

# An Assessment on the Effect of Participation of Rural Woman on Sustainable Rural Water Supply in Yemen

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**Abstract**—In rural areas of developing countries, participation of all stakeholders in water supply projects is an important step towards further development. As most of the beneficiaries are women, it is important that they should be involved to achieve successful and sustainable water supply projects. Women are responsible for the management of water both inside and outside home, and often spend more than six-hours a day fetching drinking water from distant water sources. The problem is that rural women play a role of little importance in the water supply projects' phases in rural Yemen. Therefore, this research aimed at analyzing the different reasons of their lack of participation in projects and in what way a full participation -if achieved- could contribute to sustainable water supply projects in the rural mountainous areas in Yemen. Four water supply projects were selected as a case study in Al-Della'a Alaala sub-district in the Al-Mahweet governorate, two of them were implemented by the Social Fund and Development (SFD), while others were implemented by the General Authority for Rural Water Supply Projects (GARWSSP). Furthermore, the successful Al-Galba project, which is located in Badan district in Ibb governorate, was selected for comparison. The rural women's active participation in water projects have potential consequences including continuity and maintenance improvement, equipment security, and improvement in the overall health and education status of these areas. The majority of respondents taking part in GARWSSP projects estimated that there is no reason to involve women in the project activities. In the comparison project - in which a woman worked as a supervisor and implemented the project - all respondents indicated that the participation of women is vital for sustainability. Therefore, the results of this research are intended to stimulate rural women's participation in the mountainous areas of Yemen.

**Keywords**—Assessment, rural woman, sustainability, water management.

## I. INTRODUCTION

### A. Situation Review

WATER is a source of life, as well as a source of a competing demand, which led to conflicts during the 20<sup>th</sup> century, when world's demand for water became six-fold [48]. At the international level, many researchers predicted that conflicts in the 21<sup>st</sup> century would be over water [14]. A total of 1.1 billion people in the world remain without access to safe drinking water, 84% among them live in rural areas, whereas nearly 1.6 million children under the age of five die every year as a result of contaminated drinking water and poor hygiene. Although rural coverage increased from 64% in 1990 to 73% in 2004, some 900 million people still remain unserved. Moreover, researchers estimated that 300 million

people would have access to safe drinking water and while about 80% of rural people would have better hygiene by 2015. However, Rural areas still far behind urban areas in terms of drinking water coverage from safe sources [55]. In addition, [31] it is estimated that the rural population will increase from 3.1 billion in 1995 to 3.3 billion in 2025, with over 90 percent of them projected to live in South Asia, Africa, Middle East and North African regions. Also, in South Asia and Africa, the number of people in rural areas is expected to increase, while water resources will continue to decrease.

Globally, women's participation has been encouraged since the 1990s. In the rural areas of Zimbabwe, water supply projects have supported women's participation by recommending that at least 50% of "Water Point Committee members" should be women. Women can reduce the diseases caused by unsafe water if they are more involved in Water User Communities, because they will be able to attend training courses and explore the opportunities and means of improving the health of their families. This can be done by adopting other covering-methods of water storage at home, through which many diseases can be avoided. This has been shown by a research in rural Honduran communities [46]. Moreover, experiences in Nigeria have shown that when women are involved in the implementation of water supply projects, the sustainability of such projects is improved [37].

In rural areas in Yemen, different official (water) parties stated that very few of the rural water user committees were dominated by women. Although rural women have an important role in water management resources, they do not have an active role in the implementation of water supply projects [5]. The problem of rural women in spending many hours fetching drinking water daily does not only exist in rural areas of Yemen, but also in many rural areas in other countries like Bangladesh. Faisal and Kabir [16] estimate that the average time which rural women and girls spend in collecting water in Bangladesh is about 2.5 hours a day and up to around 18 hours a week. Makoni [27] found that in rural areas of Zimbabwe, women are responsible for supplying water to their homes. Therefore, this research will be an example for rural areas in Yemen. The findings of this research are important for decision-makers (legislators and policy makers) and donors to take into account the women's learned experiences and find out the best ways to include it in the development and implementation of services intended to empower and assist rural women. Furthermore, this research will attempt to create more understanding of women's participation in water supply projects for achieving sustainability. The two focal reasons for this research are:

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- To find out why some rural water supply projects are still working efficiently, while others fail within a year.
- To find out why rural women are not involved in water supply projects and if rural women's participation is necessary for the success of water projects, as the evidence collected so far seems to suggest.

#### B. Motivation

*"The world needs more well-trained people, especially more women to assess and develop fresh-water supplies, and to manage water projects for sustainable use"* [28].

Goal three in the Millennium Development Goals is "Promote gender equality and empower women". Goal seven indicates that half of the world population will have no access to sustainable safe drinking water by 2015 [49]. One of the goals of the Yemen government regarding rural water supply is to expand water supply services, by providing services/water to more than 5 million inhabitants by 2015 in order to meet the "MDG's goal". The objective of the National Water Sector Strategy and Investment Program 2005 to 2009 is to expand water supply services in rural areas [36].

Most of the poor families that live in Yemen are 'female families', and this means women take care of these families and provide the income. Some poor families are unable to pay for water services, and the public services supply only low quality water [36].

