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Raphia Palm Grove Diversity and Wetland Conservation Challenges: Evidence from Fotouni in the Western Highlands of Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. Author PNK designed the work, conducted the survey in the field and contributed to literature searches. Author ADGF wrote the protocol and did the mapping. Author DBNK did the statistical analyses and wrote the manuscript. All the three authors have read and approved the content of the manuscript.

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ABSTRACT

Aims: Assessing the conservation status of Raphia and the interaction between local populations and Raphia palm groves in Fotouni
Study Design: Descriptive Cross-Sectional
Place and Duration of Study: The study was carried out in the West Region of Cameroon (Fotouni)
Methodology: A total of 60 Raphia palm grove owners were involved in the interview using questionnaires; mapping and direct observations were additional tools.
Results: According to the perception of 93% of the surveyed respondents, the quantity of Raphia in the area has decreased over the past 15 years, due mainly to agriculture (N=48; 80.00%) and non-regeneration (N=18; 30.00%). Farming was the main activity in the area. Raphia in the area is

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mainly used for building, craft, food source, medicine and agriculture. Respondents confirmed the presence of a diversified mesofauna in Raphia palm groves, dominated by rodents. Mapping gave evidence of a close relationship between Raphia palm groves and water points. In addition, *Raphia* provides firewood and wine. Good maintenance (N=55; 91.67%) and regeneration (N=45; 75.00%) are the main strategies implemented by the respondents to preserve their Raphia palm groves. For a long-term preservation, respondents proposed: sensitization (N=14; 23.33%), re-planting (N=20; 33.33%), pasting of warning and use of fetishes (N=16; 26.67%).

Conclusion: The current state of Raphia palm groves in Fotouni is not favourable to wetland conservation. The Ministry of Environment, Nature Protection and Sustainable Development should provide a national inventory of Raphia coverage while the local population should adopt healthy behaviours towards the exploitation of Raphia.

Keywords: Interviews; mapping; western highlands.

1. INTRODUCTION

The Raphia palm grove is of great ecological and economical importance [1-2]. Officially classified as wetlands, hence, under the protection of The Ministry of Environment, Nature Protection and Sustainable Development [3], Raphia palm groves are gradually occupying a central position in international environmental policies [4]. The genus *Raphia* (Arecaceae) is highly diversified with over 20 recognised species occurring in Africa [5]. *Raphia hookeri* G.Mann. & H.Wendl. and *Raphia mambilensis* has been reported to be endemic in Douala a town located int the littoral region of Cameroon [6]. Belonging to the "Least Concern" *Raphia vinifera* P.Beauv category on the IUCN Red list [7], (Arecaceae) is mainly distributed in the Northwest, West and Adamaoua regions of Cameroon [5,8]. Other authors mentioned two endemic species in the western highlands of Cameroon: *R. vinifera* and *R. farinifera* (Gaertn) HyL. [9], the term *Raphia* will then be used throughout this study. The *Raphia* palm is characterized by their compound pinnate leaves which distinguished them among other palms, as having the largest leaves in the Plant Kingdom [2]. *Raphia* is highly used by the population for animal feed, in house construction and in handicrafts [10]. The entire parts of *Raphia* palm are all useful economically and for domestic purposes [2]. Raphia palm groves are threatened by over-exploitation and habitat loss. The main factors in the destruction of Raphia palm groves in the majority of villages in West Cameroon include agriculture, basketry, handicrafts, constructions and decorations [3].

Raphia thrives in wetlands near watercourses, which it helps to maintain hence the symbiosis between Raphia palm groves and water. The destruction of Raphia groves in West Cameroon would have led to the drying up of the abundant surface water formerly protected by Raphia palm groves [3], yet access to safe water in Cameroon is still low [11-12]. In the Far North Region of Cameroon, among camps, 64% of individuals reported relying on surface water for their primary household water source [11], hence the necessity to protect surface waters.

