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Towards Urban Forest Restoration in the City of Bukavu, Eastern Democratic Republic of Congo: Residents' Perceptions

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Abstract

Purpose: Demographic explosion is a common phenomenon in the Democratic Republic of Congo, especially in the city of Bukavu, where more than 1.6 million inhabitants live in 60 km², following the rural exodus due to insecurity in rural areas. This situation has led to deforestation, resulting in the destruction of most of the old green spaces, exposing the city to higher risks of flooding, erosion, landslides and loss of biodiversity, among other environmental problems. This study aims to understand the population's perception of deforestation in Bukavu, and to inform policy makers on how to restore urban forests.

Methodology: To collect data for this study, we sampled and interviewed 210 informants, with 70 informants in each of the three communes of Bukavu: Kadutu, Ibanda and Bagira.

Findings: The vast majority of informants are in favor of restoring green spaces (85%). At least 72.9% of them recognize that green spaces are important for air purification, environmental improvement, ornamentation, erosion control, biodiversity conservation and food production (in the case of fruit trees). They agree that the vegetation cover has decreased, especially since the 2000s, mainly due to the rural exodus and unregulated housing construction (81.9%). The population is aware that they are the main beneficiaries of green spaces (87.1% of informants) and accuse the government of being the main destroyer of green spaces and that it should be the main actor in their restoration. At the same time, residents recognize their share of responsibility for the destruction and restoration of urban green spaces, but consider it to be less than that of the government. In order to restore green spaces, they suggested tree planting initiatives (51.7%), with a preference for *Eucalyptus* sp., *Cupressus lusitanica*, ornamental and medicinal trees. Awareness raising and planned urbanization are among the strategies proposed to restore these spaces.

A unique contribution to theory, practice and policy: The results of this study pave the way for a multidimensional understanding of climate adaptation, and demonstrate the need for a collective awakening of all stakeholders and the full mobilization of all actors in the quest to restore green spaces in the city of Bukavu for a healthier environment.

Keywords: *Urban Forest, Decision-Making, Destruction and Restoration, Accountability, City Of Bukavu.*

1. Introduction

Globally, accelerated and intensive urbanization has significantly affected the human-ecosystem nexus, including forests, leading to fragmentation and loss of forests (FAO, 2012; Useni et al., 2017a). This highlights the primary importance given to the expansion of built-up areas and other land uses at the expense of woodlands (Roy et al., 2016; Rahman et al., 2016). The impact of urbanization on the physical environment of cities is the basis for huge climate disruption, as well as negative impacts on soil, crop production, water regime, biodiversity, etc. (Arce, 2009). Intensive urbanization is one of the main causes of habitat degradation for many animal and plant species (Mallard, 2009), and it can also lead to urban land degradation (Mateso and Dewitte 2014). This has a significant impact on the loss of biodiversity and ecosystem services (Rahman et al., 2016).

Urban forestry is an integrated concept defined as the art, science and technology of bringing together forest resources and urban communities for their multiple benefits to society (Konijnendijk and Randrup, 2004). Urban forests and trees outside forests (TOF) are an important part of our environment (Bolyn et al., 2019), and in cities, good living and a healthy environment depend on the quality and extent of their coverage (Roy et al., 2017). Trees are very important due to their various ecological functions or ecosystem services (FAO, 2016; Meyer-Grandbastient, 2019) and other numerous benefits (Smith et al., 2015; Bolyn et al., 2019). The importance of urban forests for human health and well-being is incalculable (Haaland and Van den Bosch, 2015). These areas can provide habitats for animal and plant species, thus contributing to the maintenance of urban biodiversity (Saint-Laurent, 2000), and they also contribute to the amelioration of extreme weather conditions (Salbitano et al., 2017). Architecturally, trees are acoustic insulators, their presence reduces noise pollution and they also protect houses from gusts of wind and dust in the dry season (Wrong et al., 2010; Louis, 2020). Psychologically, urban forests help to calm aggressive moods caused by urban concentration (Cormier et al., 2012) and they can contribute to improving the state of mind by facilitating physical activities (Kaplan and Kaplan, 2003). Socially, they can make the city more beautiful (El Jai and Pruneau, 2015) and bring residents into closer contact with nature (Lebœuf et al., 2013). Although their contribution is often ignored and underestimated, urban forests are a valuable solution to mitigate the current problem of climate change in the world (Teo et al., 2021).

In Africa, after several decades of rapid urban growth, the persistence of some urban green spaces is based on the history of the colonial city, established and developed thanks to colonial policies as the main urban management strategy (Mbatia, 2016). On the other hand, the development of urban green spaces is part of environmental protection, the fight against desertification and various environmental disasters (Tonde, 1994). African cities are faced with an increasing urban population and rural poverty, as well as a lack of expertise in the field of urbanization and sustainable development (FAO, 2012). All these elements are caused by poor governance and lack of support for institutions involved in the management of green spaces (Kassay, 2010). For example, in the Democratic Republic of the Congo (DRC), the exponential growth of the urban population may

lead to a high demand for infrastructure, housing and other physical structures (World Bank, 2018). This may require the government to develop a green space management plan and intensify reforestation activities in urban and peri-urban areas (Useni et al., 2017b).

