Open Access Library Journal
2024, Volume 11, e12423
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Assessing the Ecological Functioning of the Riparian Zones of the Menoua Watershed of the Mount Bamboutos Landscape-West Region, Cameroon (Central Africa)

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How to cite this paper: Fouego, N., Nkengafac, N.J., Asaah, E., Ndong Tsa, M., Kenfack, S.N.V. and Jean Paul, G. (2024) Assessing the Ecological Functioning of the Riparian Zones of the Menoua Watershed of the Mount Bamboutos Landscape-West Region, Cameroon (Central Africa). *Open Access Library Journal*, **11**: e12423.
https://doi.org/10.4236/oalib.1112423

Received: October 2, 2024
Accepted: December 3, 2024
Published: December 6, 2024

Abstract

The ecological functioning of the riparian zone was investigated in the Menoua sub-watershed of the Mount Bamboutos landscape, Cameroon. Five transects of 1 km each were laid along five rivers to investigate the ecological functioning of the streams. Each transect received a score for the functioning of the riparian zone according to the RSRA method. The scoring for the functioning of the riparian zones was based on 3 parameters (water quality, Hydro-geomorphology and Fish/Habitat diversity). River 1 (Lingang) obtained scores of (5/5, 2.5/5, 2/5). River 2 (Djutitsa) obtained scores of (3/5, 1.75/5, 3.7/5). River 3 (lepeh waterfall) obtained scores of (5/5, 2/5, 4.3/5). River 4 (Mia Melieuh) obtained scores of (3/5, 1.75/5, 3.7/5), and River 5 (Baleveng) obtained scores of (3/5, 1.5/5, 3.7/5). These parameters are critical baseline information required in either the design of a restoration initiative for the Menoua Watershed of Mount Bamboutos or for the monitoring of the restoration of the landscape by watching the functional ecology development of its riparian zones.

Subject Areas

Ecology

Keywords

Ecological Functioning, Riparian Zones, Mount Bamboutos, Restoration

1. Introduction

The Cameroonian Highlands forests are a montane tropical forest ecoregion located on the range of mountains that runs inland from the Gulf of Guinea and forms the border between Cameroon and Nigeria [1]. The Western Highlands of Cameroon is one important part of this ecoregion. The Bamboutos Mountains which constitutes the western highlands, is located between latitude 5°32' and 5°51' North and longitude 9˚56' and 10˚09' East. The peak of Mt Bamboutos constitutes the fourth highest point on the Cameroon highlands chain, with an altitude of 2740 m [2]. The landscape cuts across three regions: West, South-West and North-West regions of Cameroon, starting from Batibo in the North-West region to Alou in the South-West [3].

Historically, Mount Bamboutos has been known as one of the top biodiversity hotspots in the West and Central Africa, home to primates, birds, amphibians, and plants, including high numbers of endemic species [4]. This mountain represents a key watershed that supplies major hydropower in Edea. It gives rise to several rivers and lakes across the country, including the Mbam and Mifi tributaries; River Noun, which is the main source of the Bamendjim dam and lake Bambalang; River Manyu that drains into the cross river and the Menoua that drains into Nkam and Wouri [2]. However, Mount Bamboutos, like most parts of the Cameroon highlands, has witnessed an estimated 96.5% clearance of the original montane vegetation (forest) [5], including the riparian zones, which are known to be responsible for the preservation of water.

The riparian zones of the Mount Bamboutos landscape are greatly threatened [6]. In fact, the riparian zones of the mount Bamboutos landscape, which offers several ecosystemic services are being destroyed by anthropogenic activities such as intensive agriculture (with the use of herbicides, pesticides and fertilizers), deforestation, habitation, creation of fishponds by the adjacent communities in trying to address livelihood and household income needs. This has led to soil erosion, poor soil quality, food and water contamination.

The main objective of this paper is to determine the environmental condition of the riparian zones of the mount Bamboutos landscape for restoration initiatives. This paper offers baseline information that will help in the design of a restoration plan for the Menoua Watershed of Mount Bamboutos and contribute in the monitoring of the restoration activities of the Mount Bamboutos landscape.

2. Materials and Methods

2.1. Description of Study Area

The study area represents different streams found on the Menoua watershed on the mount Bamboutos landscape in the western region of Cameroon. The presence of water catchments and river streams in Menoua division allows the establishment and long-term existence of different plant species, and ecosystemic functionalities, thus justifying their classification as riparian zones. Behind these

riparian zones are hectares and hectares of cultivated land and massive exploitation of these streams for irrigation purposes, which has led to serious water shortages as well as the almost complete degradation of the Menoua watershed.

