

Exploring Public Preferences on Possible Reclamation Land Uses for Integrating Post-Mine Brownfields into the Planned Urban Landscape in Kisumu, Kenya

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Abstract: *Mining activities for various resources usually results into disused, derelict tracts of land within other land uses within the urban landscapes. The spread of urban development over time into areas where mining activities were once carried out has led to land use problems. The presence of degraded landscapes referred to as post-mine brownfields within the urban landscape poses various land use conflicts. Brownfields fit poorly into the urban realm and are largely considered as problem spaces, barriers and obstacles. They pose several safety concerns due to crime and hazards associated with their derelict nature. They also take up vital urban land that can be put into productive and beneficial uses. They negatively affect the visual quality/aesthetics within the brownfield neighborhoods they are found within. There is need to rehabilitate Kisumu's brownfields into more productive urban land uses to integrate them into the planned urban landscape. The purpose of this study therefore was to explore the public perception on viable options for reuse and integration of post-mine brownfields into the planned urban landscape of Kisumu City. The study also sought to determine the most preferred method of implementing the rehabilitation of the most preferred reuse options. Cross sectional survey research design was used, with the unit of analysis being the brownfields and households living within a 500-metre radius from each brownfield boundary. A total of 96 willing participants selected randomly were involved in the survey within four brownfield neighborhoods that were purposively selected in the study due to long history of quarrying thus resulting into post-mine brownfields. The survey used questionnaires as data collection instrument. The study findings were analyzed using percentages and presented in tables and figures. The respondents indicated that the most preferred reuse option was construction of public facilities like school, community hall. Since all the brownfields were located within residential areas, the study concluded that the public facilities proposed must be compatible with the surrounding residential land use.*

Keywords: *Public preferences, Rehabilitation, Reclamation, Land uses, Post-mine brownfields, Urban landscape, Kisumu City, Landscape studies, Spatial planning*

INTRODUCTION

Brownfields are considered problem spaces as they are a land use, planning and real estate problem. They affect the entire community by reducing the quality of life, reduce property values. They are however a great opportunity for recovering urban land into useful and beneficial uses. They are also a big reminder of the harmful and wasteful practices of the past industrial endeavors (Jackson, 2002). Most cities have not paid attention to reclamation issues of derelict brownfields within their jurisdiction. According to Contaminated Land Rehabilitation Network for Environment Technologies CLARINET (2007), inventories of derelict brownfields can be used as a tool to support both planning activities and marketing of the site. The lack of integrated datasets about brownfields is one significant obstacle for redevelopment (CLARINET, 2007). According to Ferber et al. (2006), lack of spatial information including number, size, type of brownfields, infrastructure, and possible contamination has been defined as one of major bottlenecks for more frequent utilization of brownfields.

Reclamation means to recover derelict land that is abandoned from industrial uses including that from mining back to some productive use. Reclamation prepares the mined land for upcoming post mining uses. Good practice in mining and mine design necessitate that attention should be paid the future post mining uses of the land after the mining operations cease (Saperstein, 1990). According to Franks & Eskine (2012), rehabilitation means the process of improving disturbed land, including the development of new plant communities that may include some of the original plant species and may or may not have economic outcomes. The rehabilitation of disturbed land is a key environmental and social issue in the mining sector. The legacy of disturbed sites has created long-term challenges in many jurisdictions. The necessity to reclaim mining landscape began in Europe with the massive closing of coal mines in the 1960's and 1970's (Franks & Eskine, 2012). According to Kryzstofik et al. (2020); Martinat et al. (2016); Bendor et al. (2011), an aspect of urban revitalization that has garnered widespread political support is redevelopment of under-utilized brownfield sites that are often located in dilapidated but core urban areas. In recent years, brownfield redevelopment has emerged as a sustainable land use strategy and one of several ways to address urban sprawl and promote economic development through new job creation.

Reclamation is important in bringing the derelict brownfields that are considered wastelands and problem spaces back into beneficial use (Kryzstofik et al. 2020; Mert, 2019; Loures et al. (2015); Milgrom, 2008) Integration options vary from one urban area to the other and from locality to locality and hence a preferred reuse option applied in one area may not necessarily yield similar success in another brownfield in another locality. The study is vital to all the stakeholders including the quarry landowners, residents within the quarry locations, County Government of Kisumu, NEMA and planning and design professionals to rethink the need to address the presence of post-mine brownfields into beneficial land uses and thus eliminate their negative effects on the living environment. Wang et al. (2013) state that post-mining land use planning and design is a complex activity that requires knowledge about mining, skill and ability in planning and design, experience and collective input and that post-mining design projects should be ecologically sensitive, economically thoughtful, culturally aware, functionally capable and aesthetically appealing. Mborah et al. (2015) stress that the ultimate objective of post-mine land use and reclamation planning is to identify alternate land uses to which mined land could be put and this depends on land resources (such as physical, biological and cultural characteristics'), ownership, type of mining activity, legal requirements, location, needs of the community, economic, environmental, technical and social factors.