The forest ecosystems of Sud-Kivu province in eastern DRC face problems related to human pressure, which is considered to be a major driver of degradation processes following deforestation in the African Great Lakes region (Balagizi et al., 2013). In this province, the main activities that have a negative impact on forest cover are fuelwood harvesting, construction, sawmills and brickworks (Ngabo et al., 2014). The city of Bukavu (capital of the province), with its geographical position between Lake Kivu and the mountainous ridge, does not facilitate its expansion. This situation contributes to the encroachment of green areas and the high population density, resulting in high pressure on existing forests (Lina, 2016). In recent decades, the city's soil has been severely degraded and its vegetation has been degraded and shaved in some corners (Mugisho and Bitagirwa, 2020). As a result, the city of Bukavu has experienced severe landslides and erosion due to unplanned urbanization, resulting in several losses including loss of human lives and degradation of biodiversity (EURATA, 2005; Mateso and Dewitte, 2014). Thus, in Bukavu, the green spaces that existed a few decades ago have been significantly reduced.

Globally, urban forests are characterized by diversity, connectivity and dynamism. Diversity is explained by the existence of different land uses in urban areas, multiple land ownerships and management objectives. In terms of connectedness, urban forests are connected to other elements of the urban environment, including roads, houses, people, industrial areas and city centers. In terms of dynamics, the development of urban forest resources takes place in the context of much more powerful and rapid human-induced forces for change. The combination of all these characteristics makes urban forest management particularly complex and challenging (Dwyer et al., 2003). The aim of this thesis is therefore to investigate the implementation of coherent strategies for the restoration and promotion of green spaces in the city of Bukavu.

2. Methods

2.1.Study area

The assessment was carried out in the city of Bukavu, in the province of Sud-Kivu, in the eastern part of the DRC. It is located between 2°30'55" south latitude and 28°50'42" east longitude. It covers an area of 60 km2 and is divided into three communes including Bagira, Ibanda and Kadutu as shown in Figure 1 below (CAID, 2016; Ministry of Land Management and Urbanism: MATUH, 2016). The city is bordered by the territory of Kabare to the south and west, Lake Kivu to the north and the Ruzizi River to the east, which separates it from the Republic of Rwanda (MATUH, 2016).

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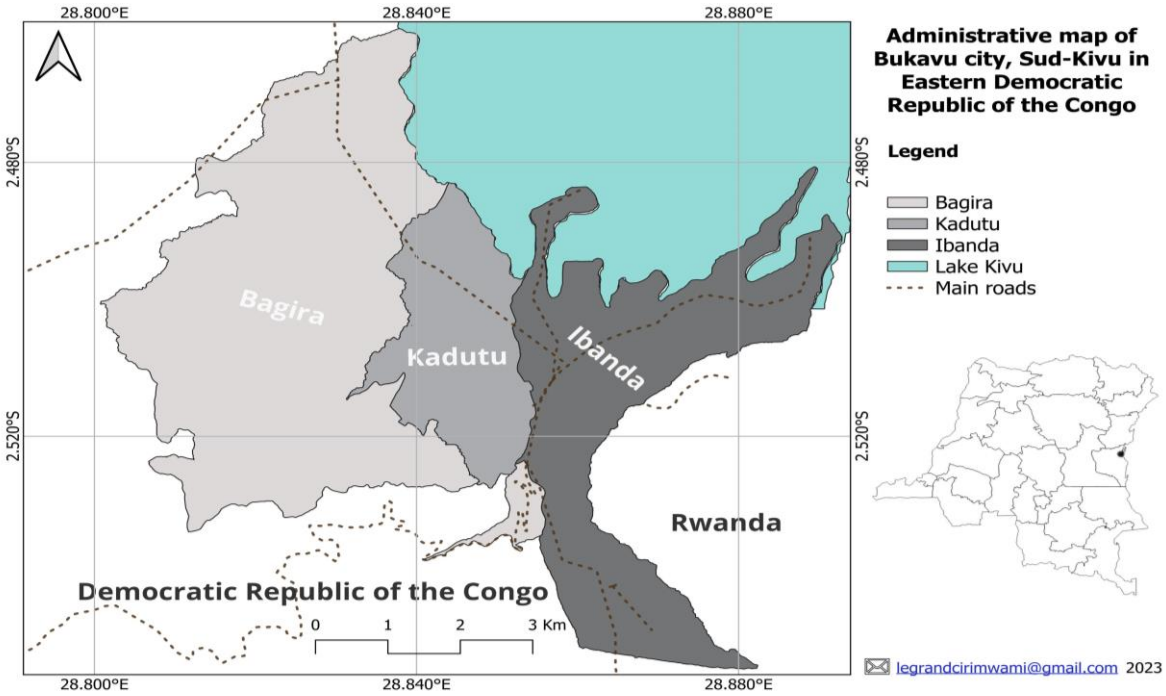

Figure 1. Location of the study area, city of Bukavu in the Sud-Kivu Province/DRC.

