THE DISTRIBUTION AND DIVERSITY OF HEDGE SPECIES IN WARDS WITHIN MAUN VILLAGE, BOTSWANA

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ABSTRACT

Researchers and policymakers are increasingly acknowledging the role of hedges in delivering ecosystem services. However, much of the existing knowledge is based on studies carried out in urban areas, with relatively little information gathered from rural or village settings. A village presents a unique set of circumstances that justify a study on hedge species. The study investigated the distribution of hedge plant species within seven (7) wards in the village of Maun using walk-by surveys of all publicly accessible roads in each ward. A total of ten (10) hedge species were recorded across the seven wards. Sedie exhibited the greatest species richness and Moeti ward the least. Kgosing recorded the highest density of hedge species (H') followed by Tsanakona, Sedie and Boseja. Riverside and Moeti recorded the lowest. Similarly, Kgosing and Tsanakona were among the wards with the highest evenness. In contrast, Sedie and Boseja recorded the lowest evenness. Of the total number of hedge species recorded nine (90 %) are internationally classified as invasive alien plants. The total mean densities of hedge plant species across the seven (7) wards were twenty-eight (28) individuals km^{-1}. Sedie recorded the greatest density and Moeti the least. *Bougainvillea spectabilis* Willd. was the dominant species in four (Sedie, Kgosing, Riverside and Tsanakona) of the seven (7) wards. *Melia azedarach* L. and *Duranta erecta* L. were limited to one ward at low densities in Kgosing and New Disaneng ward, respectively. *Dodonaea viscosa* (L.) Jacq, *B. spectabilis* and *Euphorbia tirucalli* L. were the only species observed across the seven wards. This study demonstrated that almost all the hedge species are invasive alien plants and are not uniformly distributed between the wards, highlighting the need for public awareness and management campaigns.

Keywords: invasive alien species, biodiversity, ecosystem service, road survey, community

INTRODUCTION

A hedge is a row of closely spaced shrubs or trees that are strategically managed (pruned or trimmed) to increase branch density and form a semi-permeable barrier of stems and leaves along the edge of a household fence (Blanusa *et al.,* 2019). It usually consists of a dominant woody species alongside other plants and therefore has lower species richness and diversity

(Dover, 2019). Hedges are a component of green infrastructure that provides a suite of ecosystem services such as biodiversity conservation, live fence, habitat for insects and birds, wind-breaking, temperature regulation, carbon sequestration, air and noise pollution mitigation (Blanusa *et al.,* 2019; Abhijith *et al.,* 2019; Staley *et al*., 2023; Kratschmer *et al*., 2024; Lourdais *et al*., 2025).

In the past, hedges were used in agriculture to separate agricultural fields and to mark the boundaries of grazing pastures. For example, hedgerows were utilised as live fences in Europe before the 1970s to demarcate property boundaries and keep grazing cattle apart from crops and woods (Krastchmer *et al.,* 2024). Furthermore, hedgerows, a prominent element in these agricultural landscapes, provided a range of ecosystem services, including soil health, wind protection, and raw materials (Höpfl *et al.,* 2021). They were also primarily used to enclose agricultural area, but they were also often managed to offer ecosystem services like wood for crafts and fuel, as well as natural edibles like wild fruits (Ferrante et al., 2024).

In many agro-ecosystems, hedges are essential for maintaining biodiversity (Lecq *et al.,* 2017). They play a vital role in mitigating surface and air temperatures (Cameron *et al.,* 2014; Blanusa *et al.,* 2019), reducing the risk of air pollution (Ghafari *et al*., 2020), sequestering carbon (Gosling *et al.,* 2016), conserving biodiversity (Lukash *et al.,* 2023), and providing shelter, breeding sites, and pasture for wildlife (Wolton *et al.,* 2013). Additionally, hedges provide a variety of functional purposes and add aesthetic appeal to both rural and urban settings by adding aspects like colours, fragrances, and patterns. According to Gosling *et al*. (2016), they serve as noise barriers, offer seclusion, and reduce air pollution in metropolitan settings. According to Blanusa *et al*. (2019), hedges also contribute to green infrastructure, which offers significant ecological services like biodiversity provision, pollution mitigation, and microclimate change. Carefully planned hedges may enhance the beauty and aesthetic value of any environment, whether it is in an urban garden or a rural one. They are a useful addition to both public and private places because of their adaptability in both design and function.