Many researchers have devoted their work to clarifying water scarcity and crises, the impact of water on health, water quality, and access to water and technical tools in rural areas [31], [52], [1], [42], [18], [20], [29], [24], [40]. However, only a few researchers investigated the contribution of rural women or the role of gender in rural development that could make a step forward in achieving sustainable water supply [16], [27], [41], [45] and [53]. Nevertheless, the challenge in the water supply sector is to ensure sustainability of implemented water supply projects. In addition, many experts such as [2], [7], [33] mentioned that for improving sustainable projects, female involvement should be considered in the design and implementation of such projects. For example, in Thailand, [25] indicated that women showed excellent skills in implementing successful projects and an ability to come up with good solutions to ensure sustainable projects to support the development of their villages. In Latin America, [45] mentioned that participation of women in the management, planning, conservation and use of water resources is essential for improving the quality of life of families and the communities to which they belong. Therefore, women's participation should not be ignored. So far, no one has investigated the reasons for neglecting women's roles in the implementation of water supply projects in Yemen.

#### C. Women's Role in Water Management and Projects

In the southern hemisphere, particularly in rural areas, access to water is more problematic because collecting water is consuming a significant part of housework of rural women. Thus, young women and girls are often unable to attend school due to their responsibility for water collection [12]. This was

confirmed by the UN [47], which reported that women in Senegal spend 17.5 hours per week fetching water; in Mozambique, in the dry season particularly, women spend almost 15.5 hours per week collecting water. Mostly, women have the central role in water management but they face the burden that comes from such projects because they often have not been involved in the decision-making part [10], [26]. Narayan [34] contended that women's participation in the water sector within the new institutional frameworks has remained at low levels. Reference [60] pointed out that in some South Asian countries there is a lack of visible participation of women in water projects especially in irrigation, because women's needs are fulfilled through men without participating directly. That may explain why women see no need to fully contribute to the management of water supply projects. As indicated by many experts in the Yemen water sector (such as [2]-[4], [8], [32]). Education weakness, lack of confidence from communities and ignorance from decision-makers are some of the reasons behind the lack of rural women's participation in water supply projects are reasons which caused this problem exist, not only in rural Yemen, but in many other countries. For example, [44] examined the situation of the role of women in water management in the context of rural India. He attributed the reasons for weakness of women's participation in water users' communities to the lack of education, ignorance, and heavy workload, etc. In addition, women's participation in water communities in South Asia is minimal because women are excluded from involvement on account of formal and informal membership criteria [30]. Reference [39] indicated that in eastern Nepal, some water projects ignored women's participation from the design level and that water projects were located along the roadside. However, women do not feel comfortable doing their work (washing clothes or fetching water) in the sight of the many men using the road. So, in three villages, women complained that too little attention had been paid to involving them in all levels of implementing water projects, which resulted in inadvertently increasing the burden on the women themselves. Reference [30] indicated that the improvement of women's participation will make the organizational work sustainable, especially with the number of immigrants among males increasing. In Nigeria, although rural women play an important role in several activities, particularly in water supply, they do not have enough power to play a role in decision making during the implementation of water supply projects, which may be the reason why many of these projects failed [37]. Reference [30] mentioned that the differences between female and male needs and priorities regarding resources use have had little attention. Above all, women face many barriers that prevent them from becoming involved in water resource management. In Sri Lanka, Nepal, Pakistan, and India, women's participation in water projects is much less than men's. Narayan, [34] mentioned that only 17% of the 121 "participatory" projects involved women on different levels. Jackson, [25] on the other hand, reported that in South Asia, some projects have intended to improve women's participation. Brewster et al. [10] indicated that in South

Africa awards are given to encourage women in water projects management, in order to improve their participation. In this way, South Africa has proved to have a successful means of empowering women in the water sector. Thus, women must overcome several barriers, especially social barriers, which reduce their participation in the water sector. In Morocco, after the water supply project implementation in six provinces, girls' school attendance increased by 20% in four years [54].

Evidence from many countries show that women's involvement makes these projects more likely to succeed. A World Bank evaluation of 122 water projects found that water supply projects are more effective where women were involved than where they were not: for instance, in water supply projects in Rakin in Jordan, rural women have been able to make a greater contribution to household resources, and manage the finances of the project. On the other hand, in Tanzania, a water well dried up shortly after it was created because the decision and the location of the well had been decided on by a local committee consisting only of men [17]. In addition, there are some successful examples to ensure that improving women's participation will be effective for sustainable the water supply projects. In La Sirena in Colombia, a water project was run by men only. Women faced the problem of contamination of the drinking water, which needed to be improved in terms of quality. Therefore, in 1995, women first tried to impose themselves to confirm their capability to be good leaders of water projects. Finally, many positive outcomes within projects were achieved, such as the construction of treatment plants, as well as the improvement of the health situation [22]. In Hoto village, Baluchistan (Pakistan), in 1994, women were not able to participate in a water project because of many social barriers. A participatory action research team then tried to improve the participation of women in the village in water project management. With that, women were involved in the meeting and established a new tank which would provide water to the area. As a result of this successful project, women became trusted participants in decision making. Another example of a successful water committee managed by rural women is in the Mantsonyane district in Lesotho, where 90% of the water committee members are women. Villagers prefer to elect women because women have a long experience in supplying water. Therefore, the water supply project proved to be sustainable [23].

