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Original Article

Morphometric parameters and the limnological status of the Calima reservoir, Valle del Cauca, Colombia

Parámetros morfométricos y estado limnológico del embalse Calima, Valle del Cauca, Colombia

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Spanish version

Abstract

Introduction: The bathymetry of the Calima Reservoir has changed considerably since its construction, as evidenced by the loss of useful volume, reduced depth, and morphological alterations caused by sediment accumulation in the tail waters and changes in terrestrial biotopes associated with the water surface.
Objective: To determine the bathymetric structure of the reservoir in 2023 and identify the spatial domains most affected by the entry of contaminants that may promote the growth of algae and cyanobacteria, potentially compromising the use of the water for recreation, aquatic sports, and sport fishing.
Methodology: In April 2023, a bathymetric profile was surveyed in a zigzag pattern across the reservoir using an echosounder with a transducer and GPS. The field data were organized in Excel and integrated into ArcGIS Pro 3.1.3 to generate the bathymetric layout and calculate physical parameters.
Results: Three zones were defined. Zone A: the main deposition area at the inlet of the Calima River, containing the shallowest isolines; two streams converge here, carrying most of the wastewater from the municipality of Calima El Darién, where algal blooms have been reported. Zone B: a narrow strip with depths ranging from 40 to 60 m. Zone C: the dam area, with depths close to 70 m.
Conclusions: The reservoir has an elongated shape aligned with the flow axis of the Calima River. Upon entering, the river loses horizontal energy and deposits suspended solids, forming a lentic zone that narrows toward the dam. The dendritic zones remain isolated from the main axis, and Zone A receives the highest load of urban discharges, favoring the proliferation of phytoplanktonic algae.

Keywords: Reservoir, bathymetric map, morphometric parameters, water resources

Resumen

Introducción: La batimetría del Embalse Calima ha variado notablemente desde su construcción, evidenciándose pérdida de volumen útil, reducción de profundidad y cambios morfológicos debido a acumulación de sedimentos en las aguas de cola y alteración de biotopos terrestres asociados a la lámina de agua.
Objetivo: Determinar la estructura batimétrica en 2023 y localizar los dominios espaciales más afectados por la entrada de contaminantes que pueden favorecer el crecimiento de algas y cianobacterias, poniendo en riesgo el uso del agua para recreación, deportes acuáticos y pesca deportiva.
Metodología: En abril de 2023 se levantó un perfil batimétrico en zigzag sobre el embalse, usando una ecosonda con transductor y GPS. Los datos se organizaron en Excel y se integraron en ArcGIS Pro 3.1.3 para generar el levantamiento y calcular parámetros.
Resultados: Se definieron tres zonas. Zona A: área de depósito en la entrada del río Calima, con las isolíneas más someras; aquí confluyen dos arroyos que transportan la mayor parte de las aguas residuales de Calima El Darién, con floraciones algales. Zona B: franja estrecha con profundidades de 40 a 60 m. Zona C: sector de la presa con profundidades cercanas a 70 m.
Conclusiones: El embalse presenta forma alargada según el eje de flujo del río Calima; al ingresar pierde energía horizontal y deposita sólidos en suspensión, formando una zona léntica que se estrecha hacia la presa. Las zonas dendríticas quedan aisladas del eje principal, y la Zona A recibe la mayor carga de descargas urbanas, favoreciendo proliferación de algas fitoplanctónicas.

Palabras clave: Embalse, mapa batimétrico, parámetros morfométricos, recursos hídricos