2.2.Data collection and analysis

We used the questionnaire survey technique to collect data through the structured interview method, which allowed us to collect data in the three municipalities. It was also used to obtain the opinion of the population on the presence of green spaces in their living environment. According to several authors, interviews are an appropriate method to address social and economic issues (Fifanou et al., 2011; Nyumba et al., 2017). The sample consisted of 210 inhabitants of the city of Bukavu, with 70 people per commune (Bagira, Ibanda and Kadutu). The questions were designed to identify the respondents without asking for confidential information, in order to guarantee our desire to respect confidentiality. Therefore, the questions were divided into three parts: identification of the respondent, the respondent's attitude towards green spaces and the use they would make of them. The data were analyzed using Excel and R, R version 4.3.0 (R Core Team, 2023), and a chi-square test was used to compare the different categories, while statistical decisions were made at the traditional 5% threshold ($\alpha = 0.05$).

2.3.Ethics and data availability statement

Participation in this study was voluntary, and informants had to read a short consent form before they could begin answering our questions. Participants were free to participate or withdraw from the study. The study was double approved by the second author's institutional ethics committee before and after data collection. The dataset used for this study is available on request.

3. Results

3.1.General characteristics of informants

Table 1 below presents the main characteristics of the 210 informants interviewed in the communes of Kadutu, Ibanda and Bagira.

Table 1: General overview of the characteristics of informants in Bukavu. NS = not significant.

	Number	**Percent**	**Statistics (Chi²)**
Gender			
Male	114	54.3	NS
Female	96	45.7	
Age			
18 – 23	86	41.0	Chi² = 70.05 df = 4 p < 0.0001
24 – 29	47	22.4	
30 – 35	35	16.7	
36 – 41	16	7.6	
42+	26	12.4	
Marital status			
Single	122	58.1	Chi² = 182.34 df = 3 p < 0.0001
Married	75	35.7	
Divorced	8	3.8	
Widowed	5	2.4	
Level of study			
None	5	2.4	Chi² = 235.19 df = 4 p < 0.0001
Primary	22	10.5	
Secondary	125	59.5	
Graduate	50	23.8	
Postgraduate	8	3.8	

As this table shows, most of the informants interviewed are young students and single. Their average age is between 18 and 23 years and they have a secondary education.

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3.2. Population information on green spaces

The two figures below show the number of respondents who know something about what green spaces are (Figure 2) and how they were informed about them (Figure 3) in the three administrative communes.

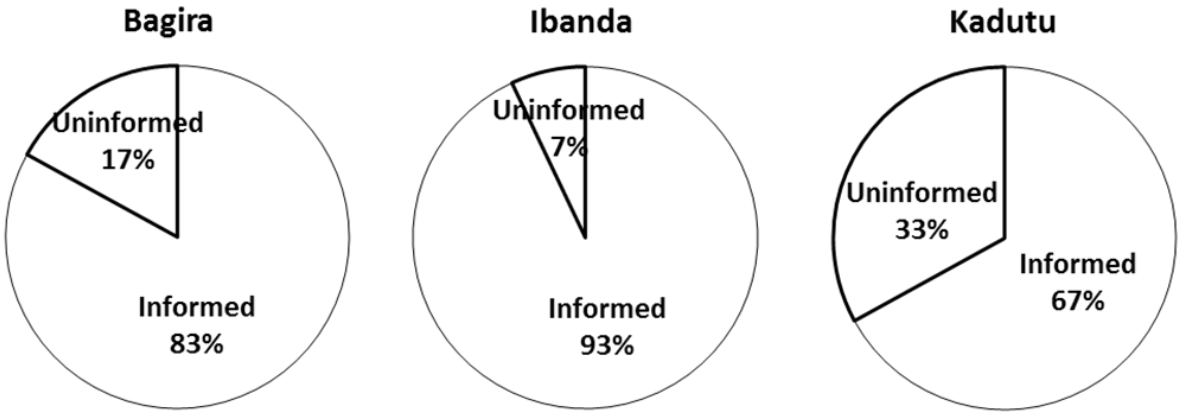

Figure 2. Percentage of respondents who are informed about green spaces in the three communes

At least 67% of the respondents are informed about green spaces in the city of Bukavu within the three communes (Bagira, Ibanda and Kadutu). People in Ibanda and Bagira are more informed than in Kadutu, where the rate of uninformed people is very important ($Chi^2 = 15.26$, $df = 2$, $p = 0.0005$).

