–6	10	19.2
	> 7	40	76.9

Table 3 Environmental impacts of waste in the dumping site

Problem type	Severity of the problem	Frequency	Percent
Spreading dust and filth	Minor	9	17.3
	Moderately	19	36.5
	Severe	24	46.2
Water contamination	Minor	3	5.8
	Moderately	15	28.8
	Severe	34	65.4
Release of methane	Minor	8	15.4
	Moderately	27	51.9
	Severe	17	32.7

Table 4 Environmental impacts of waste in the dumping site

Problem type	Severity of the problem	Frequency	Percent
Spreading dust and filth	Minor	9	17.3
	Moderately	19	36.5
	Severe	24	46.2
Water contamination	Minor	3	5.8
	Moderately	15	28.8
	Severe	34	65.4
Release of methane	Minor	8	15.4
	Moderately	27	51.9
	Severe	17	32.7
Soil pollution	Minor	3	4.8
	Moderately	31	49.2
	Severe	18	28.6
Air pollution due to burning	Moderately	14	26.9
	Severe	38	73.1

around 9 h, so that it is difficult to be there due to the bad odor and unpleasant smell, which emanated from the nearby dumping site of Gasore. The household survey also stated that the impact of the solid waste disposal site on religious institutions (in the church and mosque). Accordingly, 61.5% the household responded that the solid waste disposal site has impacted on religious institutions as moderate and the remaining 23.1 and 15.4% are as severe and minor rate, respectively. In relation with this, the majority of the household respondents (86.5%) unpleasant odors to the institution. Moreover, 78% of the respondent explained that, it creates detachment from the nearby community and 69% respondent exposed reduce social interaction due to landfill disposal site.

Based on FGD and KII, the current solid waste disposal site has been affecting economic productivity of the community since the disposal site usually exposed the local community for disease so that it could not made them to undertaken their daily work. Moreover; the economic value of their land has deteriorated due to the consequence of the spread of solid waste to their farm, lateral soil pollution, and the spread of harmful insects and pests such as rat on their farm land. As a result of these, harm the farm production and reduction of yield. This was strengthened by household survey and majority of the respondents (76.9%) stated that the solid waste dumping site was providing attractive harmful inset, pest and other vermin. The analysis also indicated that, it has been contributed to reduce the edible fruit and

vegetable by 50% in the agricultural land. This is supported by Ersoy and Bulut (2009), it state that the social impacts created by municipal solid waste management include the unpleasant odor when garbage is left uncollected and the unpleasant odor due to the landfill site, the dirty surroundings, and breeding of mosquito, worms, insects, and flies due to the landfill site.

Impact on human health

According to information generated from FGD health of animals and human was being critically affected especially in downstream areas due to water pollution (Table 5). Moreover, children were scavenging on the waste and their health was being seriously affected. Health is at risk, for those who live within 5 km within landfill site (Mataloni et al. 2016). According to FGD and KII in ‘Gasore kebele’, community those who living in the newly merging disposal site near to ‘Aresema’ church claimed that, new disposal site was affecting their children and cattle, since it is near to the residence so that children are easily accessing the solid waste and they search different material from the disposed solid waste in order to playing. Moreover, the bad smell from the site was also another problem, which troubling the local community due to infected by bacterial and viral disease. The major disease that effect the health of the community due to these dumping sites are common cold and asemia. On the other hand, the remaining uncollected garbage, which

Table 5 Health impacts of open solid waste disposal site

Cause of health problems	Severity of the problem	Frequency	Percent
Increase in the incidence of sickness among children	Minor	8	15.4
	Moderately	16	30.8
	Severe	28	53.8
Contaminated liquids or leachate, leaking from dump site could pollute Wabe river	Minor	3	5.8
	Moderately	15	28.8
	Severe	34	65.4
Children scavenge material from the waste	Moderately	12	23.1
	Severe	40	76.9
Affecting livestock	Moderately	42	80.8
	Severe	10	19.2

remains in the town is becoming a serious environmental hazard for all.

Conclusion and policy recommendation

The current landfill site of Wolkite town and its socio-economic impact were evaluated based on geospatial data such as the slope of the site, distance from the main road, river and institutions. Socio-economic data were collected using household survey, FGD and KII. ArcGIS was used to analyzed the geospatial data. Thus, the study result revealed that Wolkite municipal corporation did not has appropriate and modernized types of landfill or waste disposal site. Open dumping, open burning, and dumping of solid wastes to un-engineered landfill sites were being practiced in Wolkite town. Moreover, the socio-economic and geospatial analysis show that current landfill site has impacts on health, economic, social and ecological aspects. Generally, the existing open dumping systems in the town are not environmentally sound and socially acceptable as wastes have been dumped in inappropriate sites. Based on this finding, the landfill site/disposal site/found at Wolkite town recommended to change because the site is existed near to *Wabe* river, religious institution (church and mosque), residence and road, thus it creates many negative impacts on the community and natural resource. Moreover, the new emerging disposal site found at “*Arsema*” church also recommend to stop disposing of the solid waste to fill the gully and further study is required about the soil

leachate and compactness etc. to trigger whether it will be used for waste deposit or not. This study also recommends further study about the soil characteristics associated with the disposal site and the waste affect the agricultural land.

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Compliance with ethical standards

Conflict of interest The authors declare that have no conflict of interest.

Ethical approval In this research human participants and/or animals no involved.

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