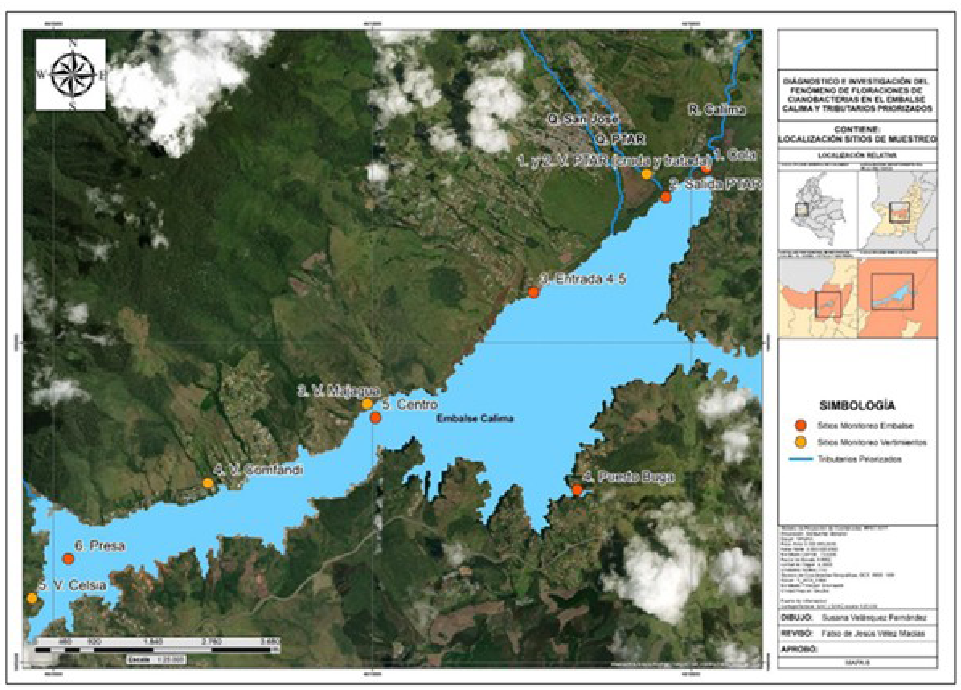
Contribution to the literature

Why was this done?
To determine the current bathymetric structure of the Calima Reservoir and define critical zones based on observed water quality at wastewater discharge sites that likely impact cyanobacteria blooms. This is done to propose alternatives for preventing and controlling these blooms, in order to take action to maintain water quality conditions in the reservoir that allow for safe recreational use.

What were the most relevant results?
To demonstrate that the dendritic zones are isolated from the main axis of the reservoir, and that in Zone A, at the tail of the reservoir where the main tributaries flow, the largest volume has been lost due to sedimentation. This favors the massive growth of phytoplankton algae, which are associated with still waters, high water temperatures during sunny periods, and the availability of nutrients derived from domestic wastewater entering the Calima Reservoir.

What results do these provide?
To treat wastewater discharged into tributaries near the reservoir's tailwater.

Graphical Abstract



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Introduction

Reservoirs are artificial freshwater ecosystems used for purposes such as providing water resources for energy generation, supplying water to water treatment plants, fishing, recreation, and water sports. Due to Colombia's energy demands, the construction of reservoirs has been the preferred route to obtaining hydroelectric power since the mid-20th century (1). The Calima Reservoir, located in the west of Colombia, within the jurisdiction of the Calima municipality of El Darién, Valle del Cauca, Colombia, was built in 1967 for hydroelectric generation. Table 1 presents the characteristics of four Colombian reservoirs, also built for energy generation purposes in high Andean biotopes. These reservoirs are used for electricity production and also for other purposes (1).

Table 1. Physical characteristics of some hydroelectric power generation reservoirs in the Colombian Andes (1).

Reservoir	Start year	Dam area Max. depth (m)	Area (ha)	Max. level (m)	Installed capacity (kw)	Useful volume Millions (m^3)	Flow rate (m^3/s)	HRT (days)	Main use
Calima	1967	98	1980	1400	120	438	76	66.6	Energy
Guatapé	1973	60	6365	1887	560	1169	88	153.7	Energy
Guavio	1993	232	1160	1640	1000	950	72	152.7	Energy
Río Grande	1989	59	1100	-	325	100	50	231.0	Energy

TRH: Hydraulic retention time. Ha: hectares

Landscapes where water reservoirs are established become attractive for various human activities, from tourism to the real estate market. This impacts territorial planning, increases land prices, limits the surrounding population capacity, and ultimately generates pollution problems such as domestic wastewater, which directly affects the reservoir's water quality. For example, urban development increases the production of domestic wastewater, which, in the case of the Calima Reservoir, flows into the water, contributing particulates and dissolved organic matter, nutrients in the form of minerals, and bacterial microorganisms.

Different interests, both economic and socio-environmental, converge in the areas associated with reservoirs, affecting the physicobiotic conditions of an artificial ecosystem such as the Calima Reservoir. Thus, the electricity generating company directs its efforts toward hydroelectric power production, while tourism operators consider themselves drivers of the local economy. The owners of the surrounding farms extend their property beyond regulatory limits and hide behind private property to fail to fulfill their obligations as citizens. The autonomous corporations in each department, created in Colombia for the environmental protection of natural resources, have limited resources to perform environmental control, promotion, and stewardship tasks in the vast area under their care to. Local civil authorities, on the other hand, limit themselves to administrative tasks, without going beyond the minimum requirements, facing a poorly sensitized community with priorities and interests that are not necessarily in harmony with nature.

As can be seen in Table 1, the Calima Reservoir is one of the first reservoirs built in our country, and even today, it provides services for power generation, tourism, recreation, water sports, and fishing.