Despite the environmental services that hedges offer, they can also have detrimental effects on the ecosystem and people, which are known as ecosystem disservices. Since some hedge species are invasive alien plants (Kashe *et al*., 2024), they possess trails that promote rapid growth, deep root systems, high seed production, or efficient vegetative spread. As a result, these hedges have the potential to outcompete native vegetation, decrease biodiversity, modify soil physicochemical properties, and disturb local ecosystems once they are established outside of their natural range. Furthermore, certain hedge species may produce poisons or allergens that could endanger both human and wildlife health (Paoletti, 2009).

The composition and diversity of hedge species are shaped by factors such as climate, soil characteristics, land use practices, and the surrounding landscape (Vanneste *et al*., 2020). In temperate areas, hedge species are typically made up of native woody plants like *Crataegus monogyna* Jacq., *Corylus avellana* L., and *Prunus spinosa* L. (Baudry *et al*., 2000). In contrast, tropical and subtropical regions commonly use species like *Gliricidia sepium* (Jacq.) Walp., *Erythrina* species, and *Leucaena leucocephala* (Lam.) de Wit (Harvey *et al*., 2005), which are favoured not only for their hedging function but also for the additional ecosystem services they provide, including fodder, firewood, and soil protection. Therefore, in many developing countries, the choice of hedge species is more often driven by the practical benefits they offer rather than purely ecological concerns.

Across Africa, typical hedge plants vary by region. In East and Southern Africa, native species such as *Euphorbia tirucalli*, *Commiphora africana* (A. Rich.) Engl. and *Ziziphus mucronata* Willd. are common, while *Gliricidia sepium*, *Erythrina abyssinica* Lam. ex DC.

and *Sesbania sesban* (L.) Merr. are prevalent in more humid zones. In drier savanna and Sahelian areas, *Ficus* species and *Azadirachta indica* A. Juss. are frequently used (Muthuri *et al*., 2023). These species are often selected because of their fast growth, resilience to drought, ease of propagation, and the array of ecosystem services they offer, including uses in traditional medicine, fodder and timber production (Temesgen & Wu, 2018). Additionally, cultural and traditional values influence species selection. For example, *Croton macrostachyus* Hochst. Ex Delile holds cultural importance in Ethiopia, while *Jatropha curcas* is widely planted in West Africa for biofuel production (FAO, 2010).

Research conducted in Botswana and South Africa has also documented the use of invasive woody alien species as hedges (Henderson, 2001; Mabusela *et al*., 2021; Kashe *et al*., 2024). Commonly reported invasive hedge species include *Cryptostegia grandiflora* Robx ex R.Br., *Cascabela thevetia* (L.) H. Lippoid), *Leucaena leucocephala*, *Melia azedarach*, *Bougainvillea spectabilis*, *Duranta erecta*, *Dodonaea viscosa*, *Lantana camara* L., and *Casuarina equisetifolia* L.

Despite this, empirical studies on composition and diversity of hedge species are limited. There is a need for systematic inventories of hedge species, especially in a village setting. Understanding the composition and diversity of hedge species. It is essential to comprehend the diversity and composition of hedge species in order to preserve the integrity of the ecosystem and to sustain rural livelihoods. Site-specific and comparative studies can help us understand hedges better and develop better conservation measures. In this regard, we assessed the distribution and diversity of hedge species in wards within Maun village. The following research questions were addressed: (i) What is the abundance and distribution of hedge plants across the different wards in the village of Maun? (ii) What is the species richness, diversity, and evenness of hedge plants in the different wards of Maun village?