Despite the proven importance of the Raphia palm grove, it is nowadays the subject of much covetousness which contributes to its rapid degradation in the highlands of West Cameroon. As they have been recognised as wetlands, there is a necessity to map Raphia palm groves and propose strategies for their better management. This study was then aimed at improving knowledge of the importance of Raphia palm groves in the conservation of water resources in the highlands of West Cameroon in general and in the Fotouni Village particularly. More specifically, Raphia palm groves and existing water bodies were mapped, and the perception of palm grove owners on Raphia and management strategies was assessed.

2. METHODOLOGY

2.1 Presentation of the Study Area

Fotouni is located in the Bandja Subdivision, Upper-Nkam Division, and West Region of Cameroon. Fotouni had 7 430 inhabitants in 2005 [13], a number that is said to have increased to 20 000 inhabitants [14]. The main activity is agriculture, which makes it the granary of the Haut-Nkam Division. Its relief mountainous, with its northern periphery marked by Mount Tchikong (1758 m ASL). To the west of the territory is Mount Baloum, which slopes south-westwards to reach the Mbo'o plain at an

average altitude of 700m ASL. Overall, the relief is a succession of mountains whose numerous gradients generally lead to rivers [15]. The map below (Fig. 1) shows the geographical location of the study area.

2.2 Survey on Raphia Palm Grove Preservation Challenges

Primary data collection was carried out through: field observations, semi-structured interview surveys and focus group surveys. The study area was divided into four (04) sub-systems or representative entities (Bano in the West, Hiéla in the East, Tchikong in the North and Babong in the South). These entities were chosen for several reasons: they are areas where there is still a relative abundance of Raphia palm groves, areas of high mobilisation of agricultural activities and representative of the relief of the locality. Tchikong is located on the peak of Mount Tchikong, Babong is low zone located in the southern valleys of the locality and Bano-Hiéla on the central plateau.

Table 1. Characteristics of the study population

Variables	Description	Number of Respondents
Localities	Bano	25
	Hiela	16
	Tchikwong	6
	Thcisso	5
	Tchouno	8
Occupation	Farmer	47
	Artisan	7
	Breeder	3
	Winemaker	3
Gender	Male	57
	Female	3
Age Groups (Years)	31-40	2
	41-50	10
	51-60	13
	Above 60	35

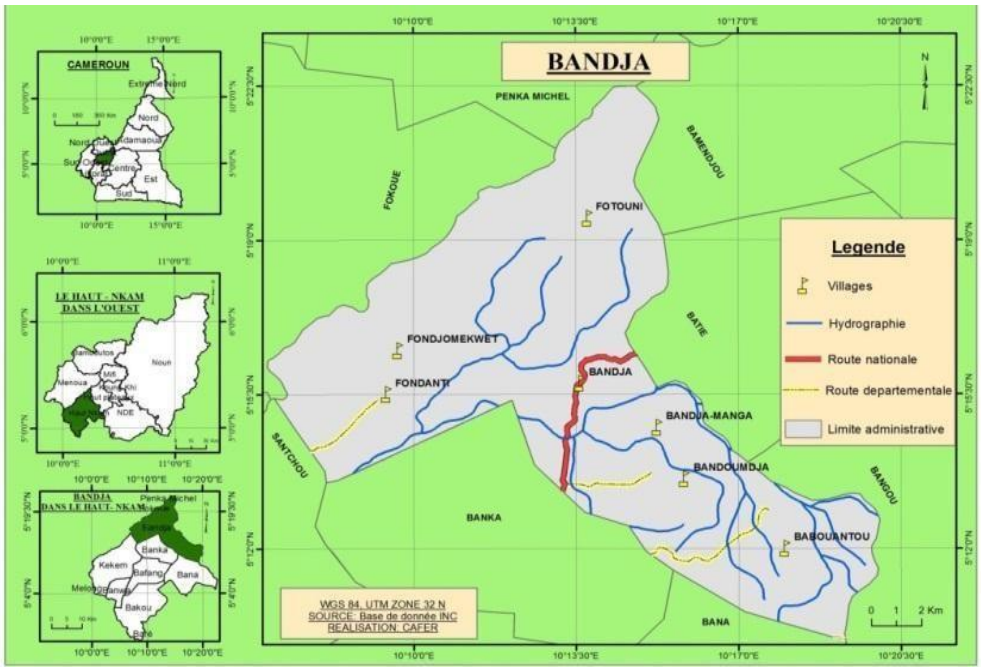

Fig. 1. Location map of the study area [15]

