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Best Practices in Mine Closure: A Case Study of Cultural Ecosystem Services in the Kenyan Mining Sector

Albert Akondo Musando and Freddy Cáceres

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EXECUTIVE SUMMARY

The mining sector's importance is increasing as the global energy transition accelerates and more populations secure higher living standards. However, the aftermath of mining operations hasn't received enough attention from governments, regulators or the public. Abandoned quarries can become breeding grounds for pests and pathogens, havens for criminal activity, dumping grounds or dangerous blights on the landscape.

None of this is inevitable. Through planning and sustainable mine closure, problems can be prevented or solved. This paper examines Kenya's Bamburi Haller Park and the way it has been successfully remediated by a private company so that the land can again provide cultural ecosystem services (CES).

CES are the non-material benefits obtained from restored ecosystems, covering everything from cultural identities to spiritual values. Ecosystem revival supports human survival and well-being, making it essential to hold mining ventures responsible for mitigating their environmental impact. Bamburi shows how this can be done.

Limestone quarrying began at the coastal site of Bamburi in 1954 with drilling and blasting that brought saline groundwater to the surface in searing temperatures, damaging local ecosystems.

Ecological restoration of the quarries started as a rehabilitation initiative and experiment in 1971. Steep cliffs were sloped, native biomes were replanted and ponds dug to support fish and aquatic plants. At each stage of the changes, the soil, air and physical environment were altered to foster the colonization and survival of indigenous wildlife. The site opened to the public in 1985.

Bamburi Cement, which is based in the area, factors biodiversity management and restoration of quarries into its company policies. The company meets with stakeholders to identify risks and opportunities and relies on rigorous mapping and science to mitigate human impacts. Reviews of progress and biodiversity management plans take place every two years.

The firm's environmental performance is built on four pillars. First, its environmental commitments are integrated into all aspects of the business process, from management to workers' health and safety.

Second, environmental consequences are constantly measured while responses, tools and capabilities undergo continuous improvement to promote best practices. This encourages the analysis of impacts throughout the life cycle of cement products. Similar plans are in place for all quarries, reflecting the importance of conservation and the community's needs.

Third, recovery and recycling of waste products in the company's own production processes is prioritized, hazardous waste generation is minimized and disposal is handled safely and responsibly.

Finally, Bamburi Cement promotes an honest, open work environment. It allows for proactive co-operation with government, regulators and communities. Ecological restoration plans for quarry sites are developed together with the people whom they affect.

This approach has transformed a mine wasteland into Bamburi Haller Park. Hundreds of species of flora and fauna have been successfully re-established and the area has become an internationally recognized ecotourism magnet, a venue for environmental education and a focal point for community recreation and spiritual renewal, generating substantial revenues from more than 180,000 annual visitors.

Any ecosystem's ability to deliver sustainable cultural services depends on sound legislation and regulation of mine closure practices, as well as private policies and investment in wildlife restoration.

The Bamburi case has clearly applicable lessons for the wider world. All parties should work together to ensure that CES considerations align with wider sustainability goals. Mining companies must integrate environmental initiatives and interventions into everyday operations. Governments need to encourage mining firms to share knowledge gained from successful closures. Solid regulatory oversight is indispensable to support the highest standards in environment management.

ABSTRACT

Mining operations leave behind quarries with inhospitable conditions, characterized by steep drop-offs, deep water, flooding and poor drainage, and in some cases, abandoned industrial waste. Increasingly, innovations in mine closure and ecological restoration are integrating human activities into post-project land uses. Drawing from the Bamburi Haller Park, a former limestone quarry, this study demonstrates that with suitable environmental practices and policy interventions, mine closure can lead to positive projects that spur economic and social benefits. As a policy tool, this paper examines cultural ecosystem services (CES) as part of best practices in mine closure and mine restoration. Visitation data and revenue records were collected covering the period from 2014 to December 2018. Results show that over 566 hectares are now under various land uses with 56.51 per cent of the quarry having been ecologically rehabilitated. The site attracted over 181,000 visitors annually with an average annual revenue of US\$330,745 from CES, including ecotourism, recreation and sports and environmental and conservation education. CES can form a strong foundation for promoting ecosystems restoration, biodiversity conservation and sustainable land use activities while showcasing best practices in environmental social governance. The resulting ecosystem is a unique model and showcase for sustainable and responsible mine closure in the extractive industry.

INTRODUCTION

Globally, few jurisdictions have enacted and implemented mine closure laws and regulations, except for a few major producers such as Australia, Canada, Chile, Peru and the United States. Kenya in East Africa has adopted similar standards. Mining operations leave behind quarries with inhospitable conditions, characterized by steep drop-offs, deep water, flooding and poor drainage, loose boulders, sharp rocks, and in some cases, abandoned industrial waste. In Kenya, structures and equipment left at abandoned quarries are also dangerous, with limited or no restoration treatment, and become hazardous sites with rugged landscapes. The sites also become breeding grounds for mosquitoes, tsetse flies and harmful organisms that cause diseases such as malaria, schistosomiasis and typhoid (Musando et al. 2021). Abandoned quarries can sometimes become sites for illicit activities, while others become dump sites, attracting invasive species of birds, including Indian house crows (*Corvus splendens*) and pests like rats and mice which transmit pathogens to humans. This paper examines cultural ecosystem services (CES), taking Bamburi's rehabilitated limestone quarry in Kenya as a study case. We examine Bamburi's model of enabling environment through company management, commitment and initiatives, policy, applicable legislation and suitable intervening frameworks. These factors contribute to best practices in environmental governance in the extractive industry, leading to the delivery of CES in the rehabilitated quarries.

This study seeks to fill the gap and encourage industries and societies to engage in treatment of quarries for sustainable CES. At the same time, it makes a call to action to governments, where public policy initiatives are needed to embed the concept of CES in forming new regulatory frameworks for mine closure. In this sense, the main objective is to situate CES in a context of global practice in the extractive industries, to assess whether CES are taken into account in the current legislation and regulatory framework for quarries and to make recommendations for strengthening policies and regulatory frameworks. This study's findings can be applied to improve the restoration of abandoned quarries and assist in developing public policy to change worldviews and embrace ecological treatment of limestone quarries as an important sustainable environmental management practice.

Vivoda et al. (2019) assert that many jurisdictions rich in mineral resources have enacted legislation that references mine closure in one way or another, with a wide-ranging level of detail regarding requirements and procedures. In most cases, mine closure requirements appear either within mining laws and associated implementing rules and regulations, or within environmental legislation specific to the mining sector, rather than in standalone mining laws. However, international compliance and standardization is steadily growing through self-reporting by firms and by states voluntarily entering into international agreements. According to the Society for Ecological Restoration (SER) (2002), ecological restoration is defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. In this paper, the authors use the term “ecological restoration” to describe all the activities which seek to recover, re-create or upgrade ecosystems that have been degraded, damaged or destroyed by mining, and bring them back into beneficial use in which the ecosystem structure and function are restored. As defined by FAO (2018), with certain precision by the authors, CES are the non-material benefits obtained from natural or ecologically restored ecosystems. These benefits include aesthetic inspiration, cultural identity and a sense of home and spiritual experience related to the natural environment. Despite the gaps in the literature, where topics like quantification, typification and others still remain under-described, the use of CES seems to be an emerging international practice for mine closure.

