

THE EFFECTIVE AGROECOLOGICAL AND CONSERVATION INTERVENTIONS IN RESTORATION OF DEGRADED ECOSYSTEMS UMGABABA, ETHEKWINI MUNICIPALITY, SOUTH AFRICA.

LUTHULI KHUMBUZILE FAVORITE AND MBEDZI MELFORD

Department of Nature Conservation, Mangosuthu University of Technology, P.O Box 12363, Jacobs, Umlazi, Durban, 4031, KwaZulu-Natal South Africa.

*Corresponding author's email: mbedzi.melford@mut.ac.za

Abstract

Anthropogenic activities are a threat to natural ecosystems. Effective agroecological and conservation interventions play a vital role in restoration of degraded ecosystems. Mitigation measures contribute to the regulation of anthropogenic activities on ecosystems and promote sustainable livelihood through environmental empowerment services. Environmental education programs addressed degraded ecosystems issues through environmental translation and interpretation. The participation of schools in environmental education programs enhances the greening strategy. Promoting sustainable development and the acknowledgement of the environmental calendar of events. Illegal dumping was identified as the prevalent human activity practice on public open spaces and nature reserves of Durban South. Plastics were calculated to be 45% in the total area of the study followed by rubble at 25%, bottles 15%, degradable papers 7%, scrap metal at 5% and the minimal waste being garden waste at 3%. Invasive alien plants were identified as another factor contributing to degrading native species and other treasured resources such as species extinction, minerals and metals, and loss of ecosystem services. This led to the implementation of the community outreach program on invasive alien plants control. Propagation training was a restoration intervention that addressed the extinction of indigenous biodiversity. The results projected that majority of Umgababa: Mnini community possessed an interest in participating in substantial farming which led to an establishment of a community vegetable garden. The garden become an agroecological intervention implemented to reduce the illegal dumping on the ecosystem.

Key words: Agroecological practices; Invasive alien plants; Anthropogenic; Degraded ecosystems; Rehabilitation

Introduction

Background of the study: With growing populations, arable land for agricultural practices such as plant production is becoming increasingly scarce. Climate change affect agroecological practices leading to failure in supplying the population with healthy and reliable food. Agroecological practices contributes to restoration and rehabilitation of degraded ecosystems. Urbanization and high rate of unemployment results in human interference on biodiversity consequential to the degraded and devastated state of ecosystems (Wezel *et al.*, 2009). In the burgeoning world population, it is vital to consider the importance of the development of sustainable agricultural and food systems. Weighing the sustainable agricultural food systems, environmental issues such as water pollution, biodiversity loss, and land degradation as well as social and economic issues will be spontaneously addressed (Wezel *et al.*, 2016). An increasing rate of unemployment results in unacceptable behaviour which includes human interference on conservation areas, public open spaces and aquatic ecosystems which negatively impact the environment. Illegal dumping is an environmental issue warrants action from the environmental management sector. Clean-up campaigns and invasive alien species control are restoring activities for the degraded conservation areas (Kordella *et al.*, 2013).

The agroecology component mainly focuses in assisting communities by provision of garden support, e.g., fencing, cultivating land and seedlings. Whereas biodiversity conservation component which is known as Parks: Natural Resources Division, the critical function of biodiversity repositories, is provision of environmental services and climate change resilience. The study was motivated by integrating the two components that collectively work on mitigation measures (Restoration/ Rehabilitation programs) of addressing environmental challenges witnessed in the identified degraded ecosystems. And determined the effectiveness of positive response from integration of agroecology and biodiversity conservation components in addressing the issue of the selected degraded ecosystems. In the past 12 years rapid destruction of different ecosystems has been observed, mainly human interference which has been pragmatic in most conservation areas. The exploitation of natural environment leads to loss of biodiversity and habitat fragmentations. The anthropogenic activities such as land invasion were caused by the community members in Nature reserves and Durban Metropolitan Open Spaces Systems (D'MOSS) were recorded in 2018-2019. In those two years the community members destroyed and burnt indigenous and endemic species demanding to utilize the conservation areas /D'MOSS for residential purposes. This act resulted negatively impacted the equilibrium state of

ecosystems. Illegal dumping was observed in most areas. High unemployment rate at eThekweni Region can be the reasons for land destruction. Different restoration and rehabilitation practices have been implemented inaccessible due to lack of environmental understanding from the community members. The aim of the study was to determine the most effective techniques and ecological restoration programs to be implemented by agroecology and biodiversity conservation components with the intention of restoring the subjugated environments of eThekweni, in the Durban South Region.

Methodology

Study area: The study was conducted in Umgababa in KwaZulu-Natal province of South Africa on the south of Durban. The study area is located in Umnini section that forms part of other five sections of Umgababa, falling under eThekweni municipality (Fig. 1). The total population of the area is 10,814 (Statistics SA, 2022). Umgababa:Mnini area is known for its large marketplace for tourists. The nearest street is 83502TRK with coordinates: - 30°49'4.792" E 30°7'26.673" S. The site is zoned as a public open space which is regarded as conservation area for eThekweni municipality. The study area is close to the community with streams passing through it, indicating the sensitivity of this ecosystem.