## II. RESEARCH STRATEGY AND METHODOLOGY

### A. Data Collection (Literature Review)

The first source of the data collection is the academic articles and books from Internet websites such as ScienceDirect and Springer Link. These are especially useful for impact identification and significance determination. The second source for data collection consists of international documents which give an overview of rural women's participation in water supply projects, such as "The World's Women: Trends and Statistics" [47], "Gender, Water and Sanitation" [48], "The Millennium Development Goals Report, 2007" [49], "Mainstreaming gender in water

management: a practical journey to sustainability" [50], and "Reaching the Rural Poor; A Rural Development Strategy for the Middle East and North Africa Region" [53]. The third source of the data collection comes from the reports of the GARWSP and SFD on four water supply projects in the Al-Delaa'a Alala sub-district. These reports will be used to provide insight into how rural women's participation is taken into account by the GARWSP, and the SFD, in the various project phases. The fourth source of the data collection is the opinion of Yemeni water management experts, in order to investigate their point of view as a specialized group.

### B. Research Field Visit

The research field visit was conducted in Al-Della'a Alaala sub-district in Shibamwa Kawkban district in Al-Mahweet governorate in Yemen was selected as a case study, because of the presence of a variety of water supply projects which were implemented by the government and donors. The study focuses on two successful and two delayed (or failed) water supply projects.

- Pre-interviews were conducted during the research plan preparation. They were designed to approach the water experts.
- Post interviews were designed to approach other water stakeholders that will include the Government Agency and donors in the selected villages.

The four rural water supply projects in Al-Della'a Alaala sub-district in Shibamwa Kawkban were visited to investigate initiatives for sustainable rural water supply projects through improving women's participation. Reference [59] mentioned that for providing reliability of research findings, different tools should be used to collect research data, such as walking near the projects to ask some rural people of the community about their opinion of the project, and using a digital camera to confirm if the project components and equipment, such as the pipes, are still working. Therefore, field observations and interviews will be used to increase reliability and credibility of the research design and help supplement credibility of the data of collected from literature.

#### 1. Why Conduct a Case Study in the Mountainous Areas in the Western Part of Yemen?

Yemen was selected as a case study because it is a water-scarce country and one of the major nations facing a water crisis, because aquifers are depleting at a fast rate. The challenge of Yemen is to find a practical solution in order to avoid becoming a desert country [52]. In addition, the selection of Yemen for the case study has several other reasons, some of which are drawn from the author's own knowledge and experiences. There is a great need to investigate how rural women can be involved, in order to achieve sustainable water supply projects in the author's country (Yemen). In addition, when implementing water supply projects, many decision-makers ignore women's roles, as well as their participation in them, although women play important roles in their villages. The lack of participation in water supply projects in Yemen by women is similar to that in

the regions of Africa and Asia. For example, case studies from Latin America, Africa, Middle East, Europe and Asia, [10] reported that sustainable water supply projects may support the active participation of local people especially rural women in managing water resources, since the contribution of women is crucial in the protection of water sources in indigenous areas. Therefore, the conclusions and recommendations of this research will be applicable to the entire region. In most areas of Yemen, groundwater is already being exploited beyond the level of recharge. The most stressed area is the western part of the country which is occupied by more than 90% of the population [35].

## 2. Why Al-Della'a Alaala Sub-District, Located in Shibamwa Kawkban District in Al-Mahweet Governorate Was Selected as a Case Study?

Al-Mahweet was selected for the case study because it includes mostly mountainous areas, with three geographical regions of 86% mountainous slopes, 11% plateau regions and 3% valleys (wadi) regions [43]. The illiteracy rate is high, especially among females, at about 71%. Most of the population of Mahweet lives in rural areas with a total resident population of 458,534 versus the total resident population in urban areas, which is about 35,023 [13]. The Al-Mahweet governorate has the highest poverty rate of around 58%, with the lowest life expectancy in Yemen with an average of 51 years. At the same time, access to water supply is 87% in urban areas, whereas in rural areas it is 31% [53]. Al-Mahweet is located in the north-western part of the country, where water scarcity is most severe. This area contains more than 90% of the population of Yemen. The situation in mountainous rural areas is even worse. An estimation carried out in 1994 for this region predicted that it will be dried out within 50 years from then [35]. The Shibamwa Kawkban district was selected from the Al-Mahweet Governorate because the poverty percentage is higher than other districts, as Table I shows.

TABLE I  
POPULATION AND POVERTY PERCENTAGES IN SOME DISTRICTS IN AL-MAHWEET GOVERNORATE [13]

Governorate Name	District Name	Total Population 2004	Poverty Percentage
Al-Mahweet	Shibamwa Kawkban	39,163	58%
Al-Mahweet	Hufash	37,884	38%
Al-Mahweet	Al Mahwait City	20,134	34%

The size of the Shibamwa Kawkban District is about 160 km<sup>2</sup> and the population is about 41,091. Shibamwa Kawkban includes 4 sub-districts of which Al-Della'a Alaala is one. Al-Della'a Alaala sub-district was selected from the Shibamwa Kawkban district because the high percentage of female illiteracy in Al-Della'a Alaala, which is about 71%, and is very high compared to the illiteracy percentage among males. Although there are several types of water supply projects, the percentage of unsafe water resources is about 80%, which is also high. Moreover, the infant mortality rate and approximate poverty percentage are high as shown in Table II.