Loures and Panagopoulos (2007), state that with increased perturbation as a result of abandoned past industrial landscapes, there has been increased deep public concern about reclamation. The strategies to reclaim derelict industrial sites should be the sustainability, quality and multi-functionality of the space with special attention to historic, socio economic and cultural aspects. Sustainable brownfield regeneration as stated by Concerted Action on Brownfield and Economic Regeneration Network. (CABERNET,2012),is the management, rehabilitation and return to beneficial use of brownfields in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations in environmentally sensitive, economically viable, institutionally robust and socially acceptable ways within the particular regional context.

Successful rehabilitation of post-mining landscapes requires a holistic approach involving, among others, the ecological and aesthetic context. Ruelle et al. (2012), state that for brownfield reclamation projects to be effective, they should explore community views and consider all the functions that regenerated sites can perform, in addition to mere economic functions. Koudela et al. (2004), state that reclamation of brownfields may improve negatively regarded urban structures of cities and offer solutions to traffic problems, construction of public utilities of a city-wide importance as well as the realization of recreational activities, the development of tourism etc. Hollander et al. (2010), state that brownfields are central to a sustainable planning strategy of thwarting urban sprawl, preserving or regenerating open space, reducing greenhouse gas emissions and reinvesting in urbanized areas. They further argue that compared to “greenfields”, farmland, forest or pasture lands that have never been developed, brownfields offer a more sustainable land redevelopment choice. Besides, it offers the advantage of addressing the urban sprawl issue, which has the crucial goal of achieving “smart growth”.

According to Hersch et al. (2010), determining re-use options of brownfields involves four steps. First, define the allowed uses of the given parcel of land in terms of local zoning policies. Secondly, determine the market conditions in terms of the highest and best use. Assessing the community needs comes third. The goal of this step in the re-use analysis is to determine what uses would improve the quality of life in the target area. The fourth step involves analyzing the options and determining an appropriate end use. Having generated a list of possible reuse options this final step involves measuring these options against the opportunities for collaboration and funding to help achieve a specific end use. If the intended reuse is harmonious with local comprehensive or neighborhood plans, partnering with the local government or with other private entities to redevelop the site is a viable option.

According to Kuter (2013), there is no unique reclamation planning scheme for the post-mining landscapes as each site is different and reclamation depends on site-specific characteristics that differ with each site and locality. Brownfields found in different areas have varying spatial attributes in terms of sizes, previous uses, locations, different effects to the environment. It is therefore vital to understand each brownfield in its own context before appropriate land use option for reuse is considered. Kuter (2013) citing Ramani et al. (1990) state that the process of integration of post-mining sites starts with reconnaissance, site investigations until the final reuse option for the site is determined after engaging several stakeholders at different stages of the planning process.

In Kenya, several areas have realized continued quarrying for stones, clay, sand and other materials needed in the construction industry. All these have resulted into abandoned post-mine residue areas and more is still expected. Most brownfields take up large portions of land within the core areas of the city that would otherwise be very useful in many ways, especially with the reality of shrinking urban land. Kisumu City has several degraded, distressed landscapes emanating from past mining activities. Past quarrying activities within the city resulted into brownfields that have not undergone any rehabilitation. These sites are currently seen largely as urban voids and problem spaces. Furthermore, the sites have since been fully engulfed into the expanding residential neighborhoods. They pose several environmental challenges within the current land use and property development market. Continued presence of post-mine brownfields without planning for their reuse into beneficial land uses through rehabilitation means the physical and social problems they pose will continue to be felt within their localities. The presence of post-mine brownfields should thus be addressed through rehabilitation to eliminate their negative effects so as to achieve social acceptance, environmental sensitivity, and economic gain. If not done, environmental stigma associated with these sites continues and the urban landscape in general suffers.

Efforts by County Government of Kisumu & Kisumu Urban Project in the year 2015 to identify and inventorize some of the spatial aspects of some of the active and abandoned quarry sites within its jurisdiction is an exercise in the right direction and this will expedite the need to rehabilitate some of the long abandoned quarries with severe effects on the environment. According to senior KUP official the study to inventorize the quarries did not cover all the abandoned quarries in the final report and that they did not map out the quarries and their spatial attributes. Currently, information regarding the types of brownfields in Kisumu City, their spatial characteristics, effects on the environment and the best land-use options for reuse through reclamation is not known. Thus, this study intended to explore the public perception on viable options for reuse and integration of post-mine brownfields into the planned urban landscape of Kisumu City, Kenya. The study also sought to determine the most preferred method of implementing the most preferred reuse options.

METHODOLOGY

The cross sectional research approach was used to study the post-mine brownfields in terms of their ecological and social effects on the environment. Reconnaissance study was conducted between 2016 and 2017 to identify and locate the post-mine brownfields within the study area of Migosi, Nyawita, Wathorego and Kanyawegi sub-locations. The reconnaissance was carried out by interviewing the area sub-chiefs who are well versed with the location, number and landowners of the brownfields within their areas of jurisdiction. The study was carried out between October 2017 and March 2018 for data collection and analysis. A reconnaissance study was carried out for post mine brownfields within Kisumu City and those sampled were the abandoned quarry sites formerly quarrying for stones that were in areas of long history of mining and that had population of people living around them. All the four brownfields under study were identified and selected for study using purposive sampling method due to their large sizes. Each brownfield became a sample site due the fact that they were existing sites of former stone mining areas and that they no longer had mining activities ongoing.

