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Identification of Degradation Factors and hydraulic dysfunction of the Galmi irrigated scheme and measures for the sustainability of the system (Niger)

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Abstract

Niger is a country with a chronic food deficit despite the efforts made by successive governments. To address this, the government considered creating hydro-agricultural infrastructure in the 1970s, but these systems have been poorly maintained since their construction. It is within this context that the present study was conducted in the Galmi irrigation scheme. Its objective is to conduct a comprehensive diagnosis of the irrigation, protection, and drainage networks in order to identify the factors contributing to their degradation and the causes of their malfunction. The methodology involved surveying a number of canals within these various networks and conducting our diagnosis in relation to them.

This study reveals that the factors contributing to the degradation of the Galmi irrigated area, leading to its poor hydraulic functioning, are numerous and multifaceted: the near-total silting up of the reservoir, the deterioration of the weirs, broken panels, silting, weed growth, and cracking of the canals. It is estimated that over 70% of the hydraulic structures within this irrigated area are degraded.

Finally, we note the poor management of irrigation water, the failure to adhere to water rotation schedules, and the breach of the protective dike.

For a successful return to irrigated agricultural activities, it would be advisable to rehabilitate this, the country's largest irrigated area.

Keywords: Identification; Degradation; Functioning; Irrigated area; Galmi

1. Introduction

Niger is a Sahel-Saharan country characterized by extremely unfavorable climatic conditions, with low rainfall that is often poorly distributed in time and space. Achieving sustainable global food security is an integral part of the social, economic, environmental, and human development goals agreed upon at the recent international conference (FAO, 1996). This political will has manifested itself through the development of several types of irrigation systems, namely fully controlled hydro-agricultural developments, off-season irrigation schemes, private irrigation, runoff water harvesting, and large- and medium-scale commercial irrigation. The hydro-agricultural developments built before the 1980s were subject to two types of management: state management, characterized by the omnipresence of the state, and then peasant management, in which farmers were empowered to take charge of all development activities (Mossi, 2009). However, today some irrigated areas are experiencing difficulties leading to serious degradation and even

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hydraulic and agronomic dysfunctions (ONAHA, 2015). The objective of this study is to identify the factors contributing to the degradation and poor hydraulic functioning of the Galmi hydro-agricultural development.

2. Materials and Methods

2.1. Materials

The equipment used in this study consisted of:

- A Haoujue brand motorcycle for travel around the site;
- A tape measure for measuring the structures;

2.2. Methods

Effective management of an irrigated area requires a diagnostic approach. With some differences, the same methodological approach was applied to all the sites selected for these assessments. It is based on the "Participatory Diagnosis and Planning of Actions to Improve the Performance of Irrigated Areas (DPRP)" method developed by IWMI and ARID (IPTRID, FAO, 2007).

2.2.1. Description of the DPRP Method

This approach, developed in collaboration with farmers, seeks to analyze the performance of their irrigated systems. It allows for the diagnosis of the main constraints and the subsequent development of an action plan to improve the system.

It has the advantage of being rapid and identifying constraints across all components of the irrigated system. For the specific case of the Galmi perimeter, the diagnostic process brought together experts with knowledge of irrigated systems (hydraulic, agronomic, and socio-organizational), development agents representing the public service at the local level, as well as farmers' organizations and farmers' representatives of the irrigated system operators.

In this study, we will use only part of the DPRP method, namely, we will conduct a hydraulic diagnostic and an assessment of the land use aspects.

2.2.2. Data Collection

The methodological approach comprises three main phases:

Preparatory Phase

- This phase consisted of an initial meeting with the Director of the Galmi Perimeter (DP) and some members of the cooperative, during which the topic was presented. This meeting also established contact with the Galmi DP, who served as the supervisor.
- A site visit with the Perimeter Director;
- Personal site visits to observe and assess the physical condition of the water reservoir, irrigation, and drainage networks.

Data Collection Phase

This phase allows us to gather available information on the sites through documentary research.

This phase allows us to collect data from technicians in the relevant departments and from the farmers themselves. It is divided into two sub-phases:

- The first sub-phase takes place at the level of the ONAHA technical departments, the Rural Engineering department, and with the farmers, and consists of collecting data through interviews with these two categories of people;
- The second sub-phase takes place in the field, which consists of surveying the perimeter along clearly defined routes to assess the various hydraulic structures.

The field observations were primarily based on transects, which, starting and ending at the perimeter, allowed us to evaluate the operational status of the perimeter.