Those who said they had never heard of green spaces were excluded from the data used to generate the figure below (Figure 3), so only 162 responses were analyzed for the question on the means by which people were informed about green spaces.

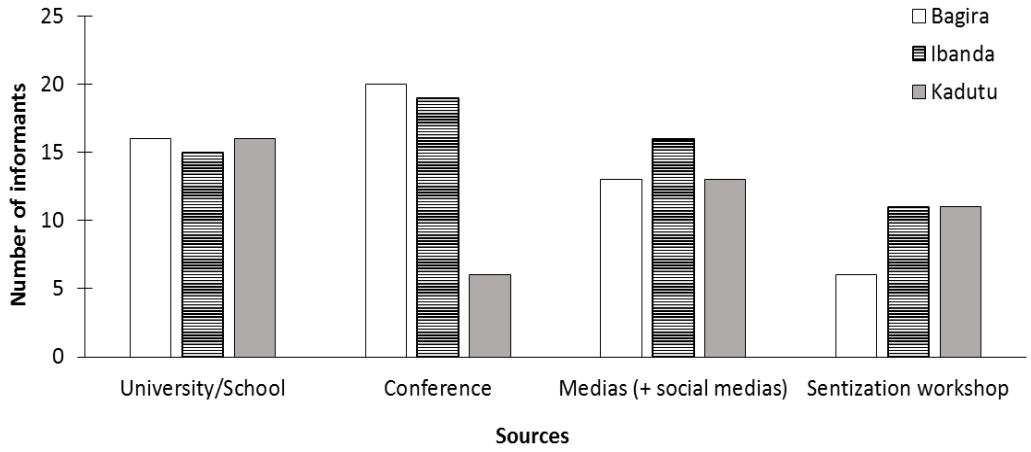

Figure 3. Ways in which respondents had heard about green spaces

In our sample, most of the respondents had heard about green spaces on different occasions, but there is no significant difference between the four sources ($Chi^2 = 5.46$, $df = 3$, $p = 0.14$). People from Bagira and Ibanda mentioned the conference as the main way they heard about green spaces, while in Kadutu most people heard about green spaces for the first time at school/university.

3.3.People's attitudes towards green spaces: distance and importance

When asked whether the people of Bukavu wanted a green space near their homes, the vast majority said yes (94.3% in Bagira, 97.1% in Ibanda and 85.7% in Kadutu). Those who did not want green spaces near their homes cited reasons such as lack of space, insecurity and the spread of certain diseases that would result from green spaces.

The respondents recognized several meanings of green spaces, as shown in Figure 4 below.

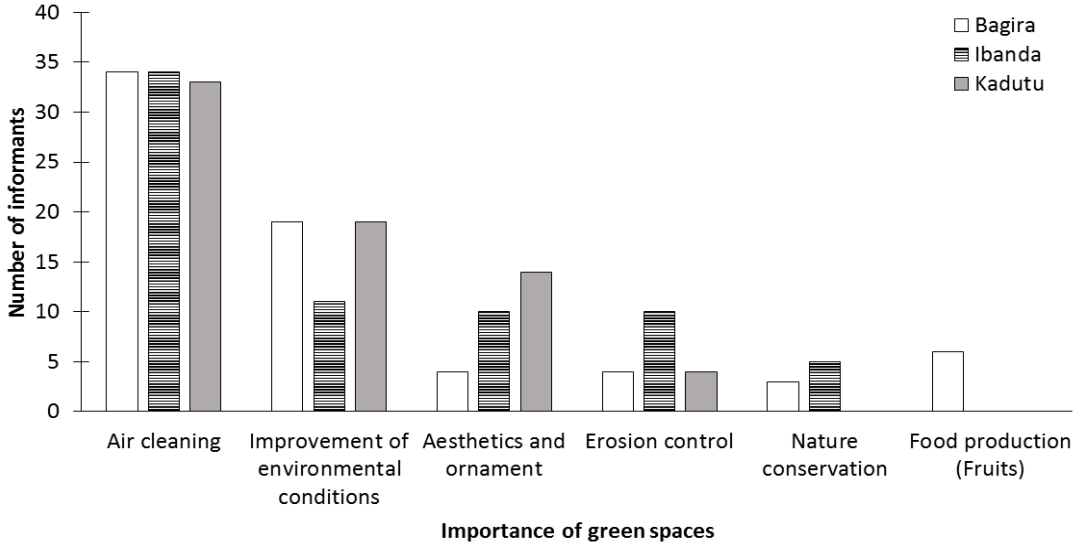

Figure 4. Importance of green spaces according to respondents

Air purification, environmental improvement and ornamental purposes were the main reasons given for the importance of green spaces. Erosion control and nature conservation were mentioned by a few respondents. In addition, the majority of respondents said that green spaces in Bukavu (in the few places where they exist) are appreciated because they make the landscape beautiful.

