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Integrated Water Management in Mountain Communities: The Case of Feutap in the Municipality of Bangangté, Cameroon

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Abstract: The whole population of Feutap still collects drinking water from two protected springs, some 1 km away from this small rural agglomeration. For many generations, the only improvement has been the protection of the springs during the 1980s. The resulting high incidence of gastrointestinal infections continues to hinder the socioeconomic development of this mountain community. This dynamic wherein "poverty begets disease, and disease begets poverty" seems endless given the number of water improvement programs and other health-focused campaigns in rural areas of Cameroon since the 1960s. Fortunately, the hydrographic regime of Feutap and its geographical situation enable the implementation of the Kilimanjaro Concept (KC), wherein rainwater is quantitatively harvested, partly infiltrated, and largely stored to (i) meet the whole-year water needs of the population, (ii) create new ecosystems, and (iii) enable irrigated agriculture. This communication prepares the implementation of the KC in Feutap, including the creation of irrigation ponds for agriculture and small farm animals (e.g., goats and sheep). The view is promoted that Feutap is a potential viable space in which life and work are possible, using the existing rainfall and the few natural springs in a sustainable manner. The presented concept can be extended to other hilly small communities with similar hydraulic regimes.

Keywords: climate resilient technique; decentralized water supply; household water use; small rural community; Sub-Saharan Africa; waterborne disease

1. Introduction

Access to safe drinking water is a basic human right and a prerequisite to public health and sustainable development [1–4]. Improving access to safe drinking water has been one of the most important global goals for the past four decades [1,5], and culminates in Goal 6.1 of the United Nations Sustainable Development Goals (UN SDGs). Goal 6 calls for improving water quality, as well as for protecting and restoring water-related ecosystems, while Goal 6.1 seeks to ensure the availability of safe drinking water for all by 2030. Only eight (8) years are now left to fulfill Goal 6.1. Thus, translating existing knowledge into practical solutions is the best effective path to stay on track and possibly achieve this goal [6,7]. The Kilimanjaro Concept (KC) has been recently presented for integrated water resources management in hilly regions [8,9]. On the other hand, the use of cisterns to warrant water supply in mountain communities is a very old decentralized solution [10–19]. This communication is about integrated water management in mountain communities, including safe drinking water supply. The applicability of the KC in a rural district of the city of Bangangté is presented. In a recent paper, Nya et al. [19] presented a hybrid model for achieving universal safe drinking water in the urban area of this medium-sized city in the Western Region of Cameroon.

There is a widespread perception that the public health responsibility of a municipality is merely accomplished by the installation of adequate watering points in a community [15,16]. In recent years, the municipality of Bangangté has celebrated many such installations in the forms of protected springs and tube wells [17–19]. The new installations are often donations from elites or from national and international Non-Governmental Organizations (NGOs) [18]. However, little to no efforts have been made to make sure that people actually make good use of the new water provision systems [19]. In other words, from a pure health perspective, the new installations cannot be counted as a success [19,20]. For the last few decades, public health workers have been often disappointed by costly water supply installations without any material improvement of the disease picture in communities [3,21–23]. In a few extreme cases, like in South East Asia (e.g., Bangladesh, India, Nepal), new installations have even worsened the health situation by creating the arsenic crisis [21]. In general, when the new installation supplies safe drinking water, it is of inadequate quantity because water has to be carried from long distances, for example, from the spring in the valley to the household on the slope of the hill. This implies insufficient water volumes to enable/encourage sufficient personal hygiene at home. The present communication implores ways to shorten the distance to the water source and thus improve water availability in the small rural community of Feutap. For this purpose, the Kilimanjaro Concept is applied.

The Kilimanjaro Concept (KC) is an innovative water management system that roots water balance on rainwater (100%) [8,24–28]. Two key features of the KC are (i) maximizing artificial infiltration for groundwater recharge and (ii) optimizing water storage for later use [9,26]. By reducing surface runoff, the KC concept equally (i) augments drinking water supplies, (ii) avoids flooding and soil erosion, (iii) helps introduce demand management for drinking water systems, (iv) provides an inexpensive supply of water, (v) provides water that needs little treatment for irrigation or non-potable indoor uses, and (vi) reduces stormwater pollution [25,26]. The KC was developed for regional water management in mountain regions [8,24,25] and has been further customized to cope with small islands as an effective and efficient weapon against salt intrusion [9]. In its original version, the KC foresees a water drainage network on a hill-by-hill basis. This communication materializes for the first time the application of the KC on a hill scale and for the water supply of a community that is still dependent on roof rainwater and water from valley springs. The village of Feutap and other comparable small communities are certainly unable to pay for the technical services required to make proper preliminary investigations, design, and construct a KC-based water supply system. However, there are enough qualified engineers capable of installing and maintaining such systems. The present communication is regarded as an indispensable consulting service that can be adapted everywhere for the construction of appropriate water supply systems. Clearly, it is about channeling the energy of small communities in hilly regions into affordable, applicable, and sustainable water supply schemes based on rainwater harvesting.

Rainwater harvesting (RWH) from impervious surface areas (e.g., administrative airports, buildings, churches, mosques, schools) is increasingly practiced in both rural and urban areas worldwide [29–33]. By harvesting rainwater, the scientific community is mainly attempting to solve problems coupled with increased urbanization and the associated dramatic transformation of land uses from green surfaces to gray constructions [34,35]. Gray construction reduces the infiltration and increases the runoff [26,32,33]. The concept of RWH has inspired scientists to solve water issues in various settings, including in rural environments, to address the following: (i) drinking water supply [19,36–38], (ii) erosion and flood mitigation [39,40], and (iii) food security [41–44]. Available studies aimed at convincing rural farmers and urban inhabitants to consider that RWH on their private properties could mitigate water-related problems in Africa [29,45,46]. In Cameroon, during the recent two decades, RWH has been investigated as a viable tool to secure safe drinking water and water to irrigate small gardens [46–51]. These studies, comparatively few in their number, cover the whole climatic spectrum of Cameroon, from the rain forest in Buea [47] and Yaoundé [46] to the dry savannah in the Far North [49]. At first glance, the affordability and the user ownership of RWH systems favor their widespread applicability in rural communities. However, although RWH has been used in Cameroon for a long time, it is still far from being utilized to its full potential. Challenges preventing its wide-scale adoption need to be identified and resolved. This paper presents the challenges and opportunities for the universal use of RWH in Feutap (Bangangté).

Providing relevant information on the landscape of safe drinking water provision in Feutap is a step forward in an attempt to establish the right water management policy, as well as to promote sustainable water services in this rural community and self-sufficiency. This research seeks to provide the most holistic information on the hydraulic cycle in Feutap in order to enhance the understanding of the prevailing situations. Such an understanding provides valuable insights into the type and nature of approaches required to improve access to safe drinking water supply in Feutap and similar mountain communities worldwide [52–56]. In fact, extensive research is required in order to select appropriate strategies rooted in clear scientific insight. The present study contributes to achieving this goal by (i) suggesting the adoption of the Kilimanjaro Concept in Feutap and (ii) paving the way for its immediate implementation.

The presentation starts with an overview description of Feutap (Section 2), followed by an evaluation of the potential of rainwater harvesting (RWH) to cover the water demand in Feutap (Section 3). Section 4 discusses how to achieve the SDG on clean drinking water provision by drawing lessons from earlier case studies, Section 5 conceptualizes the future of water management in Feutap, and Section 6 prepares its realization using the Kilimanjaro Concept (KC). Section 7 presents some aspects of how the KC will increase the living standard in Feutap, while Section 8 formulates some recommendations for its realization. A short conclusion (Section 9) closes the presentation.

2. An Overview of Feutap

2.1. General Aspects

Until the end of the 19th century, Feutap was a stand-alone village in the hilly Bamiléké region [57–60]. Today, Feutap is one of the historic districts of the chiefdom of Bangangté. Feutap is located on the highest hill of Bangangté, culminating at an altitude of 1600 m, some 4 km north of the urban area [61]. Feutap can thus be regarded as the roof of Bangangté. This hill is termed Nyabeu in the local language and can be translated as "turnover of the sun". Feutap is divided into four main quarters: Feutap 1, Feutap 2, Mboutchoua, and Pendong. This study is focused on Feutap 1 and Feutap 2, which are typical roadside communities [62]. Feutap 1 is located along the provincial road P15 (Bangangté-Bafang), and Feutap 2 is along the departmental road D62 (Bamena-Bazou) (Figure 1). In turn, Feutap 1 is divided into two sub-communities, located each on a versant of the highest Feutap hill: (i) Feutap 1 "Cogefar" on the Bangangté versant and (ii) Feutap 1 "Nyabeu" on the Bamena versant. Feutap 1 and Feutap 2 both resulted from the forced displacements of populations during the War of Independence between 1955 and 1971 [63,64]. Forced displacements as imposed by the colonial administration implied that people abandoned their bocages on the slope of hills and formed "regrouping camps" along roads (e.g., P15 and D62) where better protection by the colonial army could be warranted [64]. The population of Feutap is still in majority made up of people whose ancestors settled there before the end of the 19th century [59]. Accordingly, apart from the forced displacement, nothing special has changed in the lifestyle of this population as resulting from "national development plans". Similar situations have been reported in other African countries, for example, in the hilly Igbo lands in Nigeria [65–67]. More so, Feutap has rainfall on average annually about 1400 mm (Figure 2), thus a potential water supply source that needs to be well exploited.

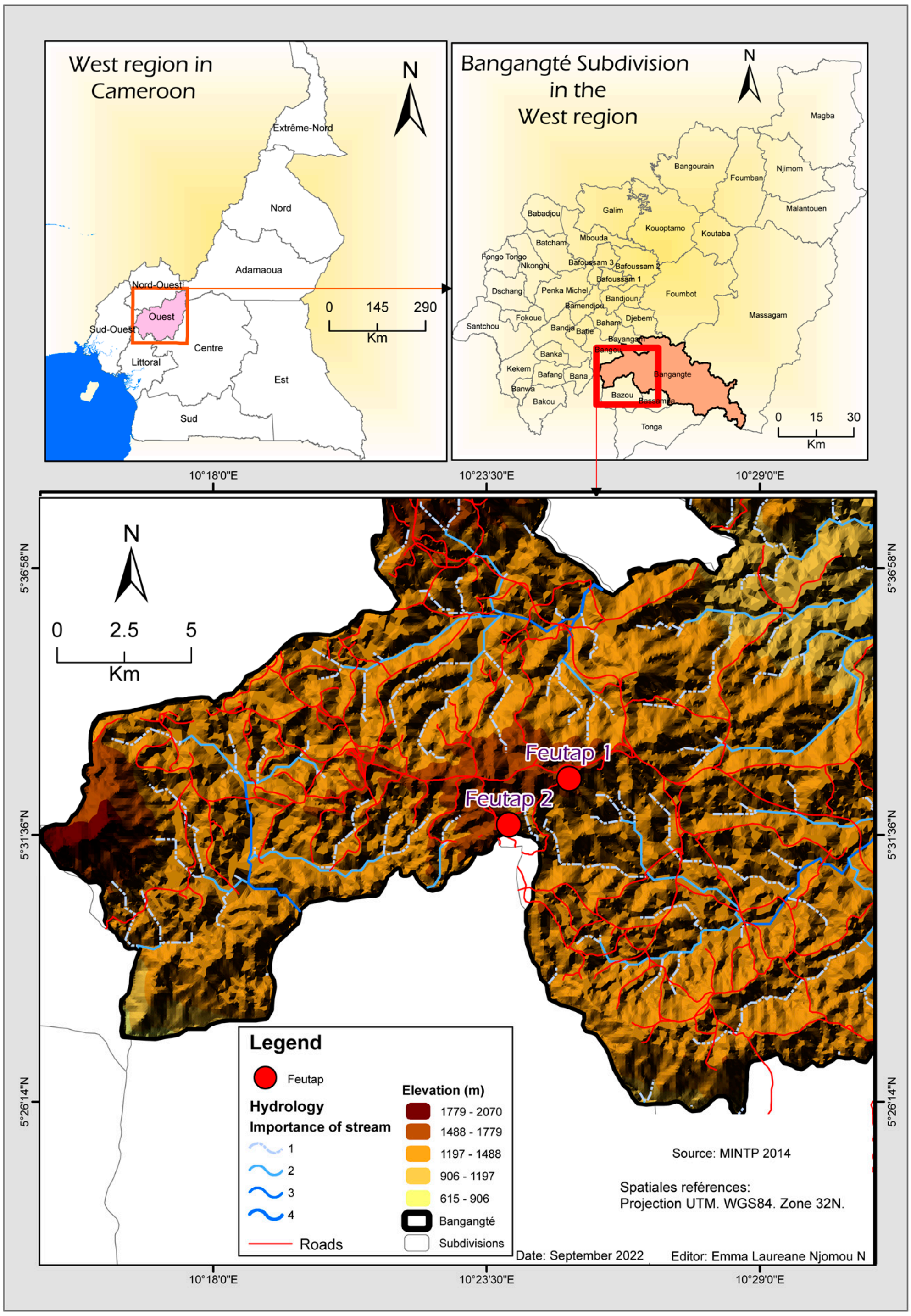

Figure 1. The location of Feutap in Bangangté. The hydrological and drainage network clearly shows that there is no river in Feutap.

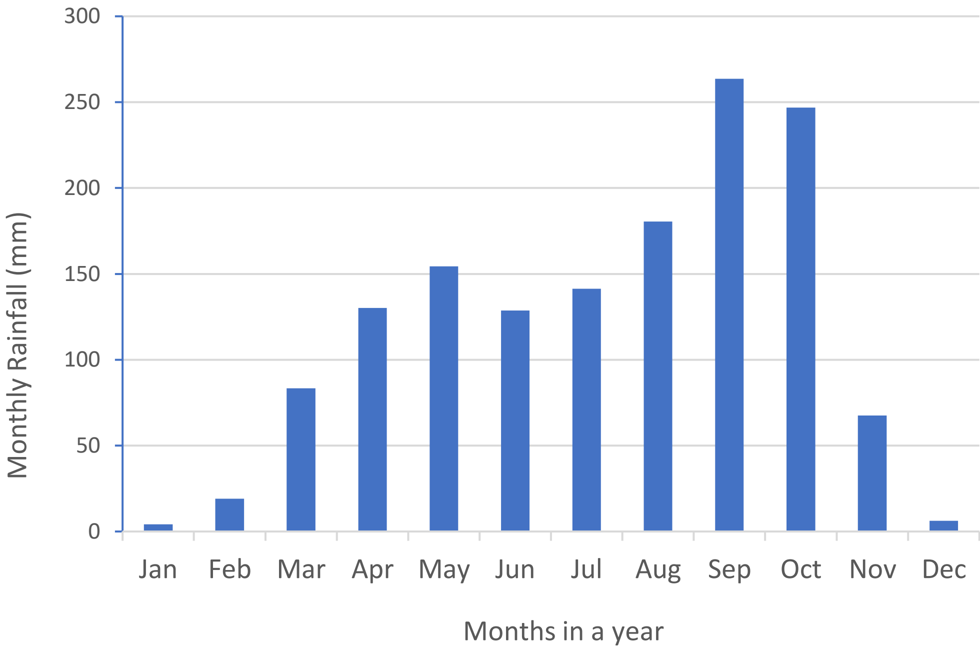

Figure 2. Average monthly rainfall distribution for the years 1951–2021. Data from Ref. [18] were actualized.

2.2. Physical and Administrative Aspects

Feutap is located in the rural area of Bangangté, between latitudes 5°26′14″–5°36′ N and longitude 10°18′0″–10°29′0″ E. It is bordered to the north by the village Bangoua, to the south by the village Bahouoc, to the west by the village Bamena and to the east by Sagnam, in urban Bangangté. It is on a plateau some 1500 m above sea level. The hydrographic network clearly shows that there is no river in Feutap (Figure 1). Feutap has a sub-montane monsoon climate with a sub-equatorial character [68]. Its population, which lives mainly from agricultural activities (e.g., subsistence agriculture), is approximately 320 inhabitants. The Teacher Training College of General Education (TTCGE—Feutap 1) and the Public Nursery School of Feutap (Feutap 2) are the only government infrastructures present in this village. Besides these, there are two evangelical churches, one in Feutap 1 and one in Feutap 2.