Following the field phase, the collected data was compiled, processed, and analyzed for the preparation of this article.

3. Results

The analysis and data collected during surveys of key stakeholders within the irrigation perimeter were crucial for understanding its operation. The infrastructure of the Galmi irrigated perimeter was assessed, including water mobilization structures, irrigation and drainage networks, and agricultural development. The results are presented in the paragraphs below.

3.1. Factors Contributing to the Degradation of the Irrigation Water Mobilization Structure: Reservoir

A reservoir is a structure that stores water in a given area to make it available when needed. The reservoir supplying the Galmi irrigated perimeter was created in 1980-1981 with a capacity of 72,000,000 m^3. Today, the reservoir is facing a lack of erosion control measures and near-total silting. These two phenomena are the root cause of the severe water level reductions in the reservoir. There are three sluice gates set at different elevations, given the 17-meter depth of the kori (dry riverbed). Despite insufficient rainfall, the watershed has become a site of agricultural activity during the rainy season, hindering the flow of water to the reservoir.

Factors Contributing to the Degradation of the Irrigation Network

The irrigation network of the Galmi hydro-agricultural development faces various problems, including the degradation of embankments, which has left approximately 30% of the canals exposed, and the deterioration and cracking of panels, which accelerate water loss, preventing some sprinklers from reaching the irrigated areas downstream.

It can also be noted that the main canal faces observed problems, such as panel degradation, but the most serious issues affecting the main canal are cracking and defective seals. As for the secondary canals, the observed constraints include weed growth, silting, panel breakage, and degraded supports. The tertiary canals, as a whole, are not functioning well. They are completely silted up; given that they were originally earth-lined canals with a trapezoidal cross-section, but now have varying cross-sections.

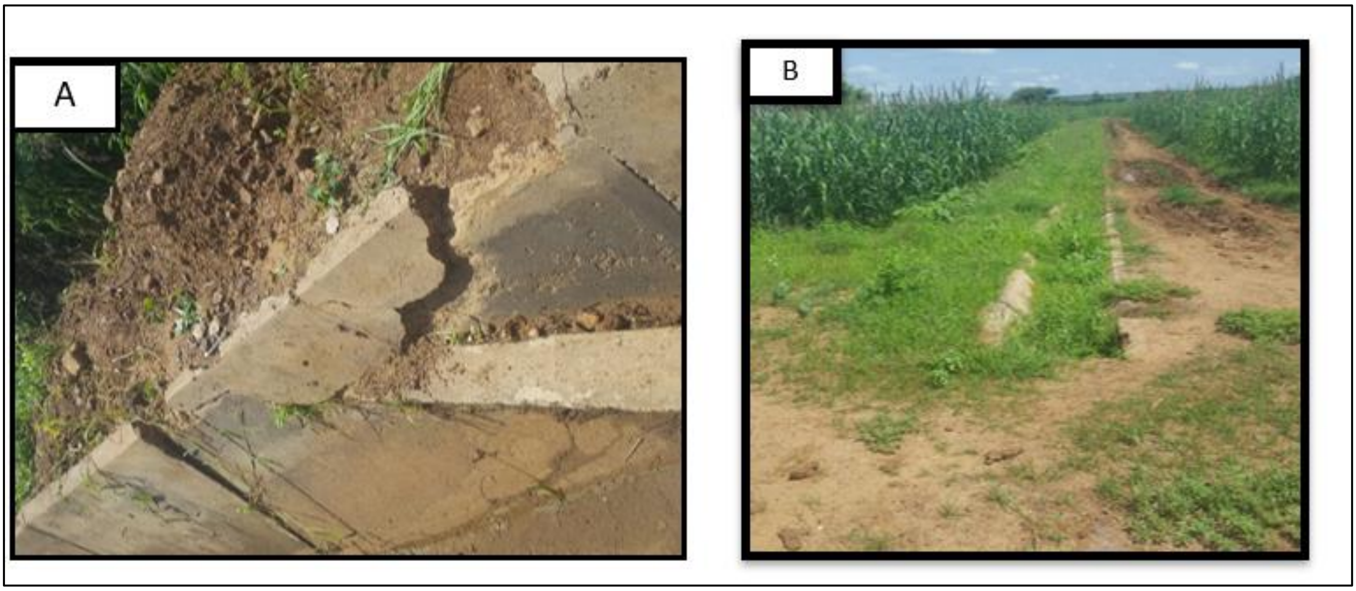

Figure 1 Broken panels on the main canal A and vegetation growth on the secondary canal B

It is clearer that the operational status of the irrigation network, particularly the main canal (photo 1.A), is compromised by severe valve breakages, while the secondary canal (photo 1.B) is overgrown with weeds, resulting in an irregular canal shape.