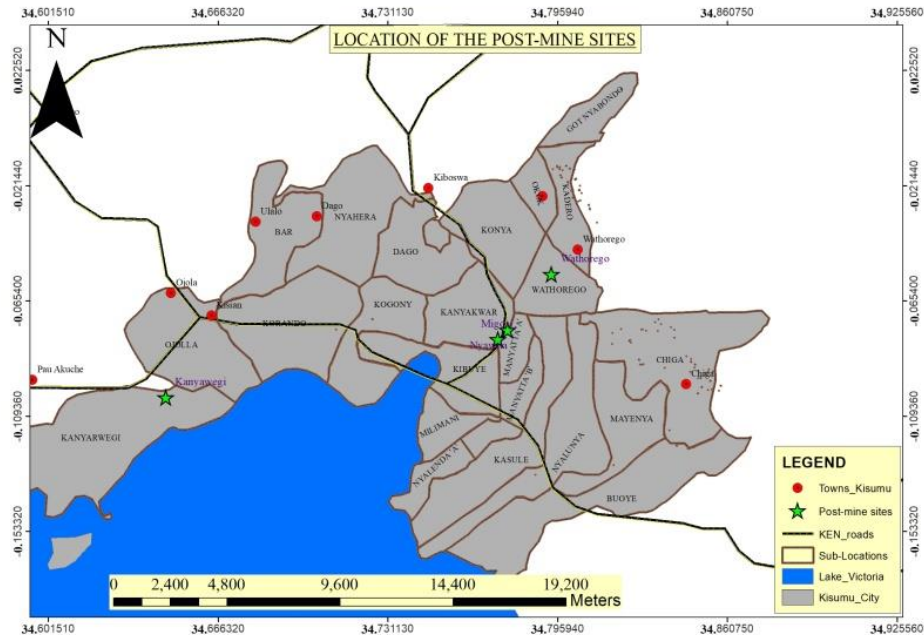


Figure 1: Map of Kisumu City showing location of the four post-mine sites under study.

Source: Digitized satellite aerial imagery (2018)

According to Pearsall (2010); Fisher (2011), other studies have defined a brownfield neighborhood as a 500 meter (0.3 mile) circular radius around a brownfield. Essoka (2010), considered a slightly larger radius of 0.5 mile to allow for more general understanding of socio-economic character of areas adjacent to brownfields. The study was based on households that are living within the 500 metres from the boundary of the brownfield within each of the four sub-locations due to the fact that some households within the brownfield localities were not aware of the presence of these abandoned quarry sites and felt they were not affected by them. According to Government of Kenya's Kenya National Bureau of Statistics GOK KNBS (2009), the four sub locations where the four post mine sites are found have a total of 13,127 households. A total of 3300 households constituting a quarter number for all the households within the four sites was used to calculate the total sample size for all the four sites. Sample size calculation was according to Mugenda & Mugenda (2003), for population less than 10,000.

Selecting the households for each brownfield site was based on the sampling frame above with a total of 96 households for all the four sites. Proportional stratified sampling technique was used to calculate the number of households to form the sub samples to be interviewed within each of the four sub locations of the study area. The number of households that constituted the sample for each sub location was therefore Migosi 35 households, Nyawita 30, Wathorego 21 and Kanyawegi 10 households Random sampling was



used to collect data from the households from the boundary of each site and in the subsequent radii within the 500 metres boundary. Five concentric circles were drawn in GIS were used to approximate the various radius for data collection around each site. Data was collected from the respondents within each diameter of the concentric rings around each site with each first household being selected randomly and others within the ring picked randomly at various ends all-round the diameter. Respondents within the various radii were distributed equally. The unit analysis in the study was the individual brownfield sites and the households found within 500m metres radius of the brownfield neighborhood for each site.

The methods used to collect primary data included questionnaires for the residents and interview schedule for key informants. Structured questionnaires which consisted of close ended questions were used during the data collection process. The data was analyzed quantitatively. Quantitative data was analyzed using descriptive statistics including percentages. Analyzed data has been presented using texts, tables and figures.

RESULTS

Respondent demographic characteristics

Respondents within the four sub-locations of the study area comprised 41% female and 59% male. The age distribution of the respondents showed that 46% were aged between years 18 and 30, 30% aged 31 to 40years, 15% were aged between 41 and 55while 9% were aged over 55years. Most respondents therefore were between ages 18 and 30. The age distribution is skewed to older age groups implying that most of the participants were mature persons. They were therefore, expected to respond adequately to the study questions that were about the effects of the post-mine brownfields within their neighborhoods at the time of the study. Marital status of the respondents was that 64% were married 34% single. Educational attainment of the respondents indicated that 22% had attained primary education, 43% secondary education and 35% had tertiary education and above. The implication of these findings to the study is that 78% of the respondents were educated beyond primary school, hence expected to understand and objectively respond to questions regarding the post-mine brownfields within their neighborhoods.

