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Generativity is a Core Value of the ESJ: A Decade of Growth

Erik Erikson (1902-1994) was one of the great psychologists of the 20th century[1]. He explored the nature of personal human identity. Originally named Erik Homberger after his adoptive father, Dr. Theodore Homberger, he re-imagined his identity and re-named himself Erik Erikson (literally Erik son of Erik). Ironically, he rejected his adoptive father's wish to become a physician, never obtained a college degree, pursued independent studies under Anna Freud, and then taught at Harvard Medical School after emigrating from Germany to the United States. Erickson visualized human psychosocial development as eight successive life-cycle challenges. Each challenge was framed as a struggle between two outcomes, one desirable and one undesirable. The first two early development challenges were 'trust' versus 'mistrust' followed by 'autonomy' versus 'shame.' Importantly, he held that we face the challenge of **generativity** versus **stagnation in middle life**. This challenge concerns the desire to give back to society and leave a mark on the world. It is about the transition from acquiring and accumulating to providing and mentoring.

Founded in 2010, the European Scientific Journal is just reaching young adulthood. Nonetheless, **generativity** is one of our core values. As a Journal, we reject stagnation and continue to evolve to meet the needs of our contributors, our reviewers, and the academic community. We seek to innovate to meet the challenges of open-access academic publishing. For us,

[1] Hopkins, J. R. (1995). Erik Homburger Erikson (1902–1994). *American Psychologist*, 50(9), 796-797. doi:http://dx.doi.org/10.1037/0003-066X.50.9.796

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generativity has a special meaning. We acknowledge an obligation to give back to the academic community, which has supported us over the past decade and made our initial growth possible. As part of our commitment to generativity, we are re-doubling our efforts in several key areas. First, we are committed to keeping our article processing fees as low as possible to make the ESJ affordable to scholars from all countries. Second, we remain committed to fair and agile peer review and are making further changes to shorten the time between submission and publication of worthy contributions. Third, we are looking actively at ways to eliminate the article processing charges for scholars coming from low GDP countries through a system of subsidies. Fourth, we are examining ways to create and strengthen partnerships with various academic institutions that will mutually benefit those institutions and the ESJ. Finally, through our commitment to publishing excellence, we reaffirm our membership in an open-access academic publishing community that actively contributes to the vitality of scholarship worldwide.

Sincerely,

Daniel B. Hier, MD

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Editor in Chief

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 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Table of Contents:

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

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Virtuous Legislation: The Royal Decree for the Sustainable Management of the Woods of Serra San Bruno, Stilo, Mongiana, and Ferdinandea

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Abstract

The Saving Forests Decree of 1773, issued by Ferdinand IV of Bourbon, marked a fundamental step in the sustainable management of the forests of the Serre Calabresi. Metal mining and processing in the region dates back to ancient times, with Greek colonies exploiting local resources for tools and coins. With the arrival of the Normans, the mines became strategic and were granted to the Carthusian monks, and the Norman smelting furnace improved military production. Under Ferdinand II, the Ferdinandea foundry reached its peak, producing high-quality weapons. The Salvaboschi decree demonstrated a growing awareness of the need to balance industrial needs with environmental protection. This study analyzes the decree, examining how its provisions are in line with modern environmental protection laws. The analysis of this study focuses on the provisions of the Salvaboschi decree and their compliance with current environmental protection laws. The main objective of the decree was to implement sustainable forestry practices through regulated logging cycles to prevent deforestation and promote natural regeneration. Analysis of the law reveals its progressive nature and its conformity with modern principles of environmental conservation. This historic legislation testifies to the early recognition of the importance of sustainable resource management and the foresight of the Bourbon

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administration in implementing practices that would benefit both the environment and industrial development. Through the study and analysis of the rules present in the document, it was possible to make significant comparisons with the laws in force. The decree demonstrates considerable foresight in the protection of natural and forest heritage. This document represents an important step towards environmental protection, highlighting a concrete and proactive commitment to the protection of natural resources. The ability to compare existing regulations with new provisions offers a clear and in-depth perspective on legislative evolution in environmental matters, confirming the importance of regulatory updates to address contemporary ecological challenges.

Keywords: Economic History, Environmental History, History of the Kingdom of the Two Sicilies, Economy of Southern Italy in the Nineteenth Century

Introduction

1. From mining extraction activity to the foundation of the New Arms Factory of Mongiana

The extraction and processing of metals in the territories of the Calabrian Serre constituted an activity undertaken since ancient times. Already from the second half of the 6th century BC, the colonies of Magna Graecia exploited the mines present in Calabria to produce tools and weapons (Fiorenza, 2019). Considering the significant presence of silver (Franco, 2003; Cunsolo, 1965), these colonies also used local mining resources to mint their own coins, providing a considerable boost to the economy and prosperity of the Greek communities settled in the region (Franco, 2019). With the Norman dominion succeeding the Byzantines in Calabria, there was a marked evolution in the approach to the management of mining resources. The mines, smelting furnaces, and watercourses, vital for powering the ironworks, acquired significant strategic importance and economic potential. These elements became subject to donations and concessions by the Norman crown, as evidenced by the concession acts drawn up in 1094 by Roger II of Normandy in favor of the Carthusian monks of San Bruno. Historical documentation reveals that the Normans, aware of the decisive relevance of mining resources, decided to introduce the smelting furnace into the forges of the Calabrian Serre. This mechanism, already in use in Nordic countries, was particularly renowned to produce Osmund iron, also known as Norman iron. This type of iron was widely used to produce arrowheads and cutting weapons characterized by superior strength and durability, thus representing a significant contribution to the development of metallurgy and the military capability of the Norman era. The attention given to mining activity in

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Calabria remained unchanged throughout the various dominations that succeeded each other in the territories between Aspromonte and the Calabrian Serre, each of which, at its time, took control of the different ironworks or their products. This historical continuum ultimately led to the period of the Kingdom of the Two Sicilies, during which the architect Gioffredo was entrusted with the task of conceiving a project to modernize the facilities. The goal was to transform the ironworks into stable industrial structures and optimize production cycles to enhance production, improving both quality and quantity. The previous administrations, up to that point, had operated on temporary processing sites, mainly due to the intensive exploitation of forests for obtaining firewood charcoal. This practice quickly led to the depletion of available timber resources. Furthermore, when charcoal had to be transported over considerable distances, the entire production process became economically disadvantageous. The mandate to architect Gioffredo (Franco, 2019) therefore reflected the need to adopt innovative and sustainable solutions to ensure the continuity and profitability of the mining industry in the area. The new complex was designed as a permanent industrial settlement, located in an area characterized by the simultaneous presence of all essential production factors: mineral deposits, forest resources for timber, and continuously flowing watercourses managed sustainably.

However, despite the good intentions and exceptional efforts, the steel complex showed significant inefficiency from the outset, often requiring further modernization interventions due to outdated processing methods, inadequate road infrastructure, and significant damage inflicted by the earthquakes of 1783. The process of improving the facilities culminated during the period of French rule, with Joseph Bonaparte (from 1806 to 1809) and Joachim Murat (until 1815), who mainly directed the activity towards military production. The military needs and the continental blockade imposed around the Kingdom of Murat established the specialization of the plant in the production of main components for rifles, pistols, and flints intended for the army. Alongside the exponential expansion of production, there was a growth in urban settlement around the factory, transitioning from temporary barracks to masonry buildings for workers, accountants, engineers, and their respective families. This transformation reflects the socio-economic and infrastructural changes resulting from the evolution of the steel industry within the context of French rule. With Ferdinand II's ascension to the throne of Naples in 1825, the economic context of the Kingdom experienced a favorable upturn, characterized by an increase in government orders (Ciccolella, 2012). The State, engaged in various public works, significantly boosted civil engineering, railways, and shipyards. Indeed, by around 1840, the Ferdinandea foundry recorded an annual production of pig iron ranging between 36,000 and 45,000 quintals (Fiorenza, 2023). This raw material was subsequently

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

transformed on-site into finished products of excellent quality, a result attributed to the use of beechwood charcoal. This economic prosperity reflects not only the positive effect of state policies on industrial demand but also the Ferdinandea's ability to adapt to new needs and efficiently exploit local resources. In 1852, the "New Arms Factory" was inaugurated, representing a significant advancement compared to the management during the Bonaparte period. While during that time only the main parts of weapons were produced to be assembled elsewhere, the new factory stood out for the complete and ready-to-deliver production of firearms and edged weapons (Fiorenza, 2023). In the same year, King Ferdinand II visited the production complex, which was emerging as the most modern and efficient in the Kingdom, as attested by the official report:

> «*Mongiana, October 19, 1852, no. 855. On the evening of the 16th, this Establishment received the honor of an almost unexpected visit from Our August Monarch, accompanied by Their Royal Highnesses, the Royal Princes, His Royal Highness the Duke of Calabria, and the Count of Trapani*». (De Cesare, 2003).

The establishment of the "New Arms Factory" and the royal visit mark a significant advancement in the plant's production and technological capabilities. The on-site production of firearms and edged weapons indicates greater autonomy and sophistication in the arms industry. The sovereign's visit underscores the socio-economic and political importance of the manufacturing complex within the Kingdom of Naples. Following this inspection, the king designated the settlement cluster as a military colony with administrative autonomy, placing its management under an officer of the royal armed forces. This officer, in addition to performing military duties, assumes the civilian role of mayor, assisted by subordinate officers.

The continuous renewal and expansion initiatives elevated the Royal Ironworks and the Bourbon Workshops of Mongiana to a leading position in the steel industry, making them a technologically advanced hub. This industrial complex attracted and quickly transformed the local workforce into a highly specialized labor force. Additionally, their production aimed to provide widespread supply across Europe. As highlighted, the exceptional working conditions within the steel center in the Kingdom of the Two Sicilies emerge through a cutting-edge legislative framework, aimed at safeguarding the forest heritage and favoring the perpetuation of coal supply. Additionally, employees engaged in mining activities served for a maximum duration of eight hours per day, while those employed in foundries were subject to a daily working limit of ten hours (Fiorenza, 2023).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

2. On laws to ensure the safeguarding and sustainable management of the environment and forest resources.

To address the indiscriminate management of forest resources, legislation was introduced to safeguard these resources, which were being depleted due to numerous small ironworks in Mongiana. This legislation, endorsed by Giovan Francesco Conty, aimed for a sustainable flow of charcoal. The "Salvaboschi Decree" of 1773 by King Ferdinand IV established a forty-year cutting cycle, allowing the annual felling of the most mature tree among forty, marked officially, to promote forest regeneration. These measures reflect a growing awareness of sustainable forest management, balancing the industrial need for fuel with the protection of forest ecosystems. This decree served as a regulatory tool to ensure both environmental preservation and a continuous supply of fuel for industries. However, over the course of thirty years (De Stefano Manno, B., Matacena, G., 1979), when the artillery took control of the establishment, the military found a lack of adherence to the previously issued safeguard decree and observed a total disregard for the fundamental principles of the existing legislation. The artillerymen found themselves in a situation where the forests, originally adjacent to the ironworks during its initial settlement phase, were now about twelve miles away from the facilities. This discrepancy led to the ineffectiveness of the initial reasons that had justified the transfer from Stilo, which had been conceived to balance the increasing transportation costs of the ore with the reduction of the price of coal produced near the ironworks. In this context, the lack of regulatory measures and deteriorating environmental conditions directly impacted the economic sustainability of the ironworks. The 1773 law aimed at mitigating the fuel supply issue faced resistance, leading to significant consequences. The military's concern, detailed in the captain's report on forest conditions, reveals a troubling situation.

> «[...] *the negligence in enforcing the laws of the past Government has resulted in the loss of the Bosco del Marchese di Arena, which, after being destroyed for charcoal production, has been cultivated and turned into farmland, thus finding itself entirely devoid of trees, in violation of the law of 1773 which ordered the owners of adjacent forests to prevent clear-cutting and cultivation in their forests under penalty of paying 500 ducats and having their properties confiscated* [...]». (BNN, 63/1).

The captain reports non-compliance with previous laws, notably highlighting the deforestation of the Marquis of Arena's forest. This area was cleared for charcoal production and then cultivated, leaving it treeless, violating the 1773 law. This law prohibited clear-cutting and cultivation of forest properties, with penalties of 500 ducats and asset confiscation for violations. This scenario underscores the importance of rigorously enforcing environmental and forestry laws to ensure sustainable management of natural

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

resources. Non-compliance with these regulations can result not only in the direct loss of forest resources but also in negative impacts on soil fertility and biodiversity. Furthermore, it should be emphasized that the report highlights the need for careful surveillance and appropriate sanctions to ensure the effectiveness of environmental laws in preserving and protecting forest heritage. The presence of a strong legal framework, with significant monetary penalties for offenders, could have provided a solid basis for enforcing the law. The military could have used this to impose compliance across all social classes, including nobles. The military's presence would serve as a deterrent. Demonstrating their commitment to enforcing regulations, the artillerymen established systematic forest surveillance by assigning guardians with armed detachments. Their tasks included prohibiting grazing, preventing the unjustified destruction of plants and saplings, and enforcing the ban on cultivating deforested land. It is undeniable that the law of 1773 failed to eliminate harmful pre-existing clauses, which granted landowners, beneficiaries of state contributions for afforestation, considerable discretion and maneuverability:

> «[...] *the forests that have belonged to this establishment for a century and a half are those called the Demanio di Stilo, which are to the east of Mongiana, beginning three miles from the present establishment, covering an area of two leagues of beech trees. These forests were purchased by the University of Stilo from the Marquis of Arena, given to the King for charcoal production, with the understanding that they retained the sole right to take some poles for their own use and the right to keep animals out of pasture* [...]». (BNN, 63/1).

Starting from the limited land extensions measured in poles, with the right to confiscate animals found grazing illegally or introduced illegally into the lands (an inherently harmful practice), it evolves towards the agricultural reconversion of previously deforested soils, considering them, in this sense, as no man's land. This process serves to highlight the determination of the new administrators of the complex:

> «[...] *it is necessary, in order to put a limit to this terrible inconvenience, to set an example by obliging the Marquis of Arena to comply with the decree, and furthermore, to compel him to sow acorns and remove the animals to regenerate his large estate of trees that have been destroyed* [...]» (BNN, 63/1).

For noble owners, non-compliance with the order would have led to stricter sanctions, extending beyond the Marquis of Arena to other landowners such as the Prince of Roccella, the Duchess of Girifalco, and the Carthusians. These owners often viewed laws from Naples as symbolic of distant power. Protecting forest heritage required more than policing; sustainable ironworking also needed botanical solutions. Captain Ritucci proposed

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

planting "pines picea," which produce high-quality charcoal, and "white birch" in degraded areas for its rapid growth and high calorific charcoal. The captain, with a military approach, issued orders to the charcoal burners accordingly.

> «[...] *to obtain excellent charcoal, it must be made in the summer, not in winter, the wood must be cut at the third hour of the moon, or in January, and it should not be very young because otherwise, with the presence of moisture, it is necessary to make many holes, called vents, in the charcoal pile, to allow air to enter, which fuels the fire, causing the charcoal to become burnt, known as Corvino, which is entirely useless* [...]» (BNN, 63/1).

The attention given to carbonization and reforestation is not merely discretionary initiatives of the ironworks administrators, driven by the concern to comply with the operational planning established in Mongiana to meet the needs of the armed forces. In this context, it is Murat himself who issues specific directives. In Decree no. 846, article 5, he instructs the Ritucci-Melograni-Paolotti Commission:

> «[...] (said Commission) *will then designate and identify the same forests and the regulations and annual cuts to be made, taking into account the vegetation and life of the trees in that climate, in order to obtain their perpetuation* [...]». The absence of generality in this provision is evident from the presence in the commission of Giuseppe Melograni, Inspector of Waters and Forests, called upon to serve as an expert in the forestry sector. (BSNSP).

The problems are numerous, including enduring harsh winter weather that interrupts the carbonization process. Fuel stocks in the warehouse were often only sufficient for two to three days due to delays in government supplies, preventing summer carbonization for winter use. Additionally, it was impossible to accumulate the full annual requirement during the favorable season. The military focused on preventing coal shortages in the "Carbonile," the largest hall in the ironworks complex, and ensuring adequate supplies to avoid such shortages. (BNN, Ms. 63/1). Not all optimizations during this period resulted from authority or oppression, nor did workers solely bear the production burden. The military authorities rejected unreasonable demands from the Neapolitan Ministry with strong arguments. When asked about supplying 60,000 cantaja of bullets, they noted that such a quantity would overwork both men and facilities. Producing one melted mass would require around 40,000 loads of charcoal, devastating surrounding forests and ceasing activities in Mongiana. The Minister's proposal to requisition mules for increasing fuel supply was kindly but firmly refused.

> «[...] *requisition is nothing but an act of the moment's necessity, it is violence, not applicable to a system of long, regular, and well-ordered work; it would drive up the*

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

> *price of charcoal by half as much again as it costs with mules and the Mongiana tariff, and make the price of raw iron material and its manufactured products much higher* [...]» (National Library of Naples, Manuscripts Section, Ms 63/7).

If the military avoids using excessive force or putting pressure on the workers, they still do not tolerate smuggling or theft of materials from the facility. They carefully monitor all stages of operations, such as cutting, carbonization, and transportation:

> «[...] *and for the charcoal burners, who although working on a piece-rate basis, it was still likely that they would sell the charcoal for a higher profit to outsiders, operations were conducted to verify the amount of wood obtained from a bushel of forested land, the amount that one man can cut per day, and the carbonization process was simultaneously monitored, along with the quantity that can be derived from a given amount of wood. Meanwhile, the charcoal burners were divided into three groups, each with its own leader, whose obligation was to report any shortages and notify if there were any smuggling activities. Additionally, it was ordered that two Forest Guards be sent daily to the carbonization site to stand guard, and they remained there overnight as well. At the end of each week, the Captain of Detail calculates the quantity that each charcoal burner leader should have delivered based on the number of men they had; this quantity is then compared to what was received, and if it is less, the leader is punished unless they disclose who is responsible for the shortfall. As for the mule drivers, they also work on a piece-rate basis, but since they could potentially miss a day's work and take advantage of a transport offered at a higher price if not supervised, it was ordered that one of them act as the leader of the others. Their obligations include reporting each evening on any absent mule drivers and any sick mules. Just as the Captain of Detail receives reports every evening on the various items received in minerals, coal, and timber during the day, he compares whether the service of the mule drivers has been proportional, given the number of existing transports and the quantity of items received* [...]». (Ms 63/12, BNN).

The nightly reports from charcoal burners are relayed through the personnel sergeant to the Detail captain, who updates operations progress from the forest guard corporal. Using this data, the officer compiles it into a load register and attends daily briefings with the director to strategize. Despite its effectiveness in preventing major shortages, the control network can't fully stop small diversions of materials to more profitable channels. The necessity of approving brigand band requests or selling coal meant for ironworks to nearby villagers is acknowledged by the administration and surveillance personnel. To combat supply diversions to bands, the administration itself engages in purchasing contraband materials unofficially, benefiting from lower prices compared to official rates. A significant improvement in conditions is expected with a proposed 40% increase in logging and carbonization costs, updating tariffs dating back to 1804. Under the new tariffs, timber will cost 11 ducats per ton, with carbonization and transportation expenses varying based on proximity to forests. The

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

introduction of differentiated tariffs for summer and winter aims to provide fair compensation during harsh conditions, with a surcharge planned for winter operations from November to late April. These changes reflect efforts to support lumberjacks and improve overall conditions, acknowledging recent improvements in healthcare and pension benefits without resorting to harsh measures of exploitation.

> «[…] *The price increase is not intended to be applied universally and in young forests, where cutting is particularly easier, but it will always be ensured that the price of labor is compensated so that an ordinary worker can earn at least 30 grains per day, both on long and short days*». (BNN, Ms 63/10)

It is not difficult to notice that salary increases are not only the result of humanitarian considerations but rather reflect more precise and tangible reasons. The primary objective is to preserve the unity and loyalty of workers in the sector, attempting to bind them as much as possible to a facility that, day by day, sees carbon workers leaving in search of more profitable employment opportunities elsewhere. Around one hundred specialized workers in the ironworks prefer their jobs due to the "filiazione" privilege, which exempts them from military service. This allows for a more stable life, but their income is insufficient to support their families. Once this period ends, many migrate to the free forests, where they can produce charcoal independently for higher profits. In nearby Serra, charcoal sells for more than double the rate in Mongiana due to no transportation costs. The recent tariff changes incentivize workers to stay, offering stable income over the volatility of the free market. Military authorities impose strict penalties for unauthorized tree felling or improper practices, such as a ten carlini fine for cutting down unmarked trees or lighting fires in prohibited areas. Charcoal burners and forest guards must ensure compliance with these regulations to protect the forest's ecosystem, prohibiting the cutting of pine groves and encouraging careful monitoring of forest health.The debate over freely gathering firewood or accumulating bundles is not applied indiscriminately. The basic needs, customs, and customary rights of the Mongiana community and neighboring villages are preserved. The facility ensures to annually provide quantities of charcoal for heating and household use, considering the population's needs. An analysis of the data stimulates reflections on daily life in the village and the fairness of distribution. The amounts of fuel provided by the administration (600 during the Napoleonic era) are distributed proportionally among officers, non-commissioned officers, employees, troops, and workers, with a decreasing distribution. Officers receive a lower per capita quantity since their residences are characterized by greater comfort and better protection from winter harshness compared to those of all other categories. Non-commissioned officers and employees are allotted a higher individual quantity, considering

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

that they reside in lower-quality housing. Workers, who are skilled artisans or simple laborers, enjoy a higher quota, as they reside in homes built in a rudimentary manner, sometimes constructed by themselves or, in previous epochs, in simple wooden shacks. Officers receive a lower per capita amount because their residences are characterized by greater comfort and better protection from winter hardships compared to those of all other categories. Non-commissioned officers and clerks are allocated a higher individual amount, considering that they reside in lower-quality housing. Workers, who are skilled craftsmen or simple apprentices, enjoy a higher rate, as they reside in dwellings built in a more rudimentary manner, sometimes constructed by themselves or, in earlier times, in simple wooden shacks. In addressing the needs of Mongiana's inhabitants, the ironworks also consider neighboring communities. In 1819, former director Ritucci, while preparing an estimate for purchasing Carthusian woods, alerted the Ministry to the residents of Serra's longstanding right to gather timber and firewood. He stressed that extending Mongiana's restrictions to Serra could jeopardize the local economy, particularly the water-powered sawmills and wrought iron craftsmanship vital for the ironworks. Captain Vincenzo Ritucci, who directed the complex from 1808 to 1811, aimed to balance Mongiana's economic interests with respect for local traditions, advocating for a holistic approach that promotes sustainability and community integration in forest resource management. (Ritucci, 1819). A key strategic goal for the ironworks administrations is the continuous expansion of forest properties. Mongiana's significant coal and timber consumption supports local sawmills and various construction needs, including roofs, floors, and water wheel structures. The demand for timber is especially high in mining, often requiring recycled props for caps, while the Arms Factory must supply both rifle castings and packaging crates. Effective and sustainable forest resource management is crucial for ensuring a steady supply to meet increasing industrial demands. Expanding forest areas is essential for maintaining production continuity. Additionally, the Neapolitan Royal Navy sources spruce trees from Serra and Mongiana for ship masts, particularly from the Fillò forest, known for its robust spruce growth.

> «[...] *from which it provides for its most beautiful and majestic masts, which mainly come from the said Fillò forest that contains no other species of timber and where trees of the same species grow with greater vigor and prosperity*» (ASMN, 1811).

As soon as opportunities arise, the governmental authority proceeds with the acquisition of available forests in the market of Mongiana. A tangible example of this practice is found in the purchase contract signed in 1825 for an oak forest in the municipality of Placanica (ASMN, 27). As early as September 1813, a government decree allocated a considerable portion of the

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

surrounding forests to the ironworks, thus consolidating its control over the forest resource. In the same year, regulatory provisions are enacted for the restoration of forests, and the most favorable periods for conducting such operations are outlined. The regulation introduces the criterion, perpetuated subsequently, of dividing the breadth of forests into forty equivalent units, intended for sequential use, one each year. This innovative approach allows for the felling of trees at the peak of their vitality, and the implementation of periodic cycles enables production planning and mitigates fuel shortages. However, drawbacks arise as the process of felling trees of considerable size leads to leaving numerous wood splinters on the ground; furthermore, charcoal derived from nearly forty-year-old plants does not achieve optimal calorific yield. This method replaces the previous practice, proposed by Melograni and briefly used, of periodically cutting the "suckers" that regrow around the stumps. The latter method involved less cutting effort, reduced waste of splinters, and a higher calorific yield of charcoal obtained from wood of appropriate age. Despite the "low forest" cutting resulting in higher charcoal production, unfortunately, it could only be used for species with rapid regrowth of "shoots".

3. The Regulation on Analytical Aspects and Environmental Protection

In Mongiana, throughout the entire operational period of the ironworks, the phases of the carbonization process have retained their unchanged structure, and this remains largely unchanged today. Charcoal burners still carry out the construction of the kilns; it is enough to travel the road from the Ionian coast to Mount Pecoraro, or to traverse the forest roads, to observe the smoke from the charcoal kilns rising above the vegetation. Saverio Strati's book "A mani vuote" offers an account of the difficult life of contemporary Calabrian charcoal burners, who still supply charcoal to the inhabitants of mountain villages, where kitchens continue to use charcoal and where the only remaining heating system is represented by the brazier (Strati, 1960). In the carbonization system employed in Mongiana in the 19th century, some disparities are evident compared to the methods used in Alpine or French regions. The entire operation is managed by the head charcoal burner, who, in addition to his daily wage, receives a percentage of the profits from each kiln worked and delivered. The head charcoal burner supervises the charcoal makers, who are paid based on piecework, advances their wages, and oversees all phases of the process. He bears the responsibility for the success of the entire operation, including the transportation of the material. The portion of forest to be felled is delimited annually by the forest guards, subject to the approval of the Detail captain or the management. The guards, under the command of the corporal guard, promptly go to the site in military uniforms

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

(of blue cloth, with scarlet cuffs and collar, buttons of white metal bearing the bourbon lily surmounted by a crown). The forest guards proceed with the marking of the trees destined for annual charcoal production by applying a stamp. This stamp is impressed into the still-living wood using a hammer-punch, generating the letter "M" (symbolizing Mongiana). A second stamp, containing the letters "SC" (referring to Sicilia Citeriore), is hammered onto the trees that delineate the section and on the trunks of the fifteen trees per moggio, in accordance with Article 35 of Forest Law No. 967 of 21/8/1826. These latter trees are preserved intact for the purpose of providing "seeds of hope." (Art. 44). The government-owned hammers are carefully kept in cases equipped with two keys, the first of which is entrusted to the custody of the director and the second to the corporal guard. The application of the stamp follows an official procedure: for each tree, all information is carefully recorded in the report, which is initiated during the punch retrieval phase. This document, signed by both the guard and the designated agent to whom the hammer was assigned, details the specific uses to which the tool has been allocated. The stamping procedure is followed by cutting, conducted from early September to the end of March, primarily using axes. Lumberjacks are assigned specific areas and must not encroach on each other's sectors. After felling, trunks are stripped of branches and cut into 80-centimeter sections called "tropelli," which are rolled to the kilns. Carbonization occurs from spring to the first snowfall, although some work during winter. Felling and carbonization periods do not overlap, so trunks often remain on-site. The carbonization process involves selecting a suitable location and building a dome structure, crucial for production success. Kilns are ignited through a channel smaller than in other methods, and the process requires continuous monitoring of smoke color to ensure proper combustion. Carbonization typically lasts six to eight days, after which air intake holes are sealed to stop the reaction. After an additional period of two days dedicated to cooling, the surface layer of soil is removed, and the pile is dismantled, usually in nighttime operations that facilitate the removal of any remaining fires. The resulting charcoal is carefully packaged in hemp sacks and transported by mules to the foundries. Here, the carriers unload the material in designated areas in front of the carbonization structures and wait twenty-four hours before proceeding with the actual delivery. The suspension of carbonization activities during the months of July and August is aimed at preventing potential fires, which could arise due to a faulty extinguishing process. Indicative projections suggest that accidental incidents of this nature could become more frequent in the second half of the century. (Archivio di Stato Catanzaro). This precautionary measure translates into an operational pause to avoid the risk of self-combustion phenomena. At the end of the quarantine period, the carbonized product is entrusted to the warehouse managers, who carry out meticulous inspection and

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

counting under the supervision of a technician. However, there were drawbacks. In particular, the class of charcoal burners and transporters lived in extreme poverty.

> « [...] *even the processing and transportation could be greatly improved*». (Giordano, 1864).

The cost of coal to the establishments was calculated approximately as follows:

Thank you for the charcoal workers.	*L. 1,01*
Profit for the head charcoal burner and different wages.	*L. 0,13*
Transportation to the foundries of Mongiana.	*L. 1,63*
	L. 2,77
You still need to add the price of timber, calculated for state-owned forests.	*L. 0.13*
Total cost.	*L. 2,90*

In the Giordano report, some economic and logistical considerations are highlighted in the evaluation of the price of vegetal fuel, as well as an attempt to compensate for an insufficient decrease of 4.010 in the use of coals through excess measurement, while discussing the financial and environmental impacts related to ecclesiastical fees and the use of forests for charcoal production.

> «[...] *for Ferdinandea, the transportation being lesser, the price of coal was calculated at L. 2.12. In the use of coals for blast furnaces, a decrease or deficiency of 4.010 is considered, a figure that is insufficient but is compensated by the excessive measurement of the coal received from the charcoal burners, at the expense of their wages. The prices of the coals mentioned do not consider the general expenses of the establishment nor the burdens that may weigh on the forests. The price of L. 0.13 attributed to timber is very low and on the total annual coal production (29,200 quintals), it barely represents the salary of the 7 guards. Now, wanting to attribute to coal its real value and especially what it can have in the future, one must calculate all the influencing conditions. The four forests Santa Maria and San Miceli, Archiforo and Chiudilli, Fallo and Chiuselli, and Boscarello came to the Domain from the ecclesiastical patrimony by instrument of June 19, 1826, in which an annual gross canon of 7500 ducats and a net tax of 6000 ducats, equivalent to L. 25,500, were stipulated in favor of said patrimony: which canon is now paid annually to the ecclesiastical treasury. However, since the forests provide little wood and timber to the establishments but rather to the sawmills, so only a minimal part of the heavy canon of L. 25,500, as well as any others that may still exist, can be attributed to the coals destined for the ironworks. For the forests of Stilo, Lacina, and Dinami, of which the first is the most essential for the ironworks, the existing burdens, as it appears from the obtained information, are very light. On the other hand, these same forests, while they can easily supply 20 to 30,000 quintals of beech coal to the establishments, are still capable of yielding a large annual income from fir and other tree species cutting, as well as from pastures*». (Giordano, 1864).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

From a series of analyses reported by Giordano emerges the possibility, in terms of sustainable management, of assigning to the government the burdens that weigh on the Calabrian state-owned forests mainly in relation to timber and other products, thus freeing up the coal destined for the ironworks. However, it is crucial to carefully consider the ecological and economic aspects in the planning of forest policies, ensuring sustainable management that balances industrial needs with the conservation of forest ecosystems.

> «[...] *The general guard of Catanzaro d'Elia, delegated to the estimation, carefully calculated the potential income of the 7 state-owned forests, both in beech coals and in the other items just indicated, and found that by attributing a value of L. 85 per hectare to the coal cutting, which is the price of timber, that is, L. 0.28 per quintal of coal (double the current price), there would be a total income of about L. 11,500, of which only L. 10,000 from the 3 forests of Stilo, Lacina, and Dinami. Instead, the other proceeds from fir cuttings, other species, and pastures, assuming some improvement in forest cultivation and communication routes, would amount to an annual total of L. 36,000, of which L. 25,000 from Santa Maria and San Miceli, 6800 from Stilo, 1,400 from Archiforo, 1,300 from Fillo, and 900 from Dinami. From the previous considerations, it can be deduced that strictly speaking, the burdens weighing on the Calabrian state-owned forests could be attributed in whole or in most part to timber and other items they are susceptible to, leaving the coal free to supply the ironworks*». (Giordano, 1864).

