



# “Ecosystem Services of Calderas Geodiversity: Case of Manengouba, Bambouto and Bamenda Volcanoes (Cameroon Volcanic Line”

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CAMEROUN



## Scheme

### I- Introduction

### II. Ecosystem services

- II. 1. Regulation services
- II. 2. Supporting services
- II. 3. Provisioning services
- II. 4. Cultural services

### III. Discussion

### IV. Conclusion

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## Introduction

The geodiversity, as the **geological diversity** (Reynard & Coratza, 2007; Giovagnoli, 2017) is being developed among geoscientist community nowadays.

According to Gray (2013), geodiversity is the **natural range** (diversity) of **geological** (rocks, minerals, fossils), **geomorphological** (landforms, topography, physical processes), **soil** and **hydrological features**.

Brilha et al. (2018), demonstrated that the geodiversity components (biotic and abiotic nature) are the **main elements for sustainability of human society** since they are the **goods** and **services** that **humans** derive from **nature**.

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## Introduction...

These **benefits** are now generally referred to as “**ecosystem services**”. Geological environment with significant ecosystem services is **volcano**.

In fact, although **volcanic hazards** pose a potential threat to **8%** of the world’s population, **perivolcanic and volcanic areas** continue to **attract a large active population** today (Doocy, 2013; Choumert-Nkolo et al., 2021).

In Cameroon, Manengouba, Bambouto and Bamenda volcanoes are **assets for anthropogenic activities** (Zangmo Tefogoum et al. 2011, 2014 2017).

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Introduction...

These volcanoes are located in an Ocean-Continental megastructure called the **Cameroon Volcanic Line**.

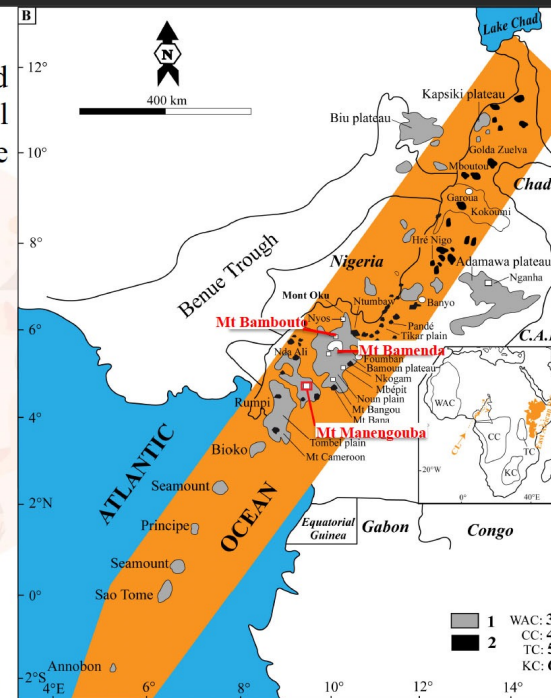
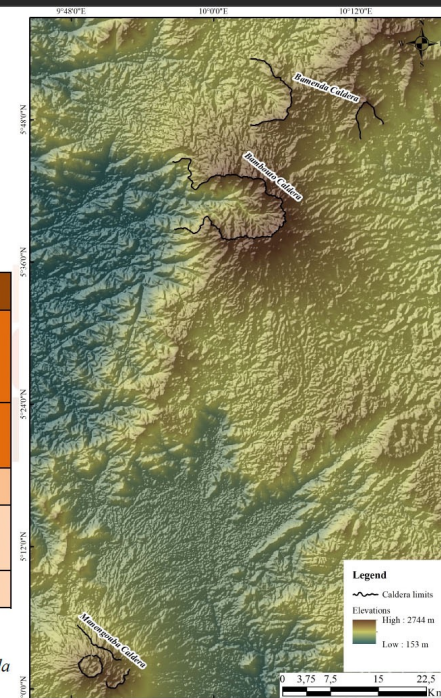


Fig. 1- Cameroon Volcanic Line

Introduction...

Calderas	Volcanoes	Sizes
Elegoum	Manengouba	7 to 8 km in diameter
Eboga		4 to 5 km in diameter
Bambouto	Bambouto	16 × 8 km
Lefo	Bamenda	3 to 4 km in diameter
Santa-Mbu		10 × 5 km

Fig. 2- Location of Manengouba, Bambouto and Bamenda Volcanoes



Introduction...