METHODOLOGY

Study area

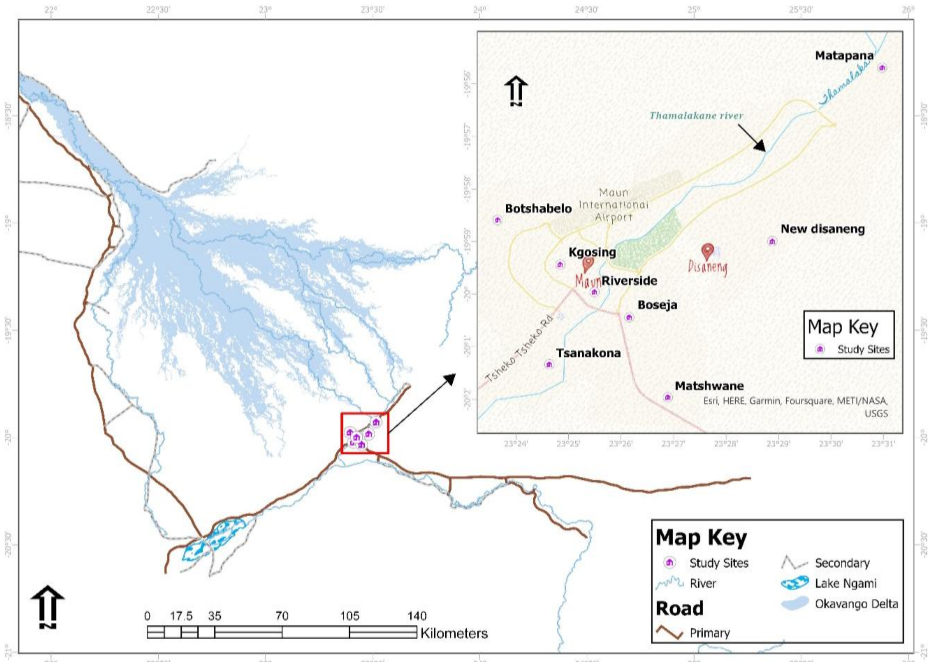
The study was conducted in seven wards within Maun village. It is the second largest village in Botswana (Statistics Botswana, 2022) situated in North West of Botswana (Fig. 1). This village has a population of about 85, 293 hence being the capital as well as the largest settlement of Ngamiland district (Statistics Botswana, 2022) and has become a regional service center over the years. Currently facing rapid urbanization, Maun village has a diversified and sophisticated economy with high development potential (Kashe *et al*., 2021). The physical environment is characterized by semi-arid conditions with average rainfall of 500 mm per annum. There is a long dry season from April to October, with a cool period from May to August, and a rainy season from November to March. The average temperature in Maun is 17.5 °C in the coolest month of July and 28.3 °C in the hottest month of October. The village is endowed with a diversity of vegetation and wildlife hence it is considered as the epicenter of safari and game industry for Botswana. The livelihoods activities in the village include farming, fishing, and gathering of veld products such as indigenous fruits (Tsheboeng *et al*., 2020).

The vegetation in Maun changes as one moves from the riparian zone (Tsheboeng *et al.,* 2020; Kashe *et al.,* 2021) to dry mixed woodlands in the upland (Kashe *et al.,* 2023). *Croton megalobotrys* Müll. Arg, *Philenoptera violacea* (Klotzsch) Schrire and *Garcinia livingstonei* T. Anderson characterise the riparian zone (Tsheboeng *et al.,* 2020; Kashe *et al.,* 2021). Dry mixed woodlands are dominated by *Colophospermum mopane* (Benth.) J. Lénard. *Terminalia sericea* Burch. Ex DC., *Philenoptera nelsii* (Schinz) Schrire, *Terminalia prunioides* M.A. Lawson and *Combretum* species (Kashe *et al.,* 2023). The mopane woodlands in Botswana cover 85,000 km^2. i.e. 15 % of the entire land mass of the country and 15.3 % of the overall area (550,000 km^2) covered by mopane woodlands in southern Africa (Makhado *et al*., 2014; Macôo *et al*., 2025). *Senegalia mellifera* (Vahl) Seigel & Ebinger, *Dichrostachys cinerea* (L.) Wight & Arn, *Vachellia tortilis* (Forssk.) Gallaso & Banfi and *Vachellia erioloba* (E. Mey.) P.J.H. Hurter all encroach on overgrazed communal rangelands (Teketay *et al.,* 2018; Tsheboeng *et al.,* 2024).

Study wards

The study was conducted in seven wards in the village of Maun, namely, Sedie, Moeti, Kgosing, Riverside, Boseja, Tsanakona, and New Disaneng (Fig. 1). In Botswana, a ward is defined as "group of households living together and forming a distinct social and political unit under the leadership and authority of a headman" (Schapera, 2019).

