

Integrated Water Resources Management on the Southern Slope of the Bamboutos Mountains: Issues Related, Challenges and Prospects

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Abstract

This research on water resource management was carried out on the southern slope of the Bamboutos Mountains. The main objective of this study was to contribute to a better knowledge and understanding of the problems related to the exploitation of water resources on the southern slope of the Bamboutos Mountains in the hope of finding appropriate management strategies. More specifically, it was a matter of identifying the stakeholders involved in the exploitation of water resources on the southern slope of the Bamboutos Mountains, identifying the problems related to the exploitation of water resources on the said slope, determining the causes and consequences of the problems related to the exploitation of the said resource and finally identifying the strategies, as well as their strengths and weaknesses used by local populations to manage the problems related to the use of water resources. Access to secondary data, and semi-structured surveys allowed the study to be conducted. This study shows that the main actors involved in the exploitation of water resources are farmers, households, industries and finally ranchers. The main problems related to the exploitation of the resource on the said slope have been identified as: conflicts of use (48.60%), water-related diseases (21.30%), distance (18%) and finally the scarcity of the resource (11.90%). These problems have as their causes and consequences respectively: overexploitation of the resource (47.30%), climatic variations (21%), pollution of watercourses (30.40%), struggle between users (54.97%), difficulty of supply (20.50%), and decline in both agricultural and domestic activities (24.53%). In order to solve these problems, local populations have developed strategies ranging from agreement to friendly resolution of conflict problems, construction of health centers for waterborne diseases and construction of alternative and closer supply points to solve distance problems. Despite all these measures, these populations are still struggling to cope with problems that affect their daily well-being.

Keywords: water resource; stakeholder; watershed; management strategy.

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1. Background information

Water is unquestionably a major challenge for sustainable development. Without progress in the water sector, it will be difficult if not impossible to achieve the other Millennium Development Goals (MDGs). According to [1] in more than 40 countries, more than 2 billion people are affected by water shortages: more than 1 billion lack safe drinking water and 2.4 billion lack adequate sanitation. Similarly, according to [2]. More than 40% of people without access to safe drinking water live in sub-Saharan Africa, with about 1.4 million children under five dying each year from diarrhoeal diseases; this represents nearly 15% of global mortality in this age group. If current projections are met, by 2050 at least one in four people will live in countries affected by chronic or recurrent freshwater shortages. It is in the same vein that the *Stockholm Environment Institute* has estimated that the proportion of the world's population living in areas of high water stress will have increased from about 34% in 1995 to 63% in 2025. Those living in the poorest countries of Asia and Africa, with low and random rainfall and high water use, are particularly vulnerable to the adverse effects of water stress on their lives and their sources of income. Confronted with the combined pressures of accelerated demand growth and continued deterioration in water quality, past management models are no longer sufficient to meet demand; it is now necessary to move beyond the technological mirage and radically rethink approaches that will satisfy human needs while maintaining the quality of the natural ecosystems that support the very existence of the human community [3]. Many developed countries have understood this and have taken concrete actions to manage their water resources efficiently [4]. Indeed, they have multiplied their actions and strengthened their political and economic commitments towards the implementation of existing measures, plans and laws in the water sector. In this regard, we can mention in the case of European countries, the implementation of the Water Framework Directive (WFD), the establishment of structures such as the International Office for Water (IOWater), the Group of European Basin Organizations (EUROPE-INBO), etc. The Cameroonian State, for its part, is striving to put in place appropriate frameworks for this policy in the water sector, including the following:

Legislative framework:

- Law n°98/005 of 14 April 1998 on the water regime,

At the institutional level, Cameroon has set up ministries and agencies working in the water sector, including the following:

The Ministry of Mines, Water and Energy; the Ministry of Territorial Administration and Decentralization; the Ministry of Environment, Nature Protection and Sustainable Development; the Ministry of Agriculture and Rural Development; the Ministry of Fisheries and Animal Industries, etc. Technical support and advisory organizations represented by the national water committee.

