Supplement to Task Force Report on Aquifer Management for Addis Abeba and Vicinity

Ethiopia: Practical Framework for Managed Groundwater Development In the Greater Addis Ababa Area

(Updated Version, February 2013)

Ethiopia: Strategic Framework for Managed Groundwater Development

Practical Framework for the Greater Addis Ababa Area

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Abbreviations

AAU	Addis Ababa University
AAWSA	Addis Ababa Water Supply and Sewerage Authority
AAEPA	Addis Ababa Environmental Protection Agency
BCM3	Billion Cubic Meters
ENGDA	Ethiopian National Groundwater Data Base
EGS	Ethiopia Geological Survey
EPA	Environmental Protection Agency
GWMATE	Groundwater Management Team
MDG	Millennium Development Goal
MoWR	Ministry of Water Resources
NGIS	National Groundwater Information System
PASDEP	Plan of Action for Sustainable development to End Poverty
RBO	River Basin Organization
SNNPR	Southern Nations, Nationalities and People's Region
WWDSE	Water Works Design and Supervision Enterprise

1 INTRODUCTION

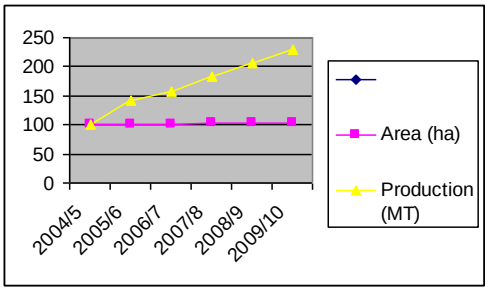
1.1 Background and introduction

'Water-centered development' is explicitly seen as the entry point for growth and improved livelihoods in Ethiopia. Increasingly water resource development is integrated with economic development and land use planning. Ethiopia has set ambitious goals for economic development – with a key role for agriculture-based industrialization – and for improving access to basic services. In domestic water supply the MDG goal for Ethiopia is to reach 70% of the populations by 2015.

Major Targets:

The ambitions in the PASDEP and Universal Access Plan on this indicator are even higher - improving coverage of safe drinking water systems to respectively 80% in 2010 and 98% in 2012. For its relatively even distribution and abundance, most of this is planned to come from groundwater systems. The PASDEP is also banking on substantial increases in agricultural production. This is to increase with 129% over the five year period, almost all of it from productivity gains.

Figure 1: Agricultural Projections PASDEP



In the last five years the large potential role and contribution of groundwater in water-centered development is recognized. Following a series of regional groundwater assessments the scope for sustainable groundwater use is larger than assumed previously and the knowledge is evolving. Groundwater so far is mainly utilized for drinking water supply. It takes care at present of 70% of rural water supply and plays a major role in several of the largest cities (Addis Ababa, Dire Dawa, Mekelle, Bushoftu, Harar) and a number of medium-sized towns. Groundwater use in irrigation, particularly large and medium scale commercial uses, is still extremely modest but several ambitious plans for groundwater based irrigation are on the table. In a number of areas with shallow groundwater farmer-driven groundwater development is taking off in many parts of the country.

The ongoing ambitious Growth and Transformation Plan (GTP) has set development objectives, of developing and utilizing water resources to fulfill social and economic priorities, sustainably and equitably, by increasing water supply coverage, and developing irrigation schemes that ensure food security. To meet the these objectives, during the Growth and Transformation Plan (GTP) five year period (2009/10-2014/15) the Urban potable water supply coverage within 0.5 km radius is expected to reach 100% while the Rural potable water supply coverage within 1.5 km radius to be 98%. During this period, additional 785,582 ha of land will be irrigated. Irrigation from groundwater is expected to cover 2 million ha by 2020.

Along with the increasing groundwater development there is growing awareness that management is needed to ensure the sustainability of investments in groundwater development, to optimize the opportunities for groundwater recharge and reuse and to regulate the long term equitable use of the

resource. In this context the Ministry of Water Resources requested support of the World Bank /GWMATE in helping developing a strategic framework for managed groundwater development, with special attention for areas of intensive groundwater development, like the Addis Ababa area.

Among the proposed intensive ground development areas, the Addis Ababa and its vicinity aquifers are given due attention and the implementation of the Strategic Framework is started by the World Bank support through a more participatory approach.

1.2 The strategic framework process and report

The strategic framework for managed groundwater development in Ethiopia is prepared by a core team under the guidance of the MoWR[1] in the period January –June 2010 and resulted in a report *Ethiopia: Strategic Framework for Management Groundwater Development (* Draft August 2010 MoWR/GWMATE). The report provides a brief overview of the current level of groundwater exploration and development in different regions and summarizes existing gaps in knowledge, capacity and management arrangements and a comparison with international practice in groundwater development and management.

The strategic management framework for the country (section 1.3) addresses the overall objectives to be set for groundwater management and how to operate in the context of the uncertainties and the gaps in knowledge and management as well as the priority activities to be undertaken. Preliminary frameworks are also presented for 4 regions and for the Addis Ababa Region

The main text is supplemented by Annexes providing more background on the status of the regions, the capacity needs and the expected impact of climate change as well as a number of tools to support the implementation of the strategic framework. Three Annexes relevant for this report are attached

1.3 The strategic framework for Ethiopia

The concise strategic framework for managed groundwater development in Ethiopia is (Figure 2) prepared based on background information and a number of interactive session with the core team.

The framework is set against the resource context in Ethiopia – i.e. its relatively complex hydrogeology, the ongoing accelerated assessment, yet also the remaining uncertainties and the concerns on natural groundwater quality – especially fluoride levels but also hardness, nitrate levels, salinity and iodine deficiency. The other part of the context concerns the socio-economic situation – the recent recognition of groundwater as a driver of growth and adaptation to climate variability. This 'rediscovery' follows a long period of groundwater being a largely unknown and underestimated as well as the absence of a strategic guidance. In addition there are broad capacity gaps – that are becoming all the more obvious with the accelerated groundwater development in Ethiopia.

[1]The GWMATE team for this activity was Albert Tuinhof, Frank van Steenbergen and MelkamuAmare Guidance was given by TesfayeTadese (Head of the Groundwater Department – MoWR) and AtoYitbarekTesssema (World Bank). The core team for the preparation of this framework consisted further of Dr SeifuKebede, Ato Taye Alemehayu, Ato Solomon Waltenigus, Dr FelekeZewge and AtoZenawTessema.

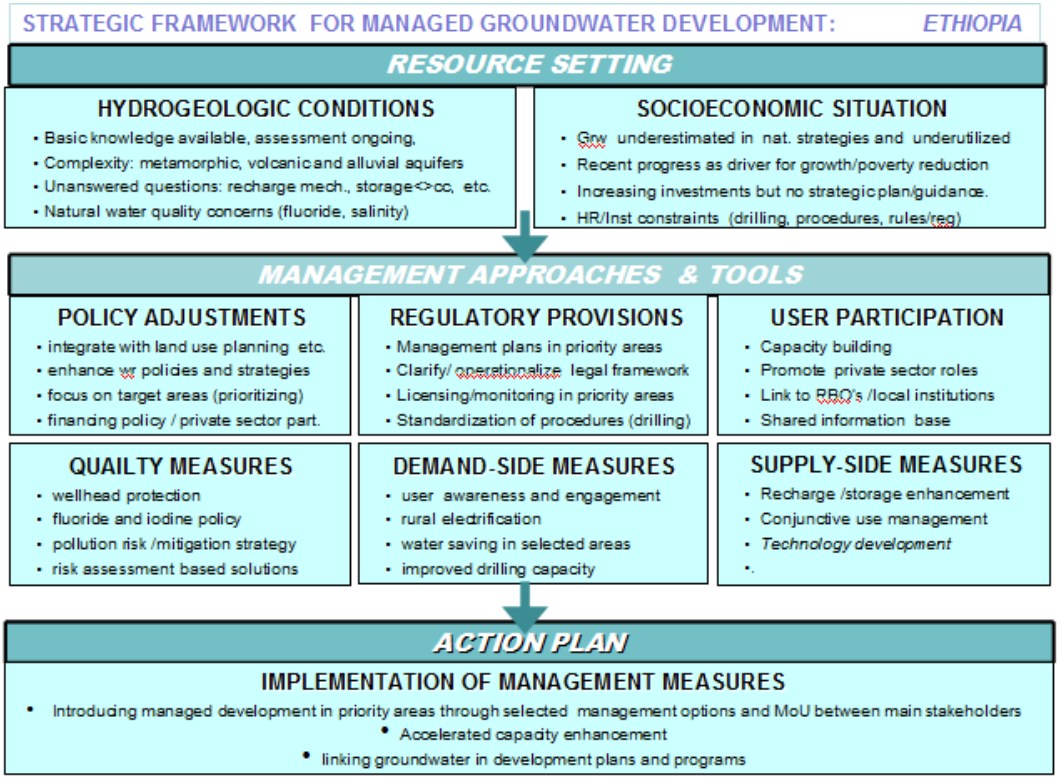


Figure 2: Strategic framework for management groundwater development in Ethiopia

The resource situation and the socio-economic situation trigger a number of instruments and measures. The first three building blocks in the management approach – ***policy adjustments, regulatory provisions and user engagement*** – create the enabling environment for effective ***measures – in managing groundwater quality and in promoting demand-side management and supply-side management***, i.e. the subject of the last three building blocks. Within each of these six building blocks the most pressing actions (at a maximum of four[2]) for managed groundwater management in the country, as it currently stands, are identified

Based on the above the following priority actions are singled out. These are activities that can be undertaken immediately and serve as a reality test for the strategic framework and managed groundwater development in general:

- prepare and implement groundwater management plans for selected areas of high intensity use – linking to local land use plans and introducing monitoring and quality protection measures.

