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The Management of Water in the IHDP Program: How Sustainable is it?

The case of- Gofa-Mebrathail Condominium Neighborhood, Addis Ababa

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Thesis Submitted to the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) Postgraduate Program Office in Partial Fulfillment of the Requirement of Master of Science in Housing and Sustainable Development.

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By: Yohana Eyob Teffera

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This thesis is submitted to the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) and to the School of Graduate Studies of Addis Ababa University for partial fulfillment of all requirements of Master of Science in Housing and Sustainable Development.

Title of thesis: The Management of Water in the IHDP program: How Sustainable? The case of- Gofa-Mebrathail Condominium Neighborhood

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Declaration

I, the candidate, declare that this thesis is prepared for the partial fulfillment of the requirements for the degree of Masters of Science in Housing and Sustainable Development entitled, **"The Management of Water in the IHDP Program: How Sustainable? The case of-Gofa-Mebrathail Condominium Neighborhood, Addis Ababa"** is my original work prepared by my own effort with the close advice and guidance of my advisor. I also declare that this thesis has not been presented in any university and all sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Yohana Eyob Teffera

_____ _____

Signature Date

Certification

Here with I state that Yohana Eyob Teffera has carried out this research work on the topic entitled "**The Management of Water in the IHDP Program: How Sustainable? The case of-Gofa-Mebrathail Condominium Neighborhood, Addis Ababa**" under my supervision and it is sufficient for submission for the partial fulfillment for the award of MSc Degree in Housing and Sustainable Development.

Yonas Alemayehu Soressa

Signature _____

Date _____

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God, thank you for being part of every step of my life. Let your blessings be on every human being and your precious creations. May my great appreciation and thanks go to the following people, who truly helped me to do this work.

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Girmachew

Abel

Mekuria

All my respondents in the case study area

God bless you all!

Abstract

The Integrated Housing Development Program (IHDP) is an ongoing mass housing development for low and middle income dwellers of urban areas in Ethiopia. This study examines the sustainability of water management in the occupied IHDP neighborhoods in Addis Ababa. The phenomenon is investigated through the analysis of a case study. The data are primarily collected through qualitative techniques supplemented by a quantitative technique. This was done in three parts: first finding out pre-design and design considerations of water management for Gofa-Mebrathaile condominium site; second investigate the household water management trend in relation to the design of the condominiums and third is measuring the level of sustainability of the water management for this neighborhood.

Based on the empirical evidence from the case study and analytical generalization the following findings are revealed. With the aim to alleviate the living standards of people the housing units are designed with indoor toilets and kitchens. This is considered to be one of the achievements of the IHDP; before moving to the condominiums, in the slum areas, people were using shared kitchens and toilets among a large group of people or do not have it at all. Due to this and the existence of flush toilets and use of conventional sewerage system the average daily demand is increased to be 111 l/c/d from the previous 30 l/c/d. From this amount 80% of the water is calculated to be used by the flush toilets to make the sewerage system work properly. But the demand and supply of water are not balanced. Due to this the case area is suffering from shortage of water. People stay on average three to four days without water and this gets even worse in dry seasons which could go more than eight days. The apartment units (usually small spaces) and the shared spaces are being occupied by water storage containers as most of the building are not built with water reservoirs.

Since the toilets and kitchens are found inside the units, there is a big chance of contamination when the water supply is interrupted, which puts the residents health in a high risk. They cannot also access external toilets in their surrounding as such options are not considered with the neighborhood design. The actions taken by different authorities are not integrated in order to solve the problem. AAWSA is the only responsible body to manage water and to overcome the problem of water shortage. The actions taken by this organization are traditional and there are no much considerations for alternative and innovative ways. Even if there are some considerations to adopt some sustainable water management principles by AAWSA, but since other decisions are not integrated the overall effect is not very visible.

The sustainable water management performance assessment method done in this research, shows that water management is partly unsatisfactory in terms of the accepted sustainable water management principles for developing countries. Finally the study recommends possible

solutions for the already built condominiums and the coming ones to have a more sustainable practice in the management of water for housing development.

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Abbreviations

AAAS – American Association for Advancement of Science, Science and Human Rights Program
AAHDPO - Addis Ababa Housing Development Project Office
AAWSA - Addis Ababa Water and Sewerage Authority
ADB - Africa Development Bank
BREEAM - Building Research Establishment's Environmental Assessment Method
CBE - Commercial Bank of Ethiopia
COHRE – Center on Housing Rights and Evictions, Right to Water Program
CSA - Central Statics Authority
DEWATS - Decentralized Wastewater Treatment System
ECSU – Ethiopian Civil Service University
ELPA – Ethiopian Electric Power Authority
EMWR - Ethiopia Ministry of Water Resources (Now being called – Ministry of Water, Irrigation and Energy of Ethiopia)
ETB - Ethiopian Birr
GC - Gregorian Calendar

GTZ - German Technical Co-operation
HC - House Connections
IHDP - Integrated Housing Development Program
IUWM - Integrated Urban Water Management
IWMI - International Water Management Institute
IWRM - Integrated Approach to Water Resource Management
KM - Kilometer
LEED-EB - Leadership in Energy and Environmental Design – Existing Buildings
LEED-NB - Leadership in Energy and Environmental Design – New Buildings
MoUDC - Ministry of Urban Development and Construction
MSC - Master of Science
MSEs - Micro and Small-Scale Enterprises
MUDHCo – Ministry of Urban Development, Housing and Construction
NRW – Non-Revenue Water
PF - Public Fountains
SDC – Swiss Agency for Development and Cooperation
SPSS - Statistical Package for Social Science
SWITCH - Sustainable Water Management Improves Tomorrow's Cities Health
UK - United Kingdom
UN - United Nations
UN-HABITAT - United Nation Human Settlements Program
US – United States
WSSD - World Summit on Sustainable Development
YCP - Yard Connections Private
YCS - Yard Connections Shared

Local terms

Ato - Mr.
Etege - Empress

Qabale - The lowest administrative unit and boundary

Woreda - Administrative units higher than Qabales

W/ro - Mrs.

W/rit - Miss

General notes

- All dimensions in the floor plans are in meters
- Unless specified, all pictures are taken by the Author

- The new public housing programmes 10/90,20/80 and 40/60 which started in 2014 are not the subjects of the study.
- The term condominium is used in this research to describe apartment blocks built under Integrated Housing Development Program.
- One US dollars is equivalent to 20.24 Ethiopian Birr (ETB) as September 12, 2015
- All dates are in Gregorian Calendar unless specified as Ethiopian Calendar (EC)
- The basic plans showing the layout of condominium neighborhood and blocks are taken from the AAHDPO and graphic presentations are done by the researcher

Chapter 1
Background to the Study

1.1 Introduction

The rapid increase of population of urban areas forces or urges governments to provide different services in order to fulfill the high demand and need. Among these, housing with proper infrastructural provision is one. Ethiopia is one of the least urbanized countries in the world but it is one of the fastest urbanizing countries in Africa and the world. And it is also one of the countries in the world which are projected to contribute 25 million or more to the global urban population increment between 2014 and 2050, next to Nigeria and Tanzania in Sub-Saharan Africa (UN, 2014). The rate of urbanization of its capital is 4.3% (CSA, 2007). Due to this and with the aim to improve the lives of urban dwellers living in substandard housing and in places where there is no enough and proper basic infrastructure, the government of Ethiopia started providing new affordable housing since 2004. This housing scheme is called the Integrated Housing Development Program or IHDP.

According to the Ethiopian Urban Housing Policy and Strategy, housing is one of the basic necessities that people need to survive (MoUDC, 2012). The same document further indicates that, housing should be beyond the walls and roofs that it should provide security, privacy, secured tenure and with proper working and circulation space. In addition housing should fulfil basic infrastructures to help improve people's health in and outside of the individual house to be found with a meaningful money and environmental cost (ibid). And one of the strategic approaches taken by the Ethiopian Government to provide such housing provision especially for the urban poor and middle income dwellers is the IHDP or the condominium housing project.

The condominiums[1] are multi-story apartments with mixed units ranging from studios to three bed room apartments. Corridors, staircases, green areas and the communal buildings are the different spaces shared among the residents. This arrangement brings a new way of living for those urban dwellers that used to live using shared toilets and kitchens and not so many water points in the house or using a public tap. In addition this housing provides individual kitchen or kitchenette[2] with dish washing sink and a toilet with flash, a hand wash basin and a shower. Such type of arrangement is expected to have continuous existence of water in the system and increase the quality of life of the people in terms of ease of access to water and improved hygiene.

[1] Condominiums are the apartment blocks or the housing typologies built under the IHDP program.

[2] Kitchenette - this is for studio types which were built and transferred since 2009

With the growing concern of the environment and the sustainable use of natural resources, this study focuses to study the sustainability of water management in the development and running of the condominium housing. Even if there are different researches conducted focusing on IHDP, the issue raised by this study is the first of its kind. Especially with the opening of housing and sustainable development graduate program since 2010, the interest is increasing to study the different aspects of condominium housing. So far different studies have been made on the spatial, social, economic and environmental impact of the condominiums. For example Wondessen Meste studied the income generation and job creation aspect of this housing in 2014; Bisrat (2008) studied the design and construction, land acquisition, and implementation process of the condominium housing projects in Addis Ababa and Berhanu's study (2010) examined how beneficiary households use their condominium units and accommodate their needs. The United Nations Human Settlement Program (UN-HABITAT) also published in 2011 a full report of the IHDP with the aim to document an innovative affordable housing program in countries of the developing world. And this study is going to be a contribution in addition to the studies conducted so far on the IHDP program.

1.2 Motivation

The Integrated Housing Development Program is trying to solve the housing shortage for the low and middle income people by giving them access to an improved housing. The IHDP has been successful in stimulating the economy, improving the living conditions of thousands of Ethiopians, and improving the functioning of the rental housing market (UN-HABITAT, 2011b). Addis Ababa has the highest housing need compared to other urban areas of Ethiopia with a ratio of 361 per 1000 population (MUDHCo and ECSU, 2015) and with a total population of 3.385 million (CSA, 2007). The government plans to address this through the IHDP program and other housing approaches by involving also the private sector. There are also a lot of other huge developments undergoing in most parts of the country especially Addis Ababa undertaking the majority of the urban development or redevelopment works. At this point it is good to evaluate and check the different development approaches which are undergoing and how sensitive they are about the long term future in terms of sustainable development. And whether there are any alternative ways of using natural resources like water.

Sustainable resource use and the provision of quality services to a growing urban population underpins the success of future cities, enables them to act as poles of economic growth and is at the core of social and economic development in an urbanizing world (The World Bank, 2013). In relation to this UN-HABITAT's publication of Sustainable Housing for Sustainable Cities states that:

> Safe water provision is crucial for sustainable housing. In the context of stressed global water resources, urban growth, rising standards of living in developing countries, and climate change water demands are rising. According to estimations 2/3 of the global population will face water shortage by 2025 (UN-HABITAT, 2013).

So with these global concerns on sustainable development especially for developing and rapidly urbanizing countries and with a personal experience living in condominium housing, I was motivated to study the sustainability of the water resource management in terms of its pre-design and design and household use. The nature of the project being large scale and on-going are also another reasons for my concerns to study its sustainability.

1.3 Relevance of the study

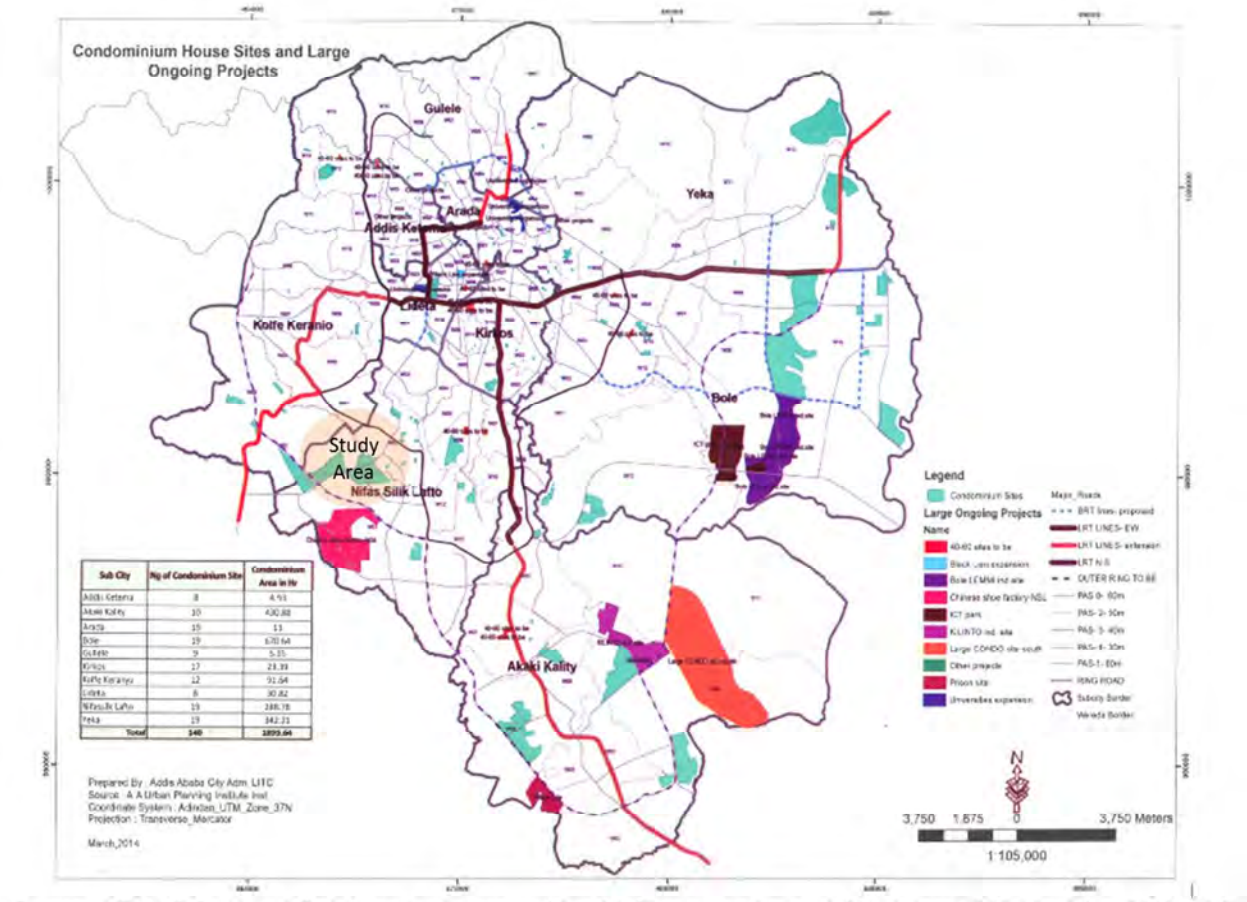
There is no shortage of innovative examples of buildings or settlements in which the level of resource use and waste generation has been greatly reduced (HABITAT, 1996). There are the many traditional buildings, settlements, companies and city governments that have always used resources efficiently and kept wastes to a minimum (ibid). What is less evident is governments prepared to develop national frameworks to promote resource conservation and waste minimization in all sectors and at all levels (ibid).

In our context, the government is working very hard in order to achieve development in many sectors. Housing is one of the sectors taking up a lot of resources. So this study wants to show what sustainable water management in housing is and by measuring what has been done so far to show how much we are working in this regard. The findings and conclusions from this study might help to see and compare the current trend with sustainable approaches. The research will also be relevant by documenting sustainable water management concepts and how we can incorporate in our housing development strategies to improve our actions further.

1.4 Problem Statement

Even if improving living conditions is one of the targets with IHDP housing scheme, there have been operating issues with water provision and sewerage disposal (UN-HABITAT, 2011b). During times of water shortage, families must collect water in buckets and carry them on their flats as there are no water tanks to generate secondary water supply in case of such emergency (ibid). According to Ethiopian water policy, the water resource available in the east and central river basins is only 10 to 20% whereas the population in these basins is over 60% (Ministry of Water Resources, 2001). Addis Ababa which is found within the central river basin is not only with the limited water resource but is also experiencing a major construction boom increasing its water consumption dramatically. And it is where the majority of the housing development is undergoing as well.

With such overlapping problems challenging the provision of decent housing this study however wants to focus in investigating how sustainably is water being managed for the condominium development. With the aim to understand and measure the pre-design and design consideration of water management in relation to the condominium's design and the household water management trends based on sustainable water management concepts. In order to show housing is one of the main development sectors where we need to manage water sustainably.



Source: Addis Ababa City Administration Integrated Land Information Center, Addis Ketema Sub City Atlas, 20014, 1st Edition.

Figure 1-1 Condominium Housing Sites & Large Ongoing Projects in Addis Ababa

(Source: Addis Ababa City Administration Integrated Land Information Center, Adis Ketema Sub City Atlas, 2014, 1st Edition)

1.5 Scope of the research

1.5.1 Spatial Scope

This research is conducted in one of the condominium neighbourhoods of Addis Ababa called Gofa-Mebrathail condominium which is named after its close proximity to ELPA store and Gofa area. It is located in the southern part of the city inside Woreda 06 of Nifas Silk Lafto subcity. It

was inhabited since 2008. This site was chosen by the class of Housing and Sustainable Development students of year 2012/13 to conduct study on various issues related to condominiums which was approved by the Chair of Housing. One of the main criteria used to choose a condominium site as a case study area was a minimum of five years occupancy[3]. And it was very advantageous for me since I have been living in one of the condominium units of the case study area for more than four years which made me see the study issue in focus that this research investigates very closely.

This research studies the water management on two locations inside Gofa/Mebrathail condominium neighborhood. These are on a unit and on neighborhood levels. On the unit level study, samples are taken from the different unit types ranging from studio to three bed room types located at different floor levels of buildings considering different mix of family sizes. The site level study will focus on how clean water is provided and how the waste water is leaving the neighborhood together with the different purposes of water inside this area.

1.5.2 Thematic Scope

The thematic scope of this study is limited to the management of water for Gofa-Mebrathaile condominium. The management is seen in two major parts as pre-design and design considerations for water management for the housing development and at post-occupancy stage of household's water management. The main strategies to bring sustainable water management in housing developments are discussed with a special focus for developing countries.

1.6 Research Question

1.6.1 How the research questions are formulated

Many areas of the world are experiencing increasingly severe water scarcity. Recent studies by the International Water Management Institute (IWMI) indicate that one-third of the population of developing countries lives in regions that have absolute water scarcity, in the sense that they do not have sufficient water resources to meet their agricultural, domestic, industrial and environmental needs in the year 2025 (Seckler, Molden, & Sakhivadivel, 2003). Such facts are bringing a concern for the wise use of natural resources to have equal share among today's and future generation's need in order to bring a sustainable development. My understanding to this concepts and my experience in one of the condominium housing areas regarding water have derived me to ask the following questions and study the situation in depth. That is; how water related actions are designed to be managed in the first place for the users and how it has been

[3] since condominiums are recent phenomenon to the country, a minimum of five years occupancy was required to study the change and living situation of the occupants

managed by the users. And the third research question focuses on measuring the sustainability of the general water management for this housing development.

1.6.2 The research questions

The major question of the research being how sustainable is the management of water resource in Gofa-Mebrathaile condominium neighbourhood, the following are a more specific research questions which can help in answering the bigger question.

1. How is water designed to be managed in Gofa-Mebrathail condominium?
2. How is the household water management in Gofa-Mebrathail condominium?
3. How sustainable is the general management of water in Gofa-Mebrathail condominium?

However, this study does not include the study of water used during the construction stage of condominiums. And does not ask the design of water in terms of the engineering dimension, rather focuses to study the spatial decisions together with water management trends. In this regard, the focuses is on pre considerations for water management and post occupancy issues related to water management with regard to the design decisions given to the condominiums.

1.7 Structure of the thesis

This thesis is structured in seven chapters. The **first chapter** presents the general introductions to the study including motivation for the study, relevance of the study, scope of the research and the research questions. In the **second chapter** the research methodology how it is selected and used are described. The contents of the chapter include: the different data types and the sources; data analysis, validity and reliability checking techniques; and description and diagram of the research design. **Chapter three** contains the different literature and discussions about contemporary challenges of urbanization, sustainable development, sustainable housing development and sustainable water development for urban housing. Here case studies are also presented from different contexts and practices from the perspective of sustainable design and use of water in housing developments. In the **fourth chapter** the contextual background is presented about the case area with a focus on water and water related perspectives. Then the collected data from the case study focusing on the design of water for the condominium and presentation of case stories of dwellers to understand the water use trends are presented in detail. **Chapter five** presents the data analysis and **chapter six** presents the findings, conclusions and recommendations of this study.

Chapter 2
Research Methodology

2.1 Introduction to the chapter

In this chapter the research method used is explained with the reason to choose it. Also it will go on discussing the types and sources of data, the rationality behind selecting the case, the techniques of data collection, way of data analysis, data validity and the research design.

2.2 Why case study?

Case study research methodology is used for this study because the research questions are dependent on actual phenomenon or contemporary situation and majorly looking for answers for the question of 'how' in real life context. And an insight of the event could be with such a method. Case studies are preferred method when (a) 'how' or 'why' questions are being posed (b) the investigator has little control over events and (c) the focus is on a contemporary phenomenon within a real-life context (Yin, 2009). This case study research method only focuses on contemporary events, events which are happening now. A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2009).

2.3 Selection of the case

Our instructors and my classmates[4] were thinking to publish a paper on a study conducted on a single condominium housing project from various angle based on a student's interest. The criteria to choose a case was at least five years of occupancy by that time, not too big or not too small site in order for it to fit different interests and its close proximity to the main city center to be accessible for most of us and to encourage repeated visits to the site. Accordingly, Gottera and Gofa-Mebrathail condominium sites were the two sites fulfilling the criteria but based on a vote finally Gofa-Mebrathail condominium was selected which was approved later by our instructors and the chair of housing. Even if it is a group decision, I have been also considering choosing the site to be my case study area. This is because I was leaving in the area for more than four years and witnessed the problem that this research is studying and wanted to have a real answer for the problem with the worry on the sustainability of the nature of water management for the area.

2.4 Type of data

Both qualitative and quantitative data are used collected from different sources. As the research is basically qualitative, the quantitative data collected is used to support the results but not as a major source of data or information to reach conclusion.

[4] Classmates – Housing and Sustainable Development graduate program class of 2012/13

2.5 Sources of data

The primary data is collected through an interview conducted with different households living in three different blocks in Gofa-Mebrathail condominium site and with different stakeholders and professionals who were or are part of the IHDP at Addis Ababa Housing Development and Construction Office, AAWSA and the case's committee members.

Secondary data are collected from AAWSA head office in Megenagna mainly for the existing situation related to water in Addis Ababa, from AAWSA's business plan document from 2011-20 and the case's condominium site water and sewerage design proposal and other documents which were available on the internet like Ethiopia's water policy, water proclamation and regulation documents. These data are used in the study to present majority of the background and pre-design considerations of water management study of the selected case.

2.6 Data stratification criteria and sampling technique

As the research's major question about sustainability of water management which requires the balanced development of the social, economic and environmental dimensions, looking for answers require to have information from varied sources in terms of especially income levels and housing condition. Slop and floor levels were the other criteria which could have effect.

Since the case study area is a big site informants were selected from three sample blocks located at different slop levels to study household's water management. The slop was a criterion because the site has a big level difference between the highest and lowest points which is around 37ms and the study wants to check if slop has effect in the distribution of water. These decisions are reached based on different pre observation, experience and informal discussions made with residents, security guards and committee members of Gofa-Mebrathaile condominium. Knowing some people who lived in these blocks also helped me to get introduced to my other informants easily. Such kind of approach also helps to get easy access to their homes and to get detailed information since it is easier for people to develop trust.

Additional information was also gathered from business areas found within the Gofa-Mebrathail condominium and their selection was based on the business' nature and level of dependence on water. Accordingly a restaurant and a ladies hair salon were chosen. And with the hypothesis that water has its influence on health an interview was also made with a doctor working inside a clinic found with in the neighborhood; because, this clinic, even if it is privately owned, it is basically serving the community inside the case area. There is a governmental health station in close proximity (1km away) but I did not include it in my study since it is serving a wider area which will be difficult to get specific information about the condominium.

Criteria for informant's profile	Rationality	What is chosen
Age	Mixing age groups as different age groups might relate differently to water.	Looking for a person matured enough to describe the situation in their families and family heads. This combines age group from young and old people
Sex	To study the relation between gender water management. This will also help to measure the social dimension of sustainability of water management in terms of gender equality and to see how women are being affected by the design and decisions related to water.	Women are more preferred.
Income level	To study how different income groups manage water and water related facilities and to understand the level of effect on such people due to design decisions related to water. To measure the economic dimension of sustainability of water management into how different income groups affected by water design.	Looking for mix of high, middle and low income house holds
Housing units	To study how the different spaces and arrangements affect the use of water management and to see how the design responds to that.	Looking for mix of three, two, one bed room units and studios
Slope levels	To study if slope has effect in the distribution of water for houses located at different levels and to see how the design responds to that.	Looking for mix of buildings located at high, middle and lower slopes
Floor levels	To study if the location of houses in different floor levels has effect in water distribution and use; and to see how the design responds to that.	Looking for mix of housing units ranging from ground to fourth floor.
Business areas	To study how water is being managed in commercial areas found within the case study area.	Looking for business activities which depend on water more.
Health center	To taste the hypothesis that water	Looking for such places where it is

	has direct relation with health and to check if there is any information related with that. This is also to study social and economic dimensions of sustainability of water management.	mostly serving the case area
Administrative and management area	To find out the different decision made for the design of water management in the case study area. To study the environmental and economic dimension of sustainability of water from design and decision perspective.	The condominium committee, AAWSA Gottera branch office, AAHDPO

Table 2-1 Rationalities Considered to Decide Informant's Profile

For the quantitative data since it is needed to draw a comparative analysis not a major source of data, the numbers are decided from the three blocks located at different slope levels selected for data gathering. Each block has five floors and 25 to 40 housing units. So the samples are decided by selecting representative units from each floor especially the extreme floors of the ground and the upper floors. So 20-30% of housing units per floor and in total thirteen households were studied, two representatives from the business area was selected and one health center has been studied in order to understand the general water management trend of the condominium.

2.7 Data collection techniques

Pilot study

At first a pilot study was conducted with some individuals I know closely who live in Gofa-Mebrathail condominium. The interview actually helped to consider the slope of the area to be criteria for the stratification of the sources. This is because I was also thinking slope could be one reason after I had two opposite experiences with water availability in the same neighborhood, my previous house being very troubled with water shortage and my second place being surprisingly continuous water availability. And I assumed slope could be the cause because the second one is visibly found on the lower slopes than my previous place. But what I learned from my pilot study was some people living in other parts were already aware of this situation and there was a rumor in the condominium that this places with continuous water supply were giving some money for people working at AAWSA so that was the reason. This and other indications helped me to revise my questions again.

Mix of semi-structured and structured interview questions

By preparing a mix of semi-structured and structured questioner I collected data from the case study and other sources which I interviewed and in order to be fully engaged with the

conversation, I was only recording without taking notes in between. But at the end of each day in order not to lose data due to some electronic failures I transcribed the conversations one by one on a paper.

Photographs

Pictures were one of the most important data for the study and I gave a separate day from the interviews to take pictures especially in the case study area. Actually what happened in the beginning was the taking of pictures which gave me ideas of questions for the interview when I was looking back the day's pictures. And at the end of each interview and according to the new information I got from my interviewees there were more pictures taken.