The Menoua watershed is located between 9°56'0" and 10°6'30" East and 5°22'0" and 5°36'30" North (See Figure 1). This watershed is part of the Coastal Rivers Watershed and is located in the Western region of Cameroon. It is mainly drained by the Menoua River, which originates in the Bamboutos Mountains, which rise to 2700 meters [3].

The zone is essentially mountainous, and the dominant activity in this area is agriculture because of the volcanic type of soil, which is very fertile [7]. The climate in this watershed is the humid tropical climate characterized by two (02) seasons. The ocean influences this climate. We have a long rainy season that lasts 07 months (mid-March to October) and a short dry season of 05 months (from November to mid-March). The rainy peaks are observed during the months of August and September. The annual rainfall calculated over 73 years is about 1805.68 mm/year [8].

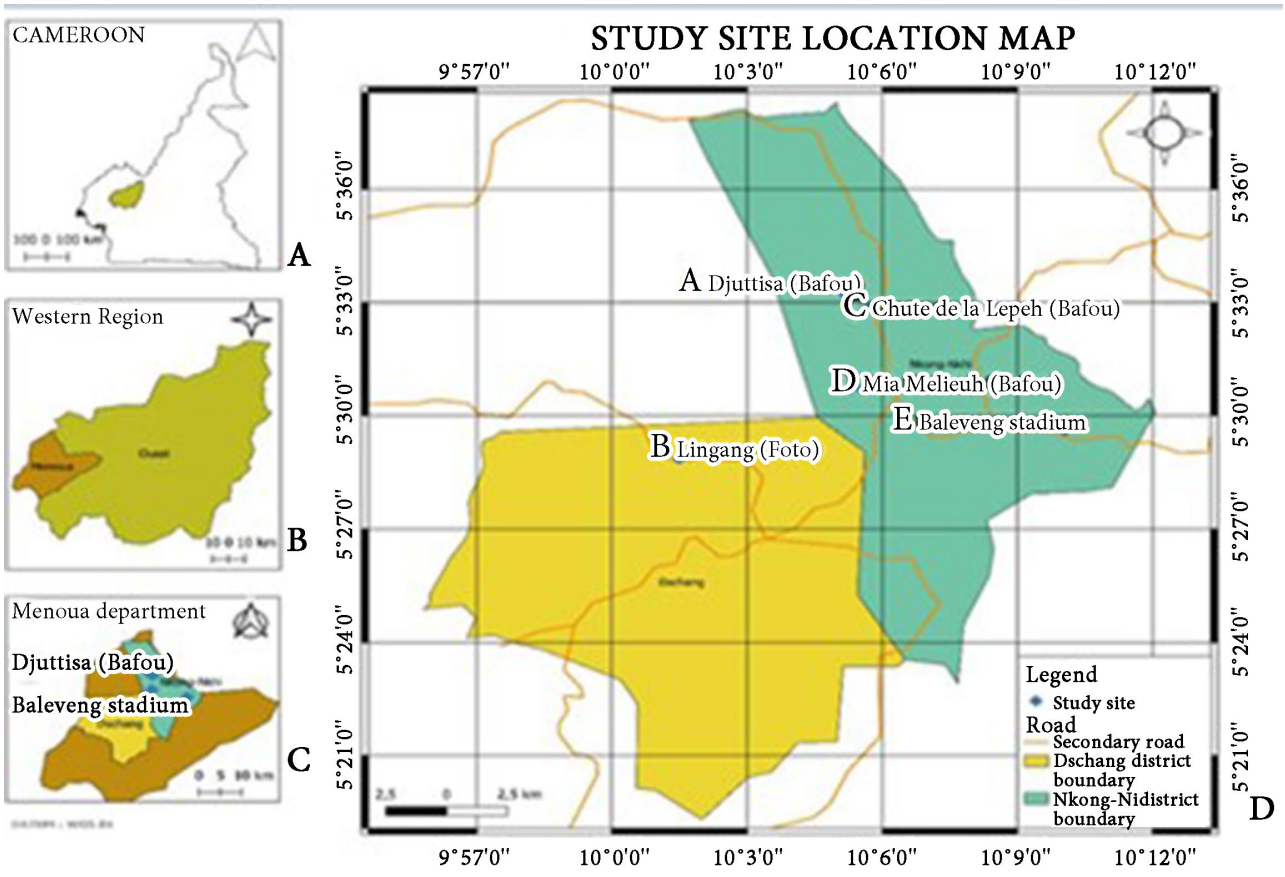

Figure 1. Localisation of study site.