Theorists of ecological restoration suggest that the practice is a crucial complement to not only conservation efforts, but also to maintaining services provided by natural capital, and thus improving human livelihoods (Dobson et al. 1997; Rohr et al. 2018). This potential value to society has propelled ecological restoration to a prominent role in global environmental policy (Bullock et al. 2011; Young et al. 2019). Increasing demand for new products and energy is translating into increased demand for raw material, leading to more natural ecosystem degradation and increasing scrutiny of mining companies’ environmental, social and governance (ESG). Increasing demand and increased scrutiny of its methods are impacting the extractive value chain, making the need for enhanced governance tools more pronounced and urgent. Ecologically restored ecosystems complement other natural and pristine ecosystems that support human survival and well-being. Bissonette and Storch (2002) remind us that before the Industrial Revolution and the subsequent explosion of human population density, the limitations of natural resources and wildlife habitats across the world were not a concern. Now, when ecosystem services are lost through land degradation, economies often suffer (Talberth et al. 2001). Archer et al. (2018) warn that threats to biodiversity affect environmental health and create conditions in some areas for the spread of zoonotic diseases and the establishment and spread of invasive alien species. Archer further asserts that the loss of nature’s contributions to people, owing to the degradation of biodiversity, strains social relations, contributing to inequity among people which is the basis of many conflicts in Africa. Despite the growing problems associated with these abandoned quarries, there is limited effort globally to resolve this environmental problem, leading to an increased loss of nature’s contributions to people due to degradation of biodiversity.

BACKGROUND: DEFINING THE POLICY PROBLEM

In theory, the appropriate balance between the enabling and restrictive elements of regulatory frameworks is the basis for ensuring that mining companies operate in a way that satisfies their commercial interests, while serving, or not impeding, the achievement of broader societal objectives (Vivoda et al. 2019). Mining companies have an opportunity to improve their efforts for transparency and become more responsive to mitigating environmental impacts from their operations. Through suitable environmentally friendly policy interventions and mechanisms, encouraging mining firms to be responsible for the environment and ensure transparency and accountability can achieve significant successes. Consistent efforts and years of advocacy, coupled with stakeholder engagement around effective governance, are beginning to pay off. The extractive sector is beginning to improve environmental compliance, with benefits impacting communities positively through CES. Across the globe, governments and financing institutions are beginning to hold mining companies accountable through regulatory frameworks, both voluntary and binding. Today, legislation outlines processes for ensuring mining companies achieve transparency and accountability.

In Africa, as elsewhere where mining is concentrated, civil society and communities are engaging in activism for environmental management responsibility as well as ensuring access to specific environmental information that is deemed to be in the public interest. Because of this pressure, government agencies and departments of the environment are taking greater measures to protect land, water and air quality. This is gradually leading to nations signing onto international standards, such as the Extractive Industries Transparency Initiative (EITI) (EITI 2023a). EITI recognizes that a country's natural resources belong to its citizens and so promotes understanding of natural resource management while strengthening public and corporate governance and accountability. Importantly, EITI provides the data to inform policy-making and multi-stakeholder dialogue in the extractive sector and enables countries to respond to pressing challenges that concern natural resource governance. EITI is also currently working on gender matters and the importance of an inclusive energy transition process (EITI 2023b). Like EITI, the Natural Resource Governance Institute (NRGI) is another organization that supports informed, inclusive decision-making about natural resources and the energy transition. According to its website, NRGI works with developing countries to minimize harms and benefit equitably from the growing demand for transition minerals used in critical green technologies (NRGI 2023). This institute has developed a Resource Governance Index to better understand the state of resource governance in countries around the world, as a benchmark, country and sector diagnostic tool, and a roadmap for policy and practice reforms at the global, regional and country levels. To enforce environmental sustainability, a fair degree of understanding mining and environmental management is required. Without compelling legislation and engaging policies, the public and private sectors may not be motivated to undertake the restoration of mine sites, especially where losses and gains are unclear.

GLOBAL POLICY CONTEXT

Many companies in the global mining sector have integrated sustainable development principles into their projects, policies and initiatives. Several international and national laws hold parties liable for damaging ecosystems, which at least partially fuels the science of restoration (Rohr et al. 2013). Requirements for mine closure vary across jurisdictions, as do the requirements for financial assurance for closure costs liabilities. According to Suding et al. (2015), United Nations members have committed to restoring 350 million hectares of degraded ecosystems to combat climate change by 2030 (Rohr et al. 2018). In Australian and Canadian jurisdictions where environmental legislation applies to the mining sector, the typical requirement is that an environmental and social impact assessment (ESIA) and a mine closure plan (MCP) are prepared for projects that anticipate significant environmental and social impacts. Commonly, project-based ESIA and MCPs serve as preconditions for project approvals and acquisition of mining licenses and require that social and environmental impacts be considered throughout the mine life cycle; that is, before mining, during mining and in the closure and post-closure phases (Vivoda et al. 2019). Most jurisdictions require affected communities to engage in the planning and approval process, and throughout the project's life cycle. During the project approvals stage, proponents first negotiate mine closure and social impact management conditions with government and other authorities, such as traditional landowners or their authorized representatives. Once a project is approved, these conditions become enforceable.

In Australia, the Mining Operations Plan (MOP) Guidelines approach mine closure as a process that is broader than mine rehabilitation encompassing, for example, optimization of land use for socioeconomic outcomes (Vivoda et al. 2019). Specifically, the guidelines require that closure objectives describe the requirements for achieving positive social and economic outcomes. The guidelines emphasize that mine closure should be considered a whole-of-mine-life process, with planning for mine closure commencing at the feasibility stage of an operation (Vivoda et al. 2019). According to the guidelines, engagement in the pre-mining phases, during early-phase rehabilitation and through closure planning, should enable stakeholders to influence closure outcomes. Early engagement facilitates agreement about post-mining land use and landscape and rehabilitation objectives. In the United States, CEMEX, a global building materials company, has successfully implemented quarry rehabilitation at a Colorado clay plant. According to the World Business Council for Sustainable Development's Cement Sustainability Initiative (2011), between 1999 and 2005 6,000 trees were planted to reforest 12 hectares of the clay quarry and 50 hectares were rehabilitated through natural regeneration. This is a good example of a deliberate effort to rehabilitate and allow for ecosystems succession to enhance CES.

Milton Quarry in the U.S. has been rehabilitated and provides CES to the surrounding community. According to the World Business Council for Sustainable Development (2011), through an extensive ongoing quarry rehabilitation project the restored landscape now features extensive naturalized water bodies with varying shorelines, wetlands, wooded upland margins and slopes, open spaces, an education centre with access to the Bruce Trail network and many kilometres of cliff face. Finally, in Yepes, Spain, the Ciruelos quarry extends over 600 hectares in Castilla La Mancha, Toledo (World Business Council for Sustainable Development 2011). The quarry restoration plans have been developed by taking into account the findings of biodiversity surveys (covering vascular plants, birds, weevils, lichens, butterflies and springtails) and working with government officials, experts from universities and NGOs.