How long the respondents had lived within the area of study and the brownfield was also analyzed as depicted in figure 8 below. Those who had stayed for less than two years constituted 14%, two to five years of stay was 33% while the majority at 53% had stayed for more than five years. The length of residence results indicates that majority of the respondents had lived in their various post-mine neighborhoods for a period that would ensure they were aware of the existence of the brownfields and able to respond to questions about the preferred reuse options through rehabilitation and choose the best method of implementing them. Table 1 below indicates the key informants who were interviewed in the study.

Table 1: Key Informants

Key informant	Organization
Director of City Planning	Planning Department
Director of Environment	County Government of Kisumu, Environment Department
Senior official	Kisumu Urban Project (KUP)
Director NEMA	NEMA, Kisumu County office
Mines and Explosives officer	Ministry of Mining ,Mines and Geology Department
Physical planner	Ministry of Lands, Physical Planning Department
Private practicing Planner	Private office
Brownfield/quarry landowners	Nyawita (2), Migosi (1), Wathorego (1) & Kanyawegi (1).

Public preferences on rehabilitation/reclamation of the post-mine brownfields

The respondents in each sub-location were asked on whether there was need to undertake reclamation of the post-mine sites within their neighborhood or to maintain them in their current states. The response on whether the Migosi post-mine site should be turned into better uses through reclamation showed that 91 % were in support while 9 % felt there was no need. Nyawita Sub-location respondents with a majority at 96% were of the opinion that the abandoned quarry should be turned into better uses through rehabilitation and not to be left in its present state. Four percent felt there was no need for rehabilitation. Response at Kanyawegi showed that 100% was in support of the abandoned quarry land being turned into better uses through rehabilitation while at Wathorego 90% were of the opinion that the abandoned quarry land should be turned into better uses through reclamation, 10% did not support reclamation into better uses.

The eight reuse options suggested to the respondents within the post-mine neighborhood included agricultural production, human settlement i.e. housing units, construction of public facilities e.g. community hall, church, school, nature conservation/forestry, production of renewable resources e.g. solar power, public parkland, landfill for waste disposal and private recreation recreation/leisure grounds. Landfill for waste disposal was the least preferred choice due to environmental problems like visual blight, foul smell that are associated with it .The majority of respondents in all the four sites were in support of reclamation that should be undertaken to put the abandoned sites in better beneficial uses.

Households living within the brownfield neighborhood were asked to suggest their most preferred choice of reuse option into which the brownfield could be reclaimed/ rehabilitated into. Each brownfield was analyzed separately within its unique setting. The most preferred choice was to be picked from eight reuse options suggested for each of the sites. The choices were preferred as presented on Table 2 below.

Table 2: Preferred rehabilitation/reuse options

Rehabilitation reuse option	Nyawita post-mine (% preference)	Migosi post-mine (% preference)	Wathorego post-mine (% preference)	Kanyawegi post-mine (%preference)
Construction of public facilities e.g. school, community hall, church	40%	24%	24%	0%
Nature conservation/forestry	4%	10%	16%	27%
Agricultural production	6%	21%	15%	33%
Human settlement i.e. housing units	24%	7%	13%	0%
Public open space/parkland	6%	16%	0%	0%
Recreation/leisure grounds	10%	5%	0%	0%
Landfill for waste disposal	4%	2%	19%	13%
Production of renewable resources e.g. solar power	6%	15%	13%	27%

Table 3: Most preferred reuse options for the four brownfields.

Sub-location/ post-mine brownfield	Most preferred reuse option	Preference %
Nyawita	Construction of public facilities	40%
Migosi	Construction of public facilities	24%
Wathorego	Construction of public facilities	24%
Kanyawegi	Agricultural production	33%

According to Table 3 above, the most preferred reuse option for Nyawita, Migosi and Wathorego sites was the construction of public facilities while agricultural production was most preferred at Kanyawegi site. Public facilities may include the construction of a communal conference hall, church, primary and kindergarten school, information centers/library.

Implementation options for most preferred reuse option

Reclamation/rehabilitation reuse option selected as most preferred need to be implemented during their planning, design and the whole project management period till they are completed. The three methods suggested to the respondents included private through the quarry landowners, public-private partnership (PPP) and public sector through the County government.