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It is a deep reservoir, with a water column of 98 m in the dam area during high water. Margalef (2) considered reservoirs as hybrid ecosystems between a river and a lake, and today, this consideration gains relevance since the condition of a reservoir's impounded waters is closely associated with its tributaries, both in terms of water quantity and quality. To analyze a reservoir, it is necessary to start with its physical configuration, that is, its bathymetric analysis, which allows the determination of the main physical parameters of the water body, including its shape, size, volume, and, indeed, its possible morphological changes over time, using current spatial modeling methods that are already quite accurate.

For the present research, the following question was posed: What is the bathymetry of the Calima Reservoir and how have its morphometric parameters changed between 1967 and 2023? It is hypothesized that over the past 56 years, the reservoir's bathymetry has changed. This is essentially reflected in the loss of useful volume, average depth, and changes in the morphology of the boundary line. This is due to sediment deposits in the reservoir's tail and erosional processes along the boundary line due to waves in an area with significant wind activity.

Bathymetry and morphometry studies of lakes and ponds have benefited significantly from advances in technology and methodology in recent years. Reservoirs and lakes exhibit differences in their morphometric characteristics, average depth, shoreline length, surface area, water quality, among others (3,4). These differences can be quantified using scaling relationships.

Problems occurring in water bodies can be studied and investigated using bathymetric data and geospatial technologies (5). In Brazil, between 2014 and 2023, in different water bodies, relationships were found between bathymetry and water quality factors such as turbidity. This last variable is especially high in the northern region of Brazil, where large hydrographic basins converge.

The use of historical and current bathymetric charts can provide relevant information on biophysical changes in water bodies, allowing for a comparative analysis of some physical parameters of environments such as reservoirs and lakes (6). For example, in Poland, a method was developed to reconstruct the relief of a pond's bottom based on old maps and subsidence rates. This method can be used to estimate the pond's water capacity for industrial or infrastructure purposes (7). In Lake Guatavita in Colombia, a morphometric study was conducted, analyzing parameters such as area, perimeter, maximum depth, and volume (8).

In Buenaventura Bay, Colombia, it was found that the effect of bathymetric changes on residence time produced changes in the bay's morphometry, significantly impacting its hydrodynamics and water renewal (9).

Previous studies in Brazil, Poland, and Colombia are examples that demonstrate the value of bathymetric and morphometric analyses in understanding the characteristics and dynamics of lakes, reservoirs, and other water bodies, which can inform their management and use.

According to these studies, land cover and terrain influence the scaling relationships between the morphometric features of lakes more than those of reservoirs. Scaling exponents relating lake area, volume, and shoreline length differ more from theoretical expectations based on geometric

doi: 10.25100/iyc.v27i2.14771

constraints for lakes compared to reservoirs. This suggests that land cover and terrain play a greater role in shaping the actual morphometry of lakes compared to the more restricted and engineered morphometry of reservoirs.

For example, the volume-area scaling exponent is larger for lakes than for reservoirs, indicating that lakes cover a wider range of volumes for a given surface area. The area-shoreline length exponent also differs more from the expected value for lakes compared to reservoirs.

These findings imply that land cover and terrain can significantly affect size-scaling relationships and overall morphometry of natural lakes, likely through processes such as erosion, sedimentation, and vegetation growth. In contrast, the morphometry of artificial reservoirs is more constrained by their design and construction. Understanding these differences in scaling relationships between lakes and reservoirs can provide insight into how land cover and terrain influence hydrological processes and ecosystem services in these water bodies (10). Thus, bathymetric data can be used to assess sedimentation in water bodies, such as the study of fluvial sediments and deforestation in the Amazon Basin (11). State-of-the-art techniques in this field include high-resolution bathymetric mapping: the use of advanced sonar equipment, such as multibeam echosounders, to generate highly detailed 3D maps of lake and pond bottoms. These maps provide valuable information on underwater topography and sediment distribution. Remote sensing technologies include the integration of remote sensing data from satellites, aircraft, or drones to monitor changes in water levels, coastal dynamics, and vegetation cover around lakes and ponds. These data help assess environmental health and changes in these water bodies (12-14).

Geographic information systems (GIS) are used to analyze bathymetric and morphometric data, enabling sophisticated spatial modeling, volume calculations, and habitat mapping in lakes and ponds, which helps to effectively manage ecosystems.

Acoustic methods such as side-scan sonar, sub-bottom profilers, and acoustic Doppler current profilers are used to study underwater features, sediment composition, and water movement patterns in lakes and ponds. These studies provide crucial data for ecological and geological research.