DEFINING CULTURAL ECOSYSTEM SERVICES

The non-material benefits obtained from natural or ecologically restored ecosystems are called cultural services (FAO 2018). These benefits include aesthetic inspiration, cultural identity and a sense of home and spiritual experience related to the natural environment. Cultural services are deeply interconnected and often linked with benefits to people that can be extracted from nature, which may include food, drinking water, timber, wood fuel, natural gas, oils, plants and materials that can be used to make products such as clothes, as well as medicinal benefits. They are also connected to regulating services, which are the non-material benefits provided by the ecosystems that include maintaining the quality of air and soil, providing flood and disease control or pollinating crops. They are often invisible and therefore mostly taken for granted. When they are damaged, the resulting losses can be substantial and difficult to restore. In many situations, CES are among the most important values people associate with nature. According to the typology of the United Nations report, *The Economics of Ecosystems and Biodiversity (TEEB)*, interaction between the different production systems and the types of ecosystem services include recreation, mental and physical health, tourism, aesthetic appreciation and inspiration for culture, art and design, spiritual experience and sense of place (Wittmer et al. 2018). Approaches in landscape aesthetics, cultural heritage, outdoor recreation and spiritual significance can be used to define and assess our environment's cultural values. They link ecological structures and functions with a range of values and benefits.

Restoring ecosystems can help maintain water and air quality, and minimize flooding, erosion and damage to wildlife and aquatic habitats caused by surface mining. This intervention can bring about various positive social, environmental and economic benefits. According to Archer et al. (2018), decline and loss of biodiversity, and the reduction of nature's contributions to people in Africa, are having an increasing impact on daily lives and hampering the continent's socioeconomic development. Ninan (2014) asserts that a better understanding of the role of ecosystem services emphasizes our natural assets as critical ingredients to inclusive wealth, well-being and sustainability. Therefore, when ecosystem services are lost through land degradation, economies suffer and this compromises human well-being. This study represents a case in quantifying the cultural ecosystems approach to mining restoration, which is part of a larger attempt to both show and apply in practice the value of mine closure.

Despite many risks and challenges facing mining companies and the environment, pre-planned restoration can contribute to positive social and ecological outcomes following the closure of a mine's production phase. There is rising interest in these practices as a key step in the ESG mandates to which mining firms are increasingly committing in their project development. Communities are acutely aware of the risks and damages associated with mining projects and are therefore pressing for mitigation strategies, environmental clean-up and restoration commitments before any mining activity takes place. Environmental activists are equally gaining momentum in demanding sustainable actions that impact their communities and their livelihoods. Consequently, it is not difficult to also establish a direct relation between ecological restoration of quarries and higher ESG performance scores of mining companies.

METHODS AND DATA COLLECTION

In addition to the case study analysis and scan of global best practices in CES mine closure, we conducted a literature review and analysis of existing policy and legal and regulatory frameworks. Also, as the paper presents the study case of the Bamburi Haller Park in Kenya, more detailed information has been included about the quarry's historical background, its specific closure process and the interventions carried out for restoration of the coastal ecosystem at the site. Current details associated with CES are also included. These data represent current activities being held in Bamburi Haller Park. At Bamburi, stakeholders are routinely informed about operations and products, their feedback is solicited and candid dialogue encouraged. Interviews, content analysis and observations of activities at the study site as well as measurements of active quarries and rehabilitated ecosystems were conducted, while visitation and revenue records at site entrances were considered relevant information for the study. Both active and retrospective data on visitors and revenues were collected at entry points, from company computer servers and in financial records, where primary and secondary data were collected between 2014 and December 2018. Data collection was carried out drawing from several sources, including publicly available data on the legislation and regulatory framework applicable for mine closure in Kenya. Historical processes data of the former quarry were gathered from Bamburi, the company that used to operate the quarry. Finally, data on Bamburi's CES were extracted from Bamburi Haller Park's operational records.

An integrated approach was used, deploying both qualitative and quantitative data collection methods. A review of literature regarding Kenya's regulatory framework and applicable laws and regulations was conducted to establish gaps as part of the CES. Bamburi's management framework, national legislation and international regulations were considered for the gap analysis. The authors examined the applicable acts and policies, including national legislation, policies and guidelines, as well as company policies which regulate the mine closure, sustainable land use and CES. Bamburi managers and staff were interviewed in order to establish the management framework supporting the successful ecological restoration of the quarries. Teachers and students from visiting educational groups were also interviewed. Content analysis, field observations and measurements were used to collect data across the 566.2-hectare study area. Primary data were obtained through observations of land use activities and measurements in both active quarries and rehabilitated ecosystems. Retrospective data on visitors and revenue were collected from entry points, company computer servers and financial records. Literature on economic as well as historical developments of the ecosystem, including land use activities, were used to describe emergent CES. Monthly visitation data and revenues from education groups, ecotourism, site memberships and social events at the study area were collected at the South Quarry (Haller Park) and North Quarry (Forest Trails) entrances. Revenue data for local and international visitors were collected for the years 2014 to 2018. Records from books, journals, booklets, maps and past photos of before, during and after the restoration were analyzed to establish development trends. Information on moderating variables was collected from interviews and documents.

RESEARCH QUESTIONS

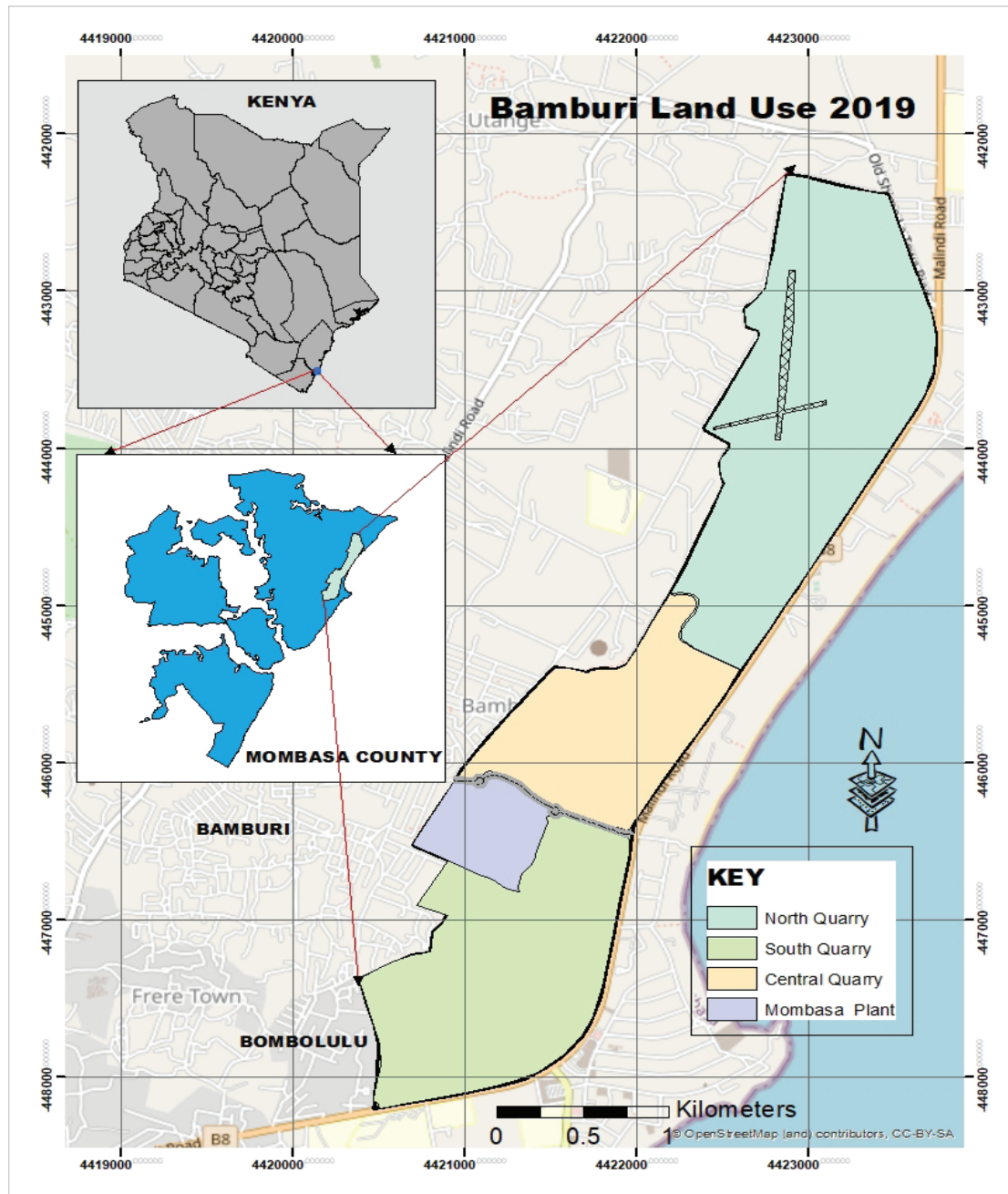
This study asks: What is the efficacy of CES in quarry ecosystems restoration, and what can be learned from the Bamburi case of mine closure that uses CES for economic development and environmental conservation?

