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4 **A CONTRIBUTION TO RESOLVING THE ISSUES SURROUNDING THE FOUNKAMA**  
5 **MICRO-DAM IN THE MUNICIPALITY OF FARANAH, GUINEA**  
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7 **Abstract:**  
8

9 As part of efforts to ensure the rational use of the Founkama Plainan objective of Pillar 1, “Agriculture, Food Industry, and Trade,” of the  
10 SINANDOU 2040 program, initiated by the Guinean government, which aims for food sovereignty, the modernization of supply chains, and the  
11 development of local processing, this study proposes the rehabilitation of the existing Founkama micro-dam, built on the Niger River bed in  
12 1981, by constructing a new modern micro-dam with a side spillway and fixed sill at the same site and elevation as the existing structure, to  
13 supplement the existing dam and address the scarcity of water resources during the dry season a critical issue for the development of agro-pastoral  
14 activities in the Niger River plain area of Faranah. In this context, climatic, topographic, hydrographic, and pedological data were collected and  
15 analyzed for the study area. The results of the analyses showed a maximum average monthly rainfall of 325.7 mm, with maximum and minimum  
16 average monthly temperatures recorded around March (approximately 36°C) and around January (approximately 13°C), respectively, and a clay-  
17 loam soil texture. The design flood discharge (100-year return period) at the watershed level is estimated at 41 m<sup>3</sup>/s, while that at the spillway is  
18 4.8 m<sup>3</sup>/s. Topographic data were used to determine the alignment of the new micro-dam and to confirm that the bottom of the reservoir basin is  
19 approximately flat. The results of these analyses were used to define the characteristics of the new micro-dam to be constructed, including its  
20 height (5.60 m), length (250.032 m), crest width (3.75 m), the slopes of the upstream (m<sub>1</sub>=2.5) and downstream (m<sub>2</sub>=2) embankments, and the  
21 total volume of compacted fill (16,500 m<sup>3</sup>). The reservoir volumes at Normal Water Level (NWL) and High-Water Level (HWL) are 412,000 m<sup>3</sup>  
22 and 450,000 m<sup>3</sup>, respectively, which will enable the development of 180 ha of land for rice cultivation out of the 260 ha currently comprising the  
23 estate. The intake structure includes a 300-mm-diameter pipeline 280 m long. As for the spillway structure, it includes a gate 2 m wide and 1.50 m  
24 high, capable of discharging a flow rate of 4.8 m<sup>3</sup>/s into the 9.35 m long stilling basin. The rehabilitation of the existing micro-dam, through the  
25 construction of a new structure meeting the aforementioned specifications, could make this resource available year-round for the development of  
26 agricultural and pastoral activities in the Founkama plain, within the urban municipality of Faranah.  
27

28 **Key words: -**

29 Hydraulic calculations, dike, spillway, Founkama Plain, Faranah.  
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35 **Introduction: -**  
36

37 Dam construction has been one of the oldest and most fascinating activities known to humankind, as  
38 water has always been the most cherished and precious element of life. Building dams on a river disrupts  
39 the natural ecosystem. This new situation leads to harmful problems both upstream and downstream of  
40 the structures (Remini et al., 2019). Added to this is climate change, which is one of the most pressing  
41 global challenges. Its impacts have become increasingly visible, ranging from rising global average  
42 temperatures to the intensification of natural disasters (floods, prolonged droughts, wildfires, etc.).  
43 Drought and water stress have become one of the most visible and devastating consequences of climate  
44 change on a global scale. According to (El Ghazlani, Benaabidate, & Zemzami, 2023), “the vulnerability  
45 of water resources to climate change is inevitable,” and the UN predicts that by 2025, one-third of the  
46 global population will be affected by water stress. Hence, understanding climate change and its impact on  
47 water resources is now a critical necessity.

48 In West Africa, agriculture forms the backbone of the economy in most countries. As in many other  
49 countries, agricultural activities play a key role in the economic and social development of the Republic  
50 of Guinea. In Guinea, approximately 70% of the population practices rain-fed agriculture. In Upper and  
51 Middle Guinea, more than 75% of the land consists of lowlands and plains, but unfortunately, these areas  
52 are poorly developed (PANA, 2007). In the Faranah Prefecture, the existing Founkama micro-dam was  
53 built in 1980. The primary objective of this structure at the outset was to irrigate 150 hectares of the  
54 Founkama plain, with the aim of meeting the food needs of students at the Valery Giscard d’Estaing  
55 Higher Institute of Agronomy and Veterinary Medicine in Faranah (ISAV-VGE/F) at the time, while also  
56 serving as a practical application site for theoretical courses. The structure was built along the road

57 connecting the urban commune of Faranah to that of Dabola. To provide a sufficient volume of water  
58 capable of irrigating the entire area at the time (150 ha), it was necessary to construct a structure with a  
59 crest height of at least 10 m. This would require the construction of a dike extending from the farm on the  
60 north side to the foot of Dandaya Hill (in the Faranah urban district) on the south side. The water from the  
61 reservoir would flood the surrounding homes (nearly 30 families at the time) and, worse, would have a  
62 negative impact on the bridge over the Founkama River. For these socio-legal and administrative reasons,  
63 the Authority at the time had asked the Institute to build a structure without displacing the population and  
64 without affecting the bridge. Thus, the Institute opted to construct a micro-dam, meeting the Authority's  
65 conditions and capable of serving educational purposes, as well as irrigating an area of 8 ha during the dry  
66 season. However, since 1982, the Institute has embarked on a comprehensive program of analysis and  
67 solution-seeking for the development and operation of the entire area at that time (150 ha) throughout all  
68 seasons, in order to resolve the mismatch between the reservoir's capacity and the irrigation water needs  
69 across the entire estate and to ensure the development of agro-pastoral activities in the Founkama plain in  
70 Faranah. It should be noted that the data to date has changed due to the strong population growth recorded  
71 in recent years. The entire estate now has a total area of 260 ha, of which 180 ha are to be developed.  
72 This focus of the Institute (ISAV-VGE/F) aligns well with Pillar 1, "Agriculture, Food Industry, and  
73 Trade," of the SINANDOU 2040 program launched by the Guinean government, which aims to achieve  
74 food sovereignty, modernize supply chains, and develop local processing. This justifies the relevance of  
75 this study titled "Contribution to Solving the Issues of the Founkama Micro-Dam in the Urban  
76 Municipality of Faranah, Guinea." The objective of this study is the year-round hydro-agricultural  
77 development and utilization of 180 ha out of the 260 ha currently comprising the Founkama plain. Thus,  
78 as a first step, climatic, topographic, hydrographic, and pedological data were collected and then analyzed  
79 for the study area. The results of these analyses were used to define the characteristics of the new micro-  
80 dam planned for construction as part of the rehabilitation of the existing structure, with the aim of  
81 achieving the objective of this study.