As a top-mountain locality, Feutap has no streams and/or rivers (Figure 1), and thus "irrigation water" [69] is an unknown notion. Agriculture is exclusively rain fed. There are just three springs, two in Feutap 1, and the other one in Feutap 2 (Figure 3). In Feutap 1, only one of the two springs is used by the residents, the most productive and the closer to the agglomeration. Figure 3 represents the distances to the most used springs. Water from these sources is used for cooking, drinking, and ensuring personal hygiene and clothing. The population of Feutap 1 Cogefar has its water from a borehole situated in the compound of the chief of the quarter. Anciently, this agglomeration used to go to a spring in the valley located in Bangoua. The spring in Bangoua is now abandoned but can be explored for water supply in Feutap after the Kilimanjaro Concept (Figure 4). A retention basin can be created at the source, and water is daily pumped to a tank within the agglomeration to partly cover certain needs. Using such a system for the safe drinking water supply of a school, for example, would eliminate the need for disinfection while producing in-home water (distance zero). Actually, the distance from the Nursery School of Feutap 2 to the protected spring is more than 1 km. To reduce energy costs, a solar pumping system is proposed (Figure 4).

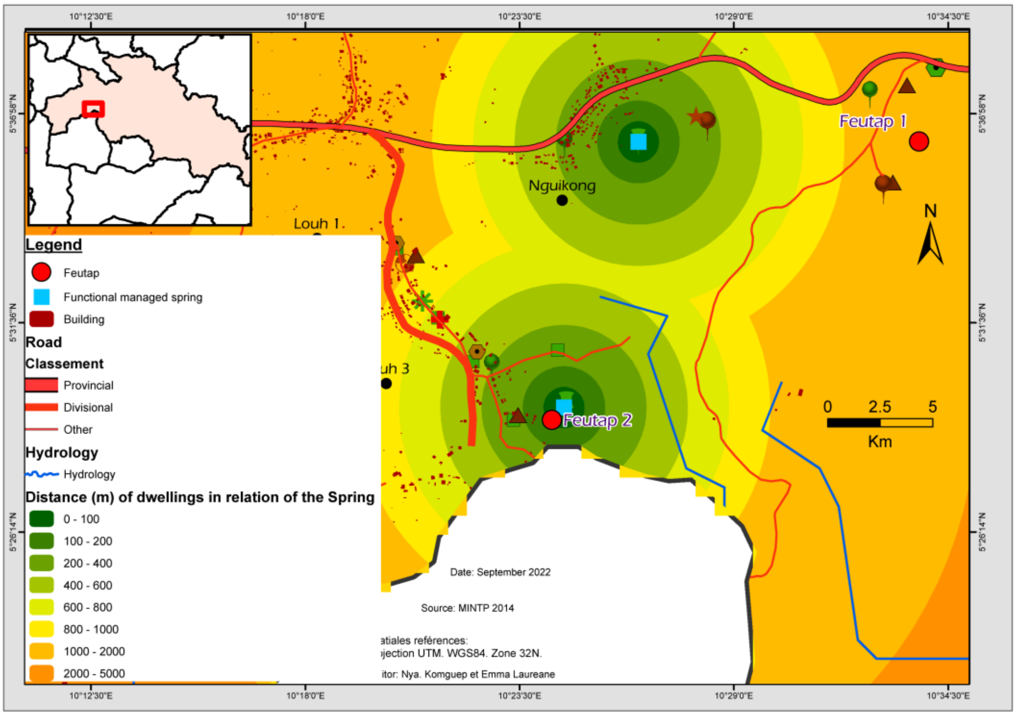

Figure 3. Distance (m) between spring and houses in Feutap village.

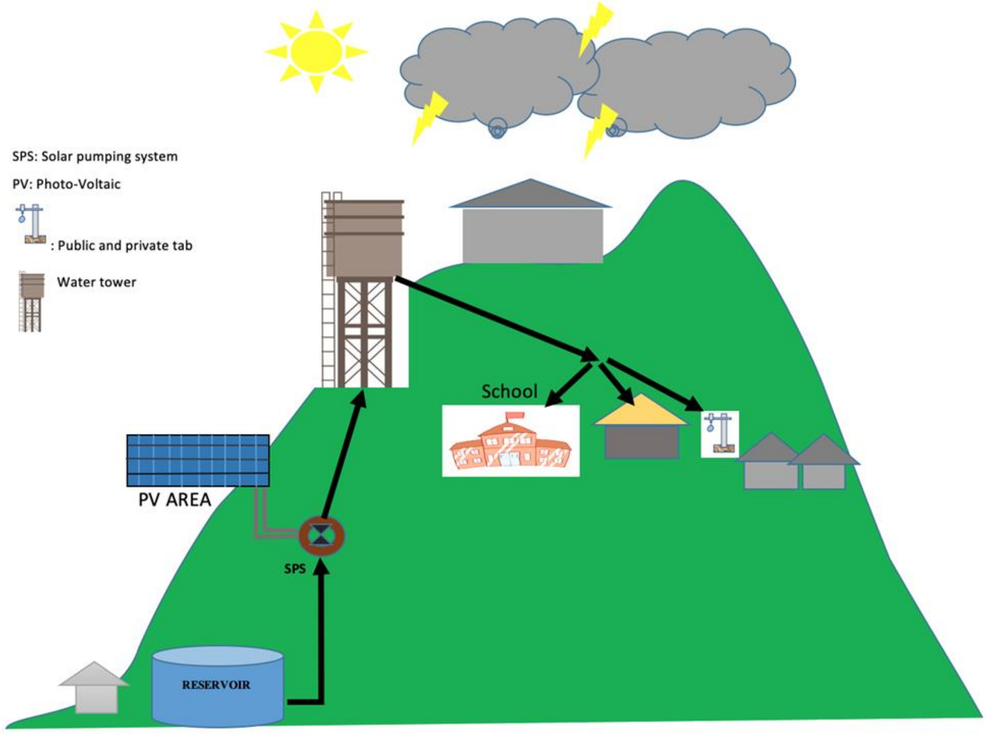

Figure 4. A conceptual depiction of a system to pump spring water stored in the valley to a point of use on the hill. As an example, a 50 m^3 retention basin can be installed at the spring and a water tower with up to 10 m^3 capacity installed in the agglomeration. The actual sizes of the basin and the tower depend on the spring productivity and/or water demand. Solar energy should be the first choice for pumping the water from the spring to the tower due to its low cost.

2.3. Historical Sketch of Water Supply in Feutap

2.3.1. General Aspects

This subsection aims to present how water management has been performed over space and time trajectory in Feutap. Usually, such a process is complex as various stakeholders and parties are involved with different aspirations [70]. Surprisingly, although three broad periods (pre-colonial, colonial, post-colonial, or current situation) are covered, there is truly little to say about access to safe drinking water in Feutap. In fact, today, like during the pre-colonial time, the large majority of the population of Feutap fetches water from a valley spring (Figure 3). Only the population of Feutap 1 Cogefar has a functioning borehole. The productivity of this borehole considerably diminishes during the dry season (January to March), and the population looks for alternative water sources, including the 'bush' spring situated in Bangoua (Section 2.2). Before the 1980s, it was commonplace in Feutap to harvest rainwater and store it in diesel metallic fuel tanks with 200 or 300 L capacity. Smaller plastic tanks were also used. These small tanks helped to shorten the frequency of water collection from the valley springs during the rainy season.

2.3.2. Protected Springs and Their Uses

Around 1985, the rural engineers protected two natural springs: one in Feutap 1 (Figure 5a) and the other in Feutap 2 (Figure 5b). These water points are located in the lowlands, at considerable distances from the houses (≥1 km) (Figure 3). The paths leading to them are very slippery in the rainy season (Figure 5c). The high productivity of the spring in Feutap 2 had led to strategies to create a retention basin at the source and pump water to the neighboring agglomerations including in Bahouoc and Balengou. This was initially the initiative of private rich individuals (called elites) during the 1970s and 1980s. In 1985, the municipality of Bangangté (Génie Rural) installed a small centralized water supply system in Feutap 2 to reduce the distance to the spring to the whole population. Water from a protected retention tank was pumped to a water tower located near the school (Figure 6a) and used to supply the population through 12 standpipes (Figure 7). Figure 6b shows such an old 'dry' standpipe from which no single drop of water has flowed since the end of the 1980s (>30 years).

(a)

Figure 5. *Cont.*

(**b**)

(**c**)

Figure 5. Photograph of protected springs in Feutap 1 (**a**), Feutap 2 (**b**), and a section of path to the spring of Feutap 2 (**c**). The spring of Feutap 2 is locally termed 'Spring NOBRA'. Own photograph, 9 January 2022.

It is not very clear how the system was supposed to be managed, but it is certain that used diesel was supplied by some willing village elites. Over time, the diesel was abandoned in favor of an electric pump. The non-payment of the electric energy by the beneficiary population led to the total cessation of the operation of the standpipes after some 3 to 4 years. Today, people have to go down to the shallows to get water, with the risks that this entails and the side effects that they have almost completely abandoned water storage at home (e.g., rainwater harvesting). An adaptive way to reduce the burden of water transport, both in Feutap 1 and Feutap 2, is to wash clothes and dishes at the source (Figure 5). Figure 5c shows a photograph of the path to the spring of Feutap 2. It gives an idea of the conditions to be braved to have some liters of water. This path is necessarily slippery after rain events. Children and elderly people have to walk this path every day.

(**a**) (**b**)

Figure 6. Photograph of the water tower (**a**) and a standpipe (**b**) in Feutap 2. Own photograph, 9 January 2022.

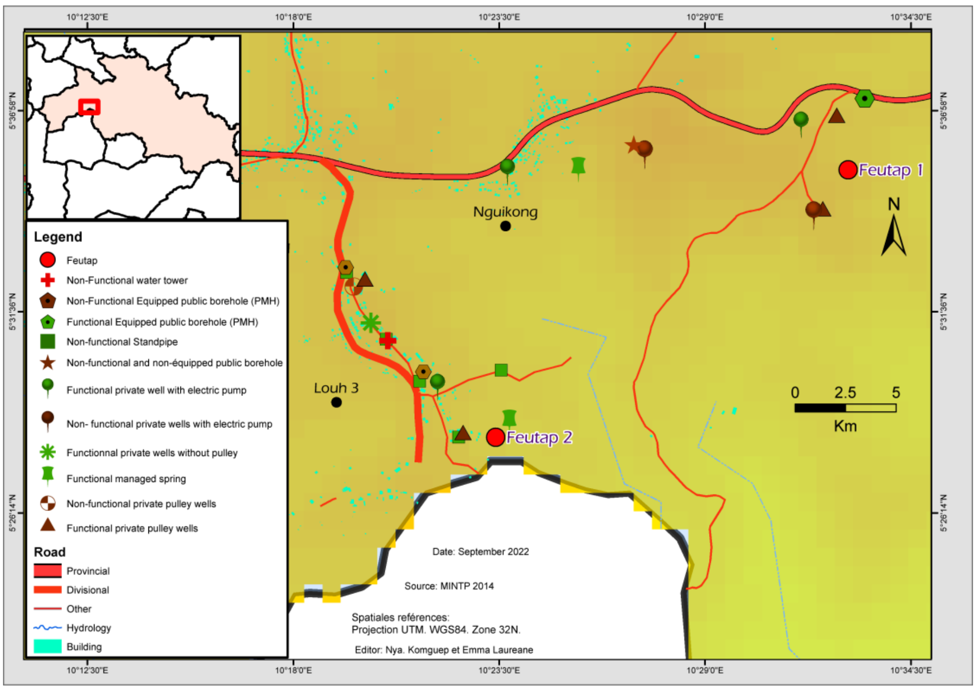

Figure 7. Map depicting the 12 standpipes in Feutap 2.

To draw water, people walk down to the shallows and come back up with some 30 kg of water on their heads.

2.3.3. Groundwater Sources

In 2008, the municipality of Bangangté constructed a borehole equipped with a hand pump at Feutap 1 [71]. This water point has regular breakdowns and almost dries up towards the end of the dry season; it is the only public drinking water point that supplies households (Figure 8). Prompt at installation, it was agreed that each household pays monthly F CFA 500 (about EUR 0.77) to assure the maintenance of this water point. Unfortunately, there was no willingness to pay, and whenever it breaks down, it is abandoned until the chief invests his own money to find a technician. In addition to these three water sources, there are four private wells in Feutap.

Figure 8. The single functional public borehole in Feutap 1 'Cogefar'. Own photograph, 9 January 2022.

In 2021, a borehole was drilled (about 120 m deep) and equipped with an electric pump to distribute drinking water to the population of Feutap 1. However, the borehole is not yet functional. Generally, to cope with the water shortage, middle-income households drill wells and equip them with either a pulley or an electric pump to facilitate drawing water. The construction of such decentralized systems requires considerable resources (more than EUR 6000, Section 6). However, given the high altitude of the area (Figure 1), and the corresponding low recharge area for groundwater, it is certain that wells and boreholes are not an environmentally sustainable solution.

To sum up, the population of Feutap does not currently have adequate access to safe drinking water. All residents rely on one human-powered borehole (Figure 8) and two managed springs (Figure 5) for water. They have to travel long distances (Figure 3) to fetch small amounts of water (up to 30 L per travel). To reduce the burden of water transport from these sources, dishwashing and laundry activities are practiced at the source with the inherent risk of biologically and chemically polluting fetched water (Figure 5). Thus, such activities should be prohibited in the immediate environment of a water point [72].

2.4. Drinking Water Supply in Feutap

Table 1 summarizes the current water supply facilities in Feutap, comprising 34 water points, of which 15 (field surveys, January 2022) are functional, while the remainder are non-functional. However, for more than 30 years, the 12 non-functional standpipes (Figure 6) and the corresponding water tower have been at best a source of hope for an even better future water supply system. Indeed, year after year, the Comité de Development de Feutap (CODEF), a local initiative for development, has been discussing strategies to revive this supply system, but still without success. Thus, currently, the whole village relies on two managed springs and one public borehole. The managed spring in Feutap 1 has a relatively low flow rate compared to the one in Feutap 2, which decreases significantly towards the end of the dry season (February/April). Private wells are increasingly being constructed to reduce the labor of water fetching from the spring in the valley. However, due to the high topography (Figure 1), most of these water points dry up completely between January and February. For all these reasons, it is imperative to revisit the water management approach in Feutap. The next section presents quantitative estimates of the water resources of Feutap.

Table 1. Baseline survey results of Feutap indicating the nature and functionality of sources of water (Stand: January 2022).

Quarters	Nature of the Water Point	Functionality	Number
Feutap 1	Managed spring (public)	Yes	1
	Public borehole with human-powered pump	Yes	1
	Private borehole with electric pump	No	1
	Private wells with pulley	Yes	2
	Private well with electric pump	Yes	2
	Private well with electric pump	No	2
Feutap 2	Managed spring (public)	Yes	1
	Private borehole with human-powered pump	No	2
	Private well with electric pump	Yes	2
	Private wells with pulley	Yes	6
	Private wells without pulley	No	1
	Water tower	No	1
	Public standpipes	No	12

The mountainous topography of Feutap, coupled with little or no surface freshwater sources (Figure 1), plays an important part in promoting and designing rainwater management systems [8,73]. Steep slopes and valleys cause rapid runoff of rainfall with minimal infiltration and recharge to the aquifer. Besides the few springs, this situation precludes the large-scale development of groundwater as a source of water supply for potable uses. Such unfavorable hydrological conditions conventionally imply the implementation of rainwater catchment systems as the main source of water for households [13,73–76]. This situation is also characteristic of small islands. However, small islands have the opportunity to use desalinated water even for potable water supply [77–79].