On the regulatory level, we can mention:

- Decree No. 2001/161/PM of 8 May 2001 establishing the attributions, organization and functioning of the national water committee, At the international level, Cameroon has signed and ratified several international conventions on water issues. These include, among others:

➤ The African Convention for the Conservation of Nature and Natural Resources or the Algiers Convention of 1968;

The disparities observed in both the mechanisms for allocating water resources and their quality are indicative of the challenges faced by Cameroon in its quest for appropriate water resource management. It also mentions in this register the need to satisfy an ever-increasing demand, the protection of the environment, and compliance with regional and international obligations. The management of water resources in Cameroon suffers from poor governance, the fragmentation of its institutions, and the absence of a proactive policy that is firmly oriented towards improving the water resource. This management is changing as political, social, economic, cultural and environmental changes take place, which seriously hamper its coherent implementation in the long term. As a result, water resources are nowadays facing increasing degradation and exploitation in the face of increasing demand, which creates problems between the different interest groups that use the resource. With the scarcity of water resources, the effects of climate change and the exponential increase in freshwater needs, competition around the resource is increasing. In Cameroon, the Western region is the most concerned first, because of the already perceptible pressure on natural resources, then because of the increase in temperature, causing a strong evaporation of surface water, and finally because of the importance of the agricultural sector for a large part of this region. These developments will have a significant impact on the productivity of the agri-food sector and, subsequently, on the import of basic foodstuffs [5]. For more than two decades, agricultural and societal water challenges in the mountains of West Cameroon have intensified, due to the development of intensive market-based agriculture by rural and returning migrants, and diversified in order to respond to the increase in inter and intra-seasonal climate variability. Despite the efforts of market gardeners and ranchers to adapt their agricultural and pastoral practices to a decrease in water resources, neighborhood conflicts have multiplied between these different consumers. It is especially in the dry season (December to February), when rivers are at low water levels and in the event of occasional severe drought, that conflicts over access to and use of water intensify. This situation is all the more paradoxical as the area has strong hydrological and water potential and has a marked orographic effect of rainfall, with more than 2000 mm of rainfall per year on the southern slopes of the Bamboutos Mountains. These problems can sometimes go as far as the destruction of market plots and the loss of livestock for Fulani ranchers or the death of certain protagonists (conflict between the chiefdoms of Fongo-Tongo and Bafou) [6]. Today, we are already witnessing uprisings in some localities in the region, such as the northern part of Bafou, due to insufficient drinking water supplies, clashes between farmers and nomads or disputes between different irrigation water users. The major importance of water for human development and agricultural income explains the risk of such conflicts: restricted access to the resource often means a deterioration in living conditions. The general objective of this study is to contribute to a better knowledge and understanding of the problems related to the exploitation of water resources on the southern slope of the Bamboutos Mountains in the hope of finding appropriate management strategies.

More specifically, it will be about:

- ✓ Identifying and analysing the stakeholders involved in the exploitation of water resources on the southern slope of the Bamboutos Mountains;
- ✓ Inventorizing the problems related to the exploitation of water resources on the said slope;

- ✓ Determining the causes and consequences of problems related to the exploitation of this resource;
- ✓ Proposing a strategy for sustainable water resources management.

2. Method

a) Study area

The study is carried out in the Bafou village, more precisely in the northern part located in the Menoua division, the Nkong-Ni district, the Nkong-Zem municipality between 5° 28' 00" north latitude and 10° 07' 00" east longitude, the village has an area of 190 km² with a population of nearly 100 000 inhabitants and a density of 526 inhabitants /km². The border villages of Bafou are: Bangang, Baleveng, Bamendou, Fotomena, Foto, Fongo-tongo, Fosimody and Bamoubock.