Table 1 Summary of constraints observed on the irrigation networks leading to the degradation of the Galmi irrigation perimeter

Irrigation Network	Observed Constraints				
	Deteriorated sluice gate	Broken panels	Silting	Grass cover	Cracking
Main canal	++	++	+	+	+++
Secondary canal	+	+	++	+++	+
Tertiary canal	/	/	+++	+++	/

Legend: + weak; ++ medium; +++ very bad; / none

Table 1 clearly illustrates the constraints observed on the irrigation network, which are classified into five (5) categories: degradation of the irrigation system, broken panels, siltation, weed growth, and cracking.

3.2. Factors Contributing to the Degradation of Drainage and Protection Networks

The degradation of the protection and drainage system is the greatest constraint on the ground. For farmers, this already hinders the development of part of the perimeter, particularly the plots served by one of the secondary canals, which is severely damaged by water from outside the perimeter. Furthermore, the disappearance of plot drains, which have been converted into arable land, exposes the plots to flooding during heavy rainfall. The drains as a whole are not functional; they are completely silted up and used for cultivation. They are in a state of disrepair.

Table 2 Constraints observed on the drainage network exacerbating the degradation of the Galmi perimeter

Drainage Network	Observed Constraints		
	Operation	Grass Cover	Silting
Main Drain	+++	+++	+++
Secondary Drains	++	+++	+++
Tertiary Drains	+	++	+++

Legend: + weak; ++ medium; +++very bad.

Table 2 shows drainage network problems such as the perimeter encroachment, which is due to agricultural use of the drainage system and lack of maintenance, leading to weed growth and siltation.

As for the dike, its northeastern section has breached over approximately 80 meters just after the confluence of three brooks (koris) that carry water from the plateaus. Since the protective ditch is no longer functioning properly, its reshaping over 500 meters and longitudinal protection with gabions over 265 meters should be considered. The breach in the dike results in water spreading over 11 hectares during the winter season, making its development increasingly difficult. This water intrusion is the cause of the complete deterioration of a portion of the S24 area.

In the northern and southern sections, the deterioration is more acute in certain areas because a significant portion is now indistinguishable from the natural terrain.

3.3. Other Causes of Malfunctioning of the Perimeter

The problem of water management in terms of organizing water rotations and maintaining infrastructure. This includes:

- Failure to respect secondary irrigation opening hours;
- Failure to respect water rotation schedules (organizational problem);
- Insufficient number of water carriers;
- Water theft;
- Poor management of irrigation water.

3.4. Measures for the Sustainability of the Irrigation System

Based on the current problems in the Galmi irrigation scheme, to prevent the worst and ensure the sustainability of this irrigation system, we propose the following main solutions:

- Weeding of the irrigation canals must be carried out periodically;
- Cracked or damaged panels on the main, secondary, and tertiary canals, as well as the supply canal, must be repaired, and non-functional tertiary valves and sluice gates throughout the network must be replaced;
- To the clearing of the drainage network;
- To the absolute prohibition of the operation of the drains;
- To the reconstruction of the embankment at the level of all dislodged canals;
- To the capacity building of the sections (groups of producers who receive irrigation water on the same day) regarding water rotation is necessary in order to raise awareness about the need to respect the maintenance of hydraulic structures, in particular.

4. Discussion

The Galmi irrigation scheme has undergone changes over time. Infrastructure maintenance within the scheme is inadequate, resulting in significant degradation of the irrigation network. The main canal exhibits severe deterioration of the sluice gates, broken panels, cracks, and a lack of defective seals. The secondary canals are in a less critical state, suffering only from weed growth, siltation, and minor panel breakage and cracking. As for the tertiary canals, sand encroachment is observed, leading to the disappearance of certain sections of the canals as they are lined with earth. These results are consistent with those found by AMADOU (2010), who studied the hydraulic constraints of the Daibery irrigated area.