Before the advent of water desalination, constructed cistern systems for single-family residences had made life easy on many islands [76,77]. The most prominent historical example has been St. Eustatius (an island in the Caribbean, a special municipality of the Netherlands), "The Island without Water" in the colonial era [76,80]. As for mountainous regions, the cascades of India [81] and Sri Lanka [13] are the best examples demonstrating that constructing adequate rainwater storage reservoirs is a powerful tool to enable even irrigated agriculture under less favorable natural conditions.

3. Rainwater Harvesting (RWH) Supply vs. Water Demand Evaluation

As previously stated, RWH technology is proving to be a potential water source not yet well exploited in Feutap. Given the currently unreliable water resources in Feutap, RWH can lead to water-secured communities. Considering the population of 350 people and a minimal per capita daily demand of 30 L, a constant demand strategy method [82] was used in the water storage equation (Equation (1)) to estimate the maximum capacity of storage (m^3) and catchment area (m^2) required to meet the target demand in a given year. A roof runoff coefficient of 80% was adopted [82], and the researchers accessed a wide range of monthly rainfall data, stretching from 1951 to 2021 (70 years' data) [18]; thus, rainfall trends are well captured for depicting potential quantities. Figure 9 displays the variation in storage and catchment size in relation to the demand. These are the maximum values for a given demand size. The demand size analyzed varies considerably to accommodate situations where non-domestic uses such as food security and livelihood activities are to be served as well (Figure 9). Storage capacity as high as approximately 64,000 m^3 will be required for meeting a daily water demand as high as 175 m^3, harvested from a catchment of approximately 56,000 m^2. A storage of approximately 3900 m^3 will be required to meet a daily demand of 11 m^3, harvested from a catchment of approximately 3400 m^2. For comparison, 3400 m^2 is the area covered by 43 houses having a total roof area of 80 m^2 or 85 houses having a total roof area of 40 m^2. Roof areas are typically larger than 50 m^2 in Feutap. A Google count revealed that 460 houses are available in Feutap. Nevertheless, in the future, the local community may be advised on varying demand especially during the dry season in order to conserve more water and hence extend the supply duration. This can be achieved by limiting usage to basic needs only [83–85].

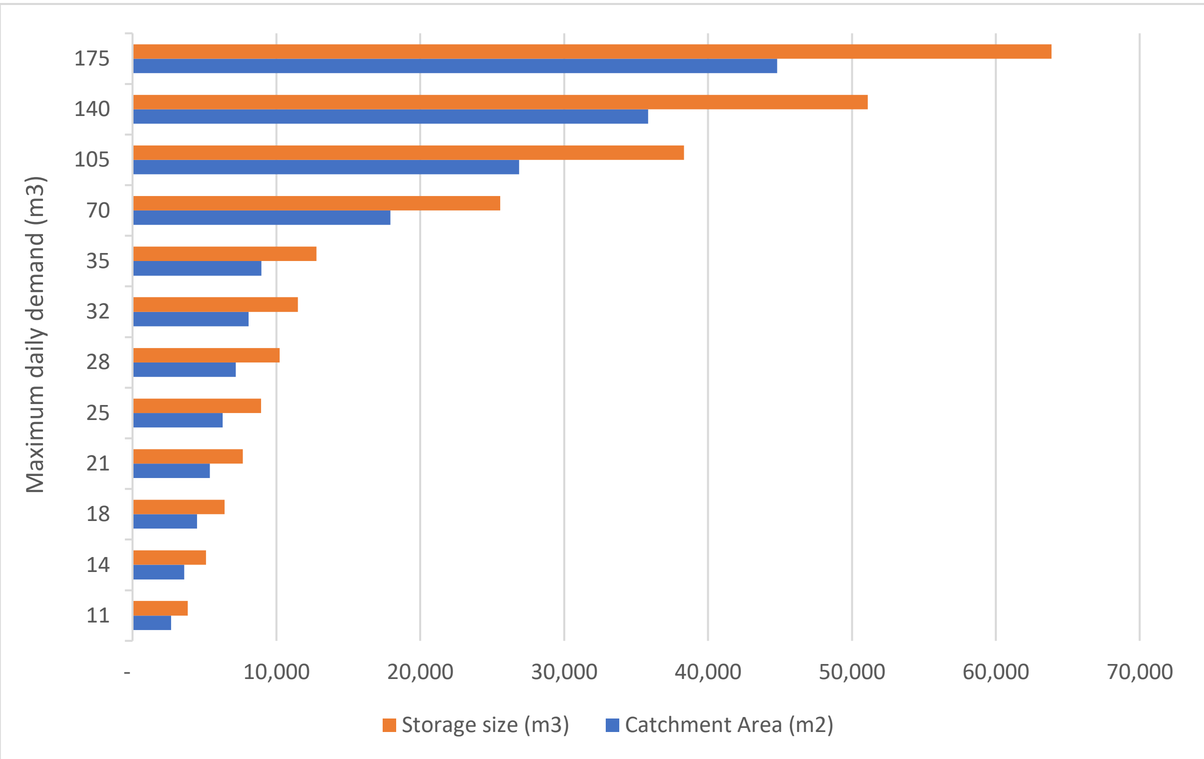

Figure 9. Illustration of water demand and resulting maximum catchment (m^2) and storage (m^3) sizes for securing the demand from roof catchments.

For unpaved surfaces, the runoff coefficient is typically lower than for roof areas (can be as low as 0.2); hence, larger catchment sizes are required for serving a specific demand size. Figure 10 displays the variation in storage and catchment size in relation to the demand for unpaved surfaces, where the runoff coefficient is approximated at 50%. Water harvested from such surfaces may be useful for food security and livelihood activities such as farming and livestock keeping. Although one will need a larger catchment, keeping surfaces unpaved is also beneficial in a way by naturally maintaining infiltration, hence recharging groundwater sources. A demand as low as 0.5 m^3 will need approximately 256 m^2 of catchment to attain a storage of 183 m^3 (Figure 10).

$$V = I \times A_c \times C \quad (1)$$

where V is the volume of rainwater harvested in an average year (m^3), I is the average rainfall amount in the year(m), A_c is the catchment area (m^2), and C is the runoff coefficient. Data on annual water demand provide a guide on the required storage capacity. With the consideration of the runoff coefficient, an indication of the effective catchment is provided.

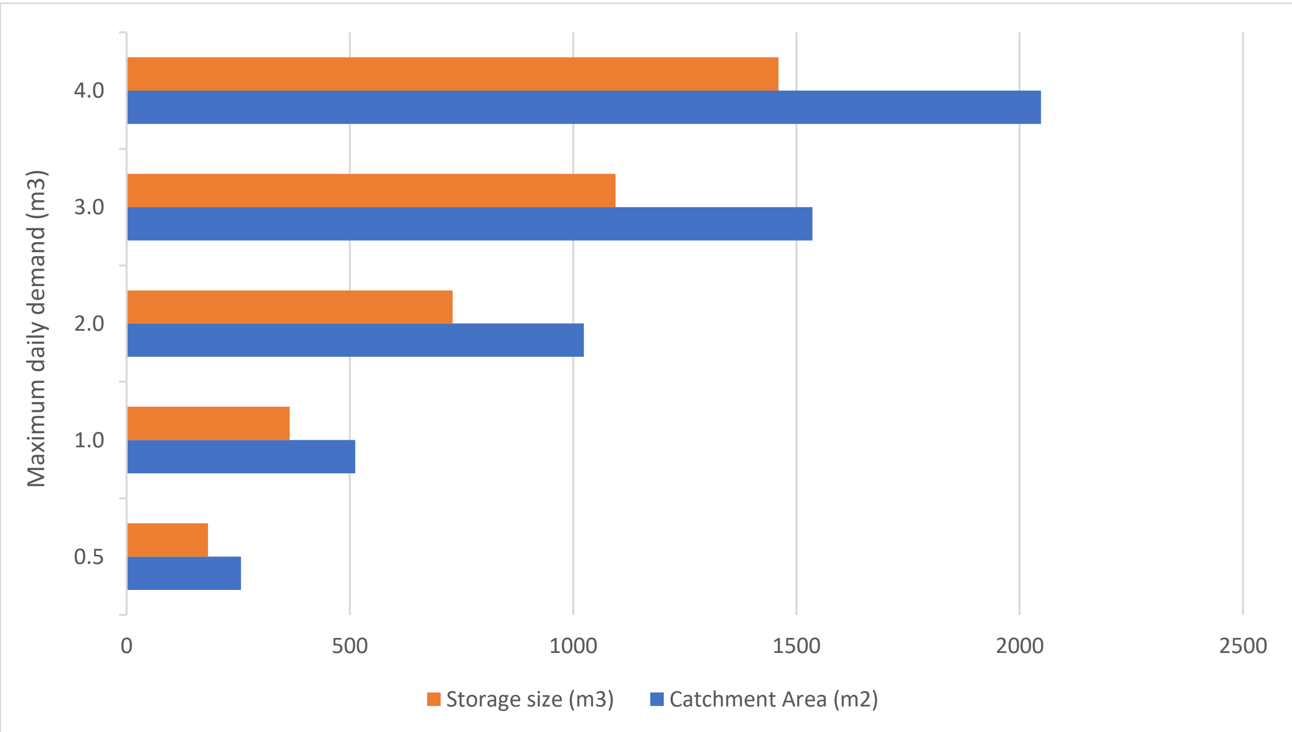

Figure 10. Illustration of water demand and resulting maximum catchment (m^2) and storage (m^3) sizes for securing the demand from unpaved surfaces.

For the illustrated capacities, it is recommended that, instead of having a single large storage facility, there should be a series of smaller-sized storage facilities, storing water from a collection of catchments (rooftops, surface) within Feutap. This is beneficial in terms of the management, operation, and maintenance of the infrastructure, as smaller units are easier to manage and control than large ones, hence ensuring effective performance. With a focus on ensuring service sustainability, decentralized systems are more recommended than centralized ones [86–91]. Fortunately, the KC is also about coordinating residential applications and large-scale non-residential RWH systems [8,9,25,28]. For example, basing the reasoning on individual houses having an average roof area of 80 m^2, the required 64,000 m^3 of water to meet a daily demand as high as 175 m^3 will be harvested from 700 houses (catchment area 56,000 m^2). This number can be regarded as huge for a community with less than 400 inhabitants. However, it shows that there is great potential for RWH in urban areas, including the city of Bangangté, which is still deficient in drinking water supply [19].

4. Achieving SDG 6.1 in Feutap

In Africa, information is limited on how to achieve and sustain positive transformations for human welfare at the national and sub-national levels [92]. Water supply is just an example for which the situation is worsened in fragile and marginal locations (e.g., coastal regions and mountains), which are additionally remote or/and rural. Feutap is such a remote, rural mountain community (Section 2). The future of Feutap can be regarded as dark when considering the expected substantial variability of onset and duration of the rainy season on water resources in a community where agriculture is exclusively rain fed. Fortunately, Brazil, China, India, Nepal, and Sri Lanka and their history teach that intensive irrigated agriculture is possible at altitudes higher than Feutap (>2000 m) and under drier conditions (<800 mm/y). Another historical fact about the glorious future of Feutap comes from St. Eustatius, an island in the Indian Ocean. Rainfall is not abundant on St. Eustatius, and there are no significant springs or underground water supplies. For water supply, inhabitants of St. Eustatius rely upon capturing and storing rainwater in brick cisterns [93]. A third case demonstrating the feasibility of the KC in Feutap is the water supply of Ekpoma in the Edo State of South-South Nigeria [94]. Here, people currently rely on rainwater under climatic conditions very similar to that of Feutap.

4.1. Lessons Learned from Water Supply in Colonial St. Eustatius

A number of lessons on water supply in Feutap may be drawn from similar cases elsewhere, such as in colonial St, Eustatius. St. Eustatius is a small Caribbean island in the Netherlands Antilles with relatively low relief, a semi-arid climate, and few natural freshwater sources. During the 17th and 18th centuries, the Dutch developed this little island into a world trade center with a large European and African population [93,95,96]. By 1900, its population averaged 8000 people. In the absence of natural freshwater, a steady supply and storage of water were needed. It is in this context that the cultural adaptation of cisterns used for the supply of freshwater occurred. Cisterns of different shapes and sizes were constructed on St. Eustatius. Cisterns were either part of the house or separate buildings in the yard. Public cisterns were also available and filled with rainwater collected from the roofs of administrative buildings. The island's relatively low relief means that little rain falls, keeping it relatively dry, and there are no swamps. Despite the large availability of cisterns at the household and community (government's reservoirs) levels, there were years in which the cisterns were empty and water had to be shipped from neighboring islands [93].

Enthoven [93] reported that the lack of water prevented St. Eustatius from developing into a full-fledged plantation economy. However, the colonial St. Eustatius clearly shows that it is possible to rely on water supply from cisterns. St. Eustatius was also a very healthy island with no yellow fever and no malaria, which were then the main killers in the Caribbean [93]. In other words, the second lesson from St. Eustatius is that a healthy life is possible in an "ocean" of water cisterns. Another lesson from the island is that in the absence of precipitation, cisterns were filled with water sailed from neighboring islands. Nowadays, desalinated ocean water would be an alternative water source. All these lessons are useful for water management today, even in mountain communities such as Feutap. A characteristic feature of Feutap that was advantageously used for water management in Sri Lanka is exactly its high altitude.

4.2. The Cascade of Sri Lanka

Ancient Sri Lankans developed a hydraulic civilization in harmony with the environment. They have demonstrated impressive skills in irrigation and water resources management. The dry zone of the country gets rain for only about 5 months a year. Reservoirs or tanks (e.g., dams, ponds) were built to store rainwater directly falling on each catchment, as well as to store water diverted from ephemeral or perennial rivers [97]. This unique hydraulic civilization is reported to be based on the following quote by King Parakramabahu (5th century BC): “No drop of water should flow into the sea without serving the interest of man” or “Let not allow a single drop of water falling as rain flow into the sea without being used for the benefit of mankind”. Based on this vision, colossal constructional efforts transformed the hills of Sri Lanka into networks of cisterns, drains, and reservoirs wherein each drop of rainwater is used and reused times and times before leaving the hill catchment [97–100].

In the arid zone of Sri Lanka. Rainwater on a catchment is collected in a cascade of small tanks and used and reused many times before coming to a large reservoir. Water from the large reservoir is used for irrigation [97,98,100]. In other words, in a region dryer than Feutap, ancient Sri Lankans developed irrigated agriculture [97,100]. Water stored in the cascade system was used for all other needs (e.g., domestic bathing and cooking, fisheries, livestock). Moreover, by feeding the large reservoirs, a series of small tanks reduced the silting problem and contributed to controlling erosion and floods. The cascade systems were maintained collectively by the villagers. The main lesson from Sri Lanka is that a cascade of tanks can be constructed in Feutap to enable irrigated agriculture.

4.3. Water Supply in Ekpoma (Edo State/Nigeria)

Ekpoma is a small town located in the Northern Ishan area of Edo State. It is the administrative headquarters of the Esan West Local Government Area. The city is located within latitudes 60,441° N and 60,451° N and longitudes 60,061° E and 60,081° E [101]. The towns in the Northern Ishan area have elevations ranging from 243.9 m to 426.6 m above sea level [102,103]. Ekpoma has mostly sedimentary bedrock with a groundwater aquifer located approximately 405 m below the Earth’s surface. Experience and investigations revealed limited groundwater recharge [73,103]. These conditions limit access to borehole water in the region. Ekpoma has two main weather seasons: (i) a rainy season occurring between March and November, with an average annual rainfall of 1562–1867 mm, and (ii) a dry season occurring between November and March [73,103]. The history of RWH in Ekpoma is difficult to trace back [73]. There is no planned RWH system in and around Ekpoma. Its unfavorable natural conditions have forced people to look for ways to secure a whole-year water supply [73]. Rich households have water tanks of different capacities (e.g., up to 18 m^3) and shapes (e.g., cylindrical, square). In the dry season, water is very expensive in Ekpoma. The poorest population of Ekpoma (without their own water tanks) buys harvested rainwater from rich households with water tanks. In 2020, 25 L of rainwater cost about 20 cents during the dry season [103]. However, this roof-top-harvested rainwater is of unknown quality [101–103]. Other water sources in Ekpoma comprise boreholes, rivers, wells, and public faucets. A recent field assessment showed that rainfall (54.1%) is the most abundant, widespread, and reliable source of surface water in Ekpoma [101,102].