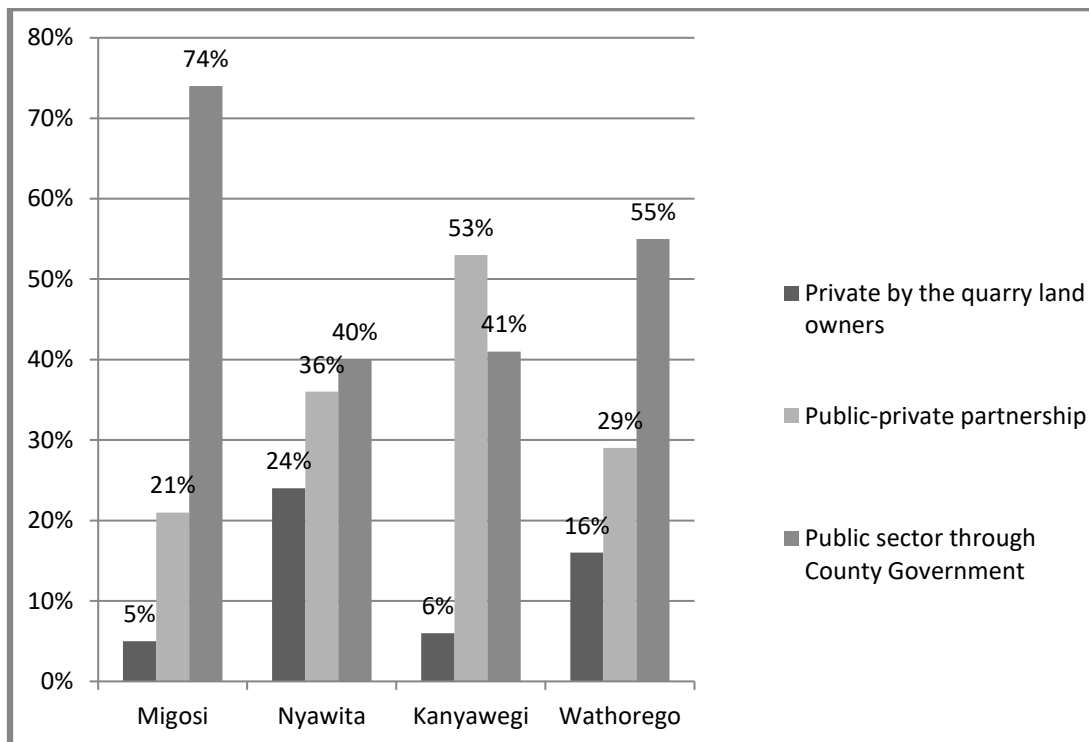


Figure 2: Implementation options for the most preferred reuse options for the post-mine brownfields during reclamation

At Migosi majority of the respondents who preferred the construction of public facilities preferred implementation of the rehabilitation through public sector through County Government of Kisumu as indicated in Figure 2 above. At Nyawita the majority respondents who had preferred construction of public facilities preferred that it should be implemented through public sector by the County government of Kisumu. According to both of Nyawita’s quarry landowners the most preferred method for implementing the rehabilitation reuse is through a private investor/developer getting into an agreement with them or the company to build and operate the rehabilitation reuses and share the proceeds in an agreed ratio among them. The use preferred by both owners of the quarry is the construction of a shopping mall such as supermarket that utilizes the deep quarry pit below for storage and ample space for parking. The owners prefer this implementation method due to lack of adequate funds to undertake this rehabilitation that requires a large capital outlay and their reluctance to sell the land to interested private developers or even to public entities like the County government of Kisumu.

According to the private owner for Kanyawegi post mine site, the most preferred implementation method for their quarry land is private funding for their interim use as conservation area through forestry. Funding needed for implementing a rehabilitation reuse for the abandoned quarry pits is not a problem/hindrance and once the company will consider its time has come then they will undertake the appropriate rehabilitation. According to Wathorego’s private owner the most preferred method for implementing rehabilitation for the Wathorego quarry land is through partnership that involves leasing the land to

interested developer to undertake a rehabilitation reuse that is acceptable to them and the neighbors. Through the partnership the developer would build and operate the facility while the profits are shared in agreed ratio with the land owner while the land still belongs to the privately owned company. According to the land owner the rehabilitation has been hindered by inadequate funds to undertake the rehabilitation process.

DISCUSSION

Most and least preferred reuse options

The purpose of this study was first to evaluate public perception on viable options for reuse and integration of post-mine brownfields into the planned urban landscape of Kisumu City of Kenya. The second purpose was to determine the most preferred method of implementing the rehabilitation of the most preferred reuse options. The study had a total of eight rehabilitation reuse options that were suggested to the households within the study areas of the post-mine sites. Several methods exist for undertaking post-mine site reclamation, rehabilitation (Kryzstofik et al., 2020; Mert, 2019; Martinat et al., 2018; Loures et al., 2015; Milgrom 2008). Frantal et al. (2013), state that it is very important to analyze and present “best practices” as examples of successful regeneration of brownfields in various geographical and land-use contexts. In Kenya, National Environment Management Authority (NEMA) guidelines on mining and quarrying requires that the land owner should establish quarry pit rehabilitation and/or after use plan to be approved by the District environment Committee as prescribed in the audit check list. The after use plan according to NEMA should identify suitable alternative land uses for the disused pits such as land restoration for agriculture, recreation, forestry and apiary, exploitation for aquaculture, exploitation as water reservoir and if suitable exploitation for sanitary land filling and these restorations of quarries should be within 12 months of depletion of the quarries.