Integrated field studies combine traditional field studies with modern technologies for a comprehensive understanding of lake and pond characteristics. This can include sediment coring, water quality sampling, and biological assessments along with high-tech instrumentation. By employing a combination of these cutting-edge techniques, researchers and environmental managers can gain deeper insights into the complex dynamics of lakes and ponds. This, in turn, facilitates better decision-making for conservation, resource management, and ecosystem restoration efforts (15-19).

Material and Methods

A bathymetric profile was created over the water surface, following the zigzag transect lines during the April 2023 sampling campaign. For this task, a boat with an 1150 HP outboard motor was used, equipped with a Hummbird 920c echosounder with a side-mounted radar transducer and GPS. A total of n = 9,553 points were collected, measuring depth in meters and coordinates in the

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WGS84 geographic reference system. Previously, the depths of 10 of the most representative sites were corroborated, using manual measurements to check the instrumental precision down to the centimeter level, finding that the differences did not exceed 5 cm (2”). This number of sites is considered optimal as long as differences are maintained within the acceptance range, in this case 2”, since they imply an appreciable additional time in the task of collecting the largest number of points of the reservoir in the shortest possible time, which corresponds to one day of sampling.

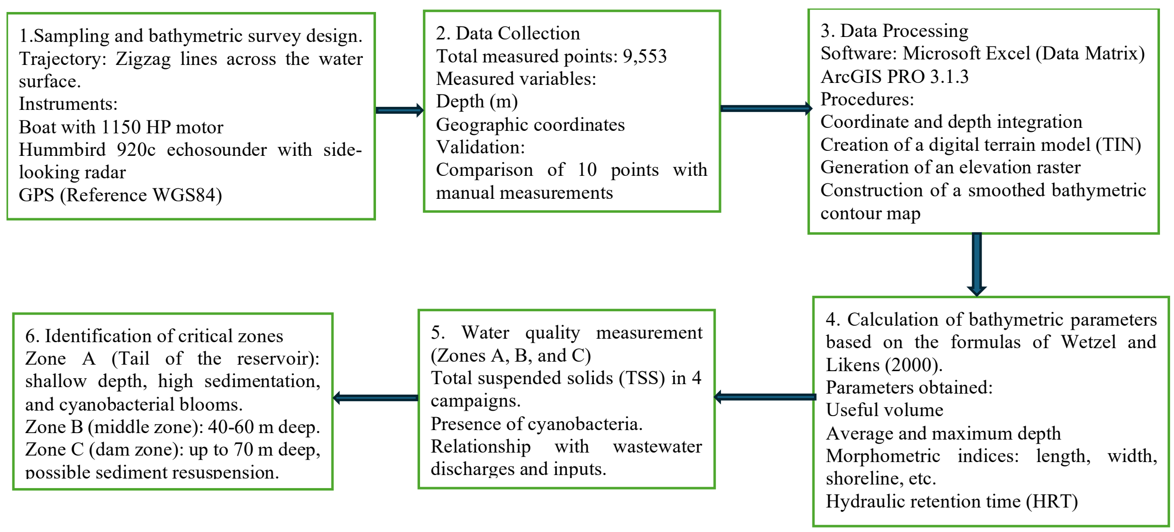

Figura 1. Conceptualization of the methodology

Subsequently, with the compiled database, a data matrix was constructed in Excel and coupled to ArcGis Pro version 3.1.3. for the bathymetric survey. Then, from the digital cartography and the data matrix, a digital TIN model was developed. Together with this, an elevation raster was generated that lead to the production of a map of bathymetric curves that was smoothed. With these inputs it is possible to calculate the bathymetric parameters, taking into account the equations proposed in Wetzel and Likens (2000) (20).

Results

Figure 2 presents the final result of the bathymetric map obtained from the field measurements. Three bathymetric zones of the reservoir are observed: Zone A (upper right portion of the map), where material has been deposited at the bottom of the water body, as seen in the 2023 bathymetric map. This zone is the shallowest zone of the reservoir, corresponding to the inlet of the Calima River. This zone is the area with the greatest loss of water storage in the reservoir. Zone B corresponds to the narrow strip of the reservoir, where depths range from 40 to 60 m, and Zone C corresponds to the dam site, where depths close to 70 m can be found. In the present study, measurements of suspended solids in water were taken in these three zones in 2023 at four different times of the year (Figures 3, 4, 5). The greatest amount of rainfall occurred in campaigns 1 and 2. Cyanobacteria blooms are occasionally found in Zone A, as in 2023 (Table 2), but not in Zones B and C.