Rainwater harvesting systems in Ekpoma are founded on exploiting available structures comprising corrugated iron roofing sheets, metal pipes, plastic polyvinyl chloride (PVC) pipes, concrete, and plastic storage tanks [103]. Pragmatic tools are sometimes used to prevent debris and dirt from roofs from collecting in storage tanks [103]. Tenebe et al. [103] reported that some storage tanks were relatively well covered with corrugated iron and asbestos sheets, while other storage tanks were left uncovered. However, a common observation is that there is no system to channel the harvested water to the point of use; thus, a large majority of residents can manually withdraw water from storage wells using buckets and long ropes, which poses risk to quality maintenance. To summarize, RWH is well known and largely used in Ekpoma under climatic conditions similar to Feutap. However, there is no coordinated water harvesting program, exposing the population to several avoidable sources of potential contamination such as (i) atmospheric pollutants and (ii) dirt from buckets and ropes.

4.4. The Current Water Management in Feutap

There are adequate water resources in Feutap for self-reliance in the water supply. However, appropriate strategies and technologies to harness the resources are lacking. Potable water demand (e.g., drinking, cooking) is met by water fetched from the two springs and a few wells (Table 1, Figure 5). Harvested rainwater from roofs (roof runoff) is only utilized by a few residents who store it in their own cisterns. Courtyard runoff, roadside runoff, and runoffs from farms and free lands are actually not harvested. Thus, there is no single existing structure to collect and store rainwater at the community scale (e.g., a cluster of neighboring residences) (Figure 11). Wastewater recycling and fire-fighting are unknown in Feutap. The few residences with modern toilets use well water or harvested rainwater for flushing. To lower the burden of fetching water, clothes, and dishes are washed at the springs (Figure 5). Clearly, there is a huge potential for rainwater harvesting in Feutap for both potable and non-potable demands (Section 3). Non-potable demands include clothes and dishes washing, irrigation, and toilet flushing. Sections 4.1–4.3 have identified rainwater tanks (including dams, lakes, and ponds) as key elements in securing sustainable levels of water services for Feutap.

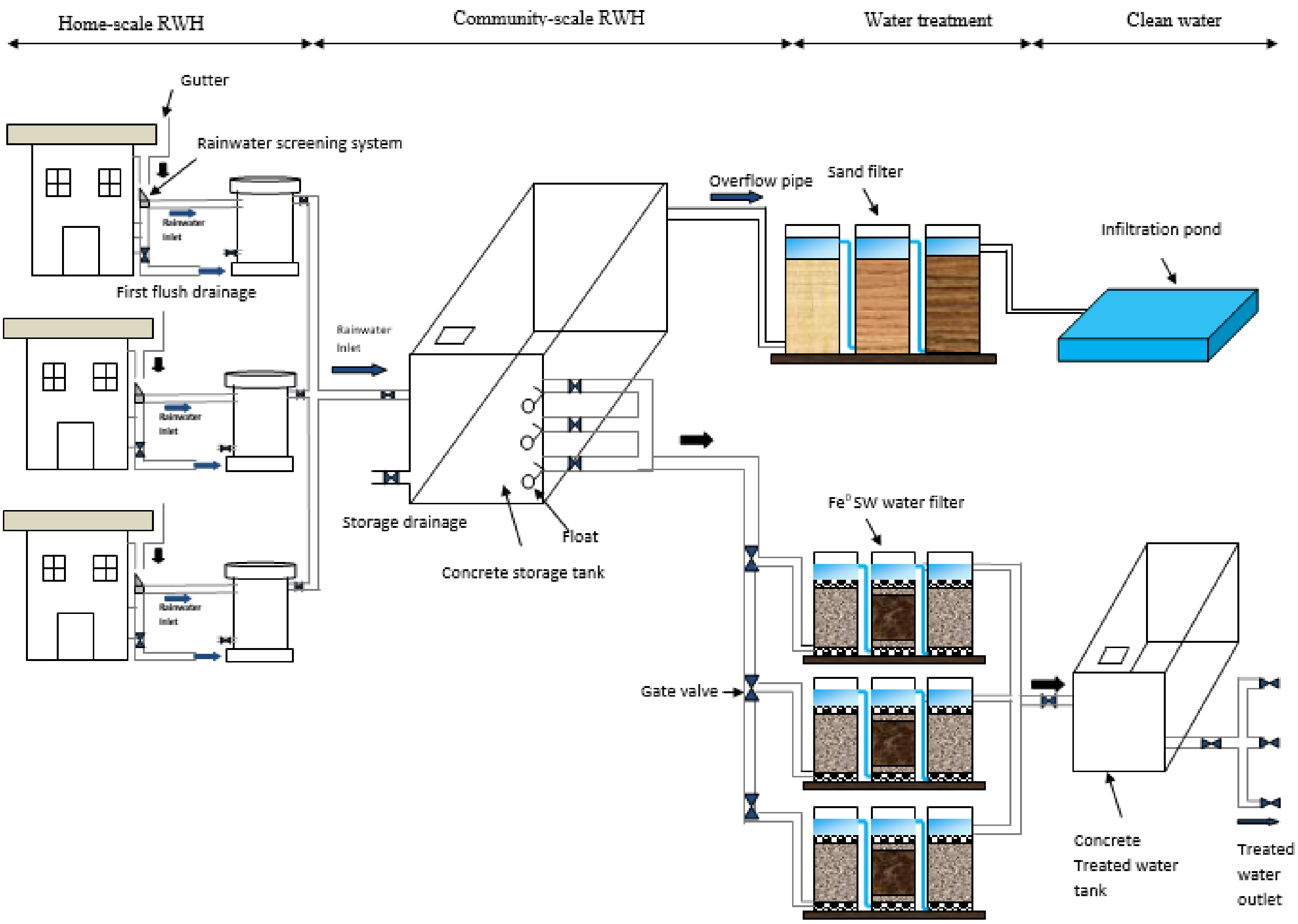

Figure 11. Configuration of a community rainwater harvesting system with a water treatment station. Community-scale water reservoirs are designed to collect overflows from cisterns and tanks from individual households and farms. Overflow from the community tank is directed to infiltration devices (e.g., ponds and wells). Fe^0 SW filter represents a sand filter amended with steel wool (Fe^0 SW) [104].

5. The Future Water Management in Feutap

Sections 4.1–4.3 have recalled the importance of RWH as a powerful means to overcome water scarcity caused by unfavorable natural conditions. In particular, individual cisterns enable water supply at the household level (St. Eustatius), while isolated tanks connected to ponds/tanks and reservoirs enable irrigated agriculture and livestock production (Sri Lanka). Technologies for RWH are part of collective memory in many cultures, but their large-scale productive exploitation is yet to be popularized [14,103–105]. For example, Kattel and Nepal [14] acknowledged that "harvesting rainwater for animals is an old-age tradition in the hills of Nepal but rainwater harvesting for agriculture is relatively a new phenomenon". As for Tanzania, large water harvesting ponds for agricultural purposes were common practices, with similar features from region to region, and even local names exist such as majaluba/ndiva [106]. This paper aims to extend this "new phenomenon" to Feutap in the hilly region of West Cameroon. This section discusses the step toward implementing generalized RWH on Feutap.

5.1. The Approach

The idea of introducing irrigated agriculture in Feutap is a step toward the application of the Kilimanjaro concept (KC) [8] in mountains. In retrospect, the KC is nothing but a rediscovery of the Ancient Sri Lankan cascade system. Being a rediscovery, there is no need for concept proof; all that is needed is how to locally fine-tune its application. Feutap is a series of hills that are inhabited for at least two centuries. There are no free parcels, even at the top of the Nyabeu. Accordingly, any space for the application of the KC has to be negotiated. As stated in Section 1, government development initiatives have not really reached Feutap. This is perhaps a blessing since Feutap is organized in self-created initiatives whose actions are more or less well coordinated by CODEF (Comité de Développement de Feutap).

Feutap is also the homestead of a regional NGO called APADER (Association pour la Promotion des Actions de Développement Endogènes Rurales), whose aim is to promote rural development. APADER is located in Feutap 1 (Bamena versant of Nyabeu) and has modern rooms for seminars and trainings. It is expected that APADER will assist in shaping new and profitable ecosystems on the hills of Feutap. The KC is introduced in Feutap by another NGO (Eau Potable Pour Tous (EPPT)), primarily interested in safe drinking water supply. Accordingly, APADER, CODEF, and EPPT are joining their efforts to enable better living conditions in Feutap. It is expected that the output will be highly transferable.

Practically, this article prepares RWH in Feutap on a home-by-home, farm-by-farm and hill-by-hill basis. Feutap is just the first step to achieve village-by-village RWH in the hilly landscape of West Cameroon (West and Northwest regions) with immediate possible extension to Eastern Nigeria, the Adamoua hills, and even the Mandara mountains (Cameroon and Nigeria). In essence, the KC is a holistic approach for basin-to-basin integrated water resources management with the potential to solve international crises, including conflicts. Rainfall is the only resource that vividly displays the concept of including all, as when it rains in an area, it rains on all regardless of profession/ethnicity/gender/income background. As an example, if rainwater is quantitatively harvested, partly infiltrated, and stored already on the top of the hills of Rwanda and Burundi, the severity of floods in Lake Victoria is automatically lessened.

5.2. Technical Aspects

On each hill, community tanks will be filled with water from smaller tanks. Small tanks are those installed in private homes or farms (domestic or household scale). A cascade tank system (CTS) is thus a series of hydraulically connected small tanks. The size of individual tanks depends ideally on the volume of harvestable water (Section 3) but practically on the affordability for the parcel owner (Section 6). The system collects, conveys, stores, and utilizes rainwater from roofs, courtyards, or lands (Figure 11). Generally, the tanks are arranged in linear or radial patterns, with sizes generally increasing with progression down the watershed [14,107].

Water from the roof is collected in vessels from various materials (e.g., concrete, plastic), shapes, sizes, and capacities (e.g., 500 to 10,000 L). Plastic vessels for RWH are largely available on the market in Bangangté, in different sizes. Ideally, a collection vessel comprises an inflow for receiving rainwater from the roof and an outflow (e.g., a faucet) to withdraw water. If many vessels are used in series, the vessel should be additionally equipped with an overflow outlet to drain water to the next vessel. Rainwater harvesting vessels constructed on ferro-cement have been reported to be the most economic and sustainable for rural water supply systems [107]. In the first instance, households in Feutap can use a series of vessels (Figure 12) and drain the excess water in a pond lined with a UV-resistant plastic liner (Figure 13). Residents can dig a pond of different sizes and capacities and use the collected water for irrigation purposes. This affordable tool can be used as a bridging solution for the rural poor before costly cisterns are built. It is important to cover the ponds to protect harvested water from the sun (evaporation) and dust, as well as to build fences to render the pond area non-accessible to animals (and children).

(**a**)

Figure 12. *Cont.*

(**b**)

Figure 12. Photographs of two 5000 L tanks: (**a**) a commercial plastic tank and (**b**) an Akkerman Calabash.

The price of an Akkerman Calabash (5000 L) (Figure 12b) was about EUR 240 in 2019 in Guinea-Bissau [107]. Despite inflation, it can be considered that its price is still lower than EUR 400 in Cameroon (December 2022). For comparison, a plastic tank with the same capacity costs EUR 609,70 (Figure 12a) in Bangangté. Residents of Feutap and local masons can be trained to construct hundreds of 5000 L (and 10,000 L) Calabashes for their own use. A Calabash is typically made with locally available tools and materials [107].

The Kilimanjaro Concept is a new approach that promotes integrated water resources management. It recommends the creation of a network to collect rainwater from roofs and uninhabited mountainous areas, store this collected water, treat it, and then use it to supply populations with drinking water. Feutap, by its physical characteristics (relief and hydrography), presents an adequate framework for the implementation of this system. KC in this area has both environmental and social economic benefits. Table 2 summarizes the KC benefits at Feutap. In summary, the KC provides in this area healthy, reliable, accessible, and quality water, available at all times for various uses. Therefore, water will be accessible at all points in the village and will allow farmers to carry out their agricultural tasks with much more ease and maximize harvests.

Figure 13. Plastic-lined pond for rainwater collection used in harvesting surface runoff for irrigation in Tanzania. Ponds should be covered to (i) minimize evaporation loss, (ii) protect harvested water from vagabonding animals, and (iii) avoid drowning of children. Own archive photograph, taken in Kilimanjaro region.

Table 2. Benefits of the application of the Kilimanjaro Concept (KC) in Feutap.

Domains Impacted	Advantages of KC in Feutap
- Living conditions	- Accessibility to safe water at short distances; - Permanent availability of water for consumption, agriculture, and household chores at a lower cost; - Durable drainage system which is applied to relieve demand pressure; - Improvement of the environment and living conditions of the population;
- Physical environment	- Rainwater collection and groundwater recharge; - Storage of collected water and redistribution during dry periods; - Reduction of surface runoff; - Development of faunal and floristic biodiversity; - Reduced risk of flooding and erosion.
- Local economy	- Facilitate the development of irrigated agriculture by integrating aquaculture and livestock; - Reduction of expenses related to waterborne diseases.
- Health	- Reduction of the prevalence rate of water-related diseases.

The KC will also play a very important role in the ecological balance of Feutap. Recharging the water table increases the amount of nutrients in the soil and promotes the growth and diversity of plants and animals. The permanent availability of water will increase the development of insect biodiversity which may further promote pollination [107–110].

This research examines fundamental issues necessary to expand Feutap's water needs, including (i) ensuring the reliability and safety of harvested rainwater, (ii) advising on infrastructure and technology for its village-scale collection and storage, and (iii) increasing community confidence in the future of water supply.

In Feutap, RWH is regarded as an effective method to supplement the supply of agricultural water. It helps save water resources and solves the problem of the lack of irrigation water [107,108]. If rainwater is collected effectively, it certainly reduces soil erosion and helps in the fight against climate change by serving as an adaptation strategy. Moreover, sensitization on understanding integrated water management will boost the engagement of people in self-reliant operation and maintenance of the systems.

5.3. The Economics

It is well established that small-scale irrigation significantly increases both the household income and nutrient intake of populations, particularly during the dry season [107,110–112]. Besides producing crops, harvested rainwater is also intended to revegetate land in Feutap (afforestation). In particular, mountain bamboos and valley raphia with a demonstrated ability to store large amounts of water in their roots will sustain afforestation in Feutap while supporting the supply of safe drinking water as known precursors of biochar production [113,114]. It is certain that combining all readily available tools to harvest rainwater is immediately affordable in Feutap. However, no detailed cost calculations and/or the payback periods can be given herein, mainly because of the high fluctuations in data for individual purposes (e.g., drinking water provision, irrigation water supply) [26,79,111,115]. Such analyses are omitted in this article for two other reasons: (i) they should be provided in a further study, and (ii) it is necessary to first present the concept to enable its implementation. Clearly, Feutap is the first planned pilot and demonstration project to prove the concept and gain practical experience. There is a great potential to extend the results of Feutap to the whole of Western Cameroon and Nigeria. The KC concept could soon be the best available and very effective measure to ensure clean water for drinking and agriculture. The application of the KC will certainly provide mountain residents with new economic impulses (Table 2).