3.4. Evolution of vegetation cover in the city of Bukavu

Figure 5 shows the informants' perception of the evolution of the vegetation cover in the city of Bukavu.

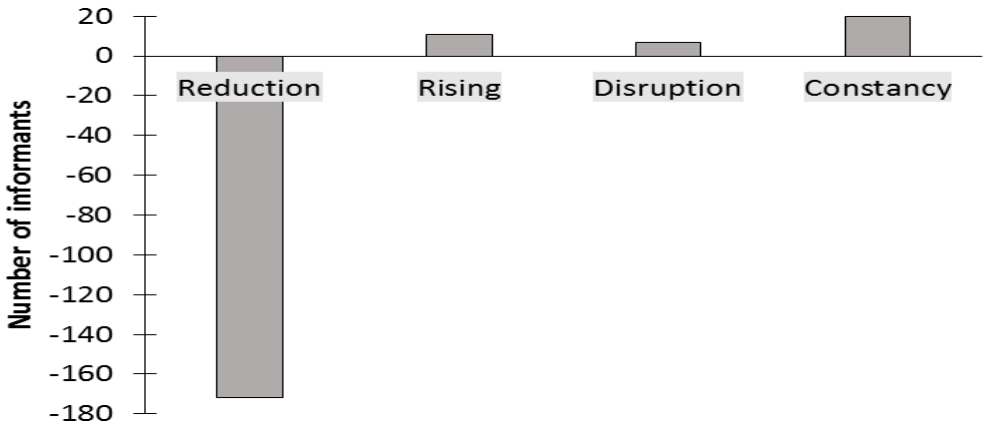

Figure 5. Evolution of the vegetation cover in the city of Bukavu: perception of the population.

A large majority of the study population (81.9%) believes that the vegetation cover in the city of Bukavu has decreased, and this observation is unanimous in all communes. A total of 83.8% of the population believe that this change in vegetation cover has become more visible between the last two decades (2000 - 2020). The disturbance category in the sense of this study is the fact that the area covered by vegetation has remained the same, but the inhabitants think that there is a change in the species composition.

3.5.Causes of vegetation cover change in Bukavu

In general, the causes of vegetation cover change in Bukavu (reduction, disturbance or increase) are shown in Figure 6.

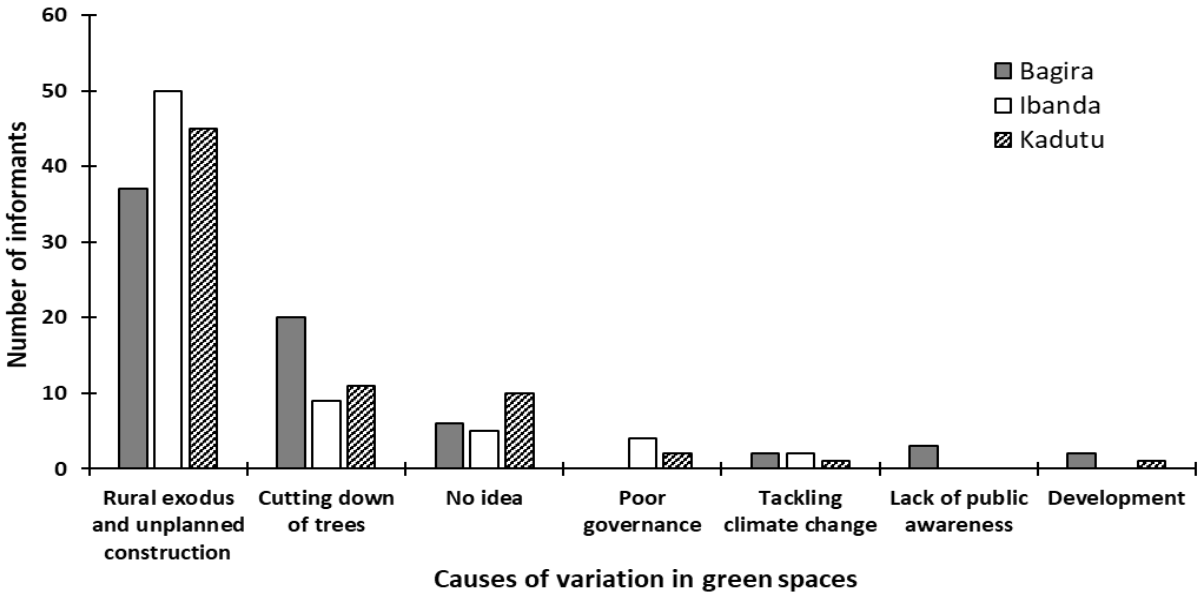

Figure 6. Causes of variation in green spaces in the city of Bukavu

Among the reasons given by respondents for the variation in green spaces, the vast majority mentioned the rural exodus (probably due to insecurity in rural areas) and anarchic constructions. Some respondents were indifferent to the question, while others who believe that green areas have increased believe that this can be explained by the fight against climate change and various development projects that include tree planting initiatives (TPIs).

