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The Founkama Micro-Dam: A Hydraulic Structure to be Preserved, Guinea

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ABSTRACT

Designed to irrigate rice paddies and improve local agricultural production in the Niger River plain near Faranah, this article focuses on the Founkama micro-dam, a hydraulic structure located in the urban commune of Faranah, Guinea. To study this structure, several field missions were conducted in the Niger River plain near Faranah, during both the dry and rainy seasons. Built on the Niger River in 1981, the Founkama micro-dam irrigates 150 hectares of the Niger River plain near Faranah. Currently, water resources are becoming scarce in the Niger River plain near Faranah during the dry season, hindering the development of agro-pastoral activities, as the micro-dam is abandoned and its infrastructure is dilapidated. These difficulties justify the validity of this study, which focused on the preservation of the Founkama micro-dam in the commune of Faranah, Guinea. The results showed that the observed deterioration of the structure could be due, on the one hand, to the aging of the materials, manifested by exposed aggregates on the upstream face as well as the presence of vegetation, and on the other hand, to the undersized circular discharge openings with an internal diameter of 40 cm located in the body of the dam, which act as flood spillways in the case of conventional dams. To safeguard this hydraulic heritage, this study proposes the rehabilitation of the existing structure and the construction of a new micro-dam with a side spillway and fixed weir on the same site and at the same elevation as the existing one, in order to supplement the existing structure and address the scarcity of water resources during the dry season, which is essential for the development of agro-pastoral activities in the Niger River plain at Faranah. This aligns well with one of the objectives of the SINANDOU 2040 program initiated by the Guinean government.

Keywords: Micro-dam, dike, sluice gate, Niger River plain, Founkama, Faranah.

INTRODUCTION

The construction of a small dam on a watercourse disrupts a natural ecosystem. This new situation will generate harmful problems both upstream and downstream of

the structure [1]. Added to this is climate change, one of the most pressing global challenges. Its impacts have become increasingly visible, ranging from rising global average temperatures to the intensification of natural disasters (floods, prolonged droughts, fires, etc.). Drought and water stress have become among the most visible and devastating consequences of climate change worldwide. The vulnerability of water resources to climate change is inevitable [2], and the UN predicts that by 2025, one-third of the world's population will be affected by water stress. Hence, understanding climate change and its impact on water resources is now a major necessity. Water is an essential resource for human, animal, and plant life. It plays a role in all human activities and in the socioeconomic development of every country. In sub-Saharan Africa, agro-pastoral activities form the cornerstone of the economy in most developing countries. Like other countries, these agro-pastoral activities are a driving force in Guinea's economic and social development. Nearly 70% of the Guinean population practices rainfed, extensive, and subsistence agriculture, which contributes to the widespread degradation of fragile ecosystems. Upper and Middle Guinea, the poorest regions of the country, alone hold more than 75% of the hydro-agricultural potential (lowlands and plains), which is unfortunately underdeveloped [3]. With rapid population growth and worsening drought (identified in Guinea as the major risk in all natural regions, particularly in Upper and Middle Guinea), water resources are dwindling, making water withdrawals for various uses difficult [3]. It is clear that the Guinean agro-pastoral sector currently faces a number of constraints that limit its development, such as the abandonment of hydraulic structures and the dilapidated state of existing infrastructure, which risks permanently compromising its growth. The implementation of conservation and restoration activities for available water resources will be timely within the framework of the SINANDOU 2040 program initiated by the Guinean government, whose pillar 1 "Agriculture, Food Industry and Trade" aims at food sovereignty, the modernization of sectors and the development of local processing. It is with this in mind that this work, entitled "The Foukama Micro-Dam: A Hydraulic Structure to Preserve," was initiated. In this article, we will study the Foukama micro-dam, located in the urban commune of Faranah, Guinea. This hydraulic structure has been in operation for over half a century. The causes of its deterioration will be the subject of this study. Recommendations for the preservation of this hydraulic heritage will be proposed.