doi: 10.25100/iyc.v27i2.14771

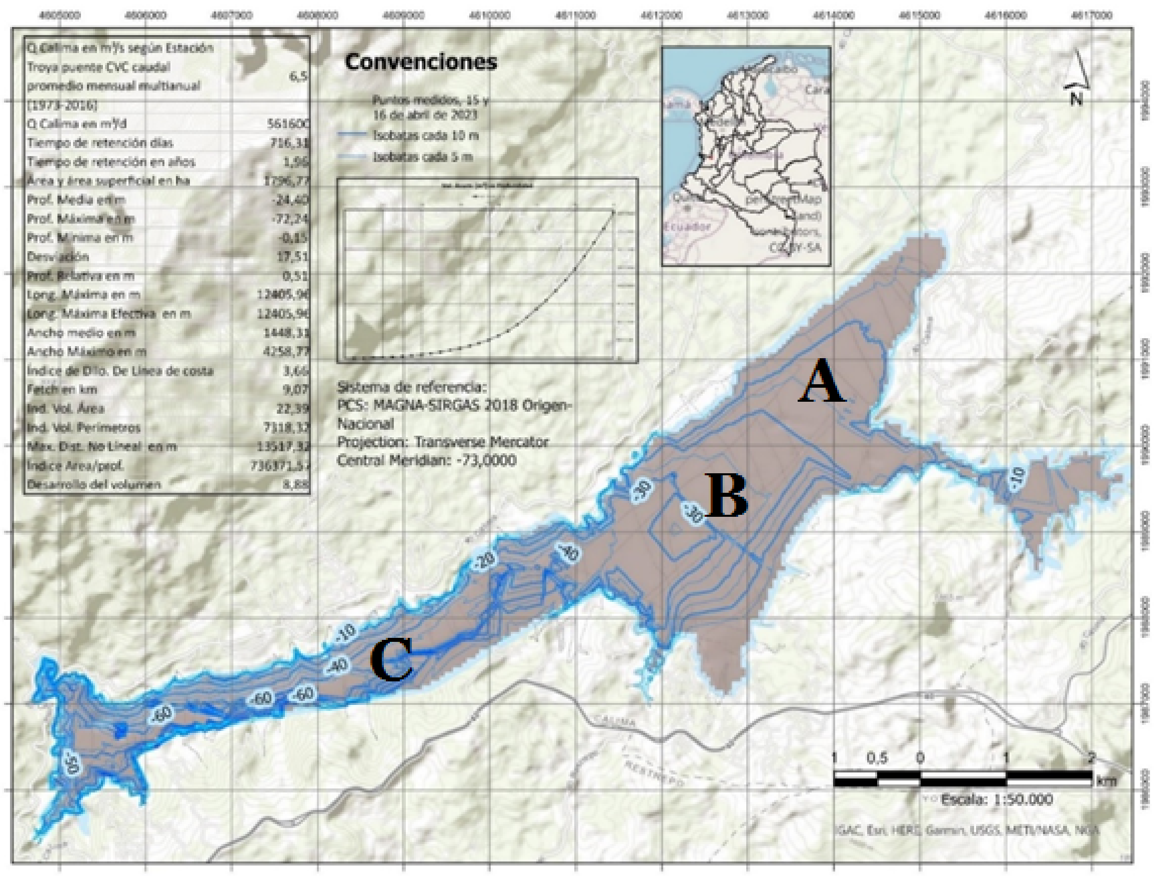

Figure 2. Bathymetric map of the Calima reservoir in 2023

In Figure 1, note the distribution of Zones A, B, and C, which correspond to the flow direction of the reservoir. Zone A is the inflow of the Calima River, while Zone C corresponds to the narrow part of the reservoir near the dam. Table 2 shows the algal density data in the three zones defined for the reservoir.

Table 2. Number of cyanobacteria individuals in volumetric samples from the Calima Reservoir in 2023.

Total cells/mL			
Depth/Point	Zone A	Zone B	Zone C
E1 (Surface)	138.000.000	0.0	0.0
E2 (Middle zone)	33.433.333	0.0	0.0
E3 (Reservoir bottom)	5.500.000.0	0.0	0.0

As can be seen in Table 3, there are significant differences in the average flow of the Calima River and therefore in the residence time.

doi: 10.25100/iyc.v27i2.14771

Table 3. Bathymetric parameters of the Calima reservoir for the years 1967 and 2023.

