

***Soluciones sostenibles sobre los impactos ambientales de la
deforestación en el municipio Yateras***
***Sustainable solutions on the environmental impacts of
deforestation in the municipality of Yateras***

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Recibido: 6 de noviembre de 2023

Aceptado: 16 de enero de 2024

Resumen

La deforestación en el municipio Yateras en la provincia Guantánamo, ha causado deterioros ambientales, con mayor impacto en las laderas de los ríos; los incendios forestales y la tala indiscriminada, ha ocasionado en varias reservas naturales, severas afectaciones a la flora, la fauna y al suelo, con un significativo impacto económico y social, por tal motivo, se acometen acciones para revertir esta situación. De ahí que el presente artículo tiene como propósito socializar soluciones sostenibles para minimizar los impactos ambientales de la deforestación en este Municipio. Se aplicaron métodos teóricos y empíricos que posibilitaron la elaboración de la propuesta. La implementación de las soluciones sostenibles contribuyen a disminuir los impactos de la deforestación para el medio ambiente y la vida humana.

Palabras clave: Deforestación; Soluciones sostenible; Reforestación; Impactos ambientales

Abstract

Deforestation in Yateras municipality in Guantánamo province has caused environmental deterioration, with greater impact on river slopes; forest fires and indiscriminate logging have caused severe damage to flora, fauna and soil in several natural reserves, with a significant economic and social impact; therefore, actions are being taken to reverse this situation. Therefore,

the purpose of this article is to socialize sustainable solutions to minimize the environmental impacts of deforestation in this municipality. Theoretical and empirical methods were applied to enable the elaboration of the proposal. The implementation of sustainable solutions contributes to reduce the impacts of deforestation on the environment and human life.

Keywords: Deforestation; Sustainable solutions; Reforestation; Environmental impacts

Introduction

The report of the Food and Agriculture Organization of the United Nations (FAO, 2016), warns that deforestation is the second most important cause of climate change after the burning of fossil fuels and accounts for almost 20% of all greenhouse gas emissions; more than the entire transport sector globally.

Despite the targets set-including the New York Declaration on Forests (NYDF, 2014), which sought to cut deforestation in half by 2030, the planet's intact primary forests continue to shrink, albeit at a slower rate. According to Hancock (2019), by 2030, approximately 47% of the planet's forests face a high risk of deforestation or forest degradation.

In 1992, during the United Nations Conference on Environment and Development, held in Rio de Janeiro, Fidel Castro was forceful in his speech and became a spokesman to denounce the destruction of planet Earth, stating:

Forests disappear, deserts spread, and billions of tons of fertile land end up every year in the sea. Numerous species are becoming extinct. Population pressure and poverty lead to desperate efforts to survive even at the expense of nature. It is not possible to blame this on Third World countries, colonies yesterday, nations exploited and plundered today by an unjust world economic order; an important biological species is at risk of disappearing because of the rapid and progressive liquidation of its natural living conditions. Man (Castro, 1992)

Although Cuban society promotes sustainable development and works for the rational use of natural resources, it does not escape this environmental deterioration caused by the deforestation of forests.

The loss and fragmentation of habitats, together with forest fires in several natural reserves and indiscriminate logging that have severely affected flora and fauna, are considered among the greatest threats to biological diversity in Cuba.

Since the triumph of the Cuban Revolution in 1959, guided by Fidel Castro Ruz, the protection of nature for which Martí advocated so much has been directed through regulations. Since then, and up to the present, the Cuban government has developed a system of organizational and legislative actions that demonstrate the will to protect the environment, such as the creation in 1976 of the National Commission for the Protection of the Environment; the modification of Article 27 of the Constitution of the Republic of Cuba in 1992; the creation of the Ministry of Science, Technology and Environment (CITMA) in 1994; the enactment of Law 81 of the Republic of Cuba for the Protection of the Environment in 1994; the creation of the Ministry of Science, Technology and Environment (CITMA), in 1994; and the enactment of Law 81 of the Republic of Cuba for the Protection of the Environment, in 1994; the enactment of Law 81 of 1997, on the Protection of the Environment and the Rational Use of Natural Resources; the approval of the National Strategy for Environmental Education in 1997, more recently, the Task Life in 2017, as a State plan for confronting climate change and Law 150/2022 "On the Natural Resources System and the Environment", strengthening the idea of integration of the environment with sustainable economic and social development.