#### 82 83 84 85 **Presentation of the study area: -**

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

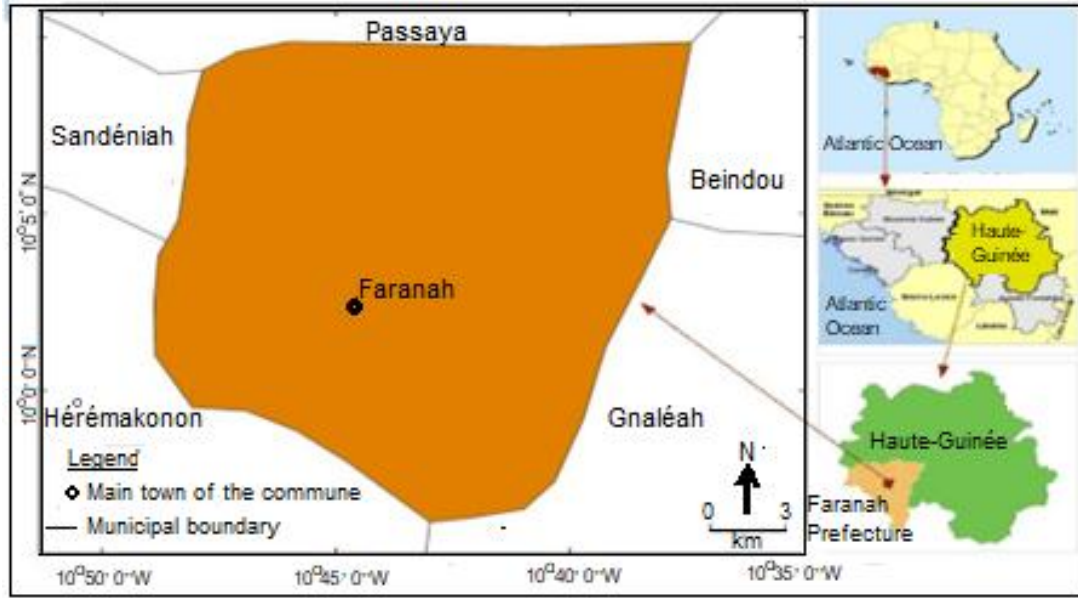
#### 88 89 **Presentation of the Faranah Prefecture: -**

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91 The prefecture is located between 10° 0' 00'' north latitude and 10° 49' 60'' west longitude. It is situated  
92 in the central-eastern part of the country, 460 km from the capital, Conakry. With an elevation ranging  
93 from 300 to 600 m, the Faranah Prefecture covers an area of 13,000 km<sup>2</sup> and has a population of 211,115,  
94 resulting in a population density of 16 people per square kilometer (Faranah Prefectural Health  
95 Directorate, 2010). It is bordered by:

- 96 • to the east by the Kouroussa Prefecture;
- 97 • to the west by the Mamou Prefecture and the Republic of Sierra Leone;
- 98 • to the north by the Dabola Prefecture; and
- 99 • to the south by the Kissidougou and Gueckédou Prefectures.

100 It comprises eleven (11) rural communes, namely: Banian, Beindou, Hèrèmakono, Nialya, Songoya, Tiro,  
101 Tindo, Marella, Passaya, Sandénia, Kobikoro, and the urban commune. Figure 1 shows the geographical  
102 location of Faranah.

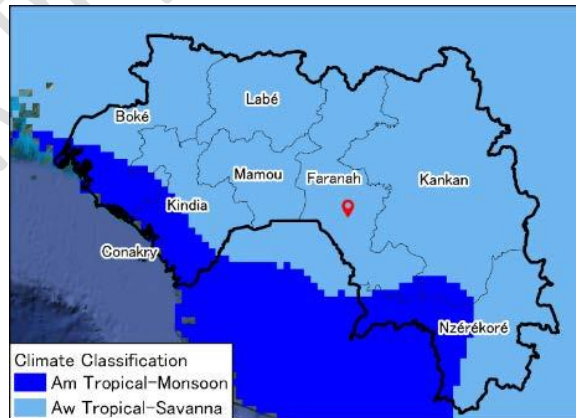
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**Figure 1:** - Geographic location of Faranah(Agrhymet Regional Center, 2014)

**Climate:** -

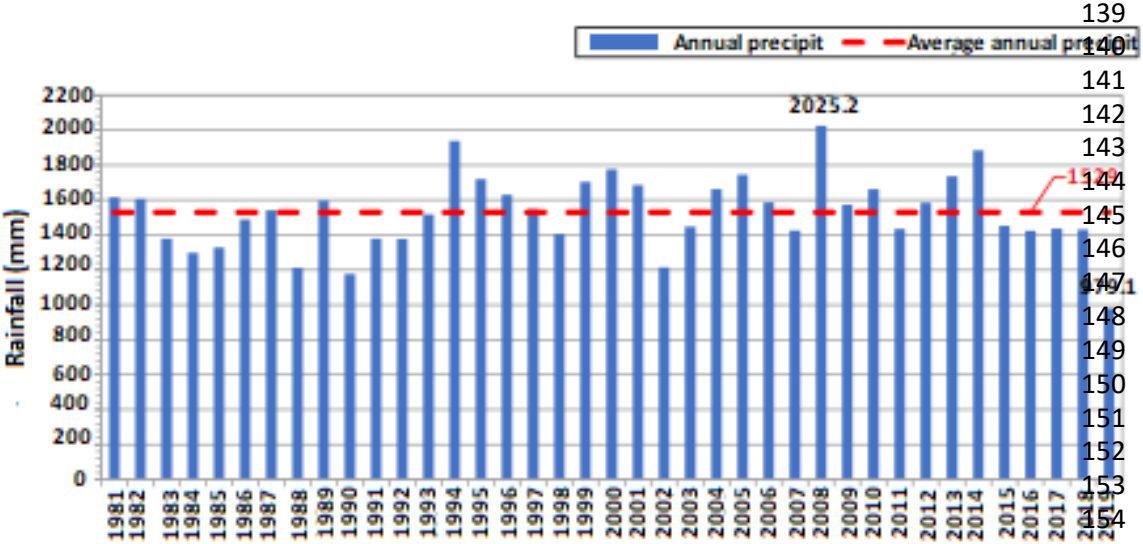
According to the Köppen climate classification, these areas have a savanna climate, while according to the World Bank's Climate Change Knowledge Portal, the rainy season runs from May to October and the dry season from November to April. The climate in the vicinity of the urban municipality of Faranah is shown in Figure 2.