This results in very low irrigation efficiency, poor drainage during the rainy season, and difficulties with traffic flow within the irrigated area. In summary, this entire constraint concerning the degradation of the irrigation network is due to the presence of numerous water leaks. It ensures a sufficient water supply to several plots. This is the same problem found by FARMA (2016) in their evaluation of the functioning of the BOGANDE irrigated perimeter in Burkina Faso. These two perimeters share almost the same hydraulic problems related to a lack of infrastructure maintenance. These results are similar to those found by the FAO (2007) during its assessment of irrigated perimeters in West Africa. The same results are consistent with those found by BOUKARY (2010) for the Djirataoua perimeter. Although these perimeters do not have the same system characteristics, they encounter the same hydraulic problem. In summary, this entire constraint concerning the degradation of the irrigation network is due to the presence of numerous water leaks. This prevents sufficient water supply to several plots. These results corroborate the work of NAMATA (2012).

Regarding the drainage network, it appears that the degradation of the drainage system is the most significant problem observed on the ground in the Galmi area. The drains in the Galmi area are no longer functioning properly; they are in a state of disrepair. The disappearance of plot drains, which have been converted into arable land, exposes the plots to flooding during heavy rainfall. This situation can be explained by a lack of maintenance and overexploitation by irrigators across almost the entire drainage network. The same observations were made by Sally et al. (1997), Aminou (1991) and ONAHA (2015) in their assessments of the Konni irrigated area, where they explain that the disappearance of drains in favor of arable land does not protect the area from flooding that could occur during heavy rainfall. These results are similar to those obtained by Rutabara (2017), who showed that poor drainage maintenance leads to flooding of cultivated plots. It can therefore be deduced that resolving the drainage network issue would prevent flooding and the unnecessary consumption of water on the plots, and could subsequently increase production (ANIDE, 2009). In short, this is a constraint that significantly threatens the development of the land.

5. Conclusion

The Galmi irrigated area is nearly 50 years old and was partially rehabilitated in 2014. This study reveals that it faces numerous constraints, with the present study focusing on those related to the hydraulic infrastructure.

Regarding the hydraulic infrastructure: the irrigation and drainage networks are severely deteriorated. This deterioration is readily apparent in the numerous panels of the main and secondary canals; the tertiary canals are almost entirely absent, misaligned, or damaged. Furthermore, the drainage network is also degraded, particularly the main drains, some of which are overgrown with vegetation or silted up, while others are in use and individual plot drains are completely absent. The farmers are concerned about the condition of the area and want it rehabilitated at the first opportunity.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed. Yes, there is no conflict of interest.

References

[1] AMADOU SABRA, 2010. Analysis of the hydraulic constraints of the irrigated perimeter of Daïbéri

[2] AMINOU I. S., 1991. Impact of mechanical treatments on the Galmi watershed, final year project, Niamey, IPDR, 30p.

[3] ANID., 2009. Rapid Participatory Diagnosis and Action Planning for the Daïbéri Area.

[4] FAO.,1996. Guidelines for Planning Irrigation and Drainage Investment Projects

[5] FAO.,2007. Rapid participatory diagnosis and planning of actions to improve the performance of irrigated areas: Application to West Africa.

[6] FARMA Alexis.,2016. Technical diagnosis of a gravity-type irrigated perimeter and proposal of a plan to improve its performance: case of the "67 ha" irrigated perimeter downstream of the BOGANDE dam. Master in Civil and Hydraulic Engineering/2IE-OuagaBurkina Faso

[7] BOUKARY ILIASSOU, 2010. Diagnosis of hydraulic structures in the Djirataoua area in the Maradi region

[8] MOSSI Maïga et al., 2009, Rapid Participatory Diagnosis and Action Planning of the Daïbéri perimeter (Tillabéry department, Niger). 58. P

[9] MAMAN NOURI.A.M, 2017, Diagnosis of irrigation and drainage network in the Konni perimeter (Tahoua-Niger)

[10] Namata.I.M., 2012. "Social management and diagnosis of water distribution infrastructures on the rice-growing perimeter of Saga" thesis for obtaining the specialized master's degree in hydraulics and irrigated systems.

[11] ONAHA, 2015. Diagnosis of the Konni hydro-agricultural perimeter, 28p

[12] RUTABARA. H., 2017. Farmers' perceptions of drainage network maintenance and solutions: A case study of Baguinéda Amont (OPIB / Mali). 116p

[13] SALLY, H., KEITA, A., & OUATTARA, S. (1997). Diagnostic analysis and performance of 5 irrigated perimeters around dams in Burkina Faso.