TABLE II  
PERCENTAGE OF ILLITERACY, PERCENTAGE OF UNSAFE WATER RESOURCES, INFANT MORTALITY RATE AND APPROXIMATE POVERTY PERCENTAGE IN AL-DELLA'A ALAALA SUB-DISTRICT [13]

Sub-district Name	Total Population 2004	Unsafe Water Resources Percentage	Illiteracy Ratio Male	Illiteracy Ratio Female	Infant Mortality Rate (000)	Infant Mortality Rate (000)
Al-Della'a Alaala	15484	80%	28	71	85.0	58.4

Al-Della'a Alaala has the highest population of the Shibamwa Kawkban district with 16,765 people representing 40.8% of the population in this district [13]. See the Table III.

TABLE III  
NAMES AND POPULATION OF SUB-DISTRICTS IN SHIBAMWA KAWKBAN DISTRICT [13]

Name of sub-districts in Shibamwa Kawkban District	No. of population	%
Al-Della'a Alaala	16765	40.8
Al-Ahjeer	13642	33.2
Madint Shibam	8136	19.8
Al-Zobirat	2548	6.2
Total	41091	100

Al-Della'a Alaala sub-district includes more than 50 villages with different types of water supply projects (mechanized, as well as non-mechanized). In addition, the most important agencies that have been implementing water supply projects there are GARWSP and SFD.

In summary, Al-Della'a Alaala was selected for the case study based on the following criteria: It includes more than 50 villages with different types of water supply projects (mechanized, as well as non-mechanized). The majority of water supply projects there have been implemented by GARWSP and SFD. Al-Della'a Alaala has the highest population in the Shibamwa Kawkban district. The percentage of illiteracy among females in this area is about 71%. The percentage of unsafe water resources is 80%. Both the infant mortality rate and approximate poverty percentage are also high.

## 3. Why the Four Water Supply Projects in Al-Della'a Alaala Sub-District Was Selected?

GARWSP and SFD are the major authorities that are implementing, mandating and addressing the needs of the rural water supply projects. The selected four water supply projects were implemented by these two institutions. The criteria for selection of the four supply projects are as follows:

- These projects were implemented several years ago.
- The projects should be from different years of submission, especially covering the period between 2000 and 2005.
- These projects are located in a mountainous area.
- The projects should include mechanized (power-driven) and non-mechanized (water harvesting) projects.
- Two projects were smoothly implemented.
- Two projects were delayed several times during the implementation stage.

4. Why Al-Galba Project, Located in Al-Harth Sub-District in Badan District in Ibb Governorate Were Selected as a Comparison Water Supply Project?

The Ibb governorate is partly situated on the mountainous areas in the western part of Yemen. It is near to Al-Mahweet because it is located in the north-western part of the country in which water scarcity is mostly stressed. The Ibb governorate has high poverty rates of around 55.1% and access to water in rural areas there is 32% [13]. The Al-Galba Water Supply Project in Al-Harth sub-district in Badan district in the Ibb Governorate was selected as a comparison project for a number of reasons, which include:

- Rural women had an active role during all the project's phases.
- The supervisor of the Water User Committee is a woman.
- The WUC implemented the project's activities and work.
- This project had a problem from the beginning with the first supervisor (man) and before a woman became supervisor of the WUC.
- The project was selected as a successful project in the Ibb government in 2007.
- The social barriers in Al-Harth, which are faced rural women, are the same in Al-Della'a Alaala.
- The project is located in a mountainous rural area.
- This project was established in 2005
- During the pre-interviews, it is selected by many Yemenis experts as a sustainable project which rural women implemented.

### C. Interviews

#### 1. Pre- Interviews

Pre-interviews were conducted with government officials from the water sector, donors, and academic people involved in water issues, in order to investigate their opinions on the reasons why the participation of rural women is neglected in water supply projects.

#### 2. Post-Interviews

*"When the face to face meeting with the interviewer is administered, the open questions will be used in different ways for understanding the questions"* [38].

The interviews will be held with about 50% men and 50% women who are heads of their households. The interviews will be developed and applied to the five water supply projects at the five villages. Two projects were implemented by SFD and the other two projects were implemented by GARWSP in the area of the case study. In addition, the comparison project was selected through some criteria. The Al-Galba Water Supply Project is located in Al-Galba village in the Al-Harth sub-district in Badan district in Ibb Governorate. It was implemented by SFD. The rural women's participation has an active role in the all phases of the project. The Al-Galba project will be compared with the other four projects in the case study (Al-Della'a Alaala sub-district in Shibamwa Kawkban district in Al-Mahweet Governorate). Ten interviewees will be selected from each project, which means

50 interviewees in total. The interviews will be categorized into four types:

The first type of interview is intended for the project officers in the government and NGO parties. These questions will focus on the project details. The second type of interview is intended for one member of the Water User Committee (WUC) in SFD or Management Committee (MC) in GARWSP and one member of the Water Maintenance Committee (WMC) in SFD or Management Committee (MC) in GARWSP. These questions focus on the different sources and quantities of water consumed, management and maintenance issues. The last two types of interviews are intended for rural households (men and women). These questions are related to the social characteristics of the household and their opinions on the water quality, which is used either for drinking or for household activities. In addition, questions are formulated to assess their evaluation of the water supply service, bills payment, as well as to seek their views about problems of water supply projects connected to their houses, and what kind of solutions they suggest. The interviewed households in the four villages will be randomly selected. Table IV shows the numbers and types of interviewees of stakeholders for the five projects.