We assess the specific CES offered in Bamburi. We argue that the Bamburi model improves industry best practices that are compliant with the policies and regulatory frameworks of the national government and consistent with the best practices of other cases of CES in the mining sector. Lessons from Bamburi Haller Park also provide future questions for policy innovation in mine closure. It is not just an identification of those lessons, but more importantly, how those experiences reimagine the interactions between public policy, regulatory frameworks and the voluntary and individual measures that private mining companies are applying under modern concepts of responsible mining and mine closure.

BAMBURI LIMESTONE QUARRY LOCATION

The case for the Bamburi operations in Kenya presents an opportunity to examine the underlying features of mining and environmental management. The study identified that Bamburi's environmental policy focuses on a number of environmental responsibilities, performance metrics and operations that commit to environmental management principles. The specific study was conducted at Bamburi quarries in Mombasa County, on the coast of Kenya (Figure 1), located at 4° 01'02" S 39° 42' 54" E. The study covered an area of about 566.2 hectares of various sections with varied activities, comprising ecologically rehabilitated limestone quarries which lie on the fossil coral reef on Kenya's coastline. The fossil coral reef provides limestone for cement production, while in adjacent areas, a few kilometres in size, there is a deposit of Jurassic sediments that provide shale (Haller and Baer 1994). The Bamburi area lies on coral reef material originally covered by a lowland dry forest and bushland.

Figure 1: Location of Study Area



(Source: Musando (2021)).

The operation began mining the site for production in 1954 and expanded over the years to an area of more than three km² of secondary bushland. The quarries were then abandoned as resources were exhausted. Coral limestone is the main raw material for Bamburi cement, comprising about 90 per cent of total raw material requirements and used as a source of calcium carbonate (CaCO₃) (Hadley 2004).

NATIONAL LEGISLATION OVERVIEW

Constitutional reforms in 2010 required the Kenyan government to enact legislation related to natural resource management to clarify the processes and procedures related to mine rehabilitation and restoration. As a major industrial project, the Bamburi Park ecological restoration model is a key national case study (Government of Kenya 2016). The *Environmental Management and Coordination Act* (EMCA) enforces mine restoration practices and regulates the conservation of biological diversity. It also requires companies to carry out environmental impact assessments (EIA) prior to mining in order to obtain a mining licence which stipulates rehabilitation of the mine site after completion of the mining process (Government of Kenya 2016). The EMCA further regulates protection of rivers, lakes, wetlands and ancestral rights. It also commits to conservation of biological diversity and biological resources *in situ* and *ex situ*, along with protection of environmentally significant areas and the coastal zone. It regulates the EIA licence, audit and monitoring processes, as well as environmental restoration orders. The National Environment Management Authority (NEMA) exercises general supervision and co-ordination over all matters relating to environmental policies. The 2016 mining legislation provides a comprehensive legal and fiscal policy framework. The *Mining Act* regulates ownership and control of minerals and mining in Kenya. The act regulates prospecting, mining, processing, refining, treatment, transport and any dealings in minerals. It also provides greater environmental protection from the negative impacts of mining activities, implying the mandatory restoration of the mined areas. The policy ensures that mining operations are conducted in a socially and environmentally responsible manner. The act provides for an environmental protection bond to ensure funds are set aside to rehabilitate quarries and mining areas after mine closure.

Other legislative tools complement the regulatory framework associated with mine closure. Among them are the *Wildlife Conservation and Management Act* of 2019, the *Water Act* (2016), the *Fisheries Management and Development Act* (2016), the *Forest Conservation and Management Act* (2016), the *Tourism Act* (2011) and the Integrated National Land Use Guideline (INLUG). In various ways, these include requirements for the quality of the living environment, economic and ecological development of community structures, the preservation of natural values and the built heritage and use of natural resources and communication networks.

A BRIEF HISTORY OF BAMBURI

About 240,000 years ago, the entire Bamburi area was submerged beneath the Indian Ocean (Haller and Baer 1995). The Bamburi Cement factory was constructed in 1951 and began production in 1954. Coral limestone became the key raw material for cement production. The limestone was excavated by drilling and blasting 30 cm to 50 cm above the groundwater. As a result of mining, the limestone combined with saline ground water subjected to high temperatures occasionally rising beyond 40 degrees Celsius due to scorching sun, which made it hard for plants and animals to flourish. The restoration process began as a rehabilitation initiative with physical landform design to make the quarry site safe and to support human activities and ecosystem functions. The environmental initiative to rehabilitate the Bamburi quarries and restore the coastal ecosystems began in 1971. The mine wasteland was landscaped to make sites safe and to support human activities and emergent habitats. Steep cliffs were sloped to achieve a 30-degree angle slope. Landform was redesigned to support grasslands, forests, wetlands and scrublands for indigenous coastal ecosystems. Ponds were dug to host aquatic organisms and support ecosystems. Aquatic plants were introduced in the ponds to serve as bio-filters for the water and as a food resource for other organisms. To date, the quarry ecosystem hosts over 582 species of indigenous trees, shrubs, grasses and lianas that support other organisms.

It is estimated that out of the total vegetation species recorded, over 200 were reintroduced by incoming birds, other animals and other forms of dispersal and natural succession into the former quarry. The vegetation species were reintroduced in the quarries to enhance and support natural ecological colonization and succession, which involved evolution of a plant community from pioneer plantation into a variety of species. These changes proved useful for development of the emergent quarry ecosystem. At each stage of the changes, soil, air and the physical environment were altered and allowed for survival of new plants and colonization of the site by various organisms. The site was opened to the public in 1985.

COMPANY POLICIES, REGULATIONS AND BEST PRACTICES

Over the years, many policies and regulations have been developed to protect and support Bamburi's ecological restoration initiative. Today, the company has mechanisms for compliance with applicable laws and regulations and the Code of Business Conduct as a minimum requirement. The company considers land control, surface rights and mineral rights, as well as local requirements for site biodiversity management and the development of rehabilitation and restoration plans for all the quarries.