3.6. Expectations and suggestions of the population of Bukavu

In this section, we identify the expectations of the population of the city of Bukavu with regard to green spaces. The results below illustrate these expectations.

3.6.1. Species preferred by the population

As shown in Figure 7 below, some species are preferred over others in green space restoration projects, and this preference varies from commune to commune.

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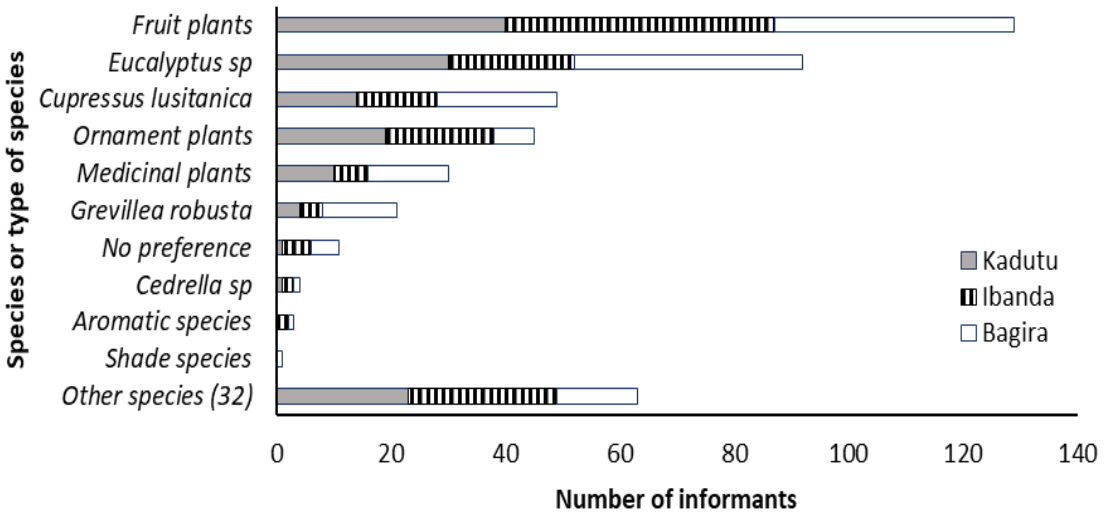

Figure 7. Species and type of species preferred by the population to restore green spaces.

The most frequently mentioned plants/species are fruit plants, *Eucalyptus* sp., *Cupressus lusitanica*, ornamental plants and medicinal plants. Informants mentioned reasons such as food production (e.g., fruit species), products for human health, erosion control and nature conservation. The population interviewed would like to see green areas throughout the city, especially along roads, in erosion areas, around public buildings such as schools, churches, etc.

When asked which species they wouldn't like to see used in a campaign to restore green spaces, *Eucalyptus* sp and *Cupressus lusitanica* were the most frequently mentioned, as they believe these species are positively associated with the loss of soil productivity.

3.6.2. Analysis of the responsibility of actors in the destruction, restoration and profitability of green spaces

This study shows that, according to the responses of informants, the government is the main actor responsible for the destruction and restoration of Bukavu's green spaces (Figure 8).