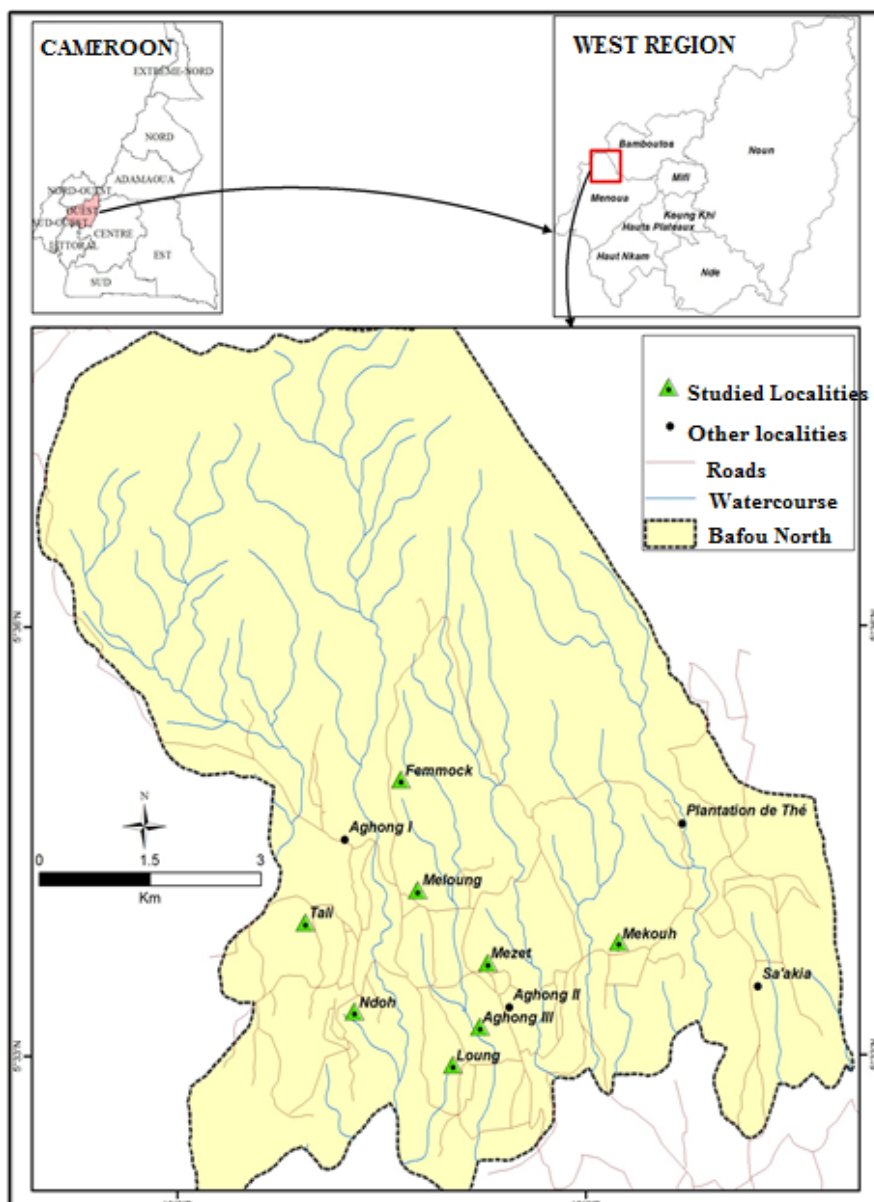


Figure 1: Biophysical characteristics

3. Data types and sources

The data collected were of two types: secondary and primary data.

a) *Secondary data*

Secondary data consists of information from published books, scientific articles, dissertations and any other document of varying degrees of interest to the topic under study. These data were collected from sources such as libraries, including those of the University of Dschang, the Department of Forestry of the Faculty of Agronomy and Agricultural Sciences' of the Global Water Partnership, etc. and from the Internet.

b) *Primary data*

Primary data are information collected in the field. They provide information directly from the studied population [7]. For this study, primary data were collected using survey frames, semi-structured interview guides and group discussions.

c) *Sampling techniques:*

To collect the relevant data, the cluster sampling technique was used. This technique is carried out in several steps, ranging from more general to more specific units. Indeed, the Nkong-Ni district, the general unit is composed of two (02) villages: Bafou and Baleveng. At the district level, the cluster unit is the quarter and for our study area, which is the Northern part of Bafou, we have carried out seven (07) out of seventeen (17) clusters. Thus, out of the 17 quarters of the study area 7 were visited for a sampling rate of 41%. The choice of quarters was made in a non-random way because the quarters where agricultural activity is most practiced and the presence of watercourses were taken into account in this choice. The choice of respondents was made randomly, with a total of 349 people interviewed, representing a rate of 12.16% of the total population. All respondents, accessible to varying and diverse degrees, were contacted taking into account the type of information sought.

4. Results and Discussions

a) *Identification and analysis of stakeholders*

The Stakeholders identified in our study are grouped according to their level of intervention and the types of uses made of the resource.

- *Types of stakeholders:*

Two types of stakeholders were identified in the framework of our study, namely:

Primary stakeholders: farmers, ranchers, industrialists, households.