**Figure 2:** - Climate in the vicinity of the urban municipality of Faranah (World Bank, 2023).

- *Annual precipitation:* -

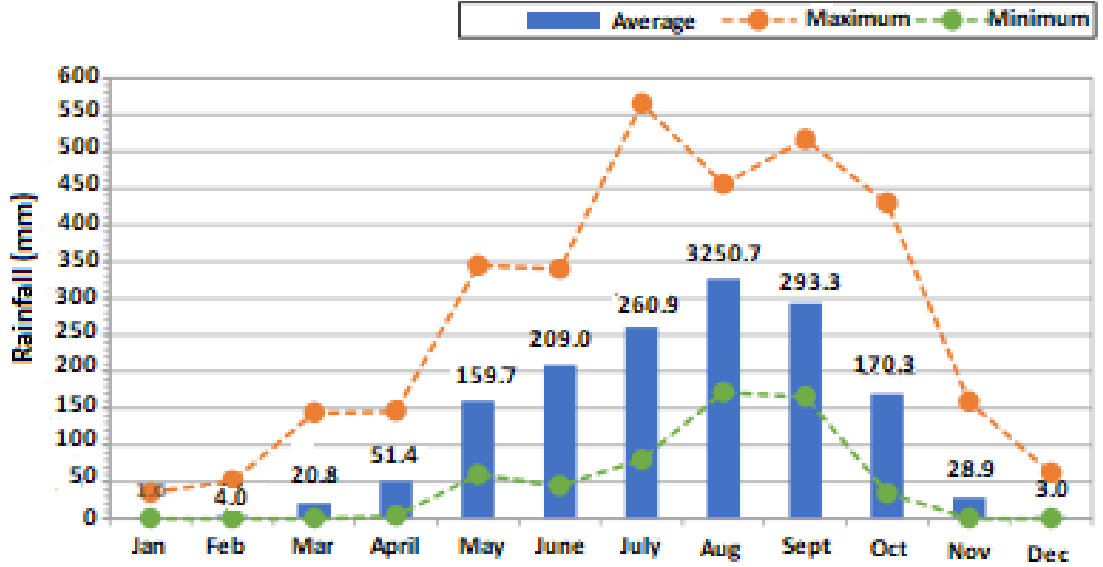
135 Figure 3 shows precipitation levels between 1981 and 2019 at the Faranah weather station. The annual  
 136 average is 1,529 mm, with precipitation of approximately 2,025.2 mm in wet years and approximately  
 137 979.1 mm in dry years. Annual rainfall data do not indicate an increase in precipitation resulting from  
 138 climate change.



155 **Figure 3:** - Annual precipitation in the vicinity of the urban municipality of Faranah  
 156 (Guinean National Meteorological Service).  
 157

158 • *Average monthly precipitation:* -

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 160  
 161 Figure 4 shows the average monthly rainfall at the Faranah weather station. The rainy season runs from  
 162 May to October, with a particularly rainy period during the three months from July to September, when  
 163 rainfall is especially heavy. Maximum rainfall of 325.7 mm was recorded in August, and there is virtually  
 164 no rain between early November and early May, a period that corresponds to the dry season.

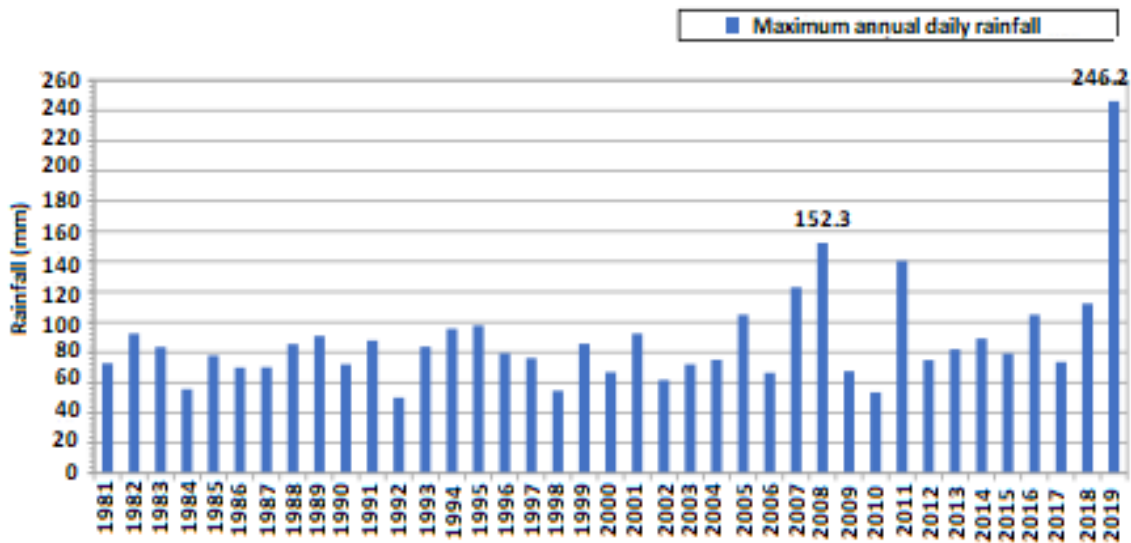


165 **Figure 4:** - Average monthly precipitation in the vicinity of the urban municipality of Faranah  
 166

(Guinean National Meteorological Directorate).