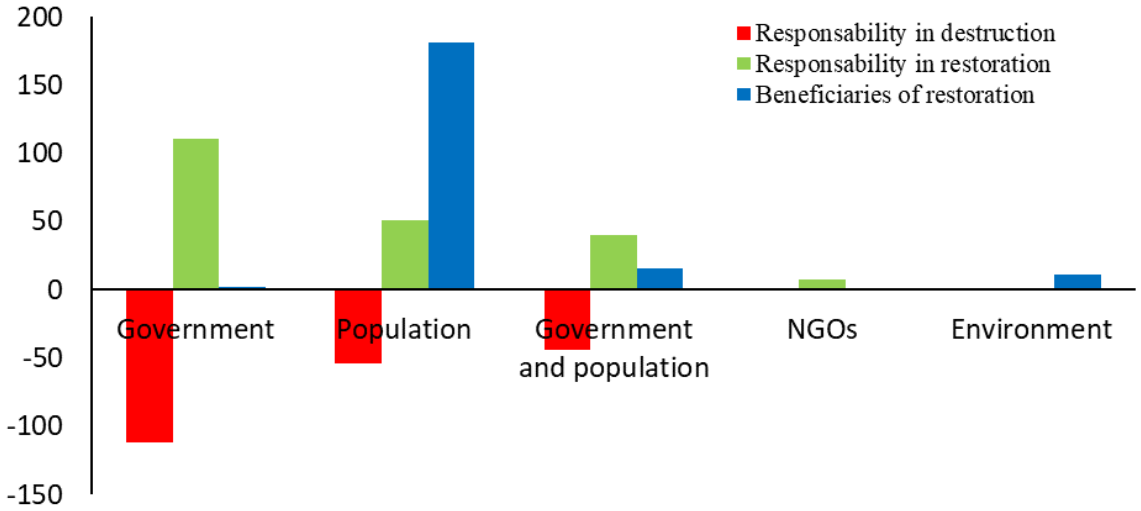

Figure 8. Responsibility for green space restoration and destruction

The above figure shows that the population knows that they are the main beneficiaries of green spaces (87.1% of informants), and blames the government for being the main actor in the destruction of green spaces, arguing that they should also be the main actor in their restoration. The population is not exempt from the destruction and restoration of green spaces, it recognizes a certain responsibility, but less than the government.

3.6.3. Some ideas for restoring green spaces

To restore green spaces, respondents think that trees should be planted, some said that raising awareness about the importance of green spaces would also be an action to take, and this was expressed by a good proportion of respondents. On the other hand, too few respondents think that there is not enough space or that the expansion of the city of Bukavu should be considered.

4. Discussion

Increasing urbanization has several consequences, including the significant reduction of green spaces as a result of various factors. Our study focuses on the restoration of green spaces as part of a socio-ecological system consisting of human settlements and open spaces, especially vegetation cover (Sambieni et al., 2018). In urban areas, the need for green spaces is increasingly felt. The restoration of nature is a real desire that has been demonstrated in the 21st century because it is perceived as a potential response to urban ills (Chaillet, 2018). Indeed, given the importance of green spaces, it is normal that the concept has become very common. However, many people remain ill-informed on the subject. It is obvious that urban dwellers in Bukavu need green spaces in their living environment. This is a rapidly growing trend around the world, as evidenced by a study conducted in 2008 by the *Union Nationale des Entrepreneurs du Paysage* in France, which showed that city dwellers (70%) choose where to live based on the proximity of public urban green spaces (Grand-Bastient, 2019). This is linked to the fact that green spaces provide various services to the community, including quality of life in many ways. In the case of Bukavu, these services were summarized in a number of components, i.e., environmental benefits (air purification, improvement of environmental conditions, biodiversity conservation, etc.), socio-economic benefits (food/fruit production for feeding and medicinal purposes, income generation, etc.) and cultural/leisure/artistic benefits (ornamentation, recreation, tourism, etc.). Based on the cultural attitudes/practices of some community members in certain geographical areas, a number of trees have benefited from special care - and even 'devotion' - as they were/are seen as part of the symbols/icons of the people's identity. This allowed the automatic 'survival' of the species under consideration, which outlived other tree species (Anderson and Maly, 2002; Fongod et al., 2014; Ntoko and Schmidt, 2021).

In fact, several benefits of nature have been highlighted: its ability to mitigate/eliminate climate pollution and related impacts in urban areas, to reduce energy consumption, or to provide a healthy and accessible environment for different social strata (Chaillet, 2018). A study conducted in Kinshasa showed that, regardless of the city's constituencies, residents expect the predominant or

most important ecosystem services to relate primarily to their economic and/or socio-cultural needs, namely food, recreation (for sighing purposes), or property ownership. Only a minimal part of the population is aware of and values the environmental quality of the city (Sambieni et al., 2018). The results and observations of our study confirm these findings.

Despite being aware of the myriad benefits of a high-quality environmental dimension - even in terms of considering suitable areas for human settlement (construction, industry, etc.) - some Bukavu residents still strongly believe that it would be foolish to move people for the prospect of planting trees. Several reasons have been given, including the lack of time to maintain the planted trees and the fact that they could be a potential source of insecurity if they later form a kind of forest canopy. They also argue that the trees could be a source of many dangers, as they can harbor many harmful animals, especially aggressive insects that can cause diseases. A similar phobic trend (regarding the 'suppression' of green spaces) has been reported in Tours (France), where people walking in public green spaces complain of a lack of overall safety, including a certain level of discomfort, particularly due to waste dumping in the vicinity (Launay, 2014). Thus, for this category of people, green spaces in urban public places allude to the presence of vegetation, especially old trees, as well as to a somewhat restricted area (Grand-Bastient, 2019). Others simply refer to them as green and/or greenery (Launay, 2014).