Parameter	Year 1967 (1)	Year 2023
Q Calima in m³/s upstream before the Reservoir		6.5
Q Calima in m³/d		561.600
Retention time days	66.6	308.3
Retention time years		0.84
Surface area in ha	1980	1796
Average Depth in m		-24.40
Max. Depth in m	98	72.24
Min. Depth. in m		-0.15
Deviation		17.51
Useful volume Mill. m³	438	402
Relative Depth. in m		0.51
Maximum length in m		12.406
Maximum effective length in m		12.405
Average width in m		1.448
Max. width in m		4.258
Coastline Development Index		3.66
Fetch in km		9.07
Ind. Vol. Area		22.39
Ind. Vol. Perimeters		7.318
Max. Non-Linear Dist. in m		13.517
Index Area/Depth		73.637
Volume development		8.88

It is important to highlight that obtaining bathymetric data from a reservoir allows for better management of water resources. In our country, obtaining basic information on reservoirs is essential for decision-making regarding water storage availability, sediment deposits, and the reservoir's useful life, among other factors. These authors of this study consider that, as time passes, physical information on a reservoir must be updated Therefore, it is considered important to recover historical information on the water body, even if it is not complete. In future years, with more limnological studies, an increasingly comprehensive database will be available.

Discussion

Zone A is probably the area with the greatest loss of reservoir water storage. It is the shallowest, less than 3 m, and although there is no historical data on volume loss, it is clearly an area of material deposits. Most of the reservoir's tributaries flow into this area. These include the Calima River, from which the reservoir originated, and two streams, one of which collects treated water from the wastewater treatment plant and another untreated wastewater, mainly domestic, from the municipality of Calima El Darién. The San José Stream and the La Virgen Stream also collect wastewater from the same municipality. These three tributaries flow near the reservoir's tailwater, precisely where the Calima River empties. The municipality that bears its name, located on the shore of the reservoir, about 5 km from the tailwater, has approximately 19,000 inhabitants. However, its population increases significantly on weekends and holidays due to the large number of tourists

doi: 10.25100/iyc.v27i2.14771

attracted to the reservoir, where there are more than 30 hotels and a large number of people from other cities who have vacation homes there.

A large amount of organic pollutants and nutrients enter the reservoir's tailwater in Zone A, and for this reason, cyanobacteria occasionally proliferate in the area near the tailwater, where the three tributaries flow.

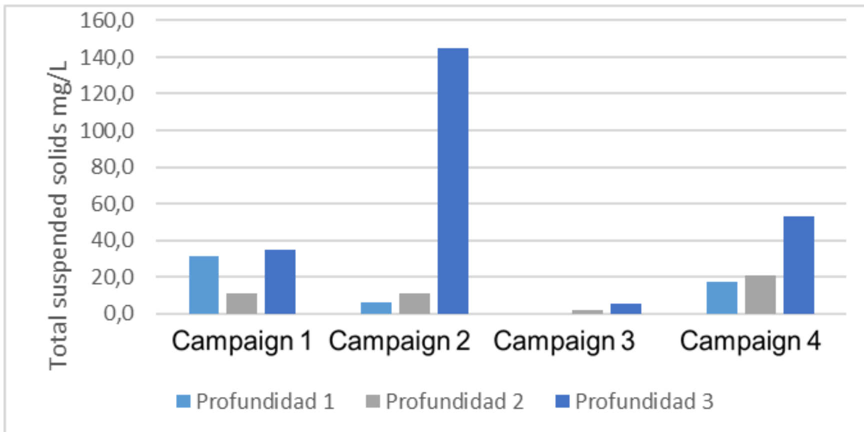

Figure 3. Profile of total suspended solids in zone A of the Calima reservoir in 2023.

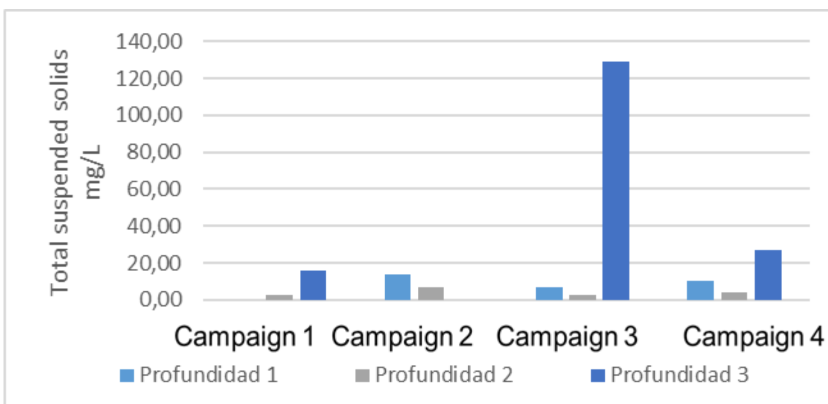

Figure 4. Profile of total suspended solids in zone B of the Calima reservoir in 2023.