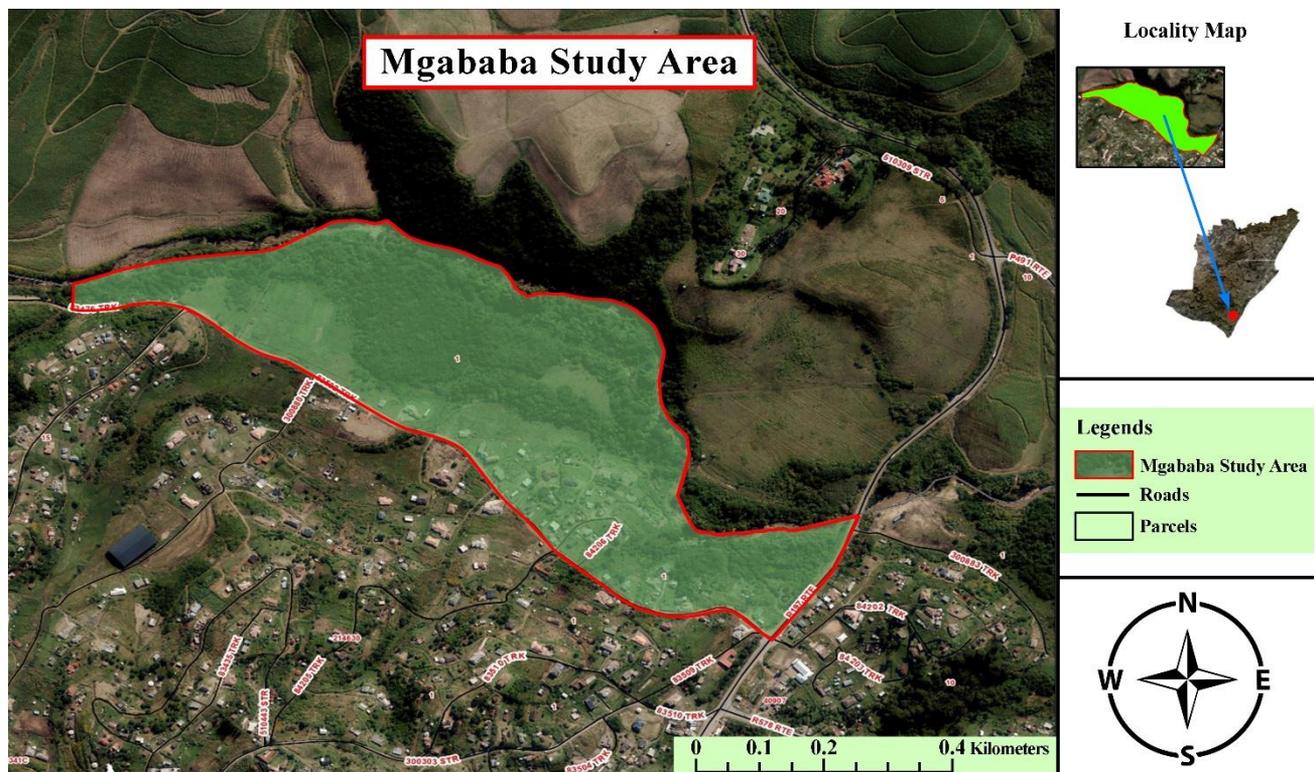


Fig. 1. The map shows the study area Umgababa: Umnini (ArcGIS).

Study design

Survey

❖ **Questionnaires:** Data obtained through the use of questionnaire assisted in planning the vegetable garden, which was implemented by agroecology department as the restoration programme of the degraded site. A total number of forty (40) respondents was randomly selected for the survey. The questions were designed to ascertain people's perception on agricultural and conservation interventions in restoring the degraded ecosystems of Umgababa. The questionnaire consisted of mixed type of questions; open and closed questions which allowed the respondents to provide information based on their experiences. The questionnaire was handed out randomly to the local community members of Umgababa. The respondents answered on paper and were given three days to respond. The information collected from the respondents formulated the restoration/rehabilitation programmes that was implemented.

After the survey, environmental education outreach programs were designed to achieve environmental interpretation for the members of Umgababa, Umnini community. The educational programs addressed the environmental challenges observed during sites inspections, enlightened and, enhanced better understanding of environmental management. Awareness was aimed to address the discrepancies on people and conservation conflicts. According to the environmental calendar of events September is the Arbor month and was observed through environmental education as part of the study. As part of youth environmental empowerment, eight school visited Umgababa area. Educational services on trees were rendered in all schools through tree planting which complemented the greening strategy of eThekweni municipality. Environmental awareness included illegal dumping, invasive alien species removal and gardening, these activities formed part in accomplishing the study.

Clean-up campaigns were conducted in September 2023 to promote sustainable livelihood through community

integration and liaison. These campaigns were community-based initiatives designed to empower communities to fulfil their constitutional right of living in a safe and clean environment. The campaigns were established to create a sense of ownership and liability from the community members to protect and clean their environment. It was essential for this initiative to be part of the study because eThekweni municipality is mandated for the implementation of clean-up campaigns as the local government servicing Umgababa area. Clean-up campaigns addressed environmental challenges observed at Umgababa.