2.2. Methods

This was done using the Rapid Stream-Riparian Assessment (RSRA) proposed by

[9]. The assessment permits to efficiently survey a number of different reaches along the same stream to provide a better understanding of both varying conditions and trends that exist within the particular watershed. The five streams selected for the assessment were pre-referenced using Google Earth.

The choices of the transects were based on 3 main factors including: A longitudinal cross-section of the Menoua watershed to cover as many villages as possible, a latitudinal cross-section to ensure that the streams on which we laid the transects were from different tributaries each and finally an altitudinal cross-section to ensure that we had an altitudinal variation.

The study focused on three functional components including:

- Water pollution indicators.
- Stream channel and floodplain morphology and the ability of the system to limit erosion and withstand flooding without damage.
- Presence of habitat for native fish and other aquatic species and suitability of these habitats for terrestrial wildlife, including threatened or endangered species.

Each of these functional components had indicators for their measurement. These indicators were quantified using scores ranging from 1 to 5 provided in the methodology.

To determine the functioning of the riparian zones of the Menoua watershed, On each study site:

- A 1 km reach transect where data will be collected was drawn.
- Two different but adjacent 200 m sample transects were laid within the initial 1 km transect, where specific quantitative data were collected. One of the 200 m sample transects was an in-stream transect and the other was a riparian zone transect.

Data was collected within these transects for the main functional components and indicators.

3. Results and Discussions

3.1. Results

Five streams were assessed on the Menoua watershed to determine the environmental functionality of their riparian zones. The results obtained were as shown on Table 1 below.

3.2. Discussions

The ecological evaluation of the riparian zones in the Menoua watershed utilized a multi-parameter approach, allowing for a comprehensive diagnosis of their ecological condition. This study applies three criteria: water pollution indicators, hydro-geomorphology, and fish/aquatic habitat, validated through the Rapid Stream Assessment of Riparian Zones (RSAR) method.

Our findings reveal significant algal proliferation in various streams, suggesting substantial nutrient enrichment and potential pollution sources. This phenomenon

Table 1. Functioning of the riparian zones of the Menoua watershed.

Indicator	Rivers				
Water pollution indicator	River 1 (Lingang)	River 2 (Djutitsa)	River 3 (Lepeh Water fall)	River 4 (Mia melieuh)	River 5 (Baleveng)
Algal growth	Little or no filamentous algae in stream Score: 5/5	Filamentous algae present in stream. Stream experienced high eutrophication level Score: 2/5	Little or no filamentous algae present in stream score: 5/5	filamentous algae present in the stream Score: 2/5	filamentous algae present in the stream Score: 2/5
River shading	Average of 63% shading for all the 3 points Score: 5/5	stream experiences an average 50% shading for all the 3 points. Score: 4/5	Stream Experiences an average 80% shading for all the 3 sites Score: 5/5	Stream experiences an average of 46.7% Shading for all the 3 sites Score: 4/5	stream experiences an average of 43.3% shading for all the 3 sites Score: 4/5
Water pollution indicator mean score	**5**	**3**	**5**	**3**	**3**
Hydro-geomorphology indicator	River 1 (Lingang)	River 2 (Djutitsa)	River 3 (Lepeh Water fall)	River 4 (Mia melieuh)	River 5 (Baleveng)
Flood plain connection and Innondation	Ratios: (1.6; 1.6; 1.29) Average: 1.49 Score: 3/5	Ratios: (3.11; 4.4; 4.9) Average: 4.14 Score: 1/5	Ratios: (2.15; 2.07; 3.1) Average:2.44 Score: 1/5	Ratios: (7.8; 1.73; 2.4) Average: 3.98 Score: 1/5	Ratios: (2.17; 1.88; 1.7) Average: 1.91 Score: 1/5
Vertical bank stability	Unstable banks in 200 m transect: 124m Instability: 31% Score: 3/5	Unstable banks in 200 m transect: 152 m Instability: 38% Score: 3/5	Unstable banks in 200 m transect: 100m Instability: 25% Score: 4/5	Unstable bank in 200 m transect: 220 m Instability: 55% Score: 3/5	Unstable bank in 200 m transect: 300 m Instability: 75% Score: 2/5
Hydraulic habitat diversity	Features present: High velocity run, low velocity run. Number of features present: 2 Score: 2/5	Features present: Low velocity run, swampy area Number of features present: 2 Score: 2/5	Features present: High Velocity run, Low velocity Run Number of features present: 2 Score: 2/5	Features present: Low velocity run, swampy area Number of features present: 2 Score: 2/5	Features present: Low velocity run, swampy area Number of features present: 2 Score: 2/5
Riparian area integrity	Description: Some signs of erosion observed in 1 km transect % disturbed: 25% eroded Score: 2/5	Description: Great signs of erosion observed in 1 km transect % disturbed: 60% eroded Score: 1/5	Description: Some signs of erosion observed in 1 km transect % disturbed: 30% eroded Score: 1/5	Description: Signs of erosion observed in 1 km transect; bank fall, roads % disturbed: 50% eroded Score: 1/5	Description: Signs of erosion observed in 1 km transect; bank fall. % disturbed: 40% eroded Score:1/5