TABLE IV  
 NUMBER AND TYPE OF SUGGESTED INTERVIEWERS\

Variable	No. of WSP officer	No. of member of WUC or MC	No. of member of WMC or MC	No. of rural men	No. of rural women	Remarks
Per project	1	1	1	2	5	10 people will be selected in every project
Total of interviewees (5 projects)	5	5	5	10	25	Total is 50 interviewers

The data will be qualitatively analyzed. Finally, the situation of the four villages will be compared before and after the implementation of the water supply projects.

### III. DESCRIPTION OF THE CASE STUDY

#### A. Location and Topography

Yemen is located on the Arabian Peninsula. Yemen is categorized as an arid region. The Republic of Yemen (ROY) is located in the South-west part of Asia. It borders on Saudi Arabia in the north and Oman in the east. It faces the Indian Ocean, the Gulf of Aden to the south, and the Red Sea to the west. Its total surface area is about 527,970 sq km. The study area selected is Al-Della'a Alaala sub-district in Shibamwa Kawkban district, which is located to the north-east of Al-Mahweet city as shown in Fig. 1 [21].

Al-Mahweet lies in the northwestern part of the Yemen highlands. The highest plateau is at about 2,600 m. The population in this governorate is about 494,557 inhabitants and the area is 2,330 km<sup>2</sup> [13]. Shibamwa Kawkban District is located in northeastern part of Al-Mahweet where the altitude is about 2,800m above sea level, and the annual rainfall is about 700 mm/year. The district size is about 160 km<sup>2</sup> and the

population is about 41,091 inhabitants. Shibamwa Kawkban includes four sub-districts, where Al-Della'a Alaala is one of them. The study area selected for this research is Al-Della'a

Alaala sub-district, which is located in Shibamwa Kawkban District in northeast of the Al-Mahweet governorate.