An in-house basic invasive alien plant training was conducted by eThekweni municipality to empower Umgababa: Umnini community on how to identify, control and remove invasive alien plants. The training focused in regulating human-induced disturbance and was identified to serve as one of the effective agricultural and conservational mitigation measures to restore and rehabilitate the ecosystem. The study area was invaded by alien plants, posing threat to the ecosystem by dominating over the indigenous flora and negative impacts on hydrology as the study areas' location comprises of the stream which is categorised as a sensitive ecosystem (Reda & Tewelde, 2017). Guided by site inspections the spread of invasive alien plant species in the study area were elevated by anthropogenic activities on the ecosystem. The training followed the Alien and Invasive Species Regulations of the National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA) which regulates all invasive organisms in South Africa (Moshobane *et al.*, 2020). The mechanical method of control was carried out on the site infested with invasive alien plants as the practical section of the training.

As part of environmental empowerment programme, a basic plant propagation training was designed and conducted at Silverglen Nature Reserve Nursery to promote sustainable livelihood. Propagation can be defined as the reproduction of plants which is achieved through several techniques (Awotedu *et al.*, 2021). Plant propagation techniques are designed to achieve specific goals depending on the owner's needs e.g., uniformity in crops, increased productivity, disease-resistant plants, and plants with desired characters (Awotedu *et al.*, 2021). The community members were trained on propagating indigenous flora which encompassed of Inter-faith healers. The empowerment emphasized on establishing community owned nurseries and on substantial farming. Methods of propagation covered on the training were stem, leaf and root cutting where the chosen part of the plant is cut and replanted for the aim of regenerating the plant (Awotedu *et al.*, 2021). The community members were trained on the importance of owning one indigenous garden (healing garden) and one vegetable garden on their private spaces. Healing properties of different indigenous plants were also covered on the training. The community members of Umgababa were encouraged to cooperatively initiate community owned nurseries and community owned vegetable gardens which can be used to address socio-economic challenges in future.

Waste management training was motivated by Durban South site inspections which was inclusive of Umgababa study area, the dumping matters on natural ecosystems were observed and recorded. The training was in compliance with the Waste Act (Act No. 59 of 2008) which a piece of South African legislation guiding on an understanding of how the

country's waste should be managed (Dlamini *et al.*, 2018). The training was provided to the community of Umgababa: Mnnini area by Solid Waste Department of eThekweni municipality in conjunction with Natural Resources Division of Parks department and Agroecology department. Consideration of recycling projects and the buyback centres was accentuated. The recycling projects would address economic issues and will keep the community of Umgababa busy. Composting of green / garden waste was also covered on the training. Proper disposal of waste was added as part of the awareness which is following the Waste Act 59 of 2008. The training was aimed to promote the reduction of dumping on natural ecosystems and to empower the community about the importance of hygiene in their environments.

A clean-up campaign was facilitated to address an environmental challenge. The community participated in this environmental empowerment event were both eThekweni municipality employees from Parks Natural resources division, Durban Solid Waste Department, Agroecology Department, and the community members of Umgababa: Umnini area. The provision of materials and equipment for the clean-up campaign was bestowed by eThekweni municipality. In compliance with the Occupational Health and Safety Act of 1993, all participants of the clean-up were provided with proper Personal Protective Equipment. Litter picking, removal of scrap metals, and rubble was executed. The rubble was loaded into code c1 trucks from Parks, Durban Solid Waste and Agroecology Departments and legally disposed at Illovu municipal Dumping Site which is located on Durban south zone. The litter collection was facilitated in a categorisation order by the education officer from Durban Solid Waste Department. The garden waste was set apart and not disposed on the land fill site because it was reserved to be incorporated the compost for the community garden.

Restoration: As part of the study, ecological restoration / rehabilitation programs were designed to serve as conservational and agricultural interventions. The restoration of ecosystems is essential as it presents potential in ecological, economic, social wellbeing, and health (Peacock *et al.*, 2023). The implemented restoration programs for the study were: waste management, invasive alien plants removal, propagation, and community gardens establishment. Ecological restoration plays a vital part in combating both aquatic and terrestrial ecosystems degradation, mitigating climate change, and restoring lost biodiversity and key ecosystem functions and services (Peacock *et al.*, 2023).

Invasive alien plants clearing: The eThekweni municipality staff and the community members of Umgababa participated in removing alien plants at Umgababa sites. Hand pulling, cutting invasive alien plants using slashers and bush knives, hoeing, ploughing, and forking were methods used for invasive alien plants removal. Herbicide application techniques were not applied. Herbicides may affect the soil properties and may result to environmental toxicity which includes effects such as water pollution, soil erosion, and loss of biodiversity (Rashid *et al.*, 2010). The biomass was removed and stacked 30 m away from the site. Three days after the stacking the biomass was burned by members of the community.