**Aim of the study**  
Studying the geodiversity of the Manengouba, Bambouto and Bamenda calderas in order to highlight their ecosystem services.

## Method

### Bibliographic Research

Intensive search of existing literatures on the concept of geodiversity and its ecosystem services

### Field

Inventory of geodiversity elements

Determination of different ecosystem services using the Classification of Gray (2013), modified by Brilha et al., 2018)

Discussions with the respective population of each caldera

### Lab

Results analysis

Mapping

Interpretation



## II. Ecosystem services

### II. 1. Regulation services

#### Role in regulating the Climate



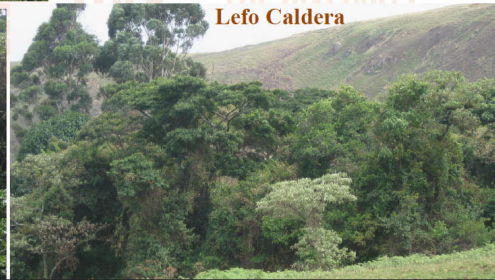
Manengouba Calderas



Bambouto Caldera

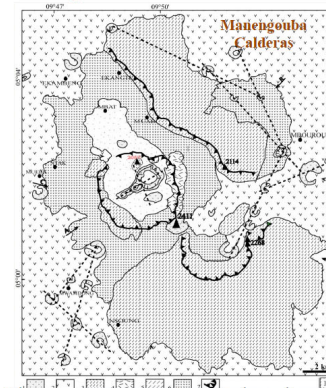


Santa-Caldera Caldera

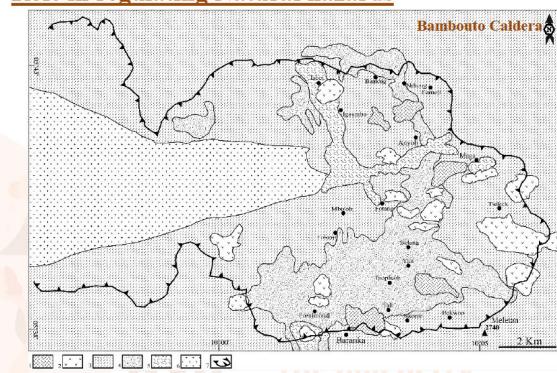


Lefo Caldera

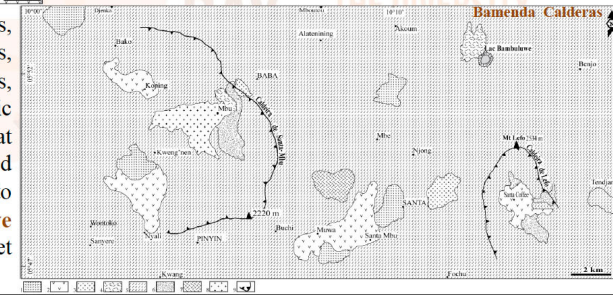
### II. 1. Regulation services...



### Role in regulating Natural hazards



The presence of basalts, mugearites, benmoréites, dolerites, trachytes, phonolites, ignimbrites, pyroclastic projections,... stipulates that these calderas have been marked by **volcanic hazards** related to **explosive** and **effusive eruptions** (Zangmo Tefogoum et al., 2014).