PRESENTATION OF THE STUDY AREA

This study is being conducted in the Republic of Guinea, in the prefecture of Faranah.

Presentation of the Faranah Prefecture

The prefecture is located between 10° 0’ 00’’ North latitude and 10°49’ 60’’ West longitude. It is situated in the east-central part of the country, 460 km from the capital, Conakry. With an altitude ranging from 300 to 600 m, the Faranah prefecture covers an area of 13,000 km² with a population of 211,115 inhabitants, resulting in a population density of 16 inhabitants per square kilometer (Faranah Prefectural Health Directorate, 2010). It is bordered to the East by the Kouroussa prefecture, to the West by the Mamou prefecture and the Republic of Sierra Leone, to the North by the Dabola prefecture; and, to the South by the Kissidougou and Guéckédou prefectures. It has eleven (11) rural communes, namely: Banian, Beindou, Hèrèmakono, Nialya, Songoya, Tiro, Tindo, Marella, Passaya, Sandénia, Kobikoro and the urban commune. Figure 1 shows the geographical location of Faranah.

Knowledge of the study site

Spanning 150 hectares, 80 of which are developed into rice paddies, the Founkama plain is located on the right bank of the Niger River, 500 meters from the Valery Giscard d'Estaing Higher Institute of Agronomy and Veterinary Medicine of Faranah (ISAV-VGE/F). It is bordered to the east by the micro-dam reservoir, to the west by the Niger River, to the north by the Zootechnical Research Center (CRZ), and to the south by the Institute's experimental farm. The site's soil is hydromorphic with a clay-loam texture and vegetation cover composed of wild grasses and sedges. The structures occupy 4% of the total area, or 6 hectares. The Founkama plain is divided into two main sections:

• High-risk zone: This zone has not benefited from any adequate development;

• Safe zone: This area has benefited from significant development for over 30 years but is now subject to the harmful effects of erosion and flooding.

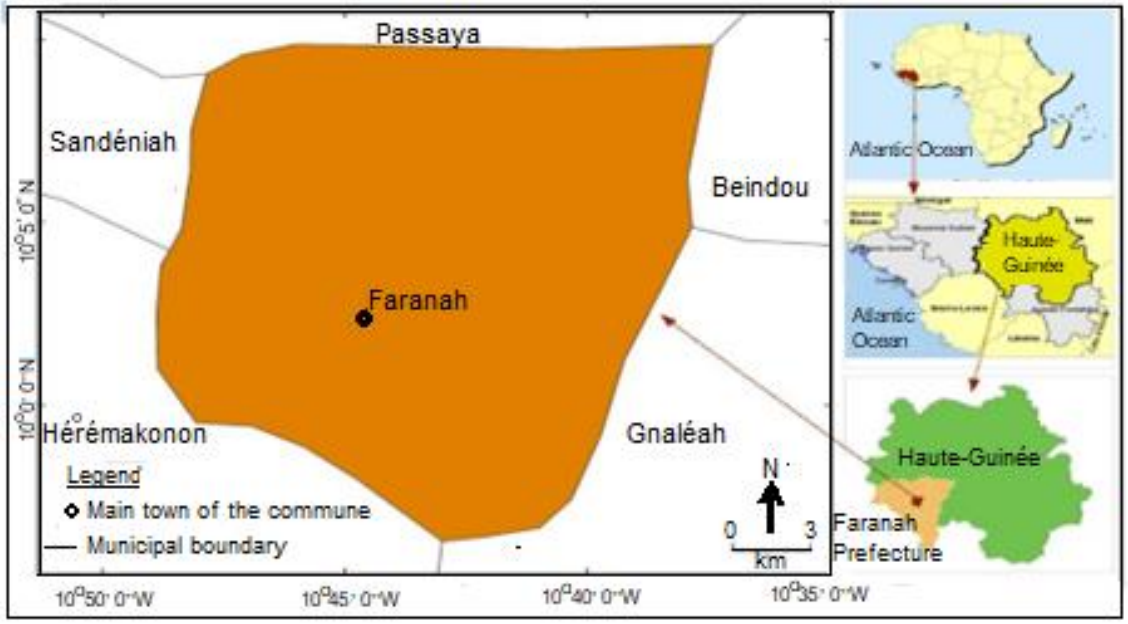

Figure 1: Geographical location of Faranah (Agrhymet Regional Center, 2014)