Propagation: The interfaith healers and Umgababa community members were trained on indigenous plants propagation. The training was scheduled for three days. The first day focused on the theory part of the course and the second and the third days the training focused on the practical aspect of the training. On day two the training was in the nursery and the last part was a guided nature walk was on the third day which was aimed to familiarise the community members with the indigenous forest. The aim of the training was to empower the community members of Umgababa and the interfaith healers to deep knowledge of indigenous plants, the unique plant's properties. And to establish their own indigenous plant nurseries in their spaces of choice. In day two which was the beginning of practical session of the training, the trainees were trained on two methods: sexual (seed) and asexual or vegetative, using different parts of the plant which are: tips, stem, leaves, or roots. Mature seeds collected at Silverglen Nature reserve nursery were tested for seed viability before the execution of the training. On the third day which was the finalisation of the training, the soil media was visited, and all properties of the soil media were explained. The time of the year to carry out different kind of cuttings, how to collect, clean and sow seeds and cuttings were facilitated. Practical training on how to prepare a tray to sow seeds and insert cuttings and where to place trays once completed were conducted. The final session was conducted in the shade house and training on watering the trays, hygiene of the tray, plant material, budding and grafting knife finalised the planned propagation training.

Community vegetable garden: For the prevention of further anthropogenic activities such as dumping on the site a community garden was established. With agroecology department being responsible for the maintenance, equipment provision and professional guidance for the project where necessary. For a period of five days the community members thoroughly prepared the soil before the planting executed, and their schedule included: clearing and cleaning of the site by removing foreign objects. Weeding, removal invasive alien plants, removal of roots, total removal of debris and surface stones. As instructed by the municipal officer, 25 cm of the soil was dug and put aside, and another 25 cm of soil was kept separately as a second pile of soil. Planting rows were created using hoes organic fertiliser (compost) from the municipality was used. Water from the natural stream running through the study area was used for watering the soil. On day eight vegetable seedlings were provided by the municipality. Municipal employees assisted in the planting of the seedlings. The planting holes were dug the municipal employees ensured that the soil level of the seedling matches the soil level of the top of the hole to be planted into. The seedlings were gently removed from their trays and planted in the prepared planting holes. The soil that was dug out was used to fill the planting holes. Watering of the seedlings was the final activity for the procedure of the community garden establishment.

Results

Based on the sites inspections conducted at Umgababa: Umini area, it was observed that most

ecosystem degradations result from the anthropogenic activities such as illegal dumping. The findings indicates that community members contemplate that public open spaces and nature reserves as vacant spaces that can be utilised for dumping. Illegal dumping was observed at the Umgababa: Umini. Plastics were estimated at being 45% in the total area of the study followed by rubble at 25%, bottles 15%, degradable papers 7%, scrap metal at 5% and the minimal waste being garden waste at 3% (Fig. 2). It was evident that waste was illegally dumped at the study site, as there is a dedicated municipal dumping site in Durban South. This unacceptable behaviour is conducted by the nearest community members and companies. Rubble wastes are derived from renovated buildings and newly built buildings.

The invasive alien plants were a challenge in eThekweni Municipality. Umgababa: Umini area was also infested with these invasive alien plant species. The study area which Umini area was also invaded by these species.

A total number of six invasive species common at eThekweni were observed at Umgababa: Muni Area. According to the assessment, *Tithonia diversifolia* (Mexican sunflower): Asteraceae family, invading most of eThekweni areas was leading in infestation by 43%, *Solanum mauritianum* (Bug weed): Solanaceae family represented 20%, 17 % was the *Senna didymobotrya* (Peanut butter cassia): Fabaceae family, *Ricinus communis* (Castor oil plant): Eucophorbiaceae family was recorded at 9%, *Tecoma stans* (Yellow bells) which is the Bignoniaceae family at 7% and *Schinus terebinthifolia* (Brazilian pepper tree): Anacardiaceae family at 4% (Fig. 3). The findings biological invasions presented the requirement for the implementation of environmental education and training programs for the community members on alien plants control and sustainable use of ecosystems. This outreach program aided in enhancing better understanding of the environment. The training was conducted by eThekweni municipality officials. The training focused on empowering the community on the identification, control, and removal of invasive alien plants. As part of restoration, a practical activity of removing the identified invasive species at the study site was considered and executed. The mechanical method of control was used to control invasive alien plants and care was taken to ascertain the prevention of environmental degradation by using the species-specific chemicals applied directly on the cut stumps. The reason for the strict herbicide application technique was to align with the implementation of community garden project which was designed as the restoration strategy for the ecosystem and for the promotion of sustainable livelihood through agroecological projects. The improper use of herbicides would contribute to water pollution, and biodiversity loss. Water pollution would destroy the stream running through the study area and would impose mortality on fauna species and flora species. This would affect the health aspect of the community consuming the water.

A total number of forty (40) respondents to the questions asked in the questionnaire highly contributed to the establishment of the findings of the study. The responses highlighted all the relevant interventions by the municipality (Fig. 4).

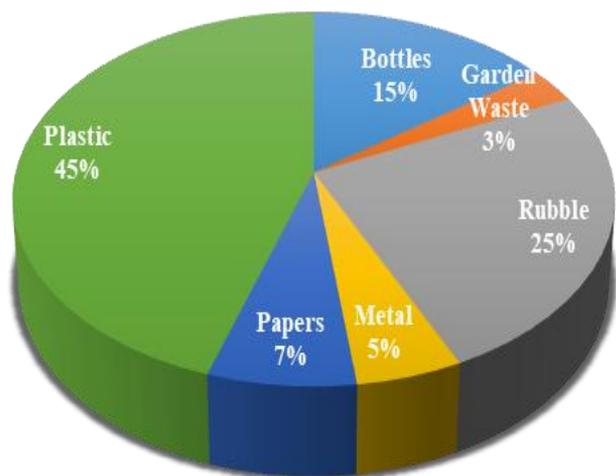


Fig. 2. Showing types of illegally waste dumped at the observed sites of Durban South.