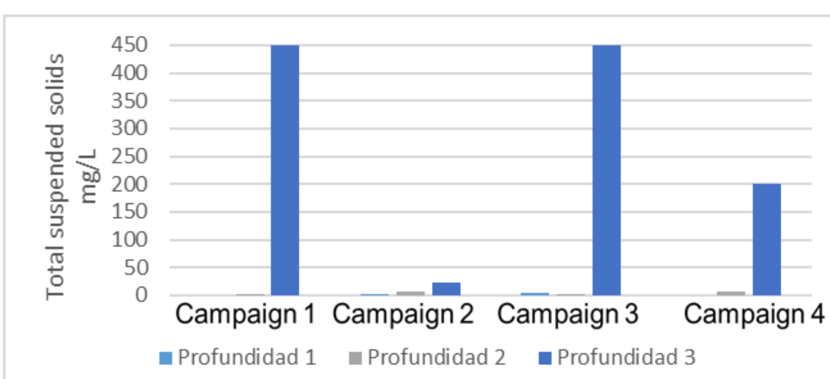

Figure 5. Profile of total suspended solids in zone C of the Calima reservoir in 2023.

doi: 10.25100/iyc.v27i2.14771

The reservoir near the tail has shallow depth. During periods when there is no rain part of Zone A remains dry, and in rainy seasons it can have a depth of 2 to 3 meters, but normally it has a depth of 1 to 1.50 meters. For this reason, when there are cyanobacteria blooms these are present throughout the water column. This is also why there is a large amount of fish in this area, which are caught by inhabitants of Calima for consumption in said municipality. This area was characterized by presenting water temperatures greater than 23 ° C, Secchi transparency less than 1 m, and high availability of nutrients. In Zone B, where the Calima reservoir narrows, depths between 40-60 m are found. Meanwhile in Zone C, at the dam site, depths close to 70 m can be found. In Zones B and C, water sports such as sailing, water skiing, windsurfing, kitesurfing and others are very popular, since this area is considered to have the best winds in the Americas and the and third-best worldwide for watersports (Calima Darién Municipality recovered from https://comunales.valledelcauca.gov.co/municipios-del-valle-del-cauca/calima-el-darien), National Youth Games (recovered from https://www.nacionalesjuveniles.gov.co/escenario/escenario/412). The water in the reservoir in Zones B and C is of good quality; in the shallowest 30 m the percentage of dissolved oxygen saturation is more than 80%, the COD is less than 20 mg / L and the limit of the photic zone is around 5 m. Cyanobacteria blooms have never occurred in Zones B and C, which may be due to the fact that very few tributaries reach these zones, which have much lower flow rates and less pollution than the tributaries that reach Zone A. If some of these tributaries that reach Zones B and C contain nutrients, they are further diluted in the reservoir because the water volume in these zones is much greater than in Zone A. Furthermore, the strong winds in Zones B and C destroy any algal masses that may exist.

In Zone A of the Calima Reservoir, during both rainy seasons, the water contained suspended solids from the tributaries. During the rainy season, the water has a higher amount of suspended solids, corresponding to material carried by runoff from the surrounding soils of the Calima River and streams. Much of this suspended material settles in Zone A when it reaches there.

In Zone B, the water carries fewer suspended solids. Regarding Zone C, which corresponds to the reservoir's dam, in three sampling campaigns, the bottom water contained a large amount of suspended solids. This is due to the fact that solids settled in the dam area are resuspended by the water that arrives with great force (especially during rainfall) through a pipeline that carries them from the Rio Grande to the vicinity of the dam. This is done to increase the water volume in the Calima Reservoir. In the present study, sediment characterizations were performed, showing that the sediments in Zone A have a high content of organic matter, while those in Zone C contain a high content of inorganic matter.

The hydraulic retention time was 0.84 years, or 308.35 days. A lower average depth than historical data was found, which could be related to the loss of useful volume.

As can be seen in Figure 2, the northwestern border, where the municipal seat and a large part of the municipality's population are located, is Zone A of the reservoir, or the tailwater, which has the largest area and receives the reservoir's main tributary, the Calima River. The old riverbed and the distance to said border are noticeable. This condition creates a mixing zone that buffers the river's energy, resulting in relative calm during periods of high reservoir levels. This, in turn, causes the other tributaries on the northwestern shore also to encounter hydraulic conditions that slow mixing

doi: 10.25100/iyc.v27i2.14771

and, when combined with other factors, such as nutrients, can enhance the appearance of algal blooms. The results obtained in this investigation reveal substantial changes in the morphometric structure and limnological quality of the Calima Reservoir, consistent with the natural and anthropogenic processes that affect artificial water bodies over time. The 8.2% reduction in useful volume and the decrease in maximum depth from 98 m (in 1967) to 72.24 m (in 2023) indicate a progressive silting of the reservoir, particularly accentuated in Zone A, where the main polluted tributaries converge.