Mapping

Mapping is done to illustrate the spatial usage of housing units and neighborhood layout in relation to household water management. This was very important because it helped to compare the architectural design of condominium housing units and the use of the spaces in relation to water and its use.

Direct observation

Direct observation was also part of the main data gathering techniques which was means of indicators for further study. Most of the direct observation was done parallel to the administration of the questionnaires and the physical mapping of the housing units.

Participatory observation

My experience of living in the area was important in order to select sites (blocks) and easily put criteria to choose people for interview. A continues follow-up of some of the activities was achieved through my presence in the area.

Informal discussions

I was talking to people informally about some of my issues and the answers I got usually helped me for further study of some of the situations. In addition the conversations were indicators of interviewees.

2.8 Data analysis techniques

In qualitative work there is no clear boundary between data collection and analysis Stake, 1998 cited in (Yitbarek, 2008). It is a process in which the researcher is constantly engaged in a chain process of data gathering and reflection (Yitbarek, 2008). The purpose of data analysis was to make the data from the fieldwork responsive to the need of answering the research questions in the study. This involves the examination, categorization and tabulation of the evidence - both of the qualitative and quantitative data. Theories from my literature review to help me frame

the subject of my study. The different criteria and recommendations for sustainable water design and use were used to measure and analyze to give answer to the research's questions. Some part of the data was tabulated and data charts and qualitative interpretations were used.

Graphs and tables were used to analyze data comparatively. Qualitative data were interpreted in the form of case story description, mapping and tabulation of information. In addition to the analysis of interviews and questionnaires; the different data collected in the form of maps, photographs, aerial photos and secondary written documents were interpreted in relation to the key issues of the research questions. The quantitative data were analyzed with the help of SPSS to illustrate and compare data.

In order to come to a conclusion and to rate the sustainability level of the management of water, a method developed by Edinburgh Sustainable Architecture Unit to evaluate the Sustainable Housing Performance Assessment Method is adopted. This method, based on principles of multiple criteria analysis and best practice, involved the weighting, assessment and aggregation of individual performance criteria within each of the performance categories (Morgan & Talbot, 2001). In this thesis principles of sustainable water management practices and strategies were taken from the literature review to do the evaluation by selecting those which best fits the context of developing countries especially Africa. The aggregate score determined the overall assessment of the performance categories. The actual values for each measurement were given based on the qualitative analysis done and the findings with respect to those principles for sustainable water management.

The results are presented visually on a 'radar diagram' and the development assigned an overall sustainability rating of excellent, very good, good, satisfactory, very satisfactory, partly unsatisfactory or unsatisfactory according to the average performance category score.

2.9 Validity and reliability

> Triangulation is the most important technique of making the results of a case study valid (Johansson, 2005). Triangulation is generally understood as "a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation" (Stake, 1998) (Yitbarek, 2008).

Yin suggests that case studies could be validated – or aim at trustworthiness – through triangulation (Yin, 2009). In this study data triangulation, use of different sources for the same unit of analysis, use of different methods of gathering data about the same unit of analysis were used to make the results of the study more reliable.

And in addition the three block's inhabitants whom I chose to be my key informants were contacted through the closest people I know who live in the same respective blocks. And the people they showed me are also the people they know and who were fully willing to help me to get their interview. And my stay in the neighborhood also helped me to cross check the data with my knowledge and to collect data faster and to get trust from the people.

2.10 Research Design

This research is designed based on the three questions that the research is inquiring. The first questions require an answer from the cause side that is design or decision, the second requiring answer from the effect side that is the use or existing situation and the third measuring or comparing both actions in terms of sustainable development trends for the sector. This study conceived based on the cause and effect relationship between water design for its management in condominium housing and the household's water management. The research questions basically explain the situations. That is why case study is adopted as main research method for the study. And theories frame the analysis and findings of the data gathered. These framing is majorly found from different theories and framework's being tested worldwide developed by international organizations like the World Bank, African Development Bank and World Summit on Sustainable Development's documents on integrated water resource management.

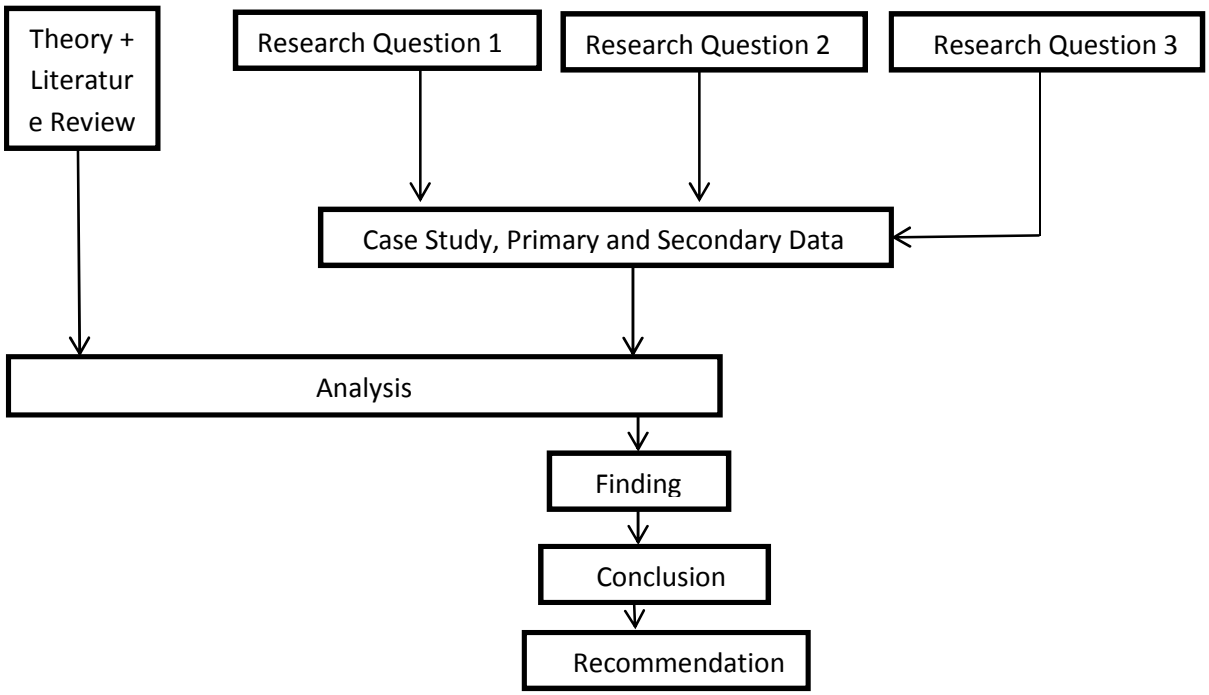


Figure 2-1 The research design

Chapter 3
Literature Review

3.1 Introduction to the chapter

In this section different theory, ideas and researches are explored and presented in relation to the main topic or key issues of the research. It includes the definition of basic terms in the way how they are used in the research and discussions of the main topic of the research by referring the different books, publications and articles. Regarding the principles of sustainable water management in housing, this study wants to focus on two specific documents by The African Development Bank and The World Bank for integrated water management principles based on the relevance especially in developing Africa. Case studies are also presented from different areas which include local and international practices for sustainable water design and use.

3.2 Challenges of urbanization

Continuing population growth and urbanization are projected to add 2.5 billion people to the world's urban population by 2050, with nearly 90 percent of the increase concentrated in Asia and Africa (UN, 2014). And by early decades of the next century, the overwhelming majority of men, women and children in every country will, for the first time in history, be living in urban surroundings (HABITAT, 1996). As the world continues to urbanize, sustainable development challenges will be increasingly concentrated in cities, particularly in the lower-middle-income countries where the pace of urbanization is fastest (UN, 2014). These facts will be or are urging governments in developing countries in fulfilling the different development needs of the people. In some cities, unplanned or inadequately managed urban expansion leads to rapid sprawl, pollution and environmental degradation, together with unsustainable production and consumption patterns (ibid).

As globally accepted, housing is the third most important thing that people need to survive next to food and water. Therefore housing has direct relationship with urbanization. As more and more people come to urban areas, the demand for housing will increase proportionally. Urban housing demand in Africa is largely an outcome of rapid and large-scale urbanization (UN-HABITAT, 2011a). Because African governments have not been proactive in acknowledging and planning for urbanization, informal, unplanned slums have proliferated throughout African cities and these are presently home a considerable, and growing proportion of the population (ibid). Dominantly poor urban population is also another problem which aggravates the challenge.

Even if urbanization has its own challenges, if responded carefully it has also a positive contribution for a sustainable urban development. For example providing public transportation,

as well as housing, electricity, water and sanitation for a densely settled population is typically cheaper and less environmentally damaging than providing similar level of services to a predominantly rural household (UN, 2014).

3.3 Sustainable development

In this research when I start to find answers to my questions and as a major or general research questions of 'how sustainable is the case's housing development in terms of water resource design and use', at this point it is important to define and understand what it means by sustainable development. And what it means by sustainable housing development and sustainable use of water in housing.

The Brundtland commission is more famous on this concept because it is the first to give a more structured and most accepted definition for it in 1987 as 'sustainable development is about meeting the needs of the present without compromising the ability of future generations to meet their own needs'. But the concept of sustainable development was first raised in a 1972 book 'Limits to Growth' again the concerns still has longer history in the 18's with the expansion of industrialism. But the first concerns about sustainability are highly focused on the environmental aspect, and most definitions and strategies were related to that. This created debates among scholars with the idea that sustainability has to address interrelated issues which has to do with economic and social aspects development which should be seen in balance or equally with the environmental aspect.

Even though different scholars and papers explain it in different terms they all almost meant and explained things similarly. According to the book Sustainable Cities, all this terms imply that in our development "…..emphasis is given to one or more of three aspects: meeting human needs; sustaining or keeping intact natural capital (including both natural resources and ecosystems) at local, regional and global level; and ensuring that human activities or values can be 'sustained' (Satterthwaite, 2004). After the Brundtland commission governments started acting on the goals of sustainability by preparing local plans and agendas which further contribute to the global sustainability achievements.

"….it is difficult to adjust buildings, settlement patterns and transport systems that developed during a long period of cheap oil and (generally) growing prosperity to much lower levels of fossil fuel use. But in nations which are urbanizing rapidly, putting in place the institutional and regulatory framework that encourages energy conservation in all sectors, minimizes the need for heating and cooling in buildings and encourages settlement patterns that limit the need for high levels of private automobile use can ensure the development of cities that are more compatible with some of the main sustainable development goals" (Satterthwaite, 2004).

Sustainable development is seen as a multidimensional process that links environmental protection with economically, socially and culturally sound development (UN-HABITAT, 2012). Sustainable development has basically three dimensions as environmental, social and economic. Sometimes there is additional dimension added to it as cultural. We say a certain development is sustainable when these three or four dimensions are met in balance. Each of these four dimensions has their own criteria to be fulfilled by the actions taken in development. Sustainable development seeks to respond to five broad requirements:

1. Integration of conservation and development
2. Satisfaction of basic human needs
3. Achievement of equity and social justice
4. Provision of social self-determination and cultural diversity
5. Maintenance of ecological integrity

3.4 Sustainable housing development

Of all forms of development and ideas of wellbeing that we can imagine, the only one we can simply no longer afford to pursue is that so far adopted by the more industrialized countries; the very one which less industrialized nations have been taking as a reference model, explicitly or implicitly. That is a development model and an idea of wellbeing based on a very clear hypothesis: to be better off, we must consume more (Ambiente, 2004). Housing development as a sector which consumes a lot of resource and producing a lot of waste both during construction and occupation, the development approach should be wisely thought especially in developing countries. At strategic, as well as at an operational, level architecture - and housing design in particular- offers a critical, though under-appreciated, mechanism for community building by helping to deliver some of the social, cultural and economic needs of a sustainable community (Peter, Tucker , & Ambrose, 2001).

Sustainable housing offers a great spectrum of opportunities to promote economic development, environmental stewardship, quality of life and social equality, while mitigating the precarious convergences of the problems related to population growth, urbanization, slums, poverty, climate change, lack of access to sustainable energy and economic uncertainty (UN-HABITAT, 2012). Affordable housing is commonly considered on a cost basis, while environmental and social issues (including people preferences, lifestyles, and cultural aspirations), as well as economic impacts are thought to be addressed separately or totally ignored (ibid).

Most mass housing developments in developing countries targets the end users to be low-income people then the way to make it available for them is making it affordable by using low

cost construction materials and technique and a more labor intensive construction. It seems that all national and international housing and planning agencies miss-state housing problems by applying quantitative measures to none or only partly quantifiable realities (Turner, 1976). Ensuring progress towards what is often termed 'sustainable consumption' that is, ensuring that the goods and services required to meet everyone's consumption needs are delivered without undermining the environmental capital of nations and the world. This implies a use of resources, a consumption of goods imported into the city and a generation and disposal of wastes by city enterprises and city dwellers that are compatible with the limits of natural capital and are not transferring environmental costs on to other people including future generation (Satterthwaite, 2004).

Sustainable affordable housing in this regard may be considered as extension of the adequate shelter- for-all strategy of the Habitat Agenda (paragraph 60): Adequate shelter means more than a roof over one's head. It also means adequate privacy; adequate space; physical accessibility; adequate security; security of tenure; structural stability and reliability; adequate lighting, heating and ventilation; adequate basic infrastructure, such as water supply, sanitation and waste-management facilities; suitable environmental quality and health-related factors; and adequate and accessible location with regard to work and basic facilities: all of which should be available at an affordable cost (UN-HABITAT, 2012).

3.5 Characteristics of sustainable housing

Although sustainable housing is often associated with wealth and affluence, it does not need to be (UN-HABITAT, 2012). So-genuinely sustainable houses are those that are inclusive and affordable for all (ibid). Addressing the issue of affordability is, therefore, a necessary condition for transformation towards sustainable housing and yet affordability is not enough, because the so-called affordable homes cannot be considered sustainable if they create negative impacts on the environment or social life (ibid). Buildings and housing account for a considerable share of the world's resources: 12 percent of global fresh water used by the building sector, 40 percent of all waste and a major amount of pollution is generated by the building sector;2 and approximately 60 percent of world's electricity is used for residential and commercial buildings (UN-HABITAT, 2012).

According to the book, 'The Sustainable Urban Development Reader' by (M.Wheeler & Timoty, 2009), sustainable housings are those that are designed, built and managed as.

- Healthy, durable, safe and secure
- Affordable for the whole spectrum of incomes
- Using ecological low-energy and affordable building materials and technology

- Resilient to sustain potential natural disasters and climatic impacts
- Connected to decent, safe and affordable energy, water, sanitation and recycling facilities
- Using energy and water most efficiently and equipped with certain on-site renewable energy generation and water recycling capabilities
- Not polluting the environment and protected from external pollutions
- Well connected to jobs, shops, health and child care, education and other services
- Properly integrated into, and enhancing, the social, cultural and economic fabric of the local neighbourhood and the wider urban areas
- Properly run and maintained, timely renovated and retrofitted

3.6 Sustainable water management

Among the different goals of achieving sustainable housing, the sustainable management of water resource is one of the major. But how to bring the sustainable ways and the different strategies for sustainable management is another question. As world population and industrial outputs have increased, the use of water has accelerated and this is projected to continue (Parliamentary Office of Science and Technology, 2002). Indeed, it is projected that by 2025 global availability of fresh water will drop to an estimated 5,100m^3 per person per year from the amount 6,600m^3 as the world's population increases by 2billion (ibid).

> Scarcity and misuse of fresh water pose a serious and growing threat to sustainable development and protection of the environment. Human health and welfare, food security, industrial development and the ecosystems on which they depend, are all at risk, unless water and land resources are managed more effectively in the present decade and beyond than they have been in the past (UN, 1992).

In most of the globally accepted documents that I went through all preach almost the same thing that is, sustainability of water is/should be addressed through an integrated approach for its management. In 2002, the need to improve water efficiency was recognized and given new impetus by the World Summit on Sustainable Development (WSSD). Article 26 of the WSSD plan of Implementation, sets an action target for the preparation of "Integrated water resource management (IWRM) and water efficiency plans" by 2005.

- Art. 26 (a): "… introduce measures to improve the *efficiency of water infrastructure* to reduce losses and increase recycling of water"
- Art. 26 (c): "Improve the efficient use of water resources and *promote their allocation* among competing uses in a way that gives priority to the satisfaction of basic human needs and balances the requirements of preserving or restoring ecosystems and their

functions, in particular in fragile environments, with human domestic, industrial and agriculture needs, including safeguarding drinking water quality"

For example the African Development Bank in view of the challenges regarding growing water scarcity exacerbated by rapid population growth & urbanization, misallocation of resources, environmental degradation, and mismanagement of water resources, the bank group came up with principle of Integrated Approach to Water Resource Management (IWRM). In which the bank lending policy encourages borrowers to adopt and implement this policy frame work or IWRM.

The central objective of the IWRM is to promote efficient, equitable and sustainable development through integrated water resources management (African Development Bank, 2000). Meanwhile the World Bank group has also prepared similar document but very specifically focusing on Integrated Urban Water Management (IUWM) that is intended in developing countries especially urban Africa. Because there is a growing sense among water professionals, municipal leaders, academics, and within the development community that a new approach to urban water management is needed (The World Bank, 2013). In words of an African academic: "meeting urban water needs in the twenty-first century will requires paradigm shift Awiti, 2012 cited in (The World Bank, 2013). Nineteenth century supply side solutions alone will not balance the over-growing demand for water driven by rapid urbanization, shortage of surface and ground water due to climate change, and competition from agriculture" (ibid).

3.7 Key principles of pre-design and design considerations for sustainable water management in housing

Addressing the sustainability of water has three strategic dimensions which are environmental, social and economic. The need to balance the three basic needs has a crucial bearing on the management of water resources. These needs interact in a symbiotic and dynamic relationship. Water resources management should be performed within a framework, which balances these inter-related needs (African Development Bank, 2000).

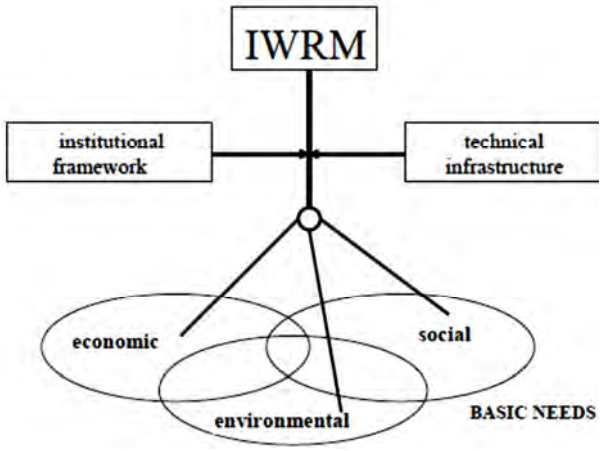


Figure 3-1 Conceptual Framework for IWRM Policy Recommendation (ADB)

3.7.1 Environmental dimension of sustainable water resource management

The environmental sustainability of water is concerned with its wise use and its protection from pollution. In order to bring this there are different strategies suggested by the World Bank with a special focus on its workability for urban areas of Africa. These strategies are supported by other international organizations like the African Development Bank and the document of World Summit on Sustainable Development (WSSD). Among these principles the following are the suggested by these organizations in order to bring environmental water sustainability, treating the urban water cycle as one system; water should be fit for purpose; diverse sources provide better water security; urban groundwater: sustaining water security and increasing water treatment potential; implementing innovative technologies and making waste water valuable (The World Bank, 2013).

3.7.2 Social dimension of sustainable water resource management

As water is a social good, all dimensions of water resources management should be analyzed adequately from the social perspective, with a view to elucidating social issues which are critical to achieving integrated water resources management as well as maximizing social benefits and mitigating detrimental social impacts. So according to the ADB's strategy recommendation the following are points in order to bring social sustainability of water: working for population pressure and urbanization; giving education aimed at creating awareness and a positive change of attitude among the population on the hygienic use and sustainable management of water resources is a key element to health improvement; gender equity which implies the effective participation of women in the planning, design, implementation, evaluation, and all other decision-making processes in water resources development and management is important; demand-responsive approach is key to the successful development of water resources. In contrast to centralized, top-down approaches that were generally favored in the past; other social issues which include cultural and traditional values of people in relation to water resources should be studied to provide a basis for designing an effective information,

communication and education program to deepen community understanding of sustainable utilization and management of water resources (African Development Bank, 2000).

3.7.3 Economical dimension of sustainable water resource management

Despite the preciousness of water, it is wasted in low value applications or used in excess because water pricing does not accurately transmit to consumers its scarcity value (The World Bank, 2013). Water pricing: getting the prices right; is at the very core of improving water resources management; prices should be set to give incentives to users to use water efficiently and sparingly in their various applications, and to producers to supply water at adequate rates and quality levels; environmental considerations: treating water as an economic good should include the "polluter pays" principle; financial considerations: since the costs of expanding water services and improving water resources management are high, further public and private investments will need to be based on a consensus on improved cost recovery are amon the economic principles to manage water sustainably (African Development Bank, 2000).

3.7.4 Institutional frame work and technical strategies

In order to get the full implementation of the above strategies the institutional and technical strategies should go along for a better support and achievement. And the different approaches for this are: water should be managed across institutions: good governance is a critical component to any water management agenda; All Players Should Be Part of the Process:- Critical to the success of IUWM is the early and continuous integration of all stakeholders—including the public—in the planning, decision-making, and implementation process; Adaptive Systems Work Best to Cope with Uncertainty: Water management must take into account that the future is inherently uncertain (African Development Bank, 2000).

The above four principles discussed under environmental, social, economic and institutional dimension can be summarized by the following diagram which show the relationship and considerations to bring sustainable water management.

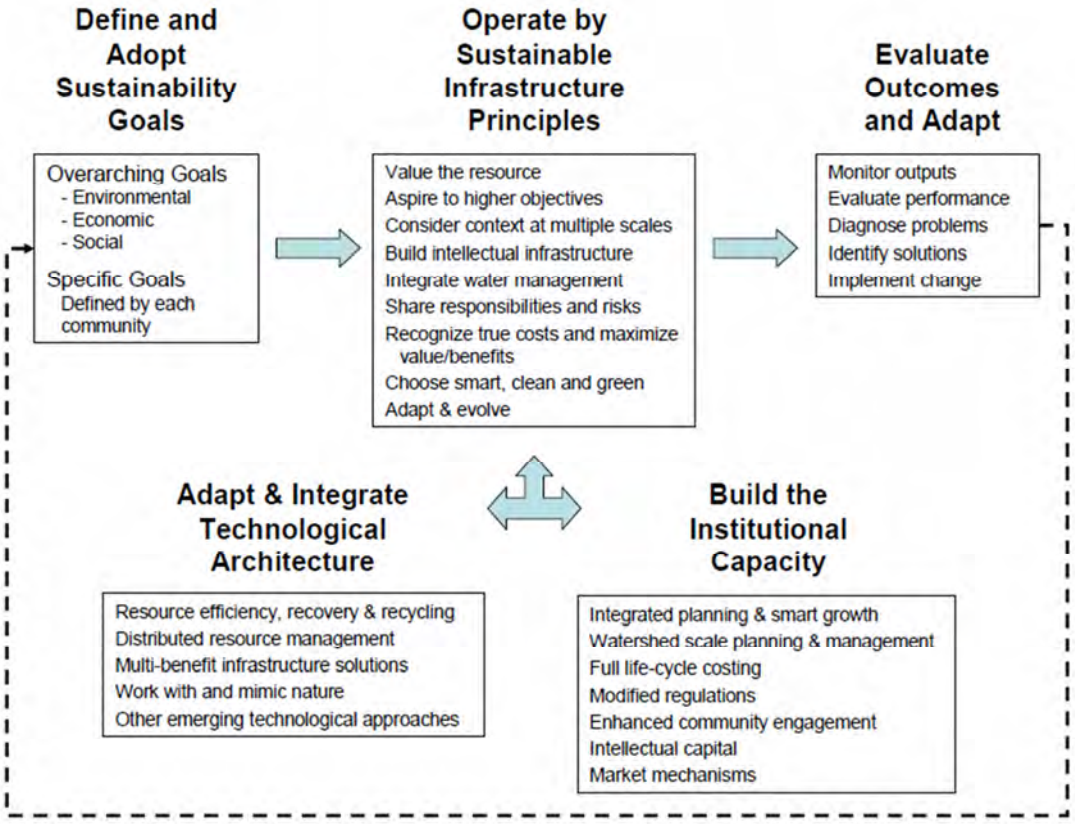


Figure 3-2 New paradigm for integrated water management

Source: Sustainable water resources management; Volume 3: Case studies on New Water Paradigm (EPRI, Alto, CA, & Tetra Tech, 2009)

3.8 Key principles of sustainable household water management

The sustainable use of water in housing is very dependent on how the general water system is managed. Analysis at the household scale exposes opportunities for rainwater harvesting and grey water recycling (The World Bank, 2013). Education aimed at creating awareness and a positive change of attitude among the population on sustainable management of water resources is a key element (African Development Bank, 2000). Educating residents through presentations, work group involvement, focus groups and the development of living learning environments is important to create and make them develop the awareness of sustainability (EPRI, Alto, CA, & Tetra Tech, 2009). And modeling sustainable practices to residents is crucial.

3.9 Assessment methods for sustainable water management in housing

With the big focus and importance being given for sustainable development different countries have developed sustainability rating systems for different development aspects. The famous sustainability rating system developed for building is LEED which was introduced by U.S. Green Building Council in 2004. This assessment method works by grading a certain building based on specifications set by the system. Although LEED is the dominant green building certification system, other systems exist around the world. Outside of the U.S., countries have adopted their

own green assessment systems, such as the UK's Building Research Establishment's Environmental Assessment Method (BREEAM) or Green Star in Australia (Sabol, 2008).

Even if there are some variations among the criteria in these rating systems, the basic assessment points focus on the selection of sustainable sites, water efficient designs, energy and atmosphere, material and resources, indoor air quality and the innovations in operation (Sabol, 2008). Sometimes there are also specific criteria developed to rate buildings of specific purpose like housing in terms of sustainability. The Sustainable Housing Performance Assessment Method is one of such type developed by Edinburgh Sustainable Architecture Unit. This was done by outlining systematically selected sustainability performance criteria generated from the basic principles of sustainable housing (Morgan & Talbot, 2001). The performance criteria were then organized under major performance categories, across four life cycle stages (ibid). The results will be presented visually on a 'radar diagram' and the development assigned an overall sustainability rating of excellent, very good, good, satisfactory, very satisfactory, partly unsatisfactory or unsatisfactory according to the average performance category score (ibid).

In order to assess the sustainability of water management in housing, the method developed by Edinburgh Sustainable Architecture Unit for assessing housing performance in terms of sustainability can be adopted. This can be done by selecting sustainability performance criteria from the principles of sustainable water management system in housing and evaluating them across the life cycles of the housing development.

3.10 Case studies on sustainable water management practices

3.10.1 Local Case Studies

Early Axumite's civilization and its storm water storage method

Source (Stuart Munro-Hay, 1991)

General Description

Of all the important ancient civilizations of the past, those of the ancient Ethiopian kingdom of Aksum still perhaps the least known (Stuart, 1991). The ancient known civilizations like the Egyptians, Mesopotamians, Indians and Chinese had there foundation along an abundant water resources or rivers. But the Aksumite civilization which is equally important with the mentioned ones but its foundation is different and unique with respect to water. And also for most of us, Ethiopians, Aksum is famous for the giant oblique and the resting place of the Ark of the Covenant in Mariam Tsion Cathedral.