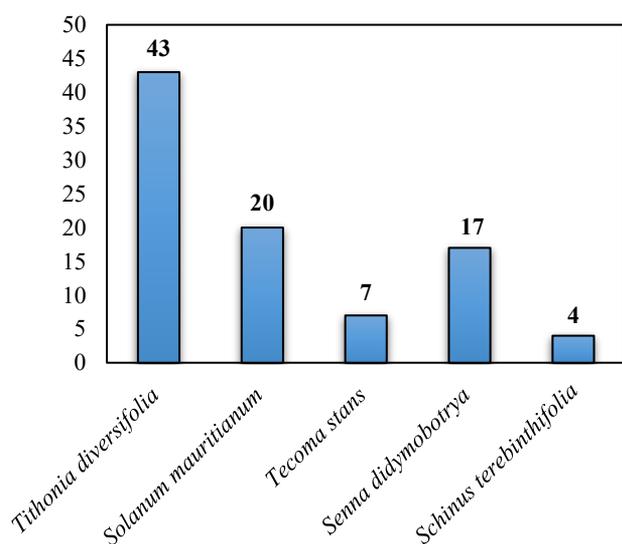
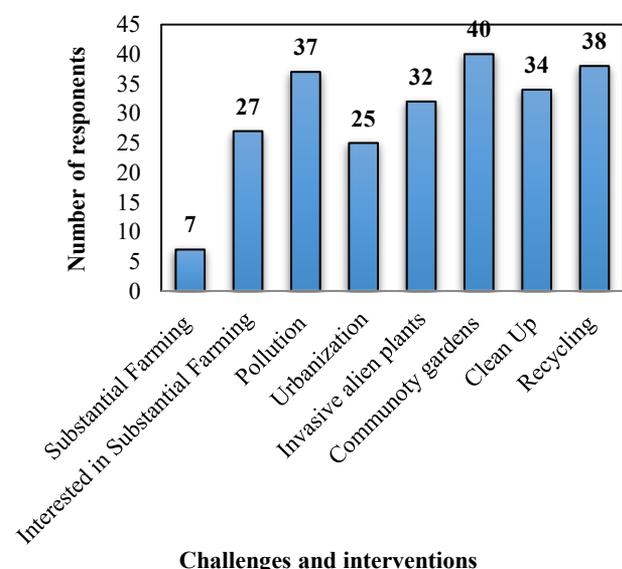


Fig. 3. Common invasive alien plants observed at Umgababa.



Challenges and interventions

Fig. 4. Showing data collected from 40 questionnaires' respondents.

Discussion

Restoration of degraded ecosystems by promoting sustainable agricultural practices, improving soil health, and enhancing biodiversity can also be achieved through agroecological interventions. Chivenge *et al.*, (2015) found that agroecological practices, such as inter-cropping, crop rotation, and cover cropping can significantly improve soil quality, reduce erosion, and increase crop yield in degraded ecosystems. Similarly, Scherr & McNeely (2008) discovered that restoration of degraded landscapes and enhanced biodiversity can be achieved by agroforestry systems which combines trees with crops and/or livestock. According to Sukdeo *et al.*, (2016), monitoring and controlling pollution, removal /control of alien invasive plants when considered as restoration interventions may enable the reduction of high sediment levels in aquatic ecosystems and improve water flow and healthy status, for example, in blue carbon ecosystems.

Littering is a crucial environmental issue affecting both humans and the environment. Consumption of various goods has resulted in an extended electronic and electrical waste, which critically threatens humans and biodiversity because of toxicity. Proper management of municipal solid waste is a challenge when it comes to service delivery. This has been observed in developing countries. The rate paying areas are more considered than the rural areas in most cases. The failing part in the administration of solid waste is due to lack of funding, interest in solutions, efficient urban planning, poor equipment for waste collection, and increasing city populations (Massa & Archdoulak, 2023). Furthermore, illegal dumping is amongst the leading environmental challenges resulting in environmental hazards and breeding ground for rats. This activity also contributes to the population growth of mosquitoes. Other environmental factors include chemicals and toxins which enters the ground water. Stakeholder involvement, clean-up campaigns, environmental awareness, landfill sites, law enforcement, use of illegal dumping cameras and social media to catch perpetrators can be implemented as mitigation measures to restore the degraded ecosystem because of illegal dumping (Hidalgo *et al.*, 2019). In South Africa municipalities are mandated to facilitate proper solid waste management. The factors of waste management are removal, storage, transportation, and final disposal of waste. Health hazards are prevented through prearranged removal frequencies. Weekly collections are ensured on weekly basis to households. It is not allowed for citizens to burn solid waste in their private spaces. There are un-serviced areas in South Africa that lead to extensive littering and illegal dumping in conservational zoned areas such as public open spaces, nature reserves and vacant land (Haywood *et al.*, 2021).