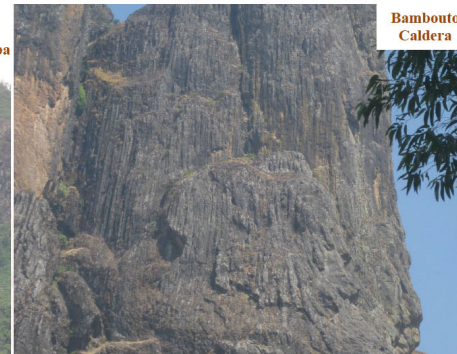


### II. 1. Regulation services... Regulating Natural hazards...

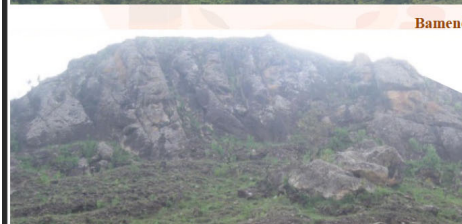
#### Outcrop in Columnar Joints



Manengouba Caldera



Bambouto Caldera



Bamenda Calderas



### II. 1. Regulation services... Regulating Natural hazards...

#### Tick weathering materials



Manengouba Calderas



Bambouto Caldera

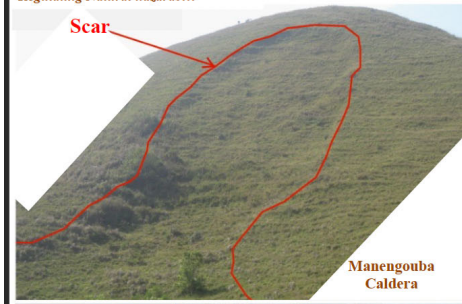


Bamenda Calderas



II. 1. Regulation services...  
Regulating Natural hazards...

## Landslides



Manengouba Caldera



cultures

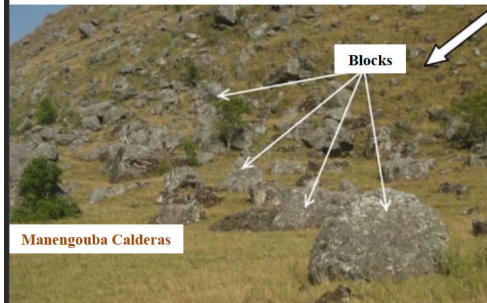
II. 1. Regulation services...  
Regulating Natural hazards...

## Landslides

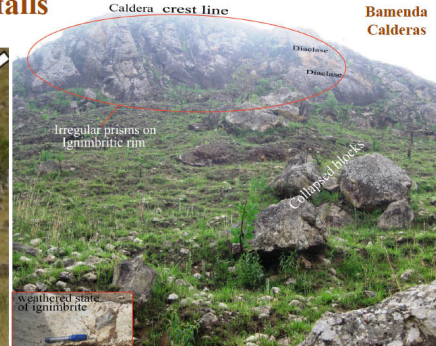


II. 1. Regulation services...  
Regulating Natural hazards...

## Rockfalls



Manengouba Calderas



Irregular prisms on ignimbritic rim

weathered state of ignimbrite

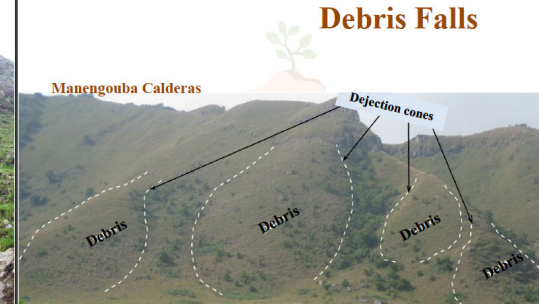


Bambouto Caldera



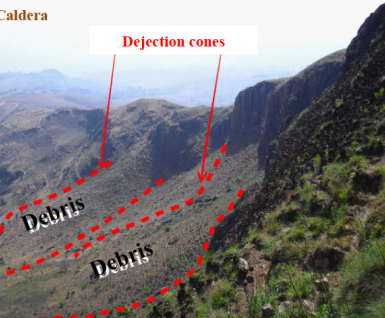
II. 1. Regulation services...  
Regulating Natural hazards...