- integrate groundwater development in larger programmes – agricultural development, irrigation development, watershed protection or road planning – making sure to maximize the benefits of groundwater use within these programme

- accelerate the development of capacity – human and material, public as well as private sector

[2] Starting point was that a maximum of 4 issues per block are formulated in order to keep the framework concise and to ensure that the selection process keeps a focus on the priority issues.

The strategic framework for the whole country should be used to define regional management frameworks for Regional States or for example for river basin or areas of intensive groundwater development. The national framework identifies the actions to be taken at national level – in terms of enabling frameworks and national policies as well as resolving the trans-boundary and interstate nature of groundwater management issues. These issues are the starting point to formulate practical frameworks and action plans for the regions or other areas. These plans are prepared in close consultation with the main stakeholders and will lead to issues which are more focused on the specific management issues in the region and result in a practical framework with for concrete actions for managing the groundwater development.

1.4 This report

This report presents the second version of the Practical Framework for the Addis Ababa region – following the same format as the National Framework and the 1st version of the Practical Framework for the Addis Ababa region. The first framework is updated in consultation with a newly established AMAR task force (Annex)from Federal Institutions, Organizations from Addis Ababa City Administration and the Oromia Regional State and contains the specific information on the practical framework for the Addis Ababa – Oromia Special Zone Aquifer Management Region and the proposed way forward to make it operational

2. GROUNDWATER SITUATION AND ISSUES

2.1 Addis Ababa Water Supply

Addis Ababa is one of the fastest growing cities in Africa. Celebrating its 125th years of establishment, Addis Ababa has close to four million population at present. It is one of the oldest and largest cities in Africa, hosting 30 percent of the urban population of Ethiopia, Addis Ababa, the capital of Ethiopia and the diplomatic centre of Africa, is one of the fastest growing cities on the continent. Its population has nearly doubled every decade. In 1984 the population was 1, 412, 575, in 1994 it was 2,112, 737, and it is currently thought to be 4 million. UN- HABITAT estimates that this number will continue to rise, reaching 12 million in 2024. (United Nations Human Settlements Program (UN-HABITAT), 2008). Despite this figures and the alarming spatial expansion (Fig. 3) the Central Statistics Agency estimate the population growth of the city to be only 2.1% per (CSA,2007).

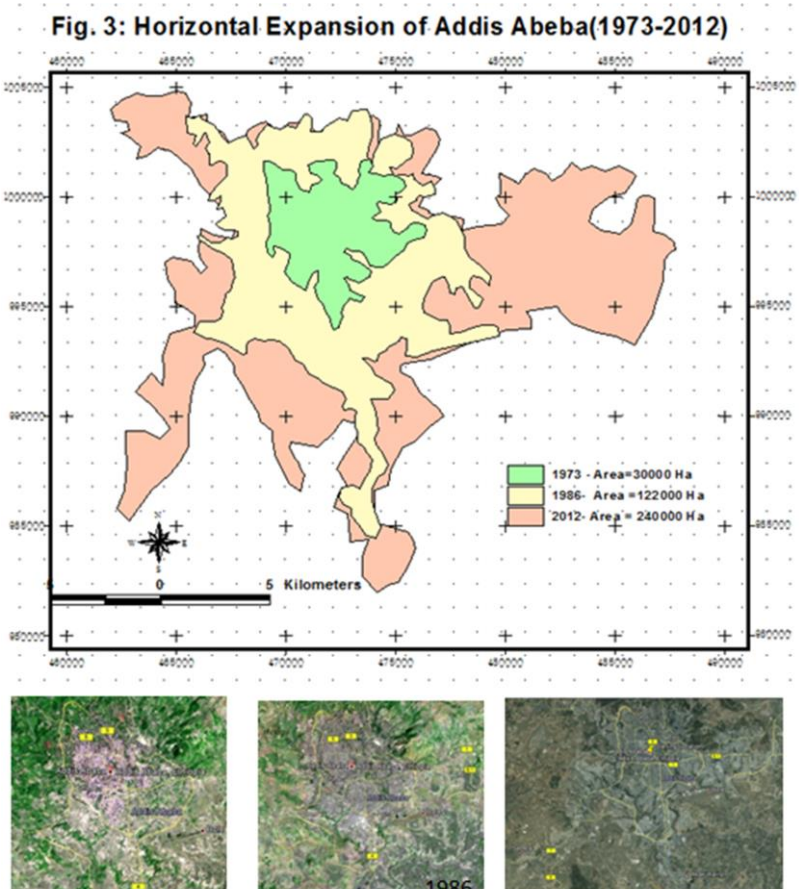


Fig.4: Well field on border of Oromia (left) and Addis Ababa (right)

As in other comparable cities groundwater contributes increasingly to the water supply of Addis Ababa. The most current estimate is that surface water provides 195 Ml/day and groundwater 105 Ml/day of the municipal water supply provided byAAWSA. The recently completed study of well fields revealed the possibility of abstracting additional 233Ml/day (WWDSE, 2012). In addition there is private pumping. The quantity of this is unknown.

Well licensing is not done systematically and an up to date well inventory is missing. The Addis Ababa Environmental Protection Agency estimates that there are close to 1000 wells in Addis Ababa – yet has a register of 500 wells only. This picture is not different from other fast growing cities where in recent years groundwater resources are being developed as an important complement to earlier surface supplies. In for instance Nairobi, Lusaka and Dar-us-Salam groundwater development is recent and taking care of at least 15% of urban water supply and regulation of private wells is incomplete.

2.2 Groundwater occurrence and use

Compared to other parts of the country, the groundwater potential in Addis Ababa region is relatively well investigated. All of four categories (see annex 3) of aquifers occur in Addis Ababa: the very shallow aquifer (below 30 meter), the shallow aquifer (30-100 meter), the deep aquifer (100-250 meter) and the very deep aquifers (beyond 250 meter).

Fig.5: Production well at Akaki well field

The most intensively used aquifers are the shallow and deep aquifers. These serve as the source of water for AAWSA, but at the same time they are also increasingly used by private parties – such as industries and horticultural farms. For the moment the shallow aquifer contributes importantly to the water supply of Addis Ababa – through the Akaki well fields and through wells drilled in different parts of the city. In recent years investigation of the deep and very deep aquifers has revealed possibility of finding large discharge wells and significant numbers of wells have been drilled for Addis Ababa water supply. The shallow and deep aquifers underlay both Addis Ababa and Oromia Region. There are no as such serious conflicts yet – but in the near future the intensified use for agriculture requires more coordination and regulation.

2.3 Groundwater exploration

Integrated groundwater exploration work has been undertaken to identify potential well fields for development. This study which is done in the five well fields: namely Legedadi-Legetafo, Ayat Fanta, Sebeta-Tefiki, Melka kunturi, and South west Akaki well field has revealed the total production if all

well fields developed is to be about 458 Ml/day. So far about 26 deep wells are drilled with a capacity of yielding 73,00 0M^3/d (most of the wells are drilled in WF-1). Average depth of recently drilled wells is around 500 m and average discharge is 65 l/s in some wells it is more than 100 l/s. There are also few artesian wells with large discharges.

There are also strong indications of the presence of a very deep aquifer (with depths above 250m) with an expected high potential. The recharge zone of this aquifer is expected to extend to the Abbay Basin. A drilling program for additional wells is underway to drill deep production wells (500 m).

Plans are afoot to develop groundwater for irrigation – particularly in the Ada and Becho plains. The constructions of pilot irrigation schemes are being undertaken in various places of these plains. In general an increase in demand for groundwater is highly likely both from the shallow aquifer and the recently discovered deeper aquifer. In the latter case pumping costs are manageable because of artesian pressure – making well development attractive, particularly, when the capacity to drill at this level increases.

Parallel with the development of the groundwater for water supply, to meet the increasing demand, AWWSA has secured budget to implement the Gerbi Water Supply project, which has the capacity of supplying 250Ml/day. It is located North of Addis Ababa on Sululta plain. Both Gerbi and Sibilu dams are located within the proposed aquifer management (AMAR) boundary to make the implementation of AMAR GWM framework more important and timely.