Fig. 1: Map of the study area

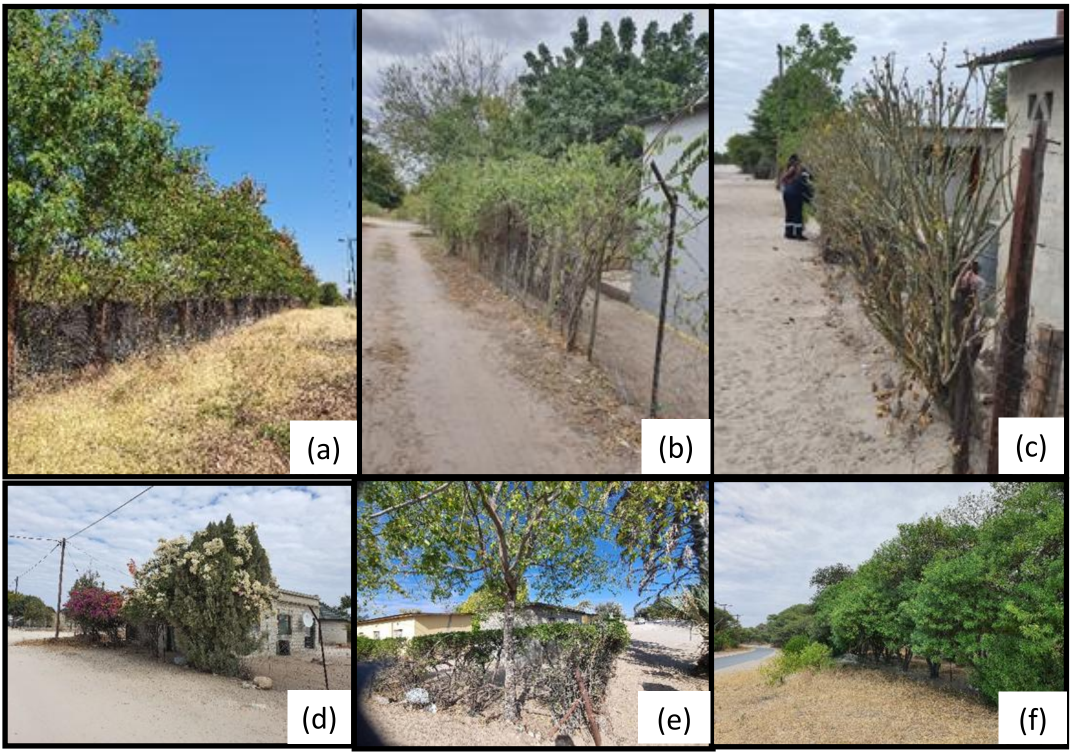


The wards were chosen at random from a pool of sixteen wards using Microsoft Excel. The wards have varying degrees of institutional development and are situated in various ecosystems. Tsanakona ward is located in a riparian zone, where the households are well-shaded by the canopy cover of riparian trees. Due to the high aesthetic value and high cost of riverfront properties, the ward is home to middle-class and wealthy residents. The oldest wards, Riverside and Kgosing, feature well-developed institutional infrastructure. The government administration centre, hotels, and core business district are all located in Kgosing ward. Riverside ward is in a riparian area and houses commercial and lodging facilities. Boseja ward is distinguished by its well-developed infrastructure and its location in dry mixed-woodlands. Because it is home to mechanical and automotive companies, it is considered an industrial area. It is also along the way to the landfill. The infrastructure and services in the relatively new New Disaneng ward are limited because it is relatively a new ward that was allocated for residential use in 2005. It is dominated by woodlands and the main species is *Colophospermum mopane* (J. Kirk ex Benth.) J. Kirk ex J. Léonard. Similarly, Moeti ward is in mopane woodland and is also dominated by *C. mopane*. It is on the outskirts of Maun, on the fringe of cropping and communal grazing areas. Some residents of this ward were relocated to New Disaneng ward to pave the way for the expansion of the Maun International Airport (Kashe *et al.,* 2023). Sedie Ward is located in a mixture of *Vachellia* and Mopane woodlands. The ward was previously a cropping and livestock farming area before it was allocated for residential use. Abandoned and unoccupied areas in this ward have been encroached by *Vachellia* species. It is also the gateway to Moremi Game Reserve, the Savuti-Mababe-Linyanti ecosystem and Chobe National Park.