• *Annual maximum daily precipitation: -*

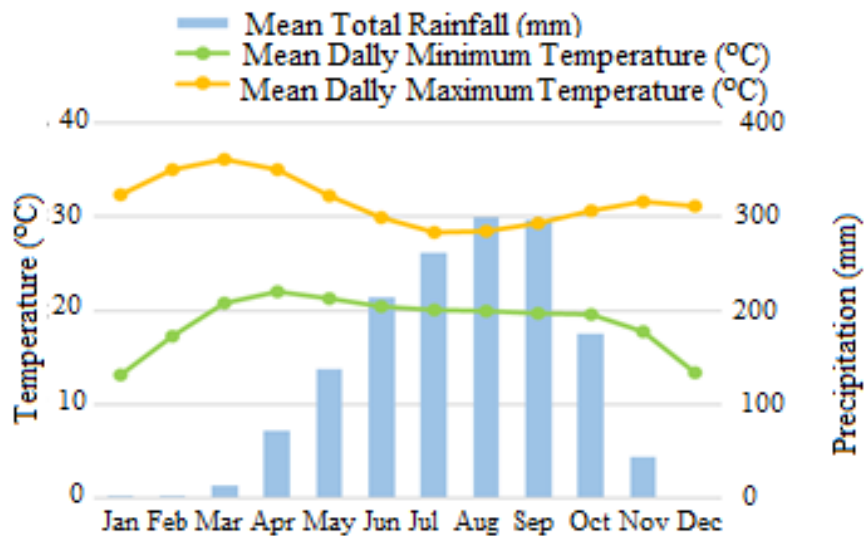
Figure 5 shows the annual maximum daily rainfall between 1981 and 2019 at the Faranah observation station. The maximum daily rainfall recorded was 152.3 mm in 2008. The 246.2 mm recorded in 2019 indicates that approximately 16% of the annual average fell in a single day, representing a sharp increase, even from a statistical standpoint. However, this value can be considered an anomaly, given that no notable changes were observed in water level and flow rate data for the period in question. Annual maximum daily precipitation over the past 20 years reached historic highs in 2008 and 2011, and shows a slight upward trend under the influence of climate change. (The 2019 value is an anomaly.)



**Figure 5: -** Annual maximum daily precipitation in the vicinity of the urban municipality of Faranah(Guinean National Meteorological Directorate).

*Temperatures: -*

Observational data from the World Meteorological Organization (WMO) covering the past 30 years (1991–2020) show that the highest and lowest temperatures are recorded around March (approximately 36°C) and around January (approximately 13°C), respectively. The temperature in the vicinity of the urban municipality of Faranah is shown in Figure 6.



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**Figure 6:** -Temperatures in the vicinity of the urban municipality of Faranah  
(WMO, 2023, World Meteorological Information Service)

**Wind:** -

Due to a lack of observations, wind conditions remain unknown, but an extremely dry trade wind known as the “harmattan,” laden with sand, blows from the Sahara toward the Gulf of Guinea, generally between November and April, bringing the dry season to the region.

**Soils:** -

According to the National Soil Service (SENASOL, 2012), the main soil types found there are:

- Ferralitic soils (FAO Ferrasols, 1989): covering more than 62% of the prefecture’s total area, they are suitable for cereal farming and arboriculture;
- Recent fluvial alluvial soils (FAO Fluvisols, 1989): These are suitable for floating rice cultivation and vegetable farming;
- Hydromorphic soils (FAO Histosols, Gleysols, 1989): These are suitable for flooded rice cultivation;
- Underdeveloped soils (Arenosols and Leptosols, FAO, 1989): These soils have a low organic matter content and warrant protection. They are not well-suited for agriculture;
- Lithic skeletal soils on scree (Regosols and Leptosols, FAO, 1989): These are found on mountain slopes and are intended for reforestation.

**Vegetation:** -

The Faranah Prefecture is a transitional zone between three natural regions of Guinea. Its vegetation consists of woody species such as *Khaya senegalensis* (A. Juss), *Parkia biglobosa* (J. Benth), *Ceiba pentandra* (S), *Daniella oliverii* (H), *Albizia gygia* (N); grasses: *Echinochloa colona* (L), *Echinochloa pyramidalis* (L), *Pennisetum purpureum* (L), *Pennisetum subangustum* (Schumps), *Imperata cylindrica* (Beauv), *Rottboelia exaltata* (L), *Urena lobata* (L); Cyperaceae: *Cyperus rotundus* (L), *Cyperus difformis* (L); and Fabaceae: *Calopogonium mucunoides* (Desv).

**Hydrographic network:** -

The main waterways flowing through this prefecture are: the Niger River and its tributaries (Mafou, Falikou, Balen, Banian, Farakoba, and Koffi).

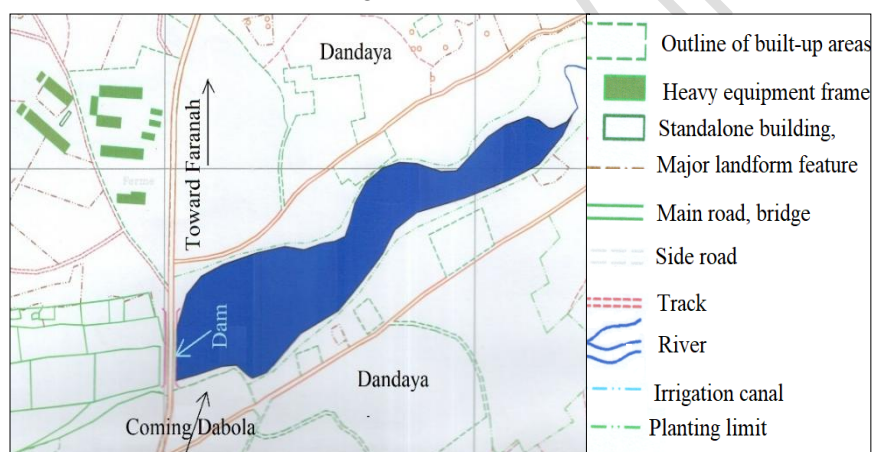
**Knowledge of the study site:** -

243 The Founkama Plain is located on the right bank of the Niger River, 500 meters from the Valéry Giscard  
 244 d’Estaing Higher Institute of Agronomy and Veterinary Medicine in Faranah (ISAV-VGE/F). It is  
 245 bounded to the east by the micro-dam reservoir, to the west by the Niger River, to the north by the  
 246 Zootechnical Research Center, and to the south by the Institute’s experimental farm (ISAV-VGE/F).

247 The reservoir basin widens around the beds of the Founkama and Tourakose backwaters, located 1,235 m  
 248 from the Faranah-Dabola national highway. It is bounded to the north by the land reserved for the Faranah  
 249 Cemetery, to the south by the Bendou Road, to the east by the Karamoko CISSE estate, and to the west by  
 250 the Dandaya neighborhood. Figure 7 shows a partial view of the geographical location of the study site,  
 251 indicating the reservoir basin and the Founkama micro-dam.