Bathymetric zoning identified three sectors with distinct physical and chemical conditions. Zone A, located at the tail of the reservoir, displayed characteristics typical of a highly eutrophic system: shallower depths (<3 m), high concentrations of total suspended solids, and the presence of cyanobacterial blooms, especially during dry seasons. This situation is directly related to the discharge of treated and untreated domestic wastewater from the urban area of the municipality of Calima El Darién, which has intensified sedimentation processes and nutrient input.

In contrast, Zones B and C maintain more favorable limnological conditions. The greater depth (40–70 m), low contaminant input, and high wind-induced mixing dynamics characteristic of these areas allow for greater oxygenation of the water column, thus limiting the occurrence of algal blooms. These spatial differences highlight the importance of considering limnological heterogeneity in reservoir management.

Furthermore, the increase in hydraulic retention time from 66.6 to 308.3 days is an indicator of an alteration in the hydrological dynamics of the system, favoring stagnant conditions that foster particle sedimentation and the development of eutrophication processes in specific areas. This finding is consistent with similar studies in other Andean reservoirs, where a direct relationship between morphometry, residence time, and water quality has been reported (9,20).

Finally, it is concluded that the morphometric evolution of the Calima reservoir is strongly influenced by anthropogenic factors, particularly the discharge of untreated wastewater. This situation requires urgent intervention through environmental restoration actions, discharge control, and territorial planning aimed at the sustainability of the aquatic ecosystem and its multiple uses (energy, recreation, fishing, tourism).

Conclusions

The Calima River presented an average inflow into the reservoir of 6.5 m^3/s, with a HRR of 308.35 days and a loss of useful reservoir volume of 8.2% over a period of approximately 56 years, according to available open data.

Given its morphometric condition, with a development index of 3.66, it can be observed that the reservoir presents an elongated shape associated with the flow axis of the Calima River. Upon entering the reservoir, this river loses its horizontal flow energy, depositing suspended solids. The reservoir then continues through a lentic or still-water zone that narrows toward the deeper dam zone. Thus, the dendritic zones are isolated from the main reservoir axis, and Zone A receives the largest amount of discharges, especially wastewater from the urban area of the municipality of Calima. This situation favors the massive growth of phytoplanktonic algae at the tail of the reservoir,

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located in Zone A, which grows especially during the dry season when dendritic conditions and water isolation are accentuated. This physical phenomenon, combined with high radiation during the dry season, has led to the development of some algal blooms in dendritic zones here. In general terms, the following conclusions are drawn:

1. Significant loss of useful reservoir volume

In the 56 years since its construction, the Calima Reservoir has lost approximately 8.2% of its useful volume, primarily due to sediment accumulation in Zone A, which affects its storage capacity and operational functionality.

2. Bathymetric zoning reveals different limnological conditions

Three distinct zones (A, B, and C) with distinct bathymetric and ecological characteristics were identified. Zone A, which is shallowest, is most severely affected by sedimentation and pollution, while Zones B and C retain greater depth and water quality.

3. Direct relationship between polluting tributaries and cyanobacteria blooms

Cyanobacteria blooms are concentrated exclusively in Zone A, coinciding with the discharge of untreated or partially treated domestic wastewater, which poses an ecological and health risk.

4. The change in morphometry evidences an alteration in hydrological dynamics

The reservoir has experienced a reduction in mean depth and an increase in hydraulic retention time (308.3 days at the time of measurements), which contributes to sluggish water conditions and favors eutrophication processes.

5. Urgent need for intervention in discharges and environmental planning

The results show that inadequate wastewater management and uncontrolled urban growth are deteriorating water quality. Corrective measures, such as effective discharge treatment and improved land-use planning in the reservoir basin, are required.

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CrediT authorship contribution statement

Conceptualization - Ideas: Fabio Vélez, NéstorAguirre, Gustavo Peñuela. Data curation: Fabio Vélez, Susana Velásquez. Formal analysis: Fabio Vélez. Investigation: Fabio Vélez, Susana Velásquez. Methodology: Fabio Vélez, Rubén Molina. Project Management: Gustavo Peñuela. Resources: Gustavo Peñuela. Supervision: Fabio Vélez, Gustavo Peñuela. Validation: Fabio Vélez, Susana Velásquez. Writing - original draft - Preparation: Fabio Vélez. Writing - revision and editing - Preparation: Gustavo Peñuela.

Financing: does not declare. Conflict of interest: does not declare. Ethical aspect: does not declare.

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