



RESEARCH ARTICLE

SUSTAINABLE WATER MANAGEMENT IN THE BAMBOUTOS DEPARTMENT (WEST CAMEROON)

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ABSTRACT

Sustainable water management is part of the process of resource replenishment. Indeed, a deterioration in water quality upstream can persist for several hundred kilometres and affect water use much further downstream. Sustainable development requires balancing social and economic concerns with environmental concerns, taking into account the essential yet limiting factor: water. The challenge of sustainable water management is an empirical study based on a qualitative approach. The data collection tools that enabled us to gather information to confirm or refute our hypotheses were semi-structured interviews and observation. Based on the information collected in the field, water is now perceived not only as an economic, vital or agricultural resource, but as a recomposed universe. To ensure sustainable water management, the populations of the Bamboutos department should take into account all the aspects and functions in which water plays a role.

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INTRODUCTION

Water is an essential resource for the survival of the human species in terms of social dynamics; it is highlighted by the centrality of water in social interaction, which poses the challenge of maintaining social cohesion among the population. Water quality and the protection of water sources can be valuable to those who use them; water is a guarantee of identity, history, pride, and belonging among members of a given community. The absence of a system for revaluing this resource has harmful consequences, as its importance remains unknown to local populations.

Strategic analysis theory is used here to explain the phenomenon under study. It is a theory of organisations developed by CROZIER and FRIEDBERG. It focuses on the power relations that actors in the organisation exchange and negotiate, as well as the internal regulations that govern their actions. The strategic approach is both more local and more individual in scope. This is because it is necessary to understand the orientations and adjustments adopted by local and customary managers in response to the new water management system. They are operating in an increasingly uncertain environment, but they have some leeway that allows them to cope with current dynamics. It is worth looking at the methods used by the inhabitants of the Bamboutos department to ensure the sustainability of drinking water sources.

METHODOLOGY

The data collection approach for this study is qualitative. The documentary guide, semi-structured interviews and observation guide are the methodological tools that enabled us to collect data in the field. This work is a cross-sectional study in the Bamboutos Department that focuses on the challenges of sustainable water management. As part of this work, we consulted and analysed existing documentation on water and its proper management in the context of water scarcity. This enabled us to assess the relevance of this topic and take stock of the situation. An interview guide using semi-structured interviews helped us to gain insight into others' worlds. The interviews focused on the strategies and rationales of the actors involved in water management, the identification of all actors, and the measures put in place to ensure a sustainable, long-term water supply. This technique enabled us to get as close as possible to the social and cultural realities related to water by exchanging and listening in an atmosphere of trust. However, some data were collected through direct observation, this observation not passive: we physically travel to sacred and utilitarian places, takes photos, notes behaviours, observes rituals live, and compares these observations with what the informants declared during the interviews. No probability was set in advance for the sampling in this study. The sampling method is non-probabilistic, specifically convenience sampling. The target population consisted of the chiefs of the

various villages, farmers, herders, and women, as they use large quantities of water, as well as people designated to manage water. The collected data were analysed using discourse content analysis. This required the selection of textual, visual, or audio documents. After transcribing the interview recordings, content analysis was conducted using an empirical-inductive approach to understand individual and social phenomena. To do this, we gathered the information needed to understand the subject and confirm or refute the hypotheses. This enabled us to analyse and interpret the results.

RESULTS

Awareness among local populations and sustainable water management:

Water is a resource essential to the survival of the human species. As for social dynamics, they manifest in the issue of water at the centre of social interaction, which poses the challenge of maintaining social cohesion among the population. Water quality and the protection of water sources can be of value to those who manage them; water is a symbol of identity, history, pride, and belonging among members of a given community. The lack of a system to promote this resource has harmful consequences, as its importance remains unknown to local communities.