252 The site’s soil is hydromorphic with a clay-loam texture and a vegetation cover composed of wild grasses  
 253 and sedges. The structures occupy 4% of the total area, or 6 hectares. The Founkama plain is divided into  
 254 two (02) main parts:

- 255 • High-risk zone: This zone has not benefited from any adequate development;
- 256 • Non-risk zone: This zone has undergone significant development for over 30 years but is currently  
 257 subject to the harmful effects of erosion and flooding.



266 **Figure 7:** -Partial map showing the geographic location of the study site (ISAV-VGE/F, 2023).

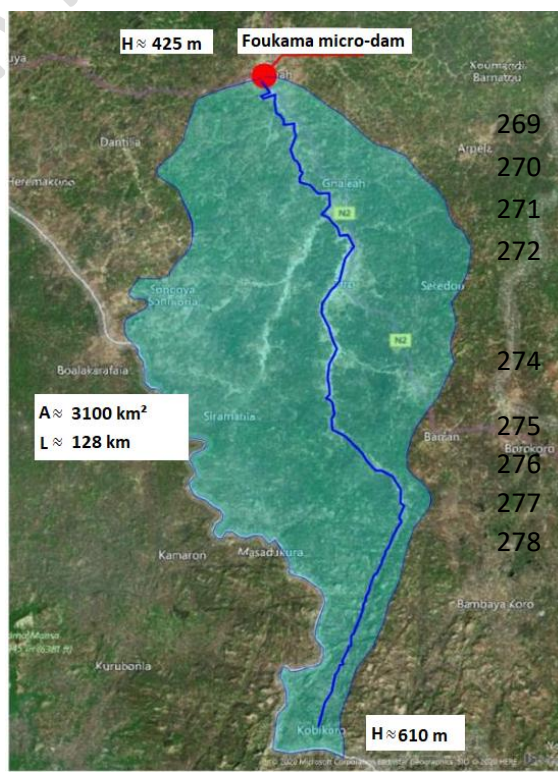
267 **Materials and methods: -**

268 **Study data: -**

269 The data used pertain to  
 270 topography, geological  
 271 conditions of the study  
 272 characteristics of the  
 273 Founkama micro-dam.

274 **Hydrography of the study**

275 Originating in a  
 276 elevation of approximately  
 277 southeastern Guinea, near  
 278 with Sierra Leone, the



269 the hydrography,  
 270 and geotechnical  
 271 area, and the  
 272 reservoir of the existing

274 **area: -**

275 mountainous region (at an  
 276 610 meters) in  
 277 the northeastern border  
 278 Niger River flows

279 northeastward before entering the Republic of Mali. It then turns southeastward, flowing through Niger  
280 and Nigeria, before emptying into the Gulf of Guinea, forming a large delta. Approximately 4,200 km  
281 long, with a watershed of about 2.1 million km<sup>2</sup>, it is the third-longest river on the African continent.  
282 Figure 8 shows the study site's watershed. Upstream of the Foukama micro-dam in the urban commune of  
283 Faranah, the watershed covers an area of approximately 3,100 km<sup>2</sup>, with a river length of about 128 km  
284 and an average gradient of around 0.144%.

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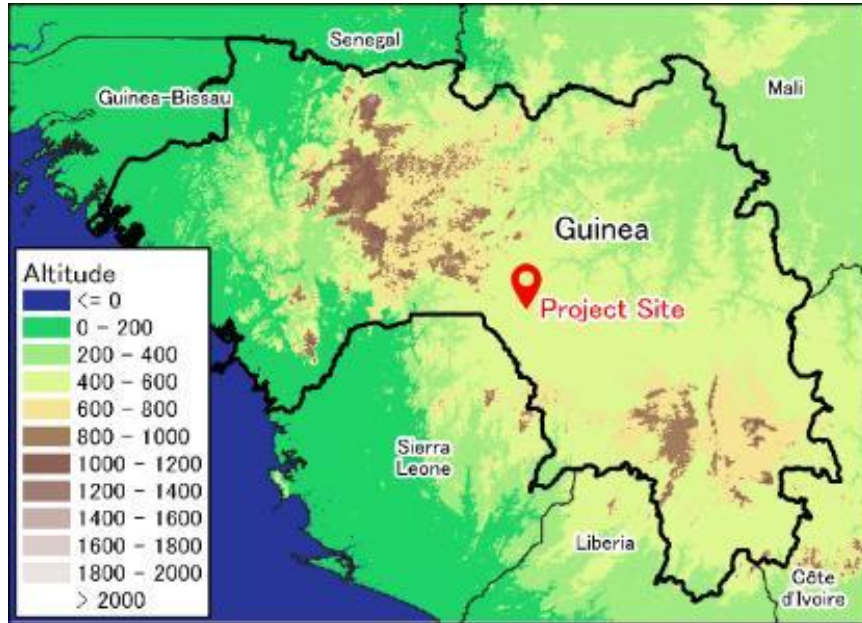
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297 **Figure 8:** - Watershed of the Founkama site in the urban municipality of Faranah (JICA, 2023).

298 ***Topography of the study area:*** -

299 The topography around Faranah is characterized by valleys at an elevation of approximately 420 to 430  
300 meters, carved into plateaus at an elevation of approximately 470 meters. It is characterized by the  
301 presence of a large valley traversed from southeast to northwest by the main channel of the Niger River,  
302 with the formation of numerous small-scale valleys that run perpendicular to it. The Niger River channel  
303 winds through the valley floor, thus exhibiting a characteristic of topography in the senile stage. For the  
304 study site, existing topographic surveys show that the valley floor is roughly flat and surrounded by  
305 hillsides. Figure 9 shows the topographic map of the area surrounding the urban commune of Faranah.



**Figure 9:** - Topography of the area surrounding the urban municipality of Faranah (JICA, 2023).

**Geological and geotechnical conditions:** -

The foundation soil of the existing micro-dam is impermeable (clay-loam). This soil can be used as construction material for building the proposed new micro-dam. Site visits revealed that there are no rocks in the immediate vicinity of the site, but large quantities are available behind the eastern hill at a distance of approximately 1 km, and sand is available 4 km away on the bed of the Niger River. These site visits detected no signs of landslides. There are no areas where natural stability could be compromised by the impoundment of the dam, by subsequent drainage, or by construction earthworks.

**Characteristics of the reservoir of the existing Founkama micro-dam:** -

The existing irrigation system in the Founkama Plain consists of a 117,529-cubic-meter reservoir, a 1,529-meter drainage canal, two ring canals (542 meters), 42 distribution canals, two dividers, and a network of embankments separating the plots.