2.3 Groundwater quality

There are quality concerns on the very shallow and shallow aquifers. If not well monitored and protected, the concern may also include the deep and very deep aquifers. The vulnerability of groundwater to pollution is a factor of the local subsurface infiltration and the nature of the multi layered aquifers. The subsurface infiltration condition of Addis Ababa area is governed by the thickness and hydraulic conductivity of the unconsolidated sediments overlying on the weathered and fractured volcanic rocks. These sediments are classified into three groups: alluvial, residual and lacustrine clay deposits Engeda 2001[3]). The alluvial deposits - mainly composed of clay - are found along the Akaki River and its tributaries. The high elevation, ridges and steep sloped areas of the city on the other hand are covered by thin layer of residual clay soils while watershed divide and plain areas of the town (central and upper part of the town) are covered by thick residual clay soils. The southern part of the town (Akaki and Aba Samuel area) is covered dominantly with very thick lacustrine deposits. The lacustrine deposits are black cotton of highly plastic clays with thickness up to 40 meters. Infiltration is particularly high in alluvial and thin residual deposits.

Where the aquifer is unconfined and groundwater depth is less than 80 meters pollution risk is high. Areas with semi-confined aquifers are considered as low vulnerability because the semi-impermeable strata prolong the travel time of the contaminants. The confined zone of the groundwater of Addis Ababa area is considered negligible vulnerability to pollution due to the high confinement of the groundwater with impermeable strata.

[3]Engida (2001), Groundwater Study of Addis Abeba Area. Report 01/1993.

Because of these settings the relatively shallow aquifers to the south of Addis Ababa are most prone to contamination discharge from Addis Ababa – whereas the pollution risk for the very shallow aquifer to the north of the city is less. For the deep and very deep aquifers the reverse is true. Here the largest contamination risk is in the northern part of the city , whereas because of the protection from thick clay beds the contamination risk of the deep aquifers is less in the southern part of Addis Ababa.

At present the highest pollution is measured around the Merkato Area The high nitrate and chloride observed at Merkato Area corresponds to the maximum population density within Addis Ababa. In addition to nitrate, many springs in the city are highly contaminated and have large number of coliforms. The contamination is most probably due to:

- Poor well construction of boreholes and improperly abandoned wells
- Septic tanks and latrine pits closely located to wells that provide contaminate pathway as a short and through the unsaturated zone

There are indications that water quality in the Akaki well field deteriorated after the well field came in operation insufficient well head protection in particular appears an important factor. In addition no groundwater protection is in effect in Addis Ababa at the moment.

3 PRACTICAL FRAMEWORK FOR THE ADDIS ABABA REGION

3.1 Introducing the framework

Figure 3 gives the Practical Framework for Managed Groundwater Development for the Addis Ababa region as it is developed by the core team. Similar to the national strategic framework for Ethiopia it is based on available data and information and set against the resource context and socio-economic situations. The management approaches and tools are described in the next section (3.2-3.7). The priority actions which were deducted from the exercise are summarized in figure 3 and further explained in chapter 4.

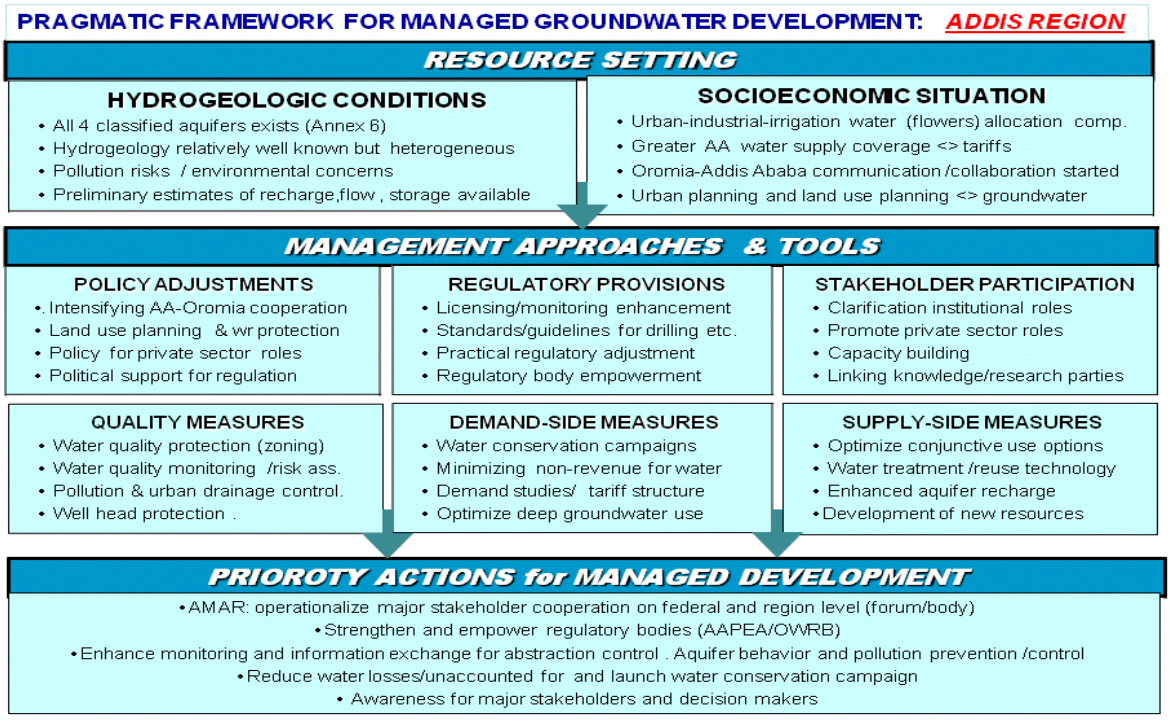
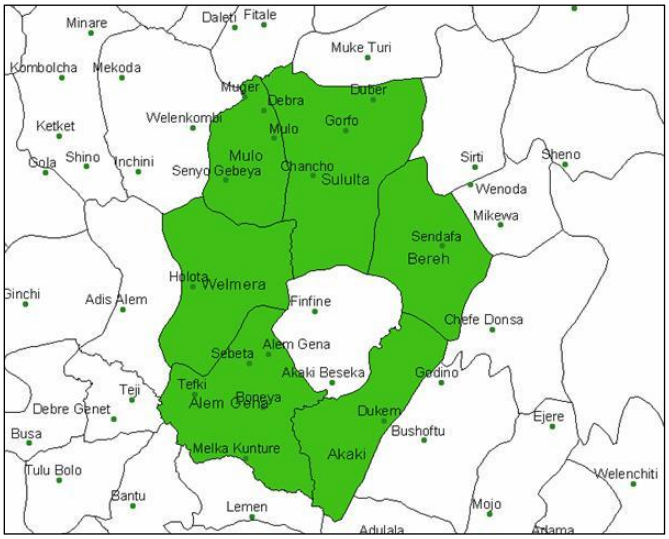


Figure 6: Practical framework for managed groundwater development in Addis Ababa region

3.2 Policy adjustments

Cooperation between Oromia and Addis Ababa

An encouraging development is the cooperation between Addis Ababa and Oromia Regional State with respect to land use planning and regional development. Cooperation between Oromia Regional State and the Addis Ababa City Administration needs to be further elaborated, since the aquifer is shared between the two regions. The Oromia Special Zone consists of six woredas surrounding Addis Ababa (see map). Land use plans have been prepared for these woredas and the eight major towns located in these. Part of the land use planning is the preparation of a Green Belt.



The Special Zone constitutes a large part of the recharge area and part of the developed well field areas. Cooperation between the Addis Ababa City Administration and the Oromia Special Zone Administration and/or the Oromia Regional State should be intensified to include the management of surface and groundwater. The cooperation in managing the water resources could be an integral part of the overall common development cooperation between the two regions.

Figure 7: Oromia Special Zone (in green)

Linking land use plans and groundwater management

Land use plans have been prepared and been approved for the Oromia Special Zone. In the land use plan prime land is allocated for agriculture and floriculture, whereas land that is less suitable is allocated to housing. The development of new heavy industry is planned in the South East of the Special Zone, away from the shallow aquifer recharge area. Environmental protection zones are planned around the urban centers, stretching for 3-5 kilometers. Along perennial and intermittent streams and around reservoirs buffer strips of 50 to 100 meters have been designated. The land use planning could be further expanded to include managed recharge – retaining run-off in recharge zones, dovetailing road design and urban design with recharge. The plan needs to be extended to include the Addis Abeba City Administration and due attention need to be given to its implementation. Otherwise, the integrated land use plan within Oromia Special Zone alone couldn't be enough to protect the hydrogeologic system, as the source of major pollutants is the city.

