Integrated water resource management in the decision-making of large firms in Morocco: Case of Managem group (Hydraulic basin of Tensift AL Haouz)

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Abstract. Water resources and economic growth are two preoccupations that take different senses. The overconsumption can be very costly in terms of the quantity and quality of water resources, which indulges many negative impacts on water reserves. In arid zones, institutions and large national firms are obligated to deliver more efforts in term of adaptation to the area's hydraulic situation. In this work, we addressed the issue of integrating good governance of water resources into the decision-making process of large firms in Morocco. We studied the case of the Guemassa mine of the Managem group, located in the Tensift Haouz basin. In order to assess the efficiency of their strategy, we carried out an impact study of the company's mining activities on the quality and quantity of the region's waterresources and we provided key information on the hydraulic situation of the region in question. As a result, the company is monopolizing a large part of the water resources of the Haouz plain and their integrated water resource management strategy is deemed insufficient.
Keywords. Water scarcity, integrated water resource management, large firms, PRA.

1 Introduction

Since the dawn of time, human activity has been dependent on water resources. For a long time, water was considered inexhaustible and abundant. Therefore, as a result, humankind has exploited this resource relentlessly, without realizing that over-consumption can have serious repercussions on the quality and the quantity of hydraulic resources. After the 1950s, consumption and production patterns underwent a number of major transformations, demonstrating the indispensability of this resource for economic growth. The resource was considered abundant and unlimited, and therefore without exchange value, i.e. a free good. This explains why water is excluded from the scope of economic analysis, since its production cost is considered inexistent. A "good that falls from the sky"[1].
The introduction of integrated water resource management [2] in the various economic sectors (agriculture, industry, energy, etc.) remain the only solution.
On a national level, Morocco is one of the twenty countries most affected by water stress. The potential of natural water resources in the Moroccan territory is 22 billion m³ per year, i.e. 700 m³ per inhabitant per year. There are several factors behind this water shortage, including the uneven distribution and spatial distribution of water resources, which means a regional disparities in rainfall as well as alternating wet and dry sequences, interspersed with years of high water levels or severe drought [3,4]. This independence leaves the major national companies with a serious challenge, as they have to cope with the gradual scarcity of the resource while limiting its negative impact on the environment. Based on these premises, our main questioning is: How does large companies deal with water scarcity, especially in the case of Managem group? What are the impacts of implementing a water management strategy in the process of decision-making on their social environment as well as their region hydraulic situation? In order to respond to these interrogations, we adopted an approach consisting of a bibliographical study of the existing situation. We then performed

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a study of the impact of Managem group activities on the quality and quantity of the region's water resources and a Participatory Rural appraisal PRA with the local residents to identify the various social repercussions of the application of good governance of water resources within the company's decision-making process.
This article is organized as follows: the first section presents several related works on the subject. The second the study area where the third exposes the materials and methods used. The third section examines the effectiveness of this strategy in terms of the company's environmental and social performance. A conclusion concludes this paper.

2 Related works

Integrated water resource management is the internalization of the externalities of massive resource use, through the adoption of sustainable development principles to the water sector. It aims as well to incorporate all stakeholders and build consensus to consolidate the preservation of water resources. This is achieved through the application of participatory governance. Authors in [5] demonstrated that an effective governance of water resources depends on incorporating an efficient interactive system that enables the information exchange between the different actors. Many studies were conducted internationally to explain the integrated water resources management (IWRM). The work in [6] adopted a quantitative analysis on a global scale to demonstrate the importance of IWRM in the achievement of Sustainable Development Goals (SDG). They implemented a regression analysis between the SDG and key water-related indicators (access to basic sanitation, treated waste water, water use efficiency, water scarcity, fresh water ecosystems and ambient water quality). The analysis covered 124 countries. The results in this work suggested taking into accountability different factors that are specific to the context in order to make the right adjustments to the policies decision making. With this conclusion in mind, researches conducted different studies to addressthe IWRM in specific context [7-10]. The work in [7] aimed to demonstrate the importance of a PRA approach during the process of reaching an efficient IWRM. Including community groups and government agencies in the various project design and political decisions must be a priority in order to match water resources with various users and their activities in the drought-affected region in Bangladesh (Agricultures, Fisheries, etc.). This research achieved two main objectives: 1. Evaluating the ongoing water status and its related resources. 2. Creating an operational system to support the decision making for sustainable water usage scheme based on IWRM . A good allocation of hydraulic resources is one of the biggest challenges that faces the implementation of an IWRM. In that order, authors in [8] proposed a participatory-based IWRM model that strengthens the protection system of Gavkhouni basin’s water resources. This model simulates management scenarios by calculating the environmental flow. The previous studies indeed demonstrated the importance of studying and analyzing the riparian perspective and suggestions. However, they lack an impact analysis of economic activities specific to the studied regions. The work [10] obtained a better understanding of the effects on the livelihoods of the local population and of the local stakeholder’s views on the IWRM in Al-Mujaylis area, Yemen. By applying PRA, the authors made the stakeholders able to analyse the causes and to propose appropriate solutions for mitigating the water problems in the area and included the impact of agriculture activities (bananas, mangos). Another approach to assess sustainable IWRM is the Participatory Watershed Land-use Management (PWLM) approach where all the stakeholders and local government units (LGUs) should work more on a global scale instead of an individual one . PWLM has been applied in [11] to evaluate the effect of the process of changing the natural landscapes by human activities and climate change on urban flooding and in [9] for water quality assessment and management. The area of this study was the Silang-Santa Rosa watershed of the Laguna de Bay lake, Philippines.