Water maintenance service by rural youth: In the same vein, the characteristics of water, such as its scarcity, uneven distribution, and cultural, symbolic, and social nature, are also controversial in themselves. The protection of lakes is a subject that generates social representations, as it fulfils the conditions outlined by Moliner (1993:5-14). Given that it fulfils all these conditions, the struggle over scarcity and resource conservation is a subject conducive to revaluing water sources. (Thus, managing water sustainably means protecting existing sources and building dams.) There is a need to raise awareness among water users in the Bamboutos Department about the challenges related to water security. Efforts must therefore be made to bring all stakeholders in this sector, as well as national decision-makers, up to speed. This will ensure adequate and sustainable water quality for human consumption, agricultural production, livestock farming and hydroelectric power. This must be coupled with the need to protect living beings and their property. In light of the above, (Simon, 58, 2021) states: "With climate change, we are raising awareness of the need to take care of water sources, inviting young people in particular to participate and take responsibility, namely by cleaning water points and no longer destroying trees indiscriminately. We are focusing on young people because we are tired and it is up to them to take over." In this regard, the voluntary involvement of young people, the mobilisation of authorities, and awareness-raising and consciousness-building are evident in the human investment organised by young motorcycle taxi drivers around the market point in Mbouda. "The young people and the management committee who get their water from the Mbouda water point are making water management sustainable and much better protected thanks to their voluntary and free involvement. The management committee of this water point regularly organises training sessions to educate them on how to use the pump. This committee raises awareness of how to respect and care for community property. To tell the truth, I have been a water technician in this municipality since 2015; this is the first time I have worked voluntarily. Indeed, it is still in its infancy: there is no text regulating their status yet, and nothing has been put

in writing. But we are working on it. And generally, this management committee is made up of residents, because when the call goes out, they don't hesitate to get involved, meaning that these communities are increasingly aware of the need to protect water. After all, water is life. Before this water source, you have to see how we suffer here at the market. The dry season was almost unbearable, but now things are a little better, and if they continue to take care as these populations do, I believe it will last. (Certilain, 31, 15 September 2021). We also need to develop a strategic approach that will enable us to build adequate infrastructure, such as dams and boreholes, and, above all, to restore the lowlands by protecting the raffia palms. "We want to set up an integrated resource management committee and, in the various municipalities, create an environment department in the four town halls of the department. This department will be responsible for environmental preservation and conservation, and this can only be successful if the local populations are committed to supporting the collective project," reports Aurèle (42, 15 September 2021).

Perception of water as a heritage to be passed on: The traditional perception of water as a "common good" among rural communities leads them to interpret it as a gift from nature and a shared heritage to be passed on. Analysis of residents' discourse reveals that the right to use water is fundamentally based on the deep-rooted belief that it belongs to everyone. Everyone can use it, but they must leave some for others. According to the authors, this behaviour is strongly correlated with religious morals and ethics. In the event of non-compliance with this rule, sanctions can vary: they can be spiritual, reminding people that controlling nature is beyond their capabilities, or communal, such as exclusion from the community, which is highly detrimental in a system of interdependence. By referring to collective rules based on reciprocity, the populations of the Bamboutos Department have been able to jointly manage water reserves and pastures without systematically compromising access or reproduction. It is therefore essential to take the protection and conservation of water sources seriously, with a view to sustainable and effective management.

The reconstituted world of water sources: Water is no longer primarily an economic, cultural or biological resource, but a substance that encompasses all of these elements. It brings together not only the original inhabitants but also farmers and herders from other regions, as well as civil servants (e.g., teachers, nurses). New social and professional configurations are emerging from the proliferation of economic activities and the repositioning of particular inhabitants. These changes necessarily require diversifying water sources. There is growing awareness of the potential depletion of water, given its vital role in the existence of rural communities. With this in mind, measures are being put in place to ensure the sustainability of these water sources. As a result, support structures have strongly backed the Bamboutos Department in improving its water policy, notably through the establishment of modern water points, such as the Bamendjing water retention dam, the installation of boreholes and the creation of water points near sacred sites.

Construction of the water retention dam in Bamendjing: The main objective of the State and its partners in constructing this dam was the socio-economic development of these regions. It therefore aimed to reduce unemployment, facilitate

the prevention and resolution of food shortages linked to irregular rainfall, and support the retraining of young people in agriculture and livestock farming. The construction of the Bamendjing dam also aimed to exploit fishery resources and increase hydroelectric production in the Bamboutos department. The image opposite shows the outer face of the Bamendjing dam, a water retention dam.



Source: Field survey, Alemjou, August 2021.

Photo 1. Bamendjing Dam

Field interviews reveal that hydro-agricultural development creates maintenance needs and socio-economic situations that must be managed. The management of farms and the maintenance of the dam's surroundings form the basis of the water management system of the Bamendjing dam. In other words, farm management and maintenance of green spaces are part of an institutional framework. This framework has been developed for both public authorities and farmers' organisations, as the Bamendjing dam is a water reservoir for multiple uses and involves various water users, including ENEO and farmers' organisations.