The perception of green spaces varies according to the urban constituency, whether the inhabitants are from Bagira, Ibanda or Kadutu. Moreover, the results do not depend on specific criteria, such as those related to the identification of respondents for the survey. Nevertheless, there is a significant difference between the responses of the inhabitants of the three communes (Bagira, Ibanda and Kadutu). This difference lies in the proportion of Kadutu residents who were reluctant/hostile to urban reforestation (i.e., as part of those opposed to the preservation/regeneration of green spaces) and is much higher than in the other two communes (Bagira and Ibanda). Elsewhere, perceptions of green spaces are influenced by specific criteria such as the gender and geographical background of users (Grand-Bastient, 2019), while location in the city also influences the understanding of green spaces (Launay, 2014).

The choice of tree species to create green spaces can be influenced by the knowledge of these species that the inhabitants have. This would explain the choice of tree species by the people of Bukavu, who mainly prefer fruit trees, medicinal trees, ornamental trees or other tree species. This underlines the potential value of trees to the people of Bukavu. Similar species such as *Eucalyptus globus*, *Cedrela* sp, *Grevilea robusta*, *Cupressus lusitanica*, fruit species and some medicinal species have also been identified as preferred species in tree planting initiatives in the region (Cirimwami et al., 2024). However, the studies conducted show that urban dwellers prefer to see familiar trees and are more inclined towards local species to highlight local heritage (Launay, 2014). The other explanation for the choice of tree species is always based on a positive perception, either related to an ecosystem-based benefit (shade, erosion control, etc.) or a societal/livelihood-based benefit (food production). Trees under consideration are selected based on their potential to cope with climate change hazards, soil and overall topography, while also considering the needs of

people and animals in the target region (Dumont et al., 2015). Shrubs are welcomed in the city of Bukavu, as the urban population does not feel disturbed by their presence, to the extent that it is proposed that selected species be planted throughout the city, especially in all public spaces. In this sense, sidewalks/footpaths and around large public buildings are particularly important. According to a study carried out in France in 2008, most city dwellers believe that more public urban green spaces should be created (Launay, 2014). In addition, the presence of green spaces in schoolyards would be beneficial for the health of students (Beaudoin, 2017).

In Bukavu, as elsewhere, both the government (which is mainly castigated) and the population (which does not refrain from going beyond the limits set) are responsible for the destruction and restoration. All in all, the government is singled out for what the population calls a "lack of initiatives" to tackle all the causes of the destruction of green spaces. These causes are mainly related to anthropic activities/attitudes that lead to, among other things, the felling of trees, the rural exodus and the construction of unwise buildings. The state is specifically blamed for failing to impose security in rural areas to curb the influx of villagers into the city. People castigated themselves for what they called 'bad faith' in trying to acquire/purchase land for construction, despite being aware of the exhausted space for building new houses; to this end, they resort to buying land even in insignificant locations (unsuitable for construction). Kassay (2017) shows this in his study carried out in Kinshasa, where green spaces are in a chaotic situation and all the city's development projects since the colonial era have been forgotten. The population lacks culture and environmental education, so the green spaces of the city of Kinshasa are turned into public dumping grounds, invaded and used for the construction of illegal buildings (Kassay, 2017). However, in some specific contexts, local leaders (for example, in Burkina Faso) face the pressure of urban sprawl and have to limit the spaces for which they are responsible and whose destruction is unacceptable to them. The urbanization crisis that African countries have faced since independence has led to an increased demand and pressure for land, resulting in the 'invasion' of protected areas for settlement purposes, thereby raising concerns about the future of urban vegetation (Deronzier, 2017).

Planting trees and raising awareness are ideal approaches to curb/reverse this trend and restore green spaces. In the same perspective of restoring green spaces, "ecological corridor", concept comes in handy, as it also consists of an array of practices/measures with potential to preserve both ecosystem and biodiversity that form the green fabric of agglomerations (Saint-Laurent, 2000).

5. Conclusions and recommendations

This attitudinal study of deforestation in Bukavu as a result of the demographic explosion and unregulated housing construction has revealed a strong desire on the part of the population for the restoration and protection of urban green spaces, and for everyone - officials and residents - to contribute to achieving this goal. To this end, and in light of the results of our study, we recommend the following five strategies (1) the creation of a provincial ministry of urban development and planning to regulate the design and construction of housing in the city; (2) the creation of an environmental police unit to enforce the regulations of the said ministry and to monitor construction

projects in the city; (3) the introduction of courses on environmental protection and management in the curriculum at all levels of education; (4) campaigns by the provincial government to promote the protection of urban green spaces; and (4) Awareness-raising campaigns by the provincial government and civil society groups on the causes and consequences of deforestation and on environmentally sound building practices; (5) The expansion of the city of Bukavu, which will address the problem of high population density, reduce pressure on green spaces and promote the creation of new ones. Further studies are needed to determine the feasibility of implementing strategies and other ways to reduce deforestation in Bukavu.

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