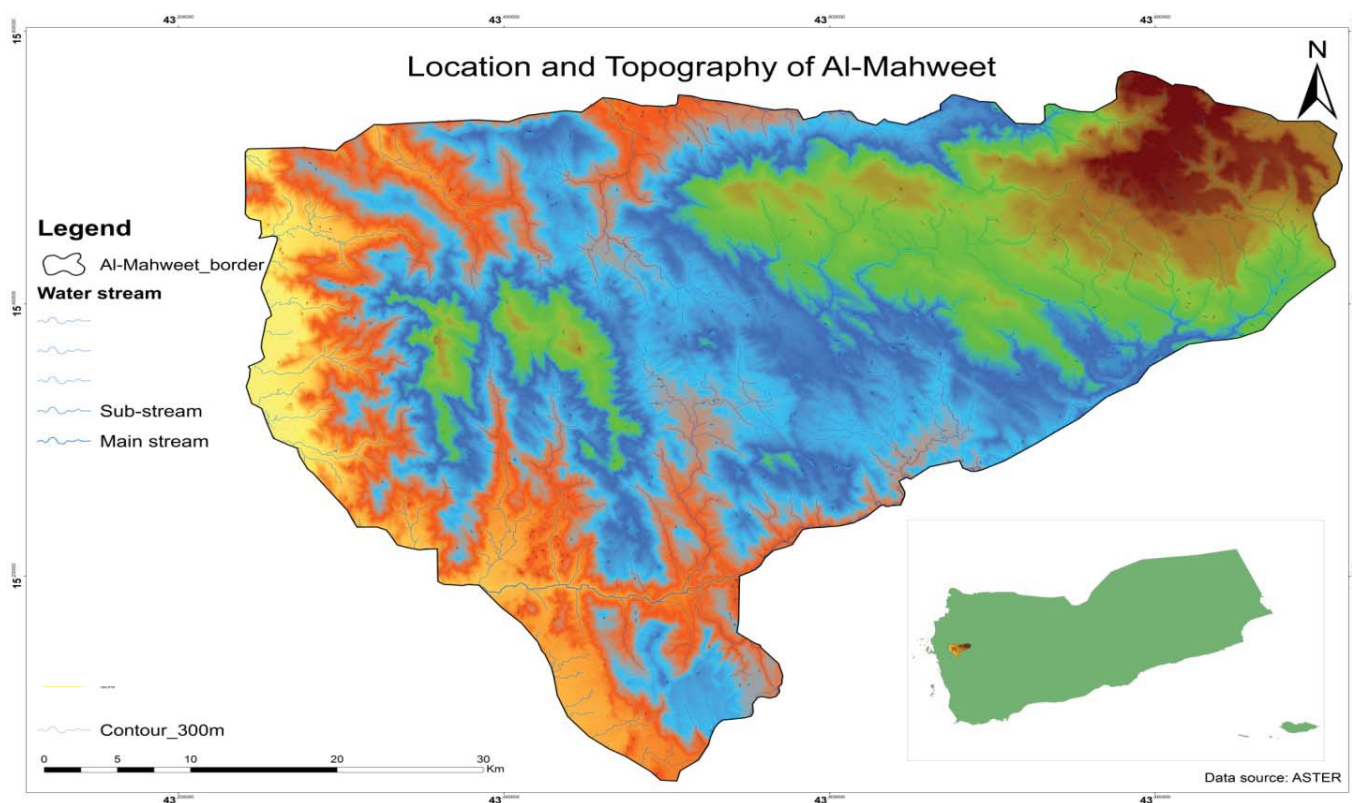


Fig. 1 Topography and Location of Al-Mahweet Governorate [9]

### B. Climate

Yemen has a predominantly semi-arid to arid climate, with rainy seasons during spring and summer, and with high temperatures prevailing throughout the year in low-altitude zones. The pronounced differences in topographic elevation observed in Yemen strongly influence climatic conditions. Seaward exposed escarpments receive more rainfall than the zones facing the interior. Yemen is shown to vary from hyper-arid (deserts, most of plateaus, parts of the coastal plains) to sub-humid, with perhaps even humid sites of a very small scale (around Ibb) [35]. There are two seasons of rain; the first one affected by the Red Sea Convergence Zone (RSCZ) which occurs in spring (March- April). The second one affected by the Inter Tropical Convergence Zone (ITCZ) which is affected by Indian Ocean and occurs in summer (July-September). The Mediterranean Sea convergence system occurs in December and January [1]. The climate in Al-Mahweet is cold and dry during winter with low temperatures record of almost 3°C. During summer the weather is rather hot and warm, with high temperatures of almost 34.4°C recorded.

### C. Annual Rainfall

Annual rainfall varies from one year to another and from one region of geography to another. For example, the Highland plains and surrounding mountains, with average

annual rainfall commonly in the range 150-300 mm, are grouped within the same class as the Ramlat-as-Sabatayn and Rub-al-Khali desert where rains are extremely rare. Some zones of limited extent in Western Yemen with relatively high rainfall have a steppe climate or in a minor zone around Ibb-even a sub-humid warm-temperate climate with a distinct dry period during the winter months. In the Al-Mahweet Governorate, the average annual rainfall is commonly in the range is 150-300 mm [35], [51].

The spatial pattern of annual rainfall varies from year to year. The controlling topographic factors, however, are strong enough to produce pronounced patterns that are fairly stable for long-term averages of annual rainfall. Most zones in Yemen have a well-defined seasonal rainfall pattern, with a first rainy season in March to May (summer period) and a second one in July to September (autumn period). Long periods of dry weather are common from October to March, although occasional storms do occur. Around the beginning of spring the heated land surface triggers inland winds which lead to occasional convective rain storms, especially along the mountain slopes, during a few subsequent months (winter period). Rainfall decreases significantly in June, which marks a short dry period. The second rainy season usually starts in July. Rains become sporadic around the beginning of autumn; then a new prolonged dry season starts. This general seasonal

pattern can be most easily recognized in the zones of relatively high rainfall. Erratic rains may occur during any month of the year. In low precipitation zones they may obscure the seasonal pattern described [51].

#### IV. ANALYSIS AND RESULTS

##### A. Literature Review

At the domestic and global level, women have the primary responsibility for water management as many authors mentioned, e.g. [27] and [37] in Zimbabwe and Nigeria, respectively. In addition, a lot of studies are required in order to discover how involving rural women can help achieve sustainable water supply, through conservation of the limited water resources, improvement of water quality in order to reduce the number of diseases, and good management of water usage. All of these could be useful to reduce concerns about water scarcity, and prevent failure of water supply projects. Thus, an investigation into possible measures to involve rural women during the implementation of water supply projects is essential.

Researchers from Asian and African regions, such as [16], [27], [41], [45] and [53] indicated that improvement of women's participation in water supply phases is important to raise the level of health among society, to raise the number of girls who attend school and to continue the water project services operation. Thus, improving women's participation will be effective for sustainable water supply projects. Moreover, for sustainable water supply projects, rural women should also be responsible for its operation and maintenance. Thus, targeting women for the training program called 'Building Capacity' aims for sustainable water supply especially in managerial and technical roles.

There are some evidences and examples showing that positive effects can be seen when women participate and take up a central role in the planning and implementation of water supply projects. Thus, involvement of rural women in water supply projects results in improved health and quality of life for the community, because women have a good knowledge of local water practices and they can disseminate messages about good water and hygiene practices.

Many investigations in Asian and African show that the causes of low woman participation in water supply projects are; (a) the weakness of institutional frameworks in the water supply projects [34], (b) the belief of rural women's needs can be fulfilled through men [60], (c) education weakness among rural women, (d) lack of confidence from communities [30], (e) ignorance from decision-makers, (f) heavy workload which rural woman could not deal with [44]. However, it may not be enough to say that women are unable to participate because of the above mentioned barriers. Moreover, some authors such as [10], [37], [60] recommended that in order to achieve sustainable water supply projects in countries, women's participation should be taken into account by a variety of stakeholders such as decision-makers, local people, etc. In this regard, some authors such as [39] and [30] indicated the

examples which confirm how important women's participation in sustainable water supply projects.