On a national level and due to the climatic situation of Morocco, all national firms must adopt IWRM specially the largest firms.

3 Study area

In our study, we will examine the case of the Managem Group[12,13]. This Moroccan company specializes in mining and hydrometallurgy, and has been operating in Africa for over 85 years. Their mining activities consumes a gigantic quantity of water every year. The Guemmassa mine in Hajjar deposit is located in the Haouz plain, more precisely 35 kilometres southwest of the city of Marrakech. The site has been producing more than 2,400 tonnes of ore per day since 1992. We justify this choice by the fact that it is the closest deposit to civilization. Indeed, towns and villages surround the Hajjar mine, Tamesluht and Oumnass to the north of the mine, the Lalla Takerkoust dam to the south-west, which represents the source of water resources, the town of Tahannaout to the east and finally the villages of Tiwli and Tamazirt to the south of the mine. This broadens the scope of our study, and maximizes the data collected from local residents.

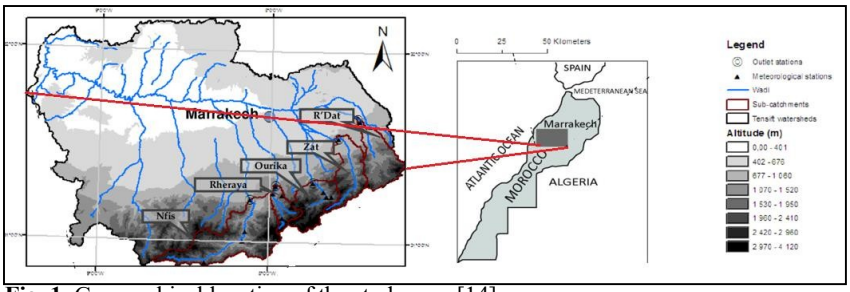

Fig. 1. Geographical location of the study area [14].

4 Materials and methods

In this work, we collected the analysed data as the following:

- From the Tensift Hydraulic Bassin Agency (THBA), we retrieved information about the quantity and the quality of water resources of Hajjar deposit.
- Using a PRA approach, we gathered information about the community feedback on Managem activities and their impact on riparian.

PRA tools can be very effective in an area with data scarcity and a culturally different context. PRA uses a range of participatory techniques to assess the resources of the group and the community, identify and rank problems specific to their context, and evaluate strategies for solving them [15]. The methods used in our case are the social mapping process, the focus group discussion process and time transects process. We collected data from a diverse sample of population from various neighbouring villages, notably Oumnass, Tiwli and Outghal, which are the closest points of civilization to the Guemassa mine. The individuals who took part in the survey were of different ages and had various occupations, either within the company (workers, employees, retired people) or outside (merchants, members of associations, teachers).

5 Results and discussion

5.1 Quality and quantity evaluation of water resources

The groundwater available in the Tensift hydraulic basin is distributed spatially in a naturally inequitable manner, but is also characterized by spatio-temporal inequality in rainfall. The main water tables in the region are presented in **Table 1**.:

Table 1. Surface area in Water tables of Tensift hydraulic basin.

Water tables	Surface area
Haouz	6000 km²
Bahira	5 000 km²
Meskala-Kourimate	1 600 km²
Mejjat	1 000 km²

This region is managed by the THBA. The agency carried out nearly 4,200 surface and groundwater analyses in 2018. The results of these analyses enabled the agency to assess the water quality of the region's various springs.
According to the quality data we gathered from THBA, we concluded the following:
- **Groundwater quality:** The results of the 2018 analyses showed overall; the quality of 80% of existing groundwater in the agency's area of operation is good to average. These results differ according to the aqueous layers:

- Haouz aqueous layer: Good to average quality in 86% of control points.
- Bahira aqueous layer: Poor quality at 27% of monitoring stations.
- Essaouira aqueous layer: Poor quality at 25% of monitoring stations, due to rising nitrate levels.

- Surface water:

- Water in streams and valleys: the quality of this water is average, with a deterioration in some towns explained by the increase in organic and biological pollution indices following the rejection of untreated wastewater.
- Dam water: In general, water from dams in the area is considered good to average.