RESULTS AND DISCUSSION

Founkama micro-dam

This is a conventional dam that is replenished by runoff during the wet season. The collected runoff is stored in the micro-dam. Its capacity is approximately 11,343.75 m³. Figure 2 shows a plan view of the Founkama micro-dam.

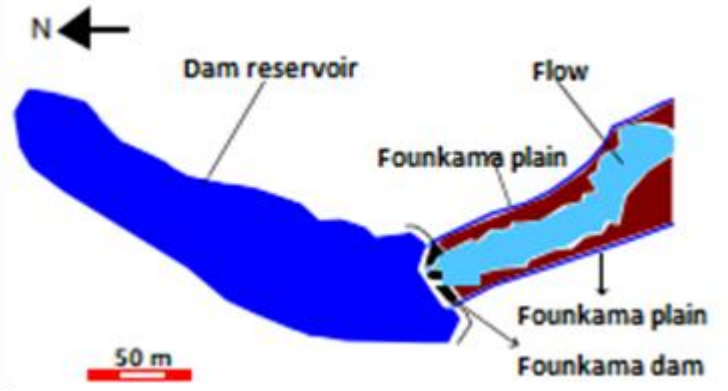

Figure 2: Synoptic plan diagram of the Founkama micro-dam [4].

The Founkama micro-dam has thus far withstood numerous floods, thanks to its dam, which is approximately 100 m long and 3.00 m high (Figure 3). It is equipped with two steel gates, each measuring 0.95 m x 2.85 m, positioned midway along the dam (Figures 3, 4, and 5). These gates are crucial for water management. They allow for regulating the reservoir level, releasing floodwaters (for safety), and draining the basin (for sediment flushing). They ensure safety by withstanding high pressures. It should be noted that during a flood, all the gates are opened to allow water to flow in. For reservoir maintenance, releasing water from the dam through the gates is essential.

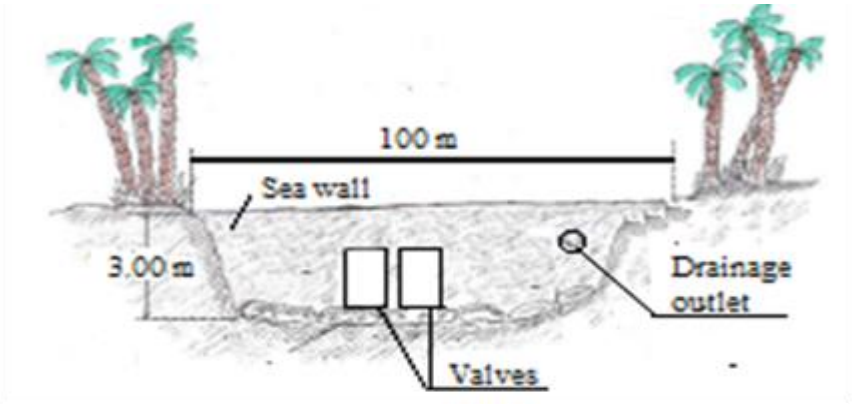

Figure3: Diagram of a cross-section of the Founkama micro-dam [4].