From the field study carried out, and the review of documents and reports on the agroforestry situation in the Yateras Municipality, data was collected, both qualitative and quantitative, which allowed corroborating the environmental problems described, where deforestation has impacted on habitat damage, in the watersheds of the rivers and the successive loss of biodiversity; the alteration of water cycles and soil erosion.

With the purpose of solving the above problems, this article aims to socialize sustainable solutions to minimize the environmental, economic and social impacts of deforestation in the Yateras Municipality.

Development

Deforestation

The Larousse Dictionary of the Spanish Language (2022) defines deforestation as "to strip a piece of land of forest plants". Thus, it is a phenomenon caused by the impact of human activities or natural causes, resulting in the loss of forests and jungles.

Deforestation is one of the most pressing environmental challenges facing our planet and our country. It is essential to understand what this phenomenon is if we want to seek effective solutions to halt its advance. Although its causes are due to multiple factors, both natural and human, the consequences of deforestation are irreversible in the environment.

The Concept Encyclopedia (2020) states that deforestation is a unique phenomenon, which can be classified according to its causes into two types:

1. Natural deforestation

This is due to the effects of natural accidents and events inherent to the earth's dynamics, which cannot be anticipated or stopped once they have begun. This type of deforestation occurs, for example, when there are big storms with lightning, tornadoes, volcanic eruptions or forest fires, which can destroy a forest in a very short time.

Another cause of natural deforestation is the pests and diseases of trees, caused by insects (such as beetles and aphids), which are capable of producing a massive "natural felling" of trees.

2. Human deforestation

This is the direct or indirect result of human activities and is therefore our responsibility. They represent the main cause of deforestation and, unlike natural phenomena, can be avoided.

Causes of deforestation in Yateras Municipality, Guantánamo Province

Characterization of the municipality under study

Yateras is one of the municipalities that conform the province of Guantánamo, Cuba; it limits to the North with the province of Holguín, to the East with the municipality of Baracoa; to the South with the municipalities of San Antonio del Sur and Manuel Tames; to the West with the municipality of Guantánamo. It has a territorial extension of 625.33 km² (62 533 ha), and a population, according to the statistical yearbook of 2022, of 18930 inhabitants. Its population is predominantly indigenous and mixed race. The head of the municipality is the town of Palenque.

The territory is mountainous, with its maximum elevation located at Pico Galán, 974 m above sea level. More than 80% of its agricultural land is mountainous and, due to its climatic characteristics, it suffers from erosion and degradation processes. Seventy-five percent of the agricultural areas are located in the Toa river basin and sub-basin, the territory's main water resource, making it a highly fragile territory in the face of weather phenomena that threaten the conservation and stability of soils, forests, water and biodiversity.

Table 1 shows the balance of areas in correspondence with their usefulness, which behaves as follows:

Table 1. Balance of the surface of the Yateras Municipality

CATEGORÍA	HÉCTARIAS (ha)	%
Superficie total del Municipio	62 533.80	100
Superficie agrícola	15 162.08	24.4
Cultivos temporales	3 360.82	5.37
Cultivos permanentes	5 833.32	9.32
Ganadería	5 967.94	9.55
Superficies no agrícolas	47 371.72	75.76
Superficie forestal	45 661.14	73.01
Superficies acuosas	584.10	0.93
Asentamientos, infraestructura y otras instalaciones	1 126.48	1.82

Source: Empresa Agroforestal Yateras, (2023)

The forest heritage is classified as semi-deciduous forests on limestone soil, where species typical of this formation can be observed. These areas are categorized as water and soil protection forests.

The main causes of deforestation in the municipality include the following:

- Forest fires, which have affected approximately 2,000 ha of forest, and significant atmospheric pollution due to CO₂ emissions into the environment.
- The expansion of land for agriculture and cattle ranching. The growing demand for food and animal products has led to the conversion of 3.5 hectares of forest into cropland and pasture.
- Illegal logging and unsustainable timber harvesting have also contributed significantly to deforestation, eliminating a total of 15.6 ha. The demand for timber for construction, furniture manufacturing and other products drives the overexploitation of forest resources. In addition to causing flooding of rivers in low-lying areas in the communities of Palenque internado, Palenque molino, with the evacuation of the inhabitants of these localities.
- The expansion of infrastructure and urbanization has led to the elimination of almost 4 ha of forest to make way for roads, houses and other social services.
- To a lesser extent, tree pests and diseases have caused the loss of 1.2 ha of forest.
- Other causes include poor reforestation management, as the technical requirements for planting trees are not met, which causes them to die prematurely, affecting 0.7 ha.