The commission therefore suggests that the Calabrian forests, crucial for the iron and steel industry and the wealth of mountainous regions, require improvement in their cultivation. It proposes the appointment of an experienced technician in forest administration to oversee forest management operations, cultivation, and improvement, including coal production. This proposal highlights the need for more careful management of forest resources, considering their economic and environmental importance.

> «[...] *However, the value of L. 0.13 currently attributed to timber is and would be excessively low in the future. A similar value for timber is, as we have seen, between L. 1.50 and L. 2 and more in the Lombard and Aosta valleys, not counting the tax, and it is L. 0.80 in the state-owned forests of Tuscany that supply the Maremma establishments. In these areas, considering the few existing communications, a value of L. 0.60 or at least L. 0.50 could be established, which would represent an income of L. 15,000 on the annual production of 30,000 quintals, and therefore, for the cutting of beech forests on fortieth rotations, the price would be L. 150 per hectare at the rate of 39.*

Therefore, the probable price of coals, also assuming some improvement in wages, would be:

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Timber (assumed)	L. 0,50
Total processing	L. 1,30
General expenses and calculated at 10,010	L. 0,20
Transportation to Ferdinandea	L. 0,80
	L. 2,80

In Mongiana, the coal from Stilo and Dinami, still transported by mule, might cost around 0.50 more, making the price 3.30 Lire. The Calabrian forests we are concerned with are not only the essential resource for the steel industry but almost the sole wealth of those mountainous regions. It is not inappropriate to mention the possible and not difficult improvement of their cultivation. Firstly, if these forests are to be kept under the administration of forest authorities, it would be advisable to assign a skilled technical employee to oversee their management. This individual would be responsible for general supervision and various operations related to cultivation, improvement, and charcoal production». (Giordano, 1864).

Finally, the commission proposes several measures for the improvement of the depleted forest land, emphasizing the need to repopulate empty areas or clearings through prompt intervention in soil regeneration. Currently, the soil, being overgrown and compacted, hinders the germination of plant seeds. The practice of ordinary cereal cultivation for several years in these empty spaces could be granted free of charge to surrounding private individuals to facilitate repopulation without any expense, resulting in mutual benefit. Further improvement proposals include the opening of horizontal ditches on steep slopes to retain water and soil, selective cutting of trees at an angle and close to the ground, removal of stumps that do not produce new shoots, and other similar considerations deemed necessary to significantly increase forest production. The importance of strategically laying out roads in the forests is emphasized to reduce costs and facilitate the transportation of coal and timber to the facilities. The proposed approach demonstrates a comprehensive and well-considered plan for the restoration and sustainable management of forest resources, considering ecological, economic, and logistical factors.

«*Among the measures to recommend for the improvement of the depleted forest land, it is worth mentioning the prompt repopulation of the frequent empty spaces or clearings that currently exist, where the overgrown and compacted soil now refuses the regrowth of plant seeds. Recognizing that in such cases it greatly benefits soil restoration to practice ordinary cereal cultivation for several years, the cultivation of these spaces could be granted free of charge to local private individuals for 2 or 3 years, who, according to the information received, would willingly participate. In this way, without expense and with mutual benefit, the beneficial purpose would be achieved. Various other measures can also be recommended, such as the opening of horizontal ditches on steeper slopes to retain water and soil, the cutting of trees at an angle and closer to the ground, the removal of stumps that clutter the land without producing shoots, and various similar precautions recognized as necessary in those*

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

> *forests, through which it would not be difficult or expensive to significantly increase production. It is worth noting how the opening of some trunk roads properly laid out in those woods would help reduce the transportation of coal and timber to the facilities*». (Giordano, 1864).

The forests surrounding the locality of Mongiana boast a significant diversity of tree and fruit species, a characteristic that contributes to their heterogeneity. Despite the presence of a varied range of species, beech and fir stand out as predominant elements, exhibiting, as is common in nature, a relationship of mutual complementarity in their vegetative development. This characteristic was promptly observed by the members of the study mission sent to Mongiana by the Ministry of the Navy immediately after the Unification of Italy. The 'Commission for the Ironworks' arrived in the town with the objective of subjecting the ironworking activity to thorough scrutiny. The importance of this examination is crucial for the community of Mongiana, as the survival of the iron industry in Calabria depends on it. Engineer Felice Giordano, at the forefront along with his colleagues, furthermore, conducted a detailed analysis through X-ray examination of the mines, ironworks equipment, and personnel involved. In 1864, Giordano will publish a detailed report on the efficiency of the ironworks in the Lombard, Aosta, Tuscan, and Calabrian regions. This document will be fundamental for assessing and improving the performance of the iron industry in these locations, thereby contributing to the progress and competitiveness of the sector on a national scale.
To better outline the impact on the forests, it is essential to emphasize:

> «[…] *These forests shading the steep slopes and peaks of the Calabrian Apennines represent a significant wealth and adornment of those mountains that border two seas at their feet. Along the banks of these mountains and on the gentle slopes, there are mild climates, gardens filled with the finest citrus fruits, and extensive and fertile olive groves. On the middle slopes, there are chestnut woods, meticulously cultivated in rows and parcels. On the higher grounds and peaks, there are ancient forests of tall trees, where the predominant beech thrives alongside spruces, wild pines, and in smaller numbers, oaks, maples, ashes, yews, elms, and various fruit trees. The nature of the woodland species, the granitic soil, the freshness of the sites and waters, imbue this elevated region with a striking resemblance to certain sites in our Alps and even to the wooded regions of Germany, particularly those of the Hercynian Forest*» (Giordano, 1864).

The observer, initially captivated by the Serre mountains' diverse landscape and unique flora and fauna, soon becomes critical due to the lack of infrastructure, particularly communication routes in the dense forests. This absence of accessible pathways hinders a full appreciation of the region's natural riches. From this perspective, the traveler emphasizes that the lack of infrastructure limits exploration and nature experiences, presenting a missed

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

opportunity for sustainable tourism and ecosystem preservation in the Calabrian Serre.

> «[...] *all the potential profit from the enormous masses of trees of various ages accumulated there, much of which could be utilized for various purposes along the adjacent Tyrrhenian and Ionian seas. Therefore, their cultivation is neglected and can be said to be abandoned to nature itself, and devastations are not infrequent, although less so than in other locations*» (Giordano, 1864).

Gratitude is expressed towards the descendants of Mongiana for their ancestors' exceptional management of forest resources, noted as superior to other Italian locations. The engineer is puzzled by the reasons behind this situation. He is particularly surprised by the significant disparity in local timber prices, prompting the need for further investigation into the economic and environmental factors influencing these differences. An in-depth exploration of the socioeconomic dynamics affecting the timber market in Mongiana is proposed to better understand this complex reality.

> «[…] *The value of timber on the site is very low. A century-old fir is hardly estimated at more than L. 13; an ordinary Scots pine at L. 2.50; even a large beech capable of providing twenty cubic meters of timber for carbonization (equivalent to nine quintals of charcoal) is estimated at from L. 1.30 to L. 1.50*». (Giordano, 1864).

The engineer, with his profit-oriented perspective, shows a clear resistance to believing that the voluminous quantity of available timber is not being maximally exploited. The apparent state of "neglect" of the forest resource stimulates the appetite of economic operators who see the opportunity to activate operational sawmills, ready to process the raw material and subsequently send it through maritime networks to reach strategic markets. The engineer's mercantile mentality seems to focus primarily on the exploitative aspect of the resource. Giordano's perplexity deepens when he compares the relatively low value of local timber-described as "exaggeratedly mild and tenuous"—to higher rates in the Lombard and Aosta valleys and significantly more in Tuscany. This discrepancy raises questions about the local population's lack of interest in the market value of timber. Giordano notes that this indifference persists despite preventive actions taken by authorities to protect the forests from degradation. Additionally, he occasionally distorts the observed data, leading to questions about whether this is due to bad faith or impatience during a visit marked by preconceived notions and diagnoses. Furthermore, the documentation states that Giordano notes:

> «[…] *for minor provisions, L. 0.145 per quintal (3 grains per cantajo) of charcoal delivered to the warehouse was paid. It happened here that sometimes the charcoal burners and mule drivers tasked with making and transporting the charcoal would*

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

> *steal much of it, to the clear loss of the owners. These charcoal burners and mule drivers demanded that the price be paid not based on the quantity placed in the warehouse but on the presumed quantity: in that case, the frauds fell to the detriment of the Government*». (Giordano, 1864).

The assumption that the Bourbon government was negligent in making payments based solely on word of mouth, and that warehouse officials endorsed transporter-declared quantities without checks, is difficult to understand. Since the Napoleonic era, muleteers faced restrictions and penalties for presumed shortages rather than compensation for estimated quantities. The engineer's perception of such carelessness from the Bourbon government remains ambiguous. His complacent attitude towards the "Bourbon" administration, combined with the haste of his visit, may lead to misunderstandings. Furthermore, his judgments about the new "Piedmontese" management lack clarity, revealing a gap in his critical analysis of their administrative practices and leaving questions about his true evaluations unresolved.

> «[…] *Now we proceed with some modifications to this system, but the accounting with the different charcoal burners proves to be very complicated and requires a lot of work from employees*». (Giordano, 1864).

The incident in question recalls the period of mass immigration of officials to Southern Italy after Unification. In a context where new job opportunities were guaranteed to those already in position, careful attention to detail was necessary to instill operational standards, often at the expense of significant human resources. The presence of Piedmontese officials, motivated by detailed insights into Southern dynamics, raises questions about the actual benefits they provided. The endemic issue of smuggling is highlighted during the commission's visit, with the conclusion that such illicit activities had ceased. A specific incident from the 1855 flood illustrates attempts to appropriate materials, emphasizing how natural disasters influenced subsequent management and the enforcement of strict penalties to maintain order and legality. To shed light on the angle adopted by the commission during the visit and to emphasize the enthusiasm aroused by the unexpected forest heritage, below is a portion of the conclusions elaborated by Giordano:

> «[...] *The ancient administration, not devoid of defects, like in general that of the fallen government, antiquated practices and almost total lack of communication contributed to make the industry in Mongiana rather unprofitable for the government. Moreover, aside from the abuses and defects inherent in it, it would be very difficult nowadays to know the precise financial result of the ancient managements, while the system then used for accounting based on tariffs and conventional prices of a country where the principle of isolation and protectionism*

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

reigned, could only present fictitious positions unrelated to true industrial benefit. Now it is a matter of energetically working to derive a better outcome from those government-owned establishments, leading them towards a future more suited to their habits. Simplifying administration, closing sources of abuse and waste, choosing, distributing, and conducting operations more conveniently, improving roads, are the most essential and urgent tasks. And first of all, it is advisable to decide whether such industry should continue under government administration or be entrusted to private industry. As for the general principle, there is no doubt that the principle of private industry prevails: only in the special case does the opinion of some hesitate, fearing that the private sector, too concerned with its immediate profit, might harshly sacrifice the customs and interests of those mountain populations who have been living for so many years on a meager but regularly paid work. It is useless to discuss this difficulty now [...] because if the enterprise offers elements of good success, these will necessarily benefit, albeit reduced in number but improved in conditions, the employees and workers. Certainly, it is necessary for the government, in its concession, to proceed with caution, nor to neglect the precautions that are allowable with the free exercise of industry. Meanwhile, the Commission admitted by a large majority the principle of the swiftest transition from government to private administration, advising the government at the same time, considering the local difficulties, to use every possible facilitation towards the lessees. Indeed, on the one hand, it is indispensable for the government to leave to private industry the opportunity to provide itself with the necessary wood and coal at a moderate price, but on the other hand, it could not abandon them entirely at the disposal of the same without some danger. As we saw, those forests possess, in addition to the species useful for the enterprise in question, many others that can be a profitable source of income for the owner: therefore, there is no reason why, by granting to industry the exclusive use and even ownership of the mine and the establishments, the government should also transfer to it in equal measure the benefit of its own forests. They could remain as before under forest administration, and this could annually provide the concessionaire with the necessary goods at agreed prices [...]». (Giordano, 1864).

The statement presents a situation of ambiguity and questionable direction. The judgment on Mongiana, described as "burdensome rather than profitable," lacks a comprehensive, objective analysis. Simplifying administration is suggested but complicated by a growing administrative structure influenced by Piedmontese policies. Contradictions arise between upholding wage earners' interests and proposing drastic worker dismissals, impacting employment. The commission, favoring free-market principles, proposes privatizing plants and mines, with an exception for managing trees. Entrepreneurs acquiring ironworks would need to prepay for coal, raising concerns about industrial management feasibility. The commission overlooks the legal context of Mongiana's forests, governed by 186 articles of a dated forest law emphasizing isolationism and protectionism. A deeper understanding of this legislation could have highlighted its role in safeguarding national heritage, leading to a fairer evaluation of Mongiana's forest resources by integrating legal, environmental, and historical perspectives.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

«*Protection was:*
Art. 12. No wooded land may be cleared or cultivated.
Art. 13. To prevent damage from misguided cultivation, even solid non-wooded lands, provided their solidity does not result from regular cultivation, may not be cultivated without permission.
Art. 16 For sloping lands, whether wooded or not, commonly called hanging lands, easily traversed by water, and causing damage to lower lands, no permissions for clearing or cultivation shall ever be granted.
Art. 17. For all other lands not covered by the previous articles, clearances and cultivations may be permitted according to the provisions of this law, following a careful examination of local needs; an examination that, in the case of wooded lands, must also consider circumstances that may, depending on the case, affect public utility due to lack of fuel and other factors.
Art. 35. Regular cutting shall be done by cutting down all trees at ground level, reserving only 15 per moggio, which shall be marked for seed or hope; and protecting the felled part, by forbidding access to animals until permitted by the General Directorate.
Art. 38. The Directorate may permit clear cutting when young forests destined for tall growth need to be thinned out. It may permit it when it concerns isolated trees at the edges and paths of the forests, seed, or mature trees, and standing dead or diseased trees.
Art. 76. Since animals are harmful to forests and woods, administrators shall ensure that grazing is prohibited, except in rocky places and useless shrubs, where they do not cause damage.
Art. 79. Stubble burning shall never be allowed within 400 palmi of woodland adjacent lands». (De Stefano Manno, Matacena, 1979).

Omitting reference to the severe penalties imposed for acts such as violation, destruction, and burning of forests, the significant sanction provided by Article 108 of the forest law under examination is highlighted. This provision stipulates a first-degree imprisonment penalty, in accordance with Article 428 of the second part of the Code, for those who commit usurpation in forests. In cases where usurpation is associated with deforestation and land clearing, an additional fine is imposed as established in Section II of the same title. This forest legislation, characterized by an extremely modern profile, assumes a national scope, and is not limited solely to the three Calabrias. The observation of limited damage to forests by Giordano testifies to the respect reserved for these resources during that period. The first unified forest laws, inspired by the Sardinian law, differed radically from the principles of the Neapolitan law "967". (De Stefano Manno, Matacena, 1979). The enactment of the Sardinian Forest law in the South after unification contrasts with the omission of mining legislation, potentially indicating an exploitative policy.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

While mining legislation favorable to underground activity was not extended to southern regions, the forest law was quickly adopted, promoting deforestation. This legislation, beneficial in Sardinia for reclaiming low scrubland, proved detrimental on the mainland, accelerating exploitation and sacrificing forests for quick profits. This policy led to speculation, increasing the value of wooded lands and providing immediate benefits to landowners. Giordano's report highlights this sudden interest in forest resources, focusing mainly on the critical aspects of the metallurgical plant while providing a detailed analysis of the surrounding forests. He conducted an in-depth exploration, starting from Bosco di S. Maria, proceeding along the Serra-Mongiana Road, and examining the woods adjacent to the plant. His route continued through the vast Bosco di Stilo and explored other woods like Lacina, Boscarello, Fillò, and Dinami. Giordano, 1864). In the exploration account, the engineer paid particular attention to the accurate evaluation of each wooded area, highlighting an unexpected specific interest in the forest heritage and emphasizing the selective nature of his analysis, focusing more on natural resources than on the industrial aspects of the area. The surface area of the demesne areas, excluding municipal and private ones, could be approximately quantified at 8,000 hectares. The dominant tree species included beech, silver fir, red fir, white fir, holly, chestnut, and heather. In addition to extensive stands of Scots pine, there were also holm oaks, oaks, yews, hornbeams, maples, alders, and, in the locality of Chiuselli, rare larch pines imported and planted by the forest inspector Thomas. From demesne lands, it was possible to obtain approximately 32,000 quintals of beech charcoal annually, in addition to 3,000 quintals from various tree species. Giordano was unable to assess privately owned forests and relied on local experts for an approximate estimate. Based on their assessments, it is estimated that they could provide 51,000 quintals of charcoal annually, suggesting they were considerably more productive than demesne forests. Considering that a forty-year-old forest, adequately populated and subject to complete harvesting, with the preservation of protection trees, could produce 500 some metric tons of forest mass (equivalent to 300 quintals per hectare), the average yield of the fortieth part would be 750 kilograms per hectare. This estimate elicited wonder and disbelief from Giordano, who commented:

> «[…] *Such charcoal production is quite remarkable, and if it were indeed admissible, it would indicate significant vegetative strength in those areas." In drawing conclusions, he adds: "[...] overall, it could be obtained from non-demesne forests a quantity of 50,000 quintals of charcoal, which, combined with the 30,000 from demesne forests, would constitute a total yield of 80,000 quintals*». (Giordano, 1864).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

The calculation was: (Giordano, 1864).

Serra	Quintali 600	Q. 4,000
Stilo	Quintali 600	
Bivongi	Quintali 600	
Arena	Quintali 1800	
Spadola e Brognaturo	Quintali 400	
Duca di Bruzzano	Quintali 1800	Q. 47,000
Marchese d'Arena	Quintali 24,600	
Pellicane	Quintali 20,600	
Total	51,000	

Together with the other members of the commission, they began their departure, met with a natural apprehension, as the fate of the ironworks was now sealed; Giordano's "verdict" was made public in 1864. Fortunately, the Government did not prove so blinded as to passively follow the advice of its own experts. It became clear that the survival of the ironworks was closely linked to the forest resources, even though vegetable fuel had already peaked and had been outdated for several decades when Fazzari took on the improvised role of industrialist. (Mazza, 2021). However, in 1873, with the drafting of the auction specifications for the transfer of the entire plant, the Government also included the forests. The significant indication of reluctance to alienate them is fully evident in the fact that, of the 524,000 lire requested for the overall purchase, a substantial 416,000 were earmarked to exclusively ensure the forest heritage of the plant. The remaining amount had a relatively insignificant value, as it had already been decided to leave Mongiana to its fate. This decision underscores the crucial importance that the Government attributed to the management and conservation of forest resources within the entire industrial complex. The sale of the forests to a buyer who understood their strategic value could be considered essential to preserve the environmental heritage and ensure a responsible transition in the destiny of Mongiana. Currently, a fraction of the work activity in the forests persists, involving some inhabitants of Mongiana who have been spared from the phenomenon of emigration. (Regione Calabria U.O.A.). Until the 1990s, these individuals offered their labor as guards at the watch-fire towers. Today, the practice of wood carbonization is still carried out by some. Others, more fortunate, manage to obtain seasonal job opportunities from the State Forestry Corps, taking on roles such as lumberjacks, planters, and guards in the mountain animal repopulation park managed jointly by the corps and the municipality. The constant presence of the Forestry Corps in Serra and Mongiana has favored the reforestation process for several years, constituting a crucial element in defense against the depletion and environmental degradation that has affected the region since it was abandoned and handed over to speculators. What was once a "complementary" occupation to the

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

activities of the forges now plays a vital role for those few brave individuals who have chosen to resist emigration. The sustainable management of forest resources, supported by the active presence of the Forestry Corps, is critically important in protecting the local environment and creating job opportunities for those who have chosen to remain in the area.

Conclusions

The "Royal Decree" issued by Ferdinand II in 1859 represents an early example of regulated forest management with the aim of guaranteeing the sustainability of forest resources intended for the metallurgical industry of the Kingdom of the Two Sicilies. This decree establishes a series of detailed rules for the conservation, use and protection of state forests, highlighting a concern about the balance between felling and reproduction of trees, a theme that resonates with modern environmental protection laws.

The decree defines a clear and centralized administrative structure, entrusting the supervision of the forests to a state forest agent resident in Mongiana. This agent has the task of drawing up annual management plans, submitted to the Minister of Finance for approval, to ensure that periodic forest cuts are balanced and sustainable. The legislation also provides for the compilation of statistical reports and the verification of the conditions of the forests through regular inspections. This attention to documentation and oversight reflects a scientific approach to forest management, similar to that adopted in modern conservation policies, where data collection and analysis are fundamental to the management of natural resources. Another relevant aspect of the decree is the regulation of tree cutting, both in terms of the felling method, which must take place close to the ground, and the season in which the cuts can be carried out. This is in line with the principles of sustainable forestry, which aim to minimize the environmental impact of logging activities. Furthermore, the decree imposes protection measures against forest fires, regulating the charring of wood and establishing restrictions for the summer months, demonstrating an early awareness of the risks related to fires, a central concern also in current environmental laws. The guardianship of the forests is entrusted to brigades of royal foresters, with collective responsibility for the damage caused. This system of accountability and oversight is similar to that of modern environmental enforcement forces, which monitor and enforce environmental laws. The uniforms and military organization of the foresters highlight a rigorous approach to the protection of natural resources, partly mirroring modern environmental enforcement agencie. The assessment of damages and the application of penalties for violations are precisely regulated, establishing specific fines and judicial procedures. This legislative detail ensures that contraventions of forestry regulations are dealt with seriously, a principle that remains fundamental in current environmental

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

regulations, where sanctions for violations are essential for deterrence and protection of the environment. In conclusion, the 1859 decree shows an advanced vision for the time on the sustainable management of forest resources. Although the methods and technologies have evolved, the principles of sustainability, protection, and regulated management of natural resources present in the decree parallel those of modern environmental protection laws. This landmark document highlights how concerns for natural resource conservation and sustainability are time-honored and continue to be relevant in the current environmental management context.

Author's contribution: This work is the result of in-depth collaborative research between Prof. Renato Ghezzi and Dr. Elia Fiorenza. This contribution opens with an introductory chapter written jointly by both authors. The second chapter was written by Prof. Ghezzi, while the third is the work of Dr. Elia Fiorenza. The conclusions are from both authors. Furthermore, the regulation reported in the appendix was a faithful transcription of the original, carried out by the two scholars. The original of this document is kept in the Mongiana Museum, located in the province of Vibo Valentia.

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14. Of Spanish origin, Giovan Francesco Conty served as director from 1771 to 1790 and designed the first ironworks complex in Mongiana, which became operational in 1768.
15. The Salvaboschi Decree, issued in 1773 by Ferdinand IV of Bourbon, also known as Ferdinand III of Sicily, represented a significant early initiative for the conservation of the territory and the protection of forests in the Kingdom of Naples and Sicily (followed later by Ferdinand II's Royal Decree of December 20, 1858).
16. Today's laws regarding environmental and forest protection reflect a more sophisticated and integrated approach compared to the past. While in the 18th century the Salvaboschi Decree mainly aimed to regulate tree cutting to ensure sustainable management, current laws

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

cover a broader range of environmental issues. Nowadays, regulations emphasize the protection of forest ecosystems not only for timber resources but also for the crucial role forests play in mitigating climate change, preserving biodiversity, and ensuring air and water quality.

17. De Stefano Manno, B., & Matacena, G. (1979). Le Reali Ferriere ed Officine di Mongiana, una scoperta di Archeologia industriale: storia, condizione operaia, tecnologie di produzione, trasformazione del territorio, architettura delle più antiche ed importanti fonderie del Regno delle Due Sicilie. Storia di Napoli e della Sicilia, Società Editrice, Napoli, p. 98.
18. BNN, 63/1 - Memory on the Mongiana Establishment made by Captain Settimo by order of Mr. Major Sappel, Artillery Commander in Calabria. (n.d.). National Library of Naples (BNN), Manuscripts Section, Ms. 63/1.
19. (BSNSP) - In the decree issued in Persano on January 16, 1811, Murat, following the proposal of the Ministry of War, appointed members of the commission with specific duties: the Director of the Ironworks and Mines of Calabria Ulterior Seconda, Battalion Chief of Artillery V. Ritucci, designated as President, V. Raimondini (Mineralogist - absent for health reasons), G. Melograni (Inspector of Waters and Forests), and T. Paolotti (Engineer of Bridges and Roads). Murat's particular attention to the problem of afforestation emerges on more than one occasion: he exerted pressure on the Minister of Finance for the enactment of a comprehensive forestry law valid throughout the national territory. Reference is made to a letter dated March 18, 1809, sent by the Minister to Poerio and preserved in Ms. XXX A 8 of the Biblioteca Società Napoletana di Storia Patria (BSNSP): "The woods and forests are of particular concern to the King, who has ordered me to present him with a project for forestry organization." As a result of discussions held at the Council of State regarding this draft law, the Administration of Waters and Forests was established, and the Forest Rangers Corps was created. For further details, see: A. Valente: G. Murat and Southern Italy, Turin 1976.
20. BNN, Ms. 63/1. The Carbonile, around 1810, measured 180x60 palmi and was divided into six compartments. National Library of Naples (hereafter: BNN), manuscripts section Ms. 63/1.
21. National Library of Naples, Manuscripts Section, Ms 63/7. According to the summary table of the current condition of Mongiana in relation to the requests made by His Excellency the Ministry of War and the Navy «[...] with which an attempt is made to ascertain how long this establishment will be able to supply 60 thousand cantara of projectiles to meet the pressing needs of the service [...]».

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

22. (Ms 63/12, BNN) - Administrative Memorandum Budjet for 1814. National Library of Naples manuscripts section Ms 63/12."
23. (BNN, Ms 63/10) - The comparison is made between the price set for beech charcoal production and for wood splitting in the century-old forests independent of tall trees intended for the service of the Mongiana ironworks. See BNN Manuscripts Section Ms 63/10.
24. The introduction of severe and specific penalties underscores the firm determination of the military authorities to preserve the environmental integrity and sustainability of the forest resource.
25. Ritucci, V. (1819). [Letter to Mr. Mar.llo di Campo Macry, General Director of Artillery]. Archivio di Stato sezione militare Napoli (ASMN), Pizzofalcone Ms 25/31819 prot. 486.
26. ASMN, 1811. Ten. Colonnello di Art. (1811, January 4). [Letter to Mar/llo di Campo Macry, General Director of Train Corps]. ASMN Pizzofalcone, Comando Artiglieria fascio 28. From Mongiana.
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29. The measurement of forests was expressed in terms of "moggio," where the moggio comprised nine hundred square steps, equivalent to seven palms and one-third each.
30. Art. 44 of Law No. 967 decreed: "The Government hammers shall be kept in a case with two keys, one to be held by the senior official of the civil administration residing in the Municipality, and the other by the Forest Inspector, or by the General Guard in the absence of the Inspector. The hammer cannot be removed without first drawing up a report, which shall be signed by the officials and the agent to whom it will be assigned. The report shall mention the purpose for which it is to be used and the instructions received on the matter from the General Directorate." For the forest regulations of 1859, see: Regulation... in the Appendix.
31. Archivio di Stato Catanzaro (ASCZ). (n.d.). Mongiana fascio 37. Regarding fires, Law No. 967 warned: "If a fire breaks out in a forest, the guards responsible for guarding the forest and the rural guards shall be required to notify the Mayors of the neighboring Municipalities, under penalty of dismissal, in addition to any penalties incurred by law. The Mayors shall convene the inhabitants at the sound of the bells, so that, provided with hoes, axes, and shovels, they may come to the aid as needed."
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 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

APPENDIX

ROYAL DECREE AND REGULATION
FOR THE ADMINISTRATION AND CUSTODY OF THE FORESTS
OF SERRA, SAN BRUNO, AND STILO
INTENDED FOR THE SERVICE OF THE ESTABLISHMENTS
OF MONGIANA AND FERDINANDEA
NAPLES
FROM THE ROYAL PRESS
Caserta, December 20, 1858
FERDINAND II
BY THE GRACE OF GOD
KING OF THE KINGDOM OF THE TWO SICILIES
OF JERUSALEM, ETC.
DUKE OF PARMA, PIACENZA, CASTRO, ETC., ETC.,
GRAND HEREDITARY PRINCE OF TUSCANY, ETC., ETC., ETC.

Having seen our sovereign resolution of this same day;
Wishing that the reproduction of the forests destined for the use of the royal ironworks of Mongiana and Ferdinandea be increased in quantity proportionate to the consumption of fuel and other timber required by said royal establishments; On the proposal of our Minister Secretary of State for Finance; Heard our Ordinary Council of State;
We have resolved to decree, and decree as follows.
Art. 1. The regulation annexed to this decree for the administration and custody of the forests of the Amortization Fund, located in the territories of Serra, San Bruno, and Stilo, and intended for the service of the metallurgical establishments of Mongiana and Ferdinandea, is approved by Us.
Our Minister Secretary of State for Finance, and the Director of our Ministry of State for War are entrusted with the execution of this decree, each for the part that concerns him.

The Minister Secretary of State
of Finance Signed, FERDINAND
Signed, S. MURENA
The Minister Secretary of State
President of the Council of Ministers
Signed, FERDINAND TROJA

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

REGULATION

For the administration and custody of the forests of the Amortization Fund located in the territories of Serra, San Bruno, and Stilo, and intended for the service of the metallurgical establishments of Mongiana and Ferdinandea.

Art. 1. The forests and state lands, both in the territory of the municipality of Serra and its environs, and in that of Stilo, destined for the needs of the royal metallurgical establishments of Mongiana and Ferdinandea, shall be administered and guarded under the supervision of a demesne forest agent, who shall reside in Mongiana, and whose duties shall be determined by the Minister Secretary of State for Finance. The General Inspection at the royal Amortization Fund and public demesne shall provide for the methods of implementing the regulation of September 2, 1813, concerning the preparation of a general map of the areas assigned to the service of the Mongiana ironworks, and the same shall be done for the demesne forests in the territory of Stilo. The compilation of statistical reports for each forest area shall then be carried out in the manner prescribed by the royal decree of December 23, 1857. The aforementioned General Inspection shall annually propose to the approval of the Minister of Finance the projects for periodic cuts in the respective forests, taking into account the species and condition of the trees populating them, the nature and extent of the needs of the said metallurgical works, which shall be consulted, and reaching agreement with the director of the same; so that in the regular and occasional cuts of those forests, a possible balance shall always be maintained between the felling and use of trees, and their reproduction.

For each section or clear-cutting in those forests, the director of said ironworks shall make a special request, at least three months before the time it is to take place, to the aforementioned General Inspection, so that the latter can proceed with the examination of the forestry suitability, especially to determine the most suitable areas for the requested cuts, and to timely provoke the corresponding approval from the Ministry of Finance. In cases of extraordinary and urgent nature, the aforementioned provision shall not apply, and the acts shall be more promptly drawn up for the respective measures by the same Minister.

It is forbidden to fell trees in clear-cuts in said areas without Our sovereign approval, and without the prior examination of forestry suitability. In extraordinary cases, for reasons of urgency, the aforementioned Minister shall have the authority to provide, taking into account the more or less urgent need, and the choice of means to remedy it. Periodic section cuts shall be authorized by the same following motivated proposals from the aforementioned General Inspection based on the verification reports of demesne forest agents or other superior employees of the same branch. The marking and hammering shall be carried out by the same officials, with the intervention of an officer designated by the director of said ironworks for cuts for their use, the head forest keeper and head charcoal burner attached to the respective establishments, in order to make them more responsible than anyone else for the manner of executing the articles indicated in the records of the hammerings; and a special report shall be drawn up in triplicate, according to the respective interests. The cutting of trees in the clear-cuts shall be done at ground level, except for four for

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

each legal load, which shall be marked for seed or hope, and reserved standing, with the cut part then being defended. The royal forest keepers shall ensure, under their strictest responsibility, that the felling of the sections is carried out in the manner indicated; and in case of abuse, they shall draw up a report against the head forest keeper or head charcoal burner in cuts for those establishments, and the main perpetrators of such contravention, if they manage to discover or catch them in the act. The season for regular section cuts in those forests, being in cold regions, shall be from October 15 to April 19. Carbonization and processing of timber shall be permitted in every season, except for the months of July and August for the sole production of charcoal, so as not to cause fires in said forests. The spruces and pines found there may be felled at any time of the year. The construction of charcoal kilns shall be carried out, according to forestry rules, under the care and responsibility of the head charcoal burner and the royal forest keepers, to prevent loss of fuel.The allocation of special sites for the corresponding furnaces shall be made by the demesne forest agent in the clearings of the sections or the same forest closest to them; and in the absence of nearby surfaces devoid of plants, said kilns may be built.