Continued

Hydro geomorphology mean score	**2.5**	**1.75**	**2**	**1.75**	**1.5**
Fish/Aquatic habitat indicator	River 1 (Lingang)	River 2 (Djutitsa)	River 3 (Lepeh Water fall)	River 4 (Mia melieuh)	River 5 (Baleveng)
Cobble embeddedness	Average embeddedness % for 3 sites: 70% Score: 1/5	Average embeddedness % for 3 sites: 80% Score: 1/5	Average embeddedness % for 3 sites: 20% Score: 4/5	Average embeddedness % for 3 sites: 90% Score: 1/5	Average embeddedness % for 3 sites: 70% Score: 1/5
Large woody debris	Description: Number of woody debris in 200 m transect: 8 Score: 4/5	Description: Number of woody debris in 200 m transect: 12 Presence of 5 plastic debris equally found in the transect Score: 5/5	Description: Number of woody debris in 200 m transect: 6 Score: 4/5	Description: Number of woody debris in 200 m transect: 25 Plastic debris found in stream Score: 5/5	Description: Number of woody debris in 200 m transect: 21 Score: 5/5
Overbank cover and terrestrial invertebrate habitat	% of vegetation hanging over bank in 200 m transect: Little or no grass overhanging on water Score: 1/5	% of vegetation hanging over bank in 200 m transect: 65% Score: 5/5	% of vegetation hanging over bank in 200 m transect: 70% Score: 5/5	% of vegetation hanging over bank in 200 m transect: 70% Score: 5/5	% of vegetation hanging over bank in 200 m transect: 80% Score: 5/5
Fish/aquatic habitat mean score	**2**	**3.7**	**4.3**	**3.7**	**3.7**

is of particular concern as it may contribute to reduced dissolved oxygen levels, critically impacting aquatic life. These observations align with the findings of [10], who reported deteriorating water quality in the Menoua watershed, thereby underscoring a persistent issue of water pollution that warrants immediate attention.

The hydrogeomorphological analysis indicates a concerning level of erosion within the streams of the Menoua watershed. This erosion is exacerbated by increased rates of deforestation, which disrupts the natural stabilization of soil along the banks. Such conditions not only affect the structural integrity of the streams but also compromise the habitats essential for various aquatic organisms. The results of this study are further corroborated by [11], indicating an increased trend of soil erosion in this region due to reduced soil cover.

The assessment of fish and aquatic habitats highlights the current insufficiencies in providing a conducive environment for aquatic species. The structural quality of these habitats is negatively impacted by both water pollution and hydrogeomorphological changes. The overall habitat conditions do not support healthy fish populations, leading to potential declines in biodiversity. This aligns with the broader ecological degradation trends reported by [6] and [2] regarding the Mount Bamboutos landscape.

The ecological data analyzed in this study elucidate the critical state of the

riparian zones in the Menoua watershed.

4. Conclusions

The ecological evaluation of the riparian zones in the Menoua watershed reveals critical insights into their current condition. The findings indicate notable challenges, including significant nutrient enrichment, along with erosion and habitat degradation, all of which contribute to the compromised integrity of aquatic ecosystems. The presence of algal blooms serves as a clear indicator of water pollution, aligning with previous studies and underscoring the urgent need for effective management strategies.

While the RSAR method provides a useful framework for assessment, its subjective nature invites caution in interpretation. Nevertheless, the tool has proven effective in diagnosing ecological health, emphasizing areas for improvement and restoration. Collaboration among stakeholders is essential to enhance riparian habitats, mitigate pollution, and promote sustainable practices. This study not only contributes to the understanding of ecological dynamics in the Menoua watershed but also serves as a call to action for conservation efforts aimed at preserving these vital ecosystems.

Conflicts of Interest

The authors declare no conflicts of interest.

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