Table 2 shows the forest patrimony of the municipality and its distribution of hectares affected by deforestation and its causes.

Table 2: Forest Assets for the year 2023

CATEGORÍA	HÉCTARIAS (ha)	%
Patrimonio Forestal	45 661.14	73.01
Superficie total deforestada	1922.4	4.2
Por incendio forestal	1 896	98.6
Por los fenómenos meteorológicos	2.4	0.13
Por urbanización	3,7	0.19
Por tala indiscriminada	15.6	0.83
Por agricultura y ganadería	3.5	0.18
Por plagas y enfermedades	1.2	0.07

Source: Company Agroforestry Yateras (2023)

As can be seen, the forest patrimony of the municipality represents 73.01% of the total area, and the deforested area represents 4.2% of the forest patrimony. It can also be seen that the main causes of this deforestation are forest fires, which represent 98.6% of the total deforested area and 4.15% of the forest patrimony; illegal logging is also a worrying factor, mainly in the Toa basin and its tributaries (Palenque River and Guayabal River).

Economic, social and environmental impacts of deforestation in the Yateras municipality

The negative impacts of large-scale deforestation are not few, nor are they easy to remedy. Among the main ones are:

- Soil degradation.
- Contamination and water quality.
- Loss of habitats and biodiversity.
- Affectations to forest cover.
- Deterioration of hygienic and sanitary conditions in the communities surrounding the Palenque, Guayabal, el Toa, and Felicidad rivers.

Environmental impact

Environmental impact refers to an alteration in the environment caused by human activity, as well as natural phenomena such as hurricanes, forest fires, floods, droughts and electrical storms, among others, which cause a disruption of the environmental balance.

Forest fires in this municipality have had a negative environmental impact on natural reserves, mainly in the Alejandro de Humbolt National Park, one of the most important protected areas in Cuba in terms of biodiversity, species richness and endemism of its biota, and currently the largest remnant of preserved mountain ecosystems in Cuba. Because of these characteristics, in 2001, UNESCO granted it the category of World Natural Heritage Site.

Between 2000 and 2021, six forest fires have occurred in the Ojito de Agua Conservation Department, which belongs to the Alejandro de Humbolt National Park. The major forest fire that occurred in 2021, according to satellite images, damaged nearly 1,823 hectares of forest, mostly pine forests and, to a lesser extent, other vegetation formations, essentially serpentine seromorphous scrub, which represents about 3% of the park's land area.

The main impacts on the flora are focused on the population reduction of some regional endemic plant species, specifically those associated with pine forests, and some in the charrascales. The most affected flora species was the pine (*Pinus cubensis* Griseb.), with an estimated population of 1,654,015 individuals in the damaged pine area.

The fauna groups that suffered the greatest impact from the fire were terrestrial mollusks and other zoological groups associated with the understory (essentially invertebrates), which suffered habitat degradation.

The greatest impact generated by this incident is precisely in the air and atmosphere due to the 24 days of continuous burning. This contribution to the environment is very harmful, since they are CO₂ emissions, a catalyst for global warming of the planet.

Similarly, forest fires have had an unfavorable economic impact for the Municipality, given the amount of human, physical and financial resources that had to be allocated by the Municipal Government to combat and extinguish these forest fires.

In the year 2021, a budget of 83 100.00 pesos was allocated for the protection against forest fires, however, the additional expenses for the extinguishing of the fire occurred this year, far exceeded that amount:

Transportation: 38 758.16 pesos

Salaries: 21 036.10

Food: 43 144.00

For a total of 102,938.26 pesos

On the other hand, the potential of sites that provide seeds necessary for natural regeneration, in many cases endangered species, was diminished. Stands and seed trees were damaged at a restoration cost of approximately 22,200.00 pesos. It is estimated that production for the years 2023 and 2024 will be affected, equivalent to 1800 kg of seeds at an approximate cost of 4800.00 pesos.