CABERNET, (2012) and HOMBRE (2012) state that it is important to consider interim uses of brownfields because brownfield regeneration is a lengthy process. Interim uses can be crucial for the long term success of the regeneration scheme. This provides a smooth continuation from the former industrial use into the future use of the area. This helps to avoid the problems of decay and dereliction and thus making the site safer and livelier (CABERNET, 2012). According to HOMBRE (2012), brownfields re-use can be for several uses that include unchanged use because of the ecological value of the site, adapted use on-sites that offer a basis for touristic or leisure related activities and use as community asset such as parkland. Other uses include return to agricultural production or forestry purposes. This includes urban farms and urban woodland. Interim or final use for the production of renewable resources may also be considered. Michaud & Bjork (1995), state that there are many advantages to siting a landfill in a mined area and therefore landfill construction should be considered as a viable reclamation method for mine sites. Reclamation of a mined area through the construction of a solid waste landfill can offer many benefits to the community, county and state in the form of taxes and tipping fees and employment opportunities in an area negatively impacted by mine closure (Michaud & Bjork, 1995). On the contrary findings in this study revealed landfill for waste disposal was the least preferred reuse option for all the four post-mine brownfields under study as indicated in Table 2 above. This was due to environmental pollution in terms of wastes, smell that is associated with it that may negatively affect the residential neighbors within.

Rehabilitation reuse as a human settlement is a viable option for the four post-mines under study partly because they are located within residential neighborhoods and cases of land use conflicts from the new rehabilitation reuse option will not arise. However the human settlement reuse option should be done without the need for backfilling the quarry holes that will need large volumes of backfill material to completely fill, compact and stabilize for any construction to be undertaken. Backfilling is not sustainable as the material needed will create new brownfields in other areas in the quest to fill these already existing post-mine sites. According to the physical planner at lands ministry, one private planning consultant and a NEMA official reuse of the post-mines sites as human settlement is the least option they prefer because the neighborhoods they are found within already have high human settlement without open spaces for recreation and without breathers within them. They also cite environmental concerns, traffic issues among reasons for not preferring human settlement as a rehabilitation reuse option.

Rehabilitation to public parkland is likely to offer a good opportunity for greening of the post-mine brownfield and its advantages to benefit the neighborhood at large. According to De Sousa (2003), the “greening experience” constitutes a valuable opportunity for increasing green spaces and thus bring about benefits such as decreasing the risks of public health and safety, recreational opportunity enhancement, economic revitalization of neighborhoods. Open space within the post-mines can be achieved as parkettes i.e. small parks that offer passive recreational activities such as sitting areas, walking paths etc. for the surrounding neighborhoods (Martinat et al., 2018; De Sousa, 2000). Martinat et al., (2018) found out that future brownfields uses such as culture/sport and children’s park are the most popular options based on gender factors. This rehabilitation reuse option is a very viable option for Migosi, Nyawita and Kanyawegi due to their spatial attributes. If accepted and implemented then this can lead to open spaces within the neighborhoods that will act as additional lungs to the neighborhoods and to whole city. According Kisumu’s Integrated Sustainable Urban Development plan ISUD (2013), open space provision greatly influences the quality of life and livability of cities and communities and that Kisumu is currently under supplied with quality open spaces which are easily accessible for all and that there is great need for more parks. The post-mine sites provide a good opportunity for rehabilitation into neighborhood parks that are within easy access by people.

Private recreation/leisure grounds can be potential neighborhood urban open spaces in the form of parks that offer variety of spaces as playgrounds, facilities for relaxation and for passive and active recreation. The sites can offer great opportunity for passive recreation if this can be done without conflicts with the neighboring land use of residential that is so close to the post-mine boundaries especially at Migosi and Nyawita. Woolley (2003), states that neighborhood parks/open spaces provide opportunities for community and cultural activities. They can allow groups within a neighborhood to have a focus for some of their activities. They are also important for educational opportunities and are important to the amelioration of the urban climate. From the respondents levels of preference for this reuse option then this is a pointer that majority do not prefer it as the most preferred choice to be implemented through reclamation and may face public opposition with many residents of the post-mine sites.

Public facilities may include the construction of a communal conference hall, church, primary and kindergarten school, information centers/library. According to one of the Nyawita post-mine land owners the site is ideal for construction of public facilities mentioned above in case they can get a private investor who can be leased the land to build and operate the facilities for an agreed period of time while paying them

agreed amount monthly. Both of quarry landowners however are against public facilities like police post that may be run by the central government or the county government as this is likely to fetch poor returns

Preferred implementation method

Implementation of the viable options or the most preferred rehabilitation reuse option can be undertaken through several methods that include privately by the quarry landowners, public sector through the County Government and public-private partnership (PPP). Franco et al. (2010), states that partnerships in rehabilitation of quarries can be in several forms such as partnerships with private companies with economic interest in the mine. Public sector through the County government was the most preferred method for rehabilitation within Migosi, Nyawita and Wathorego. This method was to implement the most preferred rehabilitation reuse of construction of public facilities Given that three of the four abandoned quarry pits are owned by private individuals under freehold titles and only Migosi is under leasehold land tenure then private implementation being least preferred means that the landowners have to consider selling the quarry lands to the County Government of Kisumu in order to undertake rehabilitation of the most preferred reuse or viable option. This method is likely to face resistance from most private quarry landowners in different places as they have to sell and lose ownership of the abandoned quarry lands. The landowners for all the four post-mine sites were unwilling to sell the lands to private developers, County Government of Kisumu in order that the public bodies undertake rehabilitation using public funds.