Installation and rehabilitation of boreholes: The initial aim of installing boreholes is to resolve the critical water shortage caused by the early drying up of water sources ("late December and early January for villages in the Batcham district and February/early March for Galim and Mbouda") and to reduce the time spent by women and children collecting water. The drilling of boreholes also aims to increase drinking water consumption and eradicate certain waterborne diseases, such as onchocerciasis, typhoid fever and gastroenteritis, with a view to improving the health of the population. The water from the boreholes is generally used for drinking and cooking. Olivier, 42, 20 August 2021) said in an interview "The main objective of this project is to supply a large part of the population with drinking water, especially during all seasons, because the surveys we conducted before starting the actual work show that there is a severe water shortage during the dry season and at the hospital as well, records show how waterborne diseases peak during the dry season. We have therefore carried out this major drilling project to help these populations experiencing water stress, which will supply more than a dozen villages. The decision to set up new water points and rehabilitate the old ones has therefore solved the problems of water shortages during the dry season and the diseases caused by the lack or poor quality of water. Several projects have been launched to this end, as illustrated. in the images below. The photos above show the borehole installed by the Enter project to resolve the drinking water shortage and ensure a sufficient supply of drinking water for all. The photo above shows the rehabilitated borehole, which was carried out with a view to sustainable water management in the Bamboutos department.



Source: Field survey, Alemjou, August 2021.

Photo 2. Water collection point, at the mountain



Source: Field survey, Alemjou, August 2021.

Photo 3. Borehole in the village of Tchuetlekouet

It is therefore up to the local water management committee to make good use of it and, above all, to manage these water points with a view to ensuring their sustainability.



Source: Field survey, Alemjou, August 2021.

Photo 4. Rehabilitated borehole



Photo 5. Reservoir under construction in Bangang

Construction of water points near sacred sites: The local population, particularly traditional leaders, dignitaries, and chiefs, has a meaningful relationship with water. For older people, in addition to its nutritional value, water is a sacred gift from God, as the chief of the village of Balafotio explains in an interview: "You will see that the water sources near sacred places never dry up because they are next to forests and these trees produce water. In addition, as we have said, this water generally allows us to make sacrifices, and since sacrifices are



Photo 6. Reservoir filled with water in Bamelio



Source: Field survey, Alemjou, August 2021

Photo 7. Protected water reservoir in Bamelio

made at all times, the water cannot dry up, especially since it often purifies us when we have done wrong. We need this water at all times for village sacrifices or to invoke the gods of our lands to deliver us from troubles. This means that by creating water sources near sacred sites, they will be inexhaustible because the 'gods' will watch over them, and even the trees near these sacred sites will protect the water sources. Following this investigation, Mauss (1969) states: "Sacred places are part of sacred objects, which are themselves permanent rites (...) Studying these places will allow us to know who is there and what is happening there."

From the above, it can be deduced that water was one of the conditions for the existence of these social groups, which shaped their lives. This water, therefore, has mythical characteristics: it is sacred, as it is one of the fundamental elements of acts of communion with God (water for baptism, holy water, the blessing of places), with ancestors, and with supernatural forces. It is used for domestic, healing, and religious purposes. As humans always seek to dominate nature, they develop practices and strategies to manage it. This is to address the needs of a large number of people living under water stress. Olivier, during an interview: "We realised that all the sacred forests are around water sources. That is why we must return to our customs and place paramount importance on the cultural aspect of water. But drought is overtaking us because of deforestation. And we realise that, culturally, our ancestors demonstrated a close link between water and the environment, for example, the forest. That's why I think it was to protect the water sources. To ensure their village would never suffer from drought, they created forests like this, with a water source at the centre. We asked the chiefs to make sacred water collection sites. We believe in what we are, so that these sources are protected culturally. We value where we come from, and if, traditionally, we say this place is sacred, then water sources will be automatically protected, and there will be less scarcity. It is therefore essential to take a step back to truly understand the significance of water sources near sacred sites, to embrace this tradition for its sustainability, with a view to overcoming water stress.

Elements of sustainable water management in the Bamboutos Department: Increased water demand due to urbanisation, economic development and agriculture, coupled

with increasingly frequent periods of scarcity linked to climate change, is creating tensions over the availability of water resources. These tensions are leading to the development of strategies to address difficulties in accessing water. In the Bamboutos Department, reforestation, resource replenishment and renewal areas, and the construction of a downstream relay reservoir are strategies being developed by local communities to mitigate frequent water shortages.