Secondary stakeholders: public services

b) Level of intervention:

In this context, stakeholders have been classified into several categories:

c) Water supply and sanitation, agriculture and livestock, information and communication

Table 4: Stake holder analysis

Stakeholders	interests/activities	Risks/assumptions
MINADER	Irrigation water supply for agricultural purposes	
MINEPIA	Ensure efficient water management and animal supply	Government policy promotes the impact of livestock on water resources
Cameroon Tea Estates (CTE)	Watering and cleaning of tea	Pollution of surrounding watercourses
Elevage promotion Afrique (EPA)	Livestock watering	
GTZ	Formation, agricultural credit, technical support	
farmers	Availability of water and sufficient quantity for irrigation	Overexploitation of water resources, particularly in the dry season for irrigation, which could reduce the amount of water available for other users
Yemba Radio Station, village associations, churches	Dissemination and management of local information	
Nkong-Zemunicipality	Train members of the local water resources management committee	

5. Identification of problems related to the exploitation of water resources

a) Water supply sources

Figure 2 shows the distribution of different water supplies by local populations.

The populations of the Northern part of Bafou are supplied from four basic sources. These are mainly watercourses, boreholes, wells and cisterns or rainwater harvesting.

This figure shows that 55% of people involved in the exploitation of water resources are supplied by watercourses (source, river) while 22.50% are supplied with water through wells, 17.60% are supplied by boreholes, and only 5.90% use cisterns or rainwater harvesting. The investigations revealed that the uses made of the water resource through boreholes, wells, cisterns or rainwater harvesting are essentially domestic (drinking water supply, laundry, bath, etc.).

The attraction of local populations to rivers as the main supply point could be at the root of the various problems related to the use of water resources observed in the area.

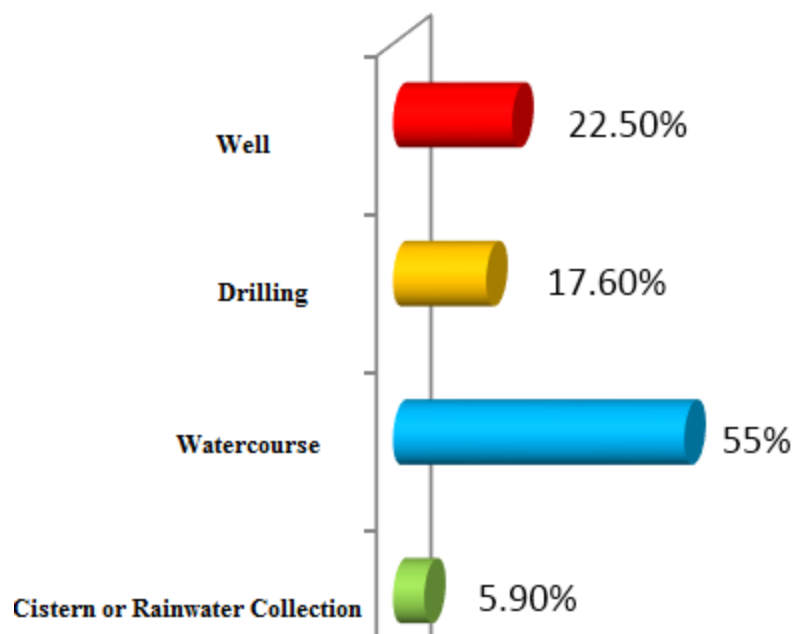


Figure 2: Different sources of water supply

b) Problems related to the exploitation of water resources

Figure 3 presents the various water resource development issues identified in the study area.

It appears from this figure that 48.60% of respondents state that the main water-related problem in the village is that of conflicts between different users, while 21.30% state that they are water-related diseases, 18.20% mention the case of distance for supply and only 11.90% mention the scarcity of this resource.

Indeed, global warming increases the scarcity of this water through rapid evaporation. As a result, farmers, herders and households are rushing to other water resources such as dams, watercourses, water bodies, etc., creating excessive pressure, which is a source of various social conflicts. These are often conflicts without confrontation but often lead to social divisions, hatred between communities.