## Debris Falls



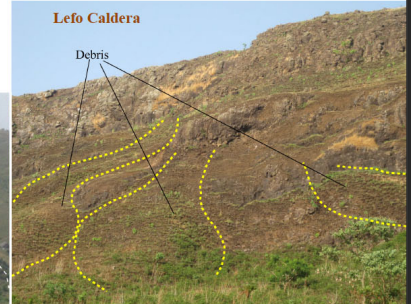
Manengouba Calderas

Dejection cones



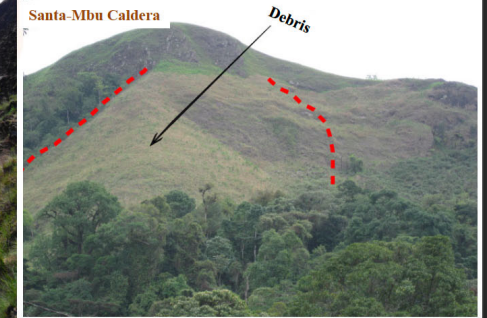
Lefo Caldera

Dejection cones



Lefo Caldera

Debris



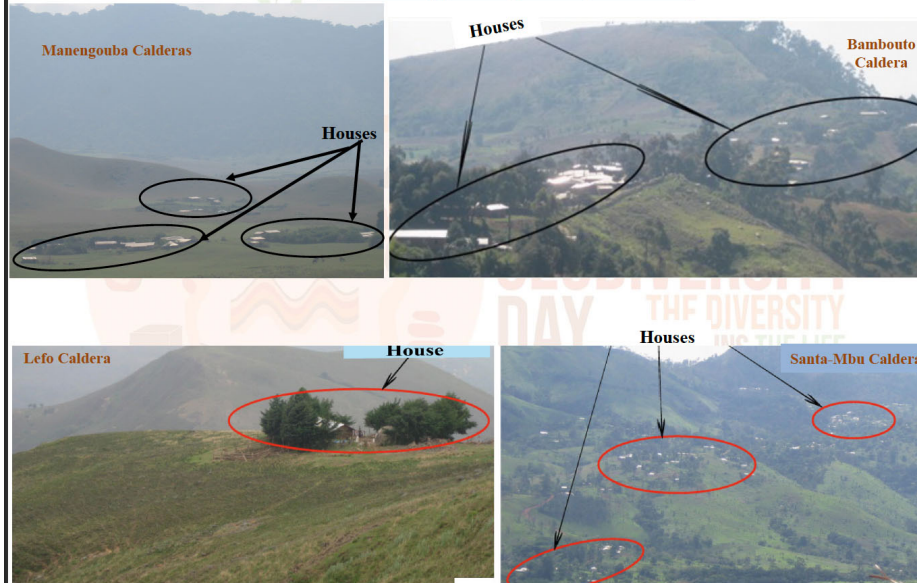
Santa-Mbu Caldera

Debris



## II.2. Supporting services

### Role in supporting lives (Habitats)



### Role in supporting human activities

#### Agriculture



#### Breeding

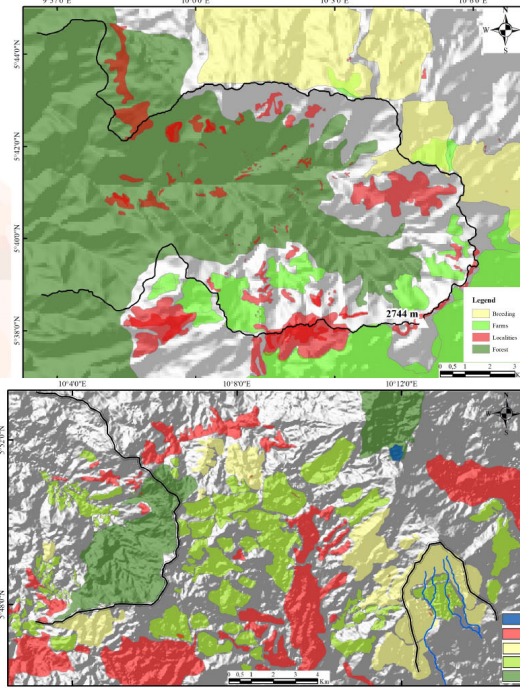
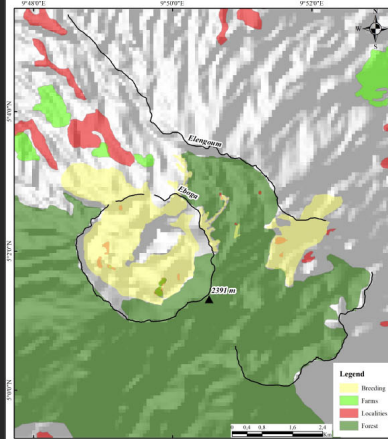




## II.2. Supporting services...

Supporting human activities...