Regarding the social impact, deforestation, due to the felling of tropical forests, has generated optimal conditions for the spread of mosquito-borne pests such as dengue fever. In addition, sunlight increases water temperatures, making it more turbid and favoring its contamination, which has caused diseases such as parasitism and poor sanitary and hygienic conditions.

Sustainable Solutions:

The municipality has a Territorial Environmental Strategy (EAT), whose Strategic Direction No. 1 is to guarantee economic growth considering the rational use of natural resources, the reduction of environmental impacts and environmental degradation, with the purpose of promoting the sustainable management of forests, recovering degraded forests and increasing afforestation and reforestation, in accordance with the goals set for the municipality.

In a world increasingly affected by climate change, biodiversity loss and environmental degradation, sustainable solutions represent a key factor in the regeneration and climate change mitigation efforts of the coming decades. These solutions are based on the power of nature to restore, conserve and protect our ecosystems and, at the same time, improve people's quality of life.

According to the definition adopted by the International Union for Nature (IUCN, 2016), nature-based solutions or sustainable solutions are all those actions that seek to protect, sustainably manage and restore natural or modified ecosystems. These solutions are those that, in turn, manage

Amarilis Peña, Roberto Pardo, Marinelis Martínez: Soluciones sostenibles sobre los impactos ambientales to address social impacts in an effective and adaptive manner, providing human well-being and biodiversity.

Cuba, undertakes solutions to fulfill the commitment on reforestation until 2030 as stated by Figueredo (2019), among which stand out:

- Reforest and restore 465 thousand ha of landscapes.
- Promote 220 thousand ha of mangroves and restoration of 110 thousand ha of forests.
- Implement agroforestry systems in 35 thousand ha, restore 100 thousand ha of land affected by mining and those highly eroded.

In order to minimize the environmental impacts of deforestation in the Yateras municipality, the following sustainable solutions are being undertaken:

Conservation and restoration; Sustainable agricultural practices; Responsible forest management; Education and Awareness.

Conservation and restoration: Vital forest areas are protected and the restorations of deforested areas are essential strategies. Nature reserves are created and reforestation and restoration programs are implemented to help recover lost ecosystems.

Sustainable agricultural practices: promotion of sustainable agriculture that minimizes the need for expansion at the expense of forests is crucial. Agroforestry, which combines crops with trees, is applied as an effective way to maintain food production and ecosystem health.

Responsible forest management: the implementation of responsible forest management practices, such as selective logging and replanting, helps to balance the demand for timber with forest conservation.

Education and awareness-raising: environmental education actions are carried out on the negative impacts of deforestation and promote sustainable alternatives essential to change attitudes and behaviors towards the care of forests and the environment.

These solutions are systematized taking into account generalized and implemented proposals, as well as those conceived in the Science and Innovation Plan for the year 2024.

In conservation and restoration are implemented:

- Ecological Restoration in ecosystems affected by fires in Palma del Tiro. This farm has a total area of 749.96 ha, of which 700.1 ha belong to natural forests and 33.80 ha to plantations. The massive reforestation program is being implemented in this area with species native to the municipality, such as: acana, lirio, cedar, majagua, ocuje, and mahogany. This will restore the original ecological structure and functions of an ecosystem that was degraded by the fire that occurred in 2021 and affected a total of 2.7 hectares of forest.
- Silvicultural restoration in the Sierra Falcón (La Cobreña) forest farm, belonging to the Agroforestry Company Guantánamo. This Silvicultural Unit has a total area of 42465.38 ha, of which 27808.46 ha belong to natural forests and 11010.05 ha to plantations. The reforestation of the forest of lot 26, with an area of 50 ha, is undertaken with the primary purpose of increasing the level of biodiversity and structural complexity in degraded adult forests, in secondary forests (normal density and degraded), in burned forests and in plantations, to improve their ecological functionality and, consequently, increase the potential ecosystem goods and services from these forests.
- Rehabilitation of the Toa River watershed, some 17,590 ha benefited from various soil conservation and improvement measures such as contour planting and live cover, gully correction, and construction of dams and live and dead barriers.
- Reforestation of the Toa watershed, as part of the vulnerability and risk reduction plan (PVR), is undertaken mainly in the tributaries (Palenque and Guayabal rivers). Because of their characteristics, they flow through populated areas and sandy soil, which increases the level of vulnerability and risk. To date, a total of 16 kilometers have been reforested along the banks of these rivers.
- Actions are implemented for sustainable coffee production in the UEB Arroyo del Medio, as a sustainable agricultural practice, restoring a total of 47 ha, with the planting of fruit trees in intercropping. As well as the preparation of the coffee nurseries that supports the 12 ha to be planted in the spring campaign.
- Forest restoration, mainly in the areas of Bernardo, with species native to the municipality, such as: acana, lirio, cedar, majagua, ocuje, mahogany, etc. This is done in areas damaged by illegal logging, strong winds, hurricanes, diseases and others, which have left degraded areas, according to the Forestry Development Plan (2023), shown in Table 3.