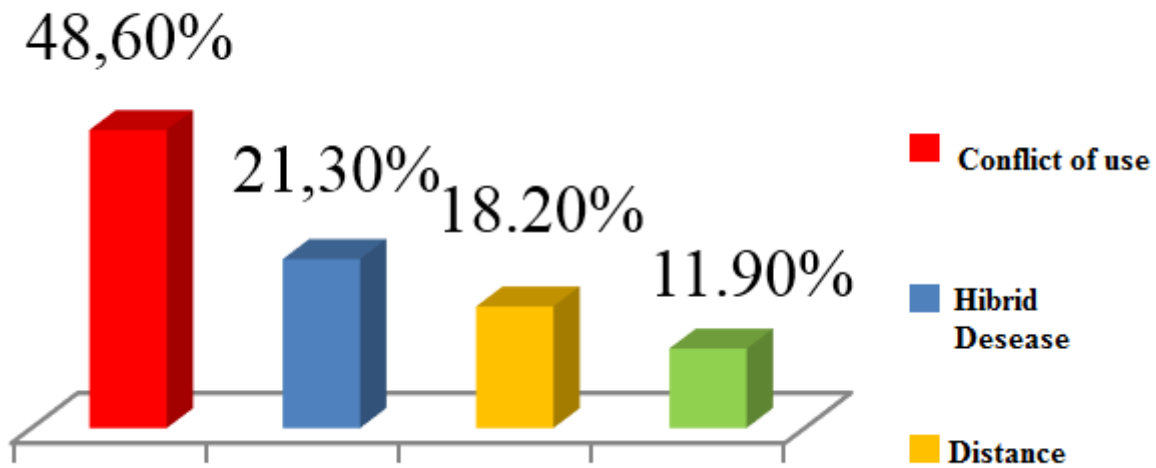


Figure 1: Problems related to the exploitation of water resources

6. Conflict of use

Reference [8] noted that conflicts over the management of natural resources (land, water, forests, etc.) have become more frequent and difficult to manage in humid rural areas in recent years. Very often spatially limited, dry season market gardening areas are all the more sought after because they are profitable, and because their production partially offset the income from products sold in the rainy season and the concomitant decline in domestic budgets [9]. Water thus generates situations of competition, at the origin of conflicts between ranchers and farmers or the latter between them; actors with divergent interests, but often forced to share the same water point.

a) *Conflicts between farmers*

Competition for access to and control of water sometimes appears, in the field, in the form of the concentration of many irrigation pipes (more than twenty) belonging to several farmers around a single water point. In this configuration, some farmers may even divert the pipes or steal them. These acts are at the root of disputes and enmities between farmers and result in the systematic destruction of the respondent's crops and pipes.

b) *Conflicts between farmers and ranchers*

As [10] pointed out, over the years, the general spread of crops and the growing hostility towards Fulani ranchers on behalf of Bamiléké farmers have gradually erased pastoral landmarks. The failure to respect the demarcation line between the agricultural and pastoral space established at an altitude of 2,000 m, the transhumance movements carried out by ranchers and the movement of farmers in search of water lead to conflicts that are sometimes open [8]. To mark their hostility to the occupation of pastures, ranchers allow their animals to enter farms to drink from water reservoirs set up by farmers. This use often leads to the destruction of fences and crops [9]. These individual confrontations multiplied in the 1990s with the rise of out-of-season

market gardening. They have sometimes turned into community conflicts (market gardeners, farmers, pastoralists). Reference [11] pointed out that from 1982 to 1985, more than 100 agropastoral conflicts were brought to the attention of the Djuttitsa Chief of Agricultural Workstation. Between 1995 and 2005, some 30 conflicts - involving the destruction of pens around cultivated areas, irrigation systems and the burning of fertilizer bags belonging to farmers, the burning of cattle camps, systematic slaughter, theft and poisoning of animals (by dumping toxic products into areas where cattle are fed) by farmers.

c) Conflicts between producers and households

Over-consumption of water at high elevations causes severe shortages below on the tray, so that modern gravity-fed water supplies are sometimes empty. The collection of drinking water is becoming very problematic for downstream households, not to mention the risk of potential contamination due to overdose of agricultural inputs. In response, the inhabitants of the foothills are sometimes forced to go and break the dikes on the mountain.

d) Waterborne diseases

Drinking water meets certain standards defined by the WHO according to the chemical and bacteriological elements it contains. Some of these elements are useful or even essential to human health if they are at low concentrations, but can become toxic at high concentrations. For example, too low concentration of iodine is responsible for thyroid disorder. There is also evidence that high sodium intake plays an important role in the development of hypertension in susceptible individuals. Some elements can in excessive quantities give the water an unpleasant taste (iron, chloride, sulphate, copper), causing people to turn away from the drinking source to use a potentially dangerous supply. The water-related diseases recorded during our interviews with the population are either due to agricultural products used upstream of rivers or to the lack of maintenance of water points because 80% of respondents say that there is no maintenance of their water supply point.