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The Importance of Surveyors and GPS Technology in Systematic Land Registration in Georgia: A Study of the Challenges and Opportunities

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Abstract

The purpose of this work is to explore the historical and contemporary importance of land registration, focusing on the crucial role played by Georgia's surveyors. The paper concentrates on the combination of GIS-based state systems with GPS PlateTalk map registrations to resolve conflicting cadastral information as well as for accurate ownership record keeping. The Georgian absence of a unified legal and administrative framework significantly complicates land boundary delineation leading to disputes among surveyors. To standardize surveying practices and improve accuracy, an all-encompassing legal framework must be put in place.

The study adopts historical, comparative legal, and hermeneutic research methods using examples from Germany and Holland that demonstrate how such advanced technologies as drones, LiDAR, and blockchain can enhance the precision, speed, and security of survey practice. Furthermore, professional education investment must be increased in both teachers and attorneys who are also informed about Geoinformation Systems (GIS), thus enabling them to perform their functions properly when it comes to law matters concerning land registers.

Conclusions urge policy-makers to invest in modern technological gadgets as well as engage in legislative reforms that would make their cadastral systems stronger. That would result in the creation of robust cadastral

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systems by investing in modern technology as well as carrying out legal reforms that would modernize their existing cadastral systems.

Keywords: Cadastral survey drawing, Land cadastre, Overlapping property boundaries, Mapping

Introduction

The importance of systematic recording of titles in land cannot be undervalued, especially in a country like Georgia where economic growth, legal clarity, and social stability depend on correct property records. After independence, Georgia went through the process of extensive land privatization that has been largely facilitated by surveyors from the Institute. The introduction of systematic registration of real estate rights has led to greater demand for accurate cadastral information thus pointing out the critical role played by surveyors in its provision.

However, Georgia's current legislative framework is fragmented and insufficient to comprehensively define surveyors' rights and duties.

An example of these technologies transforming land registration systems all over the world and how they have been reported recently is illustrated by many studies as well as articles. Notably, incorporating advanced geospatial technologies in Germany and Holland has improved spatial data accuracy significantly, thus increasing the trustworthiness of cadastral records by reducing legal disputes.

Williamson (2022) gives a general glance at how land administration systems are linked to sustainable development in different countries. It underlines how accurate land information is important for economic advancement, social orderliness, and environmental conservation. The authors also emphasize on GIS and GPS-related technologies that come into play in current land management activities while noting that a strong legal framework is required to ensure that they operate accordingly.

This research is very important for Georgia, the establishment of property boundaries and land ownership in a legal and precise manner is crucial for economic development, social stability as well as legal clarity. The lack of detail in the regulation of geospatial rights and obligations hampers the accuracy of land registration while increasing the likelihood of conflicts in addition to ineffectiveness. By looking at how modern GIS technologies can be incorporated with GPS technology in day-to-day surveying work. A land surveyor has always played a critical role in the establishment of property boundaries and the proper recording of land ownership interests. In Georgia, as part of the privatization of the land state program, a comprehensive system of surveying and land registration was required to be established to serve as the foundation for legal land ownership and to resolve land disputes. Thus, the

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Surveyor's Institute is expected to play a crucial role in the privatization process, as it will ensure the accuracy and legality of land records. However, their rights and obligations are not determined properly in the Georgian legislation. This creates inconsistencies in the everyday practice of surveyors and may cause legal disputes.

Modern surveying practice utilizes Geographic Information Systems (GIS) and GPS technologies (Merebashvili, 2023). These systems enable surveyors to collect, analyze, and display spatial data with a high degree of accuracy, which is necessary to ensure the accuracy of the cadastral records. GIS enables the integration of different data sets that provide a holistic perspective of land parcels, property boundaries, and other geographical objects. GPS technology complements the GIS by offering accurate coordinates of land parcels, which are necessary to determine their boundaries and resolve disputes. Overall, proper use of GPS and GIS technologies together with the Surveyor's Institute helps to ensure the accuracy and efficiency of the land registration system.

This article discusses the way the Surveyors' Institute and GPS technologies tackle legal issues of the systematic land cadastre establishment in Georgia. The article outlines the existing legal framework and current state of law regulating the activities of surveyors. It attempts to evaluate, whether there is a need for the systemic regulatory framework of the profession. The article considers the functions of the Surveyor's Institute and the usage of GPS technologies as examples, highlighting the factors, that have a significant impact on the legal and practical effect of the land registry.

A primary legal challenge to surveying in Georgia is a lack of coherent, integrated regulatory policy. Rights and duties of surveyors, rights and duties of land owners, buyers, and institutions, are defined in various laws, orders, and normative acts, often fragmented and sometimes contradictory. For example, while the Order of the Minister of Economy and Sustainable Development of Georgia #1-1/410 from the 3rd of August, 2016, regulates certain aspects related to land measurements in the course of public auctions, this order does not provide a comprehensive legal basis for surveying activities. The piecemeal approach leaves lots of room for dispute over land boundaries, ownership, and usage rights. The absence of unified procedures and uniform qualifications for the surveyor further aggravates these issues. In many developed countries, to become a surveyor, one has to go through very tedious training and certification procedures. These procedures make sure that the surveyor is qualified and will follow the standardized procedures. In Georgia, the lack of such criteria leads to the fact that the quality of the surveyor's work is very variable, and therefore, the reliability of the cadastre data. This situation dictates the need to institute legislation that defines the qualifications, rights, and responsibilities of surveyors, and ensures

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consistency and accuracy in land registration processes use of GPS/GIS as technology will offer a pathway to address some of these challenges. Precise and comprehensive data will enhance the accuracy of the cadastre record and reduce the potential for dispute. For example, GPS will pinpoint property boundaries precisely, while GIS will integrate multiple data layers to provide a comprehensive view of land use and ownership. However, its effective application demands a regulatory framework supportive of their implementation and guaranteeing that surveyors are adequately trained for use conclusion, even as the Surveyor's Institute is very important to the land registration process in Georgia, its great potential cannot yet be realized due to the lack of a comprehensive legal framework. Developing standardized regulations and utilizing state-of-the-art technologies would increase the accuracy and reliability of the cadastral records in Georgia, thus providing for legal ownership and reducing the number of disputes. This paper highlights said issues and attempts to provide solutions for the effectiveness of surveying activities in Georgia.

Role of geography and GIS in a legal context

Maps have been used since ancient times to determine the territories of states (Black J., 1997), therefore, cartographic data were the main tool of land distribution and jurisdiction over them. A map primarily serves to determine the physical location of a country or individual objects (Harley JB., 1987). Thus, it is also a determinant of law-making and politics. A map is more than just a geographical tool, it is a tool for gaining influence (Soja EW., 2009). Montesquieu developed new theories that linked the issues of climate and farmland with law (Montesquieu SL, 1994). His work reveals the connections between law and geography from early times to the emergence of modern laws.

Geoinformation systems have led to the creation of maps of practical use by law enforcement agencies for crime analysis and investigation purposes (Rogers R., 1994). Over time, GISs have become an important ally for law enforcement agencies, these systems are versatile and run on both mobile devices and personal computers (Heywood I., 2006).

Mapping and GIS are applied to law enforcement and in many other fields, such as town planning, environmental management, and transportation. City planners use GIS technology to analyze demographic trends, assess land-use patterns, and optimize infrastructure development. Environmental agencies apply GIS to monitor and manage natural resources, trace animal habitats, and regulate the impact of human activities on ecosystems.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Historical context of surveying activity

Surveying is as old as the practice of managing and organizing land and resources. It has roots way into antiquity, taking its origins from ancient Egypt. The need to restore the boundaries of agricultural plots destroyed annually by the flooding of the Nile River led to the development of early surveying methods. Precise measurements conducted by ancient Egyptian surveyors helped to restitute those lands but contributed to the monumental undertakings of constructing the Great Pyramid of Giza (9). Evidence of surveying can also be seen in Roman history, where surveyors were important in defining geographical units of the vast Roman Empire. As early as 300 AD, Roman surveyors were to establish precise boundaries and maintain tax registers for the lands under Roman dominion (Hopkins K). Their work set the basis for administrative systems that were based on precise land data, which underlined the role of surveyors in the governance and administration of resources. The value of surveying can also be found in the Bible, where land boundaries and landmarks are mentioned. In Deuteronomy 19:14 and 27:17, Proverbs 22:28, and Job 24:2, the importance of defining property boundaries is stressed, showing the persistence of surveying principles in ancient society (Bible, 2nd Law). The techniques of surveying evolved further with the passing of centuries, making great strides during the European Enlightenment (12). The 18th century saw the development of triangulation as a revolutionary method of surveying. Based on accurate angle measurements, it created an interlocking network of reference points for purposes of mapping and communication. The method introduced new changes in the field of surveying and paved the way for later innovations in geospatial technology.

Surveyors had to make use of many tools and instruments, such as measuring wheels, guide chains and compasses to estimate geographical data and demarcate the borders between nations. The painstaking efforts of the early surveyors not only facilitated exploration and settlement but also helped in laying the way to establish legal frameworks governing the ownership and administration of lands. Nowadays, technological innovations have revolutionized surveying into an era of unprecedented precision and efficiency. GPS and GNSS technologies have provided access for surveyors to accurately measure the coordinates of geographic objects and collect space-based data with a level of accuracy. Today, any serious surveyor would have access to GNSS rovers and total stations (Hallmann F., 1994), among other critical tools for conducting surveys accurately and quickly across any landform and weather condition. Digital mapping technologies have expanded the capabilities of surveyors, and geographic information systems have empowered them to analyze and visualize their spatial data in ways that were previously unimaginable. Surveying plays an essential role in shaping our world and assisting decision-making processes in many ways at the local,

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

regional, and global levels of planning urban communities and infrastructure, managing the environment, and disaster management. Land Surveying Institute is an ancient profession in the world that has undergone continuous evolution towards advancement for the rising needs and complexities of human societies. From the greatest ancient civilizations to the digital age, surveyors have been the silent but essential molders of the world we live in, giving us valuable data and information that help in our understanding of the Earth and its resources. The position of the surveyor remains critical in this continually evolving technological world to move us through our planet with certainty and sensitivity.

Surveyor as a land surveyor at the time of registration

In the process of registration of rights to real estate, the most important thing is the survey of the land, taking into account the interests of the buyer and the seller. for example, From the 20th century to the present day, the functional meaning of the surveyor's activity in the USA has not changed: determining the boundaries of the land - land survey, which determines the geographical boundaries of the property object. This process is necessary to avoid future neighborhood disputes due to overlapping borders. Through advanced technology and methodology, a land surveyor/surveyor provides geoinformatics data processing based on legal data. In the context of limited commercial rights, such as easements and right of way, the surveyor specifies the geographic location of the easement and accurately reflects it in the documentation (Wilson R.C., 2006). During zoning, land surveyors assess whether a property complies with municipal zoning ordinances, providing critical information to the buyer, including the seller. Land surveyors play an important role in the process of creating a topographic map, which is an essential component of construction permit documentation (15). Moreover, land surveyors have an important function in the resolution of land disputes, expert results, and providing evidence, for example, in connection with the demarcation of the country's borders, they create property and general land maps with high accuracy, which is a necessary basis in the process of real estate registration and obtaining ownership rights (16). The land surveyors are responsible for bringing the document establishing the ownership right into harmony with the actual circumstances (Pylaeva A.V., 2020). A land information system can be created with cadastral programs and digital maps, which are collected in geoinformation systems (GIS) (Tanawijaya H., Velisia M., 2022). Surveying activity is of such great importance, both in legal and other sciences, that in many developed countries the profession of surveyor requires legal education (Ronald L., Williams SR/WA). The government of Georgia carries out systematic registration of rights to land plots free of charge (20). The process of registration of ownership rights and changes in registered

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data on plots of land located in different geographical areas or within the scope of a project of special state and public importance is ongoing on a proactive basis (21, Article 2). Along with the establishment of the National Agency of Public Registry, the legal importance of systematic registrations has increased, especially in such geographical units where there is an overlapping situation in the registered data, which becomes the basis of legal disputes between the owners, and in this process the land surveyor and advanced GPS technologies play a decisive role. It is the Surveyor's Institute that provides the field digitization of agricultural land as an object, the preparation of documents necessary for the registration of ownership rights, and the specification of geographical boundaries (Navratil G., Frank U.A., 2004). Systematic registration is also a legal mechanism for obtaining ownership rights for legitimate owners (21, Article 4). Within the framework of systematic registration, a social context is provided for citizens, which implies a subsidy of the registration fee. Surveyor and GPS technologies have an advanced role in the process of effective implementation of systematic registration, protection, and realization of the rights of the true owner and owner (25, Article 2).

Integration of modern technologies

Among the advanced GPS technologies, famous are LiDAR and advanced software, which have revolutionized geodesy and play a major role in construction law for example, in completing architectural documentation (Li Y., Liu X., Han X., 2016).

Moreover, blockchain for land registration is transparent, secure for information, and publicly available, which provides the ground for the record of the ownership transaction over a plot of land. Blockchain has the power to offer a very high standard of protection of records of land ownership and to avoid fraud, as well as provide correct and updated data on information related to the landowner, and land geo-information data. The implementation of such technologies in the state institutions of Georgia deserves its support, and in the future, it will greatly increase the quality of land registrations and the protection of the rights of owners.

Educational and professional development

One way of conquering the problems facing surveying activities is for the state to develop a policy on specialized education and professional development of surveyors. The universities and other institutions of learning will provide special curricula and syllabi, meaning special educational programs that have content on new technologies and methods of measurement. Surveyors are best served by such specialized professional development programs that help them update their skills. The partnership between

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

educational institutions, government institutions, and professional bodies may provide the policy development needed for the development of the surveying profession (Zheng Z., 2018).

One of the effective ways to respond to such challenges in surveying activities is to come up with a state policy on specialized education and professional development for surveyors. It is through a set of established guidelines and incentives that various governments may wish to encourage universities and other learning institutions to design specialized curricula and syllabi that meet dynamic changes in the surveying profession. These programs would ensure measurement is undertaken with the latest technologies and methodologies, thus equipping surveyors with the latest tools and techniques in the profession.

Measuring challenges in Georgian legal reality

There is no separate legal order for surveying activities in Georgia. The surveyor's rights and duties are not sufficiently regulated at the normative level but are scattered in various articles in orders or separate normative acts, for example, order #1-1/410 of the Minister of Economy and Sustainable Development of Georgia dated August 3, 2016, where it is determined that the surveyor is signed in writing with the interested person The person acting based on the contract, who is responsible for the preparation of the cadastral survey drawing. Of course, the above will not be enough to establish the legal order of rights and duties of the surveyor's institute. Foreign countries dedicate separate normative material and legal frameworks to the order of this institution and define the rights and duties of surveyors. For example, in Germany, there is a special law about land surveying and land cadastre production, the normative content defines that a national land survey must be carried out, which means whether, for example, the registration object requested by a private owner corresponds to the state interests, land cadastre production is also carried out in the context of conducting property surveys Determining the time and boundaries of buying and selling is mandatory, and the processes are produced in geoinformation systems (26, 2004). The legislation of Georgia does not require the surveyor to be involved in the process of the agreement of the parties or to verify such an agreement, however, in the Netherlands, like France, the surveyor has the right after the field survey when the object is measured and then the geometric relationship is adjusted in office conditions through geoinformation systems (GIS), the decision of the parties will be verified and recorded by the surveyor even (Wakker J, 2003).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

GPS and GIS in cadastral boundary survey and map updating

It is easy to follow how geography evolves with law, how changes in legislation affect geography, and how geography reflects the imprints left by legal norms. The law establishes territorial boundaries (sovereignty) (28, Article 1), maintains or protects boundaries and physical location (29, Article 12), and affects spatial planning. Geodesy as a science with the help of GIS is used at the state level in the following main directions: 1. Land registration; Determination of cartographic data for cadastral systematization. An accurate map is used to determine the boundaries of a plot of land; 2. Environmental protection: Cartography creates maps, which are important for the practical implementation of environmental protection norms.

Disputes related to real estate, especially land, are a common challenge for the law, not only in Georgia but all over the world (30). The use of geoinformation systems promotes the publicity of such issues as 1. determination of land ownership, transfer of land ownership rights, information on limited commercial rights, and security information; 2. Value of land and property; 3. Land market support and analysis; 4. Data on planning and management of utility services (Ventura SJ, 1995).

In Holland To effectively process information about the rights of the owners and the plot, the cadastral and land registry agencies are separate institutions (Wakker J, 2003), that is, they divide the registration process into cartographic and administrative activities, which ultimately serve one purpose. The administrative database contains the essential legal and administrative information of any land plot, and the cadastre ensures the alignment of geo-information systems and cadastral survey drawings of the plot with administrative data (32). there is no separate legal framework for the cadastre. Since the introduction of the land register and cadastre in Holland in 1832, all changes to the cadastral map have been preserved in the geoinformation system of the land plot (Gurung P, 2021). Map updating is related, for example, to the agreement of the parties on the location of new boundaries, when the surveyor measures new boundaries establishes the coordinates of new boundaries brings them into correspondence with topographic objects, and determines objects located on the ground (Hagemans E., 2022). At the beginning of the 19th century, one of the tools used by surveyors was a chainsaw, and today the latter has been replaced by GPS devices, which are managed by RTK-kinematic servers, which means real-time coordinate digitization. The RTK method works to ensure the accuracy of the GPS. The location of objects is determined by coordinates (35), according to already registered digital cadastral data The surveyor can determine the actual (coordinates) with a GPS device (Safrei I., 2018). GPS technologies are integrated into any digital device, but surveying involves positioning through at least two satellite GPS receivers, one for measuring the baseline and the

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

other for measuring the actual distance and location of the position (Meng F., 2020).

Resolving land use conflicts is a complex process, during disputes it is necessary to analyze spatial data, which is carried out through GIS, however, to ensure the accuracy and reliability of GIS data, GPS technology is necessary, which is an advanced tool for collecting, verifying and updating spatial data. The legislation of Georgia does not provide a clear record that only licensed persons can carry out surveying activities because, in the archive records of the National Agency of Public Registry, there are several registration documents and cadastral surveying drawings, which are stored by an unlicensed person, improperly (mobile phone or so-called handheld GPS) is made with a measuring tool.

Conclusion

The relationship between geoinformation systems (GIS) and law is a complex and multifaceted process, especially in Georgia, where active work on integrating these fields is still in the early stages. This paper underscored a deep relationship between GIS and legal sciences, laying particular stress on the critical role that GIS plays in legal research and practice. The inter- and multidisciplinary nature of GIS enhances its utility in the legal domain, making it an indispensable tool for accurate land registration and property rights management. Systematic registration of rights to immovable objects is a vital process for securing property rights, which in turn ensures the social function of the land. Looking from historical and contemporary perspectives, this paper highlights the enduring relevance of the surveyor's profession. From ancient times to the present day, surveyors have been indispensable in defining property boundaries, ensuring the accuracy of land records, and facilitating legal ownership. Nevertheless, the current legislative framework in Georgia does not provide a comprehensive definition of surveyors' rights and duties, which creates considerable challenges for the profession. A lack of a unified regulatory framework for surveying activities in Georgia has resulted in inconsistencies in practice and potential legal disputes. Surveyors operate mainly as subjects of private law, but the scattered nature of existing regulations results in fragmented and sometimes contradictory guidelines. This lack of clarity hampers the reliability of cadastral data, which is crucial for accurate land registration and dispute resolution. To resolve these issues, it is indispensable to develop a comprehensive legal framework that clearly defines the roles, responsibilities, and standards of surveying activities.

Modern technologies, primarily those in GPS and the Real-Time Kinematic systems, are very important for enhancing land survey accuracy and efficiency. GPS location data, used in determining land boundaries, are crucial for collecting relevant cadastral information. RTK improves the

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process by adding the accuracy of the positions, as it delivers real-time GPS data corrections. Such technologies, if implemented massively in surveying activities, would guarantee that the cadastral data is reliable and thus reduce the probability of land disputes and enhance stability in land ownership records. In addition, the use of GIS in legal research and practice will unveil a need for a multidisciplinary approach to land registration and property rights management. GIS integrates diverse forms of spatial data into a single, comprehensive view of land use, property boundaries, and other features. This holistic view is gold for legal professionals, as it puts them in a position to analyze intricate land issues. Therefore, modern lawyers with proficiency in GIS and other related technologies have a firmer grasp of legal and national issues related to land ownership and registration. Another method of promoting the development of the surveying profession in Georgia would involve educational initiatives and continuous professional development. Universities and academic institutions should offer special courses that include modern technologies and methodologies in surveying. Continuous professional development programs will enable surveyors to keep pace with the changes within the profession to give accurate and reliable services. Moreover, universities, government agencies, and professional bodies need to collaborate to support surveyors in their professional growth and ensure a high level of performance.

In conclusion, the Surveyor's Institute plays an important role in the land registration process in Georgia. The strong potential that can, however, be realized when a harmonized legal framework is established; standardization of regulations and modernized use of technology, for example, the use of GPS and GIS, shall lead to Georgia attaining its goals of improving the accuracy of cadastral records. This will prop legal ownership, reduce disputes, and translate to the country's economic development and social stability. A robust legal framework, accompanied by investment in education and technology, will be put to find solutions for the problems which the surveying profession is going through and ensure effectiveness in land registration processes in Georgia. The need for a fully harmonized legal framework for the surveying activity is therefore great. It would provide for not only the rights and duties of the surveyors but also licensing rules and standard procedures. That will make a more predictable and stable environment for land registration for the benefit of the property owners, legal practitioners, and society as a whole. In effect, Georgia can create a transparent and efficient system of management of land ownership and registration by solving these problems and hence social and economic welfare.

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Appraisal Theory and Interpreting Political Speech

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Abstract

Appraisal theory can be used to study the semiotic content of formal speeches. This paper focuses on the study of two speeches by Ban Ki Moon. The first in 2006 was his acceptance speech and the second, in 2016, was his speech on leaving his role as Secretary General of the United Nations. By employing the same speaker and organization, this helps remove variances due to personal or corporate style. It also allows a focus on how different semiotic approaches are used at different stages of each speech. While affect is common across the speech structure, judgement is more commonly found in sections that can be seen as instances of expected politeness towards the intended audience. By using such modes, the speaker is effectively inviting agreement with their overall presentation. This also suggests a linkage between chosen mode and purpose. However, meaning-making cannot just be understood through a sentence by sentence analysis and there still remains a need to take a holistic overview and place the speech in a wider context.

Keywords: Affect, Judgement, Speech, Attitude, Appreciation, Appraisal theory

Introduction

Appraisal theory (Martin & White, 2005) focuses on the emotional content of speech and text (and images where appropriate) in building up both the intended meaning by the speaker (or author) and as interpreted by the audience. When applied to a formal speech, this allows consideration of how the speech is structured, whether the goal is to bring the audience to agreement

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(Hamby & Jones, 2022; Shahmir, Rasool & Irshad, 2023) or to exclude those not already convinced (Zhou, 2023).

Two speeches were selected for this paper. The first was the speech given by Ban Ki Moon in 2006 (Moon, 2006) on formally taking up his role as Secretary General of the United Nations. This can be broadly sub-divided into the following sub-sections: his opening remarks which include indications of appreciation at his appointment and praise for his predecessor; a discussion of his appointment process and perceived flaws he now wishes to address; and his ambitions for the UN under his leadership. The second speech was his farewell address in 2016 (Moon, 2016). Again, this can be subdivided into sections where he acknowledges the work of others, reviews his own term of office, a lengthy discussion of his personal feelings on leaving the role, and a restatement of gratitude to those present. The advantage of choosing speeches by the same person in the same organization is that this removes any variation that may have reflected individual speaking styles or differences in corporate norms.

One practical issue is that while appraisal theory offers a framework, there are challenges in its practical application (Troiano, Oberländer & Klinger, 2023; Wei, Wherrity & Zhang, 2015). This does not just include practical issues of coding, but also the basic terminology in use (Aian, 2017; Mirzaaghabeyk, 2022). Despite this, the analysis points to how different emotions are invoked, or reflected, across the different sections of a speech (Roseman & Smith, 2001). Furthermore, in both cases, the speaker seeks to fit in with the social norms of courtesy and politeness that are believed to characterize the institution (Aian, 2017; Hofmann, Troiano, Sassenberg & Klinger, 2020). This gives a pattern of emotions different from those found when the speaker has little or no interest in engaging with those who are unlikely to agree with him in the first place (Ross & Caldwell, 2020; Zhou, 2023).

Literature Review

Halliday's Systemic Functional Linguistics (Halliday, 1978) focuses on the semiotic structure of language (Soo-Guan Khoo, Nourbakhsh, & Na, 2012) rather than grammar and other aspects of meaning-making, leading to a focus on what is known as interpersonal semantics. In many contexts, the goal of a text (or a speech) is to generate an emotional response. There may be elements of information giving, meeting social sensibilities and expectations, but the end goal is often emotional. Hence, the speaker may use modes of speech designed to make them appear likeable or authoritative to make their proposal appear more attractive. Thus, the language chosen and wider speech structure is important to maintain interpersonal relationships (Hamby & Jones, 2022), and to gain the benefits of being seen as a likeable, trustworthy

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individual (Shahmir, et al., 2023). This suggests that patterns of speech have considerable bearing on their interpretation by their intended audience.

Appraisal theory (Martin & White, 2005) addresses this dynamic by exploring both the emotions invoked by the speaker and how these are understood by the listener. It also brings in an important social context both in terms of the understanding that relates to prior knowledge and attitudes as well as to what is expected. Furthermore, the two speeches studied in this paper both have large sections of what can be called politeness, as the speaker either praises his predecessor (Moon, 2006) or, on leaving the job ten years later, those who have worked with him (Moon, 2016).

These elements are important scaffolding for the rest of the speech because they are socially expected, and, if absent, it could alter any perception of the core message. Political speeches can be seen as a specific form of discourse since it is presumably intended to provide information, gain support, and create a wider narrative. This makes the emotions in both speech and the likely audience important (Zhou, 2023). Moreover, it is important to note how contrived formal speeches often are, as they are designed with a purpose (Bolouri, 2008) and, for an important figure, they are partially written by other professionals.

When applied in practice, the process of appraisal is often broken down into attitude, judgement, and appreciation. Some applications of appraisal theory also use affect, judgement, and appreciation for this process (Aian, 2017). A further complication is the use of a variety of coding systems when it is actually applied to textual analysis (Wei, et al., 2015). In general, the theory is not predictive in the sense that a given criteria will dominate, but the original assumption was that affect was particularly important as the main driver of emotional responses.

Attitude is used to capture this process of understanding the text and an emotional response. This response can either be intended by the author or attributed by the reader. As a result, emotions emerge from our appraisal of the text (where relevant), the resulting action choices, and any physiological reaction (Moors, Van de Cruys, & Pourtois, 2021; Roseman & Smith, 2001). In some situations, the adoption of an emotional response can see little or no active cognition, but in others there is a need to assess what is being said and then form a response (Briñol et al., 2018).

Judgement is the process of evaluation, originally of the character of an individual or the reliability of their intended message. Typical emotional responses are shown through qualifying adjectives such as ‘honest’ or ‘unreliable’ (Križan, 2016). So, a politician who wishes to influence an audience will tend to use a pattern of delivery that fits their expectations. Often, this will seek to create an image of reasonableness and plausibility (Moors, et al., 2021). However, there are examples where the speaker will

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

deliberately denigrate parts of a wider society so as to gain support from potential supporters. In effect, judgement can come from meeting wider social norms or rejecting them to emphasize their status as an outsider challenging the system (Ross & Caldwell, 2020; Zhou, 2023). This leads to ambiguity as to which process is being followed, an issue common across the use of appraisal theory (Martin & White, 2005; Page, 2003). The only practical solution is to consider the totality of the speech and the known aims of the speaker (Alhuthali, 2018).

Appreciation (Watson & Spence, 2007) also has a wider social aspect as both creator and viewer will draw on the context (either within the text or in wider society) to enlighten their understanding and interpretation (Coffin, 2003). In response to a speech, this can invoke pre-held beliefs that a given politician is acceptable or not, or it can be situational, responding to this particular instance. Overall, appreciation may either pre-condition the likely response or provide information missing from the actual image to come to an understanding.

Taken together, appraisal theory is "concerned with evaluation of the kinds of attitudes that are negotiated in a text, the strength of the feelings involved, and the ways in which values are sourced and readers are aligned" (Martin and Rose 78). It achieves this by offering a framework to explore emotional processing (Soo-Guan Khoo, et al., 2012), both by the active speaker seeking to create attitudes (Mirzaaghabeyk, 2022) and creates a framework of audience emotional engagement (Hamby & Jones, 2022) as the speaker makes "use of language resources in their speeches to convey emotions, judgments, and appreciation" (Mirzaaghabeyk, 2022, p.3).

Research Methods

Research into the semiotic modes in a speech often takes on both a qualitative approach as the key parts are interpreted using the concepts of appraisal theory. Also, some degree of quantitative investigation was derived by counting the incidence of attitudinal resources and how this may contribute to either different parts of the speech or, indeed, different speeches (Bolouri, 2008; Hamby & Jones, 2022; Shahmir, et al., 2023).

One enduring challenge in this field is the construction of lexicons (Troiano, et al., 2023) and frameworks. The task of emotion analysis is commonly formulated as classification, as textual units (documents, paragraphs, sentences, words) are mapped to a pre-defined reference system (Hofmann, et al., 2020). As noted above, even at the theoretical level, appraisal theory has somewhat different descriptions of its components and this becomes more complex when detailed coding structures are used. Identifying the different types of emotions and finding applications for this more subtle

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

kind of sentiment analysis may represent the next frontier in automatic sentiment analysis research (Soo-Guan Khoo, et al., 2012).

A further challenge is to define the unit of analysis. Some studies (Soo-Guan Khoo, et al., 2012) break the speech down into what are identified as key blocks, sometimes not even the size of a discrete grammatical section. This allows considerable detail in terms of the interplay between speaker and audience, but creates problems in turn. First, the decision to select this or that block is a judgement in itself. The consequence may be over-emphasis on that part of a speech that sets out policy at the expense of how the speaker uses elements of speech in more social phases, such as thanking their audience for attending. In this study, the decision was made to analyze the complete speech by sentence.

Very few sentences had no coding as they were short and others had multiple codes attributed as they sought to present multiple elements of the appraisal theory framework. Aian (2017) splits the three main sub-groups into positive and negative emotions, such as happiness and unhappiness. Thus, he created a framework for affect as shown in the table below:

Table 1. The Affect System (Aian, 2017, p. 9)

The Affect System

Affect		Surge(of behavior)	Disposition	P/N
Happiness	Cheer	laugh, rejoice, smile	Cheerful, buoyant	Positive
	Affection	hug, embrace	love, adore, like	
Unhappiness	Misery	cry, wail, whimper	down, sad	Negative
	Antipathy	abuse, curse, revile	hate, resent, abhor	
Security	Confidence	proclaim, declare	assured, confident	Positive
	Trust	entrust, believe	reliable, trusting	
Insecurity	Disquiet	shaking, restless	uneasy, anxious	Negative
	Surprise	start, faint, collapse	startled, shocked	
Satisfaction	Interest	attentive, industrious	absorbed, focused	Positive
	Pleasure	reward, praise	content, pleased	
Dissatisfaction	Ennui	yawn, fidget	jaded, stale, bored	Negative
	Displeasure	scold, blame, caution	angry, furious	

As the second subset of attitude, judgment deals with attitudes towards behaviour and has a positive and negative dimension corresponding to positive and negative judgment on behaviour. Under judgment, human behaviours are evaluated according to social expectations, shared values, social norms, as well as laws, rules, and regulations. According to different evaluative standards, judgment system can be classified into two broad categories, defined as social esteem and social sanction.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Table 2. Judgement System (Aian, 2017)

The Judgment System

Judgment		Positive	Negative
Social Esteem	Normality	normal, stable, natural	odd, obscure, peculiar
	Capacity	fit, mature, clever, expert	weak, sick, stupid
	Tenacity	brave, careful, reliable, loyal	timid, hasty, stubborn
Social Sanction	Veracity	honest, credible, frank	blunt, deceitful
	Propriety	caring, modest, generous	cruel, rude, selfish

Appreciation makes assessments of the 'things', including the things human beings make and the performances they give as well as natural phenomena that are worth evaluating. Being identical with affect and judgment, appreciation can also be recognized as positive and negative evaluative resources and–can be grouped into three sub-types: reaction, composition, and value.