Policy for private sector roles

As described in the National Framework, where groundwater has taken off it has been through private sector investment and services. This requires both a facilitating environment and a regulatory regime. There needs to a clear vision on how to engage the private sector in groundwater development and management in the Addis Ababa region, including:

- Clarity on regulatory procedures
- Opportunities to develop private sector role and capacity in drilling, well operation, monitoring compliance and communication.

Support for regulation

The reverse side to enlarged private sector involvement is better regulation. Currently regulation is weak and has no priority, as is clear to the meager manpower dedicated to it, the logistical means and the political support for enforcement. If groundwater use is to intensify and extent to agro-

economic use, regulatory activities need to be better resourced both in Addis Ababa and in Oromia. This should start by enforcing the regulations that are there by making the minimum required resources to do so available.

3.3 Regulatory provision

Enhancing monitoring capacity

Monitoring – even on the Akaki well field – is non-existent. The installed two monitoring wells are non-functional. Basic information on groundwater levels or total number of functioning wells for instance are incomplete or has not been recorded, making it difficult to make an assessment of the sustainability of groundwater extraction – by AAWSA and by other groundwater users . It is proposed to develop the monitoring and management of the Akaki well field – also to set an example nationally (see chapter 3.2). AAWSA already has a field unit that records abstraction and sees to it that the estimated safe yield is not exceeded. Recording water table depths and water quality should be added to its workload. A monitoring plan for Addis Abeba region should be developed and implemented.

Fig. 8: Abstraction strictly monitored in Akaki well field

Well development guidelines

It is proposed to develop national well drilling guidelines and the Ministry of Water Resources has made a start of this (see also chapter 3). The urgency of these guidelines is particularly high in the Addis Ababa region where intense exploratory drilling is taking place. In the drilling of the test wells a large variation in quality and techniques is observed. The well drilling guidelines would help to set quality and abstraction standards in well development and to protect the well drilling sector against unfounded complaints. The well drilling guidelines should make use of standardized well designs – in the case of Addis Ababa in particular issues associated with increasing diameter of the wells should be handled carefully, as the wells that are currently drilled are bigger in dimension which adds to the vulnerability of deeper aquifers unless proper protection measures are in place.

Strengthen regulatory body

Groundwater regulation should be strengthened. Licensing is now done by Addis Ababa EPA and Oromia Water Resources Bureau, but the effort is piecemeal and incomplete. On top of this the former licensing institution has mandate conflict. There is a large backlog particularly in the Addis Ababa city limits with many wells unregistered. Any effort in groundwater regulation should start

with reconstructing an up-to-date database of production wells – privately and publicly owned. There have been cases of the EPA being overruled moreover by the major stakeholders – when it objected on the development of some new AAWSA wells. Rather than overruling it is better than adding an objection clause to the current regulation. All in all regulatory enhancement should be practical with licensing and after licensing requirements being at par with the capacities of the regulatory bodies and the well owners.

3.4 Stakeholder involvement

Institutional roles

There are a large number of organizations whose activities have a bearing on the sustainable use of groundwater – from regulation, abstraction, recharge and quality point of view. It is encouraging that groundwater has already moved into the realm of land use planning – opening the scope to manage groundwater beyond the water domain, yet there is no organization that masterminds the management or development of groundwater.

Although there are few institutions like the MoME who are directly accountable, the development and management mandates of the water resources in Ethiopia is practically spread over many institutions. At federal level the main stakeholders are the Ministry of Water and Energy, the Federal Environmental Protection Agency, the Ministry of Mines - in particular the Ethiopian Geological Survey, the Ministry of Agriculture (as it concerns land use), the Ministry of Urban Planning and Ministry of Health and in the private sector the large groundwater user industries. Drillers' Association and Ethiopian Association of Hydrogeologists are also key actors. At regional level the major stakeholders are the Oromia Water, Mineral and Energy Bureau, the Addis Ababa Water Supply and Sanitation Authority, the Addis Ababa Environmental Protection Agency, the Oromia Land Use and Environmental Protection Bureau, and Housing Bureaus and Regional Urban Bureaus. The activities of all organization have a bearing on groundwater use and management. Roles of major stakeholders are shown in Annex 5. Several of the organizations mentioned above undertake activities that have a bearing on sustainable groundwater management – but so far have no explicit program in the field.

Capacity building

As the use of groundwater intensifies, the need for trained staff and informed users increases. This point was also made in the discussion of the national framework (section 3.2.3 and annex 3). The large need is for drilling supervisors, hydrogeologists and groundwater development and groundwater management. As the region is well endowed with educational institutes educational programs and in-house training should be dovetailed.

Linking knowledge and research parties

The complaint from practitioners and policy makers vis-à-vis the knowledge institutes is that (a) groundwater development and management gets very scant attention and (b) the attention is often far from practical. There is a need to reengage – by having trainee ships, guest lecturers, discussion on the curriculum and engaging university staff and students in studies. This is possible with the

universities and vocational training centres in the region. A mechanism that can be utilized in this respect is the University Water Sector Partnership, the Ethiopian Institute of Water Resources and many other water and environment programs in different universities that aim to bridge such gaps and coordinate activities in this respect.

Private sector roles

Private sector roles in groundwater development need to expanded and intensified – among other the Drillers Association and large groundwater user industries. Incentive structures should be created for private well developer to expand their business – both through contract arrangements and through financial incentives. At present focus has been on strengthening public sector for instance through procurement of drilling rigs – but more incentives should be created by strengthening private sector capacity. This can be done by a number of activities:

- License consultancy companies for drilling in shallow to very deep aquifers
- Carry out regular audits of work done by drillers and consultants, and link extension of permits to performance
- Design guidelines and schedules for borehole drilling project implementation
- Include borehole siting specifications in standard contracts as well provision for failed drillings
- Closer monitoring of NGOs and enforce implementation procedures according to standard documents
- Introduce engineer's estimates for drilling and siting
- Review taxation framework for the sector
- Facilitate access to credit for drillers and consultants
- Set up training programmes (collaborate with private sector) and courses
- Improve compliance and enforcement of water laws, permits and licensing conditions for drillers and consultants.

3.5 Quality measures

Water quality protection through zoning

The importance of protecting the quality of the vital groundwater resources in view of rapid urbanization and industrial development in the Addis Ababa region is imperative for long-term sustainable development.

An elaborate study[4] undertaken with the help of UNEP and UNESCO has mapped the risk of groundwater contamination in the area and is still valid. This should be the basis of zoning regulation that would regulate the siting of potentially polluters – petrol stations, industries, waste disposal

[4]Tamiru Alemayehu, Dagnachew Legess, Tenalem Ayenew, Yirga Tadesse, Solomon Waltenigus and Nuri Mohammed (2005), Hydrogeology, water quality and the degree if groundwater vulnerability to pollution in Addis Ababa, Ethiopia. UNEP, UNESCO.

plants, graveyards and the investment in sanitation measures. In addition protection zones based on pollutant travel time around critical assets – in particular well fields – should be enforced. Maps should be produced that make the zoning visible in a single overview.

Water quality monitoring and risk assessment

Water quality deterioration as a result of anthropogenic impact is evident around Addis Ababa. Samples collected from nine sites (Coca Cola well, Ras Mekonen spring, Tsebay Maremiya well, Anwar Mosque well, Africa Hotel well, Lideta spring, Mekanisa Abo spring, Abune aregawi spring and Ras Hotel well) are found contaminated and had more than the maximum acceptable concentration (MAC) of nitrate. The distribution and extentofNO3-is mapped based on the result and showed the central part of the city had higher concentration from 58 to 102mg/l pollution ofNO3- and Cl-might be due to the similar sources like seepage of pit latrines and infiltration of polluted effluents (Girma Hailu, 2011).

Monitoring of groundwater quality should start to be able to assess the Extent and degree of contamination. At present groundwater quality monitoring is being done fragmentarily. This should also be tied to drinking water provision for the city and the surrounding town sand rural population and become a routine activity on given production and observation wells. In connection to uncontrolled wastewater disposal and its subsequent use for irrigation purpose, monitoring shall include both the effluent content and the subsurface environment as this practice undoubtedly accelerated the degree of Groundwater pollution. The impacts that may come from the growing expansion of commercial and complex irrigation horticultural practices and the increasing use of fertilizers and pesticides by the farmers on rain fed agriculture shall also be part of the monitoring activities.

Well head protection

Insufficient wellhead protection has been identified as a cause of deteriorated water quality in the Akaki well field. Part of the well design standards proposed to be developed as part of the National Framework would be to include well protection. Observations around Akaki for instance show that there are sources of seepage from drain water surrounding some of the wells. This needs to be corrected.