It should be explicitly stated that attempts to compare the costs of engineered cisterns for rainwater harvesting (e.g., 30 m^3) to that of a tube well for water supply in Feutap are conceptually wrong. This is because harvesting rainwater (even without artificial infiltration) increases the productivity of wells and decreases the demand for well water (Section 3). However, the main argument against wells, especially for irrigation, is that on the mountain the recharging surface is small and groundwater recharge is minimal. This is why available wells dry out towards the end of the dry season (Section 2). In other words, the sole acceptable cost comparison is between systems to harvest rainwater: (i) Akkerman Calabash (5 or 10 m^3), (ii) commercial PVC tanks (0.25 to 10 m^3), (iii) engineered concrete cisterns (up to 100 m^3), (iv) excavated cisterns such as plastic-lined ponds (e.g., 6 m^3), and (v) infiltration wells.

6. The Kilimanjaro Concept in Feutap

6.1. General Aspects

Accessibility to safe clean water remains a challenge in Feutap despite the wide availability of frugal water treatment technologies [19,26–28]. This mountain community is still reliant on natural waters whose availability and quality are subjected to weather conditions: (i) limited amounts of clear water in the dry season and (ii) abundant amounts in the rainy season with eroded sediments (Section 2). This water crisis is exacerbated by changing lifestyles (modernization), climate change, and population growth. In particular, climate change is expected to induce varying rainfall patterns contributing to soil erosion and deadly flooding in lower localities (e.g., in the urban area of Bangangté). Climate change will significantly impact agricultural production and water insecurity, resulting in food insecurity [114]. Currently, there is limited awareness and inadequate data to address all these key issues (e.g., food security, soil erosion, water quality, and quantity) in the short term using the conventional approach. Especially, in the (still highly) centralized political system of Cameroon, local information (where available) is seldom used in planning and decision-making. In Feutap, there is a lack of actionable planning to mitigate possible impacts of climate change and this task relies on voluntary efforts of some individuals (e.g., chief, elites) and associations (e.g., APADER, CODEF, EPPT) (Section 2). Based on the state-of-the-art knowledge of rainwater harvesting and the global expertise in integrated water management, this section explores paths to solve all the named problems in Feutap using a holistic approach. Clearly, infrastructural and systemic weaknesses as well as lack of funds are considered known variables to propose a viable solution.

The viable solution proposed herein is the Kilimanjaro Concept (KC), establishing an optimum use of rainwater (precipitation) in Feutap. Intensifying rainwater harvesting (household and small-scale), extending storage facilities, and improving artificial infiltration into soils are the three pillars of this approach [8,25]. Storing rainwater primarily resolves the problem of water scarcity, despite climate changes (e.g., decreased or inconsistent rainfall) and population growth. On the other hand, storing rainwater has the potential to decrease or even eliminate dependency on rain-fed agriculture, as demonstrated by Ancient Sri Lanka (Section 4). Obviously, the KC has the potential to boost agricultural production (e.g., crops, fisheries, livestock) and create new ecosystems capable of mitigating the negative impacts of climate change. In Feutap, in particular, the introduction of mountain bamboo plantations would produce a viable precursor for biochars used in safe drinking water provision [112,115]. Clearly, it is about making the following possible in Feutap: food security, new ecosystems, new jobs (e.g., in food and water production), and an all-year safe drinking water supply. This section prepares the introduction of the KC in Feutap.

6.2. Infrastructural Aspects

There are no municipal services in Feutap and subsistence agriculture is still the main source of income (Section 2). The scarce income opportunities limit the provision of conventional water supply systems. Alternative measures are thus needed for access to a clean water supply. The Kilimanjaro Concept (KC) as proposed for Feutap is an adaptation of a group of nature-inspired strategies to locally promote the accumulation of water reserves in the subsurface and support the joint management of surface waters and groundwaters [27,116]. In this approach, roof rainwater and surface runoff are harvested and stored or infiltrated using infiltration basins, ditches, lakes, shafts, ponds, and wells. This operation recharges the aquifer and enhances the productivity of wells and springs. The advantages of infiltration wells as summarized by Szabó et al. [117] include (i) faster increase of groundwater level, (ii) lower evaporation loss, (ii) lower risk of biological activity, and (iv) smaller surface area use. However, infiltrated water should be of adequate water quality in order to avoid groundwater contamination [116–118].

The strategy to implement the KC in Feutap should be progressive while not relying (only) on large technical investments for engineered water reservoirs (e.g., cisterns and tanks). This is because of financial issues (Section 2). The plan is to encourage the progressive construction of reservoirs of different sizes mostly for storing road runoff and overflow from individual households (Figure 11). At the household level, residents will be encouraged to install underground cisterns, construct Calabash (e.g., 5000 L) [107], or buy diverse water reservoirs on the local market. In other words, before (expensive) newly engineered water reservoirs are built, rooftop rainwater coupled with hand-dug wells and plastic-lined ponds will be used to start integrated water management in Feutap. Such wells are already available in a few compounds and farms. They are actually not used because either they have dried out, or because the water table was not reached and the well project was abandoned. Using these wells for infiltration is advantageous for water management, as recently demonstrated in Hungary [117]. Such wells can be filled with gravel and/or sand to eliminate the risk that vagabonding animals fall and die in water. Alternatively, their access can be avoided by (i) constructed fences or (ii) installed covers in various materials (e.g., bamboo or iron sheets).

In summary, the implementation of the KC in Feutap requires the equipment of individual households with roof rainwater harvesting devices (e.g., gutters and downpipes, reservoirs), the procurement of weather-resistant plastic liners for ponds, and the installation of settlement-level water reservoirs. It is important that all available houses in Feutap join this collective effort, including the house of elites which are inhabited just a few weeks per year. Actually, the owners of such houses are more likely to afford installations for the realization of the KC concept. Treatment plants for safe drinking water should be considered as well (Figure 11). Rooftop rainwater and rainwater stored in household excavated cisterns, when properly harvested, is rarely polluted [107]. Its quality depends on several important factors, including (i) the location of the site (distance from pollutant sources) and (ii) the physico-chemical properties of the materials used for roof and gutters [116]. However, at the community scale, care must be taken to avoid the careless behaviors of a few residents affecting public health. Fortunately, frugal technologies for water treatment exist and can be easily customized for treating rainwater in Feutap [28,104].

6.3. Economic Aspects

The implementation of small-scale rainwater harvesting systems in Feutap can be inspired by the plan presented by Cresti [119] for the hilly Bisate Village in Rwanda. In Bisate, household rainwater catchment systems were planned to improve water consumption from less than 5 to more than 15 L/day/person [119]. The unit component of this system is a house (roof) or a compound (roof + courtyard). The challenge is to present a low-cost system that can be immediately adopted and implemented by all households in Feutap. In Bisate, the designed household rainwater catchment system consisted of an excavated pond of 6 m^3 volume, lined with a plastic tarpaulin sheet and covered with a lid (e.g., wood and iron). The system was completed with a hand pump to extract water. Feutap can adopt this system as a bridging solution while progressively installing more performant systems with larger concrete cisterns (below ground) and tanks (above ground).

There are three size classes of storage systems for RWH: small ($V < 1$ m^3), medium ($1 < V$ (m^3) ≤ 20), and large ($V > 20$ m^3) [119]. Small-size storage systems include clay or ceramic jars, plastic buckets, and old oil drums. Such storage vessels can supply household water demand for a few days or weeks in Feutap. However, greater storage is required to supply water all year round, including during the whole dry season, 5 months (Figure 2). Therefore, depending on the size of the family (water demand) medium and large tanks or cisterns for domestic rainwater catchment systems are needed (Section 3) [118–120].

A large number of options for storage systems at the household level exist [121–126]. Such systems vary in construction materials, shapes, and sizes. Selecting an appropriate storage system (cistern or tank) depends mainly on its affordability. It is evident that certain families would not afford any type of reservoir demanding money expense. As a consequence, this study considers the materials and skills locally available to construct cisterns such that willing residents can earn money by selling their labor (human capital) in assisting professional masons. The geology and the soil conditions in the populated area of Feutap are favorable for cistern construction, space is richly available in each compound, and there is a water storage tradition (Section 2). So, all that is missed is money. This study discusses the affordability of household-level storage cisterns with 30 m^3 capacity. The advantages of cisterns as summarized by Cresti [119] are the following: (i) they are located below ground (less material for walls), (ii) cisterns require little or no space above ground, and (iii) they are less likely to be damaged. As disadvantages of cisterns, the two following can be cited: (i) the need for pumps to extract water and (ii) the need for hand pumps to drain cisterns for cleaning.

Cost Analysis of a Household RWH System Comprising a 30 m^3 Cistern

This study focuses on designing an affordable household cistern to complete a domestic rainwater catchment system. This household system is a unit component for the envisaged community-scale RWH system. The proposed 30 m^3 cistern is based on (i) the findings of this work (Section 3) and (ii) the available experience found in Feutap. The selection of a solution for the delivery system, on the other hand, is based on the type of gutters and downpipes found on the local market (Bangangté): PVC semicircular gutters and downpipes. Depending on the size of the house (roof area), selected households can build several cisterns in series or larger ones. The calculations for a 30 m^3 cistern are used as a starting point, local masons can be trained to assemble them from pre-constructed plates.

The primary goal of identifying the cost of the rainwater catchment system is twofold: (i) to understand whether the proposed solution is affordable for the community of Feutap and (ii) to evaluate which types of financial assistance can be suitable to sustain the project. The average size of a household in Feutap is 6 persons or 180 L water/day (Section 3). This corresponds to 65,880 L water/year or 27,450 L water for the 5 months of the dry season. Thus, 30 m^3 cisterns make individual households self-reliant on water supply while the overflow collected in community tanks and cisterns can be used for agricultural purposes (Figure 12).

Table 3 gives an estimation of the costs for a 30 m^3 cistern. The prices represent what the market is offering as of December 2022 (rate of exchange 1 EUR for F CFA 655, BEAC). More thorough research on local market conditions in the future is recommended, in order to better optimize the total cost for the household catchment systems. However, it is clear that constructing a 30 m^3 cistern for about EUR 3300 (F CFA 2,162,190) is far less expensive than installing a borehole for more than EUR 6000 (F CFA 4,000,000). In other words, there is no scientific reason to go for expensive solutions that are endangering the future of water resources in Feutap.

As discussed above, the household rainwater catchment system will provide water inside or nearby the house. This is essential as it would drastically reduce travel time for women and children to fetch water. The time not wasted on daily "water walks" will be used for better school attendance and trade activities. This will increase education levels in Feutap while increasing the average annual income of each individual resident. To summarize, designing household (and community) rainwater harvesting systems is a powerful tool to achieve higher standards of living in Feutap. For this reason alone, the Government of Cameroon, for instance through the municipality of Bangangté should facilitate the implementation of the KC in Feutap through subsidies and loans.

This paper can be regarded as a general preliminary work for African projects similar to the Brazilian One Million Cisterns Programme (P1MC—Portuguese acronym) launched in 2000 [127–130]. P1MC was part of organized civil society actions with the primary goal to guarantee safe drinking water for farming families using simple and inexpensive strategies. Within 20 years, P1MC has benefited 628,355 families and clearly demonstrated the potential to stimulate regional economic development while contributing to increasing food security whilst enabling an environmentally friendly and community-centered approach [129,131,132]. Another very successful example is the large-scale dissemination of rainwater harvesting in semi-arid Gansu (China) during the 1990s and 1980s through the 1-2-1 project [133–136]. The 1-2-1 project was very successful and has basically solved the drinking water problems of more than a million people. The project has also led to a dramatic improvement in the living standards of rural residents, starting by eliminating the need to spend time and energy hauling water from distant sources.

Table 3. Estimation of costs for a buried concrete water cistern with 30,000 L (30 m^3) capacity.

Item	Cost Per Unit	Number Of Units	Total Cost	Total Cost
	(F CFA)	(F CFA)	(F CFA)	(EUR)
Bricks	400	320	128,000	195,42
Sand	55,000	2	110,000	167,94
Gravel	120,000	2	240,000	366,41
Cement	5450	50	272,500	416,03
Waterproof cement	6000	20	120,000	183,21
Water	10,000	5	50,000	76,34
Steel rebar FeE215	1600	16	25,600	39,08
Steel rebar FeE400	4525	24	108,600	165,80
Steel rebar FeE400a	6450	12	77,400	118,17
Hydrofuge (sikali 5 L)	20,000	2	40,000	61,07
Iron nails 80 mm	4500	5	22,500	34,35
Iron wire	9000	2	18,000	27,48
Formwork material	150,000	1	150,000	229,01
Other usables	120,000	1	120,000	183,21
Transport	30,000	1	30,000	45,80
Unskilled labor	3500	43,2	151,200	230,84
Mason fees	498,390	1	498,390	760,90
		Total	2,162,190	3,301,05

6.4. Cultural Aspects

Local culture is regarded as the real driver favoring the implementation of the KC in Feutap. There are two popular proverbs in Feutap, related to own water (private water source). The first says “Borrowed water cannot fill the calabash” or “Borrowed water cannot cook the meal” (Proverb 1). The second states, “The calabash get filled sooner when water comes from different sources” (Proverb 2). The KC is exactly a materialization of these two aspects of water management: (i) a private water cistern belonging to the household and (ii) overflow from private citterns filling the community’s reservoirs. An “invisible” meaning of Proverb 2 is that infiltrated water from individual compounds (e.g., infiltration pits) will increase the productivity of springs and wells in Feutap. To be complete, a third proverb can be considered: “Money behaves like rain” (Proverb 3). Proverb 3 means that money can finish at any time, just like rain. So, it is wise to store rainwater and to cope with money so as to be able to live joyfully when it has “gone”.

There is also a strong culture of associative life in Feutap. This was positively experienced by the authors during the field study. Women and children are ready to daily walk to fetch and carry water from the springs (Figure 3). Women are also leading in associations where a system on tontine exists to support costly projects. A tontine is a non-taxed credit where money is collected and given to one member of the association on a weekly or monthly basis [60,137]. Depending on the size of the association, each member can benefit once or twice per year. It suffices to fix the contribution in such a way that the sum will enable financing a cistern to see the era of rainwater cisterns starting in Feutap.

Feutap already regards the KC as its own initiative. The residents are ready to safely store drinking water at home (Proverb 1), just as they store corn, beans, and ground nuts inside the house. They are ready to maintain community reservoirs and start small farm businesses in the village (Proverb 2). The three named associations (e.g., APADER, CODEF, EPPT) will accompany the project and avoid community properties that suffer from the syndrome of "the tragedy of commons". CODEF as Feutap's own development initiative will care for collaboration with the municipality, CODEF will assist the residents in realizing new opportunities for water availability such as biological farming, while EPPT will monitor water management aspects and prepare the transfer of the KC to other localities.

6.5. Public Health Aspects

As mentioned in previous sections, rainwater can be polluted due to the following factors: (i) atmospheric deposition and microbial contamination, (ii) land use practices (e.g., agriculture, mining), (iii) roof material (e.g., Pb, Zn) and nature of cisterns/tanks, (iv) weather patterns (e.g., acid rain), and (v) the interactions between these factors (e.g., leaching of roof materials). Therefore, knowledge of rainwater quality is critical for safeguarding public health. Rainwater quality and its suitability for potable purposes have been discussed in several recent review articles [138–144]. To summarize, the following is certain: (i) under certain environmental conditions and while observing harvesting and storage precautions, rainwater is potable [107], (ii) in all other cases, rainwater should be treated using appropriate technologies [104,138–144]. Huang et al. [27] recently summarized some applicable frugal filtration technologies, including filtration on metallic iron (Fe^0), for instance, steel wool (Fe^0 SW) [104,145] (Figure 11). In Feutap, we recommend frequent water quality control, including periodical instrumental laboratory analysis of samples from households and community cisterns.