Sustainable water design and use practice

Even if water was one of the most important things for the civilization, it was not found in a large amount. There is no river within two miles of Aksum, but the inhabitants have good well water; there are many wells hidden and even in the plain have been found. It appears probable that, in ancient times, almost every house had its well Pearce 1831:162-3 cited in (Stuart, 1991).

Aksum was built on a gently sloping land which rose, north and east of the city, to two flat topped hills, now called Beta Giyorgis and Mai Qoho respectively. The hills around the town are formed from a granitic rock Littmann 1913: II, 6; Butzer 1981 cited in (Stuart, 1991). Between Beta Giyorgis and Mai Qoho runs the course of a stream, the Mai Hejja or Mai Malasho in its upper reaches which rises on the eastern slopes of Beta Giyorgis. Further west another stream bed that of the Mai Lahlaha, also descends from the top of Beta Giyorgis. Run-off from the Mai Hejja and down the flanks of Mai Qoho above the town is caught in a large excavated basin, officially called Mai Shum, but often referred locally to as the 'Queen of Sheba's bath' (ibid).

A School Project in Mekele

Source (Interview with the project architect Fasil Georgis)

General description

Mekele is a fast growing city in the North of Ethiopia. Water shortage is one of the challenges the city has. But a school project here came up with an alternative and innovative way of water design with a very minimum coast to address sustainable water use. The project is done by ARUP and local professionals like Architect Fasil Giorgis, my informant. The design of the water is thought starting from the beginning together with the building design.

Sustainable water design and use practice

So in this project water is collected from every building in the compound with a well dug besides the buildings and the gutter from the roof collects water to direct it to the wells. The water from the wells is used for washing hands for the students and the waste water from the hand wash basin which is built adjacent to the toilet is directed to water the plantation. The toilets are built with a septic tank; there are about six toilets and each toilet serves for three months and it will be closed for three months while the rest of the toilets will be opened for use. After three months the closed toilet will be opened and the remaining waste will be used as a fertilizer for the plantations. The toilets do not use any water and are well ventilated with a top window opened from the roof and the students are trend to pour ash on the toilet after use to prevent bad smell. And the building is also done with local construction materials and techniques which is stone. And Architect Fasil advises that this could be one solution in areas where there is big shortage of water and huge housing and university projects to use such a system in time of water shortage.

Water from Thin Air

Source (www.architectureandvision.com, 2014)

General description

Conceptualised and designed by the Italian firm Architecture and Vision, the Warka Water towers ia a bamboo, water-collecting structure that helps locals access clean water at minimal cost and impact to the environment. The 'Warka, as it's more commonly known, was inspired by a native Ethiopian fig tree symbolising fertility and generosity.

Sustainable water design and use practice

It is 12m high, weighs 80kg and estimated to collect from 50 up to 100 litres of clean, safe drinking water per day. The vertical structure consists of nine modules that are installed from the bottom to the top, and can be lifted and fixed in under a week by four people without the

need four scafolding. A special fabric is suspended inside the structure to collectt water in the air, which after natural condensation is funnelled down into a small reservoir at the base of the tower. The triangular frame structure is made of natural materials such as bamboo and can be built by village inhabitants. The Warka must be fixed with tensioning cables to withstand strong winds.

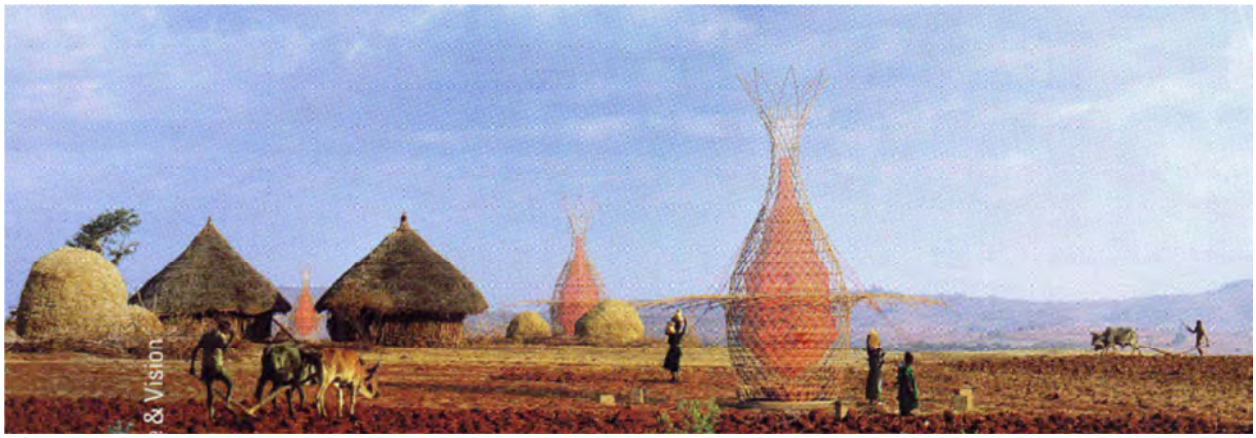


Figure 3-3 Warka water project: water collecting modules

Box 3-1 Local case studies for sustainable water management practices

3.10.2 Developing Countries Case Studies

Cascading Use of Water for Urban Agriculture: Accra, Ghana
Source (The World Bank, 2013)

Irrigated urban vegetable production in Accra provides up to 90 percent of the vegetable needs of the city. Most of the agricultural sites are located on valley bottoms along streams and drainage systems and use raw wastewater as the main source for irrigation. The research project SWITCH developed institutional guidelines and piloted a low-cost treatment system to facilitate the safe reuse of wastewater for irrigation while minimizing health risks. A demonstration project was established at the Dzorwulu-Roman Ridge site, which covers an area of 8.3 hectares in Accra.

Wastewater as a Source of Energy: Naivasha, Kenya
Source (The World Bank, 2013)
General description
A lavatory, wastewater treatment, and biogas generation facility started operation in 2008 adjacent to the Naivasha Bus Park in Naivasha (a small town 90 kilometers northwest of Nairobi). It consists of five toilet cubicles, two showers, and one urinal with the wastewater from the facility being treated and used for biogas and water generation. The biogas generation project (including the water kiosk) is operated by the Water Services Trust Fund and had a total investment cost of approximately US$50,000.

Sustainable water design and use practice
The facility served about 300 visitors per day in 2009 and provides biogas for cooking for a

nearby kiosk. The facility is managed by the local water service provider, who contracted a local community-based organization to operate the toilet on a pay-per-use basis. To generate energy from the wastewater, a biogas plant with a capacity of 54 cubic meters was constructed to anaerobically pretreat the wastewater from the toilets, showers, and wash basins, lowering the organic pollution load. Treated effluent is discharged to an existing public sewer and the accumulated sludge is removed once a year and can be used as a fertilizer. The biogas is piped (through 1.5 centimeter galvanized iron pipe) to a nearby café where it is used for cooking.

Figure 3-4 Lavatory and Wastewater Treatment Plant with Installed Biogas Generation Facility

Integration of Water Resource Management, Water Supply, and Sanitation: Polokwane, South Africa Source (The World Bank, 2013)

General description

Polokwane, the capital of Limpopo province in South Africa, was awarded Blue Drop status by the National Department of Water Affairs (DWAF) because of its recent achievements in water resource management and water supply management. Blue Drop Certification is an incentive-based regulation introduced by DWAF in 2008 to encourage excellent management of drinking water. Polokwane's reward is significant, considering that the city's dry climate requires water imports, and that rapid population growth and the demands of an expanding local economy have placed severe stresses on the system. Water sources in the region are precarious: natural inflows are low and dams were not planned for the emerging demand.

Sustainable water design and use practice

The Polokwane Municipality Water Safety Plan includes safety plans for catchment areas, treatment plants, and the distribution system. Over the past few years, the strategy has emphasized building capacity to strengthen the coordination of water use and supply; a drought management plan, including increased use of recycled wastewater; demand management by expanding water metering and volumetric monitoring programs, including the introduction of prepaid metering as well as a pressure reduction system to reduce water leakage; and a price structure in which the price of water increases with increased water usage, rewarding lower usage while also ensuring basic access for poorer households. Challenges remain substantial, but the combination of national incentives and technical support, as well as concerted efforts to link water resource management and water supply, have made

considerable progress possible.

Box 3-2 Developing countries case studies for sustainable water management practices

3.10.3 Developed countries case studies

London 2012 Olympic Park water infrastructure design, UK

Source (Arup, 2012)

General description

This case is study is selected because it shows clearly the basic principles and techniques of sustainable use of water in new developments. The water design is designed by Arup which addresses critical issues relating to resilience, flood risk, water supply and treatment by placing a re-integrated water cycle at the heart of sustainable planning, design and delivery. Arup provided multi-disciplinary engineering services for the infrastructure design of the southern section of the 2012 Olympic Park, as well as for three of the major venues. Arup's approach was underpinned by the principles of water sensitive urban design, water being one of the client's key themes in their sustainable development strategy to make the Games the 'greenest' in history.

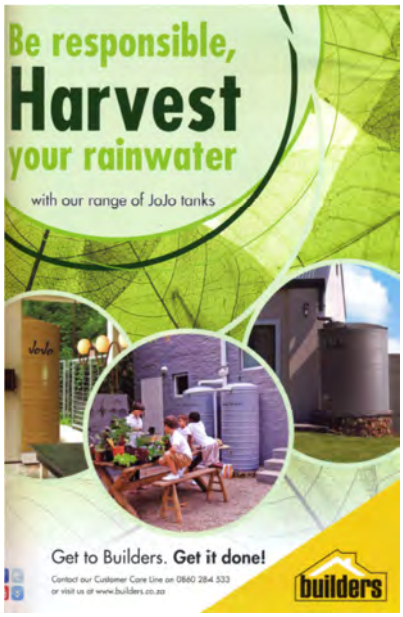
Sustainable water design and use practice

One of the main water strategy objectives was to reduce potable water consumption by 40% compared to industry standards. Through a combination of water efficiency, water re-use and water substitution measures, this target was exceeded and a 57% saving in water was achieved. 20% was through water efficient fittings in venues, and measures such as rainwater harvesting for toilet flushing. A park-wide non-potable water supply network used treated sewage for irrigation and toilet flushing, accounting for a further 37% reduction in potable water consumption, exceeding the Olympic Delivery Authority's sustainability target.

Separate foul and surface water drainage systems reduce combined sewer spills and improve river water quality whilst minimizing flood risk. The river outfalls were specially designed to maintain a continuous riverside ecology whilst controlling discharges sufficiently to avoid interference with navigation.

Box 3-3 Developed countries case studies for sustainable water management practices

3.11 Innovative technologies which can support the sustainable management of water on the market



The Pillow Tank is a flexible storage option designed to provide small and bulk liquid storage on site, facility, home, or business location. Pillow tanks are constructed from a wide range of materials equipped to handle different climates and liquid storage requirements. Fabric options for the tank generally feature either a short term or long term storage material that is rated for drinking water, gray water, fuel, or a combination of liquids.

Figure 3-5 Collection of inovative technologies to help improve water sustainability

3.12 Summury of litrature review

Buildings are the main features of housing which consume a lot of energy and resource to sustain their services. A housing has different developmental approaches which can be based on income, spacial arrangment and building structures. In any ways the way these structures use natural and scarce resources should be sustainable. Because a lot of studies show that buildings are the main sources of waste and means for emission of green house gasses which contribute for more than 50%. The majority of the buildings of urban areas world wide are used as housing or the majority of land in urban areas is taken up by housing developments. So taking sustainable decisions should be a main focus on deciding and delivering new housing schemes.

Water is one of the main natural resource used and consumed in housing. And this litrature review puts different ideas, discussions and strategies inorder to bring sustainable water mangement in housing with the aim to contribute to the bigger sustainable goal. In order to say that water sustainbility is achieved, three dimensions or aspects of its managment should run in balance which are environmental, social and economic with additional focus for the institutional system. This is becouse water is a social good that means it should be shared equaly among individuals with a focus given to poor, low income, women and children groups of societies in order to make them equal beneficiaries. And sustainability of water has also an economic dimension which means it has a monetary value which suggest water use should be based on price based on a cost recovery system in order to make it affordable and in a way the pricing and control system to express its scarsity value.

In order to devlope these three dimensions in a balanced way, different international orginizations came up with specific strategies and principles for sustainable water management to work with. These principles list different methods starting from how policies should be upp to the level of use inorder to bring water sustainability. And countries can compare their strategies with these ones and can check there level of work so far from the sustainable water mangment concept and/or can adopt and prcatice these principles. This litrature review also looks into different case studies which have been practiced especially in developing countries using similar strategies and approaches to use or manage water sustainably. These case studies will also help to get ideas how to interprate the principles into actual practices.

Chapter 4
The Case Study

4.1 Background to the study

4.1.1 Overview

Ethiopia is becoming the focus of the world in various aspects. One is its fastest growing economy and development. Before some decades the country was mostly famous for the repeated drought and political unrest. One important step in the recent development achievements of Ethiopia is the building of a number of electric power generating dams using its natural water bodies or rivers. The Renascence dam is the biggest of all which is being constructed using the Nile River water.

In fact the actual civilization of Ethiopia dates back to the time of the Aksumite. The civilization unlike the rest of known civilizations of the Egyptians, Mesopotamians, Indians etc, didn't start along with abundant water resources. Rather the city of Aksum was designed in a way water could be collected in reservoirs from the runoff coming from the mountains (refer case studies on Chapter 3).

The Geographical location of Ethiopia and its endowment with favorable climate provides a relatively higher amount of rainfall in the region (Ministry of Water Resources, 2001). Between 80-90% of Ethiopia's water resource is found in the four river basins namely Abay (Blue Nile), Tekeze, Baro Akobo and Omo Gibe in the West and South-Western part of Ethiopia where the population is no more than 30-40%. While the water resources available in the east and central river basins are only 10-20% whereas the population in these basins is over 60% (ibid).

Addis Ababa the capital city is found in the central river basins being one of the fast urbanizing countries in Africa with a rate of 4.3% (CSA, 2007) and has a population close to four million. When we see the foundation of the city before one hundred thirty years, besides being chose to be a strategic location for war and rule the rest of the provinces, water played a big role to decide on its becoming of the permanent capital of Ethiopia. The hot springs of Filwiha, on the lower slopes of Entoto was one major attraction to the Emperor and the Empress. Empress Tayitu was particularly interested in building a permanent residence by the Filwiha spring and convinced her husband to do so (Giorghis & Gerard, 2007). And it is from the mimosa trees in this area that the Empress gave the name for the new settlement Addis Ababa meaning New Flower (ibid). The settlement then was originally served by a number of springs located at the foot of Entoto mountain ridge together with a series of hand-dug wells (AAWSA, 2011).

4.2 Existing water and water related management situations

4.2.1 The Ethiopian Water Sector Policy

The policy was published in 1999 with the aim to be as an essential national policy document to steer the development and management of the country's water resources. The overall goal of the policy is to enhance and promote all national efforts towards the efficient, equitable and optimum utilization of the available water resource of Ethiopia on sustainable basis.

General Policy Objectives:-

1. Development of the water resources of the country for economic and social benefits of the people, on equitable and sustainable basis.
2. Allocation and apportionment of water, based on comprehensive and integrated plans and optimum allocation principles that incorporate efficiency of use, equity of access, and sustainability of the resource.
3. Managing and combating drought as well as other associated slow on-set disasters through, efficient allocation, redistribution, transfer, storage and efficient use of water resources.
4. Combating and regulating floods through sustainable mitigation, prevention, rehabilitation and other practical measures.
5. Conserving, protecting and enhancing water resources and the overall aquatic environment on sustainable basis.

4.2.2 Water related legislations and regulatory frameworks

Water related legislations and regulations in Ethiopia are prepared in order to ensure that the water resources of the country are protected and utilized for the highest social and economic benefits of the people of Ethiopia, to follow up and supervise that they are duly conserved, ensure that harmful effects of water are prevented, and that the management of water resources is carried out properly (Ethiopian House of Representatives, 2000). Ethiopian water resources management proclamation was issued in 2000 by proclamation no 197/2000. Also Ethiopian water resources management regulation was issued by the Council of Ministers regulation number 115/2005 for the utilization of water resource from different sources (Council of Ministers, 2005).

4.2.3 Existing water supply management of Addis Ababa

Below the ministry of water and energy, water and water related issues are administered by regional authorities. With this respect, Addis Ababa Water and Sewerage Authority, AAWSA has been providing wastewater collection, transportation and water treatment and supply services to the capital city since 1970's. The city of Addis Ababa was originally served by a number of

springs located at the foot of the Entoto mountain ridge together with a series of hand-dug wells (AAWSA, 2011).

a. Surface Water Sources

Gefersa dam is situated west of Addis Ababa by the road to Ambo. The original Gefersa dam was constructed in 1942 and consisted of a masonry structure approximately 9m in height. At this stage the supplied water was subjected to chlorination only. The dam was raised to 16m crest height in 1955 providing an increased capacity of 6,200,000m^3. The operation of treatment plant was commissioned in 1960, with a design capacity of 30,000m^3/day. The augment the Gefersa main reservoir, Gefersa III earth fill dam with an impoundment capacity of 1,200,000m^3 and approximately 15m in height and a crest length of 220m was constructed in 1966. The Gefersa dam was fully rehabilitated in 2009 and the reservoir capacity was increased to 7,200,000m^3.

Legedadi dam is situated to the east of Addis Ababa. The impounding capacity of the dam is 44,000,000m^3 and consists a rock fill section 22m high and 600m long in combination with a concrete buttress 44m high and 400m long. The dam, together with a 50,000m^3/day treatment plant, was commissioned in 1970. The plant capacity was subsequently increased to its present level of 165,000m^3/day.

Dre dam is located about 10km north of Legedadi dam. It was constructed in 1999 to provide additional supplies to the Legedadi reservoir. The dam has an impoundment capacity of 19,000,000m^3. This additional storage allows the Legedadi treatment plant to operate at its full capacity of 165,000m^3/day.

b. Ground Water Resources

To alleviate shortages of water in the city, AAWSA drilled deep boreholes in the southern part of the city and pumped the water into the system. The Akaki well field is situated southeast of Akaki town and about 22km south of Addis Ababa. The well field covers an area of about 16km^2. A total of 35 wells are drilled within this area, including twenty five production wells, four monitoring wells, four wells to supply Akaki town, one well for isotope sampling and one deep test well. The Akaki field was into operation in 2001. The current yield of the well is about 43,000m^3/day.

Box 4-1 Different water sources for Addis Ababa (Source: AAWSA business plan document 2010-2020 **(AAWSA, 2011)**)

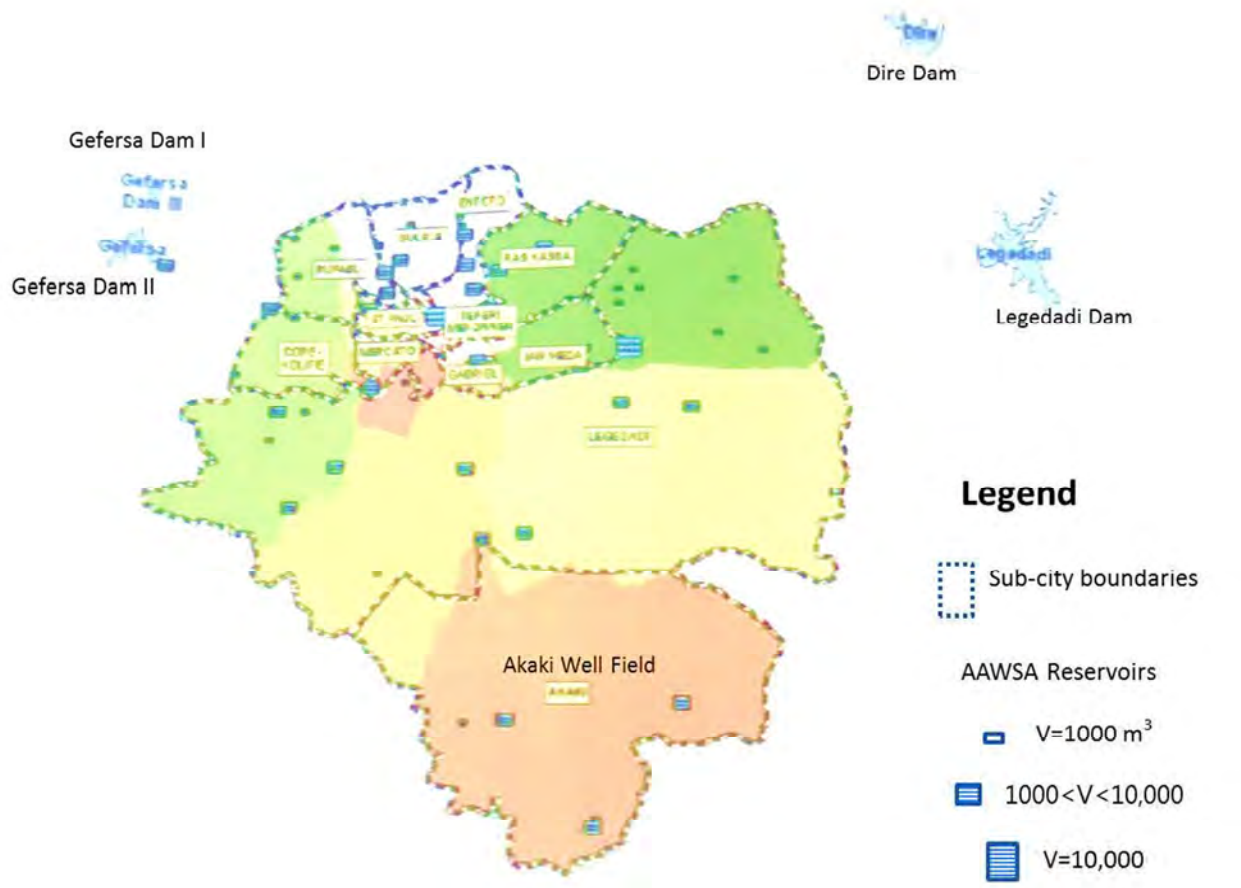


Figure 4-1 AAWSA distribution net-work sub-system areas (Source: Consultancy Service for Non-Revenue- Water Reduction, Draft Project Report)

Year	Unit	2005	2006	2007	2008	2009	2010
Legedadi	m^3/day	156,389	163,053	164,489	164,966	165,264	165,000
	10^3 m^3/year	57,082	59,514	60,038	60,213	60,321	60,225
Gefersa	m^3/day	22,782	22,297	23,197	20,596	28,959	30,000
	10^3 m^3/year	8,316	8,138	8,467	7,518	10,570	10,950
Akaki wells	m^3/day	35,452	36,612	41,035	46,088	46,088	43,000
	10^3 m^3/year	12,940	13,364	14,978	16,822	16,822	15,965
City springs & wells	m^3/day	4,757	5,052	7,658	10,433	28,249	62,000
	10^3 m^3/year	1,736	1,844	2,795	3,808	10,311	16,471
Deep wells	m^3/day	0	0	0	0	1,597	1,597
	10^3 m^3/year					583	583
Total Production	m^3/day	**219,380**	**227,014**	**236,380**	**242,083**	**270,157**	**301,597**
	10^3 m^3/year	**80,074**	**82,860**	**86,279**	**88,360**	**98,607**	**103,923**

Table 4-1 Water Sources and Production for Addis Ababa (Source: AAWSA business plan document 2010-2020 (AAWSA, 2011))

4.2.4 Water consumption trends in Addis Ababa

The current total daily production of water is estimated to be 301,597m3/day. Out of the total production 65% is from the surface water sources and the remaining 35% is from ground water. Nearly half of the billed volume is consumed by non-domestic customers. The existing water supply coverage is estimated at 81% with a supply of an average of 37 l/c/day for domestic customers.

About 86.8% of the water connections are domestic connection serving the domestic consumers, 0.5% of the connections are public taps for domestic consumers of low income and 12.7% of the connections are nondomestic connections serving non-domestic consumers. The total number of connections has exhibited an increment of 96,140 since the end of 2005 to end of 2010 within 5 years, indicating an annual growth rate of 8.3%. The increase in domestic connection contributed about 96.1% of the total increment. Growth in domestic connections has been particularly high in branches serving the outskirts of the city where new housing developments are being constructed, and more stable in the center of the city.

According to the (CSA, 2007) statistical document and AAWSA records, there are five major modes of services for domestic water consumers that correspond to five costumer categories. These are: High House connections (HC)

Medium House connections Shared (HC)
Low 1 Yard connections (YCP) Private
Low 2 Yard connections (YCS) Shared
Low 3 Public Fountains (PF)

The Addis Ababa Water & Sewerage Authority has established water supply flow rate criteria per capita per day. The domestic water demand for new housing developments is considered under the category House connections so AAWSA is utilizing 110 l/c/day including losses as standard to satisfy the needs of its customers. 110l/c/day is estimated to be the quantity of water required and designed of the water supply components of new developments. Accordingly, it has been assumed that about 80% of the water actually provided to the users within house sanitary facilities will be discharged into the sewers. According to the water demand estimation, which has been decided to be 110 lit/c/d, the average wastewater flow will be 80% of this value, i.e 88 lit/c.d.

Customer Category	Per Capita Consumption (l/c/day)			Annual Increment
	2011	2015	2020	
High	165	170	0.50	165
Medium	115	120	0.50	115
Low 1	50	60	1.00	50
Low 2	30	40	1.00	30
Low 3	20	20	-	20

Table 4-2 Projected per-capita demand by customer category (Source: AAWSA business plan 2011-2020)

4.2.5 Rapid urbanization and its effect on water supply in Addis Ababa

Addis Ababa is the fastest urbanizing city in Ethiopia and the majority of construction and developmental works are been carried out here compared to the rest urban areas of the country. According to the AAWSA business plan document, this results in the increase of marginal costs of additional water supply while available financial resources are becoming comparatively scarce. Even if the number of domestic and non-domestic users of water has increased through individual connection, the average billed volume for domestic customers has decreased over the five year period from 2005 to 2010 by 1.2%. Over the same period, average billed consumption for non-domestic connections has remained roughly constant and average consumption per public tap has grown slightly (1.1%). The main reason for the decline in the average billed volume per connection is that the increase in connections has not been supported with a proportional increase in supply.

> *"the annual growth of domestic connections over the five year period was 6%, production increased only 5% and billed volume only 4%"*

In order to solve the water shortage and to cope up with the increasing demand AAWSA has prepared a business plan document with the aim to be used as a road map for improving its services and transform it to more business oriented and efficient public utility. This plan was prepared from the year 2011-2020G.C. The water demand for the coming years is calculated with the assumption that the daily average consumption of water of an individual to be 110liters. This is because the present consumption figures in AAWSA's billing record cannot be the basis for demand projection since supply cannot mate demand at present.

AAWSA believed that in order to achieve the above supply the amount of water supplied should equally increase so the plans for this according to the business plan document are short term and long term. For the selected alternative the required investment for water supply improvement for the entire planning period will be 6.7 Billion ETB.

- The planned and being implemented water source development projects for the short term are (1) Legedadi Treatment Plant Expansion Project and (2) Ground Water Development Projects.
- The medium term source development program is aimed at development of surface water from Gerbi Dam.
- Further the plan envisages NRW reduction and control and Operation Improvement programs.