Fig. 9: Scope for improving wellhead protection

3.6 Demand side measures

Reduce unaccounted for water

Though water availability has not reached the critical levels as it has in several other fast growing third world cities, water sources is precious and needs to be saved. Addis Ababa is more than a century old and it is lacking properly planned water supply network. In old quarters of the city the water supply pipe network is very old and served beyond its service time. For these and other reasons, the figure for so-called unaccounted for water are in the order of 30-40%. Clearly such figures are at variance with the high costs of exploring and developing water resources in the larger Addis Ababa area: particularly as the city depends on sources outside the municipal borders it is difficult to accepts such large losses.

Water conservation campaigns

Water conservation is also an important issue in (future) agricultural, industrial and domestic uses. Particularly as deep aquifers with large recharge will be developed at substantial cost, cost conscious use is important. This should be encouraged by at least full real cost pricing for agricultural and other wasteful consumptions that may aggravate pollution and wastage of the resources. There are best water conservation experiences in cities around the world that can be used for the campaign.

Looking at tariff structures.

Tariff structures particularly for large consumers should reflect and should encourage efficient water use – not necessarily through paying for water consumed but also by bonus or malus system for efficient respectively wasteful water use.

The value of water is apparent from the difference in land prices in area with and without reliable surface water. This difference in prices should also be captured by the water service provider and regulator.

3.7 Supply management

Conjunctive use

Several supply side measures also contribute to the sustainable management of the groundwater. Conjunctive use is an important one. In case of the Addis Ababa area the operation of surface water reservoirs and groundwater abstractions should be synchronized. This has two dimensions:

- The surface water storage is more vulnerable to dry spells. By maintaining a balance in water supply from both surface water and groundwater, the provision of water to Addis Ababa and other fast growing cities in the region is secured during cycles of dry years too.
- There is also a need to consider the sharing of water from both (newly developed) surface water and groundwater sources between the Addis Ababa and the Oromia Regional State – particularly in the Growth Zone and there is hence a case in future water resource development plans to take into account the interests of the entire urban conglomeration
- Growing horticultural farms need to consider application of 3R and rain harvesting to minimize abstraction of the groundwater and extend use of surface runoff.

Enhanced aquifer recharge

In the catchment of Addis Ababa there is scope for enhanced recharge – particularly when linking recharge to improved watershed management programs, road planning and land use planning. Also the urban surface entire in the region increases the removal of storm water – and subsequent retention and reuse becomes more important. Storm water can be collected and spread over recharge zones – provided water quality allows. The spread over of Akaki and other polluted rivers for irrigation agriculture is a typical example for negative consequences.

Managing waste and storm water

Water use in the Addis Ababa area depends on both surface and groundwater and it is important that water from both sources is managed in a conjunctive manner. This concerns the water supply to Addis Ababa – where groundwater can act as a safety valve in drought years – compensating for low surface water supplies.

There is also a case to link wastewater and storm water into conjunctive management. Both sources can be an opportunity as source of recharge and storage but also a threat i.e. as a source of contamination. The planning of the sewer and wastewater disposal system should take this into account. The following areas are of help:

- Most sewerage water in Addis Ababa is untreated and the sewerage service coverage is only 7%. By anaerobic or aerobic treatment waste water can be made reusable for recharge or linkage to surface storage bodies
- Related to this using natural wetland areas and lakes around Addis Ababa should be investigated for their contribution to improved water quality (the kidney function) and creating other high value amenity (recreation, attractive housing)

Development of new groundwater sources

The development of new groundwater resources should be accelerated – following the ongoing assessment. Several promising well field location have not been explored.

Socio-economic assessment (small holder farmers', green house, fertilizer and pesticide use)

The complex and dynamic socio-economic situation with the proposed area of AMAR will inevitably affect the successful implementation of AMAR. The worsening poverty condition of the rural AMAR areas and the booming growth of Addis Ababa and the surrounding Oromia towns determine the future water use and environmental situation within AMAR. The rural community needs, potentially arising water use conflicts and possible collaborations have to be addressed in designing AMAR implementation plans.

4. Priority actions for managed development in Addis Ababa area

The priority actions that are formulated in framework are:

- Setting up an AMAR: a forum or body for groundwater management in the Addis Ababa and Oromia as a mechanism for coordination and stakeholder cooperation
- Strengthen and empower regulatory bodies in Addis Ababa and Oromia Region
- Enhance monitoring /information control for abstraction control, aquifer behavior and pollution prevention
- Reduce water losses/ unaccounted water and launch a water conservation campaign
- Create awareness among major stakeholders and decision makers

4.1 AMAR – shared groundwater management arrangements

The main immediate action is the establishment of arrangements for shared groundwater management arrangements in the larger area surrounding Addis Ababa. It is proposed to strengthen stakeholder cooperation in the aquifer surrounding Addis Ababa and come to an AMAR – ***Aquifer Management in Addis Ababa Region.*** It is proposed that the MoWE initiates this process – and brings together the main parties from Federal institutions and both Addis Ababa and Oromia Regions. Proposed is to link the AMAR strongly to the Oromia Special Zone Administration and the Addis Ababa City Administration – preferably as a partnership initiative of both organizations. The proposed area of operations of the AMAR would be as given in figure 4 and concerns the area of recharge and discharge of the very shallow, shallow, and deep aquifer systems – and the area of discharge of the very deep aquifers.

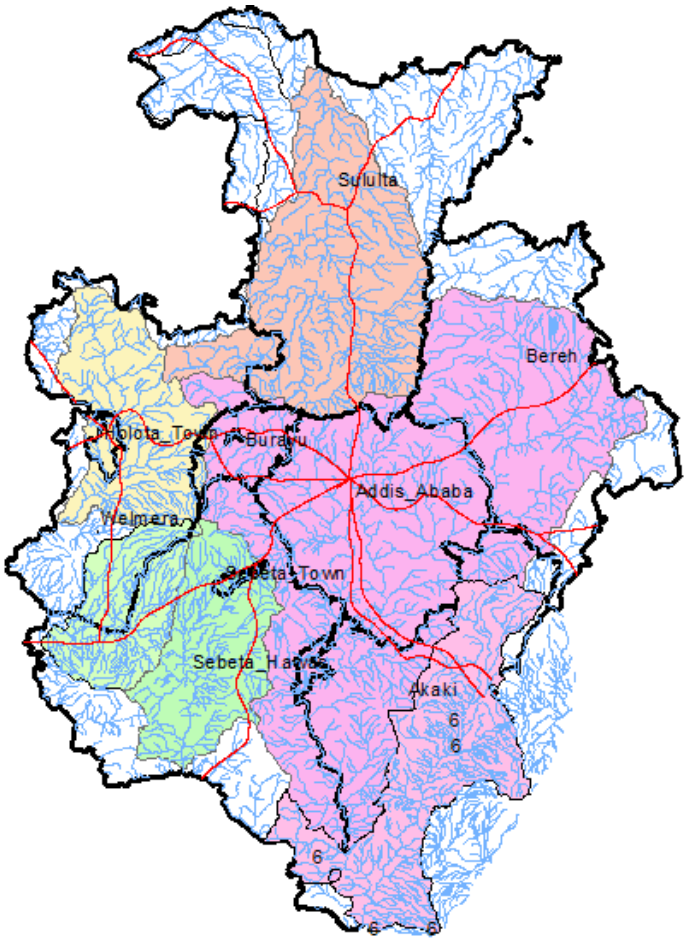


Figure 10: Proposed area of operation of AMAR and Major Catchments

The tasks of the AMAR could be:

- Coordination mechanisms between the two states on groundwater assessments, development and management – including urban drainage, waste water reuse and reservoir operations.
- Coordination with all parties in the two states on steps in groundwater protection – including land use planning and zoning
- Clearing house for all existing studies and information sources with respect to groundwater
- Initiate inventory of current abstraction with relevant institution in AA City Administration and Oromia Water Resources Bureau
- Coordinate promotion and awareness campaign both for general public and decision-making audience on aquifer characteristics and risks and opportunities of groundwater development.

If basic agreement on the AMAR is reached the institutional setting, staffing, short-term program, establishment and operational budget can be worked out.

4.2 Improving current regulation of groundwater use

Existing water act and regulations didn't address groundwater development, management and administrative issues at the required detail levels. For this reason, the implementation of AMAR needs to be supported by ample regulatory capacity in both Addis Ababa and Oromia Region. In both Oromia and Addis Ababa regulation of groundwater use should be strengthen and empowered. This requires:

- Provision of increased mandates and regulatory tools
- Widely announce licensing arrangements
- Increase staffing and logistical arrangements
- Undertake well inventory
- Retroactive licensing where appropriate, but also where necessary closing wells.

4.3 Enhanced monitoring and information exchange

Monitoring of groundwater levels and groundwater quality needs to start – preferably under the aegis of AMAR. A routine basic monitoring program should be put in place, consisting of:

- Measurement of discharge from well on the basis of water meters on shallow and deep wells. The discharge measures should be cumulated daily as well as weekly, monthly and annually
- Water quality should be sampled on production wells – preferably by the well operators and the requirement to sample quality twice a year should be part of the license
- In well fields and private intensive groundwater well development areas special monitoring wells should be established and need to be networked– indicatively one out of 20-40 wells. From these monitoring wells one month conductivity and temperature at different depths should be collected, as well as a full set of water quality indicators twice a year.

These data should be made available in the public domain – preferably as part of the AMAR outreach programs.

4.4 Reduce water losses and unaccounted for water

A measurement program assessing the main losses should be undertaken both in Addis Ababa and in other main settlements in the AMAR. The first step is to single out the areas of major losses on the basis of area inflows and consumption estimated – followed by using techniques and equipments for leakage detection and control in the distribution system. Next the scope for leakage control will be elaborated focusing on pressure dependent outflow; optimal valve locations; and the design of pressure management areas.

4.5 Create awareness amongst public and decision makers

The action can be taken up by the AMAR and requires that expertise on this subject in part of the AMAR staffing. Awareness raising may include a variety of outreach activities which are designed on the basis of a needs assessment and priority setting. Use can be made of material already used for similar purposed in side Ethiopia or abroad.

5. WAY FORWARD

In spite of the importance of groundwater now and in the future, institutions in managing groundwater are weak in the Addis Ababa Region. This is a point of concern, as one would expect in the country Addis Ababa to be a front-runner in this field. Monitoring – either of water levels, water quality or abstraction is not taking place. The regulatory framework arrangement concerns mainly well licensing by EPA. Apart from the problem in the given mandate, capacity of EPA in this respect is very limited and in fact the wells that are licensed are the ones developed by AAWSA. With a few exceptions privately developed wells are 'out of sight'. A more intensive use of groundwater would require a commensurate development of groundwater management institutions.

This first version of the practical framework for the Addis Ababa region addresses these issues and provides a roadmap to develop a broadly supported framework to manage the groundwater development in the Addis Ababa Region and ensure a sustainable allocation and use of the groundwater by the different stakeholders

Proposed next steps to bring this 1st version of the framework into practice are:

- form task force for the establishment of the AMAR and the preparation and implementation of the action plan under the guidance of the MoWR: (members could be: MoWR and other federal Ministries, Oromia Water Resources Bureau and other regional Bureaus in Oromia, Addis Ababa City Council, AAWSA, EEPA, Drillers Association, EHA, EGS, panel of experts member).
- Form a core group to endorse the work by the task force (members could be: Office of the PM, House of Federation, MoWR and MoUDC, EPA, Oromia Regional State and Addis Ababa City Council).
- reach broad agreement on the priority actions and the main targets in the coming 3 years
- prepare a position paper on the establishment of AMAR (composition, main regulatory tasks, legal mandate, organization, 3 year work plan, financial plan etc.)
- Communication with the management of the main stakeholders organizations to get their feedback and seek formal clearance
- Finalization of the AMAR organizational and operational plan
- Workshop with all stakeholders to present the final plan and launch AMAR
- Support to the implementation of the action plan

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Annex:

ANNEX 1 Summary of issues in knowledge, capacity and management

Knowledge

Issue	What is being done	What is missing
Geological surveys	- Geological maps (1:250000) 62% of the country - Hydrogeological maps 54.6 % of the country - Based on borehole information not on test drilling information and integrated method - Accelerated investment in assessment/exploration - implemented by MoWR and regions - MoWR largely engages the public enterprise WWDSE for this purpose	- Integrated groundwater exploration including test drilling for high potential areas - Lowered pace in covering the remaining area through mapping: EGS not able to live up to its mandate, other institutions are engaged in mapping – but with doubtable standard - Current assessment project wise and not linked to EGS set procedures

Information base	- Limited knowledge on:
	  ○ very shallow aquifers
	  ○ deep aquifers
	- Non reliable knowledge on shallow aquifers
	- Water quality has not been well defined and mapped
	- Scattered information – work on ENGDA discontinued
	- NGIS recently started
		- NGIS to be developed over coming years
		- Communication and dissemination strategy/ business plan

Monitoring	- Not done only patchy and project based – not even in high intensity area as in Akaki - Emerging uses of groundwater for irrigation and seeking deep aquifers for their high yield and lowered pumping cost demands very systematic monitoring	- MoWR to gazet priority areas for monitoring - Clear responsibility for well field operators - Link to NGIS
Sustainable yields	- First estimates for number of aquifer systems – but not for others - No water balances - Developed on demand basis without considering the available potential and multiple and unforeseen uses - In different localities, yields are affected by over use, climate variability and land degradation	- Confirmed prior to operation of well field - Level and abstraction monitoring in line with confirmed sustainable yield - Link to groundwater management plans - Consider multiple uses and growth dynamism - Linkage groundwater monitoring with hydrological monitoring

Capacity

Issue	What is being done?	What is missing?
Exploration	- Poor capacity to explore deep aquifers – poor supply - Public enterprises have poor capacity and management in complex well drilling - Little engagement of private sector in drilling complex exploration - Problematic contract management observed from both sides – supervision/ contract management	- No (in-country) training on deep well drilling - Limited number/no critical mass of organizations - Poor incentive mechanism as compared to other sectors in the country - Good supervision (arrangements) missing
Mechanical drilling	- Absolute shortage of drilling rigs (conservative estimate is 200- 600) – partly addressed by recent procurement drive - Shortage of submersible pumps, generators and spare parts - gap in local maintenance capacity and supply of fast moving items.	- Drilling rigs – specific to conditions (deep wells/ sediments) - Maintenance of drilling rigs to ensure continued operation
	- Presumably relatively high cost of drilling compared to other African countries- partially caused by the high cost of steel casings used in almost all drilling below 100m.	- Competition and little engagement of private sector - Little use of high pressure and high density UPVC pipes at depths beyond 150meters
	- Relatively high number of failed wells – 15% to 75% varying with regions- most of the time for technical reasons	- Analysis of well failure – probably related to lack of local engagement/ technical supervision – in some areas due to water quality issues
	- Discussion on standardizing well design started by MoWR	- Standardization
	- Professional associations like drilling and Ethiopian hydrogeological associations just set up	- Drilling association and EHA to become active partner in development of the sector
Manual well development	- Limited well development even in high potential ultra shallow aquifer - Dug well dominate	- Very shallow borewell technology – which allows deeper penetration - TVETs engagement/ private sector training - Popularization of manual drilling – among others
Expertise in groundwater development	- Pump tests not systematically done - 25-60% vacancies in 2008 (JICA report). The problem exacerbated after the road and the construction sectors become more attractive	- Training of: chief drillers, hydrogeologists and water supply engineers - Incentive mechanism and better work condition - High capacity equipment for pump tests and well development

Expertise in groundwater management	- Groundwater curricula recently being strengthened in five universities - Ethiopian Institute of Water Resources Established - PhD program in hydrogeology started at AAU	- Capacity to monitor in terms of manpower and equipment - Centers of Excellence in Groundwater development - Coordinated effort among educational institutions

Management

Issue	What is being done	What is missing
Managed development	- Accelerated highly ambitious exploitation plans/ concept for growing number of areas - Increasing use of the very shallow aquifers and emerging conflicts	- Groundwater management plans – with stakeholder engagement - Inadequate regulatory tools and lack of standard
Inter-linkage with other sectors on demand side	- Integrated land use planning process – backed by water resources assessment started in Oromia, Amhara, Somale, Afar and Gambela Regional States - Growth corridors plans - UAP	- Need to expand and need to broaden and put implementation perspective/ EGRAP Plus - Good starts on preparation of ILUP and corridor development approach are slowed -down
Inter-linkage with other sectors on supply side	- Watershed improvements programs exists but no focus on recharge, - Irrigation development but not conjunctive - Unplanned multiple use of water is emerging	- No systematic linkage and not all buffer techniques used - Conjunctive management - Assessment of impacts of recent massive watershed management activities on groundwater - Consideration of multiple use
	- Integration with land use planning on supply side	- Harmonize watershed programs with buffer management – differentiated approach
GW protection	- Not there - No enforcement of EPA rules, standards and guideline to protect aquifers from point or non-point source pollution	- Protection zones in selected areas (legal backing?) - More focused regulation around high priority point pollution - Enhancing law enforcement capabilities
Regulation	- Licensing procedure for well development in place but not known nor systematically followed - Civil code set the limit for regulation at 100 meter depth	- Activation of licensing procedure – especially in selected areas - Groundwater management and protection act/regulation
Groundwater management plans	- None existent	- Would be required in areas of intensive development
Monitoring	- See above (knowledge section)	-
Basin management	- RBO ordinance promulgation - Two RBO in place (Abay and Awash), others under preparation - Mechanism for allocation - Groundwater does not figure importantly	- In future ground water management plans linked in to river basin management - Groundwater need careful consideration for its trans-basin nature in some cases

Annex 2: Managing climate change effects and groundwater in Ethiopia

The impact of climate change effects on groundwater depends on a number of factors – but an important factor concern the recharge mechanisms. These recharge mechanism are shown in the table. Higher intensity rainfall – and important expected effect of climate change will in areas with hard rocks and thin soils led to more rainfall infiltration and recharge. Also in lowlands ephemeral rivers will receive more water and recharge more in case of more intense rainfall. In areas with thick soils high rainfall will not result in more infiltration – but in less recharge.

Expected effect	Impact	Response
More extensive drought periods	Drought particularly immediately impacts: unconfined aquifer , small aquifer systems and dissected aquifer systems (tectonic)	Local buffer techniques Local storage based on shallow aquifer characteristics
	Drought has less short term impact on: - large confined aquifers (large catchment/rare)	Regional buffer techniques: watershed + river management
Higher temperature	More non beneficial ET from areas with shallow GW	Accelerate dev. of small scale irrigation
	Less percolation – no standing water	Percolation techn. :contour trenchs, etc.
	Salinization risks for shallow gw in arid areas (Tana)	Lower gw table / Crop pattern
Higher intensity rainfall	Erosion > gullies lower gw table >accelerated erosion	Gully control, moisture holding cap, etc.
	Higher infiltration in areas with thin soils/fractured rocks	Fracture system analysis and mapping
	Lesser infiltration and more run off in areas with thick soils	Investment in buffer techn. / retention.
	Drainage problems in high land areas (relate to above)	Drainage
	More flooding in lowlands > more recharge / Salinization	Flood spreading techniques (spate irr.)
	Damage to groundwater infrastructure	Adjustments in flood protection design
Unseasonality	Little overall impact, buffering become more important	Invest in gw. Dev. and recharge
More rainfall	Depending on pattern but in general more recharge	Increase capacity to store

ANNEX 3: Proposed aquifer classification and management tables

Below is a proposed new classification of aquifers in Ethiopia – made to make a distinction between the different shallow aquifers. Different forms of groundwater management would apply to the different classes of aquifers:

Proposed name	Depth (meters)	Characteristics	Use	Intensity of use	Rock type	Aquifer type	Location
Very shallow aquifer	0 – 30	Hand dug wells Phreatic aquifer Low yields Bacteriological pol.	RWS SCI	Medium	A		
					B		
					D		
Shallow aquifer	30-100	Dug & drilled wells Phreatic & confined Low/medium yields Pollution hazards	RWS (UWS)S CI	Medium to High	A		
					B		
					C		
					D		
Deep aquifers	100-250	Drilled wells Main aquifers Medium yields Pollution hazard	UWS LSI	Medium	A		
					B		
					C		
					D		
Very deep aquifers	>250	Drilled wells Medium/high yields Recent development	UWS LSI	Low	B		
					C		

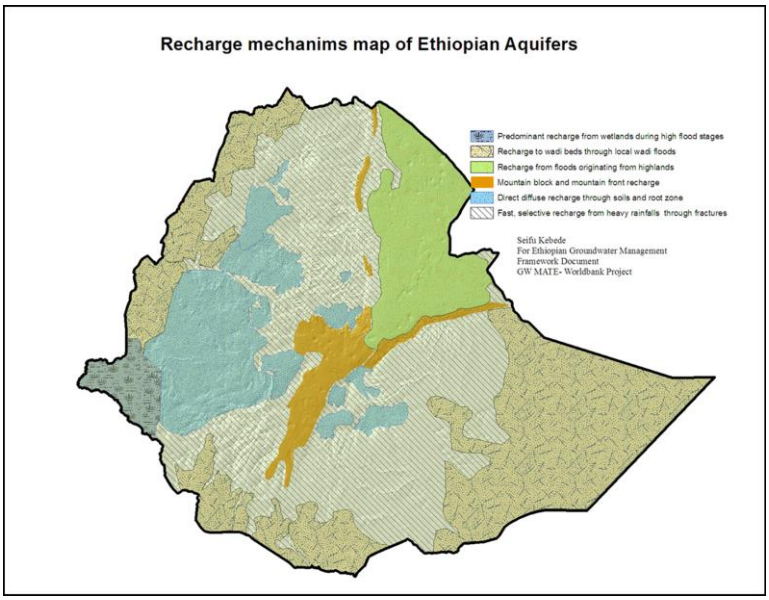
Rock type:

A Precambrian metamorphic basement rocks (cover about 23% of the country).
B Mesozoic sedimentary rocks (cover about 25%)
C Tertiary volcanic rocks—largely flood basalts— (cover about 25%)
D Quaternary volcanic rocks—largely ignimbrites—and sediments (cover about 17%)

Aquifer type: fissured (secondary porosity) (Fis) <<> sedimentary (primary porosity) (Sed)

Use Small scale irrigation (SCI), Large scale irrigation (LCI), Urban WS (UWS0 or rural WS (RWS)

Location :distinction between physical environments: H: highlands, M: midlands , L: low lands



The table below

Different groundwater scenarios and proposed management issues for different classes of aquifers

	Intensively used	**Not intensively used**
Very shallow aquifers	• Develop conjunctive use • Promote local management • Develop integration with watershed programs, shallow well irrigation and land use planning • Quality protection	• Improve capacity for manual drilling • Develop integration with watershed programmes, surface irrigation and land use planning • Promote user participation
Shallow and deep aquifers	• Groundwater management plan include land use and allocation of uses • Safeguard groundwater quality • Standardize well tech. &well head protection. • Activate regulation and monitoring	• Improving capacity for deep well drilling and maintenance services • Map natural groundwater quality and consider distance sourcing • Water allocation plan
Deeper aquifers	• Not existing yet	• Improved drilling technology and capacity • Introduce water management plan

Annex4: Some Best International Experiences

No.	Country/Town	Problem Faced	Measures taken
1	China/ Shanghai	Threatened to have been submerged in the sea- reaching up to 2.63m locally	• Shanghai was seriously threatened to have been submerged in the sea if groundwater withdrawal was not reduced from the 60's onwards. • In 1963 200 million m^3 was abstracted annually, Dominantly the industry for cooling factories in the summer • This resulted in rapid ground subsidence that measured a total 1.75 m from 1921 to 1965, locally reaching up to 2.63 m. • The city government came up with a four-fold response. – Firstly, it restricted groundwater pumping, particularly in the downtown areas. – Secondly, water users were requested to inject the same quantity of water into aquifers in winter as they pumped out in summer. – Thirdly, the industrial use of groundwater was moved out from downtown to the suburbs and more water was taken from deeper aquifers. – Fourthly, a monitoring network of land subsidence and groundwater levels was established, and a research centre was set up. • This combination of measures proved successful. • In 2007 the amount of water pumped was reduced to 40% of 1965 levels.
2	Barcelona, Spain	Threatened aquifers & lack of appropriate GWM & Admin. Institutional setup	- *Participatory aquifer management* - *Water policy* - Institutionally there is General assembly, governing board, arbitrator, technical commission and water person - There are aquifer management norms - Legal status to enforce Board decision - Hydrogeological planning boundaries - Groundwater management is based on river basin agencies (both regional and interregional) - Registration of existing and new wells compulsory - Users represented in RBA governing and management bodies - Water transaction among users allowed - River Basin Authority- o Build & manage infrastructure

			○ Monitoring quantity and quality of both surface and GW ○ Prepare water management plan ○ Keep inventory ○ Issue licence, charge use fees ○ Define hydrological boundaries ○ Groundwater Users Association (GUA) compulsory in over exploited aquifers - Water Users Associations ▪ On voluntary basis and there is members' contribution ▪ Proposed land use change ▪ Crop requirements decided ▪ Water book (Individual)- to register water and fertilizer transaction ▪ Water teller machine
3	Jordan	Lowering GW Table, well interference and use conflicts	- Water is a public property and under government control - Prohibiting drilling of new wells in most affected areas - Limiting repair of wells - All users/companies notified of the rules-violation may result in confiscation of rigs and crew will be arrested - 10 years of full inventory - All wells in the country have files - Meters installed in all wells- mandatory - Block tariff for irrigation use
4	Texas USA	Threatened aquifers & lack of appropriate GWM & Admin. setup	- Delineation of primary groundwater management areas (PFMA)- - Groundwater conservation districts- permits for well drilling, spacing and size of pumps - Incentives- low interest loans to improve irrigation systems - Water fund to lend money - Regional water planning group (RWPG)- prepare most comprehensive plan
5	New Mexico USA	Threatened aquifers & lack of appropriate groundwater management &administration setup	- Office of state Engineering to manage groundwater - Application to beneficial uses - Declared groundwater basins - Groundwater below each township is treated as separate source of water and set rules for groundwater transfer and appropriation

6	Guarani Aquifer Systems (GAS)	Transboundary/shared aquifer shared by four LA countries with growing use conflict	- Enhance and enlarge technical knowledge of the aquifer system - Well monitoring network and information system - Elaborated Strategic Action Plan (SAP) and trans-boundary issues - Proposal for coordinated management framework, harmonizing policies and management tools - Reduce quantitative and qualitative threats - Technical and socio-economic assessment - Train groundwater managers
7	South Africa	Lack of GWM regulatory and admin. tools, poorly managed and administered GW system	- Groundwater management strategy- 2002 - Groundwater management guideline, 2002 - National Water Act 1998 - Groundwater management at National Level - Catchment Management Agency (CMA) including GWM - Groundwater Advisory Group (GWAG)
8	Bangkok, Thailand	Water quality deterioration and land subsidence due to over pumping	Control on industrial well drilling and fees on abstraction. Fees are put in water fund used for monitoring, action research and capacity building regulatory measures (licensing and charging); successful targeting of groundwater management measures in objectively-defined priority areas; central groundwater 'apex' agency working i with provincial government offices to manage a diffuse groundwater resource; recycling of groundwater conservation fee into a 'groundwater fund' to finance monitoring and research activities; groundwater pollution control in the more vulnerable aquifer recharge areas
9	Bishek. Kyrgyzistan	Overuse	Groundwater plans, bans on pumping from fossil aquifers
10	Mendoza, Argentina		Development of user quota, automatic recorders on all wells, exchange of excess quota
11	Santa Fe, Argentina	Deteriorated water quality and loss of recharge	Monitoring; pollution risk management; delineation of protection zones; recharge quantification
12	Jakarta, Indonesia	Sea water intrusion	Phasing out individual pumping; increasing groundwater price four fold; 10% of water prices shared with surrounding communities

13	Shenzen, China	Water scarcity	Systematic use of rain water: capture, infiltration and treatment of roof runoff; additional management of parking area runoff and design of the storm water wetland

Annex 5: Key Actors at Federal Level

No	Institution	Current Role	Expected role to play
1	Ministry of Water and Energy	Besides setting out policies on water resources development and management, the ministry among many things keeps account of all hydrological data (hydrographic stations). The MoWE is also responsible for designing short and long term development plans of the water and energy sectors plans. There are ongoing and large scale planned groundwater assessment and development projects by the Ministry.	• Through its international links the Ministry can assist in fund soliciting and provide technical support when required for the implementation of the Master Plan. • Leading GWM programmes and install regulatory tools
2	Ethiopian Geological Survey	Mandated to make assessment of the groundwater resources and produce maps in 1:50,000 scales and more	Like any geological surveys in developed countries Geological Survey of Ethiopia shall play its part in implementing AMAR and assist in developing mapping and other standards and norms acceptable by all standards
3	Federal Environmental Protection Authority	The overall objective of EPA is to formulate policies, strategies, laws and standards including EIA guide lines and procedures which foster social land economic development in a manner that enhances the welfare of communities and the safety of the environment in a sustainable way.	The aquifers in AMAR are environmentally vulnerable to any kind of environmental disturbances. Their protection requires engagement of all potential law enforcing and regulatory organs. In this regard EPA shall play both a leading and coordination role to assist the environmental protection institutions of the two states to work together towards same goal.
4	Addis Ababa City Administration	Addis Ababa has the status of both a city and a state, with a charter endorsed by the Federal Government. This new arrangement allowed a more decentralized system. The city at present comprises 10 municipalities, each representing around 400,000 inhabitants; 90 per cent of services are provided at municipality level or lower levels. These municipalities have been offered a great deal of freedom: for example, they can set their own budgets. Governance, however, primarily focuses on the woreda.	As major beneficiary and owners of the well fields and water reservoirs with in AMAR, the City administration is expected to play a leading role in implementation of AMAR
5	Addis Ababa City Environmental Protection Authority	Addis Ababa City Environmental Protection Authority is the one who is issuing licences for drilling activities and quarry development within Addis Ababa City Administration . This assignment is not in line with the main functions of line ministries at federal level and other regions. Its main duties and Responsibilities: • Drafts environmental policies, regulations, directives and standards in line with the standard adopted by	Having these mandates the Authority shall play a key role in protecting the aquifers and its environments from any threats coming from the metropolitan Administration boundary; and in collaboration with Oromia Land and Environmental Protection Bureau can regulate the environmental safety of the catchments.

No	Institution	Current Role	Expected role to play
		the Federal Environmental Protection Authority; • Coordinates various environmental protection stakeholders; • Disseminatesideasfor sustainableenvironmentalprotection andwiseuse of natural resources; • Follows up and controls the disposal of municipal, industrial waste sand by-products; • Based on the relevant environmental declarations, gives licenses to various manufacturing and service industries and • Gives licenses and controls sub-surface mineral waste and construction.	
6	The Addis Ababa Water and Sewerage Authority (AAWSA)	AAWSA is supposed to be the owner and major responsible for AO_AMR. It is established with the objectives of supplying safe adequate water and provide waste water and sludge disposal services for Addis Ababa.	It is this mandate that made it both owner and main actor to implement the Aquifer Management plans of AO- AMR. Whatever arrangement comes, AAWSA remains to be the leading actor to implement the set up.
7	Minstry of Urban Development and Construction	MoUPC and Urban Plan Institute can play a key role in integrating the current and future groundwater development plans of the city within the Master Plan.	Any future regional and local development plans are expected to incorporate all areas of high influence/importance to the city. This demands high level cooperation with Oromia Regional State that has its own corresponding institute. In this regard the role of this institutes is vital.
8	Oromia Regional Government	The Oromia Regional Government is the source of most of the waters, hence it plays vital role in implementation of the plan. The implementation of the plan demands a high level state to state negotiations and collaborations.	Bringing implementing actors from both states can be made possible after agreements have been made at states level. There are already established high level co operations on defining boundaries and selection of waste disposal sites. Such cooperation arrangements can be extended to give back up to AO_AMR activities.
9	Finfinne Surrounding Oromia Special Zone Administration	The Finfinne Surrounding Oromia Special Zone Administration hosts all sector offices and has a responsibility to administer and manage the Special Zone. It is established with a main objective of managing the hot spot of the region that surrounds Addis Ababa city and to create systematic linkage with the metropolitan for common objectives and goal.	Implementation of the Aquifer management arrangement highly demands the involvement of this key actor.

No	Institution	Current Role	Expected role to play
		For this purpose the special zone has prepared its own integrated land use plan that incorporates urban-rural, urban-urban and rural-rural links with Addis Ababa city Administration and within itself. The three catchments and the well fields are part of the plan. As per its establishment objectives the Special Zone Administration has started to work in collaboration with Addis Ababa City Administration on a common issues, like waste disposal site selection and boundary delineations works.	
10	Oromia Land and Environmental Protection Bureau	This is a regulatory body responsible for and authority of land use and land allocation, setting priorities based on land use plans; designating protection areas, reviewing and approving EIAs submitted by investors.	OLEPB's role will be pivotal in creating change in land cover and land use. Its structure extends to zone and woreda levels. Many of the district level offices already run implementation of the studied integrated land use plan and environmental awareness raising programs
11	Oromia Water, Mines and Energy Resources Bureau	OWMEB is mandated to develop, manage and administer the region's water, mineral and energy resources. It is the main development and management agent for water resources.	As a key actor for implementation of AO_AMR, it is expected to involve in all water supply and related aspects of the AMR plans to come. It also plays a key role in regulating quarry development and mining activities that may affect the catchments and the safety of the reservoirs and the well fields and other water related structures.
12	Private Sector	Unlike water users in other parts of the country, the private sector operating with in AO-AMR are highly concerned to water issues. Private wells have started to flourish serving different horticultural farms and industries.	The private sector and professional Associations like Drillers' Association and Ethiopian Associations of Hydrogeologists also have a great role to play in shaping the future of the first deep aquifer use management

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Annex 6: General ToR for AMAR Task Force

Update the rational, mandate, tasks and structure of the AMAR in the framework report. Seek support from Ministers, AA City Administration and Oromia

- Obtain and review earlier document
- Look at larger picture (catchment management, effluent discharge) of water resource management between AA and OSZ
- Review entire set of suggested measures – make a short list

Assess experiences in Ethiopia in the use of deep aquifers and the issues

- Prepare short paper, note on this –

Make an inventory of international experiences in the management of regional aquifers and distil the relevant issues of Ethiopia

- Short paper and presentation to manage groundwater around large cities – to be shared with core team (input into discussion)

Propose composition of the AMAR, consult with the individual stakeholders to assess their needs, interests, and willingness to join the AMAR

- Make one to one visits with core teams much as possible
- Set up core team
- Make list of organization to consult

Consult with MWE on the legal and institutional requirements

- Ask for MWE ownership of the process

Prepare a draft working document on the mandate, responsibilities, tasks and structure of the AMAR

- Draft document, may be work in stages – incl. budget

Hold first meeting with the members to discuss the draft document

- Invitation by core group

Prepare the final document

Consult with the WSSP/MWE on further steps/inclusion in national strategy


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Ministry of Water and Energy