It should be explicitly stated here that chlorination is not considered an option for water disinfection in Feutap. Chlorination is conventionally used as an effective and inexpensive tool to treat water at the household level in order to reduce the incidence of diarrheal disease [142,146]. However, certain microorganisms have been shown to display increased resistance to chlorination [142,146,147]. On the other hand, the residents of Feutap would tend to use a commercial sodium hypochlorite locally known as 'Eau de Javel' to treat water. Eau de Javel is basically a bleaching agent, also used for odor removal. However, this technical solution should not be used by a layperson for water disinfection, the main reason being that it is an unstable substance. The residual activity determines its efficiency for water disinfection, and using the wrong solution would give the illusion that water is treated.

7. Toward a New Economic Era in Feutap?

The Kilimanjaro Concept strives at intercepting rainwater and using it close to where it falls for commercial, domestic, industrial, and institutional purposes, as well as agriculture, livestock, and groundwater recharge. In Feutap, it is about designing arrangements to (i) intensively store rainwater and (ii) cause rainfall to percolate the ground rather than run off its surface. It is about the construction of reservoirs to capture rainwater (not only from roofs and other impermeable surfaces) and use for livestock and micro-irrigation. Thus, rainwater is the principal (and not a supplementary) source of water for both potable and non-potable applications in Feutap. The KC uses both ancient and modern systems to collect and store rainwater from household level (some hundreds of m^2) to many hectares in order to serve large numbers of people. In other words, learning from situations where RWH systems were used because any alternative forms of water supply are lacking, including arid and remote locations (Sections 4.1–4.3), the KC is suggested herein to initiate an era of prosperity in Feutap.

Since the 1850s and the introduction of centralized water distribution systems in Europe, the industrialized world has partly abandoned RWH for several decades [87]. The ruling urban design paradigm is governed by the slogan "rain to the river" [148,149] in which rainwater is regarded as a "disturbing factor" (or a "running waste") to be channeled as quickly as possible to the next river. However, with issues related to the costs of drinking water, limited water resources, severity of floodings, and stormwater pollution, the role of RWH is being reassessed [150–154]. As learned from Ancient Sri Lanka

(Section 4.3) [155–157] and Gansu, China [132–136], RWH offers a number of environmental and economic benefits which will shape the future of Feutap and other communities. This is because the presented concept respects the framework for sustainable and replicable rural water supply systems [158,159]. The first benefit of the application of the KC in Feutap is to assist the Government of Cameroon to provide an adequate supply of safe drinking water to all residents in the coming years and thus achieving the UN SDGs 6.1 in Feutap.

It is essential to point out that, in some instances, without the KC concept, achieving universal access to safe drinking water in Feutap needs a high level of capital investment, but with an uncertain end. This is because surface water is lacking (Figure 1) while groundwater is limited and has already shown low productivity during the dry season (Section 2). On the contrary, RWH makes in-home water available and increases spring and well productivity while reducing the demand for both well and spring water. In other words, the first economic consequence is that the KC concept creates an excess of readily available surface water in Feutap, in particular at the spring NOBRA in Feutap 2 (Figure 4). Provided this water is of good quality, it can be bottled and sold in the region and abroad. There are just two prerequisites to transform spring NOBRA into a permanent income generator for Feutap and the municipality of Bangangté: (i) protect the catchment area of the spring (no polluting activities) and (ii) permanently monitor the water quality of the spring (e.g., monthly). The municipality of Bangangté should also routinely monitor the quality of community reservoirs.

There is currently a call for investments in drinking water testing as a means to increase awareness of water quality and its link to public health [22,23,160,161]. This paper has presented a very feasible way to achieve water availability in Feutap [159]. Although rainwater is of relatively good quality [87] and easy to treat to potable standards [27,28], its quality still has to be routinely monitored. This is the mission of the government through the municipality of Bangangté. This municipality is hereby encouraged to equip an analytical water laboratory in Bangangté. According to Ogisma [161] a modest laboratory can be equipped for less than USD 80,000. This amount corresponds to our own estimations based on robust devices, which are labor intensive in operating but light in maintenance.

Coming back to Feutap, the KC makes excess drinking water available, which is regarded as the first perennial "export product" to fight and possibly defeat poverty. On the other hand, collected and stored rainwater can be used for various purposes including irrigation and animal husbandry, and thus subsistence agriculture is restored [162,163] and sustained. Residents are expected to collect rainwater in self-dug ponds with varying capacities (e.g., up to 30 m^3, or even larger). This will create awareness among the residents that self-supply is possible and motivate efforts for new achievements based on more or less readily available resources, including rainwater. Based on the expertise of APADER (e.g., high-yielding seeds, training seminars), organic farming is expected to play a key role in shaping the prosperous future of Feutap.

8. Recommendations

Considering that the targeted Kilimanjaro Concept aims at maximizing water availability of high demand for domestic and agricultural uses, affordable traditional indigenous and modern techniques should be both used to harvest water at all levels. This approach will also cope with the event of erratic rainfall patterns as a result of climate change. In other words, even considered obsolete storage facilities for storing rainwater are welcome as they are still conducive for rainwater harvesting and reducing surface runoff in Feutap. To this end, it is recommended that:

- A partnership concept should be developed between the municipality of Bangangté and active associations in Feutap (e.g., APADER, CODEF, EPPT) for effective and efficient water supply. This is because the provision of safe drinking water is not a task that the residents should do alone.

- The construction of community-scale storage systems in Feutap should be planned and realized to reduce the problem of water scarcity and/or reduce the distance to the water source for the residents who cannot afford their own cisterns.
- Government should provide assistance (loans, subsidies) to the residents to construct rainwater harvesting systems at household and farm levels to enhance water supply.
- The installation of single-household gray water recycling schemes should be advocated and implemented by the municipality. This is the best way to introduce modern sanitation practices while creating awareness of their importance for public health.
- Community mobilization, focused group discussion, installation of diverse storage tanks for RW collection, training workshops on RWH and conservation, and publication of case studies should be regularly organized by the municipality and the civil society.
- The municipality of Bangangté (representing the Government of Cameroon) should endorse the responsibility for good water quality. Health officers should be routinely deployed and equipped to inspect and monitor the various sources of water.

To successfully introduce ponds and tanks in Feutap, three levels have to be considered in the design step: (i) household, (ii) farm or compound, and (iii) community. Information on the availability and each m^2 of land should be made available. The whole Feutap population should be trained on the opportunities offered by large-scale RWH. In particular regarding agriculture and livestock production as a part of extension services. This training will motivate the adoption of RWH technology, which significantly increases annual household income from agriculture and livestock. There is no doubt that RWH technology is viable in Feutap, where agricultural systems are exclusively rain fed. By adopting RWH, Feutap can diversify from cereal crops into high-value off-season vegetable crops for enhancing household income and farm profits.

9. Concluding Remarks

The article has identified constraints to develop and promote catchment-scale RWH for residents on the hills of Feutap who are small-holder farmers in the majority. Intended beneficiaries are the rural poor, including landless, unemployed youths, and women, all of whom have traditionally derived the least or no benefit from development programs. It is intended to promote a participatory approach to design and implement the targeted research. Research outputs should include (i) policy guidelines to planners and donors, (ii) research guidelines to scientists, and (iii) technical guidelines to engineers. The presented concept gives, for the very first time, an opportunity for the population of Feutap to experience irrigated agriculture while possibly integrating aquaculture and livestock.

Households of Feutap currently face poverty and a lack of monetary income. They will lack money for start-up costs for adopting the technology. The knowledge for operation and maintenance will be given in continuous training until RWH develops to the collective memory of Feutap. The lack of start-up money can be overcome by (i) subsidizing the RWH technology as a part of the climate change adaptation strategy, (ii) encouraging the village elites and other donors (e.g., church, NGO) to finance community tanks, and (iii) encouraging communal authorities to incorporate the installation and maintenance of rural RWH systems in their daily duties.

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References

1. UN SDGs. Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution Adopted by the UN General Assembly, 25 September 2015. Available online: https://sustainabledevelopment.un.org/post2015/transformingourworld (accessed on 26 January 2022).
2. World Health Organization; United Nations Children's Fund. *Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines*; World Health Organization: Geneva, Switzerland, 2017. Available online: https://data.unicef.org/resources/progress-drinking-water-sanitation-hygiene-2017-update-sdg-baselines (accessed on 6 March 2022).
3. Zhang, Z.; Zhang, W.; Hu, X.; Li, K.; Luo, P.; Li, X.; Xu, W.; Li, S.; Duan, C. Evaluating the efficacy of point-of-use water treat-ment systems using the water quality index in Rural Southwest China. *Water* **2020**, *12*, 867. [CrossRef]
4. Kemajou, D.N. Climate variability, water supply, sanitation and diarrhea among children under five in Sub-Saharan Africa: A multilevel analysis. *J. Water Health* **2022**, *20*, 589–600. [CrossRef]
5. Shannon, M.A.; Bohn, P.W.; Elimelech, M.; Georgiadis, J.G.; Marinas, B.J.; Mayes, A.M. Science and technology for water purification in the coming decades. *Nature* **2008**, *452*, 301–310. [CrossRef]
6. Hering, J.G.; Maag, S.; Schnoor, J.L. A call for synthesis of water research to achieve the sustainable development goals by 2030. *Environ. Sci. Technol.* **2016**, *50*, 6122–6123. [CrossRef]
7. Nanseu-Njiki, C.P.; Gwenzi, W.; Pengou, M.; Rahman, M.A.; Noubactep, C. Fe^0/H_2O filtration systems for decentralized safe drinking water: Where to from here? *Water* **2019**, *11*, 429. [CrossRef]
8. Marwa, J.; Lufingo, M.; Noubactep, C.; Machunda, R. Defeating fluorosis in the East African Rift Valley: Transforming the Kilimanjaro into a rainwater harvesting park. *Sustainability* **2018**, *10*, 4194. [CrossRef]
9. Pembe-Ali, Z.; Mwamila, T.B.; Lufingo, M.; Gwenzi, W.; Marwa, J.; Rwiza, M.J.; Lugodisha, I.; Qi, Q.; Noubactep, C. Application of the Kilimanjaro Concept in Reversing Seawater Intrusion and Securing Water Supply in Zanzibar, Tanzania. *Water* **2021**, *13*, 2085. [CrossRef]
10. Schiller, E.J.; Latham, B.G. A generalized method for designing rainwater collectors. *Canadian Water Resour. J.* **1992**, *17*, 121–127. [CrossRef]
11. Mays, L.; Antoniou, G.P.; Angelakis, A.N. History of water cisterns: Legacies and lessons. *Water* **2013**, *5*, 1916–1940. [CrossRef]
12. Espíndola, J.G.; Sánchez, Y.C.; Flores, C.C. Mexican rainwater harvesting movement in recent years. In *International Rainwater Catchment Systems Experiences: Towards Water Security*; Espíndola, J.A.G., Flores, C.A.C., Pacheco-Vega, R., Montes, M.R.P., Eds.; IWA Publishing: London, UK, 2020; pp. 73–82. [CrossRef]
13. Indika, S.; Wei, Y.; Cooray, T.; Ritigala, T.; Jinadasa, K.B.S.N.; Weragoda, S.K.; Weerasooriya, R. Groundwater-Based Drinking Water Supply in Sri Lanka: Status and Perspectives. *Water* **2022**, *14*, 1428. [CrossRef]
14. Kattel, R.R.; Nepal, M. Rainwater harvesting and rural livelihoods in Nepal. In *Climate Change and Community Resilience: Insights from South Asia*; Haque, A.K.E., Mukhopadhyay, P., Nepal, M., Shammin, M.R., Eds.; Springer Nature: Berlin/Heidelberg, Germany, 2022.
15. Oyerinde, A.O.; Jacobs, H.E. Determinants of household water demand: A cross-sectional study in South West Nigeria. *J. Water Sanit. Hyg. Dev.* **2022**, *12*, 200–207. [CrossRef]
16. Oyerinde, A.O.; Jacobs, H.E. The complex nature of household water supply: An evidence-based assessment of urban water access in Southwest Nigeria. *J. Water Sanit. Hyg. Dev.* **2022**, *12*, 237–247. [CrossRef]
17. Njoyim, E.B.T.; Menga, T.R.; Mofor, N.A.; Nchofua, F.B.; Njoyim, I.K. Evaluation of surface and ground water quality in the Bangangte municipality—West Cameroon. *Int. J. Res. Rev. Appl. Sci.* **2016**, *28*, 53–64.
18. Nya, E.L. Access to Drinking Water and Sanitation in Nde Division, Cameroon. Ph.D. Dissertation, University of Yaoundé I, Yaoundé, Cameroon, 2020; p. 483.
19. Nya, E.L.; Feumba, R.; Fotsing-Kwetché, P.R.; Gwenzi, W.; Noubactep, C. A hybrid model for achieving universal safe drinking water in the medium-sized city of Bangangté (Cameroon). *Water* **2021**, *13*, 3177. [CrossRef]
20. Wagner, E.G.; Lanoix, J.N. *Water Supply for Rural Areas and Small Communities*; Monograph Series of the World Health Organization Series No. 42; World Health Organization: Geneva, Switzerland, 1959.