Table 3. Appreciation System (Aian, 2017)

The Appreciation System

Appreciation		Positive	Negative
Reaction	Impact	exciting, notable, lively	dull, boring, tedious
	Quality	fine, good, splendid	bad, nasty, ugly
Composition	Balance	unified, logical, balanced	irregular, flawed
	Complexity	simple, pure, precise	unclear, plain
Valuation		deep, creative, authentic	shallow, fake, worthless

This framework was largely adopted in this study with one important alteration. Direct opposites, such as Happiness/Unhappiness, were conflated for two reasons. First, since the actual coding shows whether the emotion is positive or negative, the distinction is not really needed. More importantly, Aian (2017) tends to frame negative emotions as undesirable. This is too simplistic because emotions, such as fear, can be a useful spur to action, while disgust about something happening in the world can be a prime driver in creating a viable response.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Data Analysis

Two speeches by the former UN leader Ban Ki-Moon were compared to explore how semiotic modes and the related emotions vary according to his purpose, audience, and the structure of the speech. The first was his acceptance speech in December 2006 (Moon, 2006) and the second was his speech on leaving office at the end of 2016 (Moon, 2016). Both were formal presentations to the wider UN Assembly and to UN staff.

The coding was done at the sentence level to avoid ambiguity about the placement of sub-phrases or a eventuality that a particular sub-clause was simply a verbal filler. One consequence is that some sentences are allocated to more than one mode using Aian's (2017) typography, and practically his division of affect was simplified to happiness, security, and satisfaction with emotions. Thereafter, it was coded to indicate a positive or negative emotion (Aian, 2017).

The first speech contains 58 sentences. In turn, it was broken down into four major sub-sections: thanking the assembly and his predecessor (Opening Remarks), discussing his own appointment (Appointment), setting out his goals for the UN (Future Goals), and detailing his own plans (Plans). Each of these sections is 13-16 sentences long. The second speech is shorter (40 sentences) and again is broken into sub-sections of a short introduction, an acknowledgement of the help he has been given, a review of his personal goals, the process of leaving, and a final expression of gratitude.

For speech, the use of emotions connected with affect varies substantially across the four sections, as shown in the table below:

Table 4. Speech One: Affect

		Opening Remarks	Appointment	Future goals	Plans	Total
Happiness	N			7	1	8
Happiness	P	3	2		1	6
Security	N	2	6	1	9	
Security	P	1			1	
Satisfaction	N			3	2	5
Satisfaction	P	1	4		1	6

In these opening remarks, affect is used in a limited manner and mostly as positive emotions and these are mostly concentrated in a short three sentence section where he praises his predecessor, such as, "You have led the organization through challenging times, and ushered it firmly into the twenty-first century". However, when he discusses his own appointment, there is a shift to a more critical tone and use of negative emotions to indicate the challenges he perceives, such as, "This path is narrow and steep, and

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transcends national borders and partisan interests". This critique flows into his goals for the organization going forward, again using negative emotion to identify the depth of the problem "The dark night of distrust and disrespect has lasted far too long". In addition, this theme carries into the final section of his plans going forward "As we pursue our collective endeavour to reach that goal, my first priority will be to restore trust".

In terms of judgement, the speech has a reverse pattern.

Table 5. Speech One – Judgement

			Opening Remarks	Appointment	Future goals	Plans	Total
Social Esteem	Normality	N					
Social Esteem	Normality	P	1			1	
Social Esteem	Capacity	N					
Social Esteem	Capacity	P	3	1	1	1	6
Social Esteem	Tenacity	N					
Social Esteem	Tenacity	P	2		2		4
Social Sanction	Veracity	N					
Social Sanction	Veracity	P	1				1
Social Sanction	Propriety	N					
Social Sanction	Propriety	P	10			2	12

These are concentrated at the beginning where he is praising his predecessor. In effect, he used the sort of language to be expected when delivering such a speech. Phrases, such as "It is an honour to follow in your revered footsteps", are expected as part of such a formal event.

Even more than judgement, the use of appreciation was heavily concentrated in his opening remarks.

Table 6. Speech One – Appreciation

			Opening Remarks	Appointment	Future goals	Plans	Total
Reaction	Impact	N					
Reaction	Impact	P	1				1
Reaction	Quality	N					
Reaction	Quality	P				3	3
Composition	Balance	N					
Composition	Balance	P	1				1
Composition	Complexity	N			2	5	7
Composition	Complexity	P	4				4
	Valuation	N					
	Valuation	P	6				6

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

One thing that does stand out is the shift in relative complexity. The opening remarks are full of short, single phrase, and sentences, but the language become more complex (and thus opaque) as he moves into his plans for the future. So, while a sentence such as "I will do everything in my power to ensure that our United Nations can live up to its name, and be truly united; so that we can live up to the hopes that so many people around the world place in this institution, which is unique in the annals of human history" is perhaps to be expected, it is complex and actually rather convoluted as to what is meant.

The second speech has a very different pattern. Issues related to affect, and of positive emotions, dominate the speech and are common in each sub-section.

Table 7. Speech Two – Affect

		Introduction	Acknowl edgemen	Goals	leaving	Gratitude	Total
Happiness	N		4		4		8
Happiness	P	1	7	2	1	3	14
Security	N				2		2
Security	P		2	6			8
Satisfaction	N				1		1
Satisfaction	P		1	1	5	4	11

Positive framings of happiness are common across the speech, especially where he is noting support from others, such as "You should be very proud — just as I am so very proud to call you my colleagues". Also, negative framings of regret are very much about his personal emotions "Now I feel a bit like Cinderella".

On the other hand, judgement is rarely invoked except that of normalcy at the stages where one would expect certain sentiments to be set out.

Table 8. Speech Two – Judgement

			Introduction	Acknowl edgemen	Goals	leaving	Gratitude	Total
Social Esteem	Normality	N				1		1
Social Esteem	Normality	P	2	1			5	8
Social Esteem	Capacity	N						
Social Esteem	Capacity	P						
Social Esteem	Tenacity	N						
Social Esteem	Tenacity	P	1					1
Social Sanction	Veracity	N						
Social Sanction	Veracity	P		2		2		4
Social Sanction	Propriety	N						
Social Sanction	Propriety	P						

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Similarly, appreciation is limited except in one regard.

Table 9. Speech Two – Appreciation

			Introduction	Acknowledgemen	Goals	leaving	Gratitude	Total
Reaction	Impact	N			1	2		3
Reaction	Impact	P						
Reaction	Quality	N						
Reaction	Quality	P						
Composition	Balance	N	1	1	5	6		13
Composition	Balance	P						
Composition	Complexity	N						
Composition	Complexity	P						
	Valuation	N						
	Valuation	P						

Here, complex long sentences become very common or obscure concepts are used, such as "Tomorrow night, on the eve of the new year, I will be in Times Square for the ball drop — millions of people will be watching as I lose my job". This may be clear to some readers, and presumably those who hear the speech, but it is not something that will be universally understood. Equally, a sentence such as "First, to set priorities and stay focused — on advancing sustainable development, on climate change, on empowering women and youth, and many other issues" is almost meaningless. The four named issues are themselves a massive agenda, never mind the 'many other issues'. In turn, this leaves the intent of the sentence unclear.

Discussion

The two speeches bookend his tenure at the United Nations and, perhaps as expected, have areas of similarities (especially the social politeness expected). In addition, it also has important differences. A key among the latter is the relatively substantial, negative, and critique of the problems he is inheriting compared to his own evaluation of his tenure.

Despite both having substantial elements of what could be seen as social politeness, these actually see different emotions invoked. In the first speech, this phase is found primarily in his opening remarks and in the second, it more commonly spread across his introductory remarks, acknowledgement of those he has worked with, and gratitude for having the chance to carry out the role. In the first speech, he has 36 emotions in the introduction (7 are affect, 17 judgement, and 12 appreciation) and these are overwhelmingly positive (34 out of 36). The second speech also has 36 in such instances (22 affect, 11 judgement, and 3 appreciation). Again, this section is noted for its positive tone (34 out of 36). Thus, what is very clear is the importance of affect

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

in the second speech, even in the sections that can be seen as fitting social norms. The second speech has short statements of emotion ("I have just two words: Thank you") with a high degree of repetition ("And I thank you"). This suggests that even when the goal is similar, to deliver the forms of social politeness expected of such a speech, the semiotic resources differ. The first speech makes relatively limited use of emotions, while the second relies on them heavily. One possible reason is that the first involved more of what might be expected, such as thanking a predecessor, while the second was much more personal, expressing more personal thanks to people he has worked with.

One area of contrast is in the first speech. Here, he sets out his plans to deal with what he described as the problems facing the UN and in the second, he evaluates his 10 years he has been in charge. In the first speech, he uses 27 emotions (15 affect, 4 judgement, and 8 appreciation). These are often negative (12/15 affect) in particular in terms of evoking insecurity. Equally, the sentences become complex and unclear (5 instances of this). His review in the second speech uses 19 emotions (13 affect, 0 judgement, and 6 appreciation). The balance now is positive in terms of affect, but not for appreciation (all are negative). This suggests an attempt to present a record of success, but having to use very specific (and somewhat contrived) phrasing to achieve this ("Second, to never give up, to keep dreaming, to keep believing, and to keep working hard until we achieve progress"). However, a largely negative review is presented with substantial invoking of negative emotions compared to the positive emotions in his self-evaluation.

As a result, this fits into the expected pattern of emotions, suggesting that a basically negative appraisal of a situation will inevitably draw on negative emotions. However, the difference in how he handles the social norms of thanking suggests there is not always such a close match of emotions invoked and its overall effect. In consequence, the overall impact and the specific emotions used can vary and wider circumstances matter as well as the direct impact. In the first speech, more of the praise is relatively formalized as part of a set piece speech on taking up the role. In the second speech, it is often more personal and repetitive (the regular use of 'thank you') to invoke a different emotional range.

Conclusion

Appraisal theory is useful for exploring the emotional element of a political or formal speech. However, if the focus is essentially on the incidence of emotions, then it can be misleading. Furthermore, a negative appraisal uses mostly negative emotions, and a positive one is based on purely positive emotions. In that sense, the relationship is as expected, but the two instances of meeting social norms actually see quite different emotions involved. Also, both score highly in terms of politeness and expected elements ("Secretary-

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General Annan, I am all the more humbled because it is you I am succeeding in what you have described as "the world's most exalting job"" and from the second speech "I'm honoured to be here with you, the President of the General Assembly, the President of the Security Council and, most importantly, I'm extremely honoured and happy to meet you"), but overall work in a very different tone.

This suggests that too much emphasis can be placed on incidence of emotions rather than the precise wording used to carry that emotion. This may reflect some of the ambiguities in appraisal theory (Bolouri, 2008; Hofmann, et al., 2020; Shahmir, et al., 2023), but it also indicates that the wider meaning of a speech cannot be captured at a sentence by sentence (or phrase by phrase) level. Thus, quantitative approaches are useful, but there is a clear need to continue to use essentially qualitative approaches to studying the emotional role of formal speeches.

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Water, Sanitation, Waste Management, and Professional Activities in Relation to Diseases with Neighboring Citizens of Congo Rivers in the Brazzaville Agglomeration (Republic of Congo)

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Abstract

Situated on the right bank of the Pool Malébo, in the Congo River basin, the city of Brazzaville is rich in potential water resources. These resources are polluted by human practices that deteriorate the quality of the soil and, consequently, the quality of the water. The aim of this study is therefore to inventory the activities carried out by the population around watercourses, to investigate waste management and to assess the impact on water and soil quality. The survey sample was selected on the basis of impacted zones located between 250 m and 750 m around watercourses. The aim of this study is therefore to inventory the activities carried out by the population around watercourses, to investigate waste management and to assess the impact on water and soil quality. The survey form was drawn up using Sphinx Plus^2-Edition Lexica-V5 software. The survey data was entered into the same software, then transferred to Excel to generate the graphical. 880 people were surveyed, the most dominant age group was 25-48 years old, i.e. a rate of 66%. The most dominant gender was female, with a rate of 54%. The average age of the respondents was lower secondary school, and they were generally employed in the private sector. Commercial activities (restaurants/bars, pharmacies, grocery stores/ butchers, markets, etc.) are the most common economic activity, with a rate of around 70%; 59% of these activities are located close to or very close to the watercourse (750-1000 m). The activities that contribute to soil degradation, and consequently water degradation, in the city of Brazzaville are: 59% the dumping of household waste and/or wastewater on the ground and 32% uncontrolled urbanization. The study shows that soil and water pollution in Brazzaville is caused by poor management of household waste and uncontrolled urbanization.

Keywords: Survey, waste management, pollution, water, soil, Brazzaville

1. Introduction

The exponential development of most African cities, accompanied by very rapid population growth, poses the problem not only of the availability of water resources, but also of their quality (Nwamo *et al*., 2016). This population growth is accompanied by an equivalent need for food production, exploitable land and water (Nwamo *et al*., 2016). The Congo has enormous water potential, but is not immune to water quality problems (Ofouémé-Berton

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2010). For several decades, the country has experienced significant demographic growth, caused by a massive rural exodus resulting in an increase in urban density and anarchic occupation of the land, which is then subject to multiple anthropogenic actions and effects (Essouli *et al.*, 2020). Socio-economic human activities (agriculture, industry, livestock farming, fishing, household activities, medical care, etc.), coupled with processes due to natural phenomena (soil erosion, rainfall, evaporation, runoff, etc.) put surface water resources under great pressure, and accelerate their degradation (Hawa *et al.*,2011; Aw*et al.*,2011; Adjagodo *et al.*, 2016; Dovonou *et al.*, 2022). Consequently, the discharge of untreated industrial and urban wastewater, the presence of informal and fill sites and human activities are the main sources of deterioration in water quality (Laffite, *et al.*,2016; Poté, *et al.*,2008; MubediJ., *et al.*, 2013). Several factors, including poor waste management and the uncontrolled installation of latrines, influence the quality of soil and water resources in general, and surface water in particular. Surface water is often enriched with organic matter and suspended solids as are sult of human activity, which accelerates its degradation (Hawa *et al.*, 2011). Their composition is more variable and they are sensitive to pollution from the external environment.

Over the last thirty years, the city of Brazzaville has undergone strong demographic expansion as a result of the rural exodus, bringing its population to 21,457,783 inhabitants, with a population density of 3,646.81 inhabitants/km² (RGPH 2023). This has resulted in the city's surface area expanding from 12,000 ha to 58,840 ha, and from 7 to 9 districts (Law no. 14-2011 of 17 May 2011 redefining the boundaries of Brazzaville). This spatial expansion is the result of uncontrolled occupation of the fragile urban site, which is characterized by a hilly relief, sandy soils that are sensitive to water erosion, housing estates built without a town planning master plan and settlements that are unsuited to the conditions of the environment. In addition, the city is suffering from poor urban waste management and a lack of sanitation, exposing it to a wide range of environmental problems, including the deterioration of basic infrastructure (roads and other networks), soil and water pollution, catastrophic gullying in high areas and flooding in low areas (Louembé, 1978; Kaya-Mabiala, 2007; Zaguy-Guerembo, 2009; Nzila, 2010; Kempena *et al.*, 2014 a et b; Mayima *et al.*, 2016; Ngazzi, 2017; Nzila *et al.*, 2018). The banks of the rivers that flow through Brazzaville and into the Congo River are often clogged with heaps of solid waste, which not only impedes the flow of water, but could also impair its quality.

The aim of this study, based on surveys of urban populations, is to identify the various human activities that can influence soil and surface water quality in the city of Brazzaville.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

2. Materials and methods

2.1. Study area

The city of Brazzaville is located on the right bank of the majestic Congo River, the second most powerful river in the world after the Amazon in terms of flow (40.000 $m^3 s^{-1}$). It is 30 km long and covers an area of 263.9 km^2. It is bounded to the north-east by the Batéké plateau and the Djiri river, to the south and east by the Congo River, and to the west by the Maloto river (Figure1). It lies between latitudes 4°10' and 4°17' South and longitudes 15°16' and 15°45' East. The city of Brazzaville has nine (09) arrondissements: Makélékélé (1), Bacongo (2), Poto-Poto (3), Moungali (4), Ouenzé (5), Talangaï, (6), M'filou (7), Madibou (8), and Djiri (9). The climate of Brazzaville is currently influenced by climatic variations. It is marked by two main seasons: a rainy season that extends over a period of eight (08) months (from October to May) with average annual rainfall of 1,343.77 mm between 2003 and 2010 (Louzayadio, 2019). Brazzaville is part of the vast hydrogeological complex of the Batéké plateaux, and iscrossed by several watercourses forming a dendritic network. These waters flow over three types of ferrallitic soil, depending on the material on which they were formed. There are ferrallitic soils on weathering material from the Inkisi sandstones, ferrallitic soils on Batéké sands and ferrallitic soils on material of alluvial origin These soils all belong to the subclass of highly desaturated, depleted ferrallitic soils, which means that the sum of exchangeable bases (Ca, Mg, K, Na) is very low in the B horizon (of the order of 1 cmol (+) /kg of soil) and that the saturation rate of the absorbent complex is less than 20% (Schwartz,1986, Essouli *et al.*, 2020).

2.2. Survey method

The areas to be surveyed were chosen along the seven (07) main rivers that irrigate the city of Brazzaville (Djiri, Tsièmé, Djoué, Mfoa, Maduku, Mikalou, M'Filou) and are all tributaries of the Congo River. The survey areas were chosen upstream, mid-slope and downstream of the rivers. The survey was carried out from 09 to 14 December 2022, by a group of ten (10) students from the University of Marien N'Gouabi in the Republic of Congo. It was carried out face-to-face with the respondent, using a questionnaire developed with the help of Sphinx Plus software$_2$ -Edition Lexica-V5. The sample of people to be surveyed was selected in concentric zones, starting from a central point in the middle of the watercourse. Three concentric zones were defined with an equidistance of 250 m, the furthest zone being 750 m from the river (Dieng *et al.*, 2016; Madzella, 2019). These concentric zones were delimited using Qfield software and incorporated into the Smartphones for easy location of the zone of influence in the field (Figure 1). These survey zones were determined using a satellite image of the city of Brazzaville to cover the

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extent of the survey area. The questionnaire was submitted mainly in households and to people encountered in the survey area (shopkeepers, local players, farmers, etc.). The surveys were conducted in French and local languages, depending on the district and the social level of the population. In the field, people or households were chosen at random, while respecting the geographical representativeness of the survey area. The survey data were analyzed and entered into the Sphinx software and transposed into Excel to produce the graphs. A total of 880 people were surveyed, including 176 farmers.

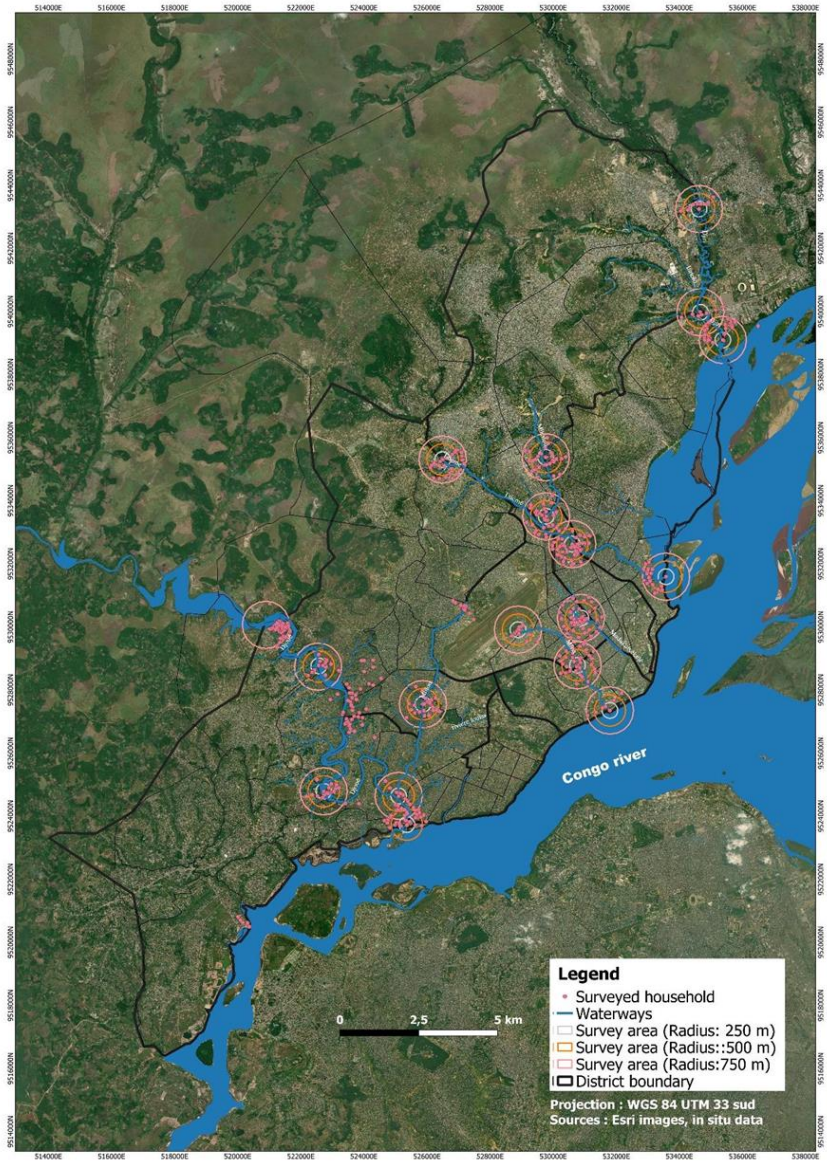

Figure 1: Survey area sites location

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

3. Results and discussion

The surveys were carried out in the eight (08) arrondissements of the city of Brazzaville through which the following rivers flow: *the Djoué*, *the Mfilou*, *the Mfoa*, *the Madutkutsékélé*, *the Tsiémé*, *the Mikalou* and, *the Djiri*. The highest proportions of respondents were found in the Djiri, Mfilou and Madibou arrondissements, which are crossed by the largest rivers, *the Tsiémé*, *Djiri*, *Mfilou* and *Djoué* respectively (Figure 2). The most representative household size, representing nearly 30% of those surveyed, is between 6 and 8 people (Figure 3).

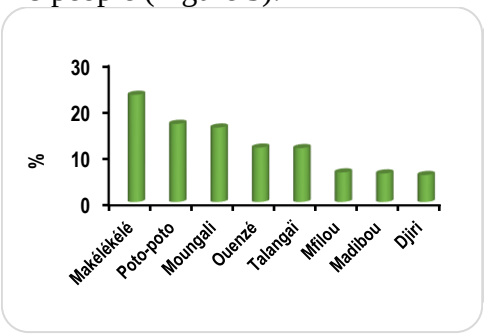

Figure 2. Frequency (%) of respondents in each arrondissement

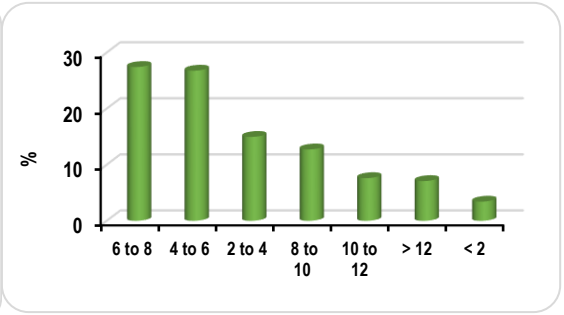

Figure 3: Frequency (%) of household sizes

According to the breakdown of respondents by gender, women are the most represented with a percentage of 54% (figure 4). The most represented age groups were 25-30 and 37-42 (Figure 5), which shows that the people interviewed in this study are mostly young and of age. Similar results were obtained by Nkounkou *et al*, (2017) who worked on drinking water in the city of Brazzaville.

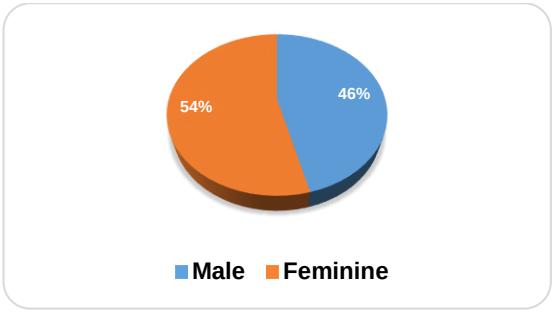

Figure 4. Breakdown of respondents by gender

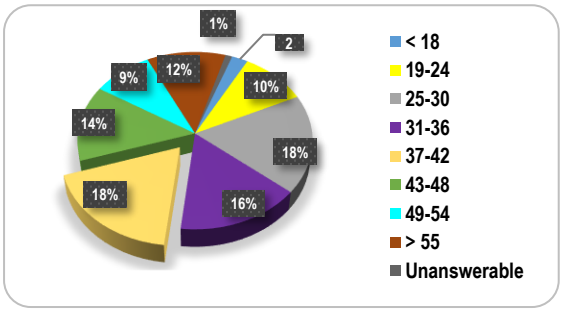

Figure 5. Breakdown of respondents by age group

According to the respondents of activity sector, 60% of them were employees, 54% of them in the private sector and 6% in the public sector (Figure 6). The majority of respondents (56.93%) had a secondary education and 26.48% had a higher education (Figure 7).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

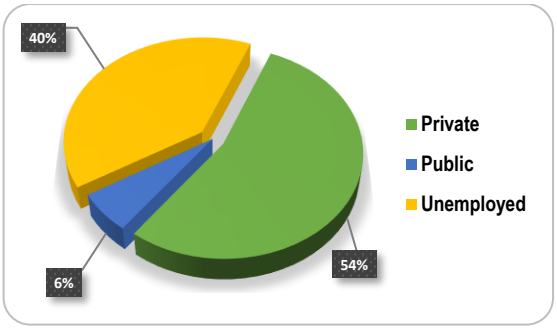

Figure 6. Respondents sector of activity

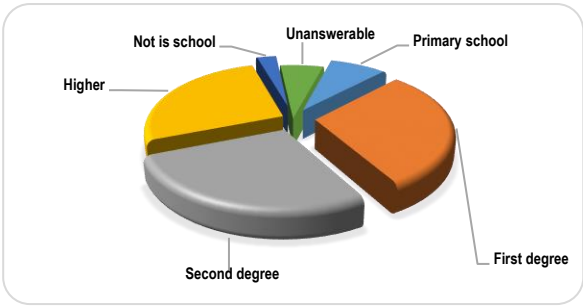

Figure 7. Level of education of respondents

Most households (79%) have a source of water supply, which in this case is the Congolese water distribution company (LCDE). A further 15% have boreholes, 7% wells and 8% springs (Figure 8). The majority of households that do not have a water supply source on the plot (87% of those surveyed) travel a distance of less than 100 m to obtain water, and sometimes more than 600 m (Figure 9). These results differ from those found by Nkounkou, (2017), where water supply was a chore for people. This can be explained by population growth, which encourages people to have a source of supply in their neighbourhoods.

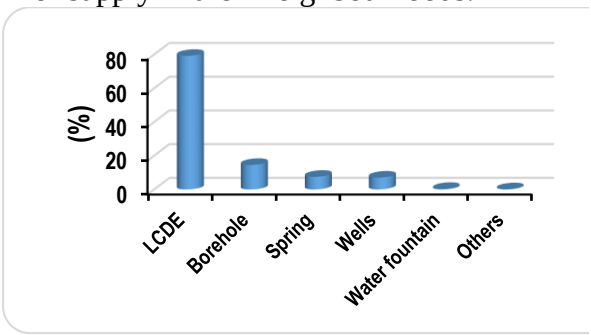

Figure 8. Water supply method

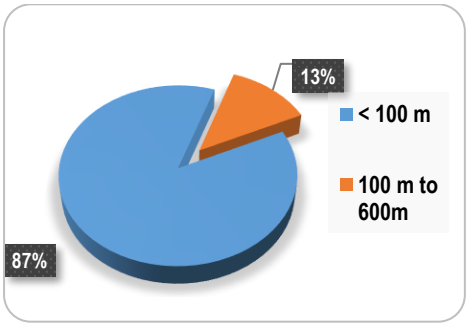

Figure 9. Distance travelled by households to obtain water

With regard to solid waste management,40.60% of households store their waste in dumps, 21.45% leave it in the open air, 14.04% burn it, 13.39% have it collected by collection companies, 8.14% is buried and the rest (2.38%) is either recycled or dumped in watercourses (Figure10). These results are in line with those found by Nwamo *et al* (2016) in the city of Douala in Cameroon, where the majority of people said they dumped their waste in rubbish bins, and a small proportion in and around watercourses. Dumping waste in this way stresses the watercourse in which it is dumped.

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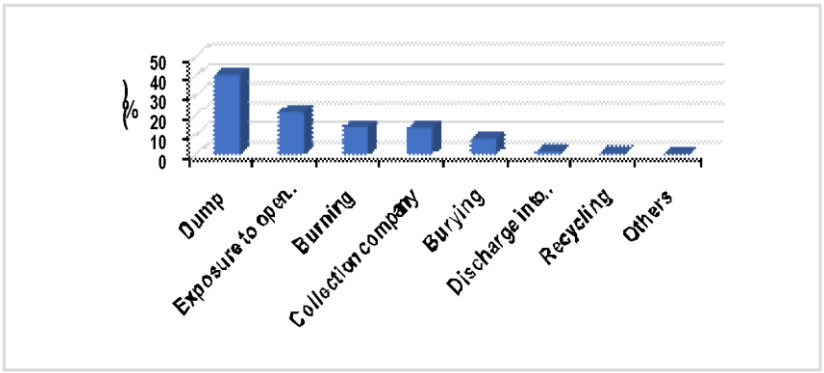

Figure 10: Waste management by households

Faecal sludge from households is mostly buried (52%) or transported by vacuum trucks (40%). Only 4% of households dump their waste in composting pits, and 3% dump it in watercourses (Figure 11).

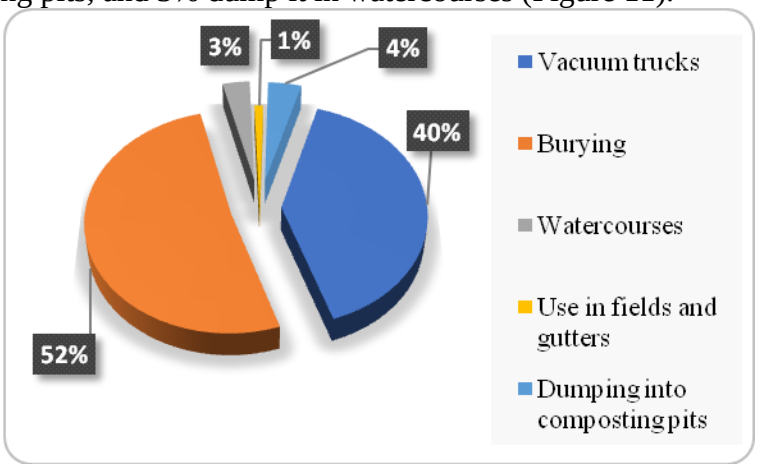

Figure 11: Management of faecal sludge by households

Several methods are used to manage domestic wastewater (Figure 12). In fact, 56% of households surveyed evacuate domestic wastewater in the street, 18% in plots and 11% in gutters. Only 9% of respondents discharge their wastewater into individual sanitation facilities (septic tanks and cesspools), which are collected by tanker trucks. Unfortunately, this water is not treated before being discharged into the environment. Controlling the quality of the water before it is discharged helps to maintain a low-pollution environment, while guaranteeing health of people (Mbaka *et al.*, 2017; Pambou *et al.*, 2022). Wastewater often contains micropollutants and other pathogenic organisms dissolved in water, which are responsible for

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waterborne diseases and the pollution of aquatic ecosystems (Pritchard, *et al.*, 2009; WHO, 2011).