Seniority and main activity were the two main criteria that guided the choice of respondents. Based on this, a total of 60 heads of households were interviewed in 04 representative blocks (Table 1). Three main actors were targeted within the framework of this study: farmers because of their strong involvement in the use of water sources and possibly Raphia stems, which can shed light on water fluctuations in terms of quality and quantity; winegrowers because of the regular use of Raphia for wine; and finally, the elders because of their great knowledge of the evolution of water and Raphia in the locality. The semi-structured surveys were carried out through an interview guide with the resource persons, essentially the elders and the actors of the agricultural activity. The interview focused on the fluctuations observed in the availability of Raphia palm groves and water sources, the origin of these changes and the perceptible consequences. Respondents were interviewed either in front of their huts, in the Raphia palm groves they owned or in a place of their choice.

2.3 Mapping

In addition to this, a GPS survey of existing water points and Raphia palm groves was carried out in order to map surface water points.

2.4 Data Analysis

Data was compiled and Analysed using Microsoft Excel 2016. The QGIS software allowed the elaboration of maps.

3. RESULTS

3.1 Spatial and Temporal Variation of Raphia Palm Groves

All the people surveyed (100%) had a good knowledge of *Raphia.* According to the perception of 93% of the surveyed respondents, the quantity of Raphia palm groves in the study area over the last 15 years has decreased (Fig. 2). Several causes that could explain this drastic reduction in Raphia palm groves were mentioned, the main ones being according to respondents: agriculture (N=48; 80%), non-regeneration (N=18; 30.00%), poor farming techniques (N=16; 26.67%), bush fires (N=7; 11.67%) and diseases (N=8; 13.33%).

According to respondents, Raphia palm trees are often used for Building, Crafts, Food, Pharmacopoeia and Agriculture. an illustration of some uses of Raphia in Fotouni is shown in Fig. 3.

3.2 Perceptions on the Implications of the Degradation of the Raphia Palm Groves in Fotouni

The degradation of the Raphia palm groves would have inevitable and irreversible consequences on the populations and their environment, either directly or indirectly. According to 53.33% (N=32) of the people surveyed, the disappearance of the Raphia palm groves will lead to a total drying up of surface water sources, others think that this disappearance will lead to material (N=7) and economic (N=7) loss, 8.33% (N=5) stated that the loss of the Raphia palm groves will lead to a loss for the local pharmacopoeia, 6.67% (N=4) think that the loss of the Raphia palm groves constitutes a loss of cultural values, 5.00% (N=3) and 3.33% (N=2) declare that this loss will lead to famine and disease respectively (Table 2).

As an ecosystem, Raphia palm groves are home to a wide range and diversity of mesofauna. Approximately 99.99% of the people surveyed confirmed the presence of animals such as rodents, birds and small mammals in the Raphia palm groves. According to the people surveyed, the Raphia palm groves provide firewood for households (N=55;91.37%) and Raphia wine (N=55; 91.67%). They also help in the regulation of temperature (N=26; 43.33%) and constitute a hunting area for small game (N=2; 3.33%).