**Methodological Approach:** -

The technical analysis of these various studies allowed us to verify our hypotheses and draw a sound conclusion from our research. The various studies conducted for the Founkama site are as follows:

Once the documentation was gathered and the information collected, a synthesis was performed; subsequently, the compilation of results from the diagnostic studies we conducted allowed us to identify the benefits demonstrating the necessity of constructing the new micro-dam, on the one hand, and the means for its implementation, on the other. Data processing initially involved prioritizing the various data collected according to their importance and grouping them based on their usefulness. We then extracted directly actionable information from this data as follows:

- Assessment of needs and losses: The functions of the reservoir were selected based on socioeconomic data, and the needs were calculated for each function in terms of cubic meters of water. The same

339 calculation was performed for losses based on meteorological data obtained from the Guinean National  
340 Meteorological Directorate, and the recommendations in the manuals “Small Dam Engineering in Sahelian  
341 and Equatorial Africa” and “Dam Engineering in Rural Development.” Thus, rainfall and temperature  
342 data from the station near the Niger Basin were utilized;

- 343 • Topographic studies: the reservoir capacity was calculated using the mean surface area method. These  
344 studies were used to determine the alignment of the new micro-dam to be constructed;
- 345 • Hydrological studies: the design flood was determined using the ORSTOM and CIEH methods, and  
346 annual inflows were estimated using the runoff coefficient estimation method.

347 The data analysis was conducted after processing in order to identify the steps needed to rehabilitate the  
348 existing micro-dam and construct the proposed one. Given the information regarding the materials and  
349 soils in the lowlands, and although no formal geotechnical studies have been conducted, the following is  
350 proposed:

- 351 • Subject to confirmation of the quality and quantity of site materials through various laboratory tests, it  
352 would be efficient to use a large portion (80%) of local material for the backfill.
- 353 • The remaining proportion (20%) could therefore consist of imported materials.

354 With regard to hydraulic design, the dimensions of the structure capable of discharging the flood flow  
355 must be determined. In this part of the study, the various structures are identified based on defined  
356 criteria, and the dimensions of each structure are then derived.

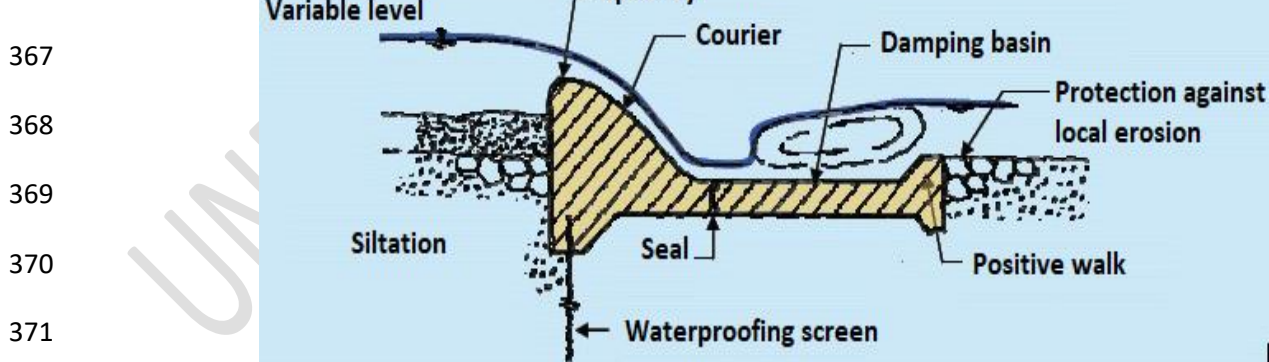
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#### 358 *Types of flood discharge structures: -*

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360 Among the range of spillways, the choice fell on the thick-crested (fixed) spillway, due to its structural  
361 robustness, its ability to handle high flow rates, and its resistance to erosion. It offers greater mechanical  
362 stability and requires less maintenance, making it ideal for small hydraulic structures. In summary, for a  
363 micro-dam, the thick-crested weir is a reliable and economical solution, prioritizing strength over extreme  
364 measurement precision. Figure 10 below shows the type of weir adopted for the new Founkama micro-  
365 dam, which is planned for construction.

366



372 **Figure 10:** -Fixed-weir spillway to be used for the new Founkama micro-dam planned for construction  
373 (Hountondji, 2026).

#### 374 *Location of the spillway: -*

375 The spillway will be positioned on the side to safely discharge excess water (floodwaters), thereby  
376 protecting the structure from submersion and failure. This configuration directs the discharge water away  
377 from the main body of the levee, reducing erosion at the toe of the micro-dam.

378 ***Dike: -***

379 The height of the levee is equal to the normal water level (NWL) plus the maximum overflow at the  
380 spillway and the clearance height. The crest width of the weir must be sufficient to prevent significant  
381 water flow over it near the crest when the reservoir is full. It must also allow for the movement of  
382 equipment for the completion of the structure and, subsequently, for its maintenance. The embankment is  
383 homogeneous, and the slope values for the upstream and downstream slopes will be determined using the  
384 table of standard values for slope design.

385 ***Slope protection: -***

386 The upstream slope will be protected by hand-laid riprap with a retaining wall installed at the base of the  
387 slope. The riprap layers must be between 0.20 m and 0.30 m thick. The downstream slope will be  
388 protected by a 40-cm-thick layer of topsoil sourced from the natural ground during the excavation of the  
389 trenches. Periodic maintenance is necessary to fill in any gullies as soon as they appear. Care must be  
390 taken to remove trees or shrubs whose roots could create areas where water flows.

391 ***Anchor trench: -***

392 It is excavated beneath the future seawall and backfilled with waterproof materials (selected clay) that are  
393 carefully compacted. Its depth must reach the bedrock to ensure the base is watertight.

394 ***Foot drain: -***

395 To prevent seepage through the levee, a single-layer drainage mat approximately 30 cm thick is planned.  
396 A toe ditch is also planned to collect water downstream.

397 ***Footrest: -***

398 The toe wall of the upstream face serves, on the one hand, to anchor the toe of the riprap in the natural  
399 ground and, on the other hand, to bear part of the thrust generated by the weight of the stones that make  
400 up the riprap. The toe wall shall have a triangular cross-section and a depth of 0.60 m, which is at least  
401 twice the largest dimension of the stones, with a minimum of 0.30 m, and a length of 1.5 m from the  
402 natural ground.