A study by Duru *et al.*, (2015) on implementing biodiversity-based agriculture to enhance ecosystem services, confirms that there are gaps in the understanding and knowledge between agroecological principles and practical applications. There are 2 factors contributing to lack of practical applications, first being the occurrence of high uncertainties about relations between agricultural practices, ecological processes, and ecosystem services and secondly, the site-specific character of agroecological practices required to deliver expected ecosystem services.

Some of the degradations are due to agricultural activities such as land use change and overexploitation (overhunting, overharvesting, and overfishing) leads to biodiversity loss, climate change, erosion, and air and water pollution (Zambon *et al.*, 2017). However, agroecological interventions play a vital role in restoring degraded ecosystems through implementation of management practices such as soil fertility and biological regulation. An adaptive management approach can serve as a framework for developing and implementing learning tools for researchers. The learning tools are knowledge based containing scientific support and experiential knowledge, and model-based games. These learning tools serve as management indicators that allow monitoring effects of practices on biodiversity and ecosystems (Duru *et al.*, 2015). Organic Farming is encouraged for sustainable environmental management but conflicts with the growing population growth, the environmental threats posed to forests and grasslands if developed on an international scale (Barbieri *et al.*, 2021).

Invasive alien plants highly contribute to ecosystems degradation. Invasive alien plants pose serious threat on the socio-economic status of South Africa and to biodiversity. The invasive alien species consume lot of water, and they are capable of outgrowing the native species. Habitat fragmentation and destruction of aquatic ecosystems may result from the invasive alien plants present in the ecosystem (Srivastava *et al.*, 2014). Amongst the common invasive plants present in eThekweni areas in the *Melia azedarach* which is reflected as the highly altering invasive alien plant in South Africa due to its rapid growth capability (Bhatt *et al.*, 2021). According to the National Environmental Management: Biodiversity Act, (Act 10 of 2004) growth of invasive alien plants is not encouraged but must be eradicated and propagation of invasive alien plants is not permitted. Invasive alien plants are categorised according to their abundance, distribution, and ecological impact (Nel *et al.*, 2004). Community involvement is essential for successful invasive alien plants control programs. Community groups are of great assistance in the control aspect of the invasive alien plants. The extent community involvement on invasive alien plants control programs contributes to rapid detection, ablation, and the control of these species. Community involvement may address factors such as funding for proper management of the invasive alien plants, the sense of ownership and liability in managing the spread of invasive alien plants. Community involvement enables the communities to provide good care of their environment (Jubase *et al.*, 2021).

Propagation of indigenous plant species is encouraged to address environmental challenges such as habitat loss and degradation, plant diseases, and projected climate change. Plant propagation is a resolution to the red listed species and for the average abundance of medicinal plants. Propagation contributes on social-economic values by providing access for the owners of the nurseries to the market for monetary benefits (Silcock, 2018). Vegetative propagation is the most practiced method. In this method plants are propagated through sexual and asexual methods. Due to the nature of plants uniqueness different types of propagation methods can be applied depending on the plant

that is being propagated (Awotedu *et al.*, 2021). Organic compost is emphasised on both indigenous plants' propagation and crop farming practises. Composted organic fertilizers application is beneficial to better soil structure, adding if antagonistic organisms, and plant nutrients supply (Siddiqui, 2004).

Environmental education, translation, interpretation, and community outreach programs contributed positively on the study. This aspect addressed the 17 sustainable development goals as it mainly focused on community integration and projects pertaining to environmental, social, and economic aspect of the community of Umgababa: Mnini area. The findings of the study indicate that there are degraded ecosystems in some areas around Durban South. The inspected areas are zoned as conservation/public open spaces, revealing the significance on biodiversity management. Thus, effective mitigation measures are a necessity to control further degradation of ecosystems. This will provide biodiversity sustainability and to regulate anthropogenic activities on ecosystems. In case the degradation continues that will define indigenous biodiversity loss and unsustainable livelihood to the nearest communities. This motivates the importance of learning effective mitigation measures to control further degradation of ecosystems.

Nature reserves and D'MOSS areas were observed to check on the degradation of the ecosystems. Pollution was among the observed environmental challenges and the different types of waste were recorded. As new community members at Umgababa builds homes from scratch and not monitored on disposal of their rubble. Plastics, scrap metals, bottles, papers, and the garden waste were identified to be more of domestic waste this validate the fact that the community is accountable for this activity. To address the issue of illegal dumping a waste management training was organised in compliance with the Waste Act (Act No. 59 of 2008). The training emphasized legal ways of waste disposal, recycling, and reduction of waste. Waste hazards on both human health and biodiversity were detailed including the positive benefits of garden waste. The training aids in changing the human behaviour towards the environment through the reduction of dumping on natural ecosystems. The community members understood the importance of hygiene in their environments. A clean-up campaign for Umgababa: Mnini site was conducted as a conservational intervention in addressing this environmental challenge. The rubble was disposed at Illovu dumping site, the bottles, plastics, and papers were utilised by the community members and taken to Doonside buyback centre. Aiming to promote sustainable livelihood. Results from the questionnaires articulated that the municipality stopped collection of domestic waste which is assumed to be leading the community members to practice illegal dumping and opting to burn the domestic waste in their private spaces. Environmental health hazards were expressed by the respondents stating unpleasant smell, rodents, mosquitoes, and flies were dominant in their surroundings because of the waste found in the study area. Arson fires in public open spaces were also predicted to be resulted from people burning waste.