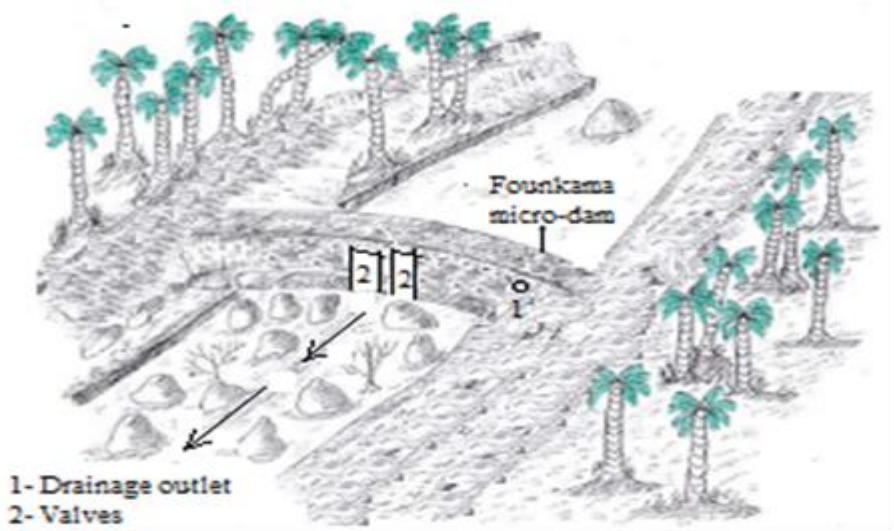

Figure 4: Synoptic diagram of the Founkama micro-dam [4].

Figure 5: Two vandalized metal valves at the dam of the Founkama micro-dam (Photo. Babilas Hountondji, 2026).

The micro-dam is also equipped with a circular orifice with an internal diameter of 40 cm, located at the top and end of the right-hand side of the dam relative to the two gates (Figures 3, 4, and 6). When the reservoir's capacity is reached, water flows out through this orifice. In this case, the orifice replaces the spillway of a conventional dam. The micro-dam serves a dual purpose: first, to create a humid microclimate in a dry region; and second, to ensure continuous irrigation.

Figure 6: Circular evacuation opening at the level of the dike of the Founkama micro-dam (Photo. Babilas Hountondji, 2026).

The crest of the micro-dam dike, 7 m wide, is a traffic lane equipped with small drainage structures such as convergents and channels on both banks to facilitate the collection of runoff water during the rainy season (Figure 7).

Figure 7: Drainage structure at the top of the micro-dam of Founkama (Photo. Babilas Hountondji, 2026).

Problems with deterioration of the Founkama micro-dam

Draining of the reservoir

The depletion of the reservoir is the real problem with this hydraulic structure (Figure 8). Indeed, in the early 1960s, a few motor pumps were introduced into the Faranah basin, but in the early 1980s, during the construction of the Foukama micro-dam, this method of water extraction accelerated. Furthermore, the socio-economic development of the Faranah municipality,

along with its rapidly growing population, led to the expansion of new agricultural land and housing in the town of Faranah. This was followed by a significant increase in the number of boreholes drilled. This phenomenon impacted the water supply to the dam, as the groundwater level dropped dramatically, resulting in a decrease in irrigation water in order to prioritize drinking water supply in the region [5-6].

Figure 8: Drying observed at the level of the basin of the Founkama micro-dam (Photo. Babilas Hountondji, 2026).

Damage to the dike

The degradation of reinforced concrete micro-dams and their associated structures pose a significant threat to their long-term viability. This degradation is primarily caused by water infiltration, design/construction flaws (cracking, poor concrete quality), and environmental factors such as floods, earthquakes, and material aging. Therefore, the appearance of degradation on the dam body of the Founkama micro-dam is a major concern that could impact the structure's lifespan. Describing these phenomena is thus crucial for understanding and analyzing the degradation patterns affecting the structure. The degradation of the dam body could be attributed, in part, to material aging. This mechanism is manifested by exposed aggregates on the upstream face, as well as vegetation (Figure 9).