The directives also provide for company rules and requirements, which emphasize compliance with legal requirements and the Code of Business Conduct and commit to understanding the site characteristics and identification of the extraction impacts. They emphasize proactive engagement with relevant stakeholders to identify risks and opportunities and establish a biodiversity management plan for sites of high biodiversity importance aligned and integrated with restoration plans. The main principle of company policy has been the delivery of ecological restoration actions based on rigorous mapping and science-based mitigation of human impact on the environment. This enhances a progressive transition towards a nature-positive future (Holcim 2022). Commitments are translated into targets and clear actions to drive performance within and beyond company operations. The company seeks to comply with local regulations in all operations and advocates for collective actions with relevant stakeholders. Financial provisions and allocation of resources are key factors in the implementation of rehabilitation plans. A review of quarry restoration and biodiversity management plans is conducted every two years or whenever there is strategic change, to align resource allocation for mine closure and ecosystems activities. Informed decisions are made for the restoration actions to improve the ecological status with greater potential for creating CES for local and international communities with positive social-economic impact.

The Bamburi's environmental policy (2018) commits the company to conducting business consistently with sustainable development principles. The policy has four pillars with assigned principles to guide progress. Pillar 1 guides the company's overall environmental responsibilities and performance. It ensures the company promotes its commitment through training and integration into the business process. It also assesses environmental due diligence in connection with acquisitions and divestments; translates commitment into actions by setting corporate objectives and targets; and monitors progress towards targets. It encourages the development and diffusion of environmentally friendly technologies, which includes using technologies and procedures that reduce the exposure of employees and community to environmental health and safety risks as well as conducting ESIA.

Pillar 2 ensures assessment and measurement of environmental impact, continuously improves processes, tools and capabilities and promotes best practices. It encourages analysis of impacts through the life cycle of cement products and solutions. The pillar guides quarry rehabilitation,

restoration and reclamation and ensures plans are in place for all quarry sites, taking into account the community's needs and expectations where feasible and relevant, fosters wildlife habitat creation and contributes to species conservation. The pillar significantly focuses on the implementation of biodiversity management plans (BMP) for all extraction sites, works to protect important areas and habitats and facilitates the conservation of any historic remains discovered during site development and quarry operations. Other critical components of this pillar are the release of pollutants, climate change and water.

Pillar 3 applies directly to the mining and process operations and focuses on the recovery and recycling of waste material in own production processes where feasible, minimization of generation of any hazardous waste and disposal of waste using safe and responsible methods.

Pillar 4 guides an open, honest work environment and promotes accountability to stakeholders. Through quarterly meetings, it informs stakeholders routinely about the cement company's operations, including rehabilitation and products, soliciting their feedback and encouraging constructive dialogue. This pillar promotes and allows for proactive co-operation with legislators, regulators and the community. Ecological restoration plans for all quarry sites are developed and implemented in collaboration with stakeholders and monitored and enforced under the local legislation. The plans consider the needs and expectations of stakeholders and, where relevant, foster wildlife habitat creation and species conservation. Clearly, this is a good example of a private-driven policy which, of course, is put in place to guide the mining company's operations but has important considerations for public policy implications.

RESTORATION RESULTS AND CULTURAL ECOSYSTEM SERVICES

The successful transformation of abandoned quarries into ecosystems through ecological restoration has enabled CES to emerge. Wildlife was integral in the restoration process and enhanced development of the biophysical environment that supports delivery of the ecosystems services. The wildlife in the emergent quarry ecosystems feed and rest in the semi-captive environment, which facilitates repopulation. For example, red-legged millipedes (*Epibolus pulchripes*) enhanced soil formation by feeding on casuarina leaves and dropping fecal matter that broke down into soil, a process that quickened soil formation. Flora and fauna in the rehabilitated limestone quarries began to attract local and international visitors who frequented the site for wildlife viewing, recreation, sports and social events. Students and staff from institutions of learning began to visit the emergent ecosystems to learn about mine closure and ecological restoration. These activities ignited diverse CES including sports, social events and recreational activities, which generate revenues through entrance fees and annual memberships to the sites. The study established that through ecological restoration, habitats re-emerged forming ecosystems that deliver and sustain CES. Table 1 shows other relevant land use activities including agricultural, residential, industrial and access roads.

Table 1. Habitats and Land Use Mapping in 2018.

Habitat type	Area (Ha)	Percentage (%)
Aquatic habitats: wetlands, ponds, lakes	15.81	2.79
Grasslands	44.35	7.83
Forests and woodland	204.35	36.09
Scrubland	70.49	12.45
Other Land Use	Area (Ha)	%
Agricultural	30.06	5.31
Residential	32.18	5.68
Industrial and access roads	169	29.85
TOTAL AREA	566.2 (Ha)	

Source: Bamburi Cement.

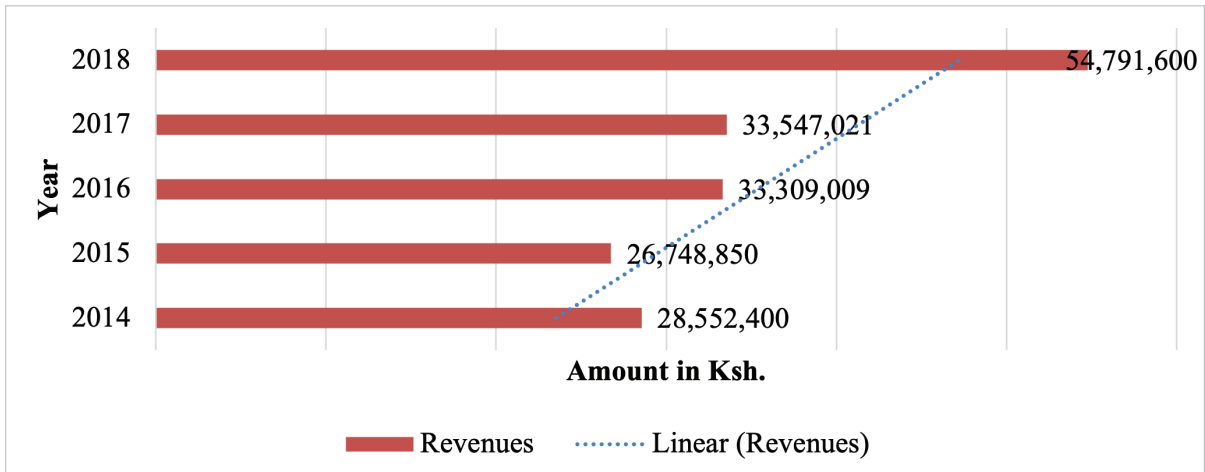
The study has shown that more than 59 per cent of land is under restored ecosystems that contribute to the delivery of CES. Residential areas, agriculture and industrial activities are all integrated with wildlife and human activities. Over 566.2 hectares are under various land uses, with 56.51 per cent of the quarry having been ecologically restored to support plant growth and diverse species of animals. About 7.8 per cent of the study site is grasslands and over 2.8 per cent is aquatic habitats. In both cases, special restoration techniques were applied to those habitat types.

Major CES delivered at the site were identified and categorized as follows:

- **Ecotourism:** The rehabilitated quarry ecosystem with its terrestrial and aquatic sceneries, with captive and semi-captive wildlife, plays a significant role in attracting visitors and generates revenue through entrance fees. It fosters awareness of the creation and sustainability of CES;
- **Environmental education:** Preschoolers, primary, secondary, tertiary and higher learners, as well as residents, seek learning experiences and attachment to the site. The site motivates people to learn more about their surroundings and take action to preserve or restore the environment. The site provides the public and governments with useful practical information for policy-makers, including government agencies;
- **Recreation, social events and sports:** Mombasa urbanites can get annual passes to the forest trails in the north quarry for exercise and relaxation. The site contributes to mental and physical health and well-being through sports, social events and recreational activities, which generate revenue;
- **Aesthetic appreciation and cultural inspiration:** The site is the largest and only rehabilitated quarry in Mombasa, a source of inspiration for both dwellers of the region and international visitors. Site enthusiasts, including artists, are intimately connected and influenced by the site. They engage in music performances, art, photography and film production; and
- **Spiritual experience and sense of place:** In many cultures, nature is closely connected to spirituality and traditional customs. The rehabilitated sites provide space and nature for spiritual experiences and reflections.