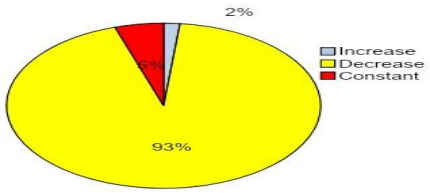

Fig. 2. 15-year's Evolution in Raphia Density in the Area

Fig. 3. Raphia palm grove and its uses: A: raphia palm grove; B: water point in raphia palm grove; C: raphia fruit; D: wine extraction; E: bag made of raphia, F: tomato basket

Table 2. Respondents perception on the consequences of Raphia loss

	Frequency (N)	Percentage (%)
Drought	32	53.33
Loss of Medicines	5	8.33
Material Loss	7	11.67
Economic Loss	7	11.67
Loss of Cultural Value	4	6.67
Diseases	2	3.33
Famine	3	5.00

3.3 Distribution of Raphia Palm Groves and Surface Water Points in the Area

Despite the strong degradation of the Raphia palm groves in the whole area, a large proportion of the Raphia palm groves still occupy the south-eastern and south-western parts of the village, the centre remains empty and the Raphia palm groves are the least dense in the north-eastern and north-western parts. The surface water points are roughly distributed over the entire study area, although a concentration of these water points can be seen in the central and northern part of the village. Above all, there is an evidence of a close relationship between Raphia palm grove and water points in the locality as seen on the map (Fig. 4).

3.4 Main Sources of Potable Water

Raphia palm groves are the main places from which the local population get water (N=39;65.00%). Public taps are relatively rare in the area (Table 3).

3.5 Local Population Proposals for the Management and Conservation Strategies for Raphia Palm Groves

The success of the Raphia palm groves before the economic crisis of the 1980s was undoubtedly accompanied by the implementation of good local policies for the management of the Raphia palm groves by the populations. Several techniques for managing Raphia palm groves have been mentioned in the case of this work. According to their frequency, they include maintenance (N=53; 88.33%), artificial regeneration (N=45; 75.00%), natural regeneration (N=11; 18.33%), the use of fetishes (N=3; 5.00%) and, finally, the use of prohibitions (N=1, 1.66%) (Table 4).

3.6 Proposals for a Better Conservation of the Raphia Palm Groves in Fotouni

Of the 60 people surveyed, 20 (33.33%) said that restocking was the best strategy for the conservation of Raphia palm groves, 16 (26.66%) said that the use of fetishes and taboos was the best strategy, 14 (23.33%) thought that raising public awareness was the ideal strategy, 5 or 8.33% leaned towards the maintenance of existing plantations, 3 (5.00%) had no idea, while 1.66% and 1.66% respectively proposed the creation of an NGO for the protection of Raphia palm groves and the regulation of the exploitation of Raphia palm groves (Table 5).

4. DISCUSSION

This descriptive cross-sectional study aimed at improving knowledge on the importance of Raphia palm groves in the conservation of water resources in the highlands of West Cameroon in general and in the Fotouni Village particularly. It appeared that, most of the respondents were farmers. This high percentage of farmers could indicate an intense agricultural activity in the area; the study area is one of the agricultural granaries of the Upper-Nkam Division. In Cameroon, economic factors push more and more people into agriculture [16]. There was a strong affiliation between Raphia to the male gender, which can be justified by the cultural realities of the Grassfields people.

All the people surveyed had a good knowledge of Raphia, both in terms of its different uses and its socio-economic and ecological values. The role of Raphia palm groves in the life of the population is tremendous: building, crafts, food, pharmacopoeia, agriculture, wine and fabrication of valuable items such as bags and baskets. In addition to its flavour, Raphia wine is a key element of the Bamiléké culture during traditional ceremonies such as weddings, funerals and meetings. The marketing of this Raphia wine allows several heads of households (winemakers) to improve the living conditions of their families. In the same line, a study in Babadjou reported that mastery of local knowledge of Raphia by the peasants was based on knowledge of the techniques of exploitation, the uses and especially its role in the traditions of the Grassfields people [1]. In Bamunka (North West Cameroon), 27% of locals are wine tappers for an income of about $37 [17]; this proves the importance of Raphia palm groves in daily life.

