A Comparison of Vegetation Composition within and Surrounding Gravel Borrow Pit Sites around Gaborone, Botswana

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***Abstract* —** This study was carried out to establish differences in the composition of vegetation within borrow pits and their surrounding undisturbed land. Three borrow pits in Bokaa; Mmokolodi; and Tlokweng; were studied. Vegetation was randomly sampled using a 10m by 10m quadrat both within and around the pits to a distance of 30m from the edge of the pits. Plant samples were collected for identification at the Botswana College of Agriculture (BCA) Herbarium and the Botswana National Botanical Garden. It was found that 40% of non-woody species were common both within and around the pits, while the majority, (60%) was found only within the pits. The species that existed only within the pits were pioneer species there to begin a process of ecological succession. The majority of woody species around the pits were not found within. However, some *Acacia* species established within the pits even though they were non-existent around them. It was concluded that the woody species around the pits were either not providing sufficient seed bank or they require certain conditions for them to successfully establish in the disturbed land. Therefore, active re-vegetation of these sites with native vegetation could help restore and assimilate them back to their natural condition within a shorter period than natural succession would achieve.

***Keywords*—**natural succession, borrow pits, rehabilitation, re-vegetation

I. Introduction

DISTURBANCE in natural communities is a term used to describe an event that results in degradation of soils and vegetation [1] It has been due to escalation in infrastructure developments in the country as a result economic prosperity as well as population growth ever since independence in 1966 and especially after the 1970's. Quarrying for gravel to be used for construction of roads and other infrastructure has over time resulted in disturbance of large chunks of land, leaving numerous borrow pits mainly along the roads. Before 1999, when legislation was passed to prescribe rehabilitation of disturbed land, these borrow pits were abandoned. This caused the pit to remain in a state of arrested successional stages [2], [3] (Fig. I). The legislation now forces quarry operators to at least re-contour the land and apply topsoil to reduce visual blight as well as encourage vegetation establishment through natural succession. Quarrying companies have also been in the forefront in terms of self-policing to ensure that their extraction processes do not overly degrade the environment [4].

Natural succession is a process by which a plant communities successively give way to others until climax is reached. It takes place because the environmental conditions of the disturbed land change over time. Each species is adapted to thrive and compete best against other species under a very specific set of environmental conditions. In the process of succession, as conditions change, species will gradually change and be replaced by a new set of species which are better adapted to the new conditions. The plant species that grow on disturbed land are due to seed bank from adjacent forests [2], [5] top soil with seeds and seeds brought in by vehicles and people working at the site. As a result, there is usual a high diversity of plant species in disturbed land compared to the immediate surrounding landscape [6]. However, studies have also shown that with time plant diversity will decrease considerably, leaving only species that persist and are well adapted to site [7]. This study sought to compare plant species within and around decommissioned gravel borrow pits at three site around the capital city Gaborone.

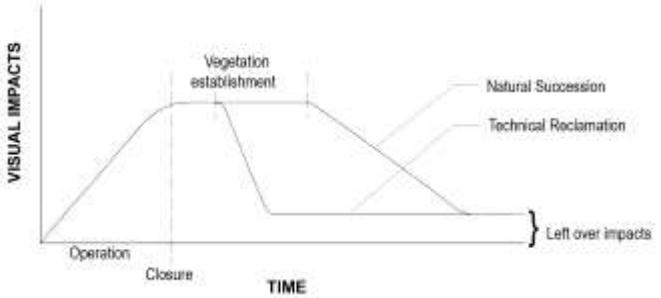

Fig. 1: Illustration of the extent of visual impact over time in mineral extraction [4]

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II. Methodology

The study was conducted at three borrow pits in Bokaa, Mmokolodi and Tlokweng villages, all around the City of Gaborone, Botswana. Information on the physical location of the borrow pits was sourced from the Department of Mines, Ministry of Mineral, Energy and Water Resource, the Government of Botswana, which provided the coordinates of the site boundaries. An intercept quadrant sampling method was used to sample plant species within and outside the borrow pits. Within each borrow pit site, four areas, each 10m by 10m were randomly selected outside the pits. Eight areas of 10m by 10m were also randomly selected. The areas for data collection around borrow pits were determined by measuring 30m away from the boundaries of each borrow pit on all sides of the pits. Plant species were recorded and voucher specimens collected within the sample areas for identification at the BCA herbarium and the Botswana National Botanical Garden.

III. Results And Discussions

The results showed that there was a variation in the type of species found within the borrow pits and those found around them (Tables I and II). It was found that 40% of non-woody species were common both within and around the pits, while the majority, (60%) were found only within the pits. The majority of woody species around the pits were not found within the pits. On the other hand, some *Acacia* species established within the pits even though they were non-existent around them, (Table III). The plant species found within the pits but not around them could be pioneer species taking advantage of the different microclimatic conditions that exist within the pits. The variation in the ground surface within the pits allows some areas to be wet while others are dry due to different exposures to sunlight and shade [8]. This provides an opportunity for a number of different plant species to establish naturally in the different portions of the pits [9], [10]. It is also common for plant species with long-range seed dispersal mechanisms to be found on disturbed sites and some thrive under such conditions [7]. As pioneer species, some of these plants are able to adapt and become productive on disturbed soils. Some of the species found within the pits but not around them could have been brought in by people and/or vehicles during the operation of the quarries. With time, as the processes of species colonization, spreading and replacement [11] occur and as soils improve, it is expected that species composition will be more reflective of that within the context of the pits.

Table I
Total Number Different Woody Plants Species

Borrow pit	Plants within pit	Plants common within and around pit
Bokaa	5	6
Mmokolodi	4	3
Tlokweng	4	4

Table II
Total Number Of Different Non-Woody Plants Species

Borrow pit	Plants within pit	Plants common within and around pit
Bokaa	17	12
Mmokolodi	15	10
Tlokweng	11	7

Table III
Plant Species Found Within But Not Around Gravel Pit At Bokaa, Mmokolodi And Tlokweng

NONE WOODY PLANT SPECIES		WOODY PLANT SPECIES	
Botanical name	Common name	Botanical name	Common name
Kohautia subverticillata	Rubiaceae	*Acacia tortilis*	Fabaceae
Urochloa mosambicensis	Poaceae	*Acacia mellifera*	Fabaceae
Decoma tomentosa	Asteraceae	*Acacia negrescens*	Fabaceae
Hermbst aedtia fleckii	Amaranthaceae	*Acacia gerradii*	Fabaceae
Hypertelis bowkeriana	Aizoaceae	*Acacia erubenscens*	Fabaceae
Acrotome hispida	Lamiaceae		
Sida cordifolia	Malvaceae		
Sesbania bispinosa	Fabaceae		
Melinis repens	Poaceae		
Guilleminea densa	Amaranthaceae		
Echinochloa bolubii	Poaceae		

IV. Conclusion

It was concluded that the woody species around the pits were either not providing sufficient seed bank or they require certain conditions for them to successfully establish and be productive in the pits. Therefore, active re-vegetation of these sites with native vegetation could help restore and assimilate them back to their natural condition within a shorter period than natural succession would achieve. This would require establishment of appropriate soil cover and re-contouring the site to or close to its original contour.

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