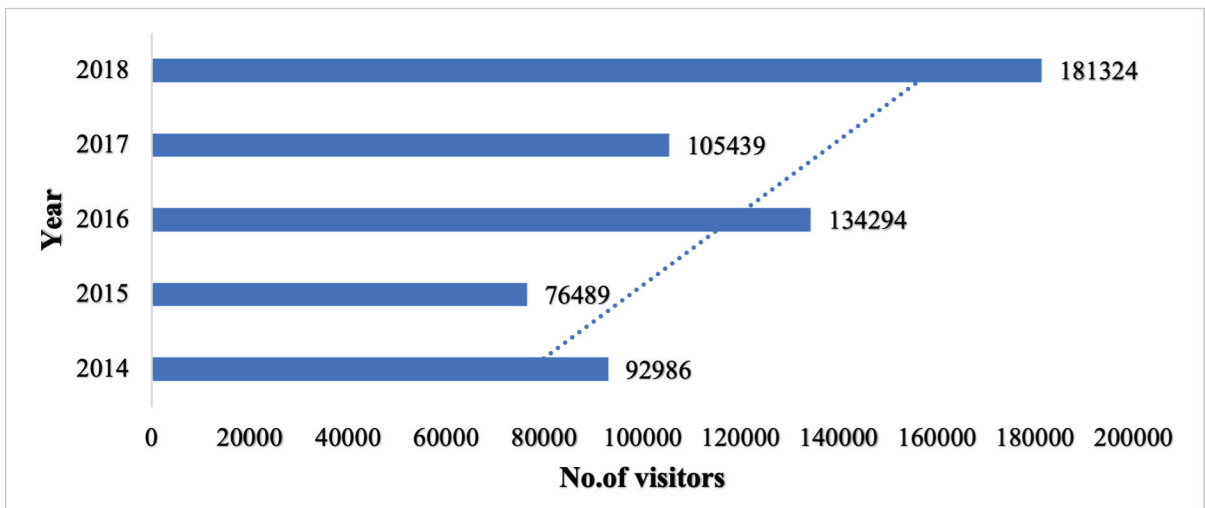
Figure 2 presents a summary of revenues generated from Bamburi CES from 2014 to 2018. The site generated revenues from local and international tourists, who visited the ecosystems to view the animals and rehabilitated landscapes and who engaged in activities including conservation education, recreation, social events and pastimes.

Figure 2: Revenues from CES



There is a clear trend to the increase of revenue as time passes, which, of course, is directly related to the increased number of visitors every year. Figure 3 shows numbers of visits with an upward trend from 92,986 visitors in 2014 to 181,324 visitors in 2018.

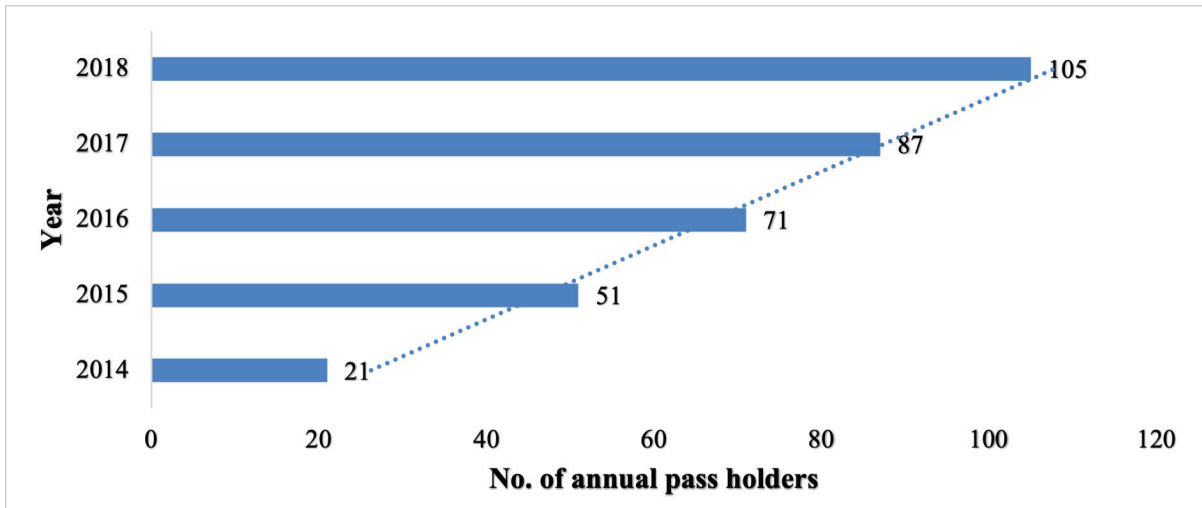
Figure 3: Analysis of Visitation from 2014 to 2018



The sites attracted over 181,000 visitors in 2018, with an average annual revenue of US\$330,745 (KSh. 35,389,776) from CES. The Bamburi rehabilitated site today offers opportunities for recreation, mental and physical health. Examples include walking and playing sports in recreation areas and green spaces. The forest trails facility at the study site provides jogging trails and grounds for sports, picnic sites, physical outdoor exercise apparatus and shelters for social events like weddings and birthday parties. The facilities attracts site users and annual pass holders who

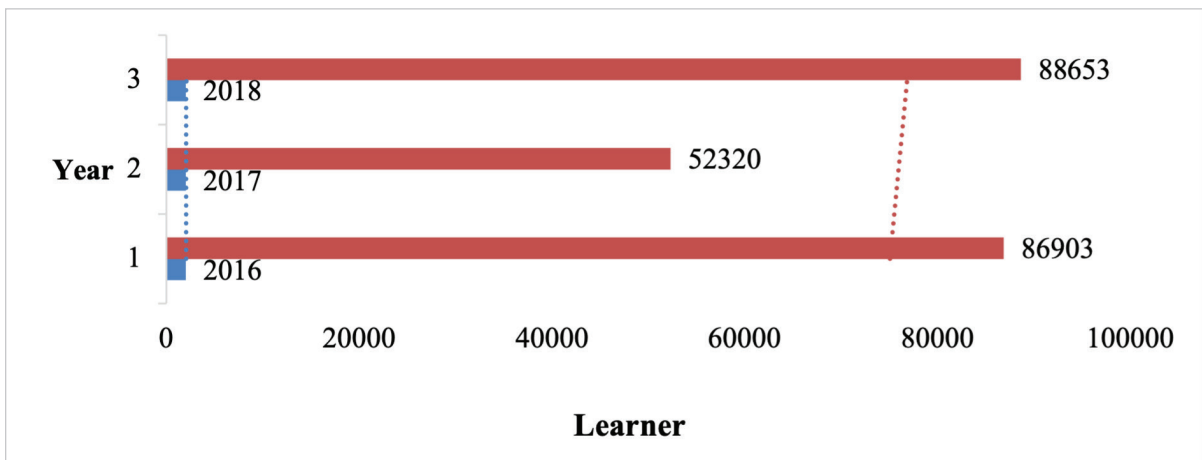
engaged in sports, recreation events and parties. Figure 4 shows the numbers of annual pass holders who accessed recreation and social activities from 2014 to 2018 at the site.