Location of human settlement and activities in the calderas

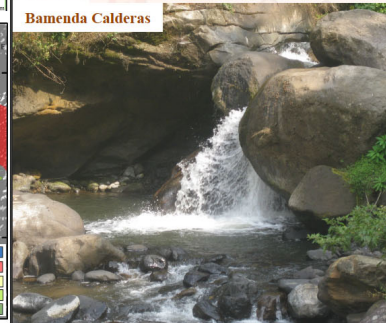


## II.2. Supporting services...

Bambouto Caldera



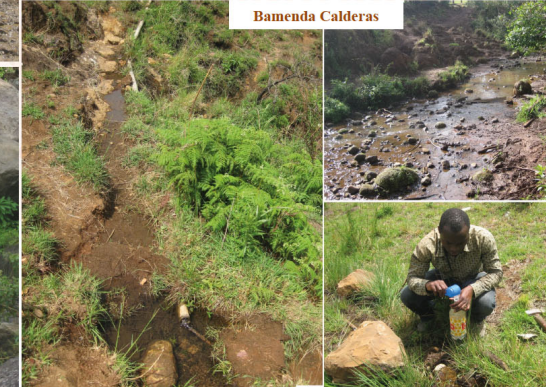
Bamenda Calderas



## Water Supply

The **waters** of natural sources found in the calderas used as **drinking water** by the **livestock** and **population**.

Bamenda Calderas



## II.2. Supporting services...

Water Supply...

### Calderas as Water Towers

For example, the overflow of the Manengouba Lakes is evacuated through an **outlet** (North-western slopes of Eboga Caldera) and is used to **refuel the city** of **Bangem** and **other villages**.



## II. Ecosystem services...

### II.3. Provisioning services

Some **frames**, **doors** and **windows** of houses and, even **bridges** are made of **wood** from the neighboring forest (s). The **Walls** and **foundations** are built with rocks. Moreover, many houses are built by **earth bricks**.

Bambouto Caldera



Manengouba Calderas



Bamenda Calderas



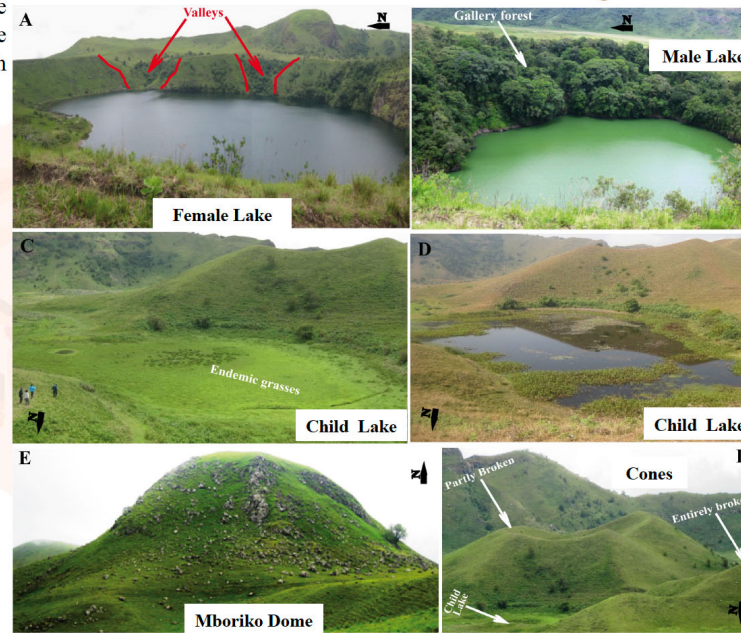


## II. Ecosystem services...

The three calderas are endowed with exceptional geomorphosites.