21. Hussam, A. Contending with a development disaster: Sono filters remove arsenic from well water in Bangladesh. *Innovations* **2009**, *4*, 89–102. [CrossRef]
22. Kozicki, Z.A.; Baiyasi-Kozicki, S.J. The survival of mankind requires a water quality and quantity index (WQQI) and water applied testing and environmental research (WATER) centers. *World Water Policy* **2019**, *5*, 55–70. [CrossRef]
23. Hubbart, J.A.; Gootman, K.S. A call to broaden investment in drinking water testing and community outreach programs. *Challenges* **2021**, *12*, 32. [CrossRef]
24. Ndé-Tchoupé, A.I.; Tepong-Tsindé, R.; Lufingo, M.; Pembe-Ali, Z.; Lugodisha, I.; Mureth, R.I.; Nkinda, M.; Marwa, J.; Gwenzi, W.; Mwamila, T.B.; et al. White teeth and healthy skeletons for all: The path to universal fluoride-free drinking water in Tanzania. *Water* **2019**, *11*, 131. [CrossRef]
25. Qi, Q.; Marwa, J.; Mwamila, T.B.; Gwenzi, W.; Noubactep, C. Making Rainwater Harvesting a Key Solution for Water Supply: The Universality of the Kilimanjaro Concept. *Sustainability* **2019**, *11*, 5606. [CrossRef]
26. Huang, Z.; Cao, V.; Nya, E.L.; Gwenzi, W.; Noubactep, C. Kanchan arsenic filters and the future of Fe0-based filtration systems for single household drinking water supply. *Processes* **2021**, *9*, 58. [CrossRef]
27. Huang, Z.; Nya, E.L.; Cao, V.; Gwenzi, W.; Rahman, M.A.; Noubactep, C. Universal access to safe drinking water: Escaping the traps of non-frugal technologies. *Sustainability* **2021**, *13*, 9645. [CrossRef]
28. Huang, Z.; Nya, E.L.; Rahman, M.A.; Mwamila, T.B.; Cao, V.; Gwenzi, W.; Noubactep, C. Integrated water resource management: Rethinking the contribution of rainwater harvesting. *Sustainability* **2021**, *13*, 8338. [CrossRef]
29. Mwenge-Kahinda, J.; Taigbenu, A.E. Rainwater harvesting in South Africa: Challenges and opportunities. *Phys. Chem. Earth* **2011**, *36*, 968–976. [CrossRef]
30. Kuller, M.; Dolman, N.J.; Vreeburg, J.H.G.; Spiller, M. Scenario analysis of rainwater harvesting and use on a large scale–assessment of runoff, storage and economic performance for the case study Amsterdam Airport Schiphol. *Urban Water J.* **2017**, *14*, 237–246. [CrossRef]
31. Uppala, P.; Dey, S. Design of potential rainwater harvesting structures for environmental adoption measures in India. *Polytechnica* **2021**, *4*, 59–80. [CrossRef]
32. Laskar, N. Reviving traditional rain-water harvesting system and artificial groundwater recharge. *Sādhanā* **2022**, *47*, 258. [CrossRef]
33. Khan, A.S. A Comparative analysis of rainwater harvesting system and conventional sources of water. *Water Resour. Manag.* **2023**, *37*, 2083–2106. [CrossRef]
34. Cook, S.; Sharma, A.K.; Gurung, T.R. Evaluation of alternative water sources for commercial buildings: A case study in Brisbane, Australia. *Resour. Conserv. Recycl.* **2014**, *89*, 86–93. [CrossRef]
35. Nnaji, C.C.; Aigbavboa, C. A scenario-driven assessment of the economic feasibility of rainwater harvesting using optimized storage. *Water Resour. Manag.* **2020**, *34*, 393–408. [CrossRef]
36. Abbasi, T.; Abbasi, S.A. Sources of pollution in rooftop rainwater harvesting systems and their control. *Crit. Rev. Environ. Sci. Technol.* **2011**, *41*, 2097–2167. [CrossRef]
37. Amos, C.C.; Ahmed, A.; Rahman, A. Sustainability in water provision in rural communities: The feasibility of a village scale rainwater harvesting scheme. *Water Resour. Manag.* **2020**, *34*, 4633–4647. [CrossRef]
38. Nya, E.L.; Lufingo, M.; Njau, K.N.; Gwenzi, W.; Wydra, K.; Keding, G.; Noubactep, C. Making decentralized options the pillar for universal access to safe drinking water in Africa. *Kenya Policy Briefs*, 2022; *in press*.
39. Jasrotia, A.S.; Majhi, A.; Singh, S. Water balance approach for rainwater harvesting using remote sensing and GIS techniques, Jammu Himalaya, India. *Water Resour. Manag.* **2009**, *23*, 3035–3055. [CrossRef]
40. Jamali, B.; Bach, P.M.; Deletic, A. Rainwater harvesting for urban flood management—An integrated modelling framework. *Water Res.* **2020**, *171*, 115372. [CrossRef]
41. Taddele-Dile, Y.; Karlberg, L.; Temesgen, M.; Rockström, J. The role of water harvesting to achieve sustainable agricultural intensification and resilience against water related shocks in sub-Saharan Africa. *Agric. Ecosyst. Environ.* **2013**, *181*, 69–79. [CrossRef]
42. Cheo, A.E.; Amankwah, E.; Techoro, P.S. Water Harvesting: A potential means for water security in the Far North Region of Cameroon. *Agric. Res.* **2014**, *3*, 331–338. [CrossRef]
43. Macias-Corral, M.A.; Sanchez-Cohen, I. Rainwater harvesting for multiple uses: A farm-scale case study. *Int. J. Environ. Sci. Technol.* **2019**, *16*, 5955–5964. [CrossRef]
44. Neupane, N.; Paudel, S.; Sapkota, R.; Joshi, Y.P.; Rijal, Y.; Chalise, A. Enhancing the resilience of food production systems for food and nutritional security under climate change in Nepal. *Front. Sustain. Food Syst.* **2022**, *6*, 968998. [CrossRef]
45. Staddon, C.; Rogers, J.; Warriner, C.; Ward, S.; Powell, W. Why doesn't every family practice rainwater harvesting? Factors that affect the decision to adopt rainwater harvesting as a household water security strategy in central Uganda. *Water Int.* **2018**, *43*, 1114–1135. [CrossRef]
46. Ako Ako, A.; Nzali, C.T.; Lifongo, L.L.; Nkeng, G.E. Rainwater harvesting (RWH): A supplement to domestic water supply in Mvog-Betsi, Yaoundé- Cameroon. *Water Supply* **2022**, *22*, 1141–1154. [CrossRef]
47. Mbua, R.L. Water Supply in Buea, Cameroon: Analysis and the Possibility of Rainwater Harvesting to Stabilize the Water Demand. Ph.D. Dissertation, Brandeburg University of Technology, Cottbus, Germany, 2013.
48. Cheo, A.E. Understanding seasonal trend of rainfall for the better planning of water harvesting facilities in the Far-North region, Cameroon. *Water Util. J.* **2016**, *13*, 3–11.

49. Cheo, A.E. Integrated Water Resources Management (IWRM): The Case Study of the Far-North Region, Cameroon. Ph.D. Dissertation, Brandenburg University of Technology, Cottbus, Germany, 2018.
50. Zoyem-Tedonfack, S.; Nfor, J.T. Rainfall variability and quantity of water supply in Bamenda I, Northwest Region of Cameroon. In *African Handbook of Climate Change Adaptation*; Springer International Publishing: Cham, Switzerland, 2021; pp. 713–733. [CrossRef]
51. Ntali, Y.M.; Lyimo, J.G.; Dakyaga, F. Trends, impacts, and local responses to drought stress in Diamare Division, Northern Cameroon. *World Dev. Sustain.* **2023**, *2*, 100040. [CrossRef]
52. Pachpute, J.S.; Tumbo, S.D.; Sally, H.; Mu, M.L. Sustainability of rainwater harvesting systems in rural catchment of Sub-Saharan Africa. *Water Resour. Manag.* **2009**, *23*, 2815–2839. [CrossRef]
53. Ishaku, H.; Majid, M.R.; Johar, F. Rainwater harvesting: An alternative to safe water supply in Nigerian rural communities. *Water Resour. Manag.* **2012**, *26*, 295–305. [CrossRef]
54. Andoh, C.; Gupta, S.; Khare, D. Status of rainwater harvesting (RWH) in Ghana. *Curr. World Environ.* **2018**, *13*, 172. [CrossRef]
55. Durodola, O.S.; Bwambale, J.; Nabunya, V. Using every drop: Rainwater harvesting for food security in Mbale, Uganda. *Water Pract. Technol.* **2020**, *15*, 295–310. [CrossRef]
56. Nguyen, X.C.; Nguyen, T.T.H.; Bui, X.T.; Tran, X.V.; Tran, T.C.P.; Hoang, T.H.; La, D.D.; Chang, S.W.; Ngo, H.H.; Nguyen, D.D. Status of water use and potential of rainwater harvesting for replacing centralized supply system in remote mountainous areas: A case study. *Environ. Sci. Pollut. Res.* **2021**, *28*, 63589–63598. [CrossRef]
57. Egerton, F.C.C. *Record of Refuge at the Court of the King of Bangangté in the French Cameroon*; George Routledge and Sons, Ltd.: London, UK, 1938.
58. Scarrone, F. Les productions végétales en pays Bamiléké au Cameroun Français. *J. Agric. Tradit. Bot. Appl.* **1950**, *30*, 158–167. [CrossRef]
59. Tardits, C. *Les Bamiléké de l'Ouest Cameroun*; Berger-Levrault: Paris, France, 1960.
60. Hurault, J. Essai de synthèse du système social des Bamiléké. *Africa* **1970**, *40*, 1–24. [CrossRef]
61. Tchindjang, M. Le rebord du plateau Bamiléké autour de Bangangté. In *Mémoire de Géographie Physique*; University of Yaoundé: Yaoundé, Cameroon, 1985; 125p.
62. Puertas, D.G.L.; Woldearegay, K.; Mehta, L.; van Beusekom, M.; Peréz, M.A.; van Steenbergen, F. Roads for water: The unused potential. *Waterlines* **2014**, *33*, 120–138. [CrossRef]
63. Notué, J.P.; Perrois, L. *Les sociétés secrètes chez les Bamiléké de l'Ouest-Cameroun*; ISH-ORSTOM: Yaoundé, Cameroon, 1984; 144p.
64. Tatuebu-Tagne, C.; Bopda, A. L'Ouest-Cameroun et l'héritage du maquis (1955–1971). Temps "longs", "moyens" et "courts" de la géographie d'une population de territoire terrorisé. In *Population, Temps, Territoires*; Session, F., Ed.; 2020; Available online: https://cist2020.sciencesconf.org (accessed on 26 January 2022).
65. Obeta, M.C. Rural water supply in Nigeria: Policy gaps and future directions. *Water Policy* **2018**, *20*, 597–616. [CrossRef]
66. Obeta, M.C. Private for-profit rural water supply in Nigeria: Policy constraints and options for improved performance. *J. Water Land Dev.* **2019**, *41*, 101–110. [CrossRef]
67. Chinyere-Onyeche, L. Emerging trends in access to drinking water in Etche Ethnic Nationality of Niger Delta, Nigeria, from pre-colonial era until now. *World Water Policy* **2021**, *7*, 52–62. [CrossRef]
68. Tsalefac, M. L'ambiance Climatique Dans Les Hautes Terres de l'Ouest Cameroun. Ph.D. Thesis, 3ème cycle de Géographie, University of Yaoundé, Yaoundé, Cameroon, 1983; 398p.
69. Klingborg, P.; Finné, M. Modelling the freshwater supply of cisterns in ancient Greece. *Water Hist.* **2018**, *10*, 113–131. [CrossRef]
70. Farhat, N.; Subramanian, S.V. *Water Management across Space and Time in India*; ZEF Working Paper Series, No. 61; University of Bonn, Center for Development Research (ZEF): Bonn, Germany, 2010.
71. Nya, E.L. Approvisionnement en eau et Impacts Sur la Santé des Populations Dans la Ville de Bangangté et sa Périphérie. Master's Thesis, Université de Yaoundé 1, Yaoundé, Cameroon, 2014; 174p.
72. Makokove, R.; Macherera, M.; Kativhu, T.; Gudo, D.F. The effect of household practices on the deterioration of microbial quality of drinking water between source and point of use in Murewa district, Zimbabwe. *J. Water Health* **2022**, *20*, 518–530. [CrossRef] [PubMed]
73. Egunjobi, L. Rainwater harvesting initiatives in Ekpoma, Nigeria. In *Water, Sanitation, Environment and Development, Proceedings of the 19th WEDC International Conference, Accra, Ghana, 6–10 September 1993*; Water, Engineering and Development Centre, Loughborough University of Technology, WEDC: Loughborough, UK, 1993; pp. 57–59. Available online: https://repository.lboro.ac.uk/articles/conference_contribution/Rainwater_harvesting_initiatives_in_Ekpoma_Nigeria/9595532 (accessed on 6 March 2023).
74. Smith, W.J., Jr. Problem-centered vs. discipline-centered research for the exploration of sustainability. *J. Contemp. Water Res. Ed.* **2009**, *142*, 76–82. [CrossRef]
75. Peters, E.J. Water quality of rainwater cisterns in the Grenadines. *West Indian J. Eng.* **2011**, *33*, 56–64.
76. Gould, J. Rainwater harvesting for domestic supply. In *Rainwater Harvesting for Agriculture and Water Supply*; Springer: Singapore, 2015; pp. 235–268.
77. Fernando-Gumbs, A.; Dierberg, F.E. Heavy metals in the drinking water from cisterns supplying single-family dwellings. *Water Int.* **1985**, *10*, 22–28. [CrossRef]

78. Smith, W.J., Jr. Improving access to safe drinking water in rural, remote, and least wealthy small islands: Non-traditional methods in Chuuk State, Federated States of Micronesia. *Int. J. Environ. Waste Manag.* **2009**, *10*, 167–189.
79. Peter, S.; Schirmer, M.; Lathan, P.; Stimpfl, G.; Ibrahim, B. Performance analysis of a solar-powered multi-purpose supply container. *Sustainability* **2022**, *14*, 5525. [CrossRef]
80. Harper, R.K. An Ethnoarchaeological Study of the Cisterns in Oranjestad, Sint Eustatius, Netherlands Antilles. Master's Thesis, College of William & Mary, Williamsburg, VA, USA, 1990. [CrossRef]
81. Van Meter, K.J.; Basu, N.B.; Tate, E.; Wyckoff, J. Monsoon harvests: The living legacies of rainwater harvesting systems in South India. *Environ. Sci. Technol.* **2014**, *48*, 4217–4225. [CrossRef] [PubMed]
82. Thomas, T.H.; Martinson, D.B. *Roofwater Harvesting: A Handbook for Practitioners*; IRC International Water and Sanitation Centre: Delft, The Netherlands, 2007.
83. Prinz, D. Water harvesting: Past and future. In *Sustainability of Irrigated Agriculture. Proceedings, NATO Advanced Research Workshop, Vimeiro, Portugal, 21–26 March 1994*; Pereira, L.S., Ed.; Balkema: Rotterdam, The Netherlands, 1996; pp. 135–144.
84. Mwamila, T.B.; Han, M.Y.; Kim, T.I.; Ndomba, P.M. Tackling rainwater shortages during dry seasons using a socio-technical operational strategy. Water Sci. Technol. *Water Supply* **2015**, *15*, 974–980. [CrossRef]
85. McAllister, G.; Wright, J. Agroecology as a practice-based tool for peacebuilding in fragile environments? Three stories from rural Zimbabwe. *Sustainability* **2019**, *11*, 790. [CrossRef]
86. Han, M.Y.; Mun, J.S. Particle behaviour consideration to maximize the settling capacity of rainwater storage tanks. *Water Sci. Technol.* **2007**, *56*, 73–79. [CrossRef]
87. Domènech, L. Rethinking Water Management: From Centralised to Decentralised Water Supply and Sanitation Models. *Doc. Anal. Geogr.* **2011**, *57*, 293–310. [CrossRef]
88. Mankad, A.; Tapsuwan, S. Review of socio-economic drivers of community acceptance and adoption of decentralised water systems. *J. Environ. Manag.* **2011**, *92*, 380–391. [CrossRef]
89. Moglia, M.; Sharma, A.; Alexander, K.; Mankad, A. Perceived performance of decentralised water systems: A survey approach. *Water Sci. Technol. Water* **2011**, *11*, 516–526. [CrossRef]
90. Moglia, M.; Alexander, K.S.; Sharma, A. Discussion of the enabling environments for decentralised water systems. *Water Sci. Technol.* **2011**, *63*, 2331–2339. [CrossRef] [PubMed]
91. Ross, T.T.; Alim, M.A.; Rahman, A. Community-scale rural drinking water supply systems based on harvested rainwater: A case study of Australia and Vietnam. *Water* **2022**, *14*, 1763. [CrossRef]
92. Rockström, J.; Falkenmark, M. Agriculture: Increase water harvesting in Africa. *Nature* **2015**, *519*, 283–285. [CrossRef]
93. Enthoven, V. That abominable nest of pirates: St. Eustatius and the North Americans, 1680–1780. *Early Am. Stud. Interdiscip. J.* **2012**, *10*, 239–301. [CrossRef]
94. Magnus, O.O. Assessment of rain water harvesting facilities in Esanland of Edo state, Nigeria. *J. Hum. Ecol.* **2011**, *34*, 7–16. [CrossRef]
95. Howard, B.P. Fortifications of St Eustatius: An Archaeological and Historical Study of Defense in the Caribbean. Master's Dissertation, The College of William and Mary, Williamsburg, VA, USA, 1991.
96. Van Keulen, F. The Island without Water: The Cisterns of St. Eustatius in the Colonial Era. Master's Dissertation, Leiden University, Leiden, The Netherlands, 2018.
97. Ranaweera, M.P. Sustainable development, ancient wisdom and Sri Lankan technology. In Proceedings of the International Conference on Sustainable Built Environment (ICSBE-2010), Kandy, Sri Lanka, 14–26 December 2010.
98. Murray, F.J.; Little, D.C. *The Nature of Small-Scale Farmer Managed Irrigation Systems in North West Province, Sri Lanka and Potential for Aquaculture*; Institute of Aquaculture, University of Stirling: Stirling, Scotland, 2000; Available online: https://hdl.handle.net/1834/20684 (accessed on 19 September 2022).
99. Shannon, K.; Manawadu, S. Indigenous landscape urbanism: Sri Lanka's reservoir and tank system. *J. Landscape Arch.* **2007**, *2*, 6–17. [CrossRef]
100. Vidanage, S.P.; Kotagama, H.B.; Dunusinghe, P.M. Sri Lanka's small tank cascade systems: Building agricultural resilience in the dry zone. In *Climate Change and Community Resilience*; Haque, A.K.E., Mukhopadhyay, P., Nepal, M., Shammin, M.R., Eds.; Springer: Singapore, 2022; pp. 225–235. [CrossRef]
101. Alens, O.P. Assessment of the use of surface water and its environmental health effects in Ekpoma, Nigeria. *Int. J. Dev. Sust.* **2017**, *6*, 2147–2161.
102. Tenebe, I.T.; Emenike, P.C.; Nnaji, C.C.; Babatunde, E.O.; Ogarekpe, N.M.; Dede-Bamfo, N.; Omole, D.O. Bacterial characterization and quantification of rainwater harvested in a rural community in Nigeria. *Environ. Nanotechnol. Monit. Manag.* **2020**, *14*, 100370. [CrossRef]
103. Tenebe, I.; Emenike, P.C.; Babatunde, E.O.; Neris, J.B.; Fred-Ahmadu, O.H.; Dede-Bamfo, N.; Etug, E.-E.; Ogarekpeh, N.M.; Emakhui, J.; Nsikak, B.U. Assessing the state of rainwater for consumption in a community in dire need of clean water: Human and health risk using HERisk. *Water Pract. Technol.* **2022**, *17*, 2005–2022. [CrossRef]
104. Tepong-Tsindé, R. Designing and Piloting a household filter for the peri-urban population of Douala (Cameroon). *Freiberg Online Geosci.* **2021**, *61*, 1–80.
105. Vargas-Parra, M.V.; Rovira-Val, M.R.; Gabarrell, X.; Villalba, G. Rainwater harvesting systems reduce detergent use. *Int. J. Life Cycle Assess.* **2019**, *24*, 809–823. [CrossRef]