Figure 4: Annual Pass Holders From 2014 to 2018



The study shows that the number of pass holders rose from 21 in 2014 to 105 members in 2018. Annual pass holders pay for membership to use the site facilities for recreational activities including cycling, jogging and picnicking, which generates revenue. The study established that education is one of the key CES at the site, arising from the restoration of the limestone quarries. Figure 5 presents an analysis of educational visits to the study site. The analysis shows learners who visited the site from 2016 to 2018.

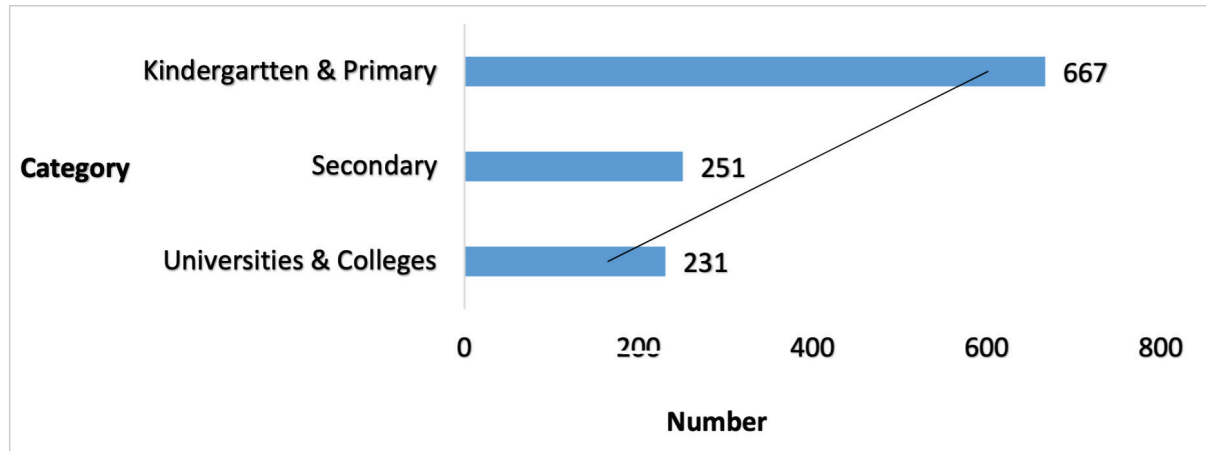
Figure 5: Analysis of Educational Visits: Learners Who Visited the Study Area From 2016 to 2018



From the education visit analysis (Figure 5), the site hosted students and teachers from kindergarten to university. Educational group visits showed an upward trend of 86,903 in 2016 and 88,653 in 2017, which shows consistent engagement in conservation education and learning and suggests significant appreciation of the features and experience through non-material

benefits including spiritual enrichment, intellectual development and aesthetic values. Figure 6 below presents the results of an analysis of educational group visits at the site. Kindergarten had the highest number of institutions at 667 groups followed by 251 secondary schools and 231 colleges and universities.

Figure 6: Education Group Visits in 2017



In 2017, education group visits included university groups, secondary schools and kindergartens, which indicates multi-age demand for the cultural ecosystem service. The study established that the rehabilitated quarry ecosystem is the largest forested man-made park in the region, with 180,000 visitors in a year. The study established that several factors including biophysical interactions, company policy and management decisions, as well as the legal framework and regulations, are vital in the sustainability of CES. In 2018, the study site received 181,324 visitors and generated over US\$500,000 from ecotourism.

DISCUSSION: OUTCOMES FROM BAMBURI'S ECOLOGICAL RESTORATION

In this paper, we argued that CES is a valuable practice following the closure and restoration of a mine. Any ecosystem's ability to deliver sustainable cultural services depends on sound legislation and regulation on mine closure practices, commitment of mining companies to develop private policies and investment of resources into ecological restoration. The progressive re-creation of the local indigenous ecosystem in the former limestone quarry created environmental integrity, key in propagating and anchoring sustainable CES. Service sustainability largely depends on ecosystem structure and committed resources to get CES off the ground by putting in place the infrastructure to deliver the services and activities to visitors. Local and international visitors to the emergent rehabilitated ecosystems generated revenues that contribute to the maintenance of the ecosystem facilities, including animal health and customer service and the safety and sustainability of the site, where animal viewing is a major pastime attracting local and international tourists. Income earned from ecotourism contributed to the management and development of local ecosystems and thus impacted the ability to generate more goods and services. Similar studies conducted by Costanza et al. (2014) elucidate that US\$7.1 trillion is generated globally by tourism. In Kenya, tourism is the second largest source of foreign exchange revenue after agriculture. According to the Kenya National Wildlife Strategy 2018-2030, in 2017, 1.4 million people visited Kenya and generated revenue of 120 billion shillings from the industry,

which is 9.8 per cent of the country's GDP (Ministry of Tourism and Wildlife 2018). Pressure from visits by groups who engaged in conservation education and learning create demand for delivery of ecosystems services. Revenues generated are used for the development of facilities and the ecosystems.

According to the Millennium Ecosystem Assessment (2001-2005), human well-being and progress towards sustainable development are vitally dependent upon Earth's ecosystems. Assessing ecosystems services is critical for measuring the links between ecosystems and human well-being for national planning. Ecosystems accounting can help address Sustainable Development Goal (SDG) 15, in which countries have agreed to integrate ecosystem values into national planning (Bordt et.al. 2018). Goal 15 of the SDG calls for protection, restoration and promotion of the sustainable use of terrestrial ecosystems, sustainable management of forests, combating of desertification and halting and reversing land degradation as well as biodiversity loss (Osborn et al. 2015).

The ways in which human activities affect ecosystems will affect the supply of CES. Changes in availability of ecosystems services can profoundly affect well-being, ranging from the rate of economic growth and health and livelihood security to prevalence and persistence of poverty. At the same time, humans are altering the capability of ecosystems to provide adequate services. Management of this relationship is required to enhance the contribution of ecosystems to human well-being without affecting their long-term capacity to provide services (Millennium Ecosystem Assessment 2014). The state of ecosystems and the health and well-being of people who depend on them are fundamentally linked (McFarlane et al. 2019). Global loss of ecosystem services due to land use change is estimated at US\$4.3 to \$20.2 trillion per year (Costanza et al. 2014). The world with its land masses, oceans and shared atmosphere, is an ecosphere, the largest ecosystem per se. Ecosystem processes are complex, dynamic, with no clear boundaries, and take place all the time everywhere. That is why valuing ecological services in environmental economics is such a difficult challenge. Africa's current population of 1.25 billion is likely to double by 2050, putting severe pressure on the continent's biodiversity and nature's contributions to people (Archer et al. 2018). This concern calls for implementation of enhanced mine closure policies and strategies that promote quarry treatment, support ecosystems recovery and prevent loss of biodiversity, including protection of economically significant nearby marine and coastal areas. Analysis of revenues from ecotourism, educational visits and recreation, as well as events, demonstrates that ecology and economy work hand in hand.