4.2.6 Existing waste water management system

According to the 2007 census about 80% of the housing units in the city use private or shared onsite disposal sanitation facilities. Only 6 to 7% of the housing units enjoy the off-site disposal system and the remaining 13 to 14% of the housing units in the city do not have toilet facility at all. On-site sanitation facility users obtain sludge collection and disposal services mainly from AAWSA (67%) and private operators. The off-site disposal system has limited sewer network coverage and a conventional wastewater treatment plant serving only some parts of Kality catchment specifically Bole, Ledeta, Old Airport, Central part of the City, Mekanisa and Kera areas.

Based on the Wastewater Master Plan document of the city and the recently compiled road map of sewerage services, AAWSA has set a target to reach a universal coverage of overall sanitation services by year 2020 through a combination of off-site and on-site disposal systems. The off-site disposal system which utilizes conventional sewerage system will increase to 50% and the on-site disposal system receiving sludge collection and disposal services will decreases to 50%. And the required investment for wastewater service improvement for the entire planning period will be 6.03 Billion ETB.

4.2.7 Existing storm water management system

The common trend in the city, storm water is managed in a way after finding the natural drainage pattern of a site by sheet flows with few active gullies or waterways that mainly originate from within an area ditches will be constructed to connect the water to a natural water source. The flow direction will be determined and will be looked for making a way to a closest streams or rivers.

4.2.8 Financial management

Sources of revenue for AAWSA are revenue from sales of water, meter rent, connection and reconnection costs, sales of material, technical service charges, other operation income, sewerage charges, sewer connections, sludge collection and related activities. The existing situation regarding the financial management of water of AAWSA's large investment requirements in the last couple of years its own contribution to major investment was limited.

Its major investments budget has been covered by the government and through loan. AAWSA has been highly dependent from the City Administration to cover major expenditures particularly capital expenditures. In its new business plan AAWSA is committed to cover 25% of its capital requirement from its revenue. Further, it has targeted to take soft loan and repay the loans from revenues. Gradually, AAWSA is attempting to reach full cost recovery.

4.2.9 Water pricing

Considering the various draw backs of the existing tariff, AAWSA revised the existing tariff rates. Accordingly, a new tariff rate has been introduced in January 2011.The changes made in the Tariff rate include the following:

· Increasing the number of bands from the previous 3 to 7

· Domestic customers pay progressively the rates for each band of their consumption

· Non domestic users pay the tariff rate of the band on their total consumption.

This means if a non-domestic user consumes 50 m^3 it will pay at Birr 5.95/m3 for the whole consumption

		Birr/m3
Water		
Domestic	0 - 7 m3/month	1,75
	8 - 20 m3/month	2,60
	> 20 m3/month	3,25
Non domestic	General	3,25
Fountains		1,75
Sewerage		
Domestic	0 - 7 m3/month	-
	> 7 m3/month	0,55
Non domestic	General	0,55
Fountains		-
		Birr/month
Fixed fee	small meter	1,35

Table 4-3 Previous tariff rate

Water		
	Public Tap	1.75
1st Band	0-7 m^3	1.75
2nd Band	8-20 m^3	3.80
3rd Band	21-40 m^3	4.75
4th Band	41-100 m^3	5.95
5th Band	101-300 m^3	7.45
6th Band	301-500 m^3	9.30
7th Band	>501 m^3	11.60

Table 4-4 New tariff rate

The tariff rate for sewerage services has not been changed. The reasons for the tariff rate and policy change were the following:

· Previous tariff rate did not make adjustments to price escalations

· The tariff rate was not revised for a long period

· The previous tariff rate will not enable the full cost recovery as stated in the water policy

· The tariff rate structure was subsidizing not only low income families but section of the society that are able to pay and can afford the marginal cost of water

· AAWSA's borrowing capacity was highly compromised and potential borrowers and international financiers were advising AAWSA to make adjustments to the tariff rate
· AAWSA should be able to increase its share of capital investment

4.3 Ethiopian Integrated Housing Development Program (IHDP)

The IHDP is a recent and widely practiced housing development in Ethiopia. The aim of this program, as the name implies is an integrated approach to solve housing problems especially for low and middle income urban dwellers, to eradicate slum areas and to create jobs through a housing development. Most of the inner parts of major urban areas of Ethiopia are occupied by housing in a very poor condition and very poor basic infrastructural provision. The history of these areas especially for the capital city Addis Ababa dates back to the first half of the twentieth century.

Due to the long years of inhabitation of these areas and there unplanned and informal growth led to the dilapidation of the housing and becoming less suitable places to live. The majority of people in this area use shared toilets and kitchen which are below standard and in a poor hygienic condition. And the houses are usually have very small spaces lived by a number of people without proper ventilation and natural lighting. So in order to bring better and decent housing for these inner city slum dwellers and together with solving the increasing housing demand, the IHDP came to practice since 2005GC.

4.3.2 Socio-economic and physical conditions

The design proposals for IHDP were based on the logic that because the houses themselves could not be of such fine quality because of the low-cost nature of the project, ample outdoor green space had to be accommodated onsite to make residents feel proud of their surroundings and 'remove the stigma of housing for the poor'. They attempted to address the inevitable difficult cultural transition of some occupants in moving from low-rise buildings to high-rise buildings through providing a well-designed neighborhood, provision of communal buildings, and a strong connection to land.

Densification is the driving concept behind condominium housing. The IHDP believes that is generally more expensive to create lateral development than vertical development so high-rise housing should be encouraged, especially in valuable inner-city locations. At present already constructed and occupied condominium blocks range from ground floor plus four to twelve story. Due to the high rise nature of condominiums the recently constructed ground plus seven and above ones are being built with water reservoirs to help serve the top floor inhabitants with water. But all ground plus four condominiums are built and being without these water reservoirs.

There are four unit typologies incorporated into each condominium block: a studio, 1-bedroom, 2-bedroom, and 3-bedroom unit types. Each unit includes a bathroom, which includes a shower, flush-toilet, and basin, and a separate kitchen. Each unit has water, sewerage, and electricity connections. Typically 40 per cent of units are 1-bedroom as statistics have shown that the balance between floor-area and purchasing price of a 1-bedroom unit is the most popular amongst condominium-applicants. The unit types are distributed evenly across each story, rather than each story having only one type to encourage a mix of income groups (UN-HABITAT, 2011b).

Among all the typologies the studio types are the most subsidized by the government in order to decrease the cost of the unit for the low income people as the studio and one bed room types were calculated to be affordable for them. And most likely the two and three bedroom types for the middle income groups of the society.

4.3.5 Design process and basic infrastructural provision for IHDP project sites

Initial site investigations are based on the 1997 Addis Ababa master plan, where potential sites are considered in terms of providing suitable settings for the construction of new buildings and analysis of the existing green- and brown-field sites. Consultants are hired to conduct a series of detailed studies on the area including the carrying capacity of the site; the local environmental aspects; the existing water supply and access roads; any existing pollutants and their potential relocation; the community's desire for condominiums; and the physical and economic frameworks that exist. Consultants also look at the impact a large-scale residential development would have on the existing social structure of the area. If the studies conclude the site is suitable for condominium development, a request is forwarded to the Land Board, headed by the Mayor of Addis Ababa, to secure the land for a condominium project.

Since this program is meant to be affordable for low and middle income households, the government has put a lot of subsidy in terms providing lease free land, free provision of infrastructures like road, water and electric supply lines. The housing development agency starts working with these authorities at the first stages of the works which is site selection. There are usually discussions about the accessibility of the new proposed site and availability of water and electric power and the amount of work and budget required.

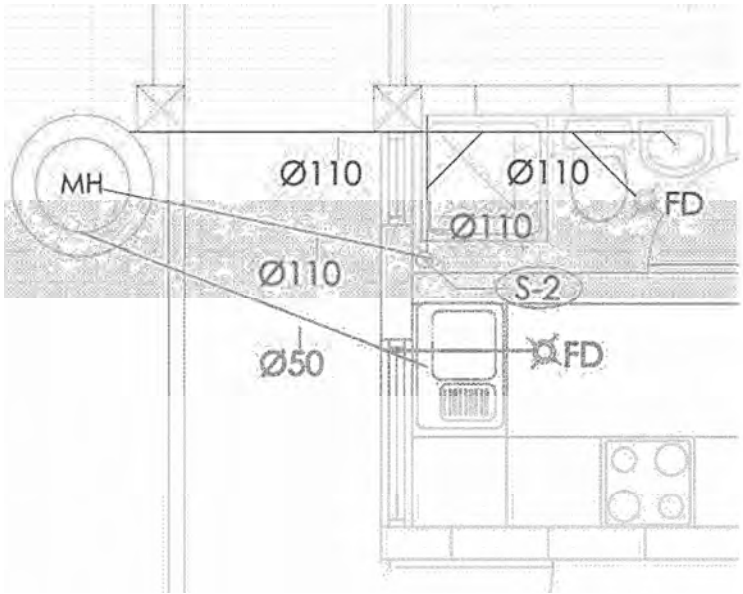
4.3.6 Water and sewerage design works for IHDP

The water design and decisions related to water in condominiums has three phases. The first one is during the site selection stage where AAWSA approves or disapproves the selection based on the water availability for the expected population coming to the area. After the approval, consultants will be hired for the neighborhood design that is for the layout of the blocks, communal buildings, and open spaces on the site since the housing block designs are

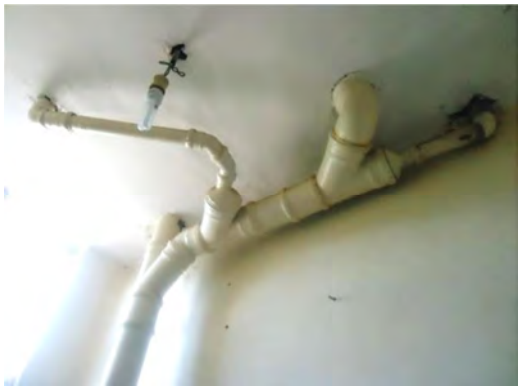
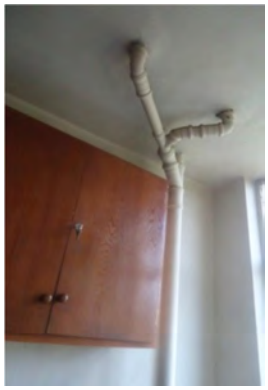
largely set (in terms of unit types, number of story, etc.). After this stage a firm working on water and sewerage consultancy will be hired in order to do the layout of water supply, sewerage line and storm water drainage lines. This is also done at the neighborhood level because the building level design is already done or it is a kind of standard for this design. The third level is based on this layout AAWSA will be responsible for the construction of the water, sewerage and storm water lines up to or away from the housing units. And also the administration of these lines will continue to be AAWSA's from this time on.

Every unit in a condominium has its water meter found at the door steps. And this water is distributed in the unit typically in the toilets and kitchens but most people add additional water points in order to have more flexible use.

Figure 4-2 Typical water supply system in a condominium typology



Waste water is collected both from kitchen and toilet from every typical level and directed to the manhole or the main sewerage line without any separation based on the type and quality of the waste.


Toilet Kitchen Sewerage pipe from the two sources

Figure 4-3 Typical sewerage system and design for a typical condominium building

4.4 Description of Gofa-Mebrathail Condominium Site

This case area is located in Addis Ababa to the Southern part of the city. The total area of the site is close to 3.9hectars. The highest and lowest points within the neighborhood have a slope difference of around 38ms. The part of the land that the condominium is built now, used to be part of the Gofa military camp. The construction of the site took place from 2007-2009 and it has been six years after the first occupation. At the moment a fence is separating these two compounds but there is a proposed road going in between them as can be seen on the neighborhood plan.

Mebrathail condominium and the Gottera condominiums were the first attempt to build large scale condominium housing construction after the pilot projects in Gerji. There are about 5000 housing units in 180 blocks with an expected population of 25000. There are six typologies of housing blocks with units ranging from studios up to three bed rooms. The neighborhood has different amenities planned like a kindergarten, a health center, a youth center and ten constructed communal buildings found at different places. And some land is also allocated for lease. According to the commute office for the condominium the proportion of renters living in this area is slightly greater than the owners and there are also some unoccupied units in some blocks.

The site is crossed by a small gorge which joins a river at the end of the site which starts from Entoto Mountain and ends in the Akaki River. There is continues urban agriculture following this river and the biggest cultivated land is found near this condominium site at its south end. The products from this farm land are sold to different markets in the city. The condominium is also one consumer of this urban agriculture where the products are sold along the two entrances of the site. Since the last two years the condominium is being troubled with shortage of water which is now even getting very serious. And water is being delivered to the inhabitants based on a program operated by AAWSA branch office at Gottera.

Figure 4-4 Google earth map showing the location of Gofa/Mebrathail condominium

Figure 4-0.5 Site situation before construction of the condominiums in 2003G.C and after occupation in 2015

Figure 4-6 2003(Before construction) **2008(During Construction)**

2011(After Occupation)

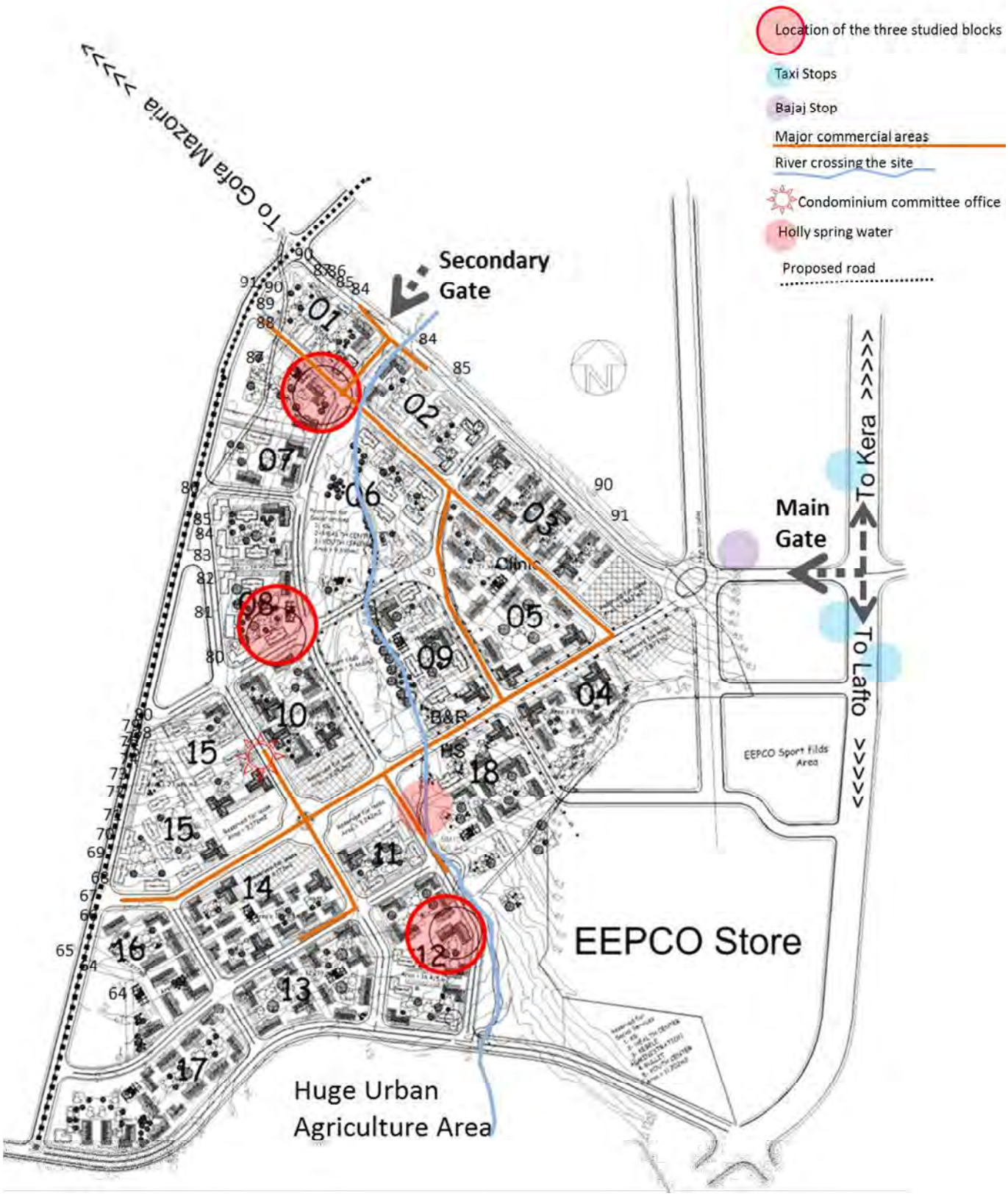


Figure 4-7 Neighborhood map of Gofa/Mebrathail condominium

4.5 Pre-design and design considerations of water management in Gofa-Mebrathail condominium neighborhood

4.5.1 Source of water to the site

The only water source to the site is AAWSA's water through the connection to the reservoir found at Gottera. This reservoir has a total storage capacity of 10,000$m^{3.}$ The water to this reservoir comes from Akaki well field and Legedadi dam from the east side of Addis Ababa. At the Gottera reservoir the water from the two sources meet and pumped to the areas which get water from this source places like Dembel, Meshualekiya, Kera, Lafto, Mekanisa including the case area.

The pipeline going to Mebrathail condominium is extended from the primary line pipe with a diameter of 150mm. But along the way there are some neighborhoods which get water from this pipe. But now it is in plan to separate the condominium's pipe from other users in a 150mm pipe which is the maximum diameter of pipe that AAWSA uses to transport water. This is to resolve the water shortage problem in the condominium.

People in this area are getting water based on a program prepared by AAWSA's branch office at Gottera. According to the expert Ato Mekuria who is responsible for the administration of the water program in the condominium, the reason for the programed water supply is because there is a big shortage of water at the source and in general in Addis Ababa, due to repeated power cut the pumps are unable to pump water effectively, and specific to the condominium site, there are also other houses who are connected to the condominium water source which affect the amount of water going to the condominium. So for the moment they chose to deliver water based on a program and in the near future they are thinking to separate the condominium's pipe line from the rest of the houses on the way and on the long run AAWSA is digging additional well in Akaki well field and the up grading of Legedadi dam which he said will resolve the water shortage of the whole city not only this condominium.

So based on the program water will be available for three days straight and disrupted for another three days straight. That means people are getting water only three and half days per week. And this situation is different and will be worse in dry seasons and there could be more than six-seven days disruption of water in the area according to the information I get from the residents. This programing is done by opening and closing of the different distribution taps found at different points found within the neighborhood. The original purpose of these taps was to be access points in order to close the line whenever maintenance is needed or pipes are broken. This taps are not visible for the public eye but someone with the information can easily access and could manipulate the water program because these taps have no locking

mechanisms. But the expert said they are thinking to prepare locks as they are becoming to be aware of such acts could happen. Even this taps do not have a water meter attached to it which could easily tell and help to collect data of the amount of water the condominium is using per day or per month.

Due to the program the people in the area are forced to store water in different containers whenever water is available and buy water from the immediate neighborhood where the pipe is different from the condominium or other places with water and for their drinking consumption people buy plastic bottled water from the shops around but not all the people. People usually buy water for 1-2birrs with the 25liters yellow water container which was originally a palm oil container and they pay 8-10birrs for a person to carry it home.

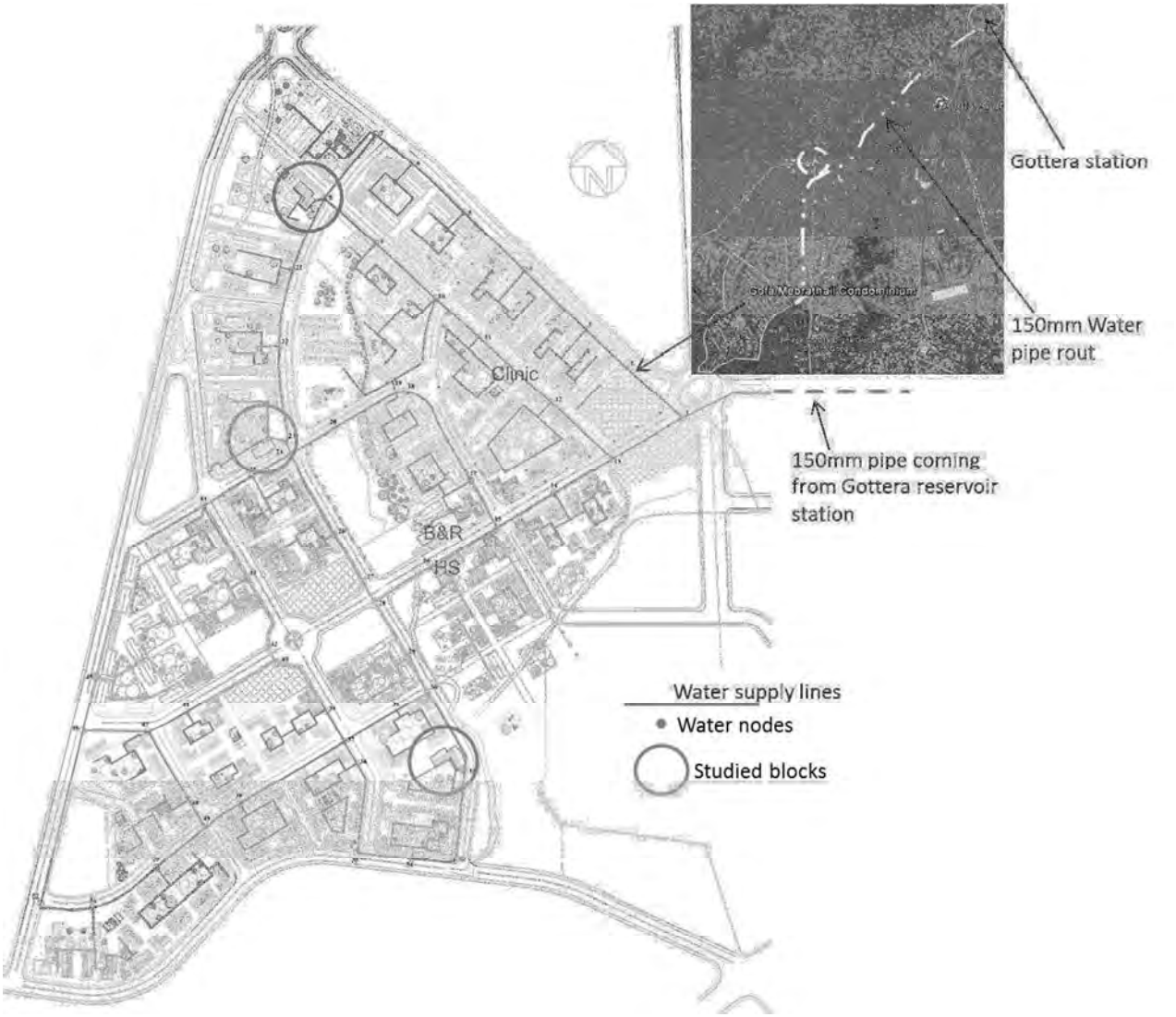


Figure 4-8 External water supply system of Gofa/Mebrathail condominium

4.5.2 Design considerations for the external water supply system for the site

Population projection

In the case of urban water, it is the supply to the inhabitants of a command area the quantities they need and could afford to pay for. Therefore, a study of the population size, its development and distribution over the area is necessary. There are 180 blocks in the site with six kinds of typologies with varying number of housing units which ranges from 20-40 per block. According to this calculation the total number of housing units found in the neighborhood is 5265. There is also around 13,211m^2 of land allocated for lease which is still not occupied so assuming it for housing purpose 250m^2 per person there will be more 53houses. Which make the total housing 5318. And based on the 2007's population censes the average number of people per family in Ethiopia is 5 people so the total number of people expected to live in the area is around 26590.

Water Demand

Water demand projections are estimated for the water supply system based on population projections and per capita water demand. The following factors are taken into consideration when evaluating projected water demand:

- Increased demand due to population growth
- Increased demand due to higher level of consumption
- Other demands for commercial, institutional and public purpose
- Losses of water due to leakage and unauthorized use

Two types of variation in water demand are of interest in the planned and design of a pipe-borne water supply. These are the seasonal peak daily demand, which is used for sizing water source capacities, treatment plants, pumping and transmission facilities, and maximum hourly demand, which is used for sizing distribution pipelines.

Domestic Water Demand

The domestic water demand has been considered under the category house connections. AAWSA is utilizing 110 l/c/day including losses as standard to satisfy the needs of its customers. 110 l/c/day was estimated to be the quantity of water required and designed of the water supply components.

a. Institutional and Commercial Demand

This relates to the water demand of facilities such as schools, hospitals, hotels etc. and small commercial enterprises and also public demand where appropriate. Identified commercial and

institutional centers found from the neighborhood plan and personal site assessment done to count the existing commercial units. Since there are no large scale industries planned or expected to come in this area so there will not be any industrial water demand.

Description	Number of institutions	Population	Unit water requirement	Water Demand
Kindergarten	1	90	5 l/pupil	450
Youth center	1	700	5 l/pupil	3500
Commercial unit	244	244	0.5 l/day	122
			Total water demand	4072 l/day

Table 4-5 Institutional and commercial water demand

b. **Fire fighting and Emergency Demands**

Water demand for firefighting purpose is assessed depending on the existence of equipment and the capacity of any firefighting service. Fire hydrants will be installed at public and municipality interest such as schools, shops, hospitals, fuel stations and at salient points of distribution network. This demand is taken off by increasing the volume of the storage tanks by 10%.

c. Unaccounted for (Non-Revenue) Water

Non-revenue water is expressed as a percentage of the total water produced for the system. Depending on the age of materials and the office capacities, a value in the range of 20-30% will be considered. This component is already considered with domestic demand. Therefore, the average unit water requirement for all purpose for the site is 111 l/c/day. Accordingly the daily water demand or water requirement at the distribution head at the condominium site water supply system is:

5318*111 l/c/day + 4072 = 590298 l/day + 4072 l/day = 594370 l/day = 594.370 m^3/day

So the total expected amount of water to come to the neighborhood is therefore **594.370 m^3/day.**

4.5.3 Waste water management system

AAWSA has established water supply flow rate criteria per capita per day. Accordingly, it has been assumed that about 80% of the water actually provided to users within house sanitary facilities will be discharged into the sewers. According to the water estimation of the project, which has been decided to be 111 l/c/day for this design the average water flow will be 80% of this value i.e 88 l/c/day. And due to the site's proximity to the already constructed sewerage system passing through Kera, the sewerage system was simply connected to the system. The conventional wastewater treatment plant serves only some parts of the city at Kality catchment

specifically Bole, Ledeta, Old Airport, Central part of the City, Mekanisa and Kera areas (AAWSA, 2011).