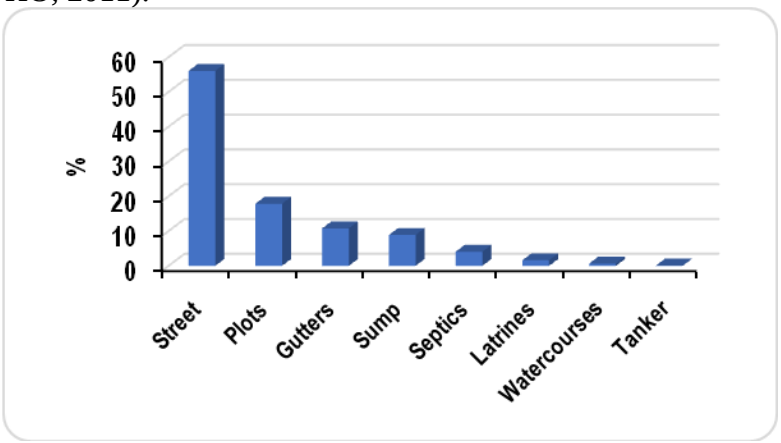

Figure 12: Wastewater disposal in households

In the city of Brazzaville, more than 80% of the population does not practise livestock farming (Figure13); of those who do,40% of waste is buried or left in the plots, 32% is used in the fields and/or gardens, 20% is dumped in the open in the street and 8% is sold (Figure14).

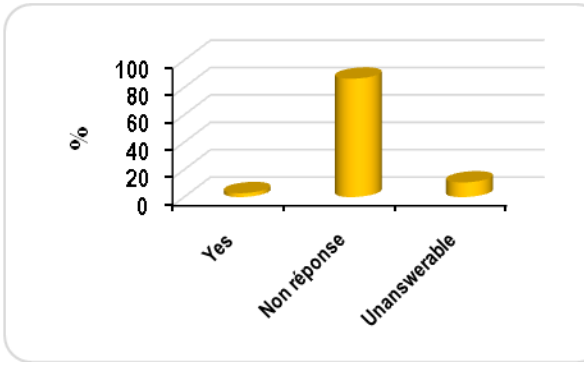

Figure 13: Frequency of livestock farming in the survey area

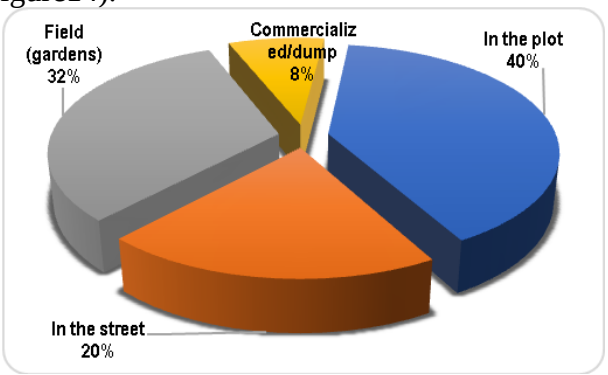

Figure 14: Frequency of livestock waste management

Regarding the link between waste management and environmental pollution, nearly 91% of households surveyed said that their environment was polluted by household waste (Figure 15). Plastic waste is the most common pollutant. This shows that the biggest source of water and soil pollution in Brazzaville is household waste.

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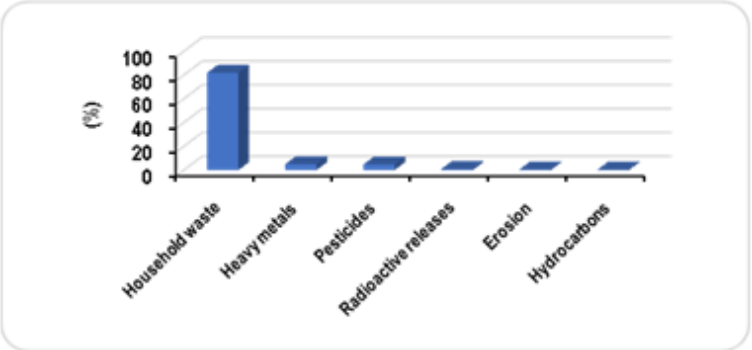

Figure 15: Sources of environmental pollution in the city of Brazzaville

According to Figure 16, the most common illnesses linked to environmental pollution in the city of Brazzaville are, in descending order, malaria (53%), diarrhoea (20%), stomach ache (16%), typhoid fever (4%) and dermatitis (3%). Cholera and urticaria were marginal. These results can be explained by the fact that these are diseases that have plagued tropical areas for millennia (INSERM, 2015).

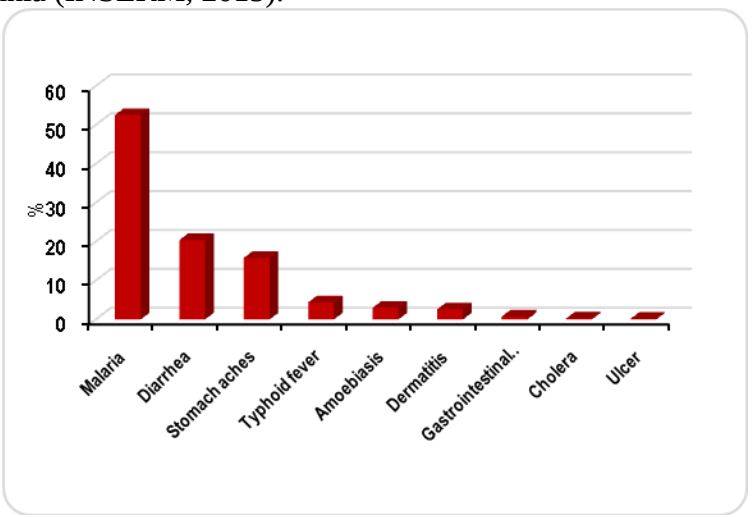

Figure 16: Type of deseases prevalent

In terms of human activities that are sources of pollutants, commercial activities (restaurants/bars, pharmacies, grocery stores/butchers, markets, etc.) are the most common, accounting for around 70%, followed by agricultural activities (17%). Other human activities (livestock farming, fishing, crafts, pharmacies and industry) are, on the whole, very little represented in the areas surveyed (6%) (Figure 17). These results highlight the predominance of commercial activities in the districts of the city of

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Brazzaville in Congo, as in some countries such as Gabon (Mombo and Edou, 2005) and the Democratic Republic of Congo (Makuku *et al.*, 2018). On the other hand, the results found by Nwamo *et al* (2016) in the city of Douala in Cameroon showed that agricultural activities (82.5%) and livestock rearing (17.5%) predominate and are used for household subsistence. The most widespread agricultural practices (Figure 18) are market gardening (vegetables, chives, spinach, etc.) (41%), maize (20%), groundnuts (11%), cassava (12%), fruit trees (8%) and sweet potatoes (2%).

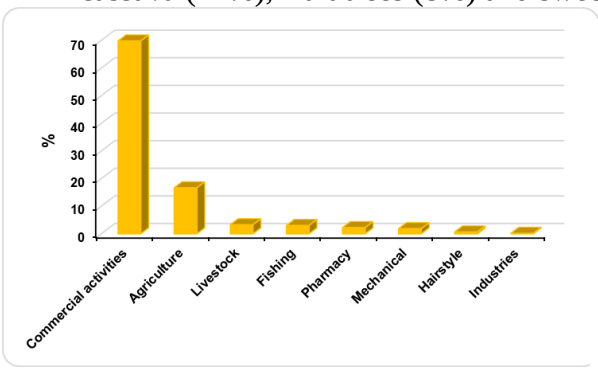

Figure 17: Human activities in the surveyed areas

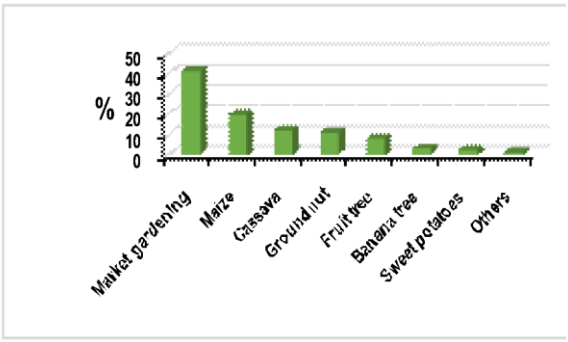

Figure 18: Type of culture produced

The assessment of the distances of the sources of pollution showed that most of these activities (59%) are located close to or very close to the watercourse (Figure 19). This can be explained by the fact that the majority of anthropogenic activities are carried out on the banks of watercourses (Aziz Assaad, 2014).

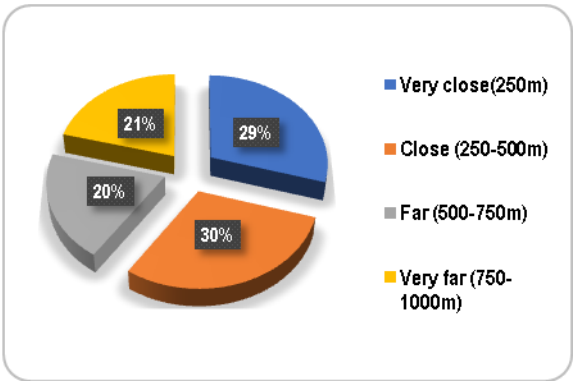

Figure 19: Distance of sites where activities are carried out from the watercourse

50% of people who practise agriculture think that the soil is fertile, whereas 40% of those surveyed said the opposite (Figure 20). The main

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criterion for recognising the level of soil fertility used by farmers is yield (figure 21).

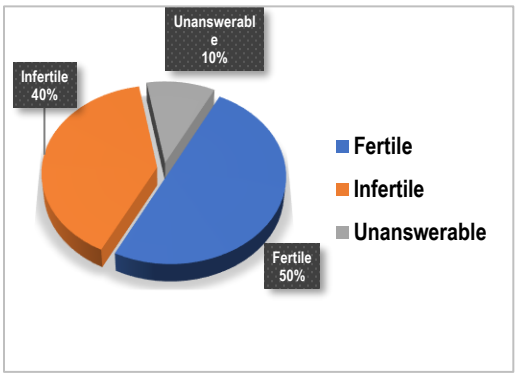

Figure 20: Soil fertility status

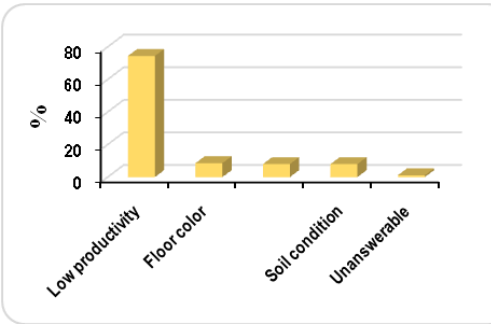

Figure 21: Warning signs of soil fatigue

To improve soil productivity, almost 60% of those surveyed use fertilisers (chemical fertilisers and organic amendments), particularly for market gardening (Figure 22); the rest of the population fallow and grow shifting cultivation. Organic soil improvers are used more often than chemical fertilisers in Brazzaville (Figure 23). Chemical fertilisers and organic soil improvers are used empirically, without any official recommendation of an optimal dose; this leads to soil and water pollution and the bioaccumulation of heavy metals in crops (Malmqvist and Rundle, 2002; Nwamo *et al.*, 2016; Nzila *et al.*, 2018).

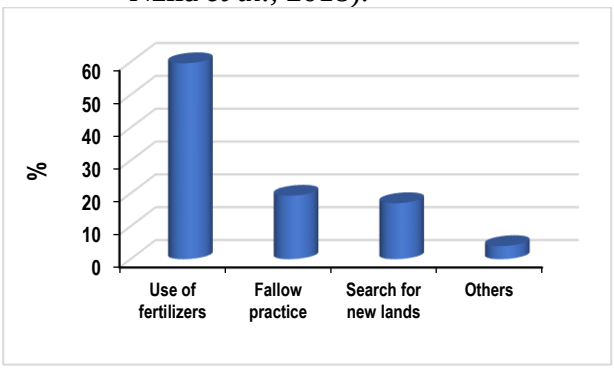

Figure 22: Measures taken in the event of soil fatigue

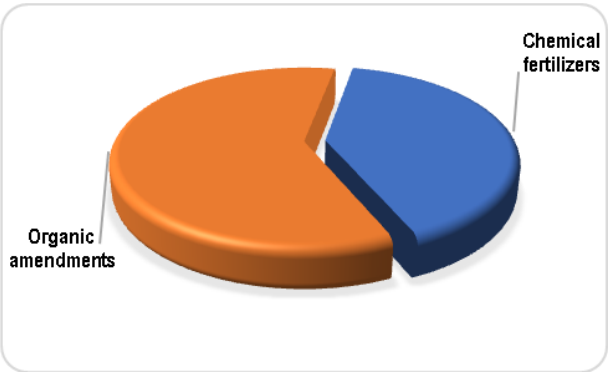

Figure 23: Type of fertiliser used

The most commonly used chemical fertilisers are NPK and urea, with less than 7 kg for NPK and 7 ml for urea on a 20 m^2 plot (Figure 24). These fertilisers are applied to the plants using various methods (Figure 25):

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broadcast (30%), around the plant (28%), as a base dressing (25%) and in patches (18%).

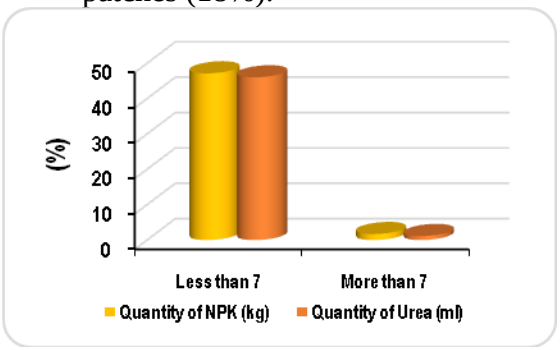

Figure 24: Amount of fertiliser used on crops

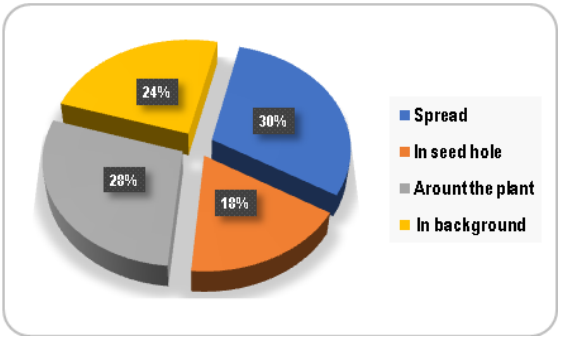

Figure 25: Methods of applying fertilisers to crops

The organic soil improvers used (Figure 26) are compost (33%), poultry droppings (28%), pig droppings (22%) and household waste (16%).

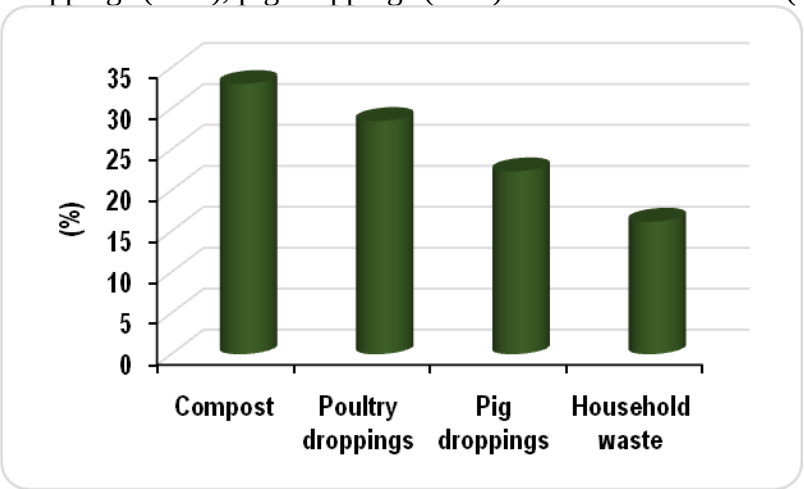

Figure 26: Types of organic amendments used on crops

Pesticides are used on 47% of crops (figure 28). Figure 28 shows that the most commonly used pesticides are insecticides (42%), herbicides (29%) and fungicides (21%). We are therefore witnessing an intensification of farming practices characterised by regular and unsustainable inputs of organic fertilizers (household waste sludge and compost, livestock manure, agro-industrial by-products, sewage sludge), mineral fertilizers and the use of various pesticides (Compaoré and Nanéma, 2010; Nzila *et al.*, 2018).

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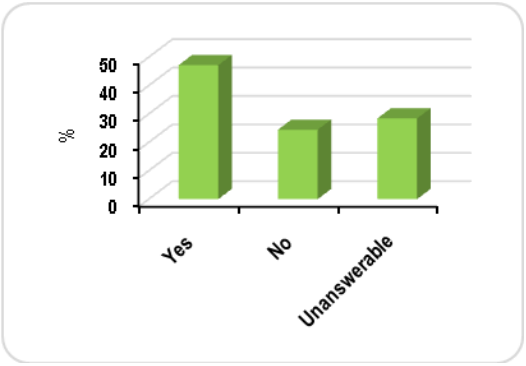

Figure 27: Frequency of pesticide use on crops

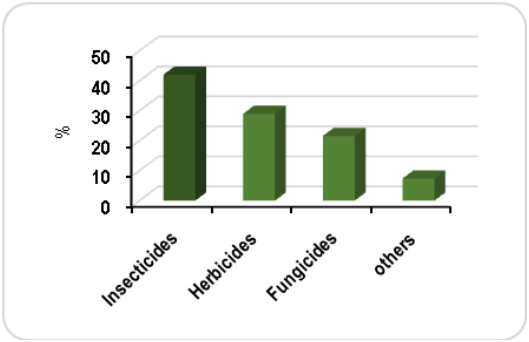

Figure 28: Types of pesticides used

Almost half of residents of Brazzaville (45%) own their own home (Figure 30). By contrast, 24% of residents rent, 21% live in family housing and only 1% live in social housing. The majority (65%) of plots are purchased from landowners, which explains why most people live in their own homes (Figure 30).

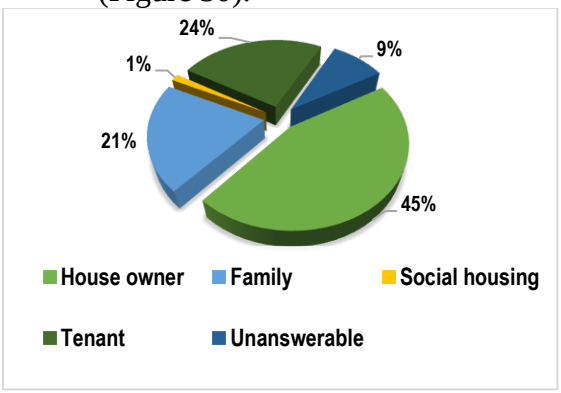

Figure 29: Housing situation of residents in surveyed areas

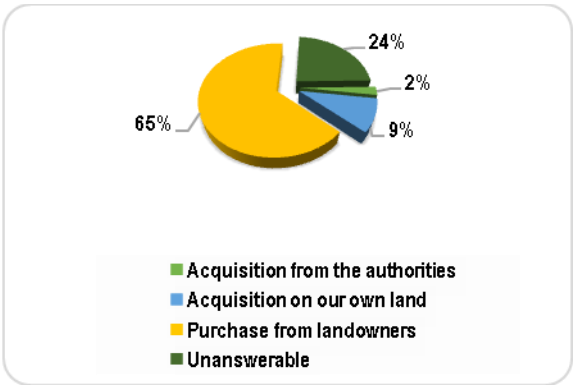

Figure 30: Land acquisition method

According to the people surveyed (Figure 31), the activities that contribute to soil degradation in the city of Brazzaville are the dumping of waste on the ground (59%) and anarchic urbanisation (32%) (Rebouh, 2019). Indeed, the city of Brazzaville includes thousands of household waste dumps that are either in the streets or in vacant lots (Zmirou *et al.*, 2003, PARSEGD, 2008; Nzila *et al.*, 2010; Mukuku *et al.*, 2018).

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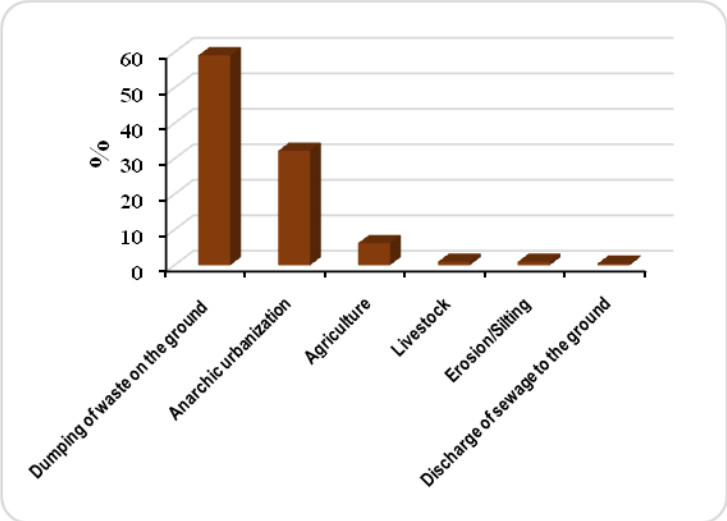

Figure 31: Causes of soil degradation in the areas surveyed

Conclusion

The Brazzaville surveys were conducted in eight (08) districts (Makélékélé, M'Filou, Talagaï, Ouenzé, Poto-Poto, Djiri, Madibou and Moungali). The most dominant age group is between 25 and 48, representing 66% of respondents. 54% of respondents were women. The average age of respondents was lower secondary school level, and they were generally employed in the private sector. The population generally uses water supplied by the national water distribution company (LCDE). 56% of domestic wastewater is discharged into the streets, resulting in a high prevalence of malaria (73%). Commercial activities (restaurants/bars, pharmacies, grocery stores/butchers, markets, etc.) are the most common economic activity, accounting for around 70%; 59% of these activities are located close to or very close to the watercourse. Farmers use organic amendments and chemical fertilizers to improve fertility and obtain satisfactory harvests. However, organic soil improvers are most commonly used by market gardeners (mainly compost). To combat plant diseases and pests, these market gardeners use pesticides, the most commonly used of which are insecticides. The activities contributing to soil degradation in the city of Brazzaville are mainly dumping waste on the ground (59%) and uncontrolled urbanization (32%). The study showed that Brazzaville city is subject to poor sanitation and household waste management practices. This state of affairs would be responsible for the degradation of the urban environment, resulting in catastrophic gullying, flooding and probably soil and water pollution.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

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Conflict of Interest: The authors reported no conflict of interest.

Data Availability: All data are included in the content of the paper.

Funding Statement: The authors obtained funding for this research from the World Bank.

Declaration for Human Participants: This study, which was based on a household survey, did not manipulate the organisms of human subjects. This study was examined and approved by the Health Sciences Research Ethics Committee (CERSSA) of the Congolese Ministry of Higher Education, Scientific Research and Technological Innovation (MESRSIT). The principles of the Helsinki Declaration for good research practices were followed.

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Le Tramway de Québec comme Catalyseur de la Durabilité des Transports Publics et de la Résilience face aux Changements Climatiques : Une revue critique

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Résumé

Entre 1990 et 2016, le transport routier a vu ses émissions de gaz à effet de serre augmenter de 52,3 %, soulignant le besoin urgent de transports publics plus durables pour lutter contre le changement climatique. Cette étude passe en revue la littérature sur le projet de tramway du Québec afin d'évaluer son potentiel pour soutenir des transports publics durables et améliorer la résilience climatique de la province. Sur les 119 articles examinés, 73 répondaient aux critères d'inclusion en utilisant la méthodologie PRISMA. Les études, publiées majoritairement entre 2016 et 2023, portent sur les impacts environnementaux, socio-économiques du tramway et les enjeux associés. L'étude évalue de manière critique le projet de tramway, soulignant son potentiel à améliorer considérablement la mobilité urbaine et la résilience climatique. Malgré les avantages du projet, tels que les gains environnementaux, sociaux et économiques, l'acceptation sociétale reste

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faible, même avec des investissements gouvernementaux substantiels et diverses propositions de tracés. Pour améliorer l'atténuation du changement climatique, une participation accrue des citoyens à la prise de décision est cruciale. Les promoteurs et les responsables doivent incarner l'écoute, la collaboration, la transparence et la cohérence pour assurer le succès du projet.

Mots-clés: Tramway, acceptabilité sociale, résilience, participation citoyenne

The Québec Tramway as a Catalyst for Public Transport Sustainability and Resilience to Climate Change: A Critical Review

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Abstract

Between 1990 and 2016, road transport saw a 52.3% increase in greenhouse gas emissions, highlighting the urgent need for more sustainable public transport to combat climate change. This study reviews the literature on Quebec's tramway project to assess its potential for supporting sustainable public transport and enhancing the province's climate resilience. Out of 119 articles reviewed, 73 met the inclusion criteria using the PRISMA methodology. The studies, predominantly published between 2016 and 2023, focus on the tramway's environmental, socio-economic impacts, and associated challenges. The review critically evaluates the tramway project, highlighting its potential to significantly improve urban mobility and climate resilience. Despite the project's benefits, such as environmental, social, and economic gains, societal acceptance remains low, even with substantial government investment and various route proposals. To enhance climate change mitigation, increased citizen participation in decision-making is crucial. Promoters and officials must embody listening, collaboration, transparency, and consistency to ensure the project's success.

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Keywords: Tramway, social acceptability, resilience, citizen participation

Introduction

Le domaine des transports est l'un des principaux générateurs des gaz à effet de serre émis et les conséquences des changements climatiques se font déjà sentir à l'échelle mondiale (Aubert, 2024). Entre 1990 et 2016, le transport routier a vu une hausse de 52,3 % de ses émissions de gaz carbonique (Equiterre, 2023). Ce taux élevé est principalement due à la croissance du nombre de véhicules légers, en particulier des automobiles (15 %) et, plus significativement, des camions légers (234 %) depuis 1990 (Equiterre, 2023). Le développement de modes de transport public plus durables et écologiquement responsables est un enjeu crucial dans la lutte contre les changements climatiques (Chaire publique AELIÉS & NÉO, 2024).

Au cœur des enjeux contemporains de mobilité urbaine et de combattre les bouleversements climatiques, la ville de Québec, terre d'innovation et de diversité, se trouve à un carrefour décisif de son développement urbain (Chaire publique AELIÉS & NÉO, 2024). Avec ses centres urbains en pleine effervescence et une population en constante croissance, les défis liés à la mobilité et à l'environnement deviennent de plus en plus prégnants. Le projet de tramway incite à créer un environnement plus sain pour les générations actuelles et à venir car il favorise la qualité de l'air, améliore l'environnement sonore, verdit les quartiers et réduit les îlots de chaleur (RSTC, 2023). C'est ainsi que s'inscrit le projet de tramway (Voir figure 1), une initiative d'envergure destinée à transformer radicalement les moyens de déplacement dans les principales villes québécoises (Barrieau, 2021).

En effet, le projet de tramway se profile comme une réponse ambitieuse et prometteuse (Chaire publique AELIÉS & NÉO, 2024). Ce projet de transport en commun électrifié vise à offrir une alternative durable et efficace à l'utilisation excessive de l'automobile, qui contribue de manière significative aux émissions de gaz carbonique et à la congestion routière dans ces agglomérations (Bourdages & Champagne, 2012). De plus, l'implantation de réseaux de transport résilients face aux aléas climatiques est essentielle pour assurer la mobilité des populations, notamment en cas d'événements météorologiques extrêmes (AECOM, 2019). Il n'est pas seulement une question d'amélioration des infrastructures de transport, mais incarne une vision globale dans la promotion d'une mobilité plus durable, efficiente et écoresponsable (Chaire publique AELIÉS & NÉO, 2024). Dans le contexte actuel où les pressions environnementales et les impératifs de résilience climatique se font de plus en plus pressants, le projet tramway revêt une importance vitale pour l'avenir du Québec.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Figure 1: Concept citadelle du tramway à Québec
Sources : (Ministère des transports, 2021), (ICI.Radio-Canada.ca, 2022), (Le Journal de Levis, 2024)

Le projet de tramway, s'inscrit pleinement dans cette initiative visant à combattre les bouleversements climatiques et d'adaptation aux enjeux environnementaux actuels et futurs (Chaire publique AELIÉS & NÉO, 2024). En intégrant un réseau de tramway moderne dans le tissu urbain, le projet a pour objectif de diminuer la dépendance envers des véhicules individuels et à encourager l'utilisation des transports collectif. Ce changement contribuerait à atténuer les émissions de gaz carbonique et à améliorer la qualité de l'atmosphère, en créant ainsi un environnement urbain plus sain et plus durable (AECOM, 2019). En investissant dans des infrastructures de transport écologiques et en favorisant l'adoption de moyens de déplacement plus durables, le projet de tramway du Québec pourrait incarner un personnage important lors du passage à une ville plus écologique et plus résiliente face aux défis climatiques actuels et futurs (AECOM, 2019).

Dans le débat sur la capacité du projet de tramway du Québec à orienter la région vers un transport public durable et une résilience climatique accrue, émergent des questions cruciales sur la mobilité urbaine. Ce projet offre une opportunité exceptionnelle de repenser la manière dont les citoyens se déplacent dans les villes québécoises, en mettant en avant de diminuer les émissions de carbone et la résilience face aux enjeux climatiques grandissants. En intégrant les planifications du développement durable et de la résilience climatique dans sa planification et sa réalisation, le tramway peut servir de catalyseur pour une approche plus holistique de l'aménagement urbain et de l'organisation des déplacements (Ermatinger et al., 2010). Ainsi, le projet de tramway du Québec pourrait non seulement conduire à un transport public

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

plus durable, mais également renforcer la résilience climatique de la province en plus d'améliorer la qualité de vie des habitants.

L'objectif de cette revue systématique vise à évaluer dans quelle mesure le projet de tramway au Québec peut contribuer à la durabilité du transport public et à la résilience climatique de la province. Nous chercherons tout d'abord à dresser un état des lieux du projet de tramway au Québec, en examinant ses caractéristiques, ses objectifs et son état d'avancement. Ensuite, nous nous attacherons à évaluer de manière critique les retombées potentielles de ce projet sur la durabilité environnementale et la résilience climatique de la région. Enfin, nous nous efforcerons d'identifier les avantages environnementaux, sociaux et économiques, mais aussi les principaux défis et opportunités associés à la réalisation et à la gestion efficace de cette initiative, dans le but de promouvoir un développement urbain durable.