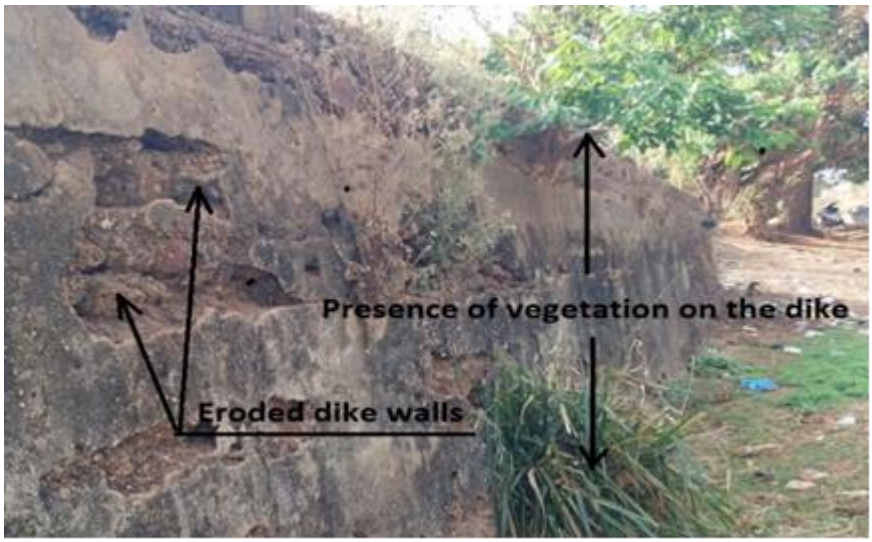

Figure 9: Vegetation presence and degradation observed on the Founkama micro-dam (Photo. Babilas Hountondji, 2026)

On the other hand, the undersizing of the circular evacuation openings with an internal diameter of 40 cm which act as flood spillways, namely one (01) planned at the level of the Founkama micro-dam dike approximately 100 m long and 3.00 m high (Figure 3), against nine (09) planned on the dike of a dam 50 m long and 1.50 m high (Figure 10 and 11), could also be the cause of the dissolution and erosion observed at the level of the body of the dike.

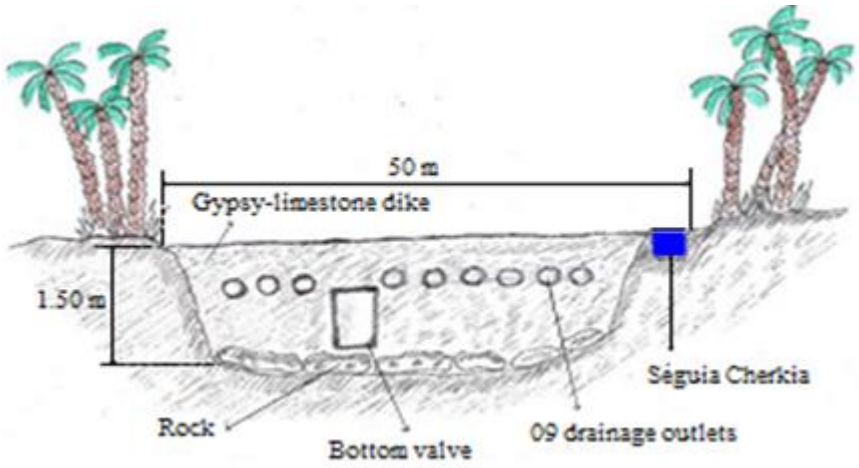

Figure 10: Diagram of a cross-section of the Tahtani dam in the Tiout oasis [4].