In Africa, nature carries significant cultural and religious significance. In coastal Kenya, traditional communities have a clear sense of place and purpose for the spiritual value of the forests, including Bamburi. Other communities in Kenya, including Kikuyu and Meru in central Kenya, as well as Maasai and Kalenjin, have maintained a sense of enrichment and empowerment from indigenous forests. The ecological restoration project created habitats and enhanced biodiversity conservation and the environment's ability to support evolving human needs. The restoration created net positive change and impact to the site, contributing to its resilience in delivery of ecosystem services. These findings agree with Umami (2017), who, found out that quarrying and biodiversity are compatible through correct resource management before, during and after extraction, leading to ecosystems services. Human impact presents the biggest threat to the environment's ability to create CES, but has greater opportunity, influence and responsibility over sustainability of ecosystem services. It is therefore important for mining companies to consider CES in their policy commitments. It is equally important for governments to consider CES when establishing a regulatory framework of mines and environmental management.

Based on the results of this study and analysis, Bamburi's policies and the current regulatory framework are well aligned with national environmental and development policies, as well as with international standards.

This study demonstrates that Bamburi could be a model for the development of new policies or instruments to improve mining company policies and regulatory frameworks across the globe for ecosystems services. It is also important to recognize that ecological restoration and CES depend on the availability of natural flora and fauna in the quarry's surroundings. In this sense, any adjacent locations targeted for restoration that are not under the mining company's control require major governmental participation. In this way, ecological restoration is inherently a multi-stakeholder process. Besides implementing an appropriate regulatory framework for mine closure, the government must maintain a policy of conservation of natural resources in its jurisdiction. This will substantially help all efforts for an appropriate mine closure and ecological restoration process.

CONCLUSIONS AND POLICY CONSIDERATIONS

The authors present Bamburi's rehabilitated quarry as a unique model and showcase for sustainable mine closure and environmental responsibility, which began as an environmental initiative leading to the delivery of sustainable ecosystem services. The restoration initiative has been sustained by enabling policies and guidelines, plus a legal and regulatory framework supporting sustainable mine closure and land use. Policies and interventions implemented by the mining company demonstrate that mining and ecosystems services are compatible and can be sustained through the development or alignment of legislation and policy frameworks backed by suitable mechanisms to achieve mutually beneficial goals. Compatibility depends on suitable full-cycle legislation and regulations, supported by environmentally friendly company policies, management initiatives and interventions. The site regulatory landscape for mine closure supports the realization of a complete mine life cycle. The company's progressive and transformative ecological restoration presents opportunities for social engagement through CES, thus expanding the social arena. Government legislation and community engagement on the social aspects of mine closure are key to addressing the costs and benefits associated with closure and present post-mining opportunities for sustainable CES. This study conforms to findings by Wittmer et al. (2018) who conducted studies in Africa for TEEB and drew attention to the global economic benefits of biodiversity, highlighting the importance of ecosystems services.

Finally, we recognize that people's current and future consumption patterns, coupled with demographic changes, continue to alter the environment significantly. We therefore emphasize the development of suitable policies in the extractive industries that promote mine closure supportive of ecosystem restoration to minimize the negative impact on the environment and deliver sustainable ecosystem services. We also assert that although mining caused massive degradation to the environment, it presented an opportunity for repurposing the site to address the needs of local communities. The Bamburi site is the largest man-made forest and nature conservation-based recreational facility in Kenya's coastal region. It can be a model to follow when considering the implementation of sustainable policies at both public and private levels.

The following considerations are made for filling gaps identified in the regulatory framework:

1. Companies should proactively co-operate with legislators, regulators and communities to ensure that CES considerations align with a wider strategic sustainability model. Put differently, the government can work with industry to learn more to include these kinds of closure practices in legislative and regulatory processes. The industry can gain better

perspectives from government, especially when considering public administration of the territory; thus an interchange of knowledge and experience can lead to balanced policies and regulations on both sides.

2. Mining companies in general are encouraged to learn from Bamburi's model about the integration of environmental initiatives and interventions. Beyond simply seeking to improve its ESG ratings or access business opportunities, the concept of CES brings direct benefits when the company can demonstrate the link between mine closure and restoration best practices and tangible positive impacts on local communities.
3. Government must encourage mining firms to exchange knowledge based on successful mining closure experiences and engage in voluntary constructive international environmental initiatives aligned to sustainable development principles and policies. At the same time, governments could provide companies with the appropriate regulatory framework to implement those best practices in mine closure and delivery of CES.
4. Clearer regulatory oversight from the government is required to encourage best practices in environmental management, supported by legislation and regulatory frameworks in the extractive industry. Government can support a commitment to the science of restoration, sustainable land use and the delivery of CES. Government can use this successful case as an industry best practice for improving legislation and regulation regarding mining closure across the country. Government can also implement language signalling that CES are part of best practices in mine closure.

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About the Authors

Albert Akondo Musando is an Environmental Scientist, an ecological restoration specialist with expertise in quarry rehabilitation and restoration, biodiversity conservation, environmental education, ecosystem services and sustainability. He is currently the Restoration, Education & Ecosystems Manager for Lafarge Eco Systems – Bamburi Cement PLC, where he rehabilitates quarries in Kenya transforming them into ecosystems for biodiversity conservation and sustainable land utilization. Currently he is working on limestone, shale and pozolana quarries spread in five Counties across Kenya. He is a trainer and speaker in many local and International forums on matters of mine closure, Ecological restoration, biodiversity conservation, environmental management and Sustainability.

Albert is a member of Environmental Natural Resources Management (ENRM) Industry Advisory Board of the Africa Nazarene University (ANU) School of Science and Technology, a National Steering Committee member of Integrated Coastal Zone Management (ICZM) of Kenya, a member of the Mombasa Smart and Sustainable City Forum (MSCF), an Environmental Management Systems (EMS) Committee member as well as Stakeholder Relations Committee member of Bamburi Cement Company.

Albert has a Bachelor's degree in Education (B.Ed) – Geography Major; Master's Degree (MSc.) in Environmental Science; Certificate in Monitoring and Assessment of Biodiversity (SI/MAB) from the Smithsonian Conservation Biology Institute in the USA. He has National Diploma in Tourism Management; Certificate on Africa Sustainability Leadership from Strathmore University (Kenya) in association with Cambridge University (SA). He has an Advanced International Certificate in Integrated Sustainable Coastal Development (ISCD) from the University of Gothenburg – Sweden.

Freddy Cáceres (Bsc. Biological Sciences, Bachelor of Applied Technology in GIS, a MSc Energy and Environment, a Master's in Safety and Work Risk Prevention, a Certificate in Integrated Management: Quality, Environment and Social Responsibility; and an Engineering degree in Environmental Management) is a biologist and professional engineer with over 25 years of experience working on environmental and social sustainability through the integration of environmental sciences, social responsibility, health & safety and cultural aspects in project and business management systems. He has been the founder and CEO of an environmental consulting firm and has 15 years of experience in ESIA's for energy, mining, infrastructure, water supply, sanitation, agriculture, urban and rural development, education and health sectors, including environmental impact assessment, management plans, OH&S, emergency preparedness, hazardous waste, and environmental monitoring and audit. He has relevant experience in Canada, Ecuador and other countries in both Latin America and Africa. He has extensive work experience with the World Bank Environmental and Social Framework, particularly with Environmental and Social standards, based on the IFC ES Performance Standards.

Currently, Freddy Cáceres works as the Manager of the Extractive Resource Governance Program, an operational unit of the University of Calgary's School of Public Policy, where he is in charge of the Program's operations, with its four lines of work: research, executive training, technical advisory and global projects.

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