Avantages des tramways pour la durabilité et la résilience climatique

Le projet de tramway de Québec a connu des évolutions significatives depuis ses débuts. La réflexion sur l'opportunité d'implanter un tramway à Québec a débuté il y a au moins quarante (40) ans (Labeaume, 2011). La figure 2 ci-dessous présente l'historique du projet de tramway à Québec.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

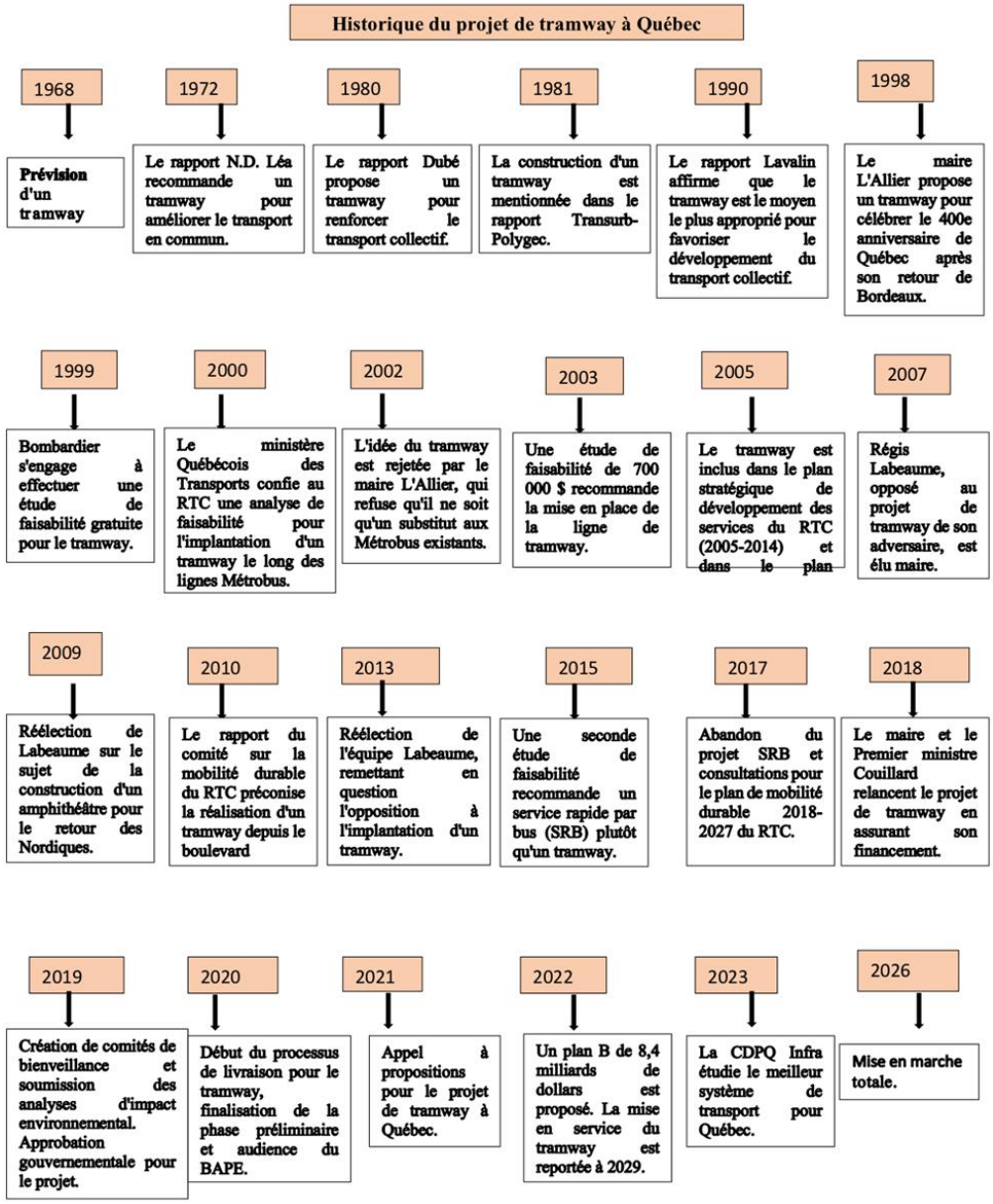

Figure 2: Historique du projet de tramway à Québec
Sources : (Ermatinger et al., 2010), (Labeaume, 2011), (Trudel, 2020),(Parent, 2023), (Bourke, 2020), (Ministère des transports, 2021), (ICI.Radio-Canada.ca, 2022), (Noovo Info, 2024), (Gérald, 2024), (Le Journal de Levis, 2024), (Martin, 2023a)

Les tramways offrent de nombreux avantages en matière de durabilité et de résilience climatique. En tant que mode de transport écologique, le tramway fonctionne à l'énergie électrique et ne produit pas de gaz carbonique, inversement aux véhicules à moteur thermique (Chaire publique AELIÉS &

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

NÉO, 2024). Cette caractéristique permet l'atténuation de la pollution de l'air et combattre le changement climatique en remplaçant les voitures individuelles et les bus diesel (Parent, 2023). De plus, le tramway symbolise la durabilité grâce à sa longue durée de vie (AECOM, 2019).

Le tramway a également des impacts très positifs sur la qualité de vie en ville. Il offre une circulation fluide et sécurisée, contribuant ainsi à améliorer la mobilité urbaine (AECOM, 2019). Grâce à un réseau étendu et bien desservi, il facilite les déplacements urbains et réduit la dépendance à la voiture individuelle (Chaire publique AELIÉS & NÉO, 2024). Cette réduction de la dépendance aux véhicules à moteur à combustion améliore la qualité de l'air dans les zones urbaines, ce qui a un effet bénéfique sur la santé publique en diminuant les affections respiratoires et cardiovasculaires liées à la pollution (AECOM, 2019).

Les infrastructures de tramway sont un atout pour l'aménagement urbain. Elles favorisent la connectivité entre les espaces, l'activité économique, et le flux des marchandises et des individus (AECOM, 2019). Cela facilite la création de quartiers plus compacts et accessibles, et encourageant le transport collectif mais aussi des modes de vie durables (BÉLAND, 2019). En ajoutant les enjeux liés au changement climatique dans la gestion des infrastructures, les réseaux de tramway deviennent plus résilients face aux défis complexes tels que le vieillissement, les évolutions d'usages et les innovations technologiques (Chansigaud, 2018).

En transportant un grand nombre de passagers de manière efficace, les tramways contribuent à réduire la congestion routière et les heures de déplacement dans les zones urbaines denses (Bourdages & Champagne, 2012). En offrant une option attrayante au moyen de déplacement individuel, ils libèrent de l'espace sur les routes pour d'autres modes de transport comme le vélo (Equiterre, 2020). De plus, les tramways sont généralement moins vulnérables aux perturbations causées par les aléas naturels comme que les inondations, les tempêtes ou les séismes, grâce à leur infrastructure fixe, souvent plus robuste et moins sujette aux dommages que les routes ou les ponts.

Les bénéfices anticipés du tramway

Les bénéfices du tramway sont multiples. Un autre avantage notable des tramways est la hausse de la qualité du service de transport en commun. Ils offrent une meilleure vitesse, fiabilité, confort et sécurité, augmentant ainsi la commodité pour les utilisateurs et améliorant l'efficacité opérationnelle (Equiterre, 2020). Bien que les budgets d'investissement initiaux soient plus élevés par rapport au Service Rapide par Bus (SRB), ils se justifient par les bénéfices à long terme, notamment une emprise plus étroite requise pour leur infrastructure.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

L'augmentation des déplacements en transport collectif est également un effet positif des tramways. Elle entraîne une hausse des revenus tarifaires, une amélioration de la santé publique en encourageant la marche et le vélo, et une sécurité accrue. Toutefois, cela peut aussi entraîner une forte affluence dans certains secteurs du réseau, nécessitant une gestion efficace pour éviter la surcharge.

La réduction des déplacements en automobile est un autre bénéfice majeur des tramways. En diminuant la congestion routière et les coûts liés aux infrastructures routières et de stationnement, ils permettent des économies pour les consommateurs et une amélioration de la sécurité routière (Equiterre, 2020). De plus, ils contribuent à la conservation de l'énergie et à l'atténuation de la pollution atmosphérique et sonore. Cependant, cela peut également entraîner une diminution de l'activité commerciale automobile.

Le développement orienté vers le transport (Transit-Oriented Development, TOD) bénéficie également des tramways. En facilitant un développement plus compact et accessible, ils réduisent les déplacements en véhicule, améliorent l'accessibilité pour les non-conducteurs, et diminuent le risque de criminalité. Ils permettent aussi de préserver les terres agricoles et les habitats naturels. Cependant, cette approche de développement peut poser des défis liés à la densité accrue, bien qu'elle favorise l'augmentation des espaces verts et des parcs, contribuant à une qualité de vie urbaine améliorée.

Impacts socio-économiques du tramway de Québec

Selon une étude de OC Transpo en 2024, la collaboration du transport collectif et du transport en voiture présente des avantages significatifs sur la santé physique et mentale des utilisateurs. Le fait de s'y déplacer permet de diminuer le risque de cardiopathie, d'AVC et d'hypertension, tout en diminuant les risques de certains cancers, comme ceux du sein et du côlon, et en réduisant la probabilité de développer un diabète de type 2 (Mueller et al., 2015). De plus, être plus actif grâce au transport en commun améliore la santé mentale des utilisateurs et renforce leur estime de soi (Labeaume, 2011). Ce mode de transport dynamique contribue à améliorer l'humeur, à régulariser le cycle de sommeil et à offrir aux usagers des moments de détente durant leurs déplacements.

Le tableau 1 ci-dessous relate les impacts socio-économiques du tramway à Québec.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Tableau 1: Impacts socio-économiques du tramway à Québec

Impacts socio-économiques	**Références**
Les bénéfices pour la santé	
Le tramway de Québec pourrait entraîner des économies totales de 323 millions de dollars sur une période de 30 ans et de 471,4 millions de dollars sur une période de 40 ans.	(Millette, 2014), (Lefebvre et al., 2020)
Les émissions de Gaz à effet de serre	
Plusieurs recherches démontrent que chaque utilisation de transport en commun de type système léger sur rail (SLR) entraîne une diminution de l'utilisation de l'automobile bien supérieure à celle du simple transfert modal (Litman, 2020). Cette baisse permet de réduire les émissions de gaz carbonique du tramway à 56 000 tonnes en 2041, 75 000 tonnes en 2056 et 90 000 tonnes en 2066, soit 1,7 million de tonnes sur 30 ans et 2,6 millions de tonnes sur 40 ans.	(Barla, 2024), (Martin, 2023b), (BÉLAND, 2019), (Millette, 2014), (Lefebvre et al., 2020)
Réduction des polluants atmosphériques	
Les émissions de polluants nocives pour la santé et l'environnement sont importantes lorsque les déplacements motorisés sont consommés, tels que le CO, les HC, les hydrocarbures aromatiques polycycliques (HAP), les oxydes d'azote (NOx), les oxydes de soufre (SOx), les particules fines (PM) et les composés organiques volatils (COV). Ainsi, une baisse des circulations automobiles conduira à une réduction des polluants atmosphériques, bien inférieurs à ceux émis par les autobus.	(Millette, 2014)
Les coûts d'exploitation du tramway	
Il est également prévu une diminution des coûts liées à la possession et à l'utilisation des véhicules automobiles.	(Barla, 2024), (Millette, 2014)
Les coûts de possession automobile	
On prévoit également une diminution des coûts liées à la possession et à l'utilisation des véhicules automobiles.	(Barla, 2024), (Millette, 2014)
Valeur du service de transport en commun pour les usagers	
Les tramways sont non seulement plus rapides que les bus, mais selon Kittleson et al. (2007), les usagers perçoivent en moyenne les trajets en transport par rail comme étant 12 minutes plus courts que ceux en bus, en raison de l'attrait des véhicules et des stations.	
Les gains de sécurité	
La diminution du trafic routier devrait entraîner une baisse du nombre d'accidents.	(Barla, 2024), (Millette, 2014)
Les gains associés à la réduire le nombre de places de stationnement nécessaires	
La demande de parking, ce qui permet de libérer de l'espace pour d'autres utilisations.	(Barla, 2024), (Millette, 2014), (Le Journal de Levis, 2024).
Gain de temps	
Étant une ressource restreinte, le temps possède une valeur qui correspond à ce qui pourrait être produit s'il était à disposition. Le temps économisé grâce à des déplacements plus rapides pourrait donc être consacré au travail, aux études ou aux loisirs. Un des avantages majeurs de ce projet réside dans la diminution du temps total de déplacement des utilisateurs par rapport au statu quo, ce qui permet de monétiser du temps pour des activités productives.	(Millette, 2014)

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Impacts des changements climatiques sur les infrastructures de transport

Les infrastructures de transport sont fortement influencées par les effets des changements climatiques, ce qui entraînent plusieurs impacts significatifs. La figure 3 ci-dessous relate ces divers impacts.

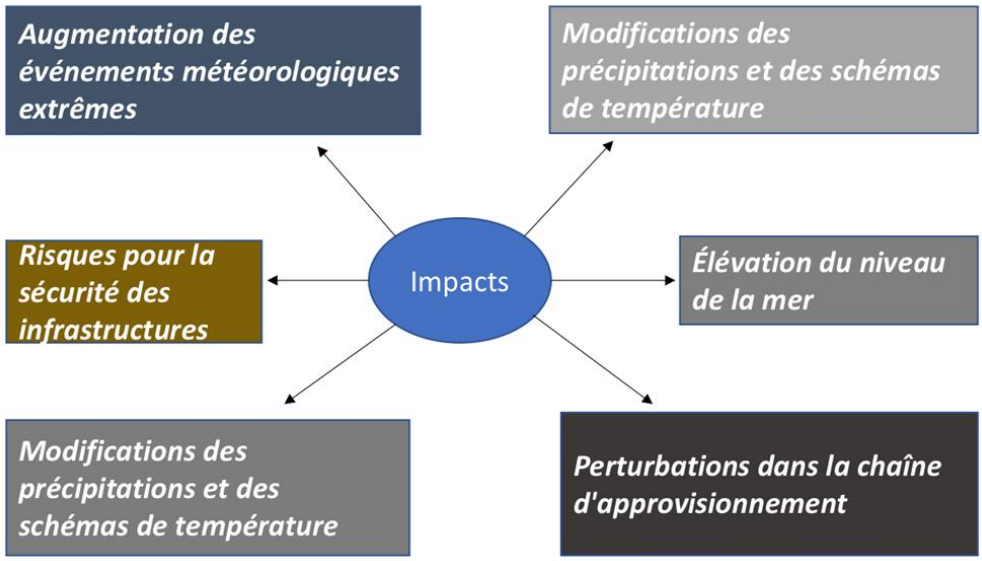

Figure 3: Impacts des changements climatiques sur les infrastructures de transport

Les infrastructures de transport sont fortement impactées par le changement climatique, entraînant des conséquences significatives. Les tempêtes, les inondation, peuvent endommager les routes, les ponts et les voies ferrées, compromettant leur fonctionnement et leur sécurité (Centre de Ressources ACC, 2019). L'élévation du niveau de la mer, due à la fonte des glaces et à l'expansion thermique des océans, menace particulièrement les infrastructures côtières, comme les routes côtières et les ports, augmentant les risques d'inondations et d'érosion, ce qui peut causer des perturbations majeures dans les réseaux de transport maritime et terrestre (Colin & Palhol, 2019).

Les modifications des précipitations et des schémas de température dues au changement climatique peuvent également affecter la stabilité des sols et des infrastructures de transport (Afroz et al., 2022). Par exemple, des précipitations extrêmes peuvent créer des glissements de terrain et des affaissements, endommageant les routes et les voies ferrées (Afroz et al., 2022). Les énormes températures, notamment les vagues de chaleur, peuvent affecter la durabilité des matériaux comme le bitume et le béton, entraînant une détérioration accélérée des infrastructures et augmentant les risques d'accidents et de pannes (Afroz et al., 2022).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

En outre, les événements météorologiques extrêmes et les changements climatiques peuvent perturber la chaîne d'approvisionnement des matériaux essentiels à la construction et à l'entretien des secteurs de transport. Cela peut causer des lenteurs dans les projets de construction et des coûts supplémentaires pour la réparation et la reconstruction des infrastructures endommagées (Colin & Palhol, 2019). Ainsi, les changements climatiques exercent une tension croissante sur les infrastructures de transport, soulignant l'importance d'adopter des stratégies d'adaptation et de renforcement pour assurer la résilience et la durabilité des réseaux de transport face aux défis climatiques futurs (Afroz et al., 2022).

Ainsi, les changements climatiques exercent une pression croissante sur les infrastructures de transport, mettant en évidence l'importance d'adopter des stratégies d'adaptation et de renforcement afin de garantir la résilience et la durabilité des réseaux de transport face aux défis climatiques futurs.

Méthodologie

Cette étude a été menée en utilisant l'approche PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (Selçuk, 2019). PRISMA est un processus de revue de la littérature. Il a été créé par un groupe d'auteurs médicaux pour améliorer la clarté, la fiabilité et la précision des revues de la littérature.

Approches de recherche documentaire

Nous avons recherché la littérature sur le thème en utilisant les moteurs de recherches en ligne suivants : Science Direct, Google Scholars qui sont des bases de données internationales et quelques presses écrites. La période de recherche de 2010 à 2024 a été sélectionnée afin de garantir une revue systématique basée sur des données actuelles et pertinentes, couvrant l'évolution récente du secteur du transport public, de la durabilité et de la résilience climatique. Les articles téléchargés étaient en anglais et en français. Dans ces bases de données, les articles ont été collectés à l'aide des termes suivants : "tramway", "changement climatique", "Québec", "résilience". Nous avions utilisé l'équation de recherche suivante dans les différentes bases de données *("projet de tramway" OR "tramway du Québec") AND ("transport public durable" OR "résilience climatique")*. Les aspects pris en compte lors de la recherche comprenaient des thèmes liés au (i) "tramway à Québec", (ii) "mobilité durable", (iii) "résilience climatique" (iv) "acceptabilité sociale du projet", (v) "obstacles et défis".

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Critères de sélection des études à inclure dans la revue systématique

Les publications rassemblées dans les bases de données électroniques ont fait l'objet d'un examen critique. Il s'agit de leurs titres, résumés et mots-clés qui ont été globalement examinés afin d'apprécier leur pertinence ou non dans la présente revue de littérature. Les publications identifiées comme doublons et les études de cas publiées en dehors du Québec ont été supprimées. Pour l'inclusion finale dans l'examen, toutes les publications ont été examinées en quatre étapes : (0) Suppression des doublons, (1) Vérification de la pertinence de la publication en fonction des titres, (2) Lecture des résumés des articles pour déterminer s'ils sont pertinents pour l'examen, (3) Téléchargement et lecture complet, (4) Récupération des publications qui répondaient à l'inclusion. Les informations suivantes ont été compilées sur les publications retenues pour cette revue sur des aspects abordés tels que : (1) mobilité durable, (2) impact socio-économique, (3) acceptabilité sociale, (4) avantages environnementaux, (5) forces et faiblesses, (6) opportunités et menaces. Les publications finales retenues ont été lues en détail pour résumer les informations et connaissances disponibles, sur la base des différents aspects mentionnés ci-dessus.

Approche d'analyse des données et méthodes de synthèse des résultats

Après une lecture approfondie des articles sélectionnés, ils ont été codés sur feuille Excel en fonction des années de publication, et des thèmes abordés dans l'étude (mobilité durable, résilience climatique, obstacles et défis, impact socio-économique, impacts environnementaux, acceptabilité du projet).

Résultats et discussions

Publications retenues

Les critères utilisés pour valider l'inclusion des articles dans la revue ont été rigoureux, tenant compte de leur adéquation par rapport aux objectifs de l'étude, de leur pertinence dans le contexte du projet de tramway au Québec qui puisse conduire vers un transport public durable et une résilience climatique. Parmi celles-ci, 43 publications (par exemple, des études sans rapport avec le sujet, des études en dehors de la situation géographique, ainsi que des doublons) ont été exclues lors des étapes de sélection et d'affinement. 76 publications éligibles ont ainsi été prises en compte pour la sélection complète des textes, un processus dont un total de 63 publications ont finalement été incluses dans la revue par la méthodologie Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) (Selçuk 2019) (Figure 4). Ces 63 études ont été publiées sur la période (2010-2024).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

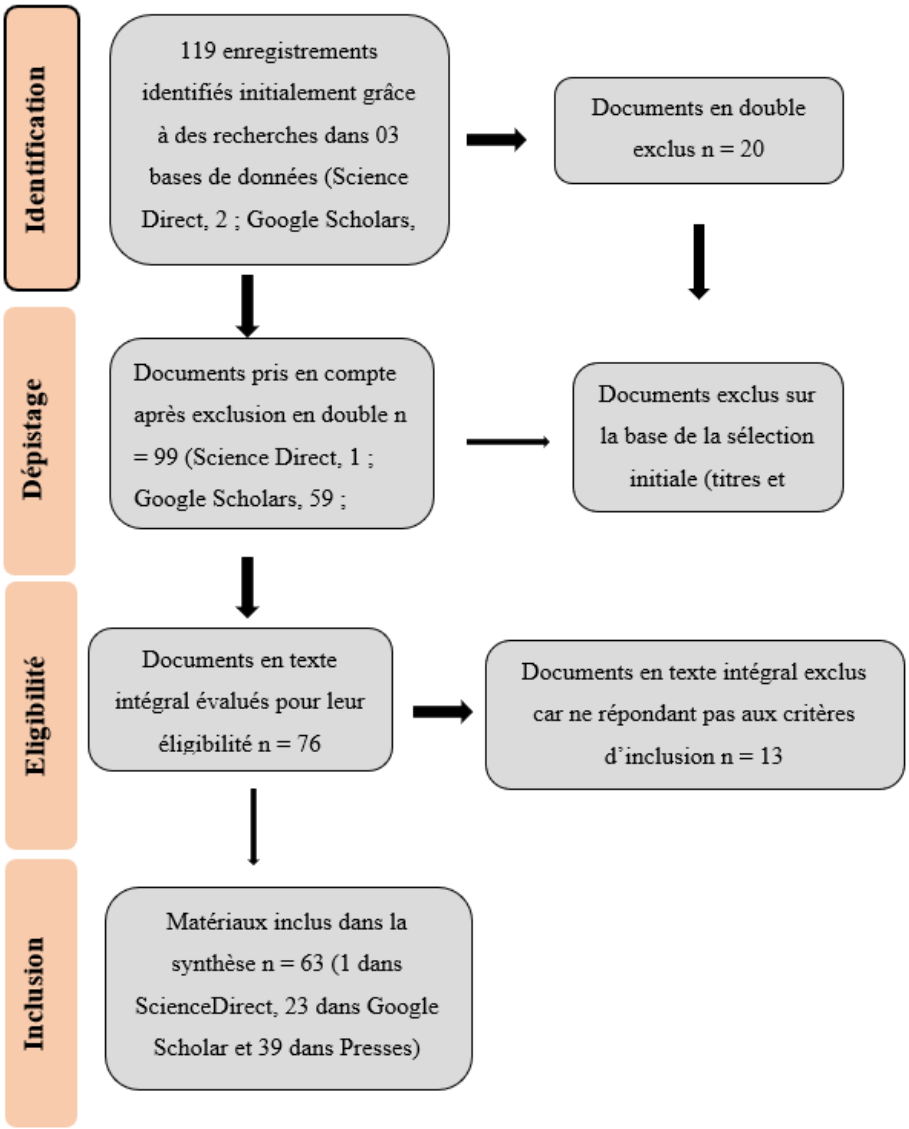

Figure 4: Diagramme montrant la sélection de 76 études incluses dans la revue systématique sur le projet de tramway de Québec

Motifs spatio-temporels

De 2016 à 2023, le nombre de publications sur le tramway à Québec, la résilience climatique, l'acceptabilité sociale du projet, la mobilité durable, les avantages environnementaux, socio-économiques, les défis et opportunités ont globalement augmenté. Les plus grands nombres d'articles (n = 18 et 11) ont été enregistré en 2020 et 2023 respectivement tandis que les plus bas (n = 1 et 2) en 2010, 2011 (Figure 5). La plupart des publications se sont plus concentrées sur le tramway à Québec, la mobilité durable, la résilience

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

climatique, les défis et opportunités, l'acceptabilité sociale, les impacts socio-économique et environnementaux du tramway (Figure 6).

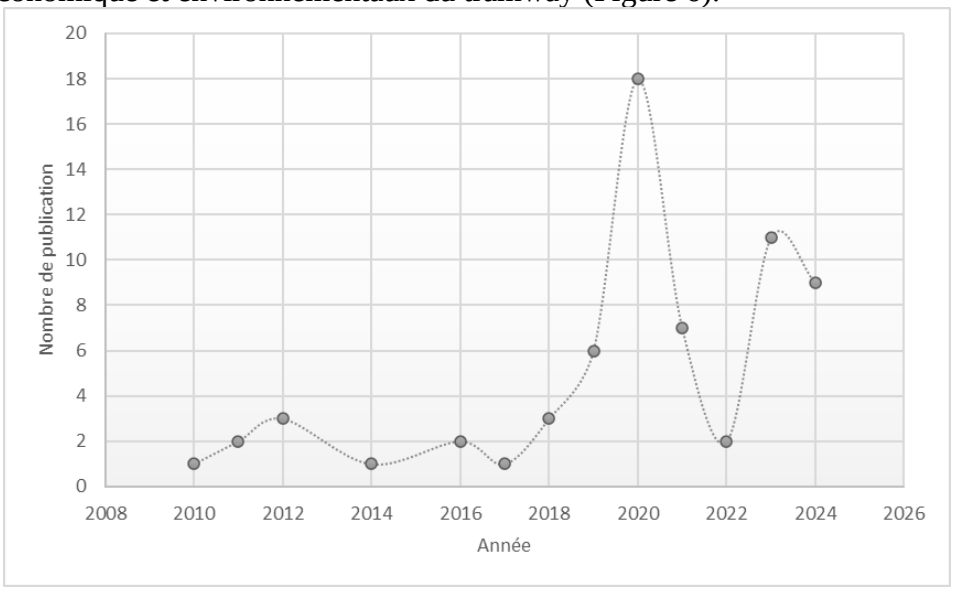

Figure 5: Nombre de publication par années

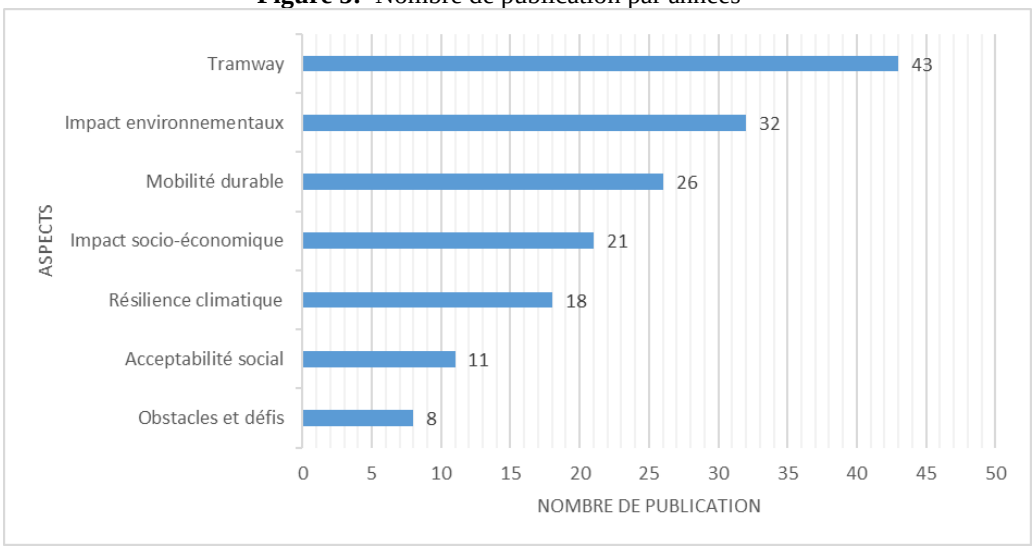

Figure 6: Nombre de publications par aspects

Synthèse des études pertinentes sur le projet de tramway de Québec

Objectifs du projet de tramway à Québec

Le tramway, un véhicule sur rail circulant principalement sur les voies publiques (Barrieau, 2021), vise plusieurs objectifs. Il cherche à atténuer les émissions de gaz carbonique et à raffiner le cadre de vie en diminuant les nuisances liées au transport, telles que la pollution et le bruit (Ermatinger et al., 2010). Le projet anticipe une augmentation des déplacements quotidiens

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

de 1,9 million en 2011 à plus de 2,3 millions en 2041, soit un accroissement de 22 % (Barla, 2024). Il encourage également la condensation urbaine et le réveil du centre-ville en rendant ces zones plus accessibles et fascinant. De plus, le tramway vise à ériger des connexions efficaces entre les principaux pôles d'activité du Québec et à améliorer l'offre de transport collectif en termes de capacité, de fréquence, de confort et de fiabilité, rendant le système plus attractif pour les utilisateurs actuels et potentiels (Barla, 2024).

Deux options sont étudiées dans le projet de tramway : un service de bus rapide (SRB) à grande capacité qui circule sur des voies réservées et a la priorité aux intersections (Barla, 2024). Deux lignes principales de 28,6 km, Est-Ouest et Nord-Sud, seront également mises en place, traversant le boulevard Charest et desservant la rive Sud (Belley et al., 2021). Selon Barra (2024), le tramway peut accueillir jusqu'à 260 passagers par rame.

Origine des émissions de GES

Le tramway de Québec est un réseau structurant de transport collectif conçu pour transformer la province et offrir une alternative durable à l'automobile (Lefebvre et al., 2020). Ce projet inclut l'instauration de la première ligne de tramway depuis 1948, qui reliera directement près de 140.000 résidents et 150.000 emplois à 800 mètres de marche. Les tramways seront des véhicules légers sur rails, alimentés par une ligne aérienne de contact portant un courant continu de 750 Common Collector Voltage) ou tension de collecteur commun (VCC) (AECOM, 2019). Les émissions de GES des véhicules de transport dépendent de plusieurs variables, dont le type et la fréquence d'usage du véhicule, le type de moteur, les conditions de circulation et les distances parcourues (Belley et al., 2021). La Ville de Québec s'engage sur l'objectif de son gouvernement pour atténuer de 20 % les émissions de gaz carbonique d'ici 2020 comparer à 1990 (Lefebvre et al., 2020), et mets aussi en place le Plan de mobilité durable qui permettra d'atteindre cet objectif (Labeaume, 2011).

Le tramway comme alternative pour réduire les émissions de GES

Le domaine des transports, représentant 45 % des émissions de GES, joue un important rôle pour lutter contre les changements climatiques (Labeaume, 2011). Le tramway à Québec est essentiel pour atténuer l'empreinte carbone des déplacements (Equiterre, 2023). Ce projet constitue un investissement clé pour la transition écologique, à l'instar des remarquables projets de transport collectif dans le monde (Equiterre, 2023). D'ici 2041, il est prévu que 100.000 déplacements supplémentaires par jour exacerbent les problèmes de circulation, de congestion et de stationnement (Le Journal de Levis, 2024). Pour répondre à ce défi, la municipalité propose un réseau structurant avec un tramway électrifié en tant que colonne vertébrale, capable

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

d'absorber 53 % de ces nouveaux déplacements, soit 9 000 automobiles en période de pointe matinale (Le Journal de Levis, 2024). En été comme en hiver, un tramway fiable et performant, renforce la résilience de la population et constitue une adaptation efficace aux changements climatiques (RSTC, 2020).

En 2022, un bilan évalue qu'environ 127 000 tonnes de CO2 seront produits pendant la construction. Durant l'utilisation, on prévoit que de nombreux automobilistes opteront abondamment pour le transport collectif, en particulier le tramway, permettant ainsi d'éviter, d'ici 2041, une grande partie des 216 000 tonnes de CO2 qui auraient été émises. Cela se traduit par un bilan net de 89 000 tonnes de CO2 non émises dans l'atmosphère 15 ans après le début de l'utilisation (RSTC, 2022). Ce bénéfice est principalement dû au transfert modal ; au fait que les gens délaisseront la voiture pour d'autres moyens de transport collectif, y compris le tramway (Lefebvre et al., 2020). De plus, le projet atteindra la carboneutralité dès la 11e année d'exploitation (RSTC, 2022). Cependant, ce gain exclut le CO2 capté par les efforts de reboisement (Barrieau, 2021). Il est prévu d'abattre 1584 arbres pour l'implantation du tramway. Pour compenser cet abattage en termes de captation de CO2, 3492 arbres devraient être plantés (RSTC, 2022). Néanmoins, il sera planté 30 000 arbres, soit un ratio de 20 arbres plantés pour chaque arbre abattu dans les quartiers concernés, favorisant ainsi de capter 583 tonnes de CO2 par an. En intégrant cette information dans l'évaluation des gaz à effet de serre du projet, l'équilibre carbone pourrait parvenir à deux ans plus tôt, dès la 9e année d'exploitation du tramway (Barrieau, 2021).

Enfin, dans l'optique de réduire les gaz à effet de serre et visant à faire du Québec un lieu de vie de bonne qualité, il urge de faire le choix de systèmes qui ne font plus appel à des carburants fossiles, qui sont silencieux et qui présentent une image alignée avec cette vision (Labeaume, 2011). L'usage du tramway permet une économie significative, car chaque rame, mesurant entre 30 et 45 mètres de long, peut transporter de 190 à 290 passagers (Labeaume, 2011). Le taux élevé du prix du pétrole et les règlements gouvernementaux visant à réduire des GES poussent rapidement les constructeurs automobiles à concevoir des voitures consommant moins d'énergie (Lefebvre et al., 2020). La popularité des voitures hybrides est en constante augmentation et plusieurs constructeurs investissent dans la recherche et le développement pour commercialiser, dans quelques années, des voitures entièrement électriques (Labeaume, 2011). Les voitures électriques réduisent la pollution atmosphérique, à une réduction significative du bruit et diminuent considérablement les émissions de gaz à effet de serre (Maupu & Stransky, 2017).