Kanyawegi post-mine most preferred method of implementation was public-private partnership (PPP) for implementing their most preferred rehabilitation reuse of agricultural production. This method was preferred by the majority of the respondents. PPP is possible implementation option as the complications of the private owner being unwilling to sell and relinquish the landownership is avoided and agreement on partnership can be reached accordingly. A private company not necessarily a mining company may offer to rehabilitate a site so that the site can be used for a different and more productive land use. The benefit is that the site is used for another productive purpose rather than forever remaining an abandoned quarry. Cowan & Mackasey (2006), state that creating partnership between mining companies and the government to fund rehabilitation of abandoned mines can provide win/win outcomes. Both the government and mining companies should be entrepreneurial in coming up partnerships arrangements where both parties benefit (Cowan & Mackasey, 2006).

Partnership between the central government and the county government can be formed to assist in cost sharing arrangements for financing to undertake rehabilitation. The most preferred reuse option at both Migosi and Nyawita that is the construction of public facilities had majority respondents preferring the public sector implementation by the County Government of Kisumu to undertake their rehabilitation. Migosi respondents preferred public implementation at 74%, Nyawita at 40% and Wathorego at 55%. This likely means that they would like the public sector such as County Government to take over the ownership of the abandoned quarry by purchasing them and planning for their rehabilitation in providing public facilities within them. According to the private practicing physical planner, PPP is best implementation method as it gives room for negotiations and may yield better results than public implementation by the County government that lacks trust from the public while private implementation may not work in cases where the landowners lack adequate funds needed to fund the rehabilitation. Other key informants like the Ministry of Lands official, NEMA director, Ministry of Mining official were also of the opinion that PPP

is the best method for rehabilitation of the post-mines as it gives room for consultations and therefore much public confidence in the process and thus better results on rehabilitation.

KUP under mandate of County Government of Kisumu in 2015 through a private consultant carried out a reconnaissance study that involved locating the various quarries both active and inactive with the Kisumu City and its immediate environs. Some of the post-mine land owners were approached on the possibility of considering their use for relocation of the biodegraded wastes from the current City dumpsite next to Moi Stadium that was full. Quarry owners approached included that of Nyawita however the quarry was not included among those that were in the reconnaissance study. Lake Quarry and Migosi post-mine sites were also not part of the report for the reconnaissance study carried out. According to KUP official with public consultation and willingness of the quarry owner then the County Government of Kisumu can consider partnering with the land owner on possible filling of the site with biodegraded wastes from the current dumpsite and when full then they can implement the reuses like planting of trees and grass cover until the soil stabilizes.

CONCLUSION

The study established that the most preferred reuse options for Nyawita, Migosi and Wathorego was construction of public facilities. There is need for the County Government of Kisumu to acquire these abandoned quarry lands that are currently owned by private land owners so that planning for the most preferred reuse option in terms of construction of public facilities can be realized successfully. The most preferred implementation method for this reuse is PPP that calls for partnership between the private and the public entities. The public facilities in terms of school, church, community hall are all compatible with the existing land use that is residential within the brownfield neighborhoods. Agricultural production as the most preferred reuse option for Kanyawegi site is also compatible with the existing and dominant land use within the area that is agricultural.

The study recommends that the most preferred reuse option by the residents should be implemented through PPP after the acquisition of the abandoned quarry lands from the current owners. PPP was chosen as the best method that would appeal to both private and public entities during the rehabilitation so that greater acceptance is achieved and hence successful planning for rehabilitation as the desired end result. The process towards rehabilitation should be holistic with all stakeholder fully on board. The post-mine brownfields owners are the most important stakeholders since all the post-mine sites are under private ownership and they should consider the likelihood of getting into partnership with the private investors or public entities like County Government of Kisumu to necessitate the rehabilitation of the sites through construction of any acceptable and compatible public facilities as the most preferred option. The views and concerns of the residents living within the post-mine brownfield neighborhood should also be included in the PPP implementation of the chosen reuse option.

From this study, the occurrence and presence of post-mine brownfields is a land use problem that has several ecological and social problems to the environment at neighborhood and whole city's urban landscape. To integrate the post-mine brownfields there is need to first understand their spatial attributes then the negative effects that they pose within the neighborhoods they are found in. Their rehabilitation/reclamation needs

engagement of several stakeholders such as the quarry neighbors, quarry landowners, regulatory authorities, planning and design professionals etc. There is need to understand each post-mine brownfield in its local context in terms of its spatial attributes and their effect as each and every site is unique and there is no one size fit it all when rehabilitating them.