Data collection

Data was collected from seven (7) wards within the village of Maun during June and July 2024. The wards were chosen at random from a pool of 16 wards. All publicly accessible roads in the wards were designated as transect for the vegetation survey. This protocol was similar to that used in previous road surveys of alien invasive plant species (Rejmánek *et al.,* 2017; McLean *et al.,* 2018; Mabusela *et al.,* 2021; Moshobane *et al.,* 2022). Each ward's primary and secondary roads were treated as transects of different length and all publicly accessible roads were sampled. Each transect was walked, and every 50 metres, a GPS waypoint was recorded. This was done on both sides of each transect to ensure that all hedge species were accurately identified and recorded. The presence, number, and identity of hedge species (examples shown in Fig. 2) were recorded on both sides of the road. The potential ecological impact and impact on public and animal health are recorded in Table 2.

Fig. 2: Example of hedges in different wards in Maun village: a = *Leucaena leucocephala*; b = *Cryptostegia grandiflora*; c = Jatropha curcas; d = *Bougainvillea spectabilis*; e = *Dodonea viscosa*; f = *Cascabela thevetia*



$$H' = -\sum_{i=1}^{S} Pi \ln Pi$$

Where, H' = Shannon-Wiener diversity index, S = species richness, P_i = proportion of S made up of the i^{th} species (relative abundance). Evenness or equitability, measure similarity of the abundance of the different hedge species in the different wards and was analysed by using Shannon-Wiener's Evenness. Its value ranges from 0 to 1 with 1 being complete evenness. It is calculated by the following formula:

$$J' = \frac{H'}{\ln(S)},$$

Where, J' = evenness and S = species richness.

Results

Species richness, diversity and eveness

A total of ten (10) hedge species were recorded across the seven (7) wards. Sedie exhibited the greatest species richness and Moeti ward the least (Table 1). Kgosing, Boseja and Tsanakona had the same species richness (six). Kgosing recorded the highest hedge species diversity (H') followed by Tsanakona, Sedie and Boseja (Fig. 3).

Table 1: The species richness of hedge species across different wards in Maun village

Ward	Species richness
Sedie	7
Kgosing	6
Boseja	6
Tsanakona	6
Riverside	5
New Disaneng	5
Moeti	4

Fig. 3: The species diversity and evenness of hedge species across different wards in Maun village