106. Mwamila, T.B. Rainwater Harvesting Potential and Management Strategies for Sustainable Water Supply in Tanzania. Ph.D. Thesis, Civil and Environmental Engineering Department, Seoul National University, Seoul, Republic of Korea, 2016; p. 168.
107. Akkerman, P. The Calabash Cistern 5000 L in Africa. In *International Rainwater Catchment Systems Experiences: Towards Water Security*; Espíndola, J.A.G., Flores, C.A.C., Pacheco-Vega, R., Montes, M.R.P., Eds.; IWA Publishing: London, UK, 2020. [CrossRef]
108. Li, F.; Cook, S.; Geballe, G.T.; Burch, W.R. Rainwater harvesting agriculture: An integrated system for water management on rainfed land in China's semiarid areas. *AMBIO A J. Human Environ.* **2000**, *29*, 477–483. [CrossRef]
109. Burney, J.A.; Naylor, R.L. Smallholder irrigation as a poverty alleviation tool in sub-Saharan Africa. *World Dev.* **2012**, *40*, 110–123. [CrossRef]
110. Kifle, M.; Engdaw, D.; Alemu, K.; Sharma, H.R.; Amsalu, S.; Feleke, A.; Worku, W. Work related injurie and associated risk factor among iron and steel industries workers in Addis Abeba. *Ethiopia* **2014**, *63*, 211–216.
111. Mango, N.; Makate, C.; Tamene, L.; Mponela, P.; Ndengu, G. Adoption of small-scale irrigation farming as a climate-smart agriculture practice and its influence on household income in the Chinyanja Triangle, Southern Africa. *Land* **2018**, *7*, 49. [CrossRef]
112. Burney, J.; Woltering, L.; Burke, M.; Naylor, R.; Pasternak, D. Solar-powered drip irrigation enhances food security in the Sudano–Sahel. *Proc. Natl. Acad. Sci. USA* **2010**, *107*, 1848–1853. [CrossRef] [PubMed]
113. Gwenzi, W.; Chaukura, N.; Noubactep, C.; Mukome, F.N.D. Biochar-based water treatment systems as a potential low-cost and sustainable technology for clean water provision. *J. Environ. Manag.* **2017**, *197*, 732–749. [CrossRef]
114. Nakawuka, P.; Langan, S.; Schmitter, P.; Barron, J. A review of trends, constraints and opportunities of smallholder irrigation in East Africa. *Glob. Food Secur.* **2018**, *17*, 196–212. [CrossRef]
115. Fusco, G. Climate rcurity in the Northern and Eastern African Regions: A Panel Data Analysis. *Sustainability* **2022**, *14*, 12664. [CrossRef]
116. Karlvin, J.; Lik-Pueh, L.L.; Ai-Wie, T.I. Determination of suitable biochar precursor as alternative for enabling access to clean water supply in rural areas. *J. Sust. Sci. Manag.* **2022**, *17*, 66–78. [CrossRef]
117. Szabó, Z.; Pedretti, D.; Masetti, M.; Ridavits, T.; Csiszár, E.; Falus, G.; Palcsu, L.; Mádl-Szőnyi, J. Rooftop rainwater harvesting by a shallow well—Impacts and potential from a field experiment in the Danube-Tisza interfluve, Hungary. *Groundw. Sust. Dev.* **2023**, *20*, 100884. [CrossRef]
118. Page, D.; Bekele, E.; Vanderzalm, J.; Sidhu, J. Managed aquifer recharge (MAR) in sustainable urban water management. *Water* **2018**, *10*, 239. [CrossRef]
119. Cresti, D. Analysis and Design of Household Rainwater Catchment Systems for Rural Rwanda. Master's Dissertation, Massachusetts Institute of Technology, Cambridge, MA, USA, 2007.
120. Rees, D.; Nyakaana, S.; Thomas, T. *Very-Low-Cost Roofwater Harvesting in East Africa*; Domestic Rainwater Harvesting Research Programme; University of Warwick: Coventry, UK, 2000.
121. Muchangi-Mbogo, E. Factors Influencing Adoption of Rain Water Harvesting Technologies among Households in Mbeere South Sub-County, Kenya. Master's Dissertation, University of Nairobi, Nairobi, Kenya, 2014.
122. Rahman, S.; Khan, M.T.R.; Akib, S.; Din, N.B.C.; Biswas, S.K.; Shirazi, S.M. Sustainability of rainwater harvesting system in terms of water quality. *Sci. World J.* **2014**, *2014*, 721357. [CrossRef]
123. Binyam, A.Y.; Desale, K.A. Rainwater harvesting: An option for dry land agriculture in arid and semi-arid Ethiopia. *Int. J. Water Resour. Environ. Eng.* **2015**, *7*, 17–28. [CrossRef]
124. Lade, O.; Oloke, D. Modelling rainwater system harvesting in Ibadan, Nigeria: Application to a residential apartment. *Am. J. Civil Eng. Archit.* **2015**, *3*, 86–100.
125. Bernard, B.; Joyfred, A. Contribution of rainfall on rooftop rainwater harvesting and saving on the slopes of Mt. Elgon, East Africa. *Sci. World J.* **2020**, *2020*, 7196342. [CrossRef] [PubMed]
126. Moraes, A.F.J.; Rocha, C. Gendered waters: The participation of women in the 'One Million Cisterns' rainwater harvesting program in the Brazilian Semi-Arid region. *J. Clean. Prod.* **2013**, *60*, 163–169. [CrossRef]
127. Petersen, P.F.; Silveira, L.M. Agroecology, public policies and labor-driven intensification: Alternative development trajectories in the Brazilian semi-arid region. *Sustainability* **2017**, *9*, 535. [CrossRef]
128. Lindoso, D.P.; Eiró, F.; Bursztyn, M.; Rodrigues-Filho, S.; Nasuti, S. Harvesting water for living with drought: Insights from the Brazilian human coexistence with semi-aridity approach towards achieving the sustainable development goals. *Sustainability* **2018**, *10*, 622. [CrossRef]
129. Brandão, E.A.F.; Santos, T.D.R.; Rist, S. Family farmers' perceptions of the impact of public policies on the food system: Findings from Brazil's semi-arid region. *Front. Sust. Food Syst.* **2020**, *4*, 556732. [CrossRef]
130. Jalil, L.; Neves, R. The One Million Cisterns Programme: New Approaches and Challenges for the Brazilian Semi-Arid Region. Infrastructure Case Study 2022, p. 6. Available online: https://d3n8a8pro7vhmx.cloudfront.net/eurodad/pages/2581/attachments/original/1642428056/case-study-brazil-FINAL.pdf?1642428056 (accessed on 6 March 2023).
131. Marguerat, Y. Des montagnards entrepreneurs: Les Bamileke du Cameroun. *Cah. Estud. Afr.* **1983**, *23*, 495–504. [CrossRef]
132. Heijnen, H. *Enhancing Economic Resilience in North Eastern Brazil by Harnessing Rain*; Rainwater Harvesting Implementation Network (RAIN): Amsterdam, The Netherlands, 2013.
133. Mou, H. Rainwater utilization for sustainable development in north China. *Waterlines* **1995**, *14*, 19–21. [CrossRef]
134. Zhu, Q.; Li, Y. Rainwater harvesting for survival and development: A revolution in Gansu, China. *Waterlines* **2000**, *18*, 11–14.

135. Cook, S. Assessing the achievements and problems of rural resource management programs in western China: A case study from Gansu Province. *China Environ. Series* **2004**, *7*, 55–60.
136. Zhou, J.; Pang, Y.; Fu, G.; Wang, H.; Zhang, Y.; Memon, F.A. A review of urban rainwater harvesting in China. *Water Reuse* **2023**, *13*, 1–17. [CrossRef]
137. Palmer, C.L. Feasibility of combined sewer systems. *Water Pollut. Control Fed.* **1963**, *35*, 162–167.
138. Ahmed, W.; Gardner, T.; Toze, S. Microbiological quality of roof-harvested rainwater and health risks: A review. *J. Environ. Qual.* **2011**, *40*, 13–21. [CrossRef]
139. Mendez, C.B.; Klenzendorf, J.B.; Afshar, B.R.; Simmons, M.T.; Barrett, M.E.; Kinney, K.A.; Kirisits, M.J. The effect of roofing material on the quality of harvested rainwater. *Water Res.* **2011**, *45*, 2049–2059. [CrossRef]
140. Devkota, J.; Schlachter, H.; Apul, D. Life cycle based evaluation of harvested rainwater use in toilets and for irrigation. *J. Clean. Prod.* **2015**, *95*, 311–321. [CrossRef]
141. Gwenzi, W.; Dunjana, N.; Pisa, C.; Tauro, T.; Nyamadzawo, G. Water quality and public health risks associated with roof rainwater harvesting systems for potable supply: Review and perspectives. *Sustain. Water Qual. Ecol.* **2015**, *6*, 107–118. [CrossRef]
142. Hamilton, K.; Reyneke, B.; Waso, M.; Clements, T.; Ndlovu, T.; Khan, W.; DiGiovanni, K.; Rakestraw, E.; Montalto, F.; Haas, C.N.; et al. A global review of the microbiological quality and potential health risks associated with roof-harvested rainwater tanks. *NPJ Clean Water* **2019**, *2*, 7. [CrossRef]
143. Khayan, K.; Heru Husodo, A.; Astuti, I.; Sudarmadji, S.; Sugandawaty Djohan, T. Rainwater as a source of drinking water: Health impacts and rainwater treatment. *J. Environ. Public Health* **2019**, *2019*, 1760950. [CrossRef] [PubMed]
144. Alim, M.A.; Rahman, A.; Tao, Z.; Samali, B.; Khan, M.M.; Shirin, S. Suitability of roof harvested rainwater for potential potable water production: A scoping review. *J. Clean. Prod.* **2020**, *248*, 119226. [CrossRef]
145. Tepong-Tsindé, R.; Ndé-Tchoupé, A.I.; Noubactep, C.; Nassi, A.; Ruppert, H. Characterizing a newly designed steel-wool-based household filter for safe drinking water provision: Hydraulic conductivity and efficiency for pathogen removal. *Processes* **2019**, *7*, 966. [CrossRef]
146. World Health Organization (WHO). *Managing Water in the Home: Accelerated Health Gains from Improved Water Supply*; World Health Organization (WHO): Geneva, Switzerland, 2002.
147. Karikari, A.Y.; Ampofo, J.A. Chlorine treatment effectiveness and physicochemical and bacteriological characteristics of treated water supplies in distribution networks of Accra-Tema Metropolis, Ghana. *Appl. Water Sci.* **2013**, *3*, 535–543. [CrossRef]
148. Kessener, P.M. Roman water transport: Pressure lines. *Water* **2022**, *14*, 28. [CrossRef]
149. Bitterman, P.; Tate, E.; Van Meter, K.J.; Basu, N.B. Water security and rainwater harvesting: A conceptual framework and candidate indicators. *Appl. Geogr.* **2016**, *76*, 75–84. [CrossRef]
150. Bun, S.; Sek, S.; Oeurng, C.; Fujii, M.; Ham, P.; Painmanakul, P.A. Survey of household water use and groundwater quality index assessment in a rural community of Cambodia. *Sustainability* **2021**, *13*, 10071. [CrossRef]
151. Gebremichael, S.G.; Yismaw, E.; Tsegaw, B.D.; Shibeshi, A.D. Determinants of water source use, quality of water, sanitation and hygiene perceptions among urban households in North-West Ethiopia: A cross-sectional study. *PLoS ONE* **2021**, *16*, e0239502. [CrossRef]
152. Hope, R.; Ballon, P. Individual choices and universal rights for drinking water in rural Africa. *Proc. Natl. Acad. Sci. USA* **2021**, *118*, e2105953118. [CrossRef]
153. Hewawasam, V.; Matsui, K. Traditional water governance practices for flood mitigation in ancient Sri Lanka. *Climate* **2022**, *10*, 69. [CrossRef]
154. Gangadhara, K.R.; Jayasena, H.A.H. Rainwater harvest by tank cascades in Sri Lanka—Was it a technically adapted methodology by the ancients? In Proceedings of the Twelfth International Conference on Rain Water Catchment Systems, New Delhi, India, 1 November 2005.
155. Imteaz, M.A.; Boulomytis, V.T.G.; Yilmaz, A.G.; Shanableh, A. Water quality improvement through rainwater tanks: A review and simulation study. *Water* **2022**, *14*, 1411. [CrossRef]
156. Li, H.; Cohen, A.; Lin, L.; Zhang, X.; Zhang, R. Recollection: Water supply improvement and health promotion campaigns in rural areas−China, 1949−2020. *China CDC Wkly.* **2021**, *3*, 10–13. [CrossRef]
157. Lilje, J.; Mosler, H.-J. Continuation of health behaviors: Psychosocial factors sustaining drinking water chlorination in a longitudinal study from Chad. *Sustainability* **2016**, *8*, 1149. [CrossRef]
158. Carter, R.C.; Tyrell, S.F.; Howsam, P. The impact and sustainability of community water supply and sanitation programmes in developing countries. *Water Environ. J.* **1999**, *13*, 292–296. [CrossRef]
159. Enéas da Silva, F.O.; Heikkila, T.; de Souza Filho, F.A.; Costa da Silva, D. Developing sustainable and replicable water supply systems in rural communities in Brazil. *Int. J. Water Resour. Dev.* **2013**, *29*, 622–635. [CrossRef]
160. Miao, G.; Fry, C. Improving safe drinking water programs one essential service at a time: Closing the water quality gap. *J. Environ. Health* **2018**, *80*, 28–30.
161. Ogisma, L. Ensuring Safe Drinking Water for the Northern Corridor of Haiti Through Expanded Testing Services. Ph.D. Dissertation, Auburn University, Auburn, WA, USA, 2022.

162. Tchawa, P. La dégradation des sols dans le Bamiléké méridional conditions naturelles et facteurs anthropologiques. *Cah. D'outre-Mer.* **1993**, *181*, 75–104. [CrossRef]
163. Fonjong, L.N.; Ngwa-Nebasina, E.; Fonchingong, C.C. Rethinking the contribution of indigenous management in small-scale water provision among selected rural communities in Cameroon. *Environ. Dev. Sustain.* **2005**, *6*, 429–451. [CrossRef]