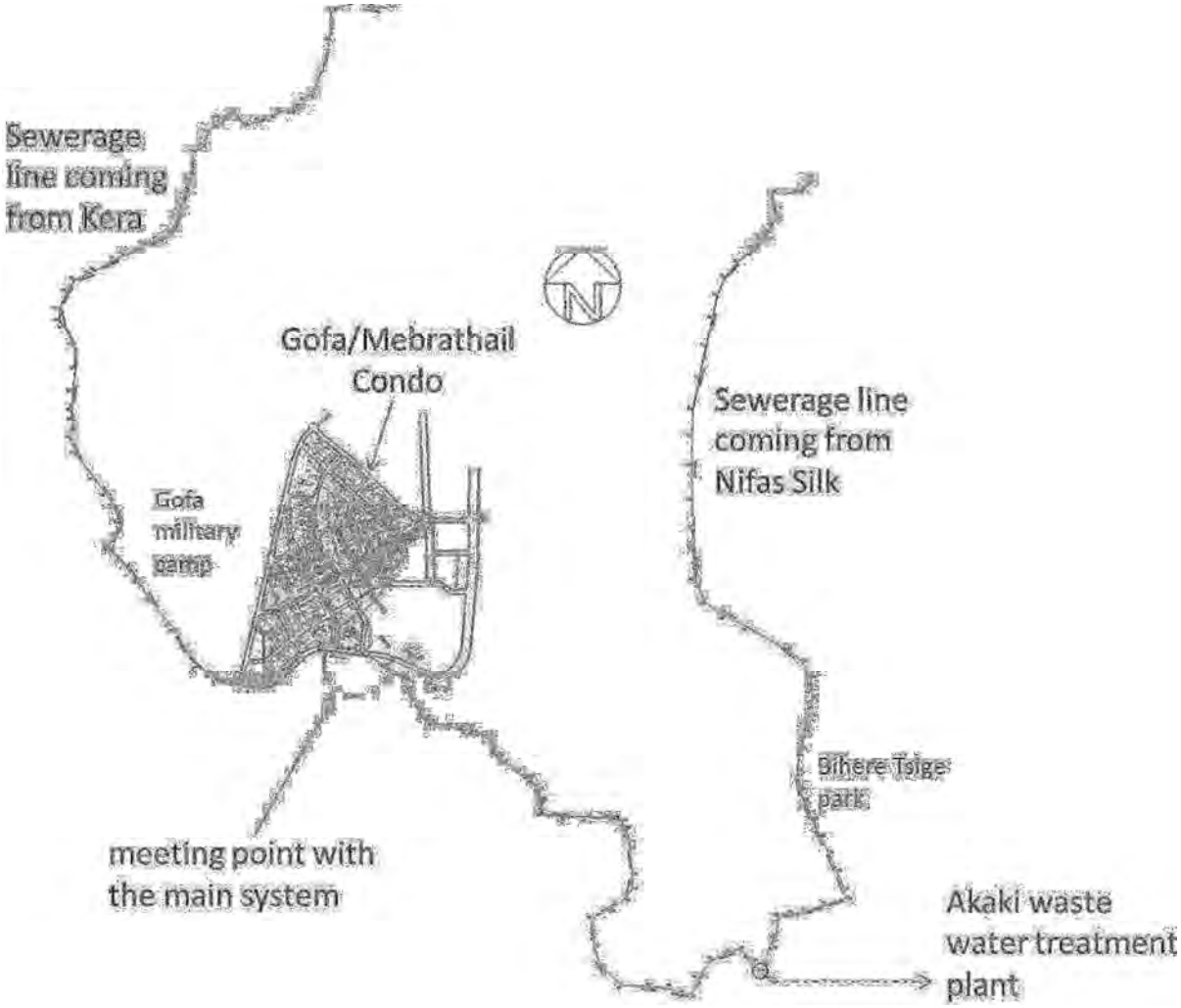


Figure 4-9 the existing centralized sewerage system

4.5.4 Storm water drainage system

Storm water is the result of rain or precipitation which comes in excess of evaporation, infiltration/ percolation, and depression storage. It is part of the natural hydrologic process that must properly be controlled, which otherwise storm water runoff can result in moisture and flooding problems.

After finding the natural drainage pattern of the site by sheet flows with few active gullies or waterways that mainly originate from within the site, the flow direction was determined and was looked for making a way to a closest streams or rivers. So the most important thing for this

study was finding out how storm water is treated or designed in cities or in housing developments. So like it was explained earlier storm water is collected in a separate drainage line and directed to rivers and streams. In this site such thing would probably happen as there is also a river crossing the neighborhood. This river is also a water source for the very big urban agriculture going on in close proximity following this river.

4.6 Household Water Management in Gofa-Mebrathail Condominium Neighborhood

4.6.1 Life Story Presentations

Block 90 description

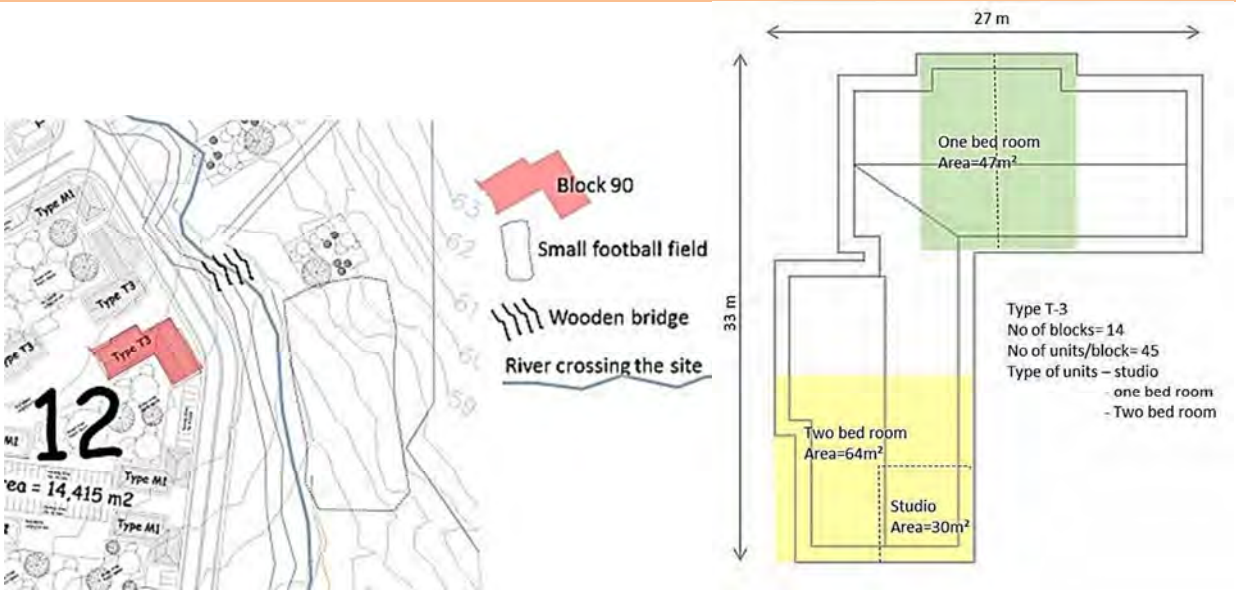


Figure 4-10 Location and layout of block 90

Block 90 is T-3 typology which is an L-shaped block. It is located in the lower level area on the neighborhood. It has a total of 45housing units on five floors from ground up to fourth floor. Out of the 45units, 20 are two bed room types, 10 are one bed room units and the remaining 15 are studios. The building faces on one side to the river crossing the neighborhood going parallel with the street and the ELPA compound and to this side there is a very small irregular field where young boys usually go to play football. And on the other side is the common open space which was not very well maintained which is used to place satellite dishes and hanging clothes. Recently it was covered by a coble stone and became a favorable place for parking.

I used to live in this block for about a year and am familiar with the place. Due to this I have managed to talk to different people with different housing units and living on different floor levels. Here the story of five families is presented in which three of them are from the first floor and two of them are from the third floor.

First Floor

Case Story 1: Wro Tsige

General Description

When I started collecting data on this block what I did first was taking pictures of people's houses without the interview. So after I took pictures of one Wro Tsige's house we agreed to make the interview the next day. Unfortunately the next morning she changed her mind because her children forbidden her not to do so; and they were not there at the moment. But I don't want to give up on her story because this case was very important for my study, as this family looks like they are low income group and are living in the smallest studio type which they own. And my pictures of the interior space encouraged me to ask more about their situation regarding water and its shortage and how they are handling it. It is also difficult to find in this neighborhood people who are low income who own a studio and live in it. Because there is a big trend in this area to rent out or sell houses by very low income people. So I decided to ask her close neighbor about Tsige's story. Off course it is not going to be exclusive but what I got was very important for my study.

This woman used to be my neighbor. I used to live on the other end of the L-shaped block from the lady's house. She looks like she is in the end of her fifty's.Tsige used to live around Aware. Due to redevelopment she was relocated to Arat Kilo area by applying for replacement Kebele house because she didn't have the money to pay for a new condominium unit. Unfortunately she did not live long in Arat Killo also, due to again a redevelopment of this area she had to move again. So this time she applied for a one bedroom unit and sold it out in an exchange for a studio which she is living in now. Now it is being three years since she started living here.

Spatial Description

The area of her house is around 25m^2 on the first floor. There are five people living in the house now; herself, three of her children and her grandson. After they moved in they have transformed the house in order to fit into it. The studios in this condominium site even if they vary in size, all are single rooms with a toilet and on one corner of the studio there is a dish washing sink with its own water point and drainage line. So Tsige and her family removed this washing sink and freed the space to make the living area of the house and they divided the room in to two with a wooden board where the other part is used as a sleeping and cooking space. They use the toilet beside its original purpose as storage for unwanted goods, water container, fire wood and to wash dishes.

Water Profile

Tsige's income depends on her children. She usually pays around thirty birr per month for her water bills. She has pieces of storage containers (not big ones) in her house where she put them

on several places in her house including in the toilet and the sleeping area under the bed and passage ways. With these containers she can store roughly around 200-300liters (calculated by adding the containing capacity of the containers from the pictures I took). According to her neighbor Tsige doesn't usually buy water and usually manages to stay the three days when water is absent. But ones in while when they run out of water Tsige buys from outside the condominium building for two birr per 25liters where her daughter around her early twenties carries to bring home and sometimes for smaller containers she usually go to fetch it herself with her grandson Mikiyas who is around eight years old.

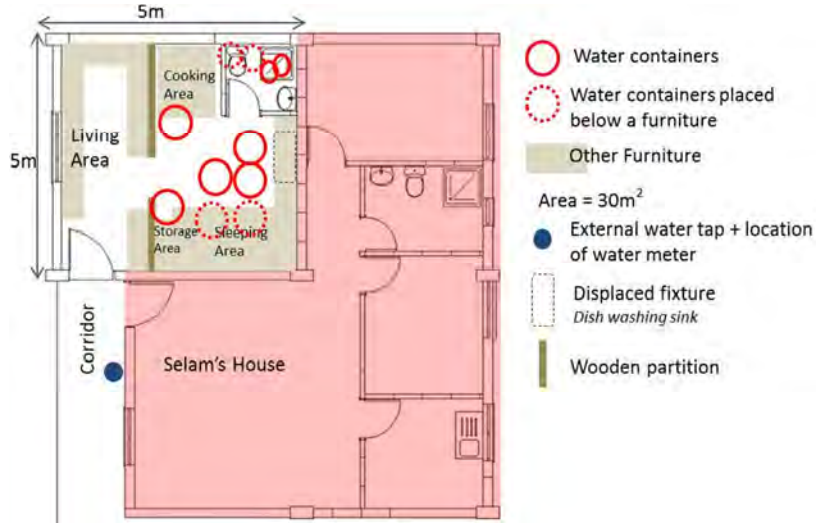


Figure 4-11 Layout of Tsige's house in relation to the different water storage space

Figure 4-12 Tsige's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Tsige	Kebele	60	Studio	30	5	90	Owner	1st

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ Month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
3	3	3	-	30	200-300	-	-	-	-

Table 4-6 Summary of Tsige's water profile

Case Story 2: Wro Menbere

General Description

Wro Menbere used to be my immediate neighbor living inside a one bedroom unit. She lives with her husband, her two little sons aged three and five and a maid. Menbere is self-employed and runs her own accountant office in Merkato. She bought this house from the owner four years ago. They used to live by renting a one bedroom condominium unit around Abinet. She said she was feeling very terrified by the rental market for housing and renters when she decided to by her own house.

Spatial Description

Her one bed room unit now is an over-furnished and clean house with an area of $47m^{2.}$ All the family uses the bedroom for sleeping and the maid sleeps in the living room on the couch. Menbere is happy to own a house but she is not satisfied with the size of the rooms in the house. Especially the kitchen is very small and sometimes they use the corridor for cooking and washing dishes and store their charcoal sac. Much of the place in the kitchen is used up by water containers one placed on top of the other. Even if they are able to store more water to find space to put the containers is another challenge they are facing. And she said she is thinking to put her new container on the corridor with the worry that she will take the shared spaces and with a fear that people might take her water and pollute it as well. During my visit to the block after a month she actually puts the big blue container on the corridor. But since she was not in her home by that time I couldn't ask her about how it was going.

Water Profile

She has also two big water containers with a capacity of 300 and 400 liters placed inside the toilet. As can be seen in the pictures it will make difficult to use the toilet properly. With all this storage materials they can store up to 1000liters inside their houses. And with this amount Menbere said they will last up to maximum four days. She said this achievement happened recently because a friend of her brought her a bigger container which can contain 400 liters. Otherwise they used to last only two days. They usually wash cloth when there is water (directly from the pipe). The biggest amount of water from their stored volume is used to flush the toilet, to clean the toilet and for washing dishes. And they add a lot of water to the toilet to ease the bad smell coming out. And this smell comes not only form the toilet she said, it also comes from the different holes in the house like from the shower tray, the hand washing basin, the kitchen sink and the floor drains of both the toilet and the kitchen. So they usually put covers on top of these holes to private the bad smell. And she said this will get worse during the absence of water because not everybody use more water to flash the toilets. They usually pay around fifty birr per month for water. She said the amount paid is not much compared to the importance water has for them. But its shortage and lack of storing space are making their life difficult living in the condominium. She said this area is much better compared to her previous condominium house in Abinet. She said they used to get water ones in a week or less.

After they started living in this house they changed the different pipes in the house several time and spent more than one thousand birr. Especially the toilet flush which they change for the third time is not working properly and the linkage is visible when there is water. She said she is thinking to replace it but it was difficult to find the right material even if she was paying a lot of money. She said she bought the last one with 250birr. Other than the toilet flash all the other pipes are working properly and even they have a hot shower which they enjoy when there is water. She has also a water filtration and her family doesn't drink direct pipe water in fear of water borne diseases. This equipment also acts as water storage for drinking.

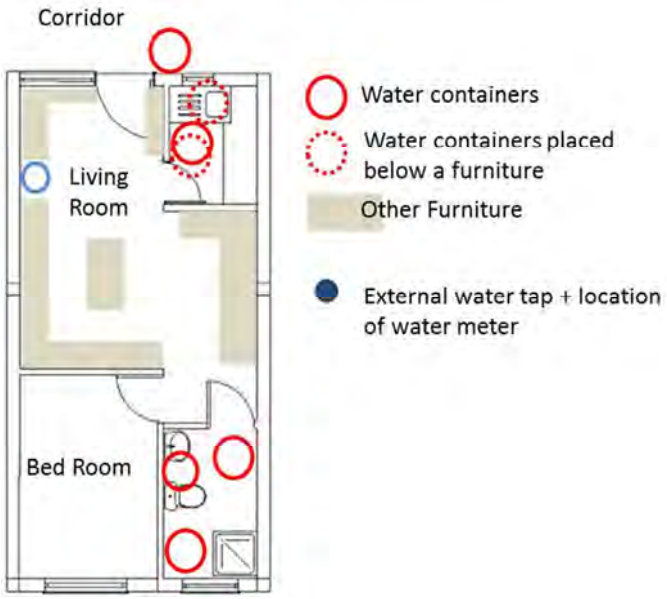


Figure 4-0.13 Layout of Menbere's house in relation to the different water storage space

Figure 4-14 Menbere's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Menbere	Condominium renter	38	1 bed room	47	5	90	Owner	1st

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ Month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
4	3	3	50	50	1000	5	50	10	No

Table 4-7 Summary of Menbere's water profile

Case Story 3: Wro Selam

General Description

Wro Selam is a woman in her last thirties of age. She lives next to Tsige. Her house is a two bedroom unit where she rented and lived here for more than four years. Before she moved here she used to live renting a house on the ground in a compound around Lafto. She lives here with her husband, her daughter who is around four years, her mother and a maid.

Spatial Description

The house feels very open and lightly furnished and has an area of around 64m^2. This unit is one of the biggest two bed room unit in this neighborhood. She said even if our house is big we have big problem of getting enough storing place for our containers. They are using the passage way, the kitchen, the toilet and the bedrooms to put the containers in unappealing way.

Water Profile

Water was not a problem in this area when they started living in the beginning; they used to have it in abundance. Water became to be a problem since the last two years. All their containers added they can store around 800litres of water. She said for us it will last for a week if the water is not coming. We usually put the waste water from washing clothes to flash the toilet. Their previous house used to have two toilets, indoor and outdoor, and a water tanker so water shortage was not a problem. And the bigger container that they are storing water used to hold the different flour in the house used for food purpose. There is no leaking or broken pipes in the house but the sewerage pipe of the house on top licks to their kitchen. Even if it was maintained several times it is still a problem. She said also they had replaced some of the pipes which were fixed when they moved in because they were poor quality and they brock easily. And since the toilet flush doesn't work properly they closed the pipe and no more using it and they use containers to add water on the dirt. And they spend around five hundred birr in total for the maintenance of different water points in the house.

Selam suggested that it is becoming very difficult to live in condominium without water. She usually pays around thirty birr for her water bills and is more or less similar to what she used to pay in her previous house. And they are forced sometimes to buy plastic bottled water for drinking when they run out of water but as she uses the rest of the water economically it is not common for her to buy water for other purposes. And the appearance of water is different in dry and wet seasons. She said now is much better we have it based on our program but during

the dry season it was difficult especially for people living on the top floors as it took longer time to reach there. Or sometimes some people missed it as it is going to reach there after they went to sleep.

Figure 4-0.15 Layout of Selam's house in relation to the different water storage space

Figure 4-16 Selam's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Selam	Private house renter	38	Two bed room	64	5	90	renter	1st

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
>4	3	3	30	30	800	>7	23	0	No

Table 4-0-8 Summary of Selam's water profile

Third Floor

Case Story 4: Wro Sumeya

General Description

Wro Sumeya is a Somalian refugee who lived in Ethiopia for more than four years. She rented this two bed room unit which is a similar typology like Selam's house on the first floor. Before she moved to this house she used to live in a one bedroom unit in another block in this area. She is living with her four children, her husband and few relatives in total around ten people live in this house.

Spatial Description

When one enters the house it feels as if it is not being occupied. There is not much furniture in the house and you can easily see water containers placed freely inside the living room, on the passage ways, on top of a bed looking like thing without the mattress and inside the kitchen. All what are visible are the basic utensils for cooking, sleeping/sitting mat and a small wooden sit on one corner. But the house looks well done with the finishing materials.

Water Profile

In total they can roughly store 650 liters with the containers they have. She said they don't use the tap water for drinking and always buy plastic bottled water. And the water they stored usually lasts for two days because she said they use a lot of water to clean themselves before prayers and have a lot of people in the family. And whenever they run out of water they buy water from outside of the condominium building with ten birr per 25 liters and they usually spend up to 60 birr per day for buying water. It is been only two months since they moved in to this house and they said they did not pay the water bill so far but they are planning on paying. The different fixtures are well done in the house and there are no pipes liking or broken.

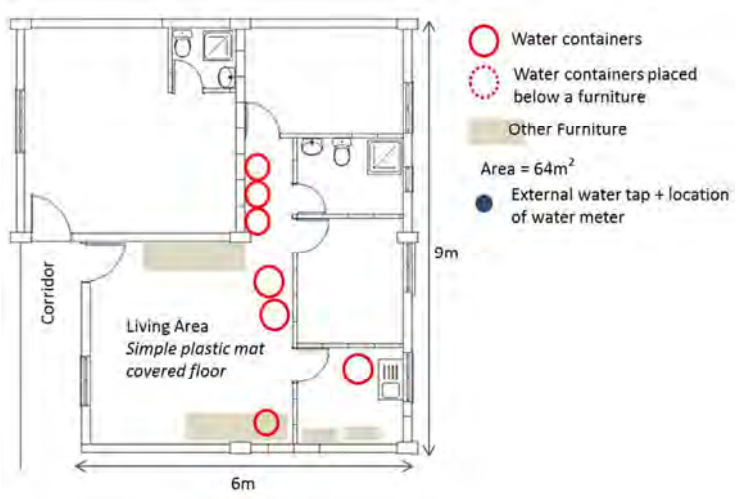


Figure 4-17 Layout of Sumeya's house in relation to the different water storage space

Figure 4-18 Sumeya's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Sumeya	Condominium house renter	>45	2 Bed room	64	10	90	renter	3rd

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
4	2	3	NA	NA	650	2	33	~1000	No

Table 4-9 Summary of Sumeya's water profile

Case 5: Wro Mulunesh

General Description

Wro Mulunesh is an old lady who is living with her four children in a one bed room unit. Wro Mulunesh owns the house and she got it through the lottery. She used to live in a Kebele house around Sebategna. Wro Mulunesh's elder son usually takes care of the green area around this block without expecting any help from people. And he uses his own water source to water the plants. Passing by this green area actually feels good. The other people's contribution is through the monthly collected ten birr from each house for cleaning the area.

Spatial Description

The arrangement of the rooms is similar to that of Menbere's on the first flour but mirrored. Her house is very neat and has a well-furnished living room. But the entrance to the house is occupied by different materials used for cooking and very small water container. Her children use the bedroom for sleeping and she sleeps on the couch. She said they use only the toilet to put different water containers and it is usually enough for them to stay the three days when water is not available.

Water Profile

Compared to the other house on this block they have the smallest amount of containers which store around 300liters and with a very clean toilet and still she is saying that it will last for three days. My suspicion is they could have more containers in her kitchen in which she was not willing to show it to me due to unknown reason. In her previous house she used to have a water tap of her own and used to share a pit latrine and a small compound with three more families. When she compared her condominium house with the previous one, she said here is much better than the previous because she has her own toilet and bigger space. The problem she is facing now is the lack of storage space for her different traditional kitchen utensils that she doesn't want to throw out. And in my previous house we didn't have many containers to store water because our toilet did not need water and water was almost always available. And even if when it is absent it would not be more than one day. And she said they used to have a public tap close by where they buy water for 50cents per twenty five liters. And she used to pay maximum of ten birr for her water bills. But now she usually pays 20-30 birr per month. Here her location on the third floor made it somehow difficult to easily access water but she said she usually managed not to waste water and usually clothes are washed when there is direct water from the tap. And there are no liking and broken pipes in the house. All the fixtures and pipes are those given with the house in the beginning. The only addition they do to the original pipe plan is adding a tap besides their water meter in order to make it easier to fetch water using different containers. This is a common trend in this area and in other condominiums because it is difficult to fetch water to fill containers or to extend plastic pipes from the rest of the pipes.

Figure 4-19 Muluneshi's water storage containers and the garden takinen care of by her son

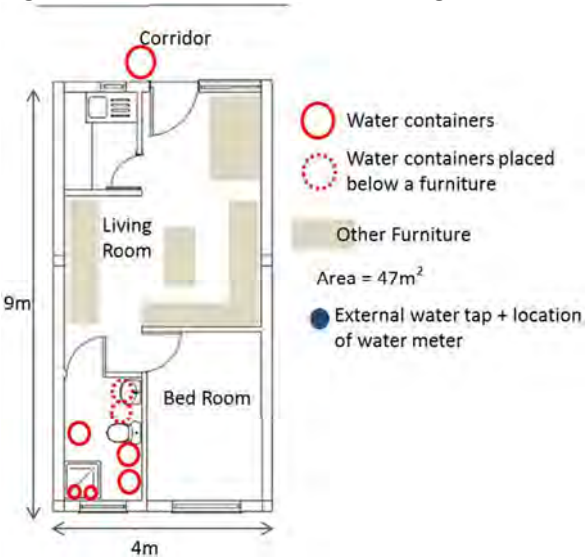


Figure 4-20 Layout of Mulunesh's house in relation to the different water storage space

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Mulunesh	Kebele	70	1 bed room	47	5	90	owner	3rd

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
>4	2	3	<10	20-30	300	3	20	0	No

Table 4-10 Summary of Mulunesh's water profile

Block 135 description

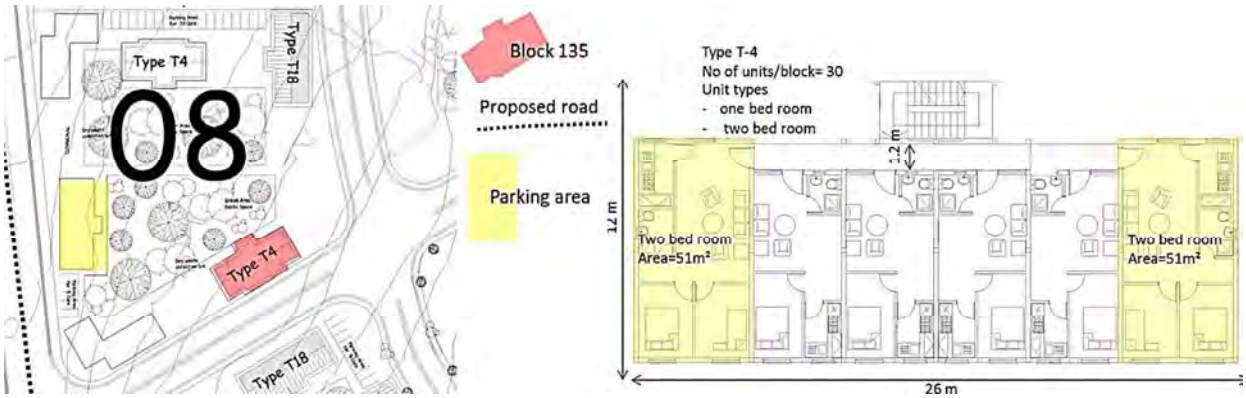


Figure 4-21 Location and layout of block 135

Block 135 is found around the intermediate slope of the compound. It is a T-4 typology which is a rectangular shaped building with a total of 30 housing units on five levels from ground up to the fourth floor. Ten of these units are two bed room units and the rest twenty are one bedroom units. The building face on the front side to a big open space where the access streets are covered with coble stone and amply green area which could be very interesting if well maintained. The cars in this area have their own separate open area for parking not mixed with the green. To the back is a small street the cars use to come to the parking and looks like it is going to join to a road on the proposed plan but which doesn't exist now.

The people I interviewed on this block are found on the third and ground levels. I know the woman living on the third floor and she was the one who introduced me to the others. Since I couldn't find willing people for the interview in a one bedroom unit all my informants are all living in a two bedroom unit.

Third Floor Residents

Case Story 6: Wro Yemisirach

General Description

Yemisirach is my husband's cousin who lives renting a two bedroom unit on the third floor of this block. The area of the unit is 60m^2. She lives with her younger son, a brother and a sister. It is been three years since they started living here through a rent. They used to rent a service area of a house inside privately owned compound around Gofa. They came to this area in search of bigger house because her sister was giving birth who is no more living now.

Spatial Description

Their previous house used to be two rooms where they used one as a sleeping area and one as a living room. They used to cook inside these rooms and sometimes on their door steps. And they used to share a water tap and a pit latrine with the owners and the other renters in the compound. Yemisirach likes a lot of things about this condominium house other than the smaller size of the kitchen and the repeated absence of water especially for them as they are located on the third floor. Since she has no bigger containers she uses every available container to store water. And she uses the corridor and the living room to put these containers.

Water Profile

In total she can store around four hundred liters. She said she never bought water from outside because she knows how to use water economically and the water she stored lasts until the water comes back after three days. Much of her stored water is used up by the toilet. She wasn't paying for water in her previous house because it is calculated together with the house rent which is common in most private houses where renting out their service areas. Here she is paying around thirty birr per month. Even if her income depends on her brother she said the amount is not much. Two times they even paid less than ten birr. She thinks that there is similar program in the compound now but one time she heard that there were places in the compound where water was never absent. And she heard people talking that someone or some people from these blocks gave money to the people working in AAWSA to have a continuous water supply.