Reforestation: planting trees that consume less water and stopping irrigated agriculture during the dry season: Trees and shrubs play a vital role in maintaining ecological balance and improving living conditions for the population. Forests, trees and herbaceous plants are essential components of ecosystems and help maintain conditions conducive to extensive agriculture and livestock farming, as well as meeting subsistence needs. By providing products (especially fuelwood and non-wood products) and environmental services to poor rural households and by contributing to the diversification of these households' sources of income, forests and trees support poverty reduction strategies and reduce food insecurity. Restoring land cover can help mitigate the effects of climate change by increasing carbon absorption and storage, even if the amount of carbon fixed per unit area remains modest. Thus, planting trees that consume less water is one of the strategies that help mitigate frequent water shortages, in the sense that "the more trees there are, the more water there is". And this will benefit the population; we must therefore replant trees, and above all, trees that consume less water can help us combat shortages. In other words, natural forests and tree plantations improve the water cycle by reducing surface runoff and facilitating groundwater recharge. Planting trees to increase rainfall has been proposed many times. Disadvantaged people are forced to exploit all available resources to survive. Overexploitation should be avoided by helping people meet their basic needs through income-generating activities. Poverty can be reduced by planting trees, as they provide products and services.

Planting forests on previously unwooded land can be effective in restoring the environment. During the second half of the 20th century, many forest plantations were established on arid land around the world, most often for protection or firewood production, and the pace of afforestation programmes accelerated.¹ According to the FAO. These programmes have used a variety of species (often exotic) and techniques, with low (non-irrigated afforestation) or high (non-irrigated afforestation with land development, irrigated from groundwater, deep aquifers or wastewater) levels of investment. It is therefore necessary to find ways to stop irrigation during the season because the success of these plantations is now a valuable source of information for future activities. According to estimates, 60 per cent of rainfall in the evergreen Amazon rainforest is generated by evapotranspiration from the forest itself.² . However, for afforestation to significantly increase rainfall in surrounding areas, huge areas need to be converted to forest, according to AVISSAR and OTTE.³ .

¹ FAO, Global planted forest thematic study: results and analysis. Planted Forests and Trees Working Paper FP38E, 2006, Rome.

²The Amazon.org Information about the Amazon River. Internet document. Available at: www.theamazon.org/amazonriver.html, 2007, accessed on 14 December 2021.

³AVISSAR, R., and OTTE, M., The impacts of afforestation in northern Israel on its local and regional hydroclimate. Paper presented to the International

| No | Surname | Age | Position | Location of interview | Date |
|----|-----------------|-------------|--|------------------------|------------------|
| 1 | Olivier, | 42 | Project Manager (Enter) | Bangang | 20 August 2021 |
| 2 | Simon | 58 yearsold | Notable | Tchutlekouet | 20 February 2021 |
| 3 | Godalone | 42 | Farmer | Nzindong-Mont | 24 August 2021 |
| 5 | Chief Balafotio | 59 | Farmer | Balafotio-Bangang | 20 February 2021 |
| 6 | Aurèle | 42 | Head of Water Services, Bamboutos Department | Mbouda-ville | 4 September 2021 |
| 7 | Certilain | 31 | Technical water agent for the municipality of Mbouda | Municipality of Mbouda | 29 August 2021 |
| 8 | Armand | 32 | Water technician | tchuetlekouet | 23 August 2021 |

Territories for resource replenishment and renewal: The basic territorial unit in continental hydrology is the watershed, the region where water enters in the form of precipitation and where the flow and transport of associated substances (eroded materials, chemical elements carried by water, etc.) take place along preferential paths towards a common downstream point, the outlet. This definition applies to both surface runoff and groundwater flow. However, the territorial unit makes it possible, on the one hand, to clearly link a resource to the territory or territories that supply it and, on the other hand, to consider water management internally within this territory or these territories, where there are numerous interdependencies across functional structures and scales (of space, time, frequency and society). According to some respondents, "The land and everything on it belongs to the landowner." This statement clearly reflects the difficulty of resolving coexistence within the same community territory and sharing the same resource in conditions of scarcity and severe water shortages. In the Bamboutos Department, water management is part of symbolic values, in accordance with traditions. However, this local management is disrupted by poverty and problems linked to climate change. Faced with these constraints, new territorial partnerships have been developed around water management, incorporating political criteria, particularly within the Bangang group. Within this territory, landscape features, processes, social groups, developments, etc., exhibit characteristic spatial, temporal, and frequency scales. The overall functioning of a water source and the related aspects of its management, therefore, refer to these scales and their own internal territories.