As some researchers such as [37] concluded, low rural women's participation is the key reason for failed water supply projects. [39] confirmed this conclusion by the example from Nepal. Furthermore, many researchers studied principles of women's participation in and contribution to water supply, as well as integrating gender needs into drinking water projects, as indicated by studies of [10]-[12], [15], [16], [25], [30], [39], [44], [45], [58] many of whom concluded that women's participation is important to improve the water supply projects performance. Therefore, this research focuses on assessing how women's participation would affect the sustainable water supply projects in rural areas in Yemen.

Results from the literature review and pre-interviews show that sustainable water supply projects improve the health of families and allow girls to attend school, and also allows rural women to use their time more efficiently for raising their education levels and attending professional trainings, such as childcare. Thus, the criteria of sustainable water supply projects were extracted by using two criteria namely availability and continuity.

##### 1. Availability

Availability means that there is enough water, for which quality lies above the standard for drinking water. Two indicators characterize the criterion of availability:

- The distance from the house to the water source, including the return trip, should take less than 30 minutes for local women, according to SFD' indicators [43], [6]. In addition, some studies such as; [19], [57] and [56] indicated that any water sources should be located at less than 1.0 km away from residents.
- Water consumption per person is not less than 20 liters a day. The WHO definition of access to water varies according to location, but averaged between 20 liters per person per day within a one kilometer walking distance from the household.

##### 2. Continuity

Continuity means the consistency of water supply from the source to the house. Three indicators characterize the criterion of continuity, as follows:

- Maintenance is an important issue for continuity, because lack of maintenance may lead to total or partial failure of the water system.
- Number of hours per day with access to water supply by households.
- Number of days per month with access to water supply by households.

##### 3. Improve the Other Aspects Which Are Related to Water

Improving other aspects which are related to water will enhance the environment surrounding the water supply project, such as health and educational issues. Thus, four indicators characterize this section, as follows:

- Water availability should improve the educational situation among girls who were responsible for fetching water before the project intervention.
- The participation level of women is encouraged in water supply projects management by counting the number of rural women as active member in the Water User Committee (WUC).

The environmental awareness standards among rural women, namely the hygienic behavior at home, type and period of the water storage at home.

#### *B. Pre-Interviews and Post-Interviews*

The pre-interviews with Yemeni experts and decision-makers from government and NGOs in the water sector and academic researchers, who are linked with water issues, were held to investigate their opinions on the barriers and impediments to sustainable rural water supply projects, and on the reasons of why the rural women's participation in water supply projects is neglected.

The barriers and impediments to achieve sustainable water supply projects are:

- Lack of awareness among the decision-makers, supporting agencies and communities.
- Social and cultural customs.
- Supporting agencies have no guidelines on how to improve rural women's participation during all projects' phases.
- Weakness of the social surveys conducted before the project intervention.

The appropriate type of water supply projects to achieve sustainability in rural mountainous areas is a water harvesting system, but the water quality needs to be improved to the drinking water level.

The challenges of weak involvement of rural women in the water supply projects are:

- Less attention to involve rural women as active party by decision-making and supporting agencies.
- Social traditional and cultural customs.
- High illiteracy among communities.
- Weakness trainings (building capacity) to the local community.
- Weak social awareness among community.

The consequences if women's participation is improved, are that sustainable water supply projects are achieved by improving the health, educational and environmental situation of the entire community.

#### *C. Research Field Visit*

Conclusions from field visit are:

- From the result of visiting the four water supply projects in the case study, the conditions to improve women's participation in the WUC are; women should be active, women should be able to read and write; women should be supported and encouraged. These conditions are important as shown successfully in the comparison project (AlGalba Project) in Al-Harth sub-district, in which the female supervisor is a well-educated university graduate,

who has the support of family support, and the community is able to take advantage of her knowledge and experiences because she is an active and hard working woman.

- All stakeholders should pay attention to improve women's participation as a practical party for achieving sustainable water supply projects.
- The comparison project is a sustainable water supply project. On the other hand, all the water supply projects in the case study are not sustainable because women's participation level is weaker.
- Regarding GARWSP' projects type, the mechanized type is not an effective way to implement sustainable water supply projects in the mountainous rural areas because the groundwater situation is over-exploitation, a decline in water level is observed in the most stressed areas of the country. The SFD project type, non-mechanized (water harvesting) is the appropriate way to implement sustainable water supply projects in the mountainous rural areas but still the water quality still needs to improve.