e) The distance

If we refer to the typology of [12] according to which reasonable or relatively good accessibility to water is defined as having a drinking water point 100 meters away, we find that the majority of people in the Northern area of Bafou travel a distance of between 1-5 km to obtain water for household use, agriculture or livestock watering. In short, access to water is not at all easy for the people of the Northern area of Bafou.

f) Water scarcity

The water needs of agro-pastoral activities in the dry season encourage active people to migrate to the banks of rivers and hydromorphic valleys, which are also coveted by ranchers who descend from the mountains (EPA breeders). Little by little, water has become scarce and this is undoubtedly paradoxical in this well watered area. Several factors may be at the origin of this scarcity of water resources in the village, but the most important one mentioned by the populations is: Inter- and intra-seasonal climate variability

7. Causes and consequences of problems

a) The causes of the problem

Figure 4 shows the distribution of the causes of the problems encountered in the study area. It can be seen from this figure that 47.30% of respondents say that the primary cause of the problems is the overexploitation of the resource. While 30.40% and 21% respectively say that the problems encountered come from watercourse pollution and climate variations, and only 1.30% do not propose any cause of these problems this can be explained by their low level of education. The causes of the problems related to the use of water resources are said to be due to the fact that: either the majority of the population practices agriculture by irrigation (54.40%), which requires a significant use of resources, or to the decrease in the water resource in our study area, or to the eucalyptus plantations of the Cameroon Tea Estate, which dates back several decades and is estimated at several hectares. These results are confirmed by the information gathered from CTE officials who estimate their annual water needs at nearly millions of cubic meters per year and acknowledge, among other things, that over time the resource is in decline and this in a considerable way, they also affirm that eucalyptus plantations in the area could be one of the major causes. The comments collected from CTE officials show us that climate variations are one of the main causes of the problems observed, which confirms those obtained from local populations. All these causes of the problems listed cannot be without consequences for both water users and water resources users.

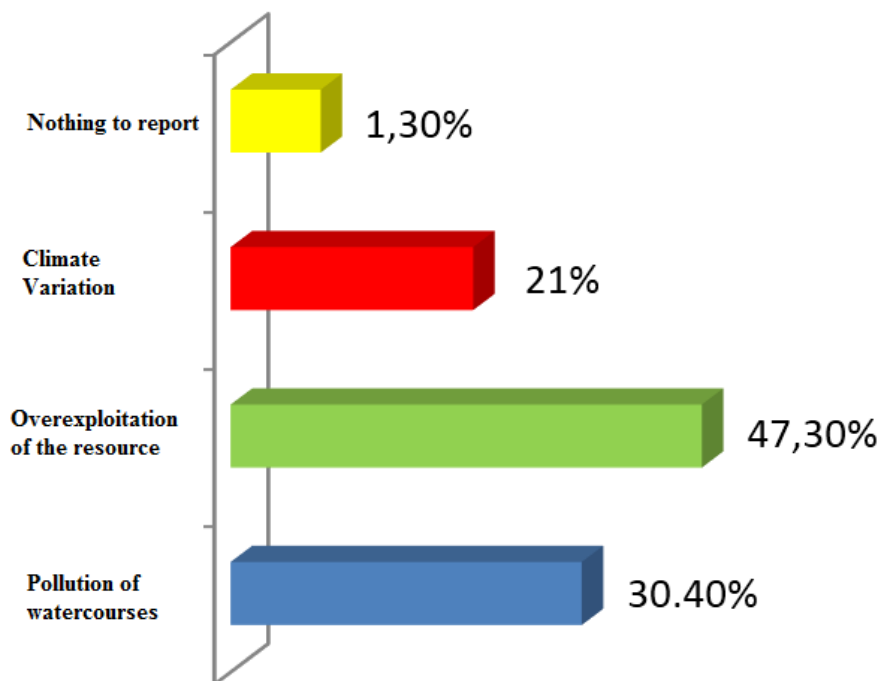


Figure 4: Causes of problems encountered

b) Consequences of the problems observed

It can be seen from Figure 5 that, the struggles/querrels between primary stakeholders represent the most

frequently reported consequence by local populations with a workforce of 54.97% followed by the decrease in activities 24.54% and the supply difficulties 20.50%.