403 **Results and discussion: -**

404 **Results: -**

405 In this section, the results of the technical study for the new Founkama micro-dam planned for  
406 construction in the urban municipality of Faranahare presented in the form of a technical data sheet in  
407 Table 1. The dam will be homogeneous, constructed of ungraded clay materials found in the project area.  
408 For construction purposes, it is necessary to excavate an anchor trench with a depth ranging from 1 to 5  
409 meters, depending on whether the location is at the inter-river level or the minor riverbed level. Based on

410 the topographic survey of the study site, the axis of the proposed structure has been marked. Figure 11  
 411 shows a partial view of the study site's topography, indicating the axis and channel of the new Founkama  
 412 micro-dam planned for construction.

413 **Table 1: -Technical Specifications for the Proposed New Founkama Micro-Dam**

<b>Technical Specifications of the Founkama Micro-Dam</b>	
<b>Bowl</b>	
Volume	450,000 m <sup>3</sup>
<b>Dike</b>	
Nature	Homogène
Length	184 m
Crest width	3.75 m
Width at the base	28.95 m
Maximum height	5.60 m
Volume of the dike	12,000 m <sup>3</sup>
<b>Spillway</b>	
Type	Thick threshold (fixed)
Position	Latéral
Length	66 m
Length of the dissipation basin	9.35 m
<b>Plug</b>	
Position	Connected to the spillway
Pipe diameter	300 mm
Length	280 m
<b>Drainage structure</b>	
Valve position	Central
Valve size	2.00 m x 1.50 m
<b>Perimeter</b>	
Surface	180 hectares
Aptitude	Rice cultivation



423 **Figure 11: -Topographic view of the site showing the alignment of the**  
 424 **proposed new micro-dam**

425 **Discussion: -**

426 **The socio-economic significance of the structure's development within the community: -**

427  
428 The majority of the population in the urban commune of Faranah relies on agriculture for their livelihood.  
429 Therefore, promoting agriculture is the key to reducing poverty and contributing to economic growth. The  
430 objective of constructing micro-dams is to meet food needs while creating better production conditions  
431 and generating benefits for both urban and rural populations (Berton, 1988).

432 Thus, the development of the Founkama plain through the rehabilitation of the existing micro-dam and  
433 the construction of a new one will provide the population with sources of income through vegetable  
434 farming, fish farming, irrigated rice cultivation, and livestock raising. According to a study conducted by  
435 (Kpéra et al., 2012), the presence of micro-dams is a consistently recognized benefit, given the wide range  
436 of activities they support. The development of the Founkama plain will therefore be of great benefit to the  
437 development of the urban commune of Faranah. The presence of water in the reservoir throughout the  
438 year will raise the water table across the entire area, thereby facilitating the construction of boreholes and  
439 traditional wells. These findings are consistent with those reported by Napon (2013) regarding small  
440 water reservoirs and their effects on living conditions.

441 Furthermore, the development of 180 hectares out of a total of 260 hectares in the Foukama Plain presents  
442 a significant employment opportunity for young people, thereby helping to curb rural migration. The  
443 proposed project will help retain the workforce in the municipality of Faranah.

444

445 **Description of the structure to be built: -**

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447 The structure examined in this study is a micro-dam that creates a water reservoir upstream of the  
448 impoundment. The water retained upstream of the micro-dam will be used for a period that is longer the  
449 larger the resulting reservoir is. The upstream slope of the dam will be reinforced with hand-laid riprap,  
450 and the downstream slope will be vegetated (Adomahou, 1999). The spillway is therefore made of  
451 reinforced concrete.

452

453 **Functioning of the structure: -**

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455 The presence of the structure on the riverbed will disrupt the natural flow regime of the water. This will  
456 cause a rise in water level upstream. Two types of hydraulic operation will be observed depending on the  
457 water level at the structure: submerged and unsubmerged conditions. Submerged operation means that  
458 the water level at the structure's immediate outlet exceeds the upper edge of the spillway. Water will  
459 therefore flow downstream under the spillway.

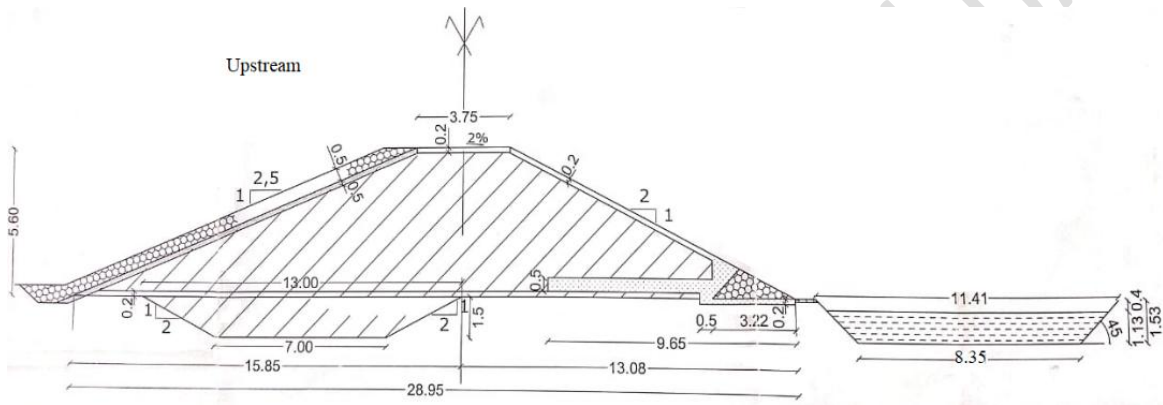
460 In contrast, the unregulated flow regime is one in which the flow rate over the sill depends on the  
461 downstream water level. The downstream water level is therefore determined by the flow conditions  
462 upstream of the structure. Unflooded operation is therefore the condition in which the flow rate upstream  
463 of the mini-dam's spillway is unaffected by the water level downstream of the structure. The flow is  
464 unflooded as long as  $H_{\text{(downstream)}} \leq 0.8 H_{\text{(upstream)}}$  but flooded otherwise.

465 The structure positioned above the spillway sill is designed to discharge high flows and thus generally  
466 protects the structure against exceptional floods. It must operate in the non-submerged regime to avoid  
467 any risk. Since the reservoir's surface area is relatively large (35 hectares) and the determined length of the  
468 spillway is 66 m, it is now evident that the flood attenuation will be very significant. This aligns with the  
469 work of Durand (1995), who states that the larger the reservoir, the greater the flood attenuation.