And living on the third floor is becoming difficult for them because the water usually reaches their home at night but the people on the ground floor start getting early morning. So compared to the people downstairs they are missing a one day water supply every time. She said they are planning to buy a bigger container because the problem is going to get worse when the dry season comes. They don't have any broken or liking pipe in the house and they never changed any pipe.

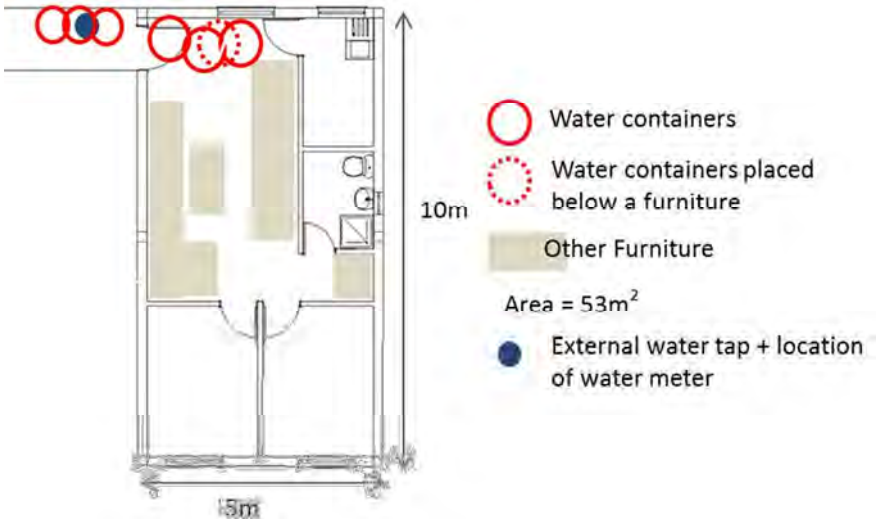


Figure 4-22 Layout of Yemisirach's house in relation to the different water storage space

Figure 4-23 Yemisirach's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Yemisirach	Private house renter	40	2 bed room	53	4	135	Renter	3rd

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
3	1	3	0	30	400	>3	33	0	No

Table 4-11 Summary of Yemisirach's water profile

Case Story 7: Wro Amina

General Description

Wro Amina is a young mom of two sons living with her husband in a two bedroom unit opposite to Yemisirach's house. Since her husband is a driver he spends most of the time outside of Addis. So as she doesn't have a job, she spends most of her time at home. She got this house through a lottery and used to live around Saris renting a single room service quarter in a private compound.

Spatial Description

Her house is furnished in a way most Muslims furnish their living rooms, a colorful mattress on the floor and well covered pillows placed along the three walls of the house. Amina said even if we have a big living room our kitchen is very tight to put our things and to work inside. She usually uses charcoal for cooking and works on the corridor. Her water containers are found inside the kitchen and the toilet.

Water Profile

She doesn't have many containers but two medium ones which can store around 300 liters. And she said it is enough for her for the three days without water. She said now they are getting water based on the program but before the water used to be absent for more than four days and sometimes she is forced to buy water from outside of the compound and she always carry it to bring home because she couldn't afford to pay eight birr for a person to carry. And they usually pay less than twenty birr for their water bills. She said not all the pipes in the house are working. They don't use the tap on the dish washing sink and the flash of the toilet. They use the stored water from a bucket to flush and to clean the dishes. She said they replaced the kitchen tap ones but never tried to repair the toilet flush. They just close the water coming to the toilet and they add water to the dirt using a container. This women as I heard it indirectly from Yemisrach, is planning to sell or rent out her house in order to buy or rent a smaller one because it is becoming difficult for her and her husband to pay the monthly payment to the bank.

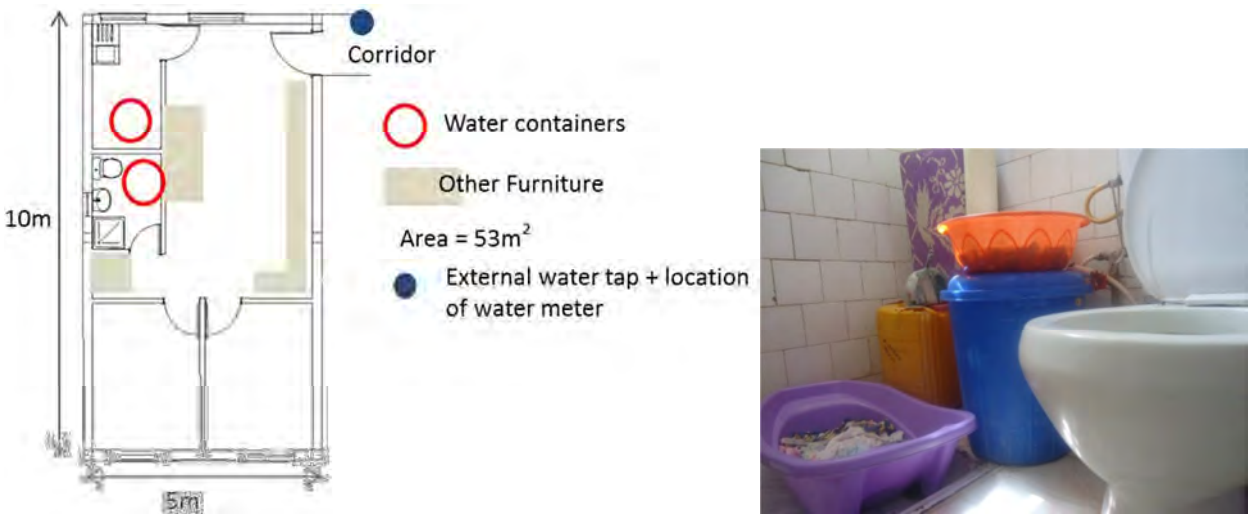


Figure 4-24 Layout of Amina's house in relation to the different water storage space

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Amina	Private house renter	32	2bed room	53	4	135	Owner	3rd

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
>4	1	30	0	<20	300	>3	25	15	No

Table 4-12 Summary of Amina's water profile

Ground Floor Residents

Case Story 8: Wro Guae

General Description

Wro Guae is an older lady who owns a two bedroom unit on the ground floor. Her livelihood depends on her children who are living together with her. In total five people are living in this house. She has been living here for more than four years now. She used to live renting two rooms around Shiro Meda area in a private compound. And she got this house through a lottery.

Spatial Description

Her living room looks over furnished and there are a lot different things both traditional and modern. They use the bedroom both as a sleeping place and storage for different materials. And put mattress on the living room whenever they have guests come. Even if they fix kitchen cabinets all the leftover spaces here is occupied by different water containers. They have also a washing machine placed on one corner of the corridor together with some water containers.

Water Profile

Compared to the other people living on the upper floors she doesn't have much problem regarding water. Her storage containers are found inside the kitchen and the toilet. With all the containers they can store more than 600liters of water which could last for them for more than three days. She said even if she wanted to use the rain water the way the gutter is constructed make it inaccessible to collect the water. Because she used to collect rain water in her previous house because it is good to clean clothes easily and it saves washing soap. She doesn't know exactly how much money they are paying for water here because her children are paying it. There is no liking or broken pipes in the house but the only water points which are working now are the shower and the tap which they extend beside the water meter on the entrance to the house. They changed most of the taps more than two times but now they gave up on it rather are using water from a bucket. In the previous house they used to share a tap, a kitchen and a toilet with the owners and water was not a problem as such. And they were not paying additional money for water.

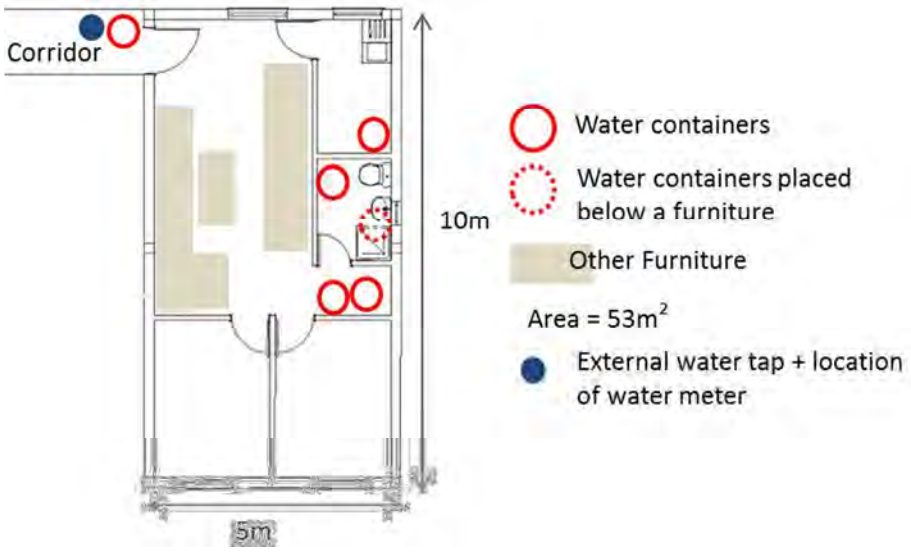


Figure 4-25 Layout of Guae's house in relation to the different water storage space

Figure 4-26 Guae's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Guae	Kebele	>70	2 bed room	53	5	135	owner	Ground floor

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
>4	3	4	0	NA	600	>3	40	0	No

Table 4-13 Summary of Guae's water profile

Case Story 9: Wro Yirgalem

General Description

Wro Yirgalem is young woman who gave birth to a child recently. She lives here with her mother, her husband and her brother. She got this two bed room unit through a lottery. They came from Gola Michael and own a Kebele housing there which belong to her mother. It is being two years since they started living here. Before that they used to rent out the house.

Spatial Description

The house is very clean with a well-furnished living room. Compared to the other residents I interviewed so far, this family uses the outdoor space to store all their water containers. She said they don't have any other storage containers in the other part of the house.

Water Profile

Their containers can store more than 700liters. This will make them stay for about a week if the water is not coming. The greatest amount of water is taken by the toilet in her house and we usually add a lot of water also to remove the bad smell this is because they say all the dirt coming from the top floors passes through them and is the means for the bad smell. During the dry season water was not coming on a proper program like now so we used to buy water from outside the compound with 2birr for 25liters and her brother carry it home or sometimes they pay 8-10birr for a person to carry.

They usually buy water for drinking because they don't like the taste of the water here and in fear of water borne diseases. They buy the 5liter plastic bottled water for 25birr and it will last for a week. And sometimes they bring drinking water from her mother's house in Gola Michael because the water there is tasty and much cleaner. There is no liking or broken pipes in the house and they recently change the kitchen pipe recently. And they changed the rest of the taps and the toilet flushes at least two times. They usually pay 50-60 birr for the water bill and the minimum amount they paid so far is 30birr. But in Gola Michael they usually pay less than 10birr and the maximum amount they paid was 15birr.

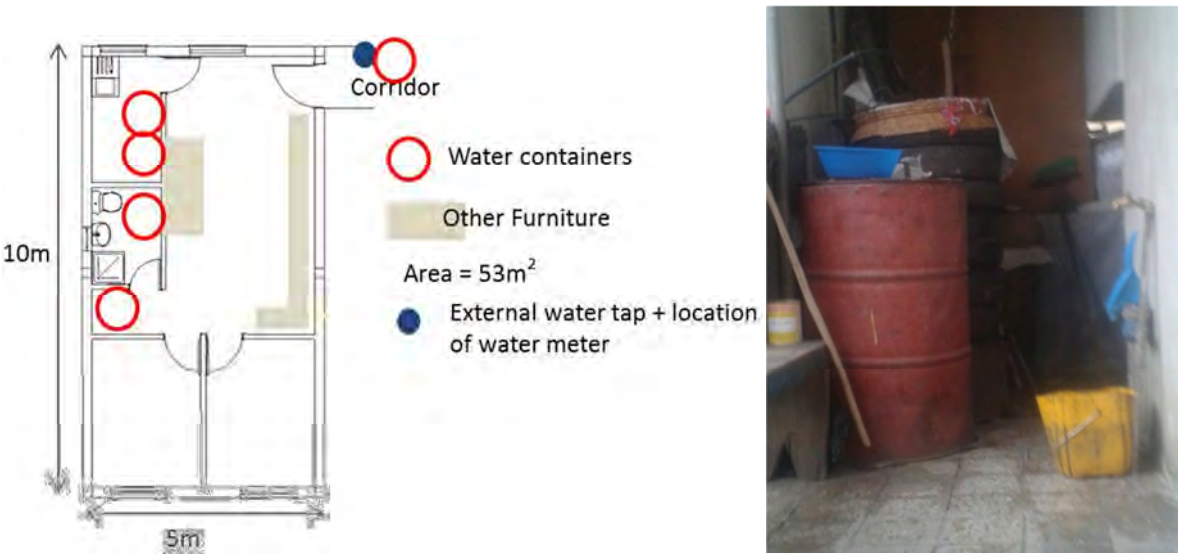


Figure 4-27 Layout of Yirgalem's house in relation to the different water storage space

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Yirgalem	Kebele	35	2bed room	53	6	135	owner	Ground floor

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
2	3	4	<10	50-60	700	7	16	100-110	No

Table 4-14 Summary of Yirgalem's water profile

Block 6 Description

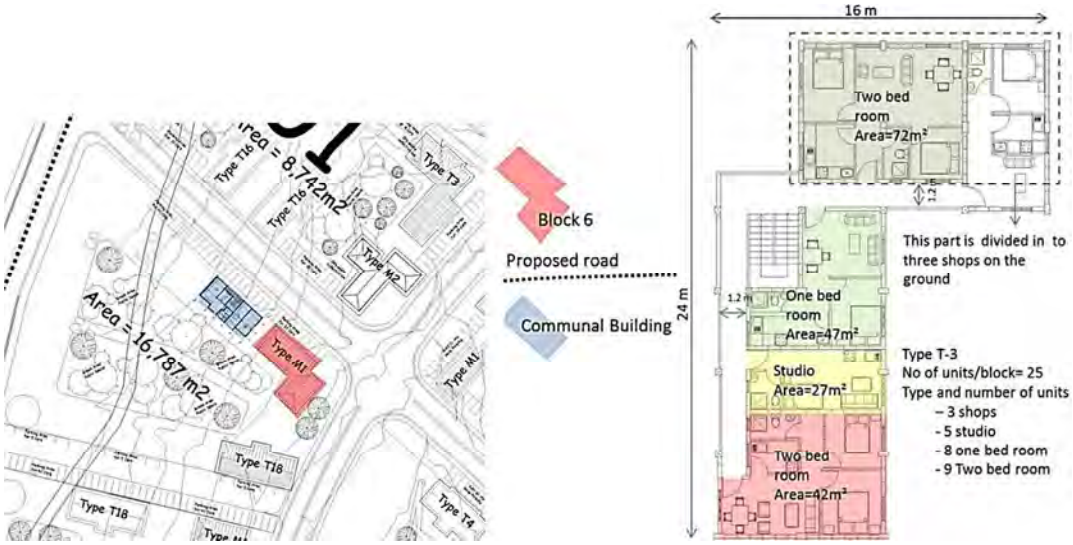


Figure 4-28 Location and layout of block 6

Block 6 is located compared to the other two blocks on the upper level of the condominium site. It is M1 L-shaped typology in which one of it is shorter. This block is close to the second entrance to the compound on the side to Gofa Mazoria. The total number of units found is 25 and out of this three units on the ground are shops, nine are two bedroom units, eight are one bed room units and the rest five are studios.

One of the communal buildings in the compound is found close to this building but is not giving any service up to now. On one side the building face a big asphalt street on one side to a common open space and on the other side along the communal kitchen to a small parking space and small street which look like is going to join in the future to a proposed road which will separate the Military housing from the condominium. I found my informants here through the people I know; one is my relative and the other used be my close neighbor when we used to live in block 62 my first block. So here I had a chance to talk to people in five households from first and fourth floors. Three of them are found on the first floor and two of them on the third.

First Floor Residents

Case Story 10: Wro Hana

General Description

Wro Hana is my husband's sister in low. She rents a one bedroom unit. She is being living here for more than a year now. She lives here with her husband, her little daughter and her cousin. Before they come to live in a condominium they used to live in peoples compound renting a two rooms unit around Gofa St Gebriel church. They used to share a water tap and a toilet with the owners and used to have her own kitchen in which the owners constructed for her with a corrugated iron sheet adjacent to the fence wall.

Spatial Description

Hana's house is usually very clean and she has well-furnished rooms all over the house. She said it was difficult to find a house in this condominium neighborhood which was big enough to accommodate their sofa set in the beginning since it is very big until they find this one in which the shape of the living room is a clear rectangle. Her cousin and her daughter sleep in the bedroom and Hana and her husband sleep in the living room on a mattress.

Water Profile

Hana said water has been a challenge since she moved here. She would have preferred to stay in the previous house if she knew it could be like this. Because there was no problem regarding water in their previous house and they even were using the same amenities that the condominium toilets have; the shower, the flash toilet and the hand wash basin. And because there was a water reservoir tank, they were not facing any problem. Here storing water is a must and finding a place to store is also difficult. Her storage containers are placed inside the toilet and the kitchen. She can store up to 400liters and she said it only last for three days because they add a lot off water on the toilet to take away the dirt. Sometimes we save the

water from cleaning clothes but will not keep it more than one day because it will bring a smell by itself if it stayed longer. We were paying around 20birr for water bill but we haven't paid for the past four months because she did not get time to go and pay. And there was no notice delivered about the payment from the authority so far.

Every tap in the house works properly except the toilet flash which continuously leaks whenever water is available but they did not do anything to repair that except trying by themselves to fix it on or two times. After they moved in they changed the tap on the hand wash basin with a better one which coasted around 180birr together with the payment for the technician. We stopped drinking water from the tap from the advisor we got from a doctor after we were sick of typhoid many times. And we drink plastic bottled water every time. We buy the 2liter bottle for 12birr and usually last for a day.

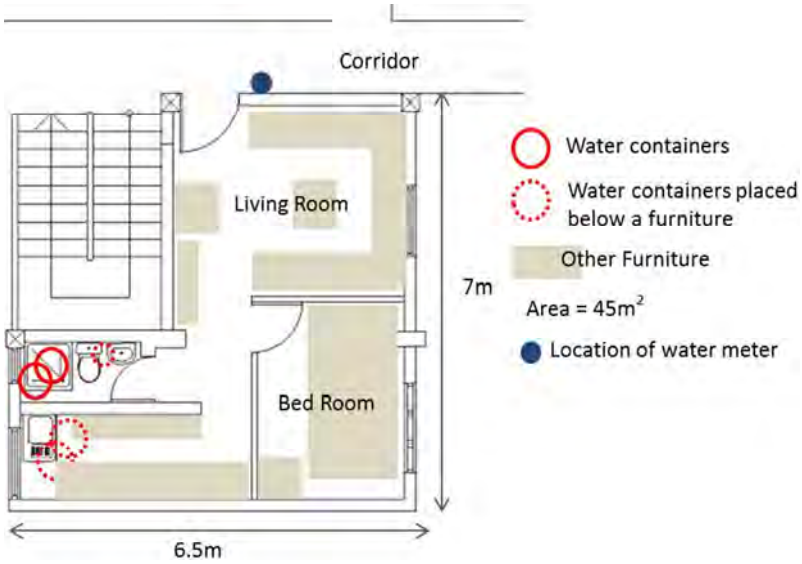


Figure 4-29 Layout of Hana's house in relation to the different water storage space

Figure 4-30 Hana's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Hana	Private house renter	30	1 bed room	45	4	6	renter	1st

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
>1	2	3	0	20	400	3	33	360	Yes (typhoid)

Table 4-15 Summary of Hana's water profile

Case Story 11: Wro Saba

General Description

Wro Saba is a young mom who is living with her husband and her little daughter in a studio they rented which is 27m^2. They have lived here for the past four years. Before they came here they she used to live with her parents outside Addis. She came to live here after she got married.

Spatial Description

Her studio is a clean room where a big bed lying under the window and in front of the main entrance and several staffs are placed along one side of wall and the corner just in front of the bed is where her kitchen materials are found close to the dish washing sink and there is a curtain hanging to cover this area. And the toilet is located on the right side of the entrance door.

Water Profile

She has several containers to store water which she placed them inside the toilet and around the kitchen corner. And in total she is be able to store around 600liters which could last for her up to a week if water is not coming. They have a separate clean 10liters container to store their drinking water. Whenever it is finished they usually buy plastic bottled water for drinking and she said one liter per day is enough for they which they buy it for 10birr. She usually uses water

economically weather it is available or not. She also saves some amount of water from the cleaner waste of washing clothes to flash the toilet.

She said she got it repaired the shower tap three times after they moved in. Since she is the only one who is using the tap for the dish washing sink she knows how to use and close it carefully otherwise it doesn't work properly but it is not leaking. The toilet is working properly and they use it whenever water is available.

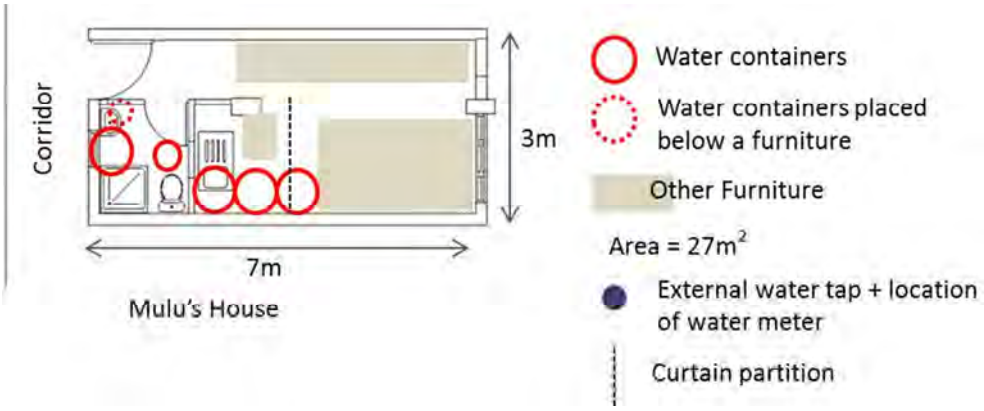


Figure 4-31 Layout of Saba's house in relation to the different water storage space

Figure 4-32 Saba's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Saba	Family house	30	Studio	27	3	6	renter	1st

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
4	2	3	0	NA	600	7	29	50	No

Table 4-16 Summary of Saba's water profile

Case Story 12: Wro Mulu

General Description

Wro Mulu is a housewife who used to be close neighbor of mine in block 62. She used to rent a two bed room unit like she has now. She lives here with her husband, her four children and some relatives. In total there are 10 people who are living in this house. They are renting this house they are living in. It has been more than four years since they started living in this neighborhood. Before they this house they leaved in two other blocks.

Spatial Description

Even if it is a two bed room house compared to the other houses I visited it is the smallest and its area is 42m^2. The children use one of the bed rooms for sleeping and the other bedroom for the husband and wife and the relatives sleep on a mattress in the living room and on the couch. They put their water storage containers inside the kitchen and toilet.

Water Profile

She said they can store enough water in there container until the water will be back. And with all the containers they can store around 700liters. It is not common for them to buy water and they store drinking water separately and never were sick from water borne diseases. The usual cost of their water bill is 30-40 birr. This unit has the hand wash basin outside the toilet on a recessed wall but they removed the fixture and made it to store charcoal which they normally use for cooking. So they use plastic bowls to wash their hands.

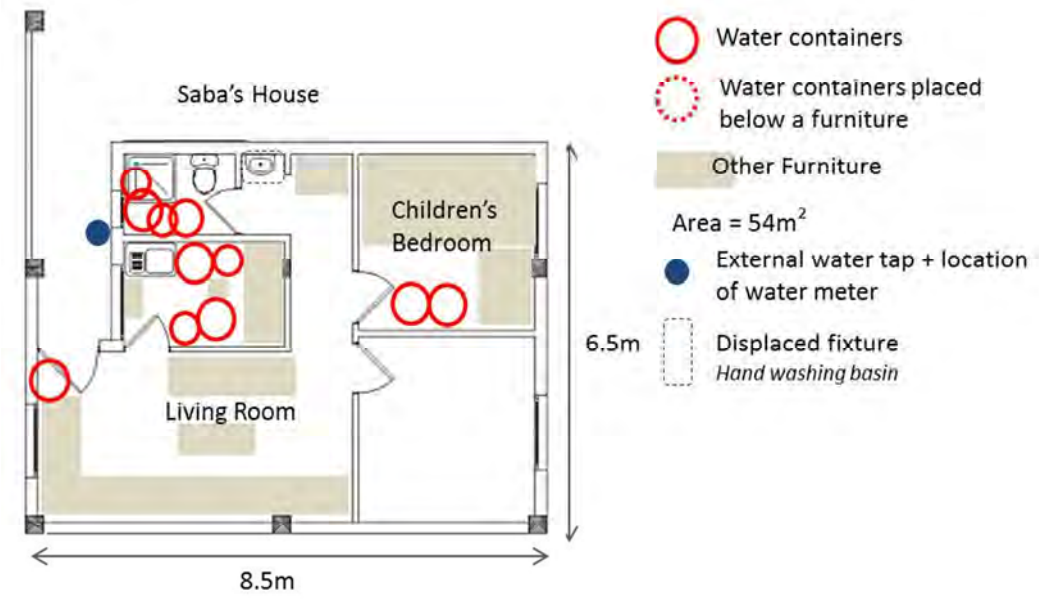


Figure 4-0.33 Layout of Mulu's house in relation to the different water storage space

Figure 4-34 Mulu's water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Mulu	Condominium house renter	40	Studio	54	10	6	renter	1st

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
>4	2	3	0	30-40	700	>3	23	0	No

Table 4-17 Summary of Mulu's water profile

Fourth Floor Residents

Case Story 13: Wro Teyibe

General Description

Wro Teyibe owns a two bed room unit on the fourth floor which has an area of 72m^2. She lives with her husband and her five children. They lived here for more than four years. Before they came here they used to live around Sebategna area in a Kebele house. They used to have two rooms there and used to share a water tap, compound, toilet and kitchen with their neighbors. They got this condominium through a lottery.

Spatial Description

They have a very nice looking, clean and spacious house. They use the indoor corridor and the shared corridor to place their water containers. Even if they have big spaces inside their house

they also use the shared corridor for cooking. This family also uses one of their bedrooms very creatively which they made a kind of bed where the bottom is covered to be used as a storage box or cupboard.

Water Profile

They have few 25 liter containers inside the house and few bigger containers on the corridor. She said those were the only containers they have to store water and it usually last for three days. With all the containers they can store up to 400liters of water. She said it is much better now to get water than few months ago because there were times that the water couldn't reach this level while the house on the lower floor are getting. Sometimes they might not get water for more than a week and were forced to spend 40birr per day to buy around 100liters of water (four 25liter yellow containers in which there original use was cooking oil containers). Normally they buy the water for one birr and they pay eight birr for a person to carry it but they say the payment for the person to carry is similar both on the first or last floor. She said the usual payment for the water bill is between 40-50birr. But they never paid less than 15birr. In their previous house even if they shared a single tap with more than nineteen people the payment then was not more than ten birr and they used to get water more frequently. They use the water they stored from the tap for drinking also and never been sick of water born disease. But sometimes when there is a complete shortage of water they buy plastic bottled drinking water.