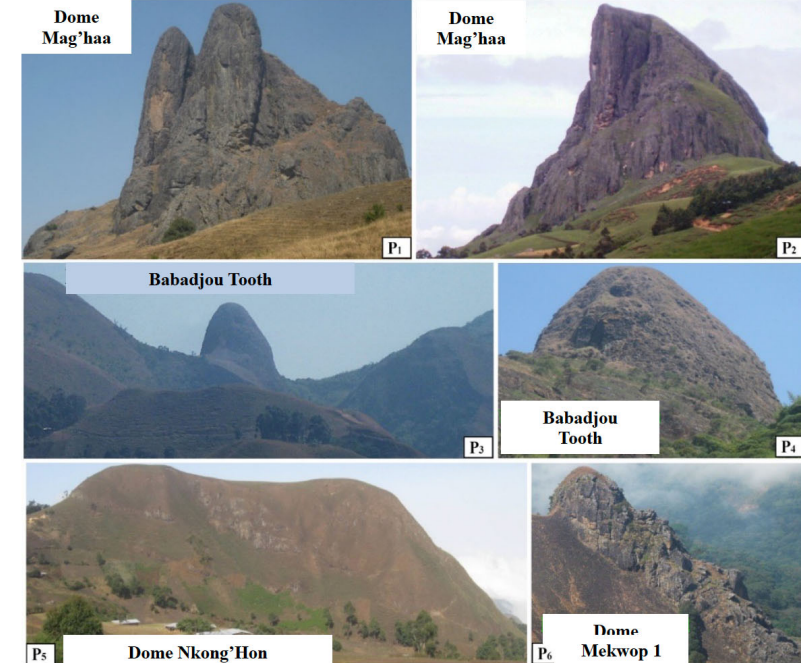
## II.4. Cultural services

### 1- Manengouba Calderas



## II.4. Cultural services...

### 2- Bambouto Caldera



## II.4. Cultural services...

### 3- Bamenda Calderas



## III. Discussion

Volcanism plays an important role for human communities, as volcanic forms are a component of the **cultural heritage of a people** (Dóniz-Páez et al., 2010).

In the study plot, some sites have a **strong cultural value** (Zangmo Tefogoum et al., 2017, 2020) which leads many families to make **sacrifices** for the purification and protection of their descendants and for **pilgrimage** to manifest their religious faith. Furthermore, through their **agropastoral potentials**, the calderas offer **employment opportunities** to many families.

For instance, agropastoral activities in each caldera generate nearly **several hundred million CFA francs** per year. Thus, these calderas help to **fight hunger** in local families and those in other regions of Cameroon and other Central African countries (Zangmo Tefogoum et al., 2009, 2011, 2014). They contribute to the **fight against the rural depopulation** that affects many regions of Cameroon in that, they allow many families to settle down.

According to Kagou Dongmo et al. (2005), Zangmo Tefogoum et al. (2009, 2014) Geodiversity components push people to conquer the green space all year round. This leads to:

- **Tribal conflicts between herders and farmers**



### III. Discussion...

- The overexploitation of natural resources  
Growing deforestation



### III. Discussion...

- Occupation of risk areas



### III. Discussion...

#### Destruction of geomorphosites-opening of quarries



### III. Discussion...

- Triggering of mass movement

#### Opening of roads on steeper slopes





### III. Discussion...

As demonstrated by Zangmo Tefogoum et al. (2015, 2019, 2020 & 2021), the three calderas are endowed with **exceptional geomorphosites** with quite high **scientific** and **additional** values, making them real **geotouristic**, **recreational** and **geoeducational** destinations.



### Conclusion

The geodiversity of the Manengouba, Bambouto and Bamenda calderas offers multiple ecosystem services including **regulation**, **supporting**, **provisioning** and **cultural** ones. Thus, these calderas play an important role in the **balance of the ecosystem**.

They favour **human activities** and ensure the **sustainability of human and animal species** because it favours the settlement of man and offer him several assets for his blossoming such as the construction of their **habitat**, **roads** and other **infrastructures**; **agro-pastoral activities** that ensure a healthy social and economic life; **geo-education** as it is a **natural laboratory** for research and **training** of early career scientists and, **recreational activities** and **geotourism**.

These caldera are essential for **social stability** and should be given attention by the **Cameroonian decision-makers** for their **protection**, **promotion** and **sustainable management**.

### III. Discussion...

According to Gray and Gordon (2008) there is a need for conservation since geodiversity is made up of values, but may also be threatened. Unfortunately, the majority of geodiversity elements in the study areas **do not benefit from legal protection** despite **anthropogenic threats** to their **integrity**. However some efforts are made by **local people** through the **building of a fence** around the geosite-Dome Mag'haa.



Thank  
You