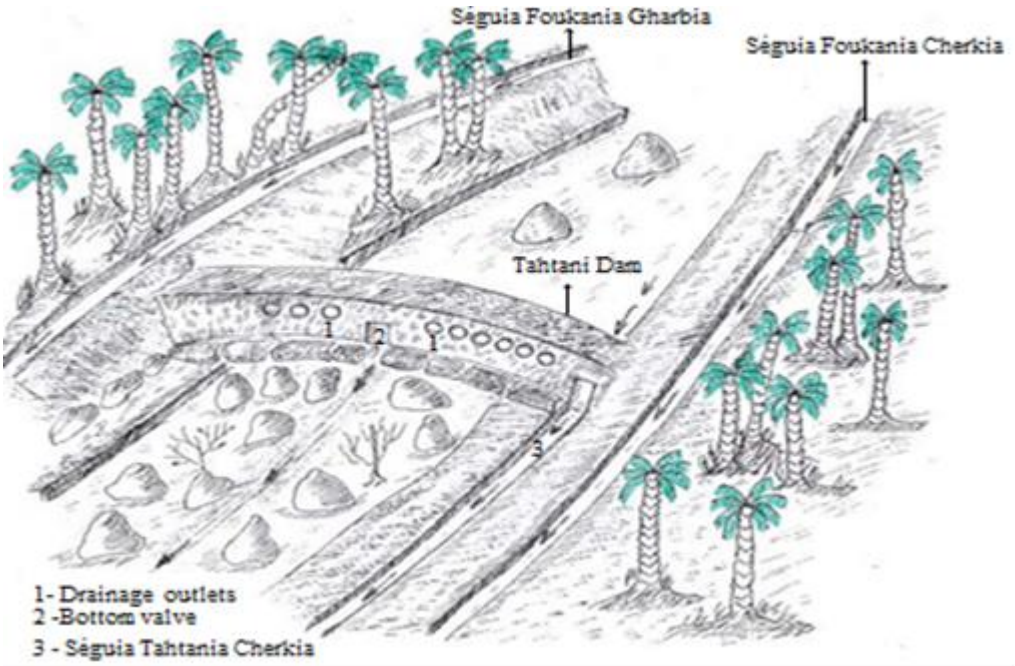

Figure 11: Synoptic diagram of the Tahtani dam in the Tiout oasis [4].

In the long term, the main effect of this mechanism is a loss of material through dissolution and subsequent erosion, exposing the reinforcement bars. Corrosion (Figure 12) accelerates damage, potentially leading, if the weight loss is significant, to a substantial decrease in stability criteria. The dissolution of materials could induce an increase in the dam's permeability, leading to increased drainage flows (fueling the dissolution mechanism) and uplift pressures (further reducing stability criteria).

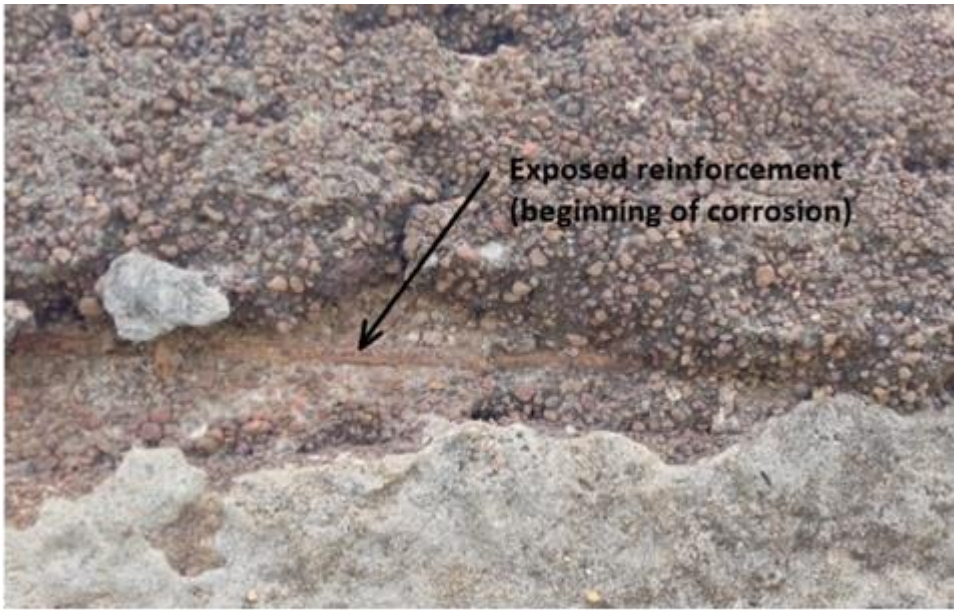

Figure 12: Dissolution and erosion of the material expose the reinforcement bars of the Founkama micro-dam dam (Photo. Babilas Hountondji, 2026).