The Raphia palm groves are of great ecological interest because they are home to species of Fauna (squirrels, frogs, dragonflies and birds). Many animals inhabit Raphia palm groves [17]. The dominance of rodents in Raphia palm groves can be explained by the fact that the latter covet the Raphia stones that they use as food. Moreover, rodents (squirrels and rats) are the main agents for the spread of Raphia cores. As for birds, they build their nests using fresh Raphia leaves. The low dominance of small mammals in the Raphia can be explained by the fact that the Raphia is generally wetlands, and therefore mostly flooded. The majority of small mammals stay there during the dry season.

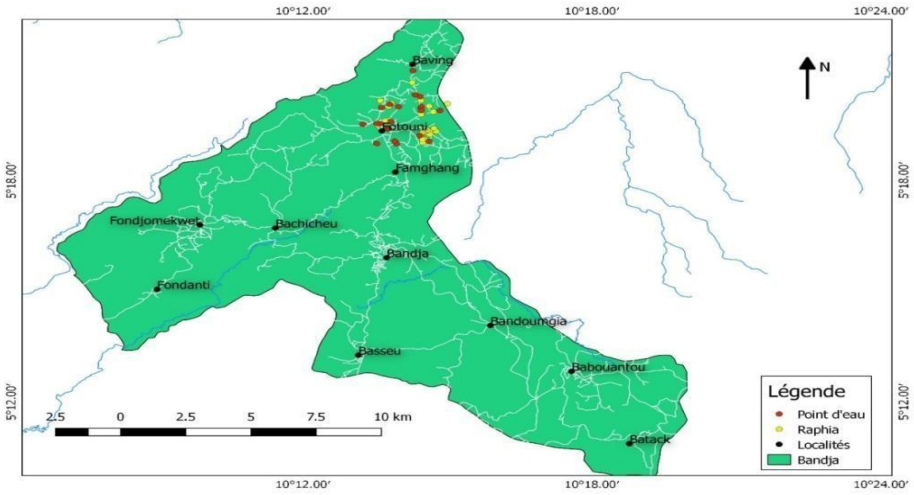

Fig. 4. Spatial Relationship between Raphia palm Groves and Surface Water Points in Fotouni

Table 3. Origin of potable water in the locality

	Frequency (N)	Percentage (%)
Near Raphia Palm Grove	5	8.33
In Raphia Palm Grove	39	65.00
Wells	4	6.67
Public Taps	11	18.33
Water Tower	1	1.67

Table 4. Existing Raphia protection techniques

	Frequency (N)	Percentage (%)
Natural Regeneration	11	18.33
Pasting Warnings	1	1.67
Using Nju'Nju to Repel Robbers	3	5.00
Good Maintenance	53	88.33
Artificial Regeneration	45	75.00

Table 5. Proposals for Better Raphia protection and management

	Frequency (N)	Percentage (%)
Regulation of Exploitation	1	1.67
Sensitization	14	23.33
Replanting	20	33.33
Paste Warnings and Use Nju'nju to Repel Robbers	16	26.67
Good Maintenance of Existing Raphia	5	8.33
Creation of NGO Dedicated to Raphia Protection	1	1.67
No Idea	3	5.00

According to the perception of 93% of the surveyed respondents, the locality has been victim of the reduction in the coverage of Raphia palm groves over the last 15 years. Raphia palm grove destruction has earlier been reported in the West Region of Cameroon, resulting is the drying up of surface water [3]. In Bamunka, Raphia occupied 1248ha in 1983, an area that has dropped to 674.08ha in 2002, due to agriculture, quest for construction sites, poor exploitation,

bush fires, pest and diseases, extinction of large mammals (useful in seed dissemination) [17]. As Raphia palm groves help to protect water bodies, it is tremendous to preserve them as the company in charge of water supply is unable to provide enough water to a fast growing population in Cameroon [18]. Several causes could explain the degradation of the Raphia palm groves, of which agriculture was the main one. In the same line it has been reported that the main causes of the degradation of the Raphia palm groves included agriculture, basketry, handicrafts and decoration; this degradation of Raphia is followed by the drying up of water bodies and low flow rate [3].