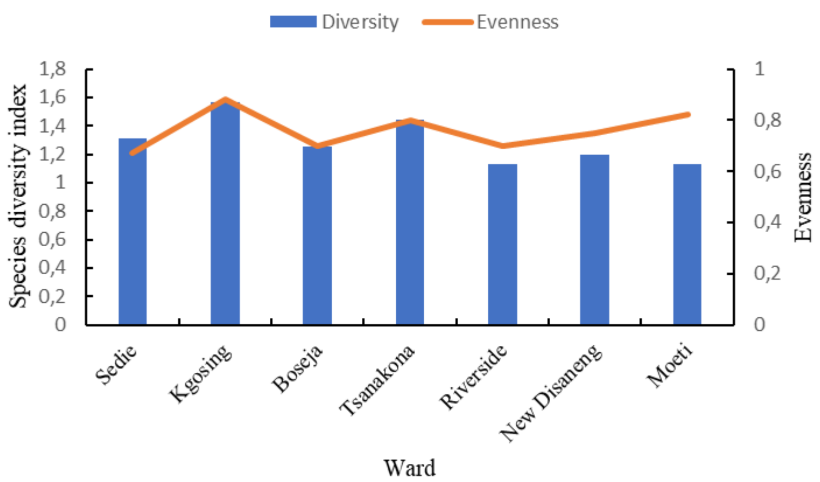


Table 2: Global distribution and invasiveness of hedge species

Species	**Common name**	**Family**	**Species origin**	**Region where species is invasive**	**Source**
Dodonaea viscosa	Sand olive	Sapindaceae	Australia, India, tropical and sub-tropical Africa	Throughout out the world, primarily southern hemisphere	Harrington *et al*. (2009)
Bougainvillea spectabilis	Great bougainvillea	Nyctaginaceae	Brazil	Naturalised across Seychelles, Philippines, Cuba and Chile	Kobayashi *et al*. (2007)
Jatropha curcas	Jatropha	Euphorbiaceae	Tropical America	South Africa, Reunion, Asia, Australia, Hawaii	Zengeya &Wilson (2021)
Cascabela thevetia	Yellow oleander	Apocynaceae	Tropical North and South America	East Timor, Southern and Eastern Africa, Australia, Anguilla, Cuba, Hawaii,	Rojas-Sandoval *et al*. (2020) Witt & Luke (2017)
Cryptostegia grandiflora	Rubber vine	Apocynaceae	Southwestern Madagascar	Africa, Asia, North and South America, the USA and Oceania	Rojas-Sandoval & Acevedo-Rodríguez (2013)
Ailanthus excelsa (Mill.) Swingle	Tree-of-heaven	Simaroubaceae	northern and central China	Asia, Africa, North America, South America, Europe and Oceania	Iverson *et al*. (2019) Bekele *et al*. (2019)
Leucaena leucocephala	Leucaena	Fabaceae	Mexico	Asia, Africa, North America, Central America and Caribbean, South America, Europe and Oceania	Weber (2003). Dana *et al*. (2003)
Melia azedarach	Chinaberry	Meliaceae	India and Pakistan	Asia, Africa, North America, Central America and Caribbean, Europe and Oceania	Chinnasamy *et al*. (2019)
Duranta erecta	Golden dewdrop	Verbenaceae	Tropical Americas	South Africa, Zimbabwe, Oceania	USDA-NRCS (2018), Seebens *et al*. (2017), PIER (2013)

Table 3: Invasive alien hedge plant species with their ecological impact and impact on human and animal health

Species	Ecological impact	Impact on human and animal health	Source
Dodonaea viscosa	Appears to invade disturbed habitats and rarely occur in undisturbed habitats	N/A	Harrington *et al*. (2009)
Bougainvillea spectabilis	Climb woody species suffocating them and displacing understorey plants.	N/A	Kobayashi *et al*. (2007)
Jatropha curcas	Form dense thickets that compete with the native species. Contains allelochemicals that inhibit growth of other plants.	Seeds are poisonous to livestock and people	Oudhia (2000); Makkar & Becker (1998)
Cascabela thevetia	Dense thickets in low lying areas and watercourses can out-compete native vegetation.	All parts extremely toxic and fatal to humans and animals	Lusweti *et al*. (2011)
Cryptostegia grandiflora	Dense infestations lead to loss of pasture and reduction in livestock carrying capacity.	Posionous to grazing animals. Toxic glycosides cause intestinal disorders	Parsons & Cuthbertson (1992)
Ailanthus excelsa	Dense thickets reduce species richness and phylodiversity, It is allelopathic.	Pollen cause allergic reactions and sap cause skin problem.	Fogliatto *et al*. (2020)
Leucaena leucocephala	Habitat transformer, Form dense thickets that displace native vegetation and reduce species diversity.	N/A	Weber (2003). Dana *et al*. (2003)
Melia azedarach	Thick monoculture stands inhibit regeneration of native plants.	All parts of the plant are poisonous to animals and humans	Henderson (2001)
Duranta erecta	Invades riparian habitats and modify native ecosystems. It is allelopathic and forms thickets that can outcompete native vegetation.	Leaves and fruits are poisonous to people and animals including dogs and cats	Scanlan *et al*. (2006); Witt & Luke (2017)

Riverside and Moeti recorded the same and lowest species diversity. Similarly, Kgosing and Tsanakona were among the wards with the highest evenness. In contrast, Sedie and Boseja recorded the lowest evenness. Of the total number of hedge species recorded nine (90 %) are internationally classified as invasive alien plant species (Table 2). The invasive plants are also reported to have a negative impact on biodiversity and are a threat to animals and public health (Table 3).