5.2 Integrated water resources management in the firm Managem Group (Hajjar Mine)

Due to the hydraulic situation of the region and the Tensift basin, the company is obliged to integrate good governance of water resources. Indeed, the Managem Group has made a considerable effort to limit the impact and externalities of its mining activities on the region's water resources, and consequently on local residents, by adopting several strategies. The ultimate aim of these strategies is to protect the water reserves of the Tensift basin, to ensure the continuity of their activities and the well-being of the local community. In fact, for the company, the issue of good water resource management must be included in all future decision-making. We summarize the company's initiatives in terms of protection and the qualitative and quantitative sustainability of the resource as follows:

- Installation of filtration and decantation systems in order to reuse used water;
- Disposal of mine waste and discharges far from rivers, valleys and all sources;
- Recycling of dikes and mine water;
- Installation of pumped ore transfer stations;
- Watering plants located on the mining and industrial site using the drip irrigation.

5.2.1 Results of the Impact analysis of Managem group IWRM on the water resources

These actions operate in two levels: quality and quantity.
In terms of quality, the greatest risk associated with mining activities is that of groundwater and surface water contamination. Surface water can be contaminated by toxic liquid discharges during mine waste disposal operations, because of both acid drainage and contaminant leaching. The biggest threat to groundwater is the infiltration of accidentally contaminated water into the ground. This anomaly can lead to a deterioration in water quality, including the fouling of groundwater. In order to evaluate the efficiency of the strategies deployed by the firm, as part of our work, we submitted a data request concerning water

quality downstream of the Guemassa mine to the TWBA, in order to prove the previous finding.

SURFACE WATER QUALITY / TENSIFT BASIN / 2020CAMPAIGN								
SECONDARY STATIONS								
Sampling point	N°IRE	O2 Dissolved	DBO5	DCO	NH4+	PT	CF	Quality
		mg 02/l	mg 02/l	mg 02/l	mgNH4+/l	mgP/l	UFC/100 ml	Global
Downstream of the mine	3660/53	8.32	<0.22	<9.37	0.053	0.099	95	GOOD
Coordinates	x	y						
Downstream of the mine Guelassa au gisement Hajjar	240933	93999						

Fig.2. Surface water quality, 2020 campaign, TWBA.

TWBA confirms that the quality of hydraulic samples taken downstream from the mine (x=240933,y=93999) in 2019 is considered good.

In term of quantity, the Guemassa mine consumes over 3 million m^3 of water annually to extract the ores Zinc, Copper and Lead, not forgetting the processing of these ores, which in turn requires the use of a high rate of water resources. These 3 million m^3 are distributed over the mining process mainly used for the vehicles and ore processing, and a small percentage goes to construction site drowning, evaporation and infiltration by accident.

We illustrate the mineral processing and conveyance circuit in **Fig.3.**, which shows that the circuit is equipped with a decantation and filtration system for the remaining 60% of water to be reused.

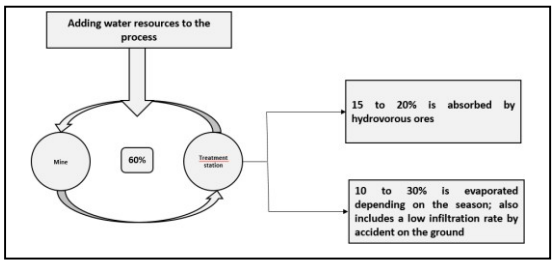

Fig.3. Circuit of mineral processing and conveying.

We note that the Guemassa mine consumes a large quantity of water annually, far exceeding the amount consumed by residents of the villages bordering the mine, which does not exceed 1 million m3 per year (according to the laboratory for remote sensing and water resources in the semi-arid Mediterranean), including domestic use and irrigation...

To better demonstrate the volume of the mine's overconsumption, we can compare its water consumption with that of the city of Marrakech, which stands at over 110 million m^3 per year, given that the city is home to over 1.3 million inhabitants in 2019 and hosts several agricultural and tourism projects. Therefore, the amount of water consumed by the mine annually (3 million m^3) represents 3.3% of the total consumption of the city of Marrakech. The company is monopolizing a large part of the water resources intended to meet the needs of its region.

5.2.2. Results of PRA on the impact of Managem group IWRM on the water resources

In order to evaluate properly the efforts made by the firm in term of good governance of water resources, it is essential to reach out to local residents to identify the various impacts of mining activities on their daily consumption of the same resource.

After processing the collected responses of the PRA, the results are as follows:

- The majority of villagers we contacted stated that water quality in the region was average, with a slight deterioration in quality in recent years.

- In terms of quantity, local residents confirmed that the company's water consumption diminishes their reserves for irrigation and domestic consumption (wells, springs, etc.), and that it monopolizes part of their water resource requirements.

The company is monopolizing a large part of the water resources of the Haouz plain, since its water consumption far exceeds that of local residents, whether for irrigation or domestic consumption. In terms of quality, the company has succeeded in managing the risks associated with water pollution in the region, by employing the right plans and methods.

In the end, despite the company's efforts, their integrated water resource management strategy is deemed insufficient. As their yearly consumption of water presents a very high risk for the region's hydraulic reserves, given its climatic situation. Operating in an arid zone, they are obliged to improve their governance of water resources.

6 Conclusion and future work

In this work, we studied implementation of IWRM in Hajjar deposit using a bi-process approach. It handled the case of Managem Group and adopted a PRA method as well as an impact study to evaluate their strategies over the quality and quantity of water resources in the Tensift basin.

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