Le ministère du Développement durable, de l'Environnement et des Parcs est responsable du Plan d'action 2006-2012 sur les changements

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

climatiques, qui fixe des objectifs précis de réduction des émissions de gaz à effet de serre (GES) pour le Québec et définit les moyens d'y parvenir (Maupu & Stransky, 2017). Ce plan a pour objectif de favoriser le développement et l'utilisation du transport en commun, ainsi que des moyens de transport alternatifs tels que le covoiturage, le vélo et la marche, parmi les mesures à prendre en compte en matière de transport des personnes (Laviolette et al., 2020). De plus, la valeur économique de la réduction des polluants atmosphériques a été estimée en multipliant la réduction des émissions par leur coût social (Millette, 2014). Le coût social unitaire des émissions de gaz à effet de serre et des polluants atmosphériques des autobus est évalué à 0,088 $ par km, comme indiqué dans le tableau suivant (Millette, 2014).

Tableau 2: Coût social ($ par km) des émissions polluantes et de GES pour un autobus (Millette, 2014)

Types d'émissions	**Coût social ($/tonne métrique)**		**Taux d'émission (gramme/km)**	**Coût social total ($ par km)**
	2011	**2014**		
CO2	81	84	587.585	0.049645
CO	1742	1817	1.577	0.002866
HC	6339	6612	0.241	0.001594
Nox	8086	8435	3.896	0.032861
Sox	6747	7038	0.007	0.000049
PM 2.5	4406	4596	0.069	0.000317
PM 10	8655	9028	0.084	0.000758
Total				**0.088090**

En 2026, ce bénéfice est évalué à 648.187 $ pour une diminution de 7,4 millions de véhicules/km et, en 2050, à 926.632 $ pour une diminution de 10,5 millions de véhicules/km (Millette, 2014)**.**

Le choix du type d'infrastructure de transport en commun joue un important rôle dans l'atteinte des objectifs d'atténuation des émissions de GES d'une ville (Aubert, 2024). Certains articles recommandent particulièrement la technologie du tramway, car elle serait plus efficiente en termes de coûts économiques et environnementaux à long terme et encouragerait les individus à faire des trajets plus courts (Condon et Dow, 2011). Aussi, les études montrent que le projet pourrait considérablement améliorer la mobilité urbaine en offrant une alternative efficace à la voiture individuelle et aux bus (Chaire publique AELIÉS et NÉO, 2024). En reliant les quartiers densément peuplés et les zones d'activités économiques, le tramway pourrait réduire les temps de trajet et la congestion routière (Bourdages et Champagne, 2012). Le tramway est ainsi une réponse aux enjeux climatiques car il réduira notre impact sur l'environnement (RSTC, 2023).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Tableau 3: Projet de tramway

Éléments	**Caractéristiques**	**Références**
Description du projet	La portée du projet du tramway de Québec comprend un tracé de 19,3 km entre les stations Le Gendre, à l'ouest, et D'Estimauville, à l'est, de même que les infrastructures de transport collectif s'y rattachant (centre d'entretien et d'utilisation, stationnements incitatifs, stations et pôles d'échanges) (Le Journal de Levis, 2024).	(Ministère des transports, 2021) (Ermatinger et al., 2010)
Gestionnaire du projet	Ville de Québec	(Ministère des transports, 2021) (Ermatinger et al., 2010)
Coût estimé du projet	3 365 000 000 $	(Radio Canada, 2023), (Ministère des transports, 2021)
Contribution maximale du gouvernement du Québec	1 865 000 000 $	(Ministère des transports, 2021)
Contribution maximale du gouvernement du Canada	1 200 000 000 $	(Ministère des transports, 2021)
Contribution de la Ville de Québec	300 000 000 $	(Ministère des transports, 2021)
État d'avancement	Actuellement à l'étude et en planification	(Ministère des transports, 2021), (Ermatinger et al., 2010)
Échéancier prévu	Mise en service : 2028	(Ministère des transports, 2021)

En résumé, les études pertinentes sur le projet de tramway de Québec (Tableau 3) mettent en évidence son potentiel à améliorer la mobilité urbaine, à réduire la contribution à l'environnement des transports et à stimuler la croissance économique régional. Malgré ses nombreux avantages, le projet de tramway de Québec doit surmonter plusieurs défis de réalisation, en matière de financement, de coordination des parties prenantes et d'acceptation sociale (Ermatinger et al., 2010).

Ces défis sont d'ordre politique, économique (gouvernance, financement), environnemental et social (conséquences sur la pollution, la capacité routière, l'offre de stationnement, les riverains et les commerçants), ainsi que technique (pente, neige, alimentation électrique) (Le Journal de Levis, 2024). Des études soulignent l'urgence d'une planification et d'une gestion efficace pour surmonter ces obstacles et assurer le succès du projet (Ermatinger et al., 2010). Pour relever ces défis complexes, la collaboration de multiples parties prenantes est essentielle.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Les parties prenantes du projet de tramway de Québec incluent les autorités publiques (gouvernement provincial et ville de Québec), les utilisateurs des autobus, les automobilistes, les opérateurs de transport collectif, les résidents de la région, la Société québécoise des infrastructures (SQI), le ministère des Transports du Québec (MTQ), et aussi des experts et des groupes environnementaux (Barla, 2024). Il est essentiel d'impliquer activement ce large éventail de parties prenantes pour garantir la transparence et l'acceptabilité du projet. Les autorités municipales et provinciales sont responsables de la planification, du financement et de la réalisation du projet, en assurant la transparence des décisions et en tenant compte les intérêts des populations. Les résidents et communautés locales, directement affectés par le projet, doivent participer activement pour garantir son acceptabilité sociale. Les entreprises et commerces le long du tracé, potentiellement impactés par les travaux de construction et les modifications de circulation, doivent collaborer pour minimiser les perturbations et soutenir le développement économique local (Cattapan, 2020). Les organisations communautaires et groupes de défense des droits représentent les intérêts des communautés locales et jouent un important rôle dans la mobilisation des résidents et la défense des populations vulnérables. Les organisations environnementales contribuent à la durabilité du projet en minimisant son impact environnemental et en promouvant des sources d'énergie propres. Enfin, les institutions académiques et les experts techniques fournissent des conseils spécialisés en planification urbaine, transports et ingénierie, aidant ainsi à la conception et à la mise en œuvre efficace du projet (AECOM, 2019).

Facteurs clés influençant l'efficacité du projet de transport public dans la promotion de la durabilité et de la résilience

Plusieurs facteurs clés influencent l'efficacité d'un projet de transport public dans la promotion de la résilience et de la durabilité. Un réseau de transport public efficace doit être accessible à tous les segments de la population, y compris les individus à situation de handicap et les résidents des quartiers périphériques (Parent, 2023). De plus, il doit viser à favoriser l'intermodalité et à développer des infrastructures pour les modes de transport actifs, contribuant à une mobilité plus durable et accessible à tous (CNUCED, 2014). La fiabilité et la fréquence des services de transport public sont également essentielles pour stimuler les usagers à prioriser les transports collectifs au lieu de leur voiture. Des horaires réguliers et des temps d'attente réduits contribuent à augmenter la satisfaction des utilisateurs et à renforcer la crédibilité du système de transport (Parent, 2023). Un autre facteur crucial est la disponibilité financière des services de transport public (UNDRR, 2024). Des tarifs abordables et des options de paiement flexibles, comme les abonnements mensuels ou annuels, rendent le transport en commun plus

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

attractif pour tous les usagers, quel que soit leur niveau de revenu (Parent, 2023). L'arrivée du tramway offre des possibilités de requalifier les milieux de vie, d'augmenter la canopée et de réduire les îlots de chaleur, contribuant ainsi à la résilience climatique de la ville (Toubin et al., 2012). Une planification urbaine intégrée est essentielle pour garantir le succès d'un projet de transport public (UNDRR, 2024). Cela implique de concevoir des infrastructures de transport en s'attardant sur des besoins des populations, des entreprises et des autres acteurs impliqués, tout en favorisant le développement de quartiers durables et accessibles (Ermatinger et al., 2010).

Facteurs influençant l'acceptabilité du projet de transport public à Québec

Dans toute cette histoire de l'implantation du tramway, le projet n'a jamais reçu l'approbation de la population (Trudel, 2020). À l'inverse, l'acceptabilité sociale est loin d'être atteinte, malgré les milliards investis par le gouvernement et les divers itinéraires possibles pour le tramway (Trudel, 2020). À maintes reprises, les citoyens ont été ravis que le projet soit abandonné (Trudel, 2020). L'acceptabilité sociale des projets de transport public est un enjeu crucial pour garantir leur succès et leur intégration harmonieuse dans la société (Trudel, 2020). Pour CAA-Québec, l'adhésion de la population et l'acceptabilité sociale sont devenues les points faibles du projet et cette difficulté à rallier la population a un effet néfaste sur ce bien commun d'une grande importance pour l'agglomération (CAA-Québec, 2024). Le cynisme ambiant est contre-productif et nuit au projet, alors que l'acceptabilité sociale et la confiance de la population en faciliteraient grandement la réalisation (CAA-Québec, 2024).

L'acceptabilité du projet de transport public à Québec, notamment le projet de tramway, a été influencée par divers facteurs politiques, économiques, sociaux, environnementaux et techniques. Le soutien et l'opposition des autorités politiques ont joué un rôle déterminant dans l'acceptabilité du projet de tramway à Québec. Le soutien du maire Régis Labeaume et des autorités provinciales, notamment avec le Premier ministre Couillard, a été crucial (Labeaume, 2011). En 2018, leur engagement a relancé le projet en assurant son financement. Cependant, l'opposition politique, visible lors des élections municipales, a également influencé l'acceptabilité. Par exemple, l'élection de Régis Labeaume en 2007 et sa réélection en 2009, basées sur des plateformes variées, ont montré des fluctuations dans l'acceptation publique du projet (Labeaume, 2011). L'inclusion des parties prenantes, telles que les autorités publiques, les opérateurs de transport, les résidents, et les groupes environnementaux, a également été essentielle (Martel, 2023). Les consultations publiques et le dialogue continu ont permis

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

de recueillir des avis et d'adapter le projet en fonction des attentes et des préoccupations des citoyens.

Le financement et les coûts du projet ont grandement influencé son acceptabilité. Les préoccupations concernant les coûts élevés, les risques de dépassements budgétaires et les retards ont alimenté les débats publics (Ministère des transports, 2021). Néanmoins, les avantages économiques potentiels, comme la création d'emplois et le développement économique et immobilier le long de l'itinéraire du tramway, ont favorisé l'acceptation (Millette, 2014). Les bénéfices économiques à long terme, tels que les économies sur les coûts de santé liés à l'obésité, ont également été des arguments en faveur du projet (Mueller et al., 2015).

Aussi, l'impact sur la qualité de vie des résidents et des visiteurs a été un facteur clé dans l'acceptabilité du projet. L'amélioration de la mobilité et de l'accessibilité, la réduction des embouteillages et la promotion d'un mode de vie plus actif ont été perçues positivement. Les bénéfices pour la santé publique, notamment la réduction des émissions de gaz à effet de serre (GES) et les économies sur les coûts de santé, ont renforcé cet aspect. Cependant, les perturbations temporaires pendant la phase de construction, comme l'accès limité aux commerces et la perturbation de la circulation, ont suscité des inquiétudes parmi les riverains et les commerçants.

Par ailleurs, la réduction des émissions de GES et de la pollution sonore grâce à l'électrification du système de transport a été un argument majeur en faveur du projet (Lefebvre et al., 2020). Cependant, les exigences d'évaluations environnementales rigoureuses ont soulevé des préoccupations quant à la faisabilité et au calendrier du projet. Les retards potentiels liés à ces évaluations ont été une source de débat. Il est crucial que le projet respecte les normes environnementales tout en minimisant les retards.

En outre, il est crucial de rendre l'information accessible (Martel, 2023). Une information claire et complète dissipe les incompréhensions et légitime les projets, favorisant ainsi leur acceptabilité (Gauthier, 2015). Le manque de transparence dans la communication du projet et de documentation pertinente aux citoyens a nui à leur compréhension et à leur adhésion (Martel, 2023). Les citoyens doivent disposer d'assez d'information et de temps pour évaluer les projets (Parent, 2023). Ensuite, il est essentiel d'avoir la qualité du processus de participation citoyenne (Martel, 2023). La participation doit commencer dès les phases préliminaires de conception du projet pour maximiser l'adhésion (Parent, 2023). La figure 7 présente un résumé des facteurs influant l'acceptabilité sociale du projet tramway du Québec.

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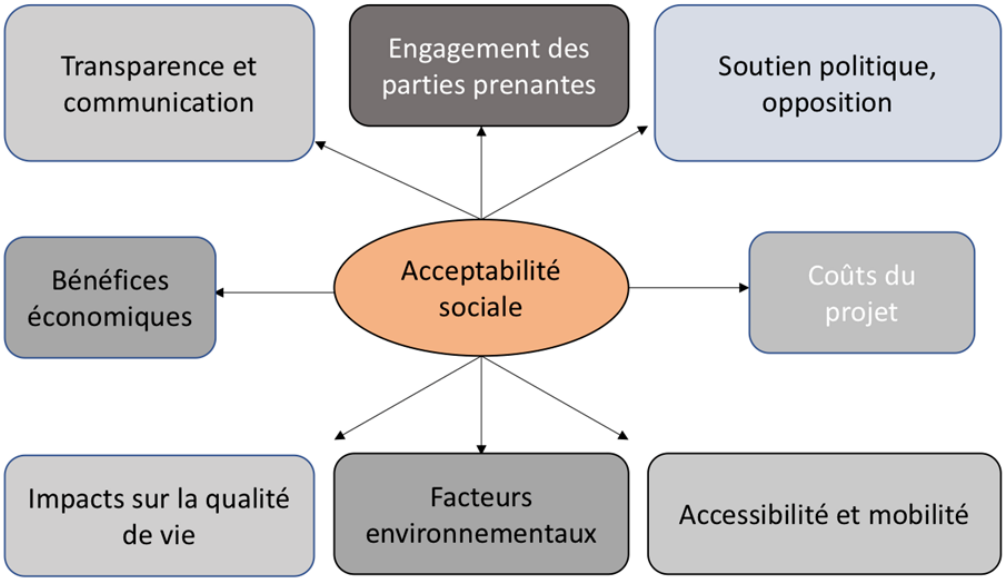

Figure 7: Cadre d'analyse des facteurs influençant l'acceptabilité sociale inspiré de Fortin et al. (2023)

L'acceptabilité du projet de tramway à Québec a été façonnée par une multitude de facteurs interconnectés. Un soutien politique fort, des avantages économiques potentiels, des améliorations prévues en matière de qualité de vie et de santé publique, ainsi que des considérations environnementales positives ont favorisé l'acceptation. Toutefois, les préoccupations liées aux coûts, aux perturbations temporaires, aux défis techniques et aux exigences environnementales ont également influencé les perceptions publiques et politiques du projet. Pour maximiser l'acceptabilité, il est crucial de continuer à engager toutes les parties prenantes, de communiquer clairement les avantages et de gérer efficacement les défis potentiels.

Évaluation des implications pour la réalisation du projet de tramway au Québec

L'évaluation des implications pour la réalisation du projet de tramway au Québec est un sujet complexe et crucial pour le développement de ce système de transport. Plusieurs aspects sont abordés tels que la gestion du camionnage pendant la construction pour minimiser les perturbations, les impacts sur la santé, les impacts social (AECOM, 2019), l'évaluation environnementale pour considérer les conséquences positives et négatives sur l'environnement, les ajustements nécessaires pendant la phase de construction pour garantir la fluidité de la circulation et impacts potentiels sur les lieux d'emplois. Le projet est également soumis à des processus d'évaluation

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

environnementale à la fois provincial et fédéral, en raison de sa traversée de deux provinces (AECOM, 2019). Pendant la phase de construction du tramway, les critères d'accès aux sites de travail seront changées, ce qui nécessitera des ajustements pour assurer la fluidité de la circulation et minimiser les perturbations (AECOM, 2019). Les impacts environnementaux du projet de tramway à Québec sont variés et comprennent des aspects positifs et négatifs (Lefebvre et al., 2020). Comme impacts positifs, nous avons l'atténuation des émissions de GES grâce à une diminution de l'usage de l'automobile et à la transition vers un mode de transport en commun plus écologique (Lefebvre et al., 2020), le taux réduit de la pollution sonore, car les tramways sont généralement moins sonores que les autobus, ce qui contribue à améliorer la qualité de vie des populations, la création de bénéfices sur les dépenses sur la santé liés à l'obésité, avec des approximations indiquant des économies importantes sur 30 et 40 ans (Lefebvre et al., 2020). En ce qui concerne les impacts négatifs, nous avons les modifications des conditions d'accès aux sites de travail pendant la phase de construction, ce qui peut entraîner des perturbations temporaires pour les travailleurs et les entreprises situés le long des tracés du tramway, le risque de retards dans la construction en raison de l'importance de se conformer à des évaluations environnementales, ce qui soulève des préoccupations quant à la gestion efficace du projet.

Forces, faiblesses, opportunités et menaces du projet

Le tableau 4 présente une évaluation SWOT (forces, faiblesses, opportunités, menaces) du projet de tramway de Québec, offrant une vue d'ensemble des avantages et des défis associés à ce projet ambitieux.

Tableau 4 : Forces, faiblesses, opportunités et menaces du projet

Forces	**Faiblesses**
Réduction significative des émissions de GES et de la pollution sonore grâce à l'électrification du système de transport (Chaire publique AELIÉS & NÉO, 2024) L'implantation du tramway à Québec permettra d'éviter l'émission de 89 000 tonnes de C02 en 2041, soit 15 ans après le début de son utilisation (Environnement, 2022). Création de bénéfices importants sur les coûts de santé liés à l'obésité, avec des économies estimées à 323 M$ et de 471,4 M$ pour une durée respectivement de 30 ans et 40 ans Le projet de tramway offre une alternative de transport en commun efficace, réduisant les embouteillages et améliorant la mobilité des citoyens (Messahel & Acherard, 2022). Le projet peut inciter le développement économique et immobilier le long de son itinéraire.	Risque de retards dans la construction en raison de l'urgence de se conformer à des évaluations environnementales, ce qui soulève des préoccupations quant à la gestion efficace du projet. Perturbations temporaires de l'accès aux sites d'emplois pendant l'étape de construction, nécessitant des ajustements pour assurer la fluidité de la circulation. Le projet de tramway a reçu une évaluation défavorable sur toutes les préoccupations liées à la communication des changements climatiques (Parent, 2023). Augmentation du prix des projets et le manque de financement peut retarder la réalisation du projet (Millet, 2016). La construction du tramway peut perturber la circulation et les commerces locaux pendant les travaux.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Le projet pourrait stimuler l'économie locale par la création d'emplois et en attirant des investissements dans la région. Il pourrait rendre les quartiers de la ville plus accessibles aux résidents et aux visiteurs, favorisant ainsi l'inclusion sociale.	Le tramway nécessite un entretien régulier pour garantir son bon fonctionnement.
Opportunités	**Menaces**
Faciliter l'intermodalité et une meilleure hiérarchisation des différents moyens de transport (piétons, cyclistes, transports collectifs) (Messahel & Acherard, 2022). Profiter de l'arrivée du tramway pour faire de la requalification urbaine et créer davantage d'espaces publics conviviaux Le tramway peut rendre la ville plus agréable en réduisant la pollution sonore et environnementale. Un système de transport moderne peut attirer les touristes et les visiteurs (Messahel & Acherard, 2022). La construction et l'utilisation du tramway génèrent des emplois locaux. Le tramway pourrait devenir un symbole emblématique de la ville et renforcer son identité urbaine. Le projet de tramway offre l'opportunité d'intégrer le système de transport collectif avec certains autres moyens de transport, comme les bus, les vélos et les voitures partagées, offrant ainsi aux résidents une solution de mobilité complète. Les stations de tramway pourraient devenir des pôles de développement urbain, stimulant la croissance économique et l'activité commerciale dans les quartiers avoisinants.	Possibilité d'un refus du gouvernement d'exempter le projet d'une évaluation environnementale complète, malgré les arguments de la Ville Risque de retards et de dépassements de coûts liés à la gestion des impacts environnementaux et des perturbations pendant la construction Certains automobilistes peuvent s'opposer au projet, craignant des perturbations dans leur routine quotidienne (AECOM, 2019). Si les fonds alloués ne sont pas suffisants, le projet pourrait être retardé ou réduit. Un système de tramway nécessite une maintenance régulière pour garantir son bon fonctionnement, ce qui pourrait entraîner des coûts supplémentaires à long terme. Le tramway doit rivaliser avec les bus, les voitures et les services de covoiturage. Des contraintes environnementales telles que des zones protégées ou des préoccupations liées à la biodiversité pourraient limiter l'emplacement des voies de tramway, affectant ainsi la faisabilité du projet.

Le tableau SWOT met en évidence les multiples dimensions du projet de tramway de Québec. Bien que le projet offre des avantages environnementaux, économiques et sociaux significatifs, il doit également surmonter des défis substantiels en termes de gestion, de financement et d'acceptation publique. Une planification et une gestion efficaces seront essentielles pour maximiser les opportunités et minimiser les risques associés à ce projet crucial pour l'avenir de la mobilité urbaine à Québec.

Recommandations pour une mise en œuvre efficace et durable du projet

Pour assurer la mise en œuvre efficace du projet de tramway à Québec, plusieurs recommandations concrètes peuvent être formulées. En tenant compte des forces, faiblesses, opportunités et menaces évoquées précédemment, ces recommandations visent à maximiser les avantages du projet tout en atténuant les défis potentiels.

Afin de faire face aux éventuels retards et aux dépenses supplémentaires, il est essentiel de renforcer la planification et la gestion du

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projet. Cela peut englober la création de plannings précis, la mise en œuvre de contrôles rigoureux des dépenses et la formation d'une équipe spécialisée dans la gestion de projet qui surveillera attentivement l'avancement des installations. De plus, il est crucial d'avoir une communication claire et transparente avec toutes les parties impliquées afin de préserver la stabilité et éviter les malentendus.

Cependant, puisque les évaluations environnementales sont essentielles, il est conseillé de travailler en étroite collaboration avec les organismes de régulation afin de garantir le respect de toutes les exigences sans compromettre les délais du projet. Dès le début du projet, il est possible de mettre en œuvre des mesures d'atténuation proactives et de mener des études d'impact détaillées afin d'anticiper et de résoudre les problèmes environnementaux potentiels.

En effet, au cours de la construction, dans l'optique de diminuer les perturbations temporaires pour les commerces et la circulation, il est nécessaire de mettre en place des plans de gestion de la construction. Ces mesures peuvent comprendre des horaires de travail adaptés, des routes de déviation pour faciliter la circulation et des campagnes d'information visant à tenir les habitants et les commerçants au courant des avancées et des conséquences à court terme. Il est également possible d'envisager la création de compensations ou de soutien temporaire pour les entreprises affectées.

Par ailleurs, le projet fait face à une menace majeure en raison du manque de financement. Il est donc conseillé de garantir la sécurité de sources de financement variées et pérennes. Cela engloberait des collaborations entre le secteur public et privé, des aides gouvernementales et éventuellement des initiatives de financement participatif. Il sera également crucial d'avoir une planification financière rigoureuse, comprenant des fonds de réserve pour faire face aux imprévus, afin d'éviter les interruptions causées par des pénuries de fonds.

En ce qui concerne la création d'un réseau de transport multimodal avec le tramway, afin de tirer le meilleur parti du tramway, il est conseillé de garantir une bonne intégration avec les autres modes de transport tels que les bus, les vélos et les voitures partagées. L'intermodalité peut être facilitée par des billets combinés ou des infrastructures adaptées (par exemple des parkings à vélos sécurisés aux stations de tramway), ce qui peut améliorer l'accessibilité et favoriser une utilisation plus importante du tramway.

Le projet de tramway offre une grande opportunité de requalification urbaine. Des projets de développement urbain autour des stations de tramway sont conseillés afin de concevoir des espaces publics accueillants et séduisants. Cela pourrait englober des espaces dédiés aux piétons, des espaces verts et des aménagements qui favorisent les échanges sociaux et la dynamique économique locale.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Conclusion

Les défis les plus ambitieux des prochaines années seront l'adaptation et la réduction des changements climatiques. Le projet de tramway de Québec illustre la nécessité pour ses promoteurs d'adopter de nouvelles stratégies adaptées à cette réalité. Le développement d'un réseau de transport collectif électrique offre des avantages environnementaux significatifs, mais il est important de tenir compte les diverses perceptions et impacts potentiels sur les résidents.

Pour lutter contre les changements climatiques, il faut intégrer la participation citoyenne accrue dans les processus décisionnels, en favorisant des décisions plus durables. Les dispositifs participatifs doivent permettre une communication bidirectionnelle et des formes de participation interactives pour protéger l'environnement de manière optimale. Mal conçues, ces stratégies risquent d'exacerber les inégalités existantes et de promouvoir des visions fermées aux changements. Par conséquent, les promoteurs de projets environnementaux doivent accorder une attention particulière à la communication pour obtenir l'acceptabilité sociale.

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Résumé

La déforestation et la dégradation inquiétantes que les ressources forestières et les formations boisées subissent en Afrique de l'ouest, sont dues aux différentes formes d'exploitations irrationnelles, notamment l'exploitation forestière et fourragère. En effet, ces deux formes d'exploitations, constituent les facteurs de pression sur certaines espèces végétales très prisées pour leur bois et fourrage. L'objectif de cette étude est de déterminer l'incidence de ces activités sur la dynamique structurale des peuplements de *Prosopis africana*, de *Ptérocarpus erinaceus*, et de *Afzelia africana*. La méthodologie adoptée est l'inventaire forestier dans les placettes de 1000 m² (100 m x 10 m) installés régulièrement à chaque 200 m le long des transects de 6 km dans chaque zone choisie. Les résultats montrent que ces activités ont une incidence négative sur la densité, le diamètre moyen, la hauteur moyenne et la surface terrière de ces trois espèces qui sont globalement faibles à cause de la densité élevée de coupe, d'émondage et de carbonisation. Ces espèces sont devenues rares avec des indices de raretés supérieurs à 80 % et leur régénération atteint rarement la maturité dans les

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zones exploitées à cause des feux de brousse, de l'agriculture et broutage sans cesse des bœufs. La structure en classes de diamètre et la structure en classes de hauteur révèlent que ces trois espèces sont représentées par les individus de diamètres et hauteurs faibles dans la zone où elles sont exploitées. Cette étude à travers ses résultats, interpelle à une gestion rationnelle de ces trois espèces par des mesures permettant leur protection et conservation durable afin d'éviter leur dégradation irréversible.

Mots-clés: Incidence, exploitation, dynamique structurale, commune Kéran1, Nord-Togo

Impact of logging and fodder exploitation on the structural dynamics of *Prosopis africana* (Gill. & Perr.) Taub, *Ptérocarpus erinaceus* Poir, and *Afzelia africana* Smith ex Pers. in the commune of Kéran 1, North-Togo

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Abstract

The worrying deforestation and degradation of forest resources and woodlands in West Africa is due to various forms of irrational exploitation, in particular logging and fodder exploitation. In fact, these two forms of exploitation are the factors that put pressure on certain plant species that are highly prized for their wood and fodder. The aim of this study is to determine the impact of these activities on the structural dynamics of stands of *Prosopis africana*, *Pterocarpus erinaceus*, and *Afzelia africana*. The methodology adopted is forest inventory in 1000 m² plots (100 m x 10 m) installed regularly every 200 m along 6 km transects in each selected area. The results show that these activities have a negative impact on the density, mean diameter, mean height, and basal area of these three species, which are low overall because of the high density of felling, pruning, and charring. These species have become rare, with rarity indices of over 80 %, and their regeneration rarely reaches maturity in exploited areas due to bushfires, agriculture, and constant grazing by oxen. The structure in diameter classes and the structure in height classes show that these three species are represented by individuals with small diameters and heights in the area where they are harvested. The results of this

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study call for rational management of these three species, with measures for their protection and sustainable conservation to avoid irreversible degradation.

Keywords: Impact, exploitation, structural dynamics, Kéran1 commune, North Togo

Introduction

La déforestation et la dégradation inquiétantes que les ressources forestières et les formations boisées subissent en Afrique de l'ouest, sont dues aux différentes formes d'exploitations irrationnelles, notamment l'exploitation agricole, forestière et fourragère. Ce qui occasionne non seulement une déforestation de 4,7 % par an, mais aussi, vulnérabilise 8 % d'essences d'arbres qui sont actuellement en danger critique d'extinction et nécessitent des mesures urgentes de conservation (FA0, 2020). En effet, face à la dégradation et la surexploitation des zones de pâturage, face à l'insécurité alimentaire due à la baisse continue de la production agricole et face aux changements climatiques, la population sans cesse croissante et pauvre, y trouve en ressources forestière, une source de revenue (charbon de bois, bois énergie, objets d'art et bois d'œuvre) et une ressource fourragère pour les animaux (Rabiou *et al*., 2015 ; Kaina *et al*., 2020 ; Assi & Ochoulou, 2020 ; Bakhoum *et al*., 2020 ; Ndiaye *et al*., 2023). Mais, cette exploitation devenue abusive et irrationnelle, conduit à un déséquilibre des écosystèmes et menace beaucoup de ligneux de disparition de leurs habitats naturels (Bakhoum *et al*., 2020 ; Abdou et al., 2020). Parmi les ligneux menacées et en danger, se trouvent *Prosopis africana*, *Ptérocarpus erinaceus* et *Afzelia africana*, dont toutes les parties sont exploitées (Houetchegnon, 2016 ; Baïyabe *et al*., 2020 ; Nanan *et al*., 2022).

Au Togo, l'accroissement des besoins des populations, la recherche des terres cultivables, ont contraint les populations à surexploiter les ressources forestières. Cette surexploitation qui se manifeste par la coupe anarchique des arbres pour la carbonisation, pour le bois de feu, pour le bois d'œuvre et la pratique de la transhumance, ont conduit à une déforestation de 0,21 % (MERF, 2021). Cette exploitation forestière est basée sur le prélèvement sélectif de certaines espèces clés de bois d'œuvre, de bois de service et de bois énergie (Kokou *et al*., 2009). Les espèces utilisées à cet effet sont *Prosopis africana, Afzelia africana, Anogeisus leiocarpus, Pterocarpus erinaceus, Terminalia spp., Khaya senegalensis,* actuellement fragilisées et menacées de disparition (MERF, 2014).

Cette situation est beaucoup plus accentuée au nord-Togo où le changement dégradant de l'environnement est plus sévère et où la survie de la population est en partie dépendante de l'exploitation des ressources forestières. En plus, le nord-Togo est une zone de prédilection des

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

transhumants qui, en saison sèche, utilisent les espèces telles que *Prosopis africana, Pterocarpus erinaceus*, *Afzeli africana*, comme fourrage pour les animaux (Kperou Gado, 2020 ; Baïyabe *et al*., 2020 ; Kossi *et al*., 2015 ; Kuiseu *et al.*, 2021).

Dans la commune Kéran 1 au Nord-Togo, l'exploitation forestière est une activité très pratiquée et considérée comme source d'emploi et de revenu. Si toutes les espèces ligneuses peuvent être exploitées, certaines cependant, sont beaucoup plus prisées à cause de la qualité de leur bois mais aussi de leur feuilles et fruits utilisés comme fourrage. En effet, l'absence de l'herbe en saison sèche, amène les transhumants et les pasteurs peuls du secteur à couper certaines espèces très appétées par les bétails. Ces espèces exploitées sans aucune réglementions, risque de compromettre leur développement et leur survie à long terme. La présente étude cherche à déterminer l'incidence de l'exploitation forestière et fourragère sur *Prosopice africana,* de *Pterocarpus erinaceus* et de *Afzelia africana* à travers leur dynamique structurale dans la commune de Kéran 1. En effet, les caractéristiques structurales et démographiques sont les indicateurs écologiques essentiels pour mesurer le niveau d'utilisation, la dynamique et la santé de ces ressources dans leur habitat naturel (Adjonou *et al.*, 2010) afin de prendre des mesures adéquates pour préserver ces espèces en vue de leur utilisation durable. Cet article s'articule autour de trois parties qui sont : cadre d'étude, approche méthodologique, résultats et discussion.