Water in shallow aquifers has played an essential role in the development and diversification of agricultural production, which makes sense from a resource-management perspective. When groundwater is accessible, it provides first-rate protection against climate hazards and the unreliability of many water distribution systems in irrigated areas. It also offers more subtle advantages. Access to groundwater greatly promotes equal distribution, and for many farmers, exploiting these waters is an ideal supply system. Because it is available on demand and exactly when they need it, they sometimes decide to invest privately in groundwater exploitation technologies to compensate for the unreliability and inequity of irrigation services that distribute surface water. In many ways, the use of groundwater has enabled farmers to escape the traditional management of irrigated areas.

Construction of a downstream relay reservoir: Water shortages have led communities to develop strategies to overcome the difficulties they face. To address this problem, the communities, with humanitarian aid (ENTER project), have set up the construction of a downstream relay reservoir. Armand explains: "We are planning to build relay reservoirs because we realised that the existing system, which we are

currently rehabilitating, had structures that were already insufficient. We had built a settling tank with a capacity of over 120 cubic metres, but there was no relay reservoir after it. So the project envisaged building relay reservoirs, particularly at the bottom of Camp Nzindong." In other words, it will be able to supply us during the dry season, a period of severe shortage, and to avoid repeated conflicts. "As I was saying, 50-cubic-metre reservoirs will solve the shortage problems. And when we store the water there, after these relay reservoirs, the water will flow down to another reservoir in the system, still ELvétas, but already built. This reservoir is a few metres from the Bangang market. So, at the Kuipou residence, there is equipment that will enable water to be sent to the reservoirs that we are going to build 50 metres below. So, two in Bafomlié and one in Bankak: this is to address the shortage. So if the network is already operational based on the studies we have carried out or that you have carried out as part of your work on the project, we believe that with these structures, the population until 2040 has been projected until 20240, so 120 cubic metres upstream, 120 cubic metres at market level and 50 cubic metres twice downstream, this will solve the shortage problem. The photos below show the work carried out to ensure the sustainability of water resources in the Bangang group.

DISCUSSION OF RESULTS

Sustainable water management in Cameroon, particularly in the Bamboutos region, faces challenges including increasing water scarcity, climate change, pollution of water resources, and limited access in rural areas. The results show a local improvement in access to drinking water and greater resilience to droughts, but logistical and financial challenges remain, limiting scalability. These recurring droughts and soil degradation are exacerbating water scarcity, particularly in Babadjou and the Bamboutos Mountains, where water collection points are drying up. These challenges thus compromise public health and local food security. According to FEUGUE KENFACK Josiane (CEPDEL), she analyses how raffia, bamboo, and black fruit tree plantations impact national water restoration objectives, using quasi-experimental methods for causality and qualitative methods to explain climatic or behavioural obstacles. These observations are consistent with those of KAFFO Célestin and FONGANG, who analysed the societal challenges that have worsened over the past two decades, advocating for sustainable rural water supply strategies in Babadjou, where local results in terms of citizen participation are promising but limited by persistent financial and climatic constraints. However, these results highlight persistent limitations, such as the lack of regular infrastructure monitoring and insufficient consideration of climate vulnerabilities, which render up to two-thirds of water points in rural areas non-functional. To enhance sustainability, systematic impact assessments and public-private-community partnerships aligned with the SDGs will need to be put in place to ensure effective coordination among stakeholders, promote

responsible innovation, and guarantee continuous improvement in environmental and social practices by 2030. This discussion doesn't just repeat the results, it interprets them, contextualizes them in the scientific literature, and shows their importance for sustainable water management

CONCLUSION

Sustainable water management in the Bamboutos department is a significant challenge amid growing pressure on water resources from population growth and agricultural and industrial activities. To ensure equitable access to quality water, it is essential to strengthen institutional capacities, promote appropriate and resilient infrastructure, and encourage inclusive and responsible governance. This approach will not only preserve aquatic ecosystems but also sustainably improve the living conditions of populations, thus ensuring harmonious development that respects natural resources in the long term. This article emphasises that sustainable water management is a multidimensional issue that requires collective commitment and coordinated action to guarantee this vital resource for present generations. It is therefore necessary to strengthen local capacities through systematic assessments of drinking water supply systems to optimise investments and ensure sustainable solutions in terms of quantity and quality. Implement integrated water resource management (IWRM) at the municipal level, using SDG indicators to assess and improve access to water and sanitation in the departments of Menoua, Bamboutos, and Noun. Develop coordinated municipal strategies with local stakeholders to support rigorous project planning.

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