The results from questionnaires indicated that 7 respondents participated in substantial farming in their private spaces and 27 respondents indicated that the majority of Mnini community members were interested in participating in substantial farming. Resulting to the establishment of a community garden to limit and reduce illegal dumping on the site. Urbanisation was identified as the cause of anthropogenic activities on the ecosystems. It was confirmed that pollution and invasive alien plants are a threat to the environment. The questionnaire fostered the implementation of propagation training, waste management, invasive alien plants clearing, recycling, and community garden projects. The plant propagation training capacitated the community on plant multiplication and establishment of indigenous plants nurseries. The trainees were empowered on two methods: sexual (seed) and asexual or vegetative, using different parts of the plant which are: tips, stem, leaves, or roots. Seed collection and seed testing for seed viability were also covered in the community training. The training promoted sustainable utilisation of fauna species and their medicinal significance. Practical training of plant propagation was served in Silverglen Nature Reserve nursery. Physical identification and census of indigenous species was conducted through guided nature walks in Silverglen Nature Reserve and allowed the trainees (Nature conservationists) to use their sense of sight, smell and touch and enjoy nature.

Agroecological intervention on addressing illegal dumping was achieved through the development of the community garden. Organic farming was emphasised. The agroecological project would aid in keeping the environment clean and prevention of further induced human activities such as illegal dumping. The community garden produced a sense of ownership to the environment. Forming a mutual understanding between, the community and municipal departments that took part in restoring their degraded area which is Umgababa: Mnini area. This project promoted sustainable livelihood to the communities because the municipality assisted on accessing the market for economic benefits. A certain portion of the vegetables were kept for personal consumption for those in need. The community vegetable garden benefited both the environment and the community. When the community members and government officials removed the invasive alien species and the rubbish dumped illegally, they created gardens in those areas, thereby making the environment clean and green and at the same time alleviating poverty.

However, the results revealing harvesting phase of the community vegetable garden has not been observed. The objectives of the study comprehend with the results recorded so far as it addressed conflicts of interest between the municipal officials and Umgababa community members.

Conclusion and Recommendations

Environmental education is essential for biodiversity conservation. The results showed that education enhanced the positive thought of people's experiences. The understanding of the environment was enlightened to the community members based on their responses on the

questionnaire which positively contributed to the relevant structuring of the study. Waste management training created space for betterment for the community members. Environmental education provided the aesthetic attractiveness of biodiversity.

It is perceived that the municipality might demarcate public open spaces in rural areas such as Umgababa to be utilised for agroecological projects that will benefit communities. The community leadership of Umgababa intervene and enquire about the collection of domestic waste so that the issue will be redressed by the municipality. Clean-up campaigns should be organised on regular basis to encourage the community to keep their environment in a hygienic state. Illegal dumping causes environmental health hazards. Environmental education in schools' benefits communities by producing environmentally aware future leaders.

Invasive alien species removal is mandatory and should be practiced enforcing environmental protection. And improve water supply; present the provision of additional ecosystem services such as improved soil quality and reduced arson fires on public open spaces and nature reserves of eThekweni municipality. Within communities, unwanted weeds may be controlled by applying plain vinegar because it contains 5% of acetic acid which would destroy most vegetation by removing all the moisture from the leaves. Selective parasites may be applied for the biological control of invasive alien plants in public open spaces and nature reserves.

Indigenous plants propagation trainings are recommended as they are beneficial to the environment and the community. Sexual propagation method is cheaper and faster than other methods. Propagation reduces extinction of plants and enables prolongation of threatened species. Communities may benefit economically from plant propagation by establishment of nurseries which may provide economic benefits by selling the indigenous plants.

Organic agriculture should be emphasised and encouraged because research indicates that it occupies 1% of global agricultural land. Farmers and persons participating on substantial farming in backyard gardening are discouraged from the use herbicides, and organic compost. Rather try to grow more organic crops, which would enable environmental preservation and sustainable livelihood. Crop rotation and mulching are cultural methods that may be used to control invasive alien species. Municipal services must always align with the global sustainable development goals.

References

- Awotedu, B.F, T.O. Omolola, A.O. Akala, O.L. Awotedu and S.O. Olaoti-Laaro. 2021. Vegetative propagation: A unique technique of improving plants growth. *World News N. Sci.*, 35: 83-101.
- Barbieri, P, S. Pellerin, V. Seufert, L. Smith, N. Ramankutty and T. Nesme. 2021. Global option space for organic agriculture is delimited by nitrogen availability. *Nat. Food*, 2(5): 363-372.
- Bhatt, A., S. Gairola, Y. Govender and P.R. de Moura Souza-Filho. 2021. The invasive *Melia azedarach* in Durban (South Africa): impacts on tree community structure. *Folia Geobot.*, 56(2): 139-147.