Table 3. Forestry Development Plan (2023)

ACTIVIDADES	AÑOS				
	2023	2024	2025	2026	2027
Reforestación (ha)	1.0	2.0	2.0	2.0	2.0
Reconstrucción. de Bosques (ha)	5.0	4.0	6.0	5.0	3.0
M. Regeneración Natural (ha)	3.0	2.0	3.0	3.0	2.0
Enriquecimiento de Bosque (ha)	50	4.0	6.0	5.0	3.0
Construcción trochas (Km)	2,0	2,0	2,0	2,0	2,0
MTT de trochas (Km)	12,0	20,0	20,0	20,0	20,0
MTT de caminos forestales (Km)	6,0	8,0	9,0	10,0	10,0
Construcción de caminos forestales (Km)	2,0	1,0	1,0		

Source: Empresa Agroforestal Yateras, (2023)

The forestry development plan until 2027 is shown, highlighting that until that date, a total of 9 ha will be reforested and a total of 23 ha of forests will be rebuilt in the Bernardo area, where weather phenomena and indiscriminate tree felling have had the greatest impact.

- A Simplified Management Plan is being implemented in the Alexander Estambolisky Agricultural Production Cooperative's (CPA) Forest Heritage, with the following activities:
 - Natural Regeneration
 - Forest enrichment
 - Silvicultural treatments (pruning, thinning and thinning).
 - Afforestation and reforestation,
 - Forest reconstruction

As education and awareness actions:

- Life Task is implemented , integrated to the initial training of the Primary Teacher in the Municipal University Center, from the conformation of a program as part of the optional curriculum, achieving the preparation of 75 graduates, which allows a better professional performance in General Education.
- Agro-environmental training for primary and agricultural education teachers is generalized. Program of Interest Circles and Scientific Societies for the National Education System.

Result as part of the Environmental Education for Sustainable Development Project of the Ministry of Education, which has been introduced in 100% of the educational institutions of the Municipality, where there are 23 circles of interest and two scientific societies.

- An action of the Science and Innovation Plan for the year 2024 is the creation of forest parks in coordination with the University of Guantánamo, the Agroforestry Company and the Forestry Unit, to carry out environmental education activities in the communities and also constitute sources for the habitat of native species of the municipality.
- The Community Project "What we need to know" is being implemented. This project is developed in vulnerable communities such as: La Bamba, Dagamal, Buena Vista and Arroyo del Medio, with activities aimed at environmental care through university extension work that promotes and raises awareness about the effects of indiscriminate logging and forest fires.
- The scientific work of undergraduate students is directed towards the environmental problems of the territory.
- Increase the number of forest rangers and their training to deal with illegal logging and forest fires.

Conclusions

Deforestation is a phenomenon of reduction of the forest area, is caused by multiple factors, both natural and human, and has irreversible consequences on the environment, and is considered one of the ten environmental problems in the world. The study carried out in the municipality of Yateras showed that the fundamental causes of the existing deforestation have been intentional forest fires and the indiscriminate felling of trees, which have caused damage to the habitat of many species, as well as to the municipality's native flora and fauna, also causing flooding of the Palenque and Toa rivers, with a considerable economic and social impact. With the implementation of sustainable solutions, it has been possible to reforest and restore 16 kilometers in the Toa river basin and a total of 575 hectares of forest, in addition to raising awareness and training a significant number of residents through environmental education activities. It is predicted that by 2030, the municipality will not have deforested areas, thus contributing to the care of the environment and biological diversity.

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