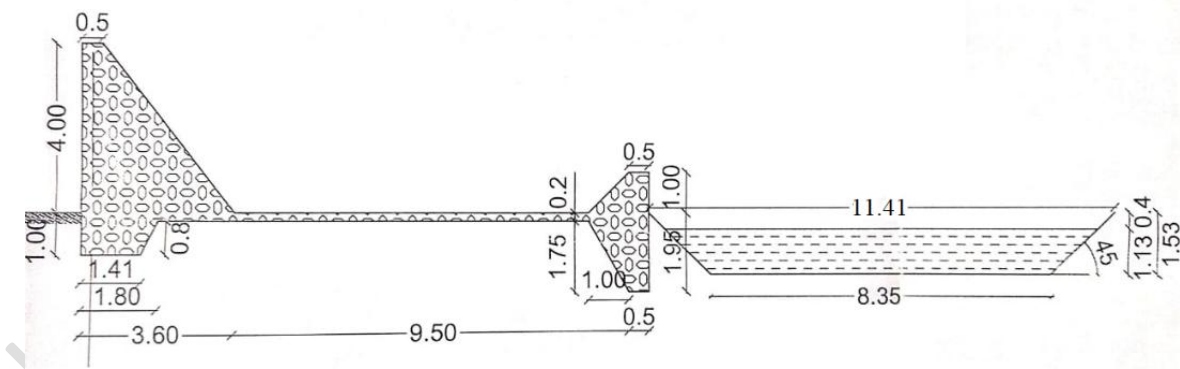
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**Figure 13: - Typical cross-sectional profile of the seawall**



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**Figure 14: - Typical cross-sectional profile of the levee with the energy dissipation basin**



**Figure 15: -Cross-sectional profile of the spillway**

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**Conclusion: -**

509 The key finding of this study is that the rehabilitation of the Founkama micro-dam through the  
510 construction of a new structure will contribute to the well-being, fulfillment, and improved living  
511 conditions of the students at ISAV-VGE/F and the population throughout the surrounding plain,  
512 specifically in terms of food needs for both groups and the practical application of theoretical coursework  
513 for the students. Indeed, meeting the agro-pastoral water needs of the local communities will enable them  
514 to generate more income.

515 The environmental and social analysis has highlighted the impacts of the new structure planned for  
516 construction, most of which are positive and significantly outweigh the negative impacts, which have  
517 been minimized. Field observations, reinforced by the results of the analyses, strongly support the  
518 feasibility of developing the 180 hectares of the downstream section of the micro-dam, which constitutes  
519 the Founkama plain.

520

521 **Conflicts of interest: -**

522 The authors declare that they have no conflicts of interest regarding the data published in this article.

523

524 **References: -**

525

526 Adomahou J. (1999). Preliminary Feasibility Study for the Construction of a Water Reservoir for Pastoral  
527 Use in the Village of Koundri. Internship Report, 48 p. (In French)

528 Bahir M., Ouhamdouch S., Carreira P.M., Goumih A., Chamchati H. (2016). Effect OF Zerrar dam on the  
529 aquifer system of Essaouira basin (Morocco). Larhyss Journal, ISSN 1112-3680, n°27, Sept 2016, pp.  
530 205-220

531 Berton S. (1988). Flood Control in Low-Lying Areas: Small and Micro-Dams in West Africa. Series:  
532 Focus. Report No. 12 – Ministry of Cooperation, Paris, 474 p. (In French)

533 Durand J. M. (1995). The Design, Maintenance, Monitoring, and Operation of Small Dams in Africa: A  
534 Handbook for Senior Technicians, 42 p. (In French)

535 El Ghazlani, T., Benaabidate, L., & Zemzami, M. (2023). Analysis of climate variability in the Guir-Ziz  
536 basin. Water and Development Review, 16-19. (In French)

537 JICA (2023). Preliminary Study Report for the Faranah Bridge Reconstruction Project on National  
538 Highway No. 2. Katahira & Engineers International Eight-Japan Engineering Consultants Inc. (In French)

539 Kpera G.N., Aarts N., Saidou A., Tossou R. C., Eilers C. H. A. M., Mensah G. A., Sinsin B. A., Kossou  
540 D. K., Vander zijpp A. J. (2012). Management of agro-pastoral dams in Benin: Stakeholders, institutions  
541 and rehabilitation research. Wageningen Journal of Life Sciences, 12 p.

542 Napon K. (2013). Small Water Reservoirs and Their Impact on Household Living Conditions: The Case  
543 of the Boura Reservoir (Sissili Province). Master's Thesis in Physical Geography, University of  
544 Koudougou, 111 p. (In French)

545 PANA (2007). National Adaptation Plan for climate change (NAP) of the Republic of Guinea. (In  
546 French)

- 547 Remini B. (2010). The water problem in northern Algeria. Larhyss Journal, ISSN 1112-3680, n° 08, Juin  
548 2010, pp. 27-46. (In French)
- 549 Remini B. (2019). Dams in cascade (Tiout oasis, Algeria): A hydraulic heritage to save. Larhyss Journal,  
550 ISSN 1112-3680, n°37, Mars 2019, pp. 175-206. In french
- 551 Remini B., Bouabibsa R., Moudjed K. (2019). Beni Haroun and Koudiat Acerdoune (algeria): two large  
552 dams threatened by the phenomenon of siltation. Larhyss Journal, ISSN 1112-3680, n°38, Juin 2019, pp.  
553 131-151. (In French)
- 554 Remini B. (2020). Algeria: The climate is changing, the water is becoming scarce, what to do? Larhyss  
555 Journal, ISSN 1112-3680, n°41, Mars 2020, pp. 181-221
- 556 Tazekrit I., Benslimane M., Hamimed A., Hartani T., Khaldi A. (2017). Concerted water management of  
557 large irrigated perimeters. case of the Habra plain (North-West Algeria). Larhyss Journal, ISSN 1112-  
558 3680, n°30, Juin 2017, pp. 121-136. (In French)
- 559 WORLD BANK (2023). Two different maps of the Köppen-Geiger climate classification: World map of  
560 the Köppen-Geiger climate classification. [https://datacatalog.worldbank.org/search/dataset/0042325/world-](https://datacatalog.worldbank.org/search/dataset/0042325/world-maps-of-the-kppen-geiger-climate-classification)  
561 [maps-of-the-kppen-geiger-climate-classification](https://datacatalog.worldbank.org/search/dataset/0042325/world-maps-of-the-kppen-geiger-climate-classification)