These observations show us that the consequences of the problems related to the exploitation of water resources stem from the fact that there is an increased demand for irrigation water, especially in the dry season, by stakeholders, especially farmers.

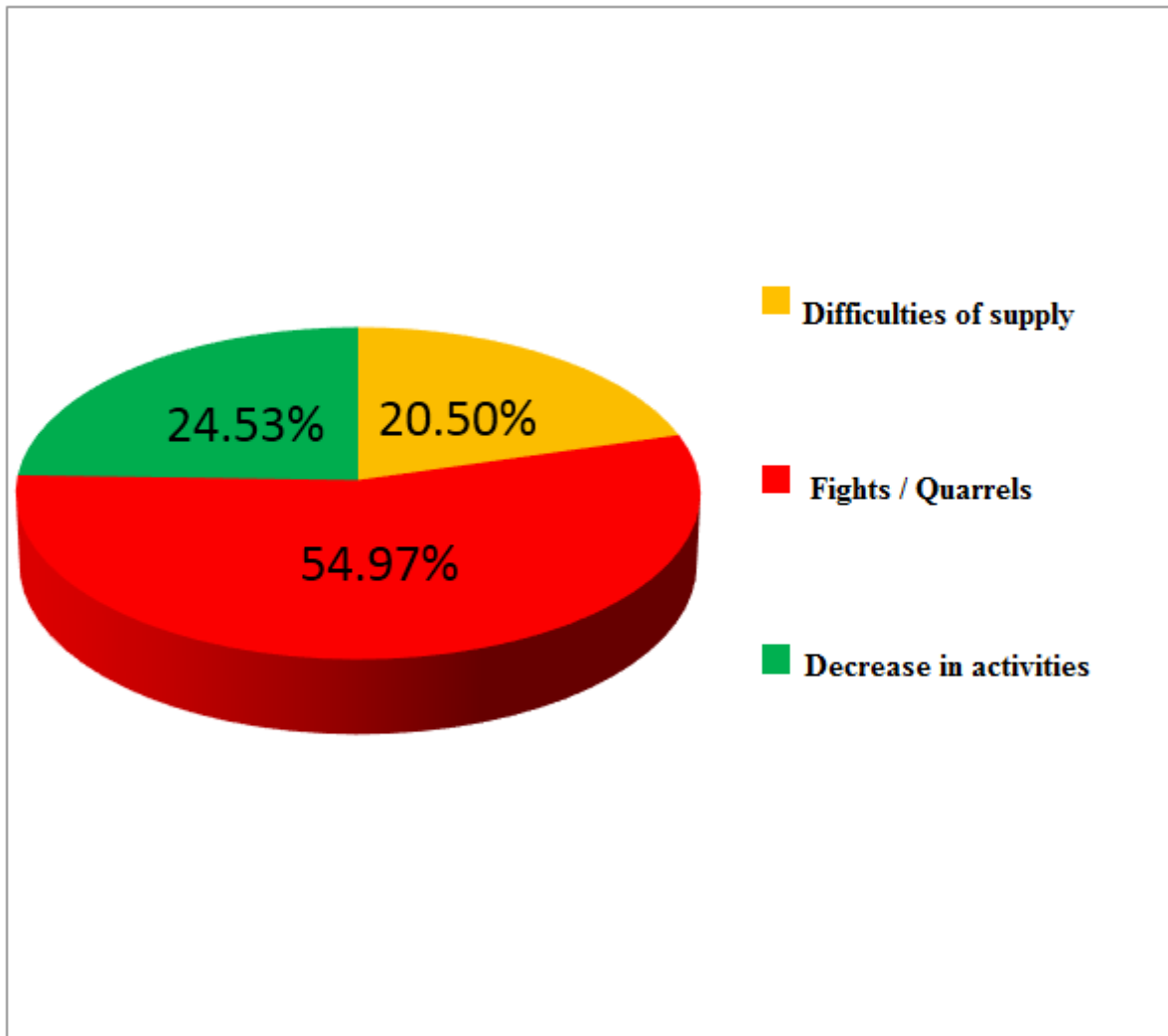


Figure 5: Consequences of the problems

8. Proposal of strategic management lines of action

Given the proposals made by the different water users for the resolution of the various problems observed, an integrated management approach is the most appropriate because it is the strategy that could help to resolve management conflicts and ensure the protection of water resources in the village. This study has developed and proposes solutions requiring the support of the State and the involvement of primary stakeholders, and is based on the intervention approach presented in the following table:

Table 3: Proposals for a strategy for the sustainable management of water resources

	Intervention approach	Indicators	Source of verification	Risks / Assumptions
Overall Objective	Contribute to the sustainable management of water resources in order to ensure social equity, economic development and slope protection	- Availability of water for domestic use, irrigation, livestock watering, Presence of water points	-Report of municipal officials NGO; -Observation.	Collaboration of local populations, availability of funds
Specific objective I	Perform a stakeholder analysis	- percentage of different stakeholders involved in planning, implementation and decision-making in water resources management	- Annual report of the authorities in charge of water resources management - attendance at the various meetings	Collaboration of all stakeholders
Activities	Identify the different stakeholders in the water sector - identify their needs/interests and available resources - highlight mechanisms for stakeholder coordination and participation			
Results	- social equality, conflict prevention, facilitating the enforcement of decisions - more participation of vulnerable groups of stakeholders (women and youth)	Percentage of participation of different stakeholders percentage of participation of women and young people	Annual report of the authorities in charge of water resources management	

Specific objective II	Prioritize water resource-related issues	<ul style="list-style-type: none"> - numbers of people who travel long distances to fetch water - number of fireplaces and departments with free-flowing fire hydrants - number of conflicts identified 	<ul style="list-style-type: none"> - Annual report of the authorities in charge of water resources management - report on the workshops 	Availability of funds; collaboration of all stakeholders
Activities	<ul style="list-style-type: none"> - Organize workshops for stakeholders to identify and prioritize issues - propose solutions - take action 			
Results 2	- prevent the waste of resources, find appropriate solutions to different problems, sustainability of the resource			
Specific objective III	Show the impact of climate change on water resources	<ul style="list-style-type: none"> - Number of hectares of land reforested - number of water retention points that have been protected - number of farmer groups trained in good farming practices - number of farmers using organic matter 	<ul style="list-style-type: none"> - forest inventory, - registration of farmers at district level - registration of authorities in charge of water resources management 	<ul style="list-style-type: none"> - Availability of funds - legislation and political will - educate the local population - collaboration of all stakeholders
activities	<ul style="list-style-type: none"> - Plant trees around water distribution points - develop good pastures - introduce intelligent agriculture - educate and communicate 			
Results	<ul style="list-style-type: none"> - Increase of infiltration and surface water - erosion reduction -reduction of the invasion of cultivable land and water points for animals 			

	-reduction of conflicts between farmers and herders			
Objective IV	Determine the water needs of users in a distribution point	Number of subscribers, standpipes in households, services and neighbourhoods, number and irrigation area of plantations	Annual report of the authorities in charge of water resources management	Availability of funds - legislation and political will - educate the local population - collaboration of all stakeholders
Activity	Water quantity assessment - educate and communicate			
Result	Prevention of waste - water availability for all users - reduction of conflicts between users and authorities in charge of water resources management			

9. Conclusion

From the data collected and the results obtained, conclusions emerge at the end of this study, which aimed to contribute to a better knowledge and understanding of the problems related to the exploitation of water resources on the southern slope of the Bamboutos Mountains: indeed, the southern slope of the Bamboutos Mountains has many problems related to the exploitation of water resources, including conflicts of use, distance, water-related diseases and finally the problems of scarcity of this resource. It should also be noted that the study revealed that the stakeholders involved in the exploitation of the resource on the said slope have been identified at the primary (farmers, ranchers, households) and secondary (public authorities) level are mainly farmers and households.

The causes of the problems listed are mainly due to overexploitation of the resource, climatic variations, pollution, lack of knowledge of techniques for collecting, conserving and managing watercourses. As a result of these causes, we have struggles/queries between the different users, difficulties in water supply and the decline in agricultural, household and livestock activities.

Local strategies for the management of water-related problems and their strengths and weaknesses have been identified. Through this analysis, we understand that the actors involved in the exploitation of water resources in our intervention zone have many assets in their favor, and strengths that could strengthen their action in terms of managing the various problems they encounter. But there are still weaknesses that hinder their expansion and even their total fulfillment.

To address these problems with a view to promoting good water resources management, the most effective solution seems to be integrated and participatory management at all levels by all stakeholders. However, it is quite difficult in practice to succeed in establishing such a management system in a context of increased poverty and permanent conflict between socio-professional groups.

Acknowledgement

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