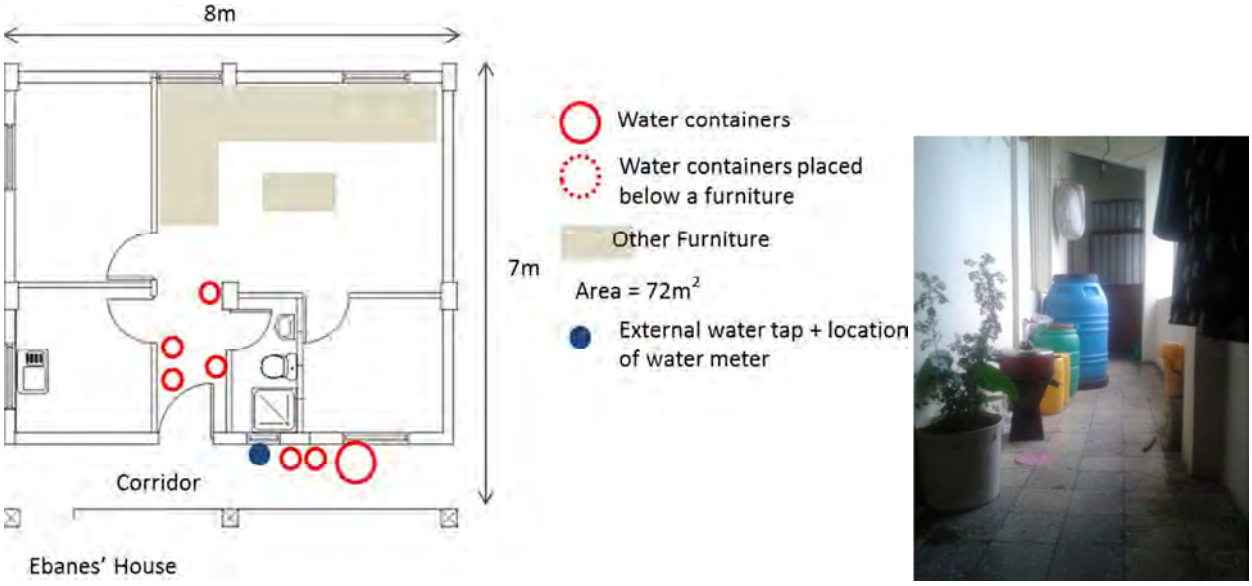


Figure 4-35 Layout of Teyibe's house in relation to the different water storage space

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Teyibe	Kebele	50	2bed room	72	7	6	owner	4^{th}

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
>4	<1	3	<10	40-50	400	<3	19	>500	No

Table 4-18 Summary of Teyibe's water profile

Case Story 14: Wro Ebanes

General Description

Wro Ebanes is an older lady who lives with her husband and son in a one bed room unit with an area of 45m^2. They lived here for about six years now. They are one of the first occupants of this condominium. They lived for about two months without water and electricity. She used to buy water from the close neighborhood and carry herself to bring it and her husband used to take a rechargeable lamp to his office where he could find electricity and brought at night. Before they came here they used to live around Olompia in a Kebele house of a single room where they used to share a compound, a kitchen, a toilet and a water tap with five other families.

Spatial Description

The living room of the house is well maintained and clean where you see a small bed lying on one corner which is used as a sleeping place for Ebanes' son. In contrast the kitchen has a lot materials placed inside which makes look like it also act as a storage place for different containers including water. Since there is no door fixed for the kitchen some of these containers extend out on to the small corridor.

Water Profile

They used to get water in abundance until two years ago. But it was getting worse until recently but now they are getting water at least four days a week. Due to this she said she store with

every available container in the house putting it on every free space. She said that she just picked the empty containers from the living room before I came as she usually puts these containers on the passage way of the living room which can accommodate four of them. The kitchen and the toilets are the other places which she puts the water containers. All the containers in this house add up to store up to 400 liters of water. She said with amount they can survive up to ten days. But whenever they run out of water she is the one who will go to fetch carrying on her back. She usually buys ones 25liter water which is mostly enough for a daily consumption in the house. But she normally uses water carefully trying not to waste.

All of the water taps and the toilet flash are working properly and they are all the fixtures given with the house. They didn't change anything so far because they use their materials properly. They have been paying so far for the water bills not more than fifteen birr. This is because she said they try not to waste much water and they are using it economically. And she said they never bought any bottled water for drinking and never been seek from water borne disease.

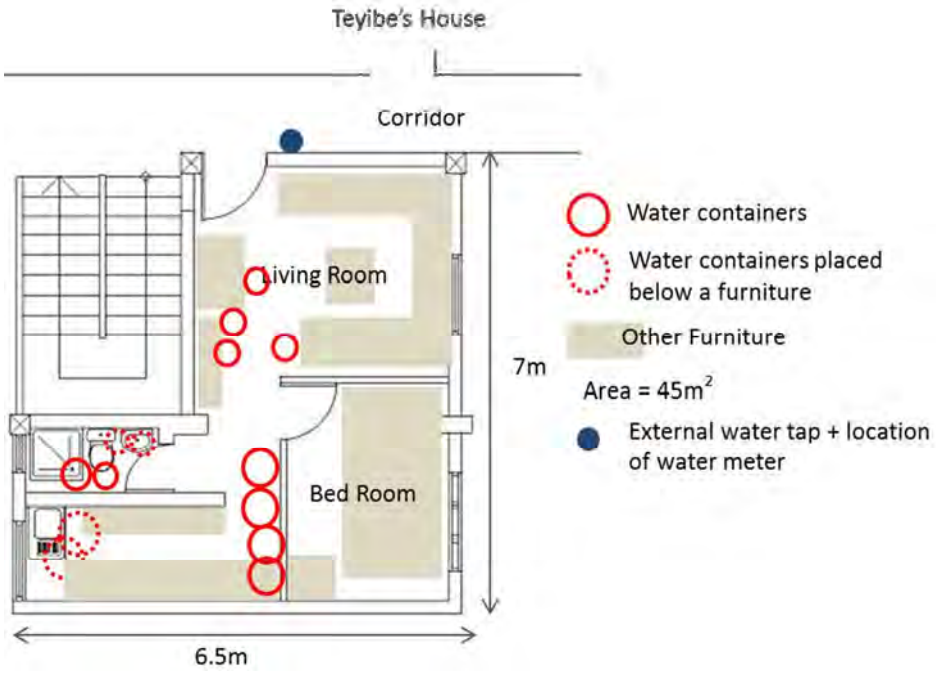


Figure 4-36 Layout of Yibanes' house in relation to the different water storage space

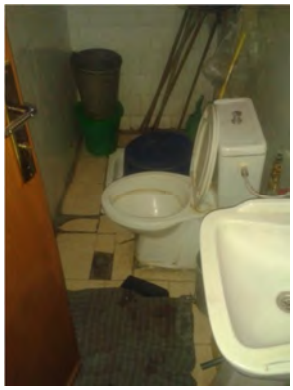




Figure 4-37 Yibanes' water storage containers

Name	Previous house tenure type	Age	Unit type	Area in m^2	No of family	Block	Tenure type	Floor level
Ebanes	Kebele	65	1bed room	45	3	6	owner	4th

No of years lived	Water availability per week		Average cost for water bill		Stored water			Average additional cost for water per/ month	Occurrence of water related disease
	Dry season	Wet season	Before condominium	After condominium	Average size in liters	Average days of stay	Average consumption/person/day		
>5	<1	3	<10	<15	400	10	13	0	No

Table 4-19 Summary of Ebanes' water profile

Chapter 5
Analysis

6.1 Introduction to the chapter

According to the data collected from different sources on the management of water for Gofa-Mebrathaile condominium, here, I present the analysis of the different variables of the study on the data collected. And the analysis of both quantitative and qualitative data is presented in this chapter.

6.2 Pre-design and design stage considerations for water management of Gofa-Mebrathaile

One of the aims of the condominium housing at its first start was providing decent housing targeting low and middle income groups of urban dwellers. One of the ways to address this was through the provision of individual toilets and kitchens for all households having their own independent sources of water and electricity. This brings the existence of several water points in a house and the use of flash toilet. And due to the low cost nature of the project for this particular section cost was minimized by providing cheaper toilet and kitchen fixtures and the connection to a centralized conventional sewerage system for waste disposal. The search for cheaper materials open the way for low quality materials which are the means for water wastage and encoring cost for the replacements. All the waste coming from the kitchen and the toilet (including hand wash basin and shower tray) is collected together and end up in the main sewerage line. That means waste water has no separation based on its quality when it is disposed. This process needs the existence of abundant water to be available in the water supply system. And there are no public toilets being designed with the neighborhoods which can serve the residents in case of water absence or for a public use.

Due to the need and demand for large number of the housing, the condominium housing has continued to be developed in a large scale. This increased the water consumption and water need proportionally and was also one of the means for the water shortage problem which is seen in the city. Even if condominiums are being designed in a way to have better water availability and flexible use, the reality in the selected case is different. This is because there is a big shortage of water.

The introduction of the condominiums brought a big difference in the way water is allocated per capita per day for residential consumption to be 111 l/c/day from about 20-30 l/c/day. This was because condominiums are being designed to consume more water especially due to the existence of the flash toilet and use of centralized waste disposal system and with the thinking that the future and ongoing housings encourage modern life style and the centralized waste

disposal system is planned to cover the whole city. So out of the 111 l/c/day amount the 88% clean water is used to run the sewerage system.

Due to the above mentioned reason and various reasons water is being a problem in the city and especially in condominiums. The only water source for this site is through its piped connection to AAWSA's sub-station at Gottera. The case condominium blocks are not designed in a way to be able to reserve water for water breakdown. It is not structurally and systematically feasible to integrate and place water reservoirs like high rise buildings should have. Systematically, meaning since the housing units have their own separate pipe line and water meter, the management and the reinstallation could be complex. And the buildings do not allow collecting rain water because the gutters are constructed touching the ground. Modifying this could be easier but unless it is integrated with the system it is discouraging for people to carry water because it requires climbing stairs carrying containers and the shortage of storage space is also another problem. And the storm water is collected in a separate drainage line to carry it to join closer rivers or streams. The water supply system for the city is working in a distribution of the available amount of water based on programming which is also true for the case's condominium housing. The condominiums housing units have usually small spaces and both private and public storage area was not thought together with the design. So finding storage place inside housing units is very difficult because people have to store large amount of water to be able to overcome the water shortage.

All these problems indicate that, there were no integrated decisions made to treat the urban water system as one. This indicates that alternative ways of getting water have not being considered. Even if it is in the early stages of application AAWSA seems to consider and try to implement some of the strategies to bring sustainable management of water. Some of these include, on its business plan document AAWSA proposes a cost recovery tariff system to get all its expenses back through its new water pricing system. This new system also has cost subsidization system for the low income groups of the society. On the other hand AAWSA is trying to find more sources for the water supply through digging additional ground water wholes. But these acts have been separately or individually performed by AAWSA and it doesn't look it gained enough support from the planners and designers side to come up with building and neighborhood designs which use water efficiently.

The shortage of water in the city is becoming a big challenge for the authority and in order to overcome this problem the digging of additional water wells in the Akaki well field and the upgrading work of Legedadi dam is undergoing at the moment and in the future they are looking for additional water sources which can serve the city.

6.3 Analysis of household's and other activities water management trends inside Gofa-Mebrathaile condominium

6.3.1 Characteristics of House Holds, Housing and Related Characteristics

Block			Housing Type before condominium		No of People living in the house	Unit Type			Floor level					Ownership type	
			Kebele	Private		Studio	1 br	2 br						Owner	Renter
90	135	6							Ground	1st	2nd	3rd	4th		
X			X		5	x				x				x	
				x	5			X		x					x
				x	5		X			x				x	
				x	10			X				x			x
			X		5		X					x		x	
	X			x	4			X				x			x
				x	4			x				x		x	
				x	5			x	x					x	
			X		6			x	x					x	
		X		x	4		X			x					x
				x	3	x				x					x
				x	10			x		x					x
			X		7			x					x	x	
			X		3		X						x	x	

Table 5-1 Summary of characteristics of households, housing and related characters

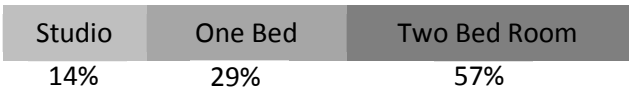
In all the surveyed households the informants were female heads of the families. This was good for the study because all information of the household is very accessible from these people as they are the main operators of the house especially in relation to water. The information gathered through them can represent their families.

Out of the fourteen surveyed households the following figures present the different quantified characteristics of the households:-

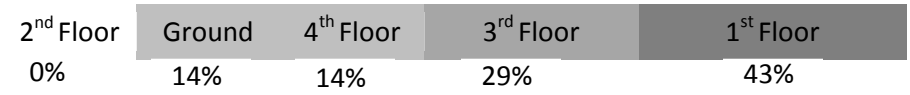
Ownership type

Housing type before condominium

Unit Type



Floor Level



Out of the fourteen surveyed households 57% are owners of the house and 43% are renters. The majority of the people lived here more than two years except Hana who lived only one and half year. Wro Ebanes have been living here for almost six years being one of the first occupants of the neighborhood. 57% of them live in a two bed room unit, 29% in a one bedroom unit and 14% of them in a studio. Out of the fourteen households again 43% of them live on the first floor, 29% of them live on the third floor, 14% of them on the fourth floor and another 14% living on the ground floor. People living on the second floor are not interviewed due to unavailability of willing people for interview. So the proportion of people interviewed on top floors (3rd and 4th) is 43% and on lower levels (ground and 1st) is 57% which make a good proportion to make a comparative analysis based on the level of floor people are located with the water situation.

Among the fourteen women interviewed five of them are old women who also own the house and whose income depend on their husbands and children. Two of the women have their own private business, four of them are housewives whose income depend on their husband and one (Yemisrach) is also jobless but her income depends on her brothers. From this we can do the following figure as income dependence and having own income. So the majority of the women have no income source of their own which 86% of them.

Income situation of the informants

6.3.2 Water Source and Use Practices of Households

The main source of water for all residents in condominium housing is potable water which is provided for every household. But due to shortage and the need for large amount of water, people also store water in a various kind of containers in their houses and it is also common to buy water mostly from the immediate neighborhoods when they run out of their stored water. And also plastic bottled water for drinking when there is water shortage and some of them in fear of water borne diseases.

Block			Average cost of potable water per month. In birr. BC-before condo IC-in condo		Cost for additional water per month. In birr	Expenditure on new storage containers Yes/No	Availability of Water Per Week		Used spaces for putting containers C- corridors LR-Living Room K-Kitchen T-Toilet BR-Bed Room					Storage Capacity per liters	Stored water duration of stay in terms of days
							Dry Season	Wet Season							
90	135	6	BC	IC					C	LR	K	T	BR		
X			NA	30	NA	Yes	3	3	x	X	x	x	x	~200	NA
			50	50	10	Yes	3	3	x		x	x		~1000	5
			30	30	0	Yes	3	3			x	x	x	~800	>7
			NA	NA	240	Yes	2	3		X	x	x	x	~650	2
			<10	20-30	0	Yes	2	3	x			x		~300	5
	X		0	30	0	Yes	1	3	x	X	x			~400	>3
			0	<20	15	Yes	1	3			x	x		~300	>3
			0	NA	0	Yes	3	4	x		x	x		~600	>3
			<10	50-60	100-110	Yes	3	4	x					~700	7
		x	0	20	~360	Yes	2	3			x	x		~400	3
			0	NA	50	Yes	2	3		X	x	x	x	~600	7
			0	30-40	0	Yes	2	3			x	x	x	~700	>3
			<10	40-50	>500	Yes	<1	3	X	X				~400	<3
			<10	<15	10	yes	<1	3		X	x	x		~400	=10

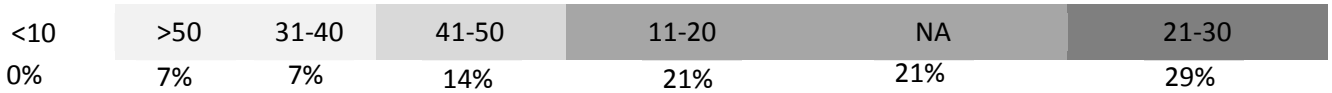
NA- information not available

Table 5-2 Summary of water profile for households

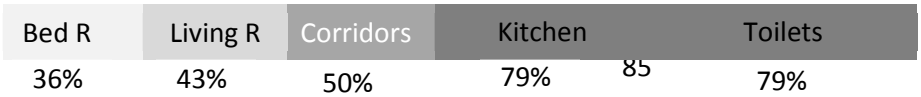
Out of the fourteen surveyed households the following figures present the different quantified water source and use practices of households:-

Water bills before condominium in birr

Water bills in condominiums in birr



Preferable storage container placing spaces by users



Storage capacity of people's containers in liters

401-500	<300	501-600	700-1000	601-700	300-400
0%	7%	14%	14%	21%	26%

People are saying the amount of birr they are paying now for the water bills is fair, when it is compared with their previous situation that is before starting living in condominiums, the difference is very high. For example 71% of them used to pay less than ten birr but now there is no one paying less than 15 birr the minimum. This is because 64% of them used to live in people's compounds in which there was not additional payment for water which is calculated together with the house rent and the rest 36% used to rent a Kebele house in which the respondents said they were paying a small amount of money usually less than ten birr.

This additional cost is also backed up by the extra amount of money people are taking out to buy water and water storage containers due to the shortage of water in the area. All interviewed people had spent money to buy additional containers for the storage of water. Due to smaller space of condominiums and the available containers in the house majority of the people store which are 26% between 300-400 liters. The total number of people living in the surveyed housings is 76. If we calculate the daily demand of water for these people based on AAWSA's 111 l/c/day, the total amount will be 8436 l/day.

The average family size of the respondents is 5.4 and if we calculate the average daily demand of water for the family it will be 1562 liters but the figures show that the people cannot even store and are not using this amount of water due to water shortage. Only 14% of them store water close to 1000liters but still this amount is going to be used in average for more than three days. If we calculate the amount of water used per person from the stored amount during the average three day water is not available, for example 400liters divided by 3 days and again divided by 5.4 people, the people are only able to use 25 l/c/day which is only 22% of the water allocated to be the average demand which is 111 l/c/day. Off course this calculation is still dependent on other factors like people's way of use and buying of additional water.

This also indicates that the sewerage system is not working properly because enough water is not going in to the system. But off all the stored water the biggest amount is used to flash toilets. Depending on different reasons people's stored water duration of stay in terms of days is not similar or the range is different for similar amounts. And since there are no external toilets or public toilets in the neighborhoods people have no other choices than using their

indoor toilets with a minimum amount of water in a way health could be at risk with poor hygiene. And breathing inside the houses is difficult due to bad smell coming out of the sewerage system which is another threat to health.

The stored water duration of stay varies from house to house. This is due to family size, ways of water use differ among individuals even if the action is the same, some people use water very economically like use of gray water for toilet flashing and some of them don't store such type of water due to very small spaces and in fear of bad smell when keeping gray water long, in fear of spending extra money on water people leave some of the activities which require water or prefer to do in very small amount or when water is available.

Whenever they are totally run out of their stored water, people are forced to buy water from the immediate neighborhood found on both Mebrathail and Gofa area. The usual price of water for 25liter container varies from 1-2birr and they will pay 8-9 birr for a person to carry it home. And due to the low income situation of the people and the excessive amount of money they will spend for a person to carry the containers sometimes people go and fetch by themselves carrying on the backs. And usually according to my respondents, they (women) or their children are responsible for it.

The main purpose of water in the houses is for drinking, cleaning and cooking. And the use of flashing toilets which began to be operated at large after the coming of the condominiums is also applied for this condominium. The household's entire toilet fixture is similar which is given with the housing units. The flashed water amount of this toilet's is 8 liters per use.

6.3.3 Awareness on water saving and conservation

Respondents were also asked about their awareness, knowledge and practice of water conservation. Almost all of the interviewed heads were in one way or another aware of the notion of water conservation. When asked about what water conservation means, they responded that water conservation is a concept related with economic, disciplined use of water or it is avoiding wastage of water.

Respondents were also asked about water wastage and reuse of water. 14% of the respondents said they feel there is water wastage in the house due to the continuous leakage of the toilet flush and leaking hand wash basin pipe especially when potable water is available. One of the respondent said she changed the equipment for the third time now but it is still not working and she is thinking to get it repaired again and the other one said her husband tried to repair it few times but was not fixed.

Due to the poor quality of the fixture the flash button breaks easily and leakage of water is also noticeable in most of the places. This put the residents to cost additional money for repairing. From my interview more than half of these toilets are not working and people use other containers to pour water on the toilet instead of the flash. Even if they didn't remember the amount of money they spent most them have paid three to four times to replace and repair easily damageable water fixtures provided with the housing. And they said it is also difficult to find fixtures which are durable.

Whereas 86% of the households responded that they reuse water. Usually the water from washed clothes and dishes they save for a while and use to flash the toilets. The response I get especially from the older ladies about storing or using rain water is positive but they put the challenge of carrying to upper floors and the way the gutters are constructed is too close to the ground and not accessible for them to fetch even by the people living on the ground floors. Two of the ladies even suggested that using rain water is also good to better clean clothes and saves the washing soap consumption besides being additional source of water for them. And these ladies and two more responded that they used to collect rain water in their previous houses even if water is available for the mentioned advantages of rain water. And another point one lady raised was since availability of potable water gets better in the rainy season when compared to the dry season which makes the rain water less important. But everyone would have been forced to fetch rain water if water was absent in this season.

6.3.4 Health related problems in relation to water

According to the interview I made with a doctor working in a private clinic found in the neighborhood, shortage of water is also being a threat to health. The clinic is the only one found inside the neighborhood giving service basically for the condominium for general treatment. The doctor said that almost 70% of the patients coming to the clinic are affected by typhoid and typhus. And the main causes of these diseases are poor hygiene and contaminated water. The way the condominiums are designed with the kitchen and toilet spaces together with the rest of the rooms and the problem with shortage of water is increasing the saturation of bacteria in the wet rooms and which can easily be transmitted to the rest of the rooms and putting people in risk of getting infected. He said people, in order to save water they may not add enough amount of water to the toilets and may not clean it every day also which makes them to be venerable to be caught by a disease. And also he added that another means for the cause of typhoid and typhus is drinking unclean water from the water itself or the water container and spoiled food. Even if it is not the focus of this study there is also a shortage of electric power supply in this neighborhood which is another means of food spoilage to refrigerator stored foods. Due to lack of awareness people are using their food from the fridge directly or without warming it very well.

According to another study that the doctor mentioned the two diseases typhus and typhoid are becoming the most prevalent diseases in Addis Ababa due to water shortage which bring poor sanitation. And these diseases also used to be most prevalent in rural areas and but the margin is declining there and increasing in the capital or urban areas. And he said he usually advise his patients to boil their water or use water treatment equipment or bottled water for their drinking consumption and to clean the toilets and kitchens very well. According to the doctor people normally spend up to 400 birr for adults and up to 250 birr for children to get treatment and medicine for such diseases. And some people might come again and again being sick of with the same disease sometimes even within less than a month time.

With regard to this two of my respondents said they are not using the tap water in fear of such diseases and not liking the taste and are using plastic bottled water which they buy with 12birr the 2liter drinking water or with 25 birr the 5liter bottled drinking water. And one of them even said she and her husband was caught typhus several times and according to a doctor's advice they stopped drinking direct water from the tap. One of my respondents has her own water treatment equipment and which also uses it to store drinking water and they all do not drink from the tap in fear of water borne diseases. The rest said they have separate containers to store their drinking water and when they run out of it the usually buy the bottled water for drinking and one lady said she uses also the water she buy from outside for drinking as well. And except one of the women the rest have no history of getting sick of typhoid. The other health problem occurring in relation to water and condominiums is disease related the breathing system. As most respondents replied this is due to the bad smell coming from the sewerage system through every hole that is found in the house. In order to get rid of the bad smell people usually add a lot of water on the toilet which they say it will relief them for a while. And usually this is usually a big problem when there is water shortage as well. And some people put covers on top the different holes in the house including the toilet, the kitchen sink, the shower tray, the hand washing basin and the floor drains found in the kitchen and the toilet.

6.3.5 Water and business in the condominium

In order to understand the situation regarding water for the business areas found in the condominium which base their activity highly on the availability of water and which this situation also will directly or indirectly affect the rest of the inhabitants because they are the most users of these services. So I chose two businesses a ladies hair salon and a restaurant. Both the respondents said their businesses are highly dependent on water and consume a large amount of water per day. And the water shortage here is making them to buy extra-large amount of water and to spend extra money on car fuel since they are both using their cars to

bring water from available places. Both these businesses are using shared spaces in order to put their water containers and in an unaesthetic way as shown in the pictures.

The hair salon owner (Dani Beauty Salon) said now she is at least not running around to buy water because she recently bought a huge container which can store up to 5,000 liters which could last longer and which also depends on the number of customers she is serving. This container is placed on the front door of the hair salon and is also becoming a trend in the neighborhood because availability of water is also major part of this business. And she said they use 25liters of water for every customer to wash the hair and they also use water for other purposes like cleaning, washing towels and flashing toilets. The restaurant (Kiru Bar and Restaurant) also has one 1000liters bigger container and a lot of 25liters water containers placed at the back of the restaurant on the space which is considered to be shared with other dwellers. The owners of these two businesses said they had a permission from the commute and the sub-city to place the containers on the shared places and they said the people (inhabitants) of the respective blocks have not complained so far.

Figure 5-0.1 Dani's Water Container

Kiru's Water Containers

Chapter 6
Findings, Conclusions and Recommendations

7.1 Sustainability of the management of water in condominium housing

This section of the study adopted the innovative method 'Sustainable Housing Performance Assessment Method' developed by Edinburgh Sustainable Architecture Unit (Morgan & Talbot, 2001). This method was developed to assess the multiple dimensions of housing quality, in the case of sustainability dimension, the method, based on principles of multiple criteria analysis and best practice, involved the weighting, assessment and aggregation of individual performance criteria within each of the performance categories.

In this thesis principles of sustainable water management practices and strategies listed under the four dimensions of sustainable water management were taken from the literature review to do the evaluation by selecting those which best fits the context of developing countries especially Africa. Accordingly the findings are summarized based on the different performance category extracted from the analysis in the previous chapter. Finally the actual values for each measurement were given by the author based on the findings with respect to those principles for sustainable water management. The following table shows the different performances needed to bring sustainable water management both at design and occupancy stage

Life cycle stage	Performance category	
Design Stage categories	Environmental Strategies	Urban water cycle as one system
		Fitting water for a certain purpose based on its quality
		Diverse sources to provide better water security
		Urban ground water (Sustaining water security and increasing water treatment potential)
		Application of innovative technologies
		Making waste water valuable
	Social Strategies	Working for population pressure and urbanization
		Health and education (education aimed at creating hygienic use and sustainable management of water resources)
		Gender
		Participation

		Other social issues
	Economic Strategies	Water pricing
		Economic considerations
		Environmental considerations
		Financial considerations
	Institutional Strategies	Managing water across institutions
		All players as part of the process
		Adaptive systems to work best to cope with uncertainty
Occupancy stage categories	House hold water management	
	House hold waste water management	
	Water management by other users	

Table 6-1 Performance category for different life cycle stage for sustainable water management

7.1.1 Findings for design stage category

a. Environmental dimension

The ways the condominiums are designed are in a way clean water could be wasted uneconomically. The provision of flash toilet which use large amount of water and a centralized waste water collection system which require a lot of water and the projects large scale nature are being the means for the wastage. And since there are no alternative means to get other sources of water like recycled water, rain or storm water and design decisions which encourage minimum or efficient use of water and decentralized waste treatment plants or methods fresh water is easily wasted. Such approaches are not being the focus because the only achievement considered was providing modern housing with indoor toilets and kitchens. Even out door toilets were not part of the design which could have been a good solution during water abstraction which has a good positive impact on the environment and to save water and money and to minimize health risks. In general the concepts of urban water cycle as one system, water should fit for purpose, making waste water valuable and the use of innovative technologies are not considered for this housing's water management system. In order to look for more sources of water AAWSA is targeting to dig more underground water holes but since this act is not integrated with the other approaches its contribution to solve the water problem is very small.