Distribution of hedge species in different wards

The total mean densities of hedge species across the seven (7) wards were 28 individuals per km^{-1} (Table 4). Sedie recorded the greatest density and Moeti the least. *Bougainvillea spectabilis* was the dominant species in four of the seven wards (Sedie, Kgosing, Riverside and Tsanakona). *Melia azedarach* and *Duranta erecta* were only present in one ward at low densities in Kgosing and New Disaneng ward, respectively. The two species seem to spread along the fence and were not intentionally planted as hedge. *Dodonaea viscosa*, *B. spectabilis* and *Euphorbia tirucalli* were the common species recorded across all seven wards.

Table 4: The density of hedge plant species observed in seven wards in the village of Maun. Dodo visc = *Dodonaea viscosa*; Boug spec = *Bougainvillea spectabilis*; Jatr curc = *Jatropha curcas*; Casc thev = *Cascabela thevetia*; Euph tirc = *Euphorbia tirucalli*; Cryp gran = *Cryptostegia grandiflora*; Aila exce = *Ailanthus excelsa*; Leuc leuc = *Leucaena leucocephala*; Meli azed = *Melia azedarach*; and Dura erec = *Duranta erecta.*

Wards	Density (km^{-1}) of hedge plant species										Total
	Dodo visc	Boug spec	Jatr curc	Casc thev	Euph tirc	Cryp gran	Aila exce	Leuc leuc	Meli azed	Dura erec	
Sedie	1.5	3.7	0.5	0.3	0.5	0.1	0.1	0	0	0	6.7
Moeti	1.2	0.6	0.4	0	0.1	0	0	0	0	0	2.3
Kgosing	0.7	1	0.2	0	0.3	0	0	1.2	0.2	0	3.6
Riverside	0.1	1.2	0	0	0.4	2	0	0.1	0	0	3.8
Boseja	2.5	1	0.3	0	0.5	0.1	0.1	0	0	0	4.5
Tsanakona	0.3	1.2	0.3	0.1	0.7	0.1	0	0	0	0	2.7
New Disaneng	0.7	1.7	0	0	1.8	0	0	0.1	0	0.1	4.4
Total											28

DISCUSSION

The study assessed the type and number of plants grown as hedges across the different wards in Maun. The results revealed differences in the distribution of hedge species across the seven wards. Almost all the hedge species were potential invasive alien plant species posing a threat to biodiversity, public and animal health. Invasive species are a major threat to biodiversity and animal health (Macic *et al.,* 2018). This finding concurs with studies by Kashe *et al*. (2024) and Mabusela *et al*. (2021) which highlighted the presence of woody invasive alien species in hedges in Botswana and South Africa, respectively. All parts of the potential invasive hedge species *Cascabela thevetia* and *Cryptostegia grandiflora* are poisonous to people and livestock (Parsons & Cuthbertson, 1992; Lusweti *et al.,* 2011). This implies that while hedges provide ecosystem services, they can also provide ecosystem disservices when the potential invasive alien plant species are used.

The hedge species were not evenly distributed across the seven wards. Some wards had substantially greater numbers and densities of hedge species than others. However, the number of hedge species found was disproportionately less than in other studies in Ethiopia, Kenya and Uganda which recorded 15–60 species per village hedge system (Asfaw & Lemenih, 2010). This difference is largely attributed to use of native species in hedges in other studies, whilst in this study almost all hedge species were woody invasive alien species. In Botswana and South Africa, invasive alien plant species are often preferred over native species for use as hedges due to several reasons including fast-growth, allowing landowners to quickly establish effective barriers (Richardson *et al*., 2000), dense foliage and thorns, providing effective physical barriers to intruders and livestock (Shackleton *et al*., 2014), high tolerance to drought and poor soil, which is advantageous in semi-arid regions, where native species may not thrive as well (van Wilgen *et al*., 2012), lack knowledge of suitable native alternatives or access to indigenous plant nurseries, leading to continued reliance on readily available exotics (Jubase *et al*., 2021).