The idea of rehabilitating the existing micro-dam at Founkama and building a new one

Based on the principle of "evoking history to better study the future" [7], the existing Founkama micro-dam was built in 1981. The location was chosen due to the topography and the presence of significant water resources on the bed and banks of the Niger River, which flows through the town of Franah. This area is therefore very rich in water flowing over the riverbed and banks. However, given the passage of time, the extensive damage observed to the dam's structure, along with the acts of vandalism described above, no longer allows the structure to fulfill its intended functions. Indeed, over time, water needs have increased due to the expansion of new agricultural land and the enlargement of the Founkama plain. The existing hydraulic system has become inefficient and has a low yield. These reasons are pushing public authorities to build more and more dams to increase the availability of naturally limited water resources and to cope with the strong temporal irregularity (seasonal and interannual) of rainfall [8]. Thus, based on Pillar 1, "Agriculture, Food Industry, and Trade," which aims for food sovereignty, the modernization of supply chains, and the development of local processing, of the SINANDOU 2040 program, this study proposes the rehabilitation of the existing micro-dam and the construction of a new, modern micro-dam on the same site and at the same elevation as the existing one. This new dam will complement the existing one in achieving the objectives of Pillar 1 of the SINANDOU 2040 program. For the new micro-dam, and for technical and economic reasons, this paper has opted for the design of a micro-dam with a side spillway and a fixed (thick) weir, which will be located upstream of the existing micro-dam. The choice fell on the thick (fixed) weir for its structural robustness, its capacity to handle significant flow rates, and its resistance to erosion. It offers better mechanical stability and requires less maintenance, making it ideal for small hydraulic structures. Figure 13 below shows the type of spillway adopted for the new Founkama micro-dam.

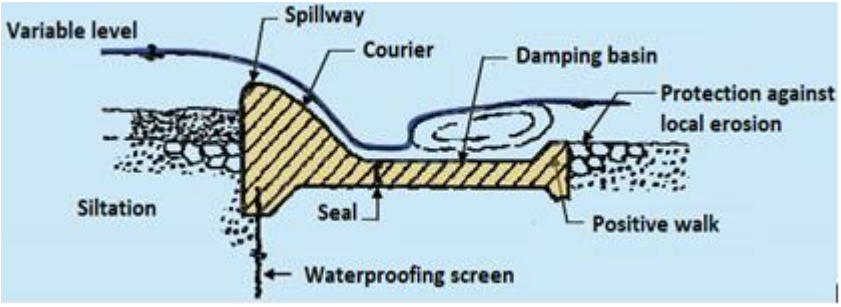

Figure 13: Fixed weir spillway to be adopted for the new micro-dam at Founkama (Babilas Hountondji, 2026).

The lateral position was chosen to allow for the safe discharge of excess water (floods), thus protecting the structure from submersion and breach. This configuration keeps the discharge water away from the main body of the dam, reducing erosion at its base. The dam's size is determined by the area of land to be irrigated.

CONCLUSION

This work was carried out to contribute to the development of the Founkama plain in the commune of Faranah, Guinea. As mentioned at the beginning of this study, the hydraulic system, namely the Founkama dam with sluice gates and reservoir, located in the urban commune of Faranah, Guinea, dates back to 1981. Approximately half a century old, this system is no longer functional. The reservoir's waters have dried up due to the lowering of the water table caused by pumping from several boreholes. Today, the rehabilitation of the existing Founkama micro-dam is essential, as is the construction of a new micro-dam with a side spillway and fixed weir to supplement the existing one and address the scarcity of water resources during the dry season, which is crucial for the development of agro-pastoral activities in the Niger River plain area of Faranah. This aligns well with one of the objectives of the SINANDOU 2040 program initiated by the Guinean government.

Declaration by Authors

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Conflict of Interest: No conflicts of interest declared.

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