Agriculture is the main cause of the decrease in Raphia palm groves since farmers use fresh Raphia palm stems to make the packaging for their products to take to the markets. In addition, poor agriculture may accelerate erosion rendering water bodies turbid and promoting the filling up of these wetlands. Because of systematic use of a huge number of agrochemicals in agriculture [16], water bodies in Raphia are very exposed. It has been reported that agricultural inputs (pesticides) are very risky to the aquatic environment, posing both acute and chronic risk [19] moreover, in the study area (Fotouni), 31 pesticide commercial names corresponding to 18 active ingredients have been reported to be used by farmers [20]. The intense cutting of Raphia without repopulation (overexploitation) seems to be the cause of their degradation. Bush fires are linked to the clearing by fire, this situation only occurs mainly in the Raphia found in mountains.

The high frequency of the use of Raphia palm groves for building could be explained by the fact that Raphia palm bamboos in their dry state are used for the construction of attics in households, dryers, hedges or fences, sheds for the display of goods at the market, and the solidification of bamboo houses. Fresh leaves are used for the manufacture of straw roofs. As far as handicrafts are concerned, bamboos are used in the manufacture of art objects: bags, chairs, ceilings, baskets, kitchen accessories and decorations. The Raphia palm groves produce wine called "Raphia wine" which is used in food and the stones are also edible. Raphia wine is also used in the composition of medicines and can also cure vision problems. Raphia play an important role in agriculture at two levels: as an ecosystem they provide shade for off-season crops and also provide moisture; and bamboos are used as stakes for plantations (tomatoes and plantains). Fresh Raphia bamboos are used to make packaging (crates) for food products, especially tomatoes and peppers. In the same line, it has been reported that *Raphia* bamboo are used to manufacture many products: bed, chair, tomato basket, kitchen basket, festive basket, boat, door, window, comb and ceilings; fruits are comestibles and are dried and used for decoration [17,21]. As far as material and economic losses are concerned, peasants mainly use Raphia palm groves for the construction of their huts. On the other hand, the valorisation of Raphia bamboos constitutes a pillar of development of the Bamiléké culture. This is justified by the presence of this decorative material in all the chiefdoms of West Cameroon. The economic loss can be justified by the contribution of the marketing of art objects or Raphia wine to the family income of Raphia farmers. About 16% of the people surveyed fall into this category of farmers; most of them having stated that the marketing of Raphia derivatives is their only way of earning money to support their families.

There was a strong dependence between Raphia palm groves and surface water sources; more than 70% of the valleys visited were flooded. In the same line, *Raphia* has been reported to be common in swamps and marshes [6]. It shows that the Raphia network is modelled on the local hydrographic network, hence, a strong geographical and ecological dependence of the two components. This association can be explained by the fact that the Raphia palm groves generally grow in flooded areas, maintaining the water that shelters them on the one hand, and on the other hand, the Raphia palm groves, through their deep roots, are able to draw from the underground water table the quantities of water that they bring to the surface on a regular basis as a source of water. Raphia palm grove is very interesting from a hydrological point of view as it is capable of sucking water from the water table for surface use [8]. In the same line, it was reported that the palm grows best in swampy soils having high rain fall, high temperature (22-33°C), sunshine of not less than 5-7h and high relative humidity [2]. In Benin, there are three main species including *Raphia hookeri, Raphia sudanica* and *Raphia vinifera* which are encountered in forest galleries and swamps [10]. Cultivated in the West and North West regions of Cameroon, *R. vinifera* mainly occurs in open habitats, growing along streams and generally forming monodominant stands [5].