The greatest densities were recorded in Sedie and Boseja wards. These two wards are sandwiched between the Thamalakane River and dry mopane woodlands in the upland. Owing to the easy accessibility of water and woodland resources, these wards host different livelihood activities. Similar studies in urban areas found that densely populated areas harbour more invasive alien plant species (McLean *et al.,* 2017; Mabusela *et al.,* 2021). This partly explains the high densities of potential invasive plants grown as hedges. The proliferation of potential invasive alien plant species grown as hedges could be attributed to the horticultural trade (Ööpik *et al.,* 2013; Hulme *et al.,* 2018). In South Africa, gardens have been reported as the main source of invasive alien plant species (McLean *et al.,* 2018; Moshobane *et al.,* 2022). However, in Botswana, roadside markets and homebased nurseries are the main suppliers of potential invasive alien plant species. This partly explains the wide use of potential invasive species in hedges in Maun village.

Moeti and Tsanakona wards recorded the least densities of hedge species. Tsanakona ward is located in a riparian area along the Thamalakane River and houses a significant number of middle-class households with perimeter wall fences instead of live hedges. In addition, the riparian area is endowed with diverse big and tall trees that form a closed canopy (Kashe *et al.,* 2024). It is probable that riparian tree species provide ecosystem services that would normally be provided by the hedges and as a result negate the need for a live hedge. Likewise, Moeti ward is in mopane woodlands and it was evident during the survey that most residents have retained mopane trees in their yards to provide shade and windbreaks. It is not surprising that it recorded the lowest density of hedge species.

Dodonaea viscosa, *Bougainvillea spectabilis* and *Euphorbia tirucalli* were the only species that were observed across all the seven wards. *Dodonaea viscosa* is a drought and wind resistant species that is grown globally as a live hedge due to its dense, bushy habitat (Lawal & Yunusa, 2013). It can be easily propagated by seeds or cuttings, which are readily available. *Bougainvillea spectabilis* is extremely showy, floriferous and resilient plant that produces bright blooms throughout the year (Sudipta *et al.,* 2012). Furthermore, its aggressive climbing and shrub growing habit coupled with attractive flowers makes it good hedge species (Salam *et al.,* 2017). *Euphorbia tirucalli* was the only native species grown as a hedge. It was the most widely used live hedge before woody invasive alien plant species were introduced. The distribution of *Ailanthus excelsa*, *Melia azedarach* and *Duranta erecta* was limited to one or two wards at low densities suggesting that these species were probably spontaneous natural colonisation along the fence boundary. This assertion is corroborated by McCann *et al*. (2017) who observed that while hedges are mostly planted, some hedges may be a result of spontaneous natural colonisation of the fence boundary or fence line by invasive hedge species.

CONCLUSION

The study complements an emerging but growing body of research in Botswana that indicates that potential invasive alien plant species are common in different sectors and land uses calling for more effort to prevent new introductions and manage those already present. All hedge species except one are potential invasive alien plants, suggesting a lack of knowledge about their ecological impact and impact on public and animal health. This calls for raising awareness and engagement of the local communities in the management of potential invasive plants. Efforts to manage potential invasive species in Botswana are defeated by a lack of environmental law or national regulations to monitor and control potential invasive alien species. The government is advised to develop environmental law that will manage potential invasive alien species.

Management and policy implications

Invasive alien species (IAS) regulation

The cultivation and trading of IAS must be governed by comprehensive national policies with legal and regulatory structures in order to avoid and regulate IAS. The 1916 noxious weed act (CAP 35:04) is the only piece of legislation that stipulates that designated plant species may not be allowed to grow on a property or the landowner is guilty of an offence; however, the list of species is rather outdated and does not cover the majority of invasive plant species. Legislation for IAS importation and cultivation, as well as trade regulations, make up the regulatory frameworks for IAS. Invasive alien species management and control should also be guided by a comprehensive policy approach, and it should be made clear that IAS must be watched over and under control.

Public awareness

When it comes to implementing policies and management practices, public awareness and knowledge of IAS and other environmental challenges are essential. A lack of awareness can impede, delay, or even prevent the successful implementation of management practices (Dickie *et al.* 2014). Therefore, relevant government departments and academic institutions should conduct public awareness campaigns to sensitise the local communities about IAS.

Nursery regulations

The international horticultural trade is reported as the leading force behind the importation of exotic species and nurseries are a source of propagule pressure. There should be legislation for the registration, monitoring and inspection of nurseries. Nursery owners and other traders of invasive species should attend invasive species awareness workshop before their registration.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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