REFERENCES

- CABERNET (2012). *Concerted Action on Brownfield and Economic Regeneration Network*. The Scale and Nature of European Brownfields.
- CLARINET (2007) .*Contaminated Land Rehabilitation Network for Environment Technologies.Brownfields and Redevelopment of Urban Areas*, www.clarinet.at/library/brownfields.pdf
- Cowan, W.R. and Mackasey, W.O. *Rehabilitating Abandoned Mines in Canada: A Toolkit of Funding Options*, National Orphaned/Abandoned Mines Initiative (<http://www.abandoned-mines.org/pdfs/ToolKitFundingReport.pdf>) (2006).
- De Sousa, C.A. (2003). Turning brownfields into green space in the city of Toronto. *Journal of Landscape and Urban planning*.
- De Sousa, C.A. (2000). Brownfield redevelopment versus Greenfield development: a private sector perspective on the costs and risks associated with brownfield redevelopment in the greater Toronto area. *Journal of Environmental management*.
- Essoka, J. (2010). The gentrifying effects of brownfields redevelopment. *Western Journal of Black Studies*. Vol 34, Issue 3, September, 2010.
- Ferber,U., Grimski, D., Millar, K., & Nathanail, P. (2006). *Sustainable Brownfield Regeneration: CABERNET Network Report*. The University of Nottingham
- Fisher, B. (2011).Brownfields redevelopment and gentrification: A socio-economic evaluation of the EPA Brownfields Pilot Program. Master thesis
- Franco, S., Kadletzo., & Stevens, R. (2010). *Strategic framework for managing abandoned mines in the minerals industry*.
- Frantal, B., Kunc, J., Novakova, E., Klusacek, P., Martinat, S., Osman, R. (2013): *Location matters! Exploring brownfields regeneration in a spatial context (case study of the South Moravian Region, Czech Republic)*. *Moravian Geographical Reports*, Vol. 21,No. 2, p. 5–19.
- Government of the Republic of Kenya (2009): Kenya National Bureau of Statistics, Kenya Population and Housing Census, Volume II; Distribution of population by

administrative units.

Hersch, R., Morley, D., Schwab, J., & Solitare, L. (2010). REUSE- *Creating community based brownfield redevelopment strategy*. American Planning Association report

Hollander, J.B.; Kirkwood, N.G.; Gold, J.L. Principles of Brownfield Regeneration: Cleanup, Design, and Reuse of Derelict Land; Island Press: Boston, MA, USA, 2010.

HOMBRE (2012). *Holistic Management of Brownfield Regeneration. Europe: overview and proposals*. ITDP Institute for Transport and Development Policy.

Kisumu Integrated Sustainable Urban Development plan ISUD. (2013). Planning for Kisumu's future. The plan: part 1.

Koudela, V., Kuta, V., & Kuda, F. (2004). *The effect of brownfields on the urban structure of cities*. Slovak journal of civil engineering.

Krzysztofik, R., Dulias, R., Pietraga, K., Sporna, T., & Dragan, W. (2020). Paths of urban planning in a post-mining area. A case study of former sandpit in southern Poland. *Land Use Policy* 99 (2020) 104801

Kuter, N. (2013). *Reclamation of degraded landscapes due to opencast mining*. Intech landscape architecture magazine.

Loures, L., Panagopoulos, T., Burley, J. (2015). Assessing user preferences on post-industrial development. *Environment and Planning B. Planning and Design* 0 (0), 1-22.

Loures, L., & Panagopoulos, T. (2007). Sustainable reclamation of industrial areas in urban areas in urban landscapes. *A journal of sustainable development and planning*.

Martinat, S., Dvorak, P., Frantal, B., Klusacek, P., Kunc, J., Navratil, J., Osman, R., Tureckova, K., & Reed, M. (2016). Sustainable urban development in a city affected by heavy industry and mining? Case study of brownfields in Karvina, Czech Republic. *Journal of Cleaner Production* 118 (2016) 78-87.

Mert, Y. (2019). Contribution to sustainable development: Re-development of post-mining brownfields. *Journal of Cleaner Production* 240(2019) 1118212.

Michaud, L.H., & Bjork, D. (1995). *The feasibility of constructing solid waste landfills as reclamation method for abandoned mine lands*. Paper presented at Sudbury '95 conference on mining and the environment, Sudbury, Ontario May 28th-June 1st, 1995.

- Milgrom, T. (2008). Environmental aspects of rehabilitating abandoned quarries: Israel as a case study. *Landscape and Urban Planning* 87(2008)172-179
- McCandless, C., & Spirn, A.W. (2013). *No longer just a hole in the ground*. The adaptive reuse of resource depleted quarries.
- Mborah, C., Bansah, K.J., & Boateng, M.K. (2015). Evaluating alternate post-mining land uses: A review. *Environment and Pollution*; Vol. 5, No. 1; 2016.
- Mugenda, O.M., & Mugenda, A.G. (2003). *Research Methods: Quantitative and Qualitative Approaches*. Nairobi: Acts press.
- Pearsall, H. (2010). From Brown to Green: Assessing social vulnerability to environmental gentrification in New York City. *Environment and Planning C.*, 28(5), 8872-886.
- Ruelle, C., Halleux, J.M & Teller, J. (2012). Landscape Quality and Brownfield Regeneration: A Community Investigation Approach Inspired by Landscape Preference Studies, *Landscape Research*, DOI:10.1080/01426397.2011.647898
- Saperstein, L.W. (1990). "Reclamation," *Surface Mining*, Society for Mining, Metallurgy & Exploration Inc. (SME)
- Woolley, H. (2003) *Urban Open Spaces*. Spon Press, London. <https://doi.org/10.4324/9780203402146>