Decrease in the cover of the Raphia palm groves was accompanied by the decrease in the sources of surface water with the main consequence of the drying up of surface water. The low percentage of responses presenting famine and disease as consequence of the loss of Raphia palm groves can be justified by the fact that the latter are indirect consequences; famine linked to the disappearance of the firewood offered by the Raphia palm groves and its contribution to off-season agriculture. Diseases are linked to the use of Raphia wine in the composition of traditional medicines and its contribution to improving the quality of drinking water. In this case, it will be a question of waterborne diseases in particular. The decrease in the flow of rivers, erosion and climate change are other implications of Raphia destruction [3]. The destruction of Raphia has many consequences: abandonment of primary activities, loss of cultural value, flooding, extinction of species, increased erosion and turbidity of rivers [17].

Most of the respondents get water for domestic us from Raphia palm groves. This is another indicator of poor access to potable water. In a study carried out in Ngaoundéré, a town of about 200 000 inhabitants, it was found that 70% of the population has no access to potable water and the main source of potable water (80%) were wells [22]. The lack of control over population growth make the capacities of Cameroon Water Utilities Corporation (Camwater) limited, forcing the local population to look for alternative sources of water such as wells, boreholes and springs [12].

Good maintenance is the main traditional technique used to maintain the Raphia palm groves. As *Raphia* plants require very little agricultural inputs for their development, maintenance consists essentially of removing dead parts in the Raphia tufts, clearing the Raphia palm groves and drainage to reduce the amount of water in the Raphia palm groves. Maintenance is carried out seasonally by the head of the household using a cutlass. Artificial regeneration consists of letting the Raphia palm groves grow, produce seeds and let these seeds germinate to create new clumps. Artificial regeneration consists of repopulating the Raphia palm groves with plants harvested on the site or elsewhere by the owner himself. Some people simply preferred to put fetishes in their Raphia palm grove to prevent the farmers from entering it to cut stems: this technique seems to be disappearing. The inclination towards the use of fetishes could be linked to the success of this technique in the past for the maintenance of Raphia palm stands. Awareness-raising can be justified by the fact that most owners believe that young people have no idea of the importance of Raphia palm groves for the community and therefore have an unnecessary perception of Raphia palm groves. The low rate of proposals for the maintenance of existing Raphia palm groves can be explained by the fact that the locality has already lost more than 85% of the coverage of the Raphia palm groves, so maintenance is a suitable for a quicker recovery than the mass repopulation of the Raphia palm groves. It should be noted that the destruction of Raphia in the West Region of Cameroon exposes the population to an unprecedented ecological crisis [3]. In addition to this unsustainable use, other covariates such as pesticide use in agriculture exist; these chemicals are risky to livings organisms inhibiting these wetlands [23-24] as many also bioaccumulate in Raphia, a phenomenon that may contaminate Raphia wine or fruits consumed by animals and human beings. Fortunately, Raphia palm groves are officially classified as wetlands, hence, are under the protection of the Ministry of Environment, Nature Protection and Sustainable Development [3].

5. CONCLUSION

At the end of this study on Raphia and water resource conservation in the highlands of West Cameroon, it can be concluded that Raphia has many uses in the study area. The quantity of Raphia palm groves in the study area over the last 15 years has decreased due to anthropogenic pressure. The network of Raphia palm groves is modelled on the locality's hydrographic network. Several techniques for the management of the Raphia palm groves were mentioned: maintenance, artificial regeneration, natural regeneration, the use of fetishes and finally the use of warning boards. Maintenance and repopulation are the best strategy for conserving the Raphia palm groves. Based on this, future studies should replant Raphia, sensitize the local population, assess heavy metal accumulation in these wetlands as well as water quality analysis in Raphia palm groves. The Ministry of Environment, Nature Protection and Sustainable Development should provide a national inventory of Raphia coverage to better regulate the exploitation. The local population should adopt healthy behaviours towards the

exploitation of Raphia and raise awareness of the younger generation on the importance of Raphia.

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CONSENT

Only inhabitants owning a Raphia palm grove and who accepted to participate in the survey were considered in this study.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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