- Chivenge, P., T. Mabhaudhi, A.T. Modi and P. Mafongoya. 2015. The potential role of neglected and underutilised crop species as future crops under water scarce conditions in Sub-Saharan Africa. *Int. J. Environ. Res. Pub. Health*, 12(6): 5685-5711.
- Dlamini, S., M.D. Simatele and N. Serge Kubanza. 2018. Municipal solid waste management in South Africa: from waste to energy recovery through waste-to-energy technologies in Johannesburg. *Local Environ.* 24(3): 249-257.
- Duru, M., O. Therond, G. Martin, R. Martin-Clouaire, M.A. Magne, E. Justes, E.P. Journet, J.N. Aubertot, S. Savary, J.E. Bergez and J.P. Sarthou. 2015. How to implement biodiversity-based agriculture to enhance ecosystem services: a review. *Agro. Sust. Develop.*, 35(4): 1259-1281.
- Haywood, L.K., T. Kapwata, S. Oelofse, G. Breetzke and C.Y. Wright. 2021. Waste disposal practices in low-income settlements of South Africa. *Int. J. Environ. Res. Pub. Health*, 18(15): 8176
- Hidalgo, D., F. López, F. Corona and J.M. Martín-Marroquín. 2019. A novel initiative to counteract illegal dumping in rural areas of Valladolid Province (Spain). *Enviro. Sci. Poll. Res.*, 26(35): 35317-35324
- Jubase, N., R.T. Shackleton and J. Measey. 2021. Motivations and contributions of volunteer groups in the management of invasive alien plants in South Africa's Western Cape province. *Bothalia-Afr. Biod. Cons.*, 51(2): 1-13.
- Kordella, S., M. Geraga, G. Papatheodorou, E. Fakiris and I.M. Mitropoulou. 2013. Litter composition and source contribution for 80 beaches in Greece, Eastern Mediterranean: A nationwide voluntary clean-up campaign. *Aquat. Ecos. Health Manag.*, 16(1): 111-118.
- Massa, G. and V.M. Archodoulaki. 2023. Electrical and electronic waste management problems in Africa: Deficits and solution approach. *Enviros.*, 10(3): 44.
- Nel, J.L., D.M. Richardson, M.J.K.K.J. Rouget, T.N. Mgidi, N. Mdzeke, D.C. Le Maitre, B.W. Van Wilgen, L. Schonegevel, L. Henderson and S. Naser. 2004. A proposed classification of invasive alien plant species in South Africa: towards prioritizing species and areas for management action: working for water. *S. Afr. J. Sci.*, 100(1): 53-64.
- Peacock, R., M. Bently, P. Rees and J.N. Blygnaut. 2023. The benefits of ecological restoration exceed its cost in South Africa: An evidence-based approach. *Ecos. Ser.*, 61: 101528.
- Rashid, B., T. Husnain and S. Riazuddin. 2010. Herbicides and pesticides as potential pollutants: a global problem. In *Plant adaptation and phytoremediation* (pp. 427-447). Dordrecht: Springer Netherlands.
- Reda, A. and F. Tewelde. 2017. Impact of invasive alien plants on biodiversity and livelihood of local communities in Tigray, Ethiopia. *World App. Sci. J.*, 35(11): 2364-2378.
- Statistics, S.A., 2022. *South Africa population by province 2022*, Umgababa: South African government.
- Scherr, S.J. and J.A. McNeely. 2008. Biodiversity conservation and agricultural sustainability: Towards a new paradigm of 'ecoagriculture' landscapes. *Philosophical Transactions of the Royal Society B: Biol. Sci.*, 363(1491): 477-494.
- Siddiqui, Z.A. 2004. Effects of plant growth promoting bacteria and composed organic fertilizers on the reproduction of *Meloidogyne incognita* and tomato growth. *Bioresource Tech.*, 95(2): pp. 223-227.
- Silcock, J.L. 2018. Aboriginal translocations: the intentional propagation and dispersal of plants in Aboriginal Australia. *J. Ethnobot.*, 38(3): 390-405.
- Srivastava, S., A. Dvivedi and R.P. Shukla. 2014. Invasive alien species of terrestrial vegetation of north-eastern Uttar Pradesh. *Int. J. Forest. Res.*, (1): 959875.
- Moshobane, M.C., L.R. Nnzeru, K. Nelukalo and N.P. Mothapo. 2020. Patterns of permit requests and issuance for regulated alien and invasive species in South Africa for the period 2015-2018. *Afri. J. Ecol.*, 58(3): 514-528.
- Sukdeo, P., S. Pillay and H. Ballabh. 2016. Ecological Restoration and Remediation of a Degraded Estuary: The Case of the Mvoti Estuary, KwaZulu-Natal, South Africa.
- Wezel, A., S. Bellon, T. Doré, C. Francis, D. Vallois and C. David. 2009. Agroecology as a science, a movement and a practice. A review. *Agro. Sust. Dev.*, 29(4): 503-515.
- Wezel, A., H. Brives, M. Casagrande, C. Clement, A. Dufour and P. Vandenbroucke. 2016. Agroecology territories: places for sustainable agricultural and food systems and biodiversity conservation. *Agro. Sust. Food. Sys.*, 40(2): 132-144.
- Zambon, I., A. Colantoni, M. Carlucci, N. Morrow, A. Sateriano and L. Salvati. 2017. Land quality, sustainable development and environmental degradation in agricultural districts: A computational approach based on entropy indexes. *Environ. Impact. Assess.*, 64: 37-46.