### V. RESEARCH CONCLUSION AND RECOMMENDATIONS

#### *A. Conclusions*

- In Yemen's rural areas, women are responsible for fetching water from often remote areas, and on average it takes them more than four hours daily. Although rural women play an important role in managing water, they can't participate in the activities of the four water supply projects in the case study held in Al-Della'a Alaala sub-district, for several reasons, including ignorance from decision-makers; weak guidelines or planning in the supporting agencies (local or NGOs) for improving women's participation in the project's activities; lack of training programs before project implementation to strengthen women's abilities, especially in the awareness and maintenance skills; high illiteracy among women; the belief of rural women's needs can be fulfilled through men.
- The criteria for sustainable water supply from literature, international documents and experiences which were used to evaluate the sustainability of the water supply projects in the case study provide a good starting point for improving rural women's participation during all project phases.
- The analysis shows that water supply projects will become more sustainable if women participate actively.
- The majority of the respondents in the SFD projects agreed that women's participation brings improvements in the water supply project. Moreover, they indicated that the consequences of participation by women would enhance sustainable projects. They mentioned that rural women could participate effectively, if they receive training courses. For example, women could be responsible for carrying out maintenance work, such as cleaning the basins and tanks, and changing the tank's tap. However, SFD projects do not have practical guidelines to



improve women's participation in the all phases of the project.

- Almost all men and most women interviewees in the GARWSP projects said that women should not participate in the project, because the project type was mechanized. The project management does not focus on involving the rural community in the project. Moreover, the maintenance part is hard to manage by women, especially as they do not have the skills or experience to deal with project management or maintenance. In addition, GARWSP does not have guidelines for improving women's participation. Moreover, the awareness among decision-makers in GARWSP and the communities are weak.
- In order to improve women's participation in the Water User Committee (WUC), women should: be able to read and write, and be active; and to be respected by the local community and have good experience to deal with the projects' tasks.
- In all five projects, health consideration is weak because the SFD and GARWSP agencies have no health awareness program in the project implementation stage. Furthermore, the projects focus on providing water quantity, but not on investigating and improving the water quality.
- GARWSP-type projects should be changed from mechanized projects to non-mechanized projects and GARWSP and SFD should take water quality improvements into consideration.
- Rural women (gender) do not receive enough attention in the Water Policies and Strategies as an active party during the water supply projects.
- Improving rural women's participation in the non-mechanized water supply projects is the key to achieving sustainable water supply. Furthermore, women's participation can help achieve sustainable mechanized water supply projects. These goals can be attained if women's participation is taken into account from the beginning by the supporting Agencies and society.

#### *B. Recommendations*

The recommendations focus on three kinds of stakeholders, namely: decision-makers; parties who carry out drinking water projects; and the supporting agencies GARWSP and SFD.

##### 1. Recommendations for Decision Makers

- Elaborate the involvement of women in their strategies and policies.
- Raise awareness among decision-makers about women's participation.
- Consider women's participation as a long-term learning process.
- Incorporate women's participation in water policies, strategies, and law, as a long-term learning process.

##### 2. Recommendations for Parties Who Carry out Drinking Water Projects

###### a) General Recommendations.

- Gender Strengthening is very important and should be encouraged.
  - Women's participation should be involved as an efficient approach by supporting agencies, society and the potential supporting donors. A few steps can be taken to take this forward:
    1. Creating an active guideline for improving women's participation as practical stakeholders in all water supply project phases.
    2. Sharing the current experiences among different stakeholders before the project takes place of the water supply project. This can be done through organizing a workshop to discuss the approach and philosophy, as well as reviewing information needs and available information sources. Also, the workshop could be used to develop a proposal with key stakeholders to set up a database for an information exchange network. Key donors should be invited for this workshop so they get hands-on information from the stakeholders.
    3. Effective communication amongst all stakeholders. The communication requires a serious effort of awareness rising among all stakeholders, such as decision-makers in the water sector, professionals, interest groups and the public at large. Communication may identify opportunities to solve problems in the water sector, whereby the lack of women's participation is one of them.
  - Establishment of training and awareness programs to improve the Agencies counselors' knowledge and skills.
  - Consideration of the participation of women in the social survey conducted by them, because projects are usually based on these surveys.
  - Drawing up a social awareness program before the project takes place in order to improve women's participation, and exploration of the possibility to involve them in the projects, such as involving women in the WUC as active members.
  - Strengthening women by implementing training programs to build on their capacities, knowledge and skills, to deal with and manage water projects, especially in terms of awareness and maintenance. These trainings should be focused on the practical parts. These training programs could consider the following topics:
    1. Project management and implementation' tasks.
    2. Maintenance of the project' equipment.
    3. Organizational management.
    4. Financial aspects including accounting, fee collection and funds management.
    5. Increasing health and environmental awareness.
- Recommendations for GARWSP:
- Change the type of water projects from mechanized to non-mechanized in mountainous rural areas, or add some water harvesting projects to the mechanized projects in order to recharge the groundwater.

- Improve the participation of local people to contribute to project activities and find the appropriate way to increase women's participation.
- Rural women can play an active role in the management of water supply services and can undertake minor maintenance activities, while playing a lead role in the health and environmental awareness among the community

#### Recommendations for the Social Fund for Development (SFD)

- Consider an investigation of the water quality aspect and try to find suitable solutions.
- Improve women's participation in project management, maintenance and awareness.
- Rural women can play a vital role in the project management, such as manage water usage and protect the projects' equipment; health and environmental awareness that includes encouraging increased hygiene in the home; and maintenance, such as cleaning the catchment areas and ponds.

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