1. Cadre d'étude

La zone d'étude est la commune Kéran 1 (801 km2) (Fig. 1) située dans la préfecture de la Kéran.

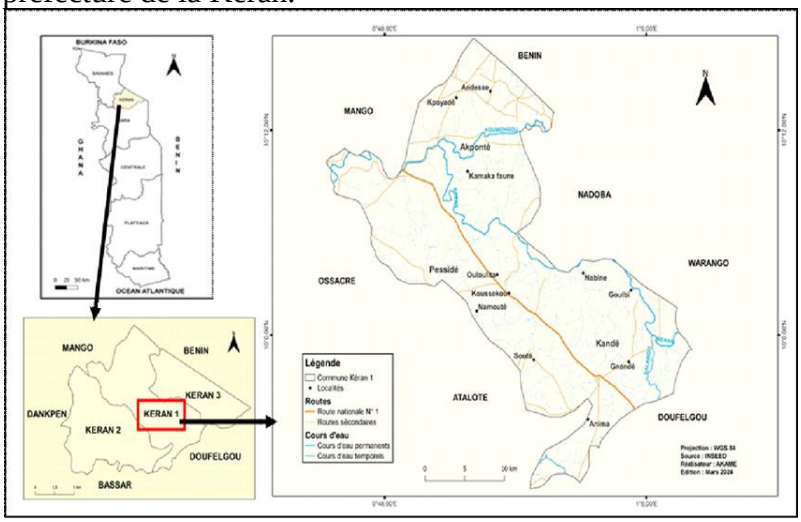


Figure 1 : Localisation de la commune Kéran 1
Source : Institut Nationale de la Statistique des Etudes Economiques et Démographique (INSEED)

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Le climat qui prévaut dans ce secteur, est de type soudanien. Il présente une saison pluvieuse d'avril à octobre et une saison sèche de novembre à avril (Fig. 2-a). Au cours de cette dernière souffle l'harmattan, un vent très chaud le jour, plus frais la nuit, très sec, et le plus souvent chargé de poussière. Dans la Kéran, sur la période 1972-2002, les précipitations annuelles moyennes avoisinent 1200 mm, dont plus de 250 mm pour le mois d'août. Sur la même période, la température moyenne approche 28°C (Fig. 2-b). Les valeurs mensuelles moyennes fluctuent de 24,9°C, en août, à 30,8°C, en mars. Les trois mois les plus humides, de juillet à septembre, sont également les plus frais.

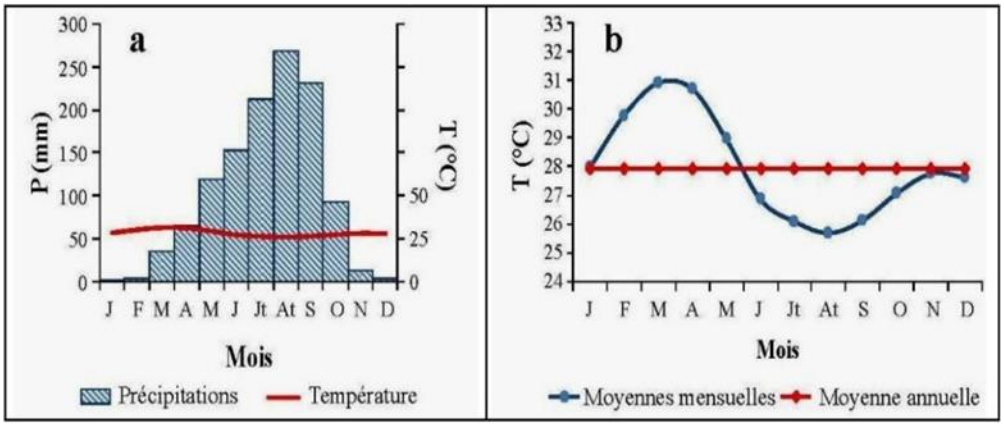


Figure 2 : Diagramme ombrothermique (a) et températures mensuelles moyennes (b) à la station de Kanté de 1972 à 2002.
Source : Direction Générale de la Météorologie Nationale (DGMN-Togo).

Le relief dans la partie nord (Cantons de Péssidé et d'Akpontè) de la commune se présente sous la forme d'une plaine (150-200 m) dont le substrat appartient au supergroupe suprallitique du bassin de volta, et, dans sa partie sud (Canton de Kanté), sous forme de collines peu élevées, entre 300 et 400 m dont substrat est constitué par la série schisteuse de Kanté (PETIT, 1981).

La couverture pédologique du secteur est variée : sols peu évolués, sols ferrugineux tropicaux, vertisols et sols hydromorphes (Faure et Bpennanaech, 1981). Les sols ferrugineux tropicaux, généralement profonds dans les plaines, correspondent aux zones cultivées. Le long des cours d'eau et dans des dépressions humides, des sols à texture fine présentent des caractères hydromorphes avec des textures variables (limono-sablo-argileux, sablo-limoneux, limono-argileux). Sur les sommets et les pentes, secteurs de Kandé, les sols peu évolués d'érosion sont peu épais et présentent le plus souvent une forte proportion d'éléments grossiers. En bas de pente, les sols peu évolués d'apport (colluvions) sont propices à un enracinement profond. En bas de pente également, mais sur roche, peuvent se trouver des vertisols. Certains de ces sols sont cultivés et portent les cultures variées, alors que d'autres sont

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

colonisés par une végétation spontanée très diversifiées dont les savanes, les forêts galeries, les forêts claires et sèches.

La commune Kéran 1, compte 44399 habitants, soit 55,43 / km^2 (RGPH-5, 2023). Les groupes ethno-linguistiques majoritaires sont les Lamba et les N'gan-gan. Les principales activités économiques sont l'agriculture (sorgho, maïs, riz, igname, arachide, haricot, fonio...), l'élevage (volailles, bovins, caprins...), la chasse, le commerce (produits agricoles, bois énergie, charbon de bois) et l'artisanat (objets d'art en bois).

2. Approche méthodologique

2.1. Collecte des données

Les données forestières, concernant les trois espèces, ont été collectées dans les placettes rectangulaires de 100 x 10 m, positionnées régulièrement à chaque 200 m, le long des transects de 6 km, dans chaque site choisi selon leur état d'exploitation. Le site de la réserve de la Kéran non exploitée et l'autre, une zone de cultures et de jachères. Au total, 40 placettes, en raison de 20 par site, ont été investigués. Les mesures dendrométriques (diamètre, hauteur) n'ont porté que sur les individus de ces trois espèces ayant au moins 10 cm de diamètre à 1,30 m au-dessus du sol. Les autres individus dont la circonférence est inférieure à 10 centimètres (cm), ont été considérés comme faisant partie de la régénération (Ajonou *et al*., 2010). Selon les mêmes auteurs, la régénération est évaluée dans cinq petites placettes de 25 m² (5 m x 5 m) délimitées à l'intérieur de chaque placette investiguée, dont quatre installées au niveau des angles et la cinquième au centre de la grande placette. Ainsi, à l'intérieur de ces petites placettes, les rejets de souche, les drageons et les semis naturels ont été dénombrés afin d'évaluer la densité de chaque mode de régénération. L'état d'intégrité des individus a été noté afin d'évaluer l'intensité de l'exploitation de l'espèce sous forme de carbonisation, d'émondage et de coupe.

2.2. Traitement des données

Les données collectées ont permis de calculer le diamètre moyen (Dm), la hauteur moyenne (hm), la densité (D) et la surface terrière (Gr) de chaque espèce. Les formules utilisées à cet effet sont :

- Densité : $D = Nx / Srx$
- Hauteur moyenne : $Hm = \sum hi / Ni$
- Diamètre moyen : $Dm = \sum di / Ni$
- Surface terrière : $G = \sum Ci^2 / \pi 4$

Où Nx est le nombre d'individus trouvés dans le groupe végétal x, Srx la surface couverte par le groupe x (total des surfaces des placettes correspondant à ce groupe), hi la hauteur d'un individu i, di le diamètre d'un

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

individu i et Ci la circonférence d'un individu i. Les calculs sont effectués pour les individus ayant un diamètre à 1,30 m de hauteur supérieur ou égal à 10 cm.

Les histogrammes de distribution destinés à rendre compte de la structure démographique des formations ligneuses, ont été établis, à l'aide du logiciel "Minitab 16", pour des classes correspondant à des différences de diamètre de 10 cm ou à des différences de hauteur de 2 m. Les distributions sont ajustées suivant les trois paramètres de la loi de Weibull (Weibull, 1951), qui se fonde sur la fonction de densité de probabilité. Celle-ci peut être ainsi défini (Rondeux, 1999) :

- Densité de probabilité : $f(x) = (c / b) . ((x - a) / b)^{c-1} . e^{x-[a/b]c}$ (5)

Où x est le diamètre des arbres, a un paramètre de position (nul si toutes les catégories d'arbres sont considérées et non nul si les arbres considérés ont un diamètre ou une hauteur supérieure ou égale à a), b un paramètre d'échelle ou de taille (il est lié à la valeur centrale des diamètres ou des hauteurs des arbres du peuplement considéré) et c un paramètre de forme lié à la structure (en diamètre ou hauteur) considérée.

L'Indice de Rareté (IR) a été calculé pour évaluer la disponibilité de ces espèces végétales exploitées par la population (Yaovi *et al.*, 2021). La rareté reflète ici la fréquence à laquelle la plante a été observée dans la zone.

Il a été calculé selon l'équation suivante : IR = (1- ni/N) × 100

ni = nombre de relevés dans lesquels l'espèce i est présente et N = nombre total de relevés.

Les seuils d'interprétation utilisés sont : IR< 60 %, pour les espèces très fréquentes dans les formations végétales ; 60 ≤ IR< 80% pour les espèces moyennement fréquentes et IR ≥ 80 % pour les espèces dites rares.

Densité d'exploitation (D_{ex}) a été calculée par la formule suivante :

$$D_{ex} = \left(\frac{Ni}{S}\right)$$

Où Ni est le nombre de coupe ou d'émondage ou de brûlis et N nombre total de pied de l'espèce.

3. Résultats

3.1. Incidence de l'exploitation forestière et fourragère sur les caractéristiques dendrométriques et structurales de *Afzelia africana*

Les résultats sur les caractéristiques forestières de *A. africana* sont différents suivant les zones. Dans la zone protégée, la densité (8 pieds/ha) de *A. africana* est élevée que dans la zone exploitée où elle est de 2 pieds/ha. Aussi, son diamètre moyen (105 cm) et sa hauteur moyenne (9,44 m) dans la zone protégée sont grandes, contre un diamètre moyen (56,75 cm) et une hauteur moyenne (6,5 m), faibles dans la zone exploitée. La surface terrière (1,82 m²/ha, dans la zone protégée est plus élevée que celle dans la zone

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

exploitée, qui est de 0,03 m²/ha. Inversement, la densité de coupe (12,5 pieds/ha), d'émondage (1,5 pieds/ha), sont grandes dans la zone exploitée et nulles sinon très faibles (d'émondage, 0,5 pieds/ha ; coupe, et carbonisation, 0,0 pieds)

Sur le plan structural, la distribution des classes de diamètre (figure 3a) et des classes de hauteur (figure 3b) est en cloche dans les deux zones. Cependant, dans la zone protégée, prédominent les individus de grands diamètres dont, 56,25 % ont un diamètre > 100 %, suivis de 18,25 % des individus de diamètre compris entre 60 à 70 cm et 80 à 90 cm. Dans la zone exploitée, c'est plutôt les individus de diamètre moyen qui prédominent dont 50 % des individus de diamètre compris entre 50 à 60 cm et 25 % des individus de diamètre compris entre 40 à 50 cm et 60 à 70 cm. Dans le même temps, l'espèce est constituée des individus de grandes hauteurs comprises entre 10 à 12 m et 12 à 14 m dans la zone protégée et des individus de hauteur moyenne comprise entre 8 à 10 m dans la zone exploitée.

La régénération des pieds de *A.africana*, faite par semis dans la zone protégée est très faible (3,5 pieds/ha), alors qu'elle est élevée (29,8 pieds/ha) dans la zone exploitée et est faite plus par rejet et drageonnage que par semis.

D'une manière générale, que ce soit sur le plan dendrométrique et structural, l'espèce est mieux représentée dans la zone protégée et faiblement représentée dans la zone exploitée. En effet, dans la zone exploitée, l'espèce est intensément exploitée à des fins divers (photo 1). Cette situation fait que l'espèce est devenue très rare dans la zone car son indice de rareté, 95 %, est supérieur à 80 %.

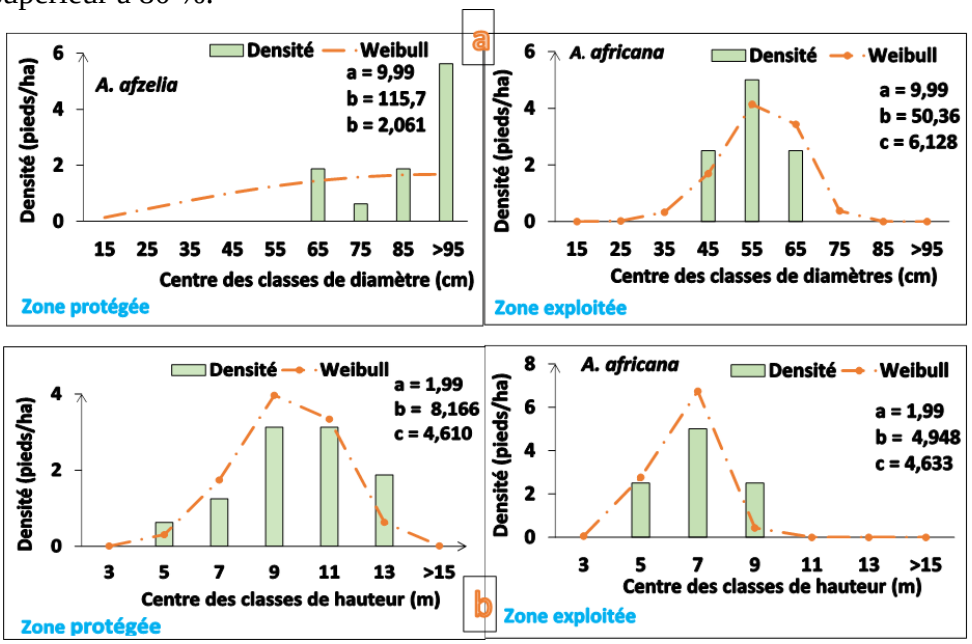


Figure 3: Distribution des classes de diamètre et de hauteur dans les deux zones

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Photo 1 : Planche photographique montrant les différentes formes

Photo 1 (a) : A. afzelia coupée et dont le tronc est emporté pour la fabrication des planches. La photo 1 (b) montre A.africana dont les feuilles sont coupées par les pasteurs peuls pour nourrir leur bœuf et la photo 1 (c) indique les planches issues de A.africana au sol.
Clichés : AKAME, 2024

Incidence de l'exploitation forestière et fourragère sur les caractéristiques dendrométriques et structurales de *Prosopis africana*

L'analyse des paramètres dendrométriques montre que la densité (30 pieds/ha) de *P.africana* dans la zone protégée est plus élevée que sa densité (4 pieds/ha) dans la zone exploitée. De même, son diamètre moyen (70,5 cm) et sa hauteur moyenne (10,5 m), sont plus grands dans la zone protégée que dans la zone exploitée où le diamètre moyen (32,13 cm) et la hauteur moyenne (4,75 m), sont faibles. La surface terrière (2,73 m²/ha) est plus grande dans la zone protégée et faible (0,08m²/ha) dans la zone exploitée. Contrairement, les densités de coupe (37, 5 pieds/ha), d'émondage (11pieds/ha) et de carbonisation (23 pieds/ha), de cette espèce dans la zone exploitée sont plus grandes que dans la zone protégée où elles sont nulles.

La distribution de *P. africana* en classe de diamètre (figure 4a) et en classe de hauteur (figure 4b), présente une allure en cloche dans la zone protégée et une allure en « J » renversé dans la zone exploitée. Dans la zone protégée, cette structure se caractérise par une prédominance des centres de classes de diamètre 55 cm (20,34 %), 85 cm (18,64 %) et plus de 95 cm (16,95 %). Alors que dans la zone exploitée, l'allure en « J » renversé indique la prédominance des individus de centre des classes de diamètre faible, 15 cm (33,33 %). Les individus de centre des classes de hauteur de 13 m (47,76 %) prédominent dans la zone protégée, alors que dans la zone exploitée, ce sont les individus de centre des classes de hauteur, 3 m (50 %) qui sont dominants.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

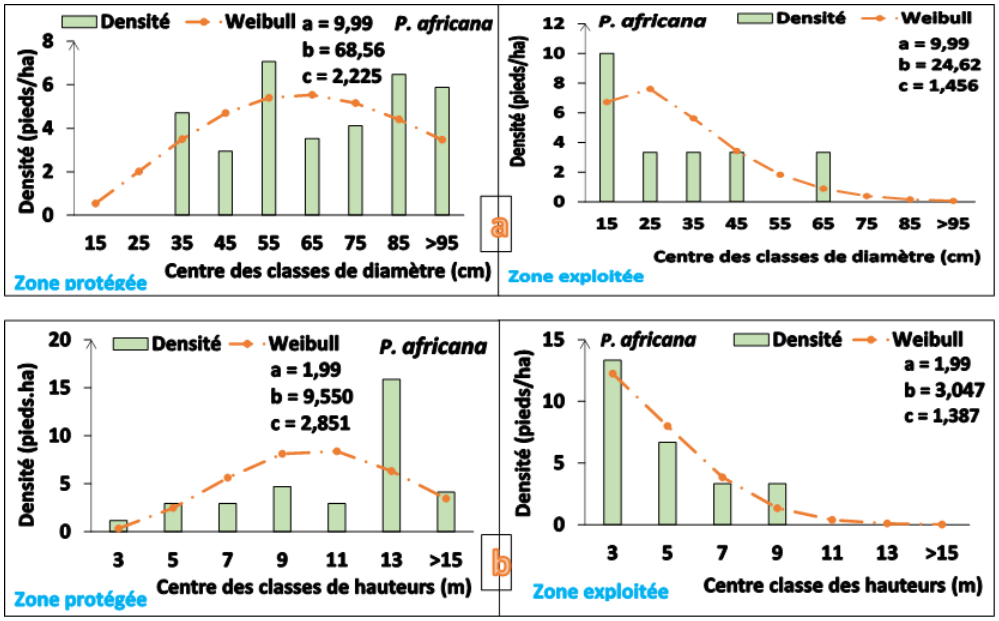


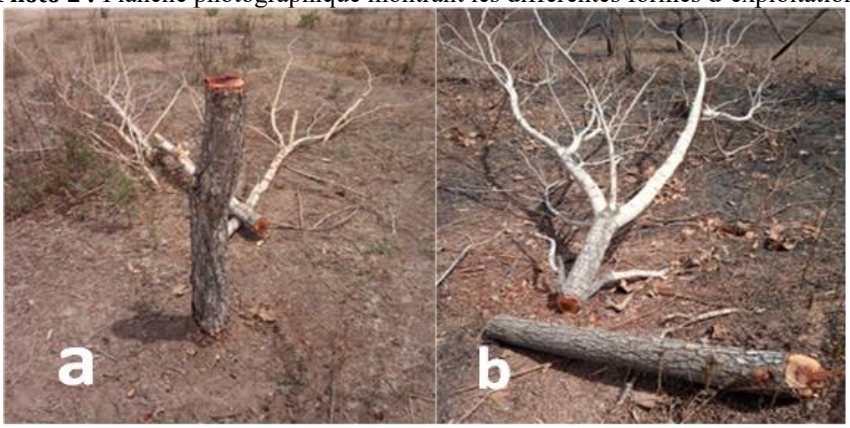
Figure 4 : Distribution des classes de diamètre et de hauteur dans les deux zones

La régénération des pieds de *P. africana* dans la zone protégée est très faible (2,5 pieds/ha) alors qu'elle est élevée (18 pieds/ha) dans la zone exploitée. Dans la zone protégée, la régénération est assurée par semis et très rarement par le rejet. Par contre, elle est assurée beaucoup plus par le rejet que le semis dans les zones exploitées.

L'indice de rareté qui est de 40 % et inférieur à 60 %, révèle que l'espèce est disponible dans la zone protégée et très rare dans la zone exploitée puisque cet indice est de 85 % et supérieur à 80 %. La rareté de cette espèce est due à la coupe pour sa carbonisation. Même les espèces de petits diamètres sont coupées pour la fabrication du charbon de bois et les feuilles pour fourrage (photo 2).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Photo 2 : Planche photographique montrant les différentes formes d'exploitation



La photo 2 (a) : P. africana coupée dont les feuilles ont servi pour nourrir les bœufs, la photo 2 (b) : indique le tronc de P. africana coupée pour la carbonisation.
Cliché AKAME, 2024

Incidence de l'exploitation forestière et fourragère sur les caractéristiques dendrométriques et structurales de *Pterocarpus erinaceus*

Sur le plan dendrométrique, *P. erinaceus* est plus dense, 46 pieds/ha, avec une grande surface terrière, 8,08 m² /ha, dans la zone protégée. Par contre, dans la zone exploitée, l'espèce a une faible densité, 12 pieds/ha et une faible surface terrière, 0,064m²/ha. Tout de même, l'espèce a un diamètre moyen, 97,78 cm, et une hauteur moyenne, 11,10 m, plus grands dans la zone protégée, que dans la zone exploitée où, son diamètre moyen, 17,75 cm, et sa hauteur moyenne, 7,21 m, sont plus faibles. Par ailleurs, les densités de coupe, 54,5 pied/ha, d'émondage, 75,5 pieds/ha, et de carbonisation, 57 pieds/ha, obtenues dans la zone exploitée sont plus grandes que les densités de coupe, 4 pieds/ha, d'émondage, 2 pieds/ha, et de carbonisation, 7,2 pieds/ha, très faibles dans la zone protégée.

Sur le plan structural, la distribution des classes de diamètre (figure 5a) et des classes de hauteur (figure 5b) dans la zone protégée, monte une allure en cloche qui caractérise la prédominance des individus de hauteur et de circonférence grandes. Par contre, dans la zone exploitée, cette distribution est en « J » renversé et indique ainsi l'abondance des individus de hauteur et diamètre, faibles. En effet, dans la zone protégée, les classes de diamètre dominant sont 80 à 90 cm (47,83 %) et plus de 100 cm (29,35 %), alors que dans la zone exploitée, les individus les plus prépondérants sont représentés par la faible classe de diamètre 10 à 20 cm (79,17 %). Par ailleurs, les classes de hauteur, 10 à 12 m (28,26 %), et plus de 14 m (23,91 %), sont plus abondantes dans la zone protégée alors que dans la zone exploitée, les individus sont de faible hauteur et représentés par les classes, 2 à 4 m (37,5 %), et, 4 à 6 m (28,83 %).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

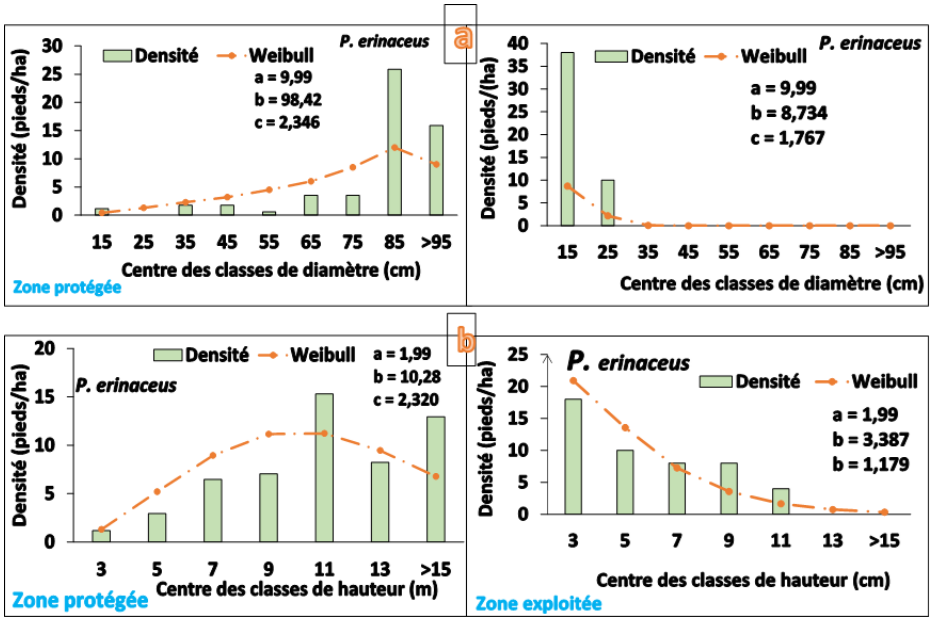


Figure 5 : Distribution des classes de diamètre et de hauteur dans les deux zones

Les résultats révèlent aussi que la densité, 69,6 pieds/ha, de régénération de *P. erinaceus* dans la zone protégée est plus faibles et se fait plus par semis, alors que dans la zone exploitée, cette densité, 101,2 pieds/ha, de régénération se fait par rejet et drageonnage.

De plus, cette espèce devient rare dans les zones exploitées puisque son indice de rareté est de 79,6 %. Or, un indice de rareté compris entre 60 % et 80 %, signifie que l'espèce est moyennement fréquente. Cette rareté de l'espèce est due à son utilisation pour le fourrage, la carbonisation et la fabrication des planches (photo 3).

Photo 3 : Planche photographique montrant les différentes formes d'exploitation

Photo 3 (a) : les feuilles coupées de P. erenaceus utilisées comme fourrage que les bœufs broutent, photo 3 (b) : pieds de P. erenaceus brulés à la base à des fins de carbonisation et la photo 3 (c) : planches issues de P. erenaceus.
Cliché AKAME, 2024

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Discussion

La présente étude a montré que l'exploitation forestière et fourragère a une incidence négative sur le développement de ces trois espèces.

En effet, on constate que la densité, le diamètre moyen, la hauteur moyenne et la surface terrière de ces espèces sont plus grandes dans la zone protégée et très faibles dans la zone exploitée. Leur faible représentativité dans la zone non protégée est due à l'exploitation intensive dont elles font l'objet à travers les coupes abusives, la carbonisation et l'exploitation fourragère. Le même constat est fait ailleurs. En Côte-d'Ivoire (Goba *et al*., 2019 ; Nanan *et al*., 2022) et dans la région centrale au Togo (Segla *et al*., 2005 ; Adjonou *et al*., 2010), la densité, la surface terrière, le diamètre moyen et la hauteur moyenne de l'espèce *P. erinaceus* régressent à cause de ces exploitations forestières et fourragères. Au Burkina-faso, Ouégraogo *et al*., (2005) signalent que *A. africana* subit une dynamique régressive à cause de ces mêmes facteurs. Au Nord-Cameroun, Onana et Devineau (2022) constatent que *A. africana* a de faibles densités surtout dans les zones de pâturages ou surpâturées alors qu'au Bénin, Houetchegnon (2016) souligne que *P. africana* a une densité, une surface terrière, un diamètre moyen et une hauteur moyenne très faibles dans les zones de forte occupation de sol.

Cette étude a aussi montré que la régénération des espèces se fait plus par rejets que par semis dans la zone exploitée. Alors que dans la zone protégée, c'est l'effet contraire. La régénération par semis de ces trois espèces dans la zone protégée peut s'expliquer par la disponibilité des semences. En effet, la floraison de *A. africana* se fait entre mars et avril (Donkpegan *et al.*, 2014), période à laquelle elle est émondée ou coupée par les pasteurs peuls pour fourrage aux animaux dans la zone. Dans la zone exploitée, les semences sont réduites voir absentes car les coupes, l'émondage ou la mutilation répétée de ces espèces empêche la floraison et production de semence. De plus, l'intensité de coupe favorise la multiplication par rejet de ces espèces à travers les souches. Dans l'ensemble, la densité de régénération de ces trois espèces est grande dans la zone exploitée et faible dans la zone protégée. Cela peut s'expliquer par l'ouverture de la canopée. En effet, dans la région centrale au Togo, Adjonou *et al*. (2010) soulignent que les perturbations induites par les activités et l'ouverture de la canopée semblent favoriser ces modes de multiplication pour l'espèce *P. erinaceus*. Pour ce qui est de l'espèce *A. africana*, outre les rejets, elle se multiplie par drageonnage (Douka *et al.*, 2019). Il faut aussi dire que ces rejets n'atteignent souvent pas l'âge adulte à cause de feu de brousse, du pâturage et l'agriculture

La présente étude a révélé que la distribution des classes de diamètre et de hauteur pour les trois espèces est en cloche et centrée sur les individus de grands diamètres et de grandes hauteurs dans la zone protégée. Cela s'explique par le fait que, la zone étant protégée, ces espèces ne subissent pas

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une pression à part quelques coupes et émondages illicites. Par contre, dans la zoné exploitée, les structures en diamètre et en hauteur, traduisent une allure en « J » renversé. Cette structure caractérise les individus de faibles diamètres et de faibles hauteurs. Cette situation est due aux prélèvements effectués dans les classes d'individus de grandes circonférences et de grandes hauteurs. De plus, les émondages répétitifs diminuent constamment la hauteur de ces espèces qui deviennent rabougries. Ces résultats sont proches de ceux de Goba et *al*. (2019) en Côte-d'Ivoire qui ont souligné que ces structures témoignent aussi du prélèvement sélectif des arbres de plus gros diamètres pour les exportations pendant les exploitations forestières illégales. Par ailleurs, au centre Togo, la structure en cloche démontre d'un état d'équilibre des espèces alors que la structure en « J » renversée témoigne d'une perturbation suite aux pressions multiformes sur les espèces (Adjonou et *al*., 2010).

Ces différentes pressions ont conduit à la régression et la rareté de ces espèces dans les zones exploitées. En effet, ces trois espèces sont disponibles dans la zone protégée avec des indices de rareté inférieurs à 60 %, alors que dans la zone exploitée elles sont devenues rares avec des indices de rareté supérieur à 80 %. La rareté de ces espèces est due à la manière dont elles sont exploitées. En effet, elles sont coupées à des hauteurs qui ne leur permettent pas de régénérer par rejets ou par drageons. Aussi, les émondages répétitifs ne permettent pas le renouvellement des semences pour assurer la régénération naturelle. Ces résultats se rapprochent de ceux de Hamawa (2021) qui souligne que la pression agropastorale impacte négativement la structure et la régénération des espèces fourragères dans la zone sahélienne au Cameroun et expose l'espèce *Afzelia africana* à la disparition. Aussi, Nanan *et al.* (2022) montrent que l'abattage des arbres par les scieurs, les feux de végétation et la carbonisation, constituent les causes de disparition de *P. erinaceus*.

Conclusion

La présente étude a montré que l'exploitation forestière et fourragère ont une incidence sur la dynamique structurale de *Afzelia africana, Prosopis africana* et *Pterocarpus erinaceus.* En effet, la densité, la surface terrière, le diamètre moyen et la hauteur moyenne de ces espèces sont très faibles dans les zones de cultures et jachères comparativement à la zone exploitée où ces paramètres dendrométriques ont des valeurs très fortes. Cette situation est due à la densité élevée de coupes, d'émondage et de carbonisation de ces espèces dans la zone exploitée, contrairement à la zone protégée où ces densités d'exploitation sont nulles sinon très faibles à cause de quelques coupes et émondages illicites. Par ailleurs, ces exploitations ont une incidence négative sur la distribution des classes de hauteur et des classes de diamètre de ces espèces qui se caractérisent par une allure en « J » renversé dans la zone où elles sont exploitées. Cette allure traduit l'existence seulement des individus

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de faibles diamètres et de faibles hauteurs, et, signifie que les coupes sont faites dans les classes de diamètre moyen et les classes de hauteur moyenne. Ces espèces se renouvellent plus par rejets que par semis avec de très grandes densités. Mais, ces jeunes plants de régénération n'atteignent jamais l'âge adulte à cause de feu de brousse, de broutage des bœufs et de l'action de l'agriculture. Dans ces conditions, ces espèces sont devenues très rares voir absentes par endroit. Ce qui interpelle à une prise de conscience et à une adoption des mesures fermes pour leur protection et conservation afin de leur utilisation durable.

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