Life cycle stage	**Performance category**		**Performance Score** 0.1 – Unsatisfactory,0.2– Satisfactory 0.3 – Good, 0.4 – Excellent
Design Stage categories	Environmental Strategies	Urban water cycle as one system	0.2
		Fitting water for a certain purpose based	0.1

		on its quality	
		Diverse sources to provide better water security	0.2
		Urban ground water (Sustaining water security and increasing water treatment potential)	0.2
		Application of innovative technologies	0.1
		Making waste water valuable	0.1

Table 6-2 Environmental dimension performance score of the management of water in Gofa-Mebrathail condominium

b. Social dimension

The condominium design approach being a low cost housing development its intention is providing affordable housing for low and middle income groups of the society. But its actual affordability opportunity is being questioned for the low income households due to the expenses required before and after occupation. In this particular case the shortage of water which is bringing additional cost for households in terms additional water, additional containers and health problems are bringing a big burden on the very low income households compared to the rest of the society. Due to economic reasons low income households may not cop up with the problem and could be the means for the deterioration of the buildings as they may not afford to maintain their houses or have to spend extra money which will make their life difficult and which may cause social segregation and inequality. The way to provide decent housing seems for this people is being mismatched by the unavailability of water.

Due to continuous disruption of water women and children are being more affected by the situation when cleaning with less water which makes the vulnerable in risking their health. Those low income housewives are forced to carry water in their backs fetching it elsewhere. Especial attention is not given in gender focused education about water conservation and making them participate in water planning decisions.

Life cycle stage	**Performance category**		**Performance Score** 0.1 – Unsatisfactory,0.2– Satisfactory 0.3 – Good, 0.4 – Excellent
Design stage categories	Social Strategies	Working for population pressure and urbanization	0.2
		Health and education (education aimed at creating	0.1

		hygienic use and sustainable management of water resources)	
		Gender	0.1
		Participation	0.1
		Other social issues	0.1

Table 6-3 Social dimension performance score of the management of water in Gofa-Mebrathail condominium

c. Economic dimension

Even if AAWSA had started a tariff system which progressively lead to recover its costs since 2011 but still this has not been totally achieved which makes the authority dependent on other sources for its major investments. The new water pricing system is also designed in a way the cost of low income households cost could be subsidized by high income groups which is a positive dimension and an appreciated approach by IWRM strategies. The economic consideration for the environmental impact of water use only considered in reducing non-revenue water with the different systems AAWSA created. There are no controlling mechanisms designed to make a person pay extra for the misuse of water in the household as long as the person is paying the price for it.

Life cycle stage	**Performance category**		**Performance Score** 0.1 – Unsatisfactory,0.2– Satisfactory 0.3 – Good, 0.4 – Excellent
Design stage category	Economic Strategies	Water pricing	0.2
		Economic considerations	0.2
		Environmental considerations	0.1
		Financial considerations	0.2

Table 6-4 Economic dimension performance score of the management of water in Gofa-Mebrathail condominium

d. Institutional dimension

When reading through these findings up to now if water shortage is causing all this problems, one might think that this could be solved easily with making abundant water available on the site. But this never had been solved by the authority by looking for other sources which it is still looking for. It will be like always running at the back of the problem but never reaching it or coming on the front. The role of the decision on the water usage in the housing unit, block and neighborhood is decided by the housing authority and the water authority comes last to provide water for the requirement. The only communication made between the housing

agency and AAWSA is during site selection weather the site could be served with the already existing infrastructure or if there is a need for upgrading or new developments. And the housing agency is making decisions based on the already existing infrastructure and plan for water provision, sewerage disposal and storm water drainage. In fact the second has more flexibility compared to the first relation the authorities have. But the housing agency looks like that it has no responsibility with the situation being created by water shortage and making it only the responsibility of AAWSA. This shows that there is no integration of different institutions in order to take decisions together and work together in order to solve problems. The water supply authority also has no control over the decision of the type of fixtures used inside the housing units which are being a means for water wastage. But the action which is being taken by AAWSA that is looking for additional water source and ground water excavation is positive because it is one way of the IWRM to have different options of water resource.

Life cycle stage	**Performance category**		**Performance Score** 0.1 – Unsatisfactory,0.2– Satisfactory 0.3 – Good, 0.4 – Excellent
Design stage categories	Institutional Strategies	Managing water across institutions	0.1
		All players as part of the process	0.1
		Adaptive systems to work best to cope with uncertainty	0.1

Table 6-5 Institutional dimension performance score of the management of water in Gofa-Mebrathail condominium

7.1.2 Findings for occupancy stage category

In the studied case area the use of water has been influenced by its availability. Its availability had three phases. During the first occupation that is before almost six years in 2009, water was not available at all and the first occupants were forced to buy water from the closest neighborhoods by carrying it themselves or paying for a person to carry. This situation lasted for two months when the neighborhood is connected with AAWSA's water source. Then water was abundant and people had no problem of water brakes and absences until the past two years. Water after that is being supplied on a program basis basically three day supply and three day absence but which show variation in different seasons. When water is made available based on a program in wet seasons and longer day or average five days absence in dry seasons. Water provision is only observed at a unit level not on block or neighborhood level. Green areas are being watered by willing groups of individual's water sources or whenever there is rain which is a reason for mishandling of green areas or unfortunate decision by the commute to cover them with a coble stone and widening car parking options.

The reasons for this particular case was the general water shortage seen in the city added by the frequent electric power breakage at Gottera substation which decreases the water pumps efficiency and since the main source pipe coming to the site is being shared by other houses on the way which decrease the amount. The actual availability of water in the housing units is highly affected by the floor levels they are found. The people living on the ground and first floors have higher advantage to get water throughout the days water is made available and this opportunity decreases as one goes to the top floors. The last two floors the third and fourth floors are troubled because it takes almost 12 hours for the water to reach the top floor after it comes on the ground floors. And this makes it also to go away faster from the last floors than the rest. This makes the top floors to be without water with more days than the lower floor residents. The general slope the neighborhood has no or less effect on the distribution of water because the main water to site comes on the higher ground and in order gravity or slope not to affect the distribution, the water operators open the tap for the pipes going to the lower slopes first and the other taps based on a sequence. But the situation of the taps without locks and easier accessibility by a person with information about these things makes it easily be manipulated.

Due to the shortage of water people are storing water with different containers inside their houses the kitchen and the toilet being the most favorable place, on shared spaces like the corridors on top floors and common spaces on the ground floors. In order to store big amount of water people buy big and more containers which could be found from the shops found inside the neighborhood and elsewhere. Due to the smaller spaces of most of the inside spaces people are lacking proper circulation space making difficult to perform different activities which are intended with the space design's first intension. And this makes also difficult for people not to store enough water which can last longer and which is enough for their activities and sanitation at some points being less addressed which make people to be vulnerable for different poor sanitation and water borne diseases. This will lead to additional cost on the households to get treatment and buy medicine.

After using their stored water for the days that the water is absent and whenever they run out of it, they usually buy water from the immediate neighborhood carrying it by themselves or other person. In which the price to pay for the person to carry is five times bigger than the cost of water. This is making the residents to spend extra cost on their living to buy water and additional containers.

Whenever water is available it is also difficult to use the different taps in the houses because most of them are either not working properly or broken subjected to unnecessary water

wastage and additional cost for the water. And people are also forced to spend unnecessary money on the replacement of equipment or to live it as it is using other traditional or manual ways for example to wash hands, dishes and to flash the toilets. Actually the traditional way of flashing toilets has been more effective and water efficient because the dirt can be taken away by less amount of water than the flash itself because better force is been gained from the hands. The good quality flash toilets have mechanism to give the water more pressure which the condominium toilets do not have.

The proportion of the renters compared to the owners is slightly greater. This is due to the owners preferred to rent out their houses due to different reasons. One important reason among the many (could not list everything because this needs another study of its own) is people who are very low income renting out their houses in order to cover the monthly payment for the bank and they living in other areas with cheaper prices. So it is difficult to find really low income people in the condominium. If these people were actually living in their houses with the current water problem it would have been disastrous, difficult and more expensive for very low income people. The situation seems it is coping up because it is dominantly a rental market and somehow people seem to live affording it but not enjoying it. The billed consumption of households has shown more than a two fold in price for most households when comparing to their earlier housing situation which make the jump their row for the level of consumer category of Low 1 or Low 2 (20-50 l/c/day) to a medium consumer level of water (115 l/c/day).

Life cycle stage	**Performance category**	**Performance Score** 0.1 – Unsatisfactory,0.2– Satisfactory 0.3 – Good, 0.4 – Excellent
Occupancy stage categories	House hold water management	0.1
	House hold waste water management	0.2
	Water management by other users	0.2

Table 6-6 Household water managment performance score of the management of water in Gofa-Mebrathail condominium

7.2 Sustainability assessment for water management and use in Gofa-Mebrathaile condominium

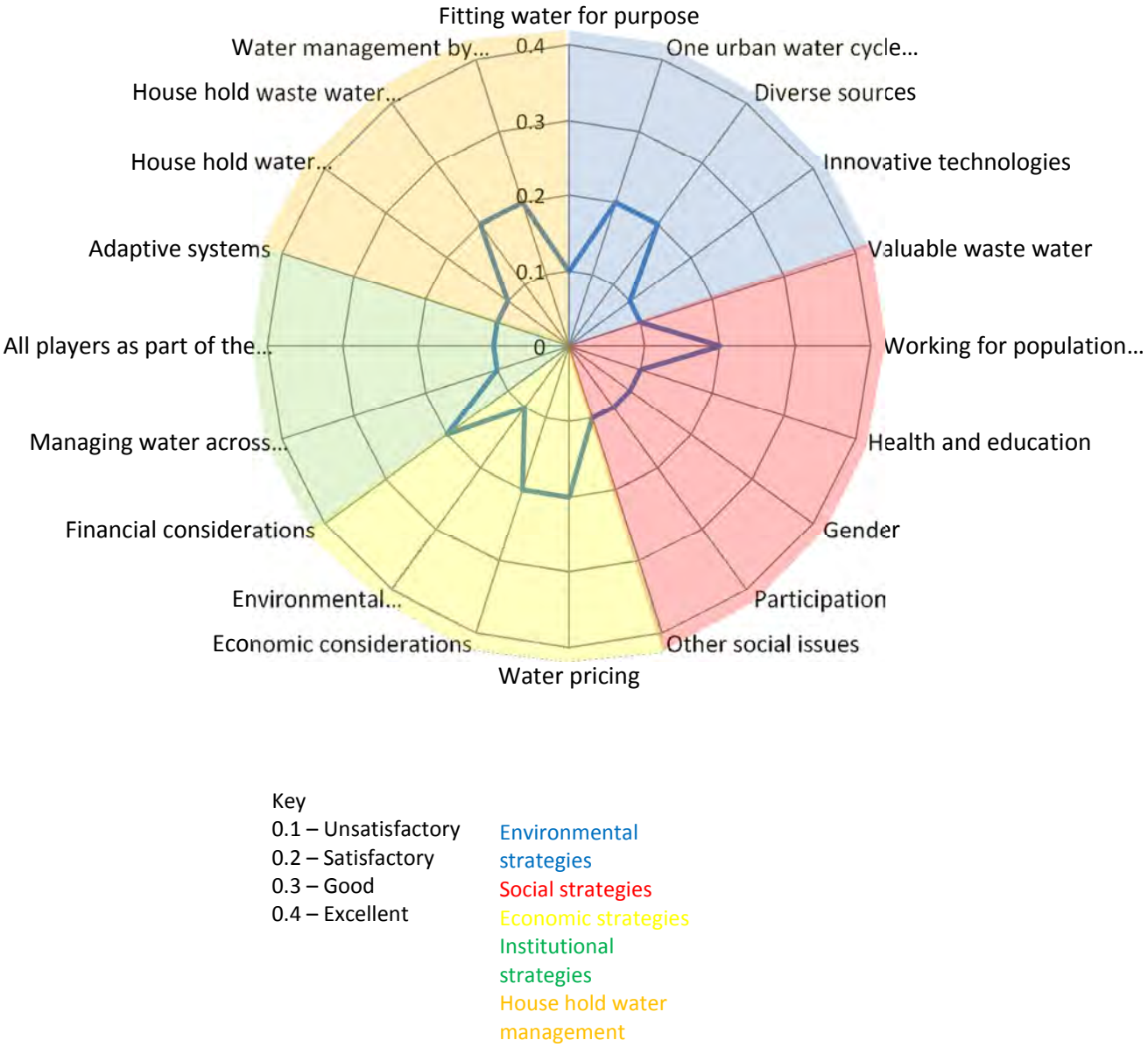


Figure 6-1 Radar diagram of sustainability performance of the management of water for Gofa-Mebrathaile condominium

The average score of this assessment is 0.145 which indicates the score to be partly unsatisfactory for the general water management approaches of this condominium project. There are some indicators of trying to consider and work on some of the strategies of sustainable water management within the different dimensions but since this individual acts are not integrated with each other the effects are not visible and bold.

7.3 Conclusion

The IHDP has started and is undergoing in a huge scale with the main focus to solve housing shortage and to improve housing conditions of the low and middle income groups of urban dwellers. Due to this affordability has been the main issue which has been addressed through its low cost design approach and construction techniques. But its affordability value is considered only on the purchasing stage or process of the housing units to own it. Beside its affordability nature the environmental impact of the housing development was not thought of in depth. This has its own direct impact on the social and economic situation of the people. This is because the existing water management system has not given enough guidance and control in how new developments should come up with design decisions to promote sustainable water management. The condominium buildings are over designed in relation to water supply and waste disposal system above the capacity of the water supply authorities potential and the current water supply amount. There are no alternative systems like big water storage mechanisms, water recycling and rain water harvesting mechanisms.

The housing and water supply and sewerage institutions are working separately to overcome demand and needs in their respective responsibilities without integrating their actions and looking for alternative options for the problems related to water shortage. Such planning decisions are highly affecting the people living in the condominiums as it is bringing additional burden on their social and economic situation. Due to shortage of water people are spending more money than they used to pay before condominiums. Water shortage together with the unit design of condominiums put people's life in danger of health problems and costing them additional money. The houses might be affordable to buy but the living costs with regard to water is not being affordable and continue to be unaffordable for especially the IHDP's target group inhabitants those who are low income.

Failing to match water supply to water demand is leading to a water resource crises. Unlike an energy crisis, a water crisis takes longer to develop but has more far-reaching consequences (Jayes, 2014). The current situation looks like it is sustaining with the situation because the condominium is dominated by a rental market which is covering its own water cost and somehow people are affording to live and have a choice of living in other water available areas by going around. But this is not a positive direction. And things will be much worse than the situation today if the actual low income owners were living inside these buildings. Since it is going to be difficult for them to spend extra amount of money on water and water related expenditures like replacing easily damageable water and toilet fixtures their living situation would not have been different from their previous housing conditions. This leads to the prediction of the creation of vertical slum areas on the condominium buildings. This will bring again women and children to be more vulnerable to be affected by such a situation. As women

will risk their health while doing different household activities like cleaning with less water and will be hurt again to fetch water going to other areas which will make them to focus less on their children and personal life.

The effect of such water management decisions and its consequences is found to be affecting the more the socio-economic situation of the households than its environmental impact for the current generation. And for the future these impacts will be bigger and will be a threat to the next generation as well in all dimensions. So according to sustainability assessment method for water management in Gofa-Mebrathaile condominium housing, the radar diagram indicates that the design approach for water design and use trends in this condominium site is partly unsatisfactory in terms of considering sustainable measures. But some of the works that AAWSA is under taking to solve the water shortage can be appropriated to manage the system in a more sustainable way. Among these approaches looking for additional sources of water which is one approach in sustainable water management to have or making wide and alternative source of water and the new tariff system which aims to recover all the costs are few acts which can grow in to large scale sustainable water management system if there are also works done to bring more strategies and different institutions integrate their works. And the expansion of the centralized central sewerage system which can easily be integrated with alternative and decentralized waste water disposal system which encourage a site reuse its own waste water is another approach. The planning in AAWSA is being done with huge money but none of the planning consideration looks for ways to recycle waste water and harvesting alternative water sources. And the planning is not also long lasting. The amount of budget they put to do the traditional solutions would do better if they incorporated other alternatives for a sustainable water design and use approach. This is due to there is no enough knowledge and decision potential among the housing and water development officials.

The sustainable management of water can be also supported by the participation of people themselves through giving training and lessons about alternative water using techniques and technologies using different media. And since water loss could also be substantially reduced through more careful consumption, which can be achieved through education, awareness and real public participation in water issues. And our path to the future can be achieved with very low cost strategies in order to increase the benefit of both generations.

7.4 Recommendations

With the pace and the amount of condominiums being built, with the current water management system; the current water supply trend does not seem to cop up very soon. And international predictions indicate that availability of fresh water will become more difficult because of very fast urbanization especially in developing countries. So it is good to think in

terms of incorporating alternative designs for water in addition to the traditional water management system. So the following are different points recommended from this study which are going to be workable for our context of the condominium housing.

Policy recommendations

- **A need for consistency to implement what the policy recommends:** at policy level there are a lot of bold and strong recommendations to manage water sustainably at every level which includes household use. So at implementation level these sustainable ways and methods of achieving it should be known in detail and the development should align with that. Otherwise the policy level recommendation or the policy itself will be irrelevant. This is also true for our housing policy and strategy document, as it mentions to develop housing in sustainable way.
- **Referring and adopting sustainable water management principles:** there are a lot of studies done in the principles and methods of sustainable water management being developed by local and international experts and organizations available to refer. Commitment to bring strategies to apply this and consistently performing it will bring change from our present traditional water management trends. Such actions have also a support from various lending organizations like the World Bank and African Development Bank.
- **Flexible policies and strategies**: our policies should be flexible enough to adopt to different situations especially with the increased shortage of fresh water in urban areas.
- **The need for policy to abandon low quality materials imported to the country –** since the main problem to unwanted leakage is the import of easily damageable materials; the policy should be revised to put strict quality controls to imported materials. This can be a good indicator to start to produce materials here based on a certain standard and to produce fixtures which are innovative enough to allow minimized water usage.

Institutional Recommendations

- **Integration among the different bodies to work together: -** addressing water shortage problem should not only be handled by the water authority only. The housing agency, the consultants and the community should be responsible to come with long term solutions to the problems which arise after occupancy of the neighbourhoods which in this case is water shortage. The water management system should be detailed enough to indicate ways how different developments fit into it for sustainable management of water.

- **Revise decisions whenever problems arise: -** the design of condominiums should be revised in order to integrate different water storage mechanisms, to separate waste disposal lines and to bring in recycled water for different use within the housing units and at the neighbourhood level. This is also true for the water management system to create more adaptive system for different situations.
- **Creating community awareness about the value of water in a way to teach its scarcity: -** this can be achieved through different awareness creation campaigns, using the mass media, social media and involving the community in the different decisions regarding water.
- **Empowering community organizations:**-in condominium neighbourhoods the committee can be given the role of administration and implementation of local waste water recycling techniques which will serve the community.

Planning and Design level recommendations

- **Rethinking the centralized sewerage (waste water treatment) system: -** even if it is a cheaper way to treat water it will be also good to integrate it with decentralized waste treatment systems installed within a condominium neighbourhood to allow each neighbourhood use its own recycled waste water. The initial cost of such treatment plants might be high but has a long lasting advantage. And enables water to be used for different purpose based on its quality. Flush toilets will not have a problem with water, green areas can be well maintained and urban agriculture can be practiced without the fear of contaminated water from factories which is a good means for food security and job creation. And over flows can be connected with the centralized sewerage system.
- **Low cost housing doesn't mean low quality: -** the housing development agencies and water supply authorities should check the quality of materials in order to bring water fixtures which should not be a means for water wastage and should encourage innovative materials in such terms. This act requires the integration of work among different institutions on the decision of such issue.
- **Water related outdoor services: -** these include public toilets and public washing areas in case of emergency for water breakdown and to have a better environment.
- **Outdoor and shared dry toilets:** the introduction of such toilets within a condominium neighbourhood shared among a group of blocks to be used during water breakdown, as outdoor toilets to save flushing water and as a public toilet for other users. The dry waste coming out of these toilets can be used as fertilizer for gardening and green areas. The other advantage of such toilets is minimizing the risk on health when using

indoor toilets with less water. The toilets can be a means of income for the community by making other users pay for the service and by the selling of fertilizers.

- **Communal water storage mechanisms**: to encourage and help communities collect rain water and to store piped water and integrate it with the system to be used during water break down. The collection can be done using some innovative materials found in the market like big water tankers and pillow thanks.

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Appendix1. List of Key Informants

House holds				
Name	**Block**	**Floor Level**	**Occupation**	**Unit type**
Selam	90	1st	Private work	2 bed room
Menbere	90	1st	Private work	1 bed room
Sumeya	90	3rd	House wife	2 bed room
Mulunesh	90	3rd	House wife	1 bed room
Yemisirach	135	3rd	House wife	2 bed room
Amina	135	3rd	House wife	2 bed room
Yirgalem	135	Ground	House wife	2 bed room
Guae	135	Ground	House wife	2 bed room
Hana	6	1st	House wife	1 bed room
Saba	6	1st	House wife	Studio
Mulu	6	1st	House wife	2 bed room
Teyibe	6	4th	House wife	2 bed room
Ebanes	6	4th	House wife	1 bed room

Business Areas				
Name of business	**Informants name**	**Position**	**Block**	**Floor Level**
Kiru Bar and Restaurant	Getachew	Manager	35	Ground
Dani Women Hair Salon	Genet	Owner		Ground
Medihanialem Medium Clinic	Untold	Medical Doctor		Ground

Professionals		
Name	**Background**	**Importance for this research**
Ass. Professor Fasil Giorgis	Architect and Urban Planner	Member of the first groups of professionals who designed condominiums

Officials			
Name	**Position**	**Section**	**Location**
Ato Yohanes	Expert	Condominium Water Supply and Sewerage Works, AAWSA	AAWSA Head Office, Megenagna
Ato Mekuriya	Woreda 20 area Senior Technician and Group Leader	Responsible for Mebrathaile Condominium water supply and water program AAWSA	AAWSA Gottera Branch Office
Untold	Commute Member	Gofa/Mebrathaile Condominium Commute	Gofa/Mebrathaile Condominium
Untold	Security Guard	Gofa/Mebrathaile Condominium Commute	Gofa/Mebrathaile Condominium

Appendix 2. Interview form for data collection for condominium residents

For a Household

Name	Block			Housing Type before condominium		No of People living in the house	Unit Type			Floor level					Ownership type	
				Kebele	Private		Studio	1 br	2 br						Owner	Renter
	90	135	6							Ground	1st	2nd	3rd	4th		

Occupation	No of years of occupancy	No of rooms in the house

1. When is water available?
2. How many water points do you have in your house?
   Do all of them work?
   Do you use all of them?
3. Have you ever changed the original fixtures given with the house?
   If yes, why?
   How many times?
   How much money did you spend in average?
   Is there a leaking pipe or flash in your house? How long has it been like this? What measure did you take to fix it?
4. How much money do you pay for the water bills in average?
   Do you pay it every month?
   Do you know what will happen if you don't pay your water bill every month?
   What kind of punishments are there?
   How much money did you used to pay before living in condominiums?
5. What kind activities do you do using water in your house?
6. What happens when water is absent?
   From where do you bring water?
   How do you store water?
   Where do you place your water containers?
   How much water can you store?
   How long does it last?
   How do you flash the toilet when there is no tap water?
   Do you buy water from other place? Where? For how much? How far is it?
   What did you do in your previous house when water is interrupted?
7. What do you do in order to save water? Do you do the same when water is also available?
8. From where do you get your drinking water?

9. Do you store rain water? How? Where?
10. Have you ever got sick of water borne diseases?
11. Does your floor level affect water existence in your house?
12. How do you compare your previous house and your condominium in terms of water?

Appendix 3. Interview questions for AAWSA Gottera branch office

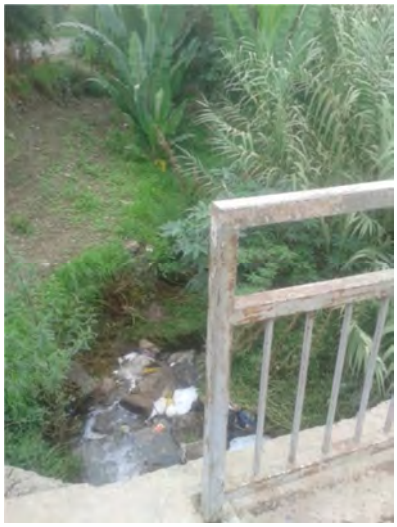
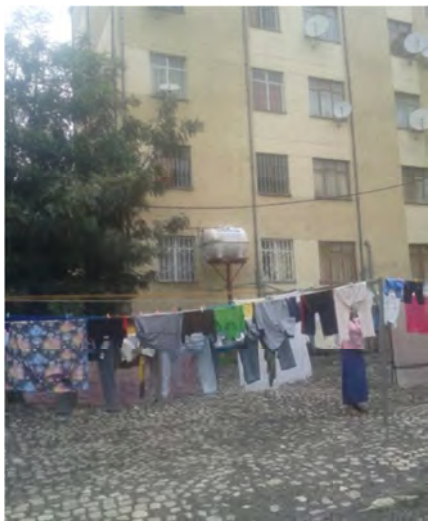
1. Name _____
2. Position _____
3. Which areas does this branch serve?
4. How big is the reservoir size?
5. How much water comes to the reservoir each day?
6. Where is the source of water to this reservoir?
7. Is it possible to know how much water is going to Gofa/Mebrathaile condominium?
8. There is a big shortage of water in the neighbourhood. What is the reason?
9. How do you control the water program in the neighbourhood?
10. Do you think there is a fair distribution of water among the blocks? How do you control that?
11. Does the big slope difference in the site affect the water distribution?
12. How are the people reacting to this water shortage?
13. Is there a plan in your office in order to solve the problem?
14. When do you think this is going to be solved?
15. Do you have any connection with the condominium housing development office for different water decisions?

Appendix 4. Pictures showing the different water related situation in the neighborhood









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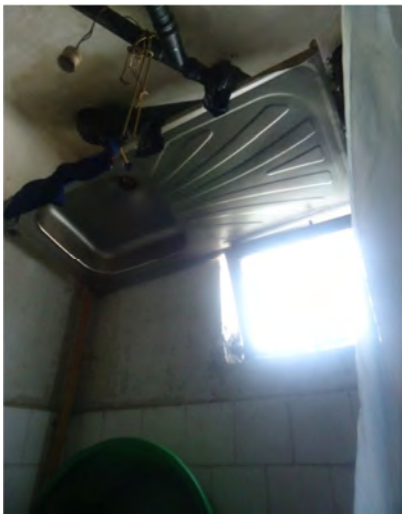



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