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**RAINWATER HARVESTING
FOR CLIMATE CHANGE ADAPTATION IN
ETHIOPIA: POLICY AND INSTITUTIONAL ANALYSIS**

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<u>Table of Contents</u>	<u>Page</u>
Acknowledgement	i
Table of Contents	ii
Abstract	iii
1. Introduction	1
1.1. Background	1
1.2. The Research Problem:	4
1.3. Objectives	6
1.4. Methodology	6
2. Climate Change Adaptation and Rainwater-harvesting	7
2.1. Climate Change Adaptation	7
2.2. Rainwater-harvesting	10
3. Policy Analyses	20
3.1. Analytical Framework	20
3.2. Analysis of Policies, Strategies, Legislation, Programmes and Plans	21
4. Implementation and Institutional Analysis	39
4.1. Implementation of Rainwater-harvesting Programs	39
4.2. Institutional Analysis of Rainwater-harvesting Development Intervention	47
5. Setting the Scene for Rainwater-harvesting-based Adaptation	58
5.1. The Policy and Institutional Backdrop	58
5.2. Mainstreaming Rainwater Harvesting-based Adaptation into Development	59
5.3. Adaptation as a Phased Process	60
5.4. The Mitigation-Adaptation Nexus	61
5.5. Assessment and Mapping of Vulnerability and its Components	62
5.6. Avoid Maladaptation	64
5.7. Centrality of Disaster Risk Management in the Institutional Setup	65
References	68
List of Policy, Strategy, Legislation, Program and Plan Documents	73
Profile of Key Interviewees:	75
About the Author	76
<u>List of Figures</u>	
Fig. 1 The Evolution of Organizational Setup and Linkages for Climate Change and Rainwater-harvesting	51
Fig. 2 Planning System for Rainwater harvesting-based Climate Change Adaptation	61
Fig. 3 A Proposed Organizational Setup for Rainwater harvesting-based Adaptation	66

Abstract

Most recent climate science reports have determined with a high level of certainty that global climate is changing. As the urgent need for climate change mitigation remains crucial, putting all the necessary resources and institutions in place for future adaptation is indispensable. Even with a complete cessation of carbon dioxide emissions, global temperature would continue to rise for some time making adaptation unavoidable. The impact on water resources is central to all other impacts. Hence, the water sector must seek alternative water resources and develop improved water management approaches that will reduce pressure on already stressed systems. The Intergovernmental Panel on Climate Change (IPCC) has listed rainwater-harvesting as a key strategy for a planned adaptation in the water sector. This research is an inquiry into the policymaking, institution building, and program and project implementation experiences in Ethiopia with regard to rainwater-harvesting as it may be beneficial as a springboard for the design of future climate change adaptation strategies. The research is both evaluative and prescriptive. Basing itself on the rainwater-harvesting and climate change adaptation literature; sectoral and intersectoral policy, strategy, plan and program documents, as well as relevant proclamations; key informant interviews; and the researcher's personal experiences derived from the long research-based association with the issue, the research has conducted analyses of policy, strategy, legislation, plan and program documents; institutional arrangements; and the implementation of plans and programs. It was found out that intervention into rainwater-harvesting as a drought-buffer in Ethiopia has seen in a vicious cycles of wrong-planning, wrong implementation, and failure. Wrong timing of interventions; absence of phased incrementally of projects; 'mass-production' rather than 'customization' of project actions; confusion in the rainwater-harvesting nomenclature; that most related policies, strategies and legislations are pre-climate change providing no significant value for the formulation of specific climate change adaptation strategies; and that there is no mechanism to coordinate actions for the policy statements about rainwater-harvesting that are found strewn in almost all policy and strategy documents. For a more effective adaptation to climate change, based on rainwater harvesting, actions are suggested to mainstream rainwater harvesting-based adaptation into development; to design adaptation as a phased process; integrate mitigation and adaptation; put in place effective systems for assessment and mapping of vulnerability; avoid maladaptation; establish the centrality of disaster risk management in the institutional setup for rainwater harvesting-based climate change adaptation.

Key words: climate change adaptation, rainwater harvesting, policy analysis, institutional analysis, Ethiopia,

1. Introduction

1.1. Background

The global climate that we take for granted is changing. It is changing not in the way we have become used to in the last and current generations, but it is changing and will keep on changing in a manner that could make life so different. Climate science has already determined that the change is going to take place with a high level of certainty. According to the Intergovernmental Panel on Climate Change (IPCC, 2007), as also confirmed in the latest assessment report (IPCC, 2013), the warming of the climate system is unequivocal; many of the observed changes since the 1950s, such as increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level are unprecedented over decades to millennia.

Climate change is not a new phenomenon on Planet Earth. What is new is the source of the major driver of the change and the anticipated magnitude of impact on ecosystems and human society. The impact of climate change that occurred in the Pleistocene, which may have affected a few hundred thousand hunting and/or cultivating ancestors of ours, cannot be compared to the impact on seven billion souls and their technological hardware that have dominated the world. Moreover, the impact is expected to become worse in view of the extent of poverty worldwide and the resultant high vulnerability of human societies to the impacts of change.

What are causing climate change now, have also caused changes historically. There are historic evidences of increases in the atmospheric concentrations of carbon dioxide, from volcanic activities and other natural events and processes, enough to cause short-term or longer-term climate changes. However, the major causal role has been played by other more enduring cycles (solar and orbital). As these natural cycles remain important, anthropogenic causes of climate change have become more potent to an extent unprecedented in geologic history. That is why the response to the climate change of our time has become two-pronged: mitigation and adaptation. What is dubbed as mitigation is the deliberate reduction in the emission of greenhouse gases (especially CO₂) and the complementary sequestration of the same; and adaptation means devising ways and means to survive the change and endure. It was impossible for societies in the past to mitigate for causes that have global dimensions and not of their own making.

This should not imply, however, that humans have not affected the environment to an extent, which could bring about climatic changes at regional and local levels. For instance, they have altered vegetation in ways that probably influenced precipitation on a regional scale (Orlove, 2005). This could happen, as it happened in the Sahara, through a biogeophysical feedback mechanism, where increase in albedo resulting from a decrease in plant cover caused a decrease in rainfall; the decreased rainfall cyclically reduced plant cover, and consequently increased albedo, which reinforced the decrease in rainfall, perpetuating drought (Charney et al, 1975). Mitigation in this situation could take the form of eliminating the local or regional causes of local and regional climate changes. Some reversal could be brought about by replanting vegetation and increasing land cover. Although this has not been a widespread practice, there are a few examples of successful rehabilitation of degraded lands as could be seen in the images of amazing recovery of the land cover depicting the large-scale greening effort in Tigray of northern Ethiopia (Kifle, 2012). The urgent need for climate change mitigation remaining critical, putting all the necessary resources and institutions in place for future adaptation is indispensable. Even with a complete cessation of carbon dioxide emissions, global temperature would continue to rise for some time (Gillett et al, 2011) making adaptation unavoidable. Adaptation is a ‘no-regret’ course of action because even if climate change turns out to be a myth it will remain to be a sustainable solution to many other ecological, economic and social problems.

Human history is a history of adaptation. There are plentiful archeological and paleontological evidences of adaptation to climate change and variability, both biological and cultural. For instance, Pandey et al (2003) documented over a hundred instances of rainwater-harvesting-based adaptation to climate variability in India during the Holocene. Details of the adaptive responses to climate variability of the Maya Civilization, the Vikings in Greenland, and the Dust Bowl in the USA are also given by (Orlove, 2005). Virtually all past adaptations, except in the stories of the Biblical “Joseph the Dreamer” and the Ark of Noah, are reactive adaptations. However, for the impending climate change of our time, in a historic era where humans have become more organized and better equipped with advanced technologies for prediction

and action, proactive adaptation should be the top priority climate change adaptive response.

Impacts of climate change occur on ecosystems, food security, health, water resources, settlements and infrastructure. It is argued that the impact on water resources is central to all other impacts. The IPCC (2007) takes water impacts to be crucial for all sectors and regions; and UN (2012) has considered water as the primary medium through which climate change influences the Earth's ecosystems and thus the livelihood and well-being of societies. The most plausible basis for these assertions is the fact that the hydrological cycle, which is the mode of existence of water, is also the main embodiment of the climate system itself. The report by Working Group II of the IPCC (Bates et al, 2008) has given the details of the likely to very likely impacts of climate change on water resources as follows: 1) Changes in the hydrological cycle (increasing atmospheric water vapor, changing patterns of precipitation intensity and extremes resulting in drought and floods, widespread melting of mountain glaciers and icecaps reducing water availability during dry periods, and changes in soil moisture), 2) Higher water temperatures affecting water quality, 3) Sea level rise increasing salinization of coastal groundwater and estuaries; thus, reducing availability of freshwater for humans and ecosystems in coastal areas.

Although the aforelisted impacts on water resources are caused by climate change, there are also other no less potent non-climate causes of the impacts, such as, population pressure and land use changes. Disentangling the climatic and non-climatic causes and their respective impacts is one of the greatest practical challenges posed for climate change adaptation. Nevertheless, as much as it is a challenge it is also an opportunity for climate change adaptation to resolve the non-climate change impacts as well. The 'two-birds-with-one-stone' feature of climate change adaptation could help to convince planners as well as ordinary people to act.

Although difficult and less straightforward adaptation to climate change may be in-action is not an option. The key question that should arise at this point is what kind of action could be considered as most appropriate in this context. There is a simple and straightforward answer to this question: 'No business as usual'. The water sector must seek alternative water resources and develop improved water management approaches

that will reduce pressure on already stressed systems (Brookes et al, 2010). The ‘soft path’ approach advocated by Gleick (2003), favors lower cost community-scale systems, decentralized and open decision making, application of efficient technology, and environmental protection, against the construction of massive centralized infrastructure. For Cain (2010), such a sustainable path is small-scale rainwater-harvesting. Similarly, Brookes et al (2010) have also recommended storm water harvesting and aquifer recharge as key innovative responses to address climate change risks. A more forceful statement was made by Desarda (2001) about the importance of rainwater-harvesting that it is ‘the need of the hour’ requiring a mass movement for its implementation and a paradigm shift from engineering methods of exploiting water in a destructive way to an ecologically sound approach. Furthermore, ‘expanded rainwater-harvesting’ is listed as a key strategy for a planned adaptation in the water sector (IPCC, 2007) as well as in the National Adaptation Programme of Action (NAPA) for Ethiopia (National Meteorology Agency, NMA, 2007).

1.2. The Research Problem:

With a population of over 80 million, Ethiopia is one of the poorest countries of the World, ranking 173rd in the Human Development Index (HDI) in 2012. Although the Country is endowed with huge diversity of natural resources, it has been unable to utilize them for the improvement of the living standards of its population. As a result of the extensive subsistence agriculture and animal rearing practiced for many centuries, a spiraling population growth, long external and internal wars, unfavorable global economic order, and lack of prudence in the cultural value systems with regard to environmental resources, the Country’s land and land-based resources have become severely degraded. This is particularly true to the cereal growing northern-half of the Country. Drought, both as an outcome and a cause of the degradation of natural resources, has been occurring, at increasingly shorter intervals, since antiquity. The occurrence of drought in Ethiopia has been having significant economic, social and political consequences. Two severe droughts in the last Century have contributed to the downfall of the last Monarchy and shaking of the power of the succeeding Military rule. The official response to the recurrence of drought in the Country has varied from utter neglect during the Monarchy, transitory attention by the Military, and zealously

by the Ethiopian Peoples' Revolutionary Democratic Front, EPRDF- Government.

While all kinds of efforts are being made to alleviate the impacts of periodic drought occurrences on livelihoods, policy makers and ordinary people alike have come face to face with an imminent threat of a more widespread and enduring climate change. Alongside the IPCC's global and regional trends and projections, confirming "beyond reasonable doubt" that climate is changing, there are National and local evidences of change of a long-term nature. There has been a warming trend in the annual minimum temperature over the past 55 years in Ethiopia, increasing by about 0.37⁰C every ten years (NMA 2007). Non-instrumental observations of increased warming and dryness in the formerly drought-free parts of Ethiopia have also been reported (Yohannes, 2012). Ethiopia's contribution to global greenhouse gas emissions is negligible; but it receives a disproportionate share of the harm from climate change impacts.

Most policy makers and relevant government bodies in Ethiopia have recognized the gravity of the problem. The greatest challenge for them is to put in place sustainable strategies, over a wider scale, to adapt to climate change impacts. Action of any significance has not yet started in Ethiopia to date on a large enough scale. The NAPA for Ethiopia is a proposal document limited to a few scattered projects. Climate change adaptation in Ethiopia, which is expected to encompass all spheres of life, both in urban and rural settings, requires more comprehensive planning and implementation, and the integration of the long-term with the short-term. Above all, climate change adaptation in Ethiopia must be built on relevant policies and institutional frameworks if a satisfactory level of success is to be ensured.

There are rich experiences of policymaking, institution building, planning and implementation of rainwater-harvesting systems in Ethiopia, as buffers for climate variabilities as well as to reduce land degradation, for nearly half a century. Such experiences normally invite questions such as how successful they were, and whether or not they could be used as guidelines and/or building blocks for the more comprehensive rainwater-harvesting-based climate change adaptation in the near and far future. The research adopts the "looking forward into history" approach, in which the past is examined as a way of preparing for the future. This approach has its weaknesses, though. It is clear that for a future as colossal as adaptation to changing

climate the past can only serve as a lesson rather than a guide. In an ideal situation, where accurate projections about the future climate scenario could be available, ‘backcasting’ is the best approach to planning climate change adaptation. Backcasting, as opposed to forecasting, is about first defining a desirable future and then formulating policies and programs that help getting there rather than preparing for the future based on past and present trends.

1.3. Objectives

The general objective of this research is to assess how much policy and institutional groundwork exists for climate change adaptation, through rainwater-harvesting; and to set forth a framework for an adaptation future in Ethiopia. The specific objectives are:

1. Appraising the practices of rainwater-harvesting in Ethiopia in the past five decades
2. Reviewing the policy, strategy, program, and legislation documents, and institutional arrangements that pertain to rainwater-harvesting in light of their merits and demerits for long-term climate change adaptation
3. Setting forth frameworks for policy formulation and institutional setup for a more effective adaptation to climate change

1.4. Methodology

This research is a qualitative research. It is based on data obtained from:-

1. The rainwater-harvesting and climate change adaptation literature on Ethiopia
2. Analysis of several sectoral and intersectoral policy, strategy and program documents, as well as relevant proclamations
3. Interviews with three key informants (See Appendix about the profiles of key interviewees)
4. The researcher’s personal experiences derived from the long enough research-based association with the issues of rainwater-harvesting and climate change adaptation

2. Climate Change Adaptation and Rainwater-harvesting

2.1. Climate Change Adaptation

Adaptation is adjustment in ecological, social, and economic systems, through changes in processes, practices, and structures, in order to reduce the vulnerability of communities, regions, and activities to climatic change, variability, and extremes (Smit and Pilifosova, 2001). The classification of adaptation, put forward by Smit et al (1999), is composed of pairs of overlapping categories: autonomous vs. planned, spontaneous vs. purposeful, automatic vs. intentional, natural vs. policy, passive vs. active, responsive vs. anticipatory, reactive vs. proactive, ex post vs. ex ante, short-term vs. long-term, instantaneous vs. cumulative, and localized vs. widespread. Other more action oriented categories of adaptation are also given in Smit and Pilifosova (2001) viz. bear losses, share losses, modify threats, prevent effects, change uses, and change locations.

The attention paid to adaptation, as a planned response, came up later in the course of the climate change negotiations. In its objective statement, the first global official document on climate change, United Nations, UN (1992), mentioned adaptation as a gradual natural process, which should not be affected by dangerous anthropogenic interference with the climate system. Article 10 of the Kyoto Protocol seems to be more concrete about planned adaptation in that it obliges parties to take “measures to facilitate adequate adaptation” to climate change (UN 1998). Adaptation is now firmly established, in the climate change response platform by the Nairobi Work Programme on impacts, vulnerability and adaptation to climate change (NWP) and the Cancun Adaptation Framework (CAF). Adaptation constitutes two interrelated courses of action, namely, building adaptive capacity and transforming that capacity into action (Adger, et al, 2005). These courses of action are normally preceded by assessment of impacts and vulnerabilities as well as development of adaptation options that are appropriate to them. Adaptive capacity is the ability of ecosystems, societies, organizations, and individuals to adapt to the impacts of climate change, variabilities and extremes.

The components of adaptive capacity, identified in Smit and Pilifosova (2001), are economic resources (assets and finance), technology (options), information and skills (knowledge about options, capacity to assess options, ability to implement options), and institutions (governance and entitlements). These are straightforward, quantifiable, and

predictable elements of adaptive capacity, and are crucial for the success or failure of adaptation. The lack or the inadequacy in one or more of these components could impede adaptation. However, the importance of the economic, technological and ecological/physical limits, which are amenable to more convenient analysis and modeling have been overvalued in the climate change adaptation discourse. During implementation, social limits become more complex yet more decisive determinants of successful adaptation. Knowledge status about future climate changes, risk perception, and ethical values pertaining to the changes frame how societies develop rules and institutions to govern risk and to manage social change and the allocation of scarce resources (Adger et al, 2009).

Adaptation is inherently scalar. The economic, technological, informational, and institutional components of adaptive capacity can be addressed and implementation can be more beneficially undertaken within the contexts of these spatial hierarchies. Success needs to be evaluated against effectiveness, efficiency, equity and legitimacy criteria at these different, but interacting levels (Adger et al 2005). Three levels of the spatial scales for climate change adaptation, identified by Smit and Pilifosova (2001), are summarized as follows: 1. Global level (cooperation between industrialized and developing countries, support from global research institutions and policy facilitation, funding and monitoring, removal of barriers to international trade, and transfer of technology, technical and managerial skills), 2. National level (emphasis on poverty reduction, development policy geared more toward vulnerable sectors, support adaptation at local or community levels including the private sector, set up systems for monitoring and communication, pursuit of sustainable economic growth, development of adaptive technologies and innovations), and 3. Local level (establishment of social institutions, prevent marginalization of sections of population, encouragement of diversification of income sources, risk-spreading, provision of knowledge, technology, and financial support). Although the spatial scales remain useful for the contextual implementation of adaptation, they are not free from social-cultural constraints. The values that underpin adaptation decisions become more diverse and contradictory as one moves from small-scales to larger-scales (Adger et al, 2009).

Thomsen et al (2012) have drawn a distinction between adaptation and manipulation,

where the former is more respectful of the intrinsic integrity of social–ecological systems, and hence, applies internal or self-regulating modification; while the latter is more reductionist, separating system elements from one another and creating adverse path dependencies that tend to lessen the likelihood of effective adaptation in the future. It is also important to distinguish adaptation from another term, which is gaining popularity in climate change adaptation science, viz. maladaptation. Maladaptation occurs when an action, contrary to intentions, increases vulnerability to climate change related impacts of ecosystems, societies, organizations, and individuals. Barnett and O’Neill (2010) identified five types of maladaptation: 1. Increasing emissions of greenhouse gases, 2. Disproportionately burdening the most vulnerable, 3. High opportunity costs relative to alternatives, 4. Reducing incentives to adapt by encouraging dependence on others, stimulating rent seeking behavior, and penalizing early actors, and 5. Path dependency which decreases flexibility by committing capital and institutions to large infrastructural developments that are difficult to change in the future.

Climate change adaptation is expected to be more flexible, reflective and iterative in a staged process of building on short-term strategies to get to long-term results (NCCARF, 2012). That is, it has to be incremental, aiming to improve efficiency within existing technological, governance, and value systems; as well as transformational, involving alterations of the fundamental attributes of the systems (IPCC, 2012). The distinction made between short-term actions and long-term objectives is important in making adaptation efforts more realistic and appealing to all involved. The reality about climate change is that the change is a change of averages. Mean values can only be conceived not perceived. It is just like the difference between the computed trend, representing mean values and the actual or observed distribution. Decision making for climate change adaptation is encouraged or discouraged, more often, based on the observed variabilities and extremes, rather than by the imaginary calculated mean value. This is confirmed by the IPCC (2001) that a change in climatic averages is actually experienced through variability and extremes. That is why people become more inclined to make judgments about climate change based on weather where the effects of climate change are perceived to be sudden and severe (Henry, 2000). It is argued in Adger et al (2005) that adaptation that requires large-scale investment is likely to be triggered through extreme

events that raise the consciousness of climate change within policymaking and hence giving legitimacy to governmental action. This is the compelling reason why existing policies to reduce the risk of climate-related disasters provide an obvious entry point for mainstreaming adaptation policies (Lebel et al, 2012). Hence, the most important point of convergence of disaster risk management and adaptation to climate change is the focus on reducing exposure and vulnerability, and thus, increasing resilience to the impacts of climate extremes (IPCC 2012).

Climate change adaptation need not and could not be a separate activity. Climate change impacts are so pervasive, affecting almost all sectors and regions in time and space, that isolated actions of adaptation planning and implementation would bear little benefits. Adaptation should rather facilitate its development and implementation through mainstreaming into existing development planning, leveraging much larger financial flows in sectors affected by climate risks than just by the amounts available for financing adaptation separately (Lebel et al, 2012). However, one of the major practical challenges to mainstreaming adaptation is the project oriented approach in national, regional and local development, in which funding lasts for a few years, contributing insignificantly to the reduction of climate risks in the long-term (Lebel et al, 2012).

Integration for climate change adaptation is not limited to mainstreaming into national, regional and local development. It should also interface with mitigation. Four types of inter-relationships between adaptation and mitigation are identified by Klein et al (2007): 1. Adaptation actions that have consequences for mitigation, 2. Mitigation actions that have consequences for adaptation, 3. Decisions that include trade-offs or synergies between adaptation and mitigation, and 4. Processes that have consequences for both adaptation and mitigation. It is also believed by many that the nexus between mitigation and adaptation will be attractive to stakeholders and potential funding agencies alleviating the acute shortage of finance for adaptation.

2.2. Rainwater-harvesting

2.2.1. Concept and Classification

“The story of drought is common and old. Civilizations have come and gone in its wake. This is a story of survival—a story of rain” (Payne and Neumann, 2007: 105). This picturesque statement was written out of frustration that the rain that was being

harvested and used for millennia, across diverse cultures, is forgotten and replaced by highly engineered water projects; and at the same time, out of delight that there are clear signs of its reemergence in many parts of the world. In spite of such esteem this ages-old technology is able to command, little justice is done to its conceptualization.

There has been a great deal of confusion with regard to its definition as it can be demonstrated in the following examples. Ngigi, (2003) defined rainwater-harvesting as the collection and concentration of runoff; but Mati (2012) used this particular definition for floodwater harvesting rather than for rainwater-harvesting, ascribing the latter to ‘rainwater collection’ and storage only. While Rockström (2002) conceptualized water harvesting as a term describing the collection and conservation of runoff water originating from ephemeral streams during storms, Mati (2012) characterized it as an amalgam of rainwater and floodwater harvesting. Critchley and Siegert (1991) also used water harvesting to mean the collection of runoff and divided it into rainwater-harvesting as the collection of runoff from roofs or ground surfaces and floodwater harvesting as the collection of discharges from watercourses.

Although it is not obvious in the definition of water-harvesting by Rockström (2002), the three objectives of water harvesting listed down, viz. systems that improve infiltration of rainwater into the soil, systems that prolong the duration of soil moisture availability in the soil, and systems that store surface and sub-surface runoff for later use imply that water harvesting is a composite of rainwater-harvesting and runoff/floodwater harvesting. A much earlier definition by Boers and Ben-Asher (1982) is based on the spatial and scale attributes of rainwater-harvesting, that it is distinctive to arid and semi-arid regions, depend on local sources, and are small-scale operations.

Such problems of ambiguity and inconsistencies in definition could be seen in light of the difference between connotative and denotative meanings. Water harvesting may connote the harvesting of rain and floodwater; but its denotative meaning cannot be limited to these particular sources only. Unless it is taken just as an agreed upon conventional nomenclature there is nothing in the word ‘water’, without any qualifying adjective preceding it, that would restrict its meaning to rain and flood. Hence, the literal meaning of water harvesting must logically include surface water in lakes and rivers and groundwater in aquifers as well. This kind of vagueness and confusion in the

semantics can have adverse effects on rainwater-harvesting policymaking, planning and implementation. The concern is reflected in Sultana (2007) that interpretation is crucial for the implementation of policies; as some policy-documents in Bangladesh are making a wrong distinction between roof water harvesting and rainwater-harvesting.

The acceptability, effectiveness, and efficiency of rainwater-harvesting systems in time and space depend, a great deal, on which combination of the technologies or methods is the most appropriate. Different types or methods of rainwater-harvesting are suitable for particular places and situations. Hence, an inventory of the types of rainwater-harvesting technologies and their respective values and limitations is a very useful support for decision making. However, the lack of consistency in the definition of rainwater-harvesting is also reflected in its taxonomy. Among the several classification schemes of rainwater-harvesting three are selected for a comparative analysis. The bases for their selection are, 1. Representation of nomenclature versions (use of ‘water harvesting’ vs. use of ‘rainwater-harvesting’), 2. Details of classification scheme and 3. Uniqueness.

The classification scheme by Critchley and Siegert (1991) categorizes ‘water harvesting’ into rainwater-harvesting and floodwater harvesting; but the basis for distinction is not consistent. Rainwater-harvesting is from a local source while floodwater harvesting is from channel flow. The assumption may be that distant sources have greater chances of being channeled than local ones; but there is a continuum between deep channels and tiny rills, which poses problem of neat classification. Sheet and rill flows are the physical expressions of runoff that is harvested from roof catchments as well as ‘overland’ catchments; the two sub-categories of rainwater-harvesting. The classification should have been based on the relative distance of the source of the water to be harvested. The classification of rainwater-harvesting, which appeared ten years later in Ngigi (2003) has a fundamental difference with that of Critchley and Siegert (1991) at least in using ‘rainwater-harvesting’ as an umbrella term in place of ‘water harvesting’. Floodwater harvesting/farming, which is categorized as separate from runoff water harvesting, in Critchley and Siegert (1991), is combined with runoff-based systems as macro-catchment spate irrigation in Ngigi (2003). Roof water harvesting, which should be distinguished from overland runoff harvesting does not

appear as separate sub-category in Ngigi (2003). It can only be presumed that it is subsumed within the runoff-based catchment and storage systems.

What is not included in the classification scheme by Critchley and Siegert (1991)- the direct harvesting of rainwater without a need for collection area- forms one of the two major categories of rainwater-harvesting in Ngigi (2003). This type of rainwater harvesting technology, which includes myriad soil inversion (terraces, bunds, trenches, pits, and basins) and non-soil inversion techniques (mulching, reduced or zero tillage, and sub-soiling), is the pillar of soil and water conservation. In the relatively more unconventional classification by Sonbol (2006), rainwater-harvesting is classed as a second sub-category of water harvesting; and fog harvesting appears in the scheme as one of three major water harvesting types, along with overland flow and 'groundwater harvesting'. One of the major loopholes created by the use of the term 'water harvesting' is the excuse to maximize the extraction of groundwater as a 'sustainable' water acquisition. The celebrated advantage of rainwater-harvesting is that it is additional source of water which can relieve the burden on the conventional sources such as lakes, rivers and groundwater aquifers. This seems to be a classification system, which has greater relevance to the more arid Middle East than to the rest of the world. The separation of runoff harvesting and floodwater harvesting, into distinct categories, in Critchley and Siegert (1991) is also shared by Sonbol (2006).

2.2.2. Rainwater-harvesting Policies

Although rainwater harvesting is a sustainable strategy for adaptation to climate change, particularly for regions where water resources are fast depleting due to over extraction and/or increasing dryness of the climatic regime, its implementation is not as straightforward as it may seem to be. Enabling policies for rainwater uptake and implementation are a first step for increased adoption. Nevertheless, the biggest challenge is that rainwater-harvesting is not included in water policies of many countries where water resource management systems are based on surface and groundwater (Salas 2009). Wherever such policies exist, they have come in the forms of 'stick and/or carrot' kinds of legislation.

The 1998 drought in Malaysia forced the government to formulate policy on the use of rainwater-harvesting, which was an alien technology for Malaysians. Since the policy

made rainwater-harvesting and utilization optional, only a few adopted it on the ground that it was expensive, takes much space in the backyard and becomes breeding place for mosquitoes among many other reasons. Following the failure of the optional policy, the government made rainwater-harvesting mandatory for large buildings in 2006. However, the new policy needed legislative amendments in some laws and regulations, such as building laws and specifications to accommodate rainwater-harvesting, permits, market availability, duty laws, and incentive laws for local manufacturing, in order to provide a legal ground for implementation (Mohd. et al, 2007). There are also clear statutory conflicts in the South African rainwater-harvesting policymaking. On the one hand, the water legislation makes rainwater-harvesting a permissible source; but it forces users to use only water from an authorized service provider on the other (Warwick, 1999).

Incentive-based rainwater-harvesting legislation, in three developed countries, is reported in rainwater-harvesting.org. In some states of Australia, some rebate for purchases is made upon connecting rainwater tanks to toilets, washing machines, and outdoor faucets. Rain taxes are collected in Germany for impervious surface on property that generates runoff encouraging people to reduce impervious surfaces in order to get tax reductions. Some US states and cities have setup systems of tax credit and generous rebates for the installation of rainwater-harvesting systems, and subsidized rates for rain-barrels.

There are much tougher laws, in favor of rainwater-harvesting, in India than anywhere else. As reported by rainwater-harvesting.org some 16 Indian states and cities, including New Delhi and Mumbai, have enforced uncompromising laws making rainwater-harvesting mandatory but with varying criteria. The kinds of building required to have rainwater-harvesting facilities varied from all new buildings; commercial, institutional, tourist and industrial only; residential only; government buildings; and those having tube wells in their compounds. The total area size of the property or building for which rainwater-harvesting becomes compulsory varies from 250 to 1500 square meters. In some cases, tube wells in the compound are prohibited or owners of tube wells are required to dig percolation wells for groundwater recharge. The laws are so stringent that in Tamil Nadu, for instance, for those who fail to comply, the government would construct the facilities on its own and recover cost and other additional charges from the owners.

2.2.3. Literature Review: Rainwater-harvesting in Ethiopia:

- *Literature Statistics*

A mostly web-based search of the literature came up with over 60 works on ‘rainwater-harvesting’ and ‘water harvesting’ in Ethiopia. It is recognized that there could be many more articles, undergraduate or graduate student theses, and consultancy reports that did not manage to find their way into the World Wide Web. Three-quarters of the search results showed publication or issue dates only within the last decade. This indicates that although rainwater-harvesting has been one of the food security and poverty reduction strategies for over a quarter of a century, its inclusion as a research and academic agenda is much more recent. Although it was not the chief subject matter of their research Habtamu (1990) and Kloos (1990), the two pioneering scholars on small-scale irrigation in Ethiopia have included assessments on the earth dams and ponds that formed an important part of the small-scale irrigation strategy of the Military Government of Ethiopia in the late 1980s. The surge in the rainwater-harvesting related research output in the last decade coincides with the time of the rainwater-harvesting ‘craze’, in which mammoth implementation campaigns jumped from one approach to another, with an end-result of disillusionment. The large number of ill-fated rainwater-harvesting schemes became ‘gold-mine’ for numerous evaluative academic research, workshop themes, and consultancy reports. The literature clearly revealed a lack of link between development planning and research. Engaging in prescriptive research and future scenario building, rather than only evaluative research, could have saved resources from wastage and the intended beneficiaries from a permanent erosion of confidence on the technology.

The analysis of the literature revealed that use of either ‘water harvesting’ or ‘rainwater-harvesting’ as a nomenclature for the water technology in the titles varied by 65 to 35 percent respectively. No clear pattern is identifiable that relates the use of ‘water harvesting’ or ‘rainwater-harvesting’ to one or the other ‘school of thought’, paradigm shift, study area peculiarity, or taxonomic logic. Apparently harmless through this variation may seem to be, the use of ‘water harvesting’ and ‘rainwater-harvesting’ alternatively more often than not opens loopholes for those who would prefer go for the ease in water extraction from the conventional sources. Describing the ‘water

harvesting' approach adopted for the Amhara region of Ethiopia Lee et al (1999) clearly indicated that the intervention includes the development of surface and groundwater resources, and small water storage structures. Other experiences of a readiness to slip back to the dependence on groundwater resources are revealed in many parts of the Amhara and Tigray regional states. The regional governments are reported to have encouraged the continuation in the use of the 'abundant' groundwater in wells, which were accidentally discovered while digging for pond and tank construction. The digging for ponds and tanks was abandoned as it was now believed that shallow wells are the most efficient and 'sustainable', components in the regional water-harvesting program (Rämi, 2003).

In terms of study area distribution, the literature search results show that the share of Tigray, the northern region of Ethiopia, is as high as 30 percent. This may be explained by the huge in-situ as well as ex-situ rainwater-harvesting project implementation experiences of the Region and the Mekele University factor, which has several researchers specializing in dry land and water management issues at its disposal.

● *Thematic review*

All the search results are taken into account for the 'literature-statistics' presented in the preceding section; but the thematic review to follow is focused only on selected publications. Several issues pertaining to the rainwater-harvesting are discussed in the publications; one of such important issues is the approach used to implement rainwater-harvesting programs. The problem of implementation of policies, strategies and programmes is a key challenge not only for rainwater-harvesting but also for most other poverty reduction and development interventions in Ethiopia. Earlier attempts to introduce rainwater-harvesting systems, in the forms of ponds, terraces and bunds, during the military rule of Ethiopia were frustrated by unfavorable and sometimes conflicting policies, strategies and programmes. The challenges, as documented by Kloos (1990), were required membership in producers' cooperatives as a precondition for potential beneficiaries, disruptive villagization and resettlement programmes, lack of support schemes for construction materials and agro-inputs, absence of water policy and legislation, and non-existence of beneficiary participation in project planning and implementation.

With a change of government from the Military to the EPRDF the implementation of a new micro-dam approach to rainwater-harvesting was launched in the northern region of Ethiopia in the second half of the 1990s. The major reasons for the failure of the implementation, as captured by Yohannes (2004) are as follows: the speed at which the micro-dams were being constructed did not allow time for reflection and re-design; no rigorous geological and pedological investigations were made resulting in massive seepage losses; and the site selection approaches shifted from 'site-hunting', in which priority was given to the location of storage, to 'area-based', in which priority was given to the irrigation command area, expecting both to match. After the microdam approach was abandoned and replaced by the much higher-speed implementation of the household or farm-level pond program several research outputs lost no time to expose the causes of the failures of the pond program. In a study conducted in the Amhara region of Ethiopia Daniel (2007) identified the construction of ponds without prior rehabilitation of degraded lands; knowledge limited only to engineering of structures and economics of cost analysis; one size fits all designs adopted; and the lack of credit facilities as the chief challenges of the program implementation. From another perspective, the often-recommended use of rainwater-harvesting for increased crop production to improve agriculture in the dry lands as well as and in the dry seasons is considered by Daniel (2007) as a misplaced effort on the part of decision makers. He argues that rainwater-harvesting should more beneficially be used for dry spell irrigation within the growing season where evidences show that bumper grain yield can be attained. This is obviously a reference to the more agriculturally productive regions, which can boost production at the national level.

The most comprehensive assessment of the pond program has come from Rami (2003) who characterized the program as ambitious, fast and experiment on a vast scale: 1) Much of the one billion Ethiopian Birr (ETB), earmarked for food security programs, was used for water harvesting programs, 2) Tens of thousands of ponds were built in one year and hundreds of thousands planned for the following years in Amhara and Tigray regions, 3) Junior experts, with inadequate training and experience, and transport facilities were unable to bear the imposed quotas compromising the quality of the work, 4) Tanks constructed on black cotton soil were cracking but quotas had to be filled

regardless, 5) The target population in the water scarce lowlands shunned as inaccessible and quotas fulfilled elsewhere, and 6. The poor were not necessarily selected because the quota pressure forced 'willingness and industriousness' to be the dominant criteria for selection of beneficiaries.

Rainwater-harvesting implementation in Ethiopia is beleaguered by institutional problems from the outset. During the period of micro dam construction in Tigray, the Commission for Sustainable Agriculture and Environmental Rehabilitation of Tigray (Co-SAERT) has had a problematic relationship with the regional bureau of agriculture (BoA). The former monopolized decision making on site selection and construction of the schemes and after completion the BoA was required to manage the projects about which it had little knowledge (Yohannes, 2004). A similar problem was observed in the pond program that started later on (Daniel, 2007). There was a case of a fake participation of the target population in a rainwater-harvesting program in Tigray. According to Segers et al (2008), an implementation 'tactic', which turned two essentially unrelated rural development programs- rainwater-harvesting pond programme (RHPP) and the public work component of the productive safety net programme (PSNP) - into practically intertwined interventions. The key recruitment criterion for the more beneficial PSNP was made to be willingness to participate in the RHPP. Considering RHPP as stepping stone, participants never bothered about its success. While the lack of participation of farmers in the planning and implementation of both micro-dam and pond construction, and the resulting low adoption was typical (Yohannes, 2004 and Daniel, 2007), the construction of stone bunds and soil bunds in Tigray region showed better participation and adoption compared to that of the more complex structures (Katoa et al, 2011).

A lot of experimental research was done to ensure the usability of one or the other rainwater-harvesting structures. It is felt that one explanation to the failures of rainwater-harvesting development interventions is the inappropriateness of the choices from the 'menu' of rainwater-harvesting structures for particular locations and situations. Some of such findings and recommendations include eyebrow basins for hillsides where stones are available while trenches for areas where stones are scarce (Sisay, 2009); the three-fold rectangular shapes proved to be the best geometry among the square and

two-fold rectangular ponds in minimizing initial cost of construction, seepage and evaporation losses (Ahmed and Shyam, 2005); and the best effect of combining tied-ridges with soil fertility improvements during below-average rainfall seasons for improved maize yield (Birhanu, 2012).

Rainwater-harvesting helps to reduce vulnerability of communities arising from the shortage of water induced by temporary or permanent changes in the climate and/or the depletion of the water resources. However, the paradox is that a technology that is meant for reducing vulnerability increases it. This is a case of maladaptation where increased malaria infestation takes away the benefits of rainwater-harvesting. Two research results on the northern region of Ethiopia show the increased epidemiology of malaria because of the expansion of rainwater-harvesting schemes. One is the study conducted on the large scale construction of half-moon ponds and ditches by Mekonnen and Mitiku (2010) and the other by Fitsum et al (2013) on the wells and ponds closer to households.

The huge number of challenges that the implementation of the rainwater-harvesting systems faced notwithstanding, there have been benefits from the adoption of the technology. One example is the possibility created by rainwater-harvesting for the planting of onions, which raised farmers' income higher than what they used to get from rain-fed *teff* and wheat combined (Akalu et al, 2010). At a much wider scale Nyssen et al (2008), by way of comparison of photographs of the landscape of Tigray, now and 30 years ago, and substantiated by field verifications, they were able to show the benefits brought by rainwater-harvesting in rehabilitating the environment, significantly reducing erosion, and increasing infiltration and vegetation cover.

3. Policy Analyses

3.1. Analytical Framework

Policy is a guide and a framework for decision-making and action. The Cambridge Advanced Learner's Dictionary defines policy as a set of ideas or a plan of what to do in particular situations that has been agreed officially by a group of people, a business organization, a government or a political party. It also sets the direction and parameters for the formulation of laws and programs (Kizito, 2008). Policies are not only those that are written and sealed. Many times, policies are pronounced even when they have not been articulated in writing or are enacted without being written (Kizito, 2008). The success of policies in bringing about the desired effects depends on the right choice and mix of choices of the policy instruments. Policy instruments are the application of regulatory or state-based and economic or market-based actions or a continuum of varying combinations of both (Howlett, 2005). The analysis in this section examined the policies, related to rainwater-harvesting for climate change adaptation in Ethiopia, in terms of content and the choice of instruments. In the course of the analysis, answers were sought for important questions like: how unambiguously terms and concepts are defined in the policy documents, what motivating factors, history, and intent led to the creation of the policies, whether or not there are inherent contradictions between different policy areas obstructing or neutralizing each other, and which organizations are responsible for carrying out individual policy statements.

The Cambridge Advanced Learner's Dictionary defines 'institution' both as a large and important organization, as well as, a custom or tradition accepted as an important part of a particular society. There is little divergence between the literal and the academic definitions of the term. Bandaragoda (2000) characterizes institutions as 'underlying rule systems and organizations as agents of change'. 'Rules of the game', which make up institutional arrangements, can be both formal (written rules and procedures) and informal (established norms and practices). In research as well as in popular usage there is a tendency to skew the meaning of 'institutions' towards the 'organizations' side. This is justifiable on the ground that, it is ultimately the organizations that put policies, strategies, and laws into practice. A sufficing example is given by Bandaragoda (2000) about the establishment of irrigation departments following the enunciation water

policies and the enactment of irrigation ordinances, and the UN and the World Bank founded on international laws and conventions. Organizations once established modify or change policies and rules, by which they are created, whenever deemed necessary.

The analysis of institutions is about the what, how and why of their nature and operations or structures and mechanisms. It also examines the institutional environment or settings, which is important, among many other things, for the understanding of how sustainable programs or projects become once external sources of finance stop. Another main area of inquiry in institutional analysis is the institutional structure, in which the forms, linkages, levels and relative importance in decision-making powers, strengths, weaknesses, competitions, conflicts, and demarcations are described. The issues in organizational demarcation such as the appropriateness of the assignment of responsibilities to actors, adequacy of the coordination mechanisms, the feasibility of organizational consolidation or separation, and the adequacy of matching responsibilities, authority and capacity for action (Agarwal et al 2000) are central to the analysis of institutional structures. In addition, stakeholder identification and analysis provides useful information for institutional analysis. Stakeholders are all those who have interest in the issues being addressed as measured in terms of welfare or utility; some are active- they affect the system, some are passive- they are affected by it.(FAO, 2001).

In the following section, policies and institutions that are directly or indirectly related to rainwater-harvesting as an adaptation strategy to climate change, variability and extremes in Ethiopia will be analyzed within the frameworks discussed. Although the analyses are extended, back in time, to include policies and institutions for rainwater-harvesting since the 1960s the greater part of the coverage is devoted to the last two decades.

3.2. Analysis of Policies, Strategies, Legislation, Programmes and Plans

If the definition of the term policy by Kizito (2008) is to serve as a conceptual basis for policy analysis, policy making could be said to have started right from the beginning of societies. Leaders at all levels were issuing all kinds written and verbal orders or guidelines for groups of people or for entire societies to implement and report. In

conventional policy research of our time the tacit agreement on the forms policies assume is quite clear. Policies are understood to mean those decisions and guidelines for actions, which come more often than not as formal written documents resulting from the work of several professionals in the respective fields, and approved by some executive and legislative body. In view of this, policy making for interventions into the economies and livelihoods of societies in Ethiopia can be traced back to the time of the last Monarchical government. The policies came in the forms of formal planning documents for the series of five-year plans not in the forms of parliament approved policy documents, as we know them today. Even during the Military government that replaced the Monarchy no policies of any significance were formulated except for the ill-fated economic policy issued in the first year of Military rule. During the whole time, annual planning documents were produced by central bodies to run a command economy accompanied by guidelines for the countless economic, social, environmental and political campaigns that were being conducted. The details of the two periods as it pertain to rainwater-harvesting and climate change is discussed in the following section on the analysis of policy implementation.

Almost the entire National and sectoral policies are phenomena of the EPRDF period. Those policies that pertain to rainwater-harvesting, ranging from only one to several statements, and from implied to directly referred to, and never mentioned or implied but related are included in the policy analysis. Since the policymaking process includes the formulation of strategies, programmes and plans, and the enactment of related laws and regulations, these elements are also subsumed in the analysis. All the components of the policy making process under consideration span from 1993 to 2011. Starting the policy analysis with the supreme law of the land provides with the foundation on which all other policies and legislation are built. The Federal Constitution of Ethiopia (Federal Democratic Republic of Ethiopia, FDRE, 1994), in Article 43, has bestowed all citizens of the Country with the right to participate in national development and, in particular, to be consulted with respect to policies and projects affecting their communities. It is stressed that after all, the basic aim of development activities shall be to enhance the capacity of citizens for development and to meet their basic needs. This particular Constitutional provision is fundamentally important but often overlooked in

development interventions, both governmental and non-governmental. One of the major causes for the failure of rainwater-harvesting interventions is that program implementers seem to forget that beneficiary participation is a constitutional right not a coordinator or donor prerogative.

A year before the FDRE Constitution came into effect the EPRDF-led government laid a cornerstone of its economic development direction that came to be known as the Agricultural Development Led Industrialization, ADLI (Transitional Government of Ethiopia, TGE, 1993) was created on the third year of the EPRDF takeover. The strategy, which was formulated out of the long cherished political ideology of the EPRDF, became the mother of all policies, strategies and programs. ADLI is founded on the deep-seated conviction, shared by all member parties of the ruling coalition, that industrialization in a Country like Ethiopia, with 85% of its population in agriculture, could be realized only by boosting this very sector rather than by weakening it. Under ADLI, expansion especially of smallholder agriculture will increase demand for industrial products, produced by domestic industries. Agricultural sector can supply food to domestic markets and raw materials for the industries and export.

The implications of ADLI for rainwater-harvesting are clear. Rainwater-harvesting is in essence small-scale operation and management fit for smaller scale irrigation, industrial, domestic and environmental use. Rainwater-harvesting-based smallholder irrigation, small-scale manufacturing and domestic use create demand for construction materials like: cement, plastering materials or waterproofing materials, tanks, gutter systems, polythene plastic for lining, and water lifting devices, which can be more cheaply produced by local industries. Smallholder rainwater-harvesting-based agriculture can play a significant role in improving the nutrition status of both rural and urban residents through the transformation of the cropping patterns. Public health is a prerequisite for higher labor productivity and innovativeness. Availability of water for domestic uses from rainwater-harvesting frees women and girls to involve in education and production. Ensuring water security for urban residents and even agro-industries that use plenty of water in their production process can benefit from rainwater-harvesting. Rainwater-harvesting can improve the productivity of agriculture in areas that suffer from climate variabilities, helping them to contribute more to National development

beyond fulfilling their own needs. This can facilitate the shift of budget from aid to development. As the rainwater-harvesting product industries expand, supported by a huge domestic market, they may start to export their relatively low-priced products to external markets. Through the multiplier effect generated by the domestic demand and supply chain, rainwater-harvesting contributes to economic growth.

The centrality of poverty reduction in ADLI is relevant for rainwater-harvesting and climate change adaptation. Poverty is the most fundamental economic problem in Ethiopia; and it is among other things closely linked to water security. Sullivan et al (2003) have established the link by deriving the water poverty index from the interacting components of access to water (quantity, quality and variability), water uses (domestic, food, and productive purposes), capacity for water management, and environmental aspects. Rainwater-harvesting plays a critical role in the linkages by creating ease of access to water for all uses and more cost effective management and environmental sustainability. As incomes and asset building of farmers and pastoralists, who are benefiting from rainwater-harvesting-based high value crop and livestock production, increases their vulnerability to climate change and variability declines. This will help them to boost their capacities to adapt more effectively to climate change impacts. Rainwater-harvesting also gives a helping hand in the effort to attain the global targets, related to access to water, food security, and environmental protection, in the Millennium Development Goals.

It would be very difficult if not impossible for rainwater-harvesting to prevail, particularly in the initial popularization phases, without the substantial public spending principle upheld by ADLI. Rainwater-harvesting cannot survive and thrive in the face of stiff competition advocated by liberalist economic paths to development where public spending is discouraged, domestic markets widely opened, and supply and demand relationships fully subject to cost-benefit calculations. Although ADLI provides solid ground for people and resource-centered growth, which deviates from the beaten-track of international development recommendations, some questions remain to be answered with regard to its instruments for implementation. One key question, related to the promotion of rainwater-harvesting as a climate change adaptation strategy, is to what extent the sectoral and intersectoral policies, strategies, legislations, and programs have emanated from the ADLI principle.

3.2.1. Rainwater-harvesting related policies

- *Water Resources Management Policy and Strategy*

The most directly related policy to rainwater-harvesting is the Ethiopian Water Resources Management Policy (Ministry of Water Resources, WoWR, 1999). The policy document has statements in its preamble, which imply the importance of rainwater-harvesting. Water resources in Ethiopia are uneven in their spatial and temporal distribution. The required amount is not available at the right time because rainfall either occurs ahead of time or comes too late or even stops short in mid-season. Two of the five general policy objectives— manage and combat drought and floods through efficient storage and rehabilitation measures— are actions, which can better be achieved through the implementation of appropriate rainwater-harvesting technologies. Moreover, three of the six principles of the policy, which include decentralized management, participatory approach, equity, efficiency, reliability and sustainability, are consistent with the water resource management approach characteristic of rainwater-harvesting systems. The irrigation policy stresses the need to develop and enhance small-scale irrigated agriculture and grazing lands for food self-sufficiency at the household level. This is a policy area that is inseparability linked with rainwater-harvesting. The association between small-scale irrigation and rainwater-harvesting in the literature is ubiquitous.

In the water technology field the following policies are stated: establish partnership amongst academic circles, industry and the water sector for the sustainable development of technology; develop practical strategies for the successful transfer, adaptation, and assimilation of internationally recognized technologies to local circumstances; and promote and develop indigenous technology based on artisans. These policy statements are relevant for rainwater-harvesting for the technology is considered appropriate to local social, economic, and environmental conditions. However, application of these policies in the rainwater-harvesting systems is not as straightforward as it may seem to be. The issue of technology transfer and adoption is also an important subject in other policies and strategies.

The Education and Training Policy of Ethiopia (Ministry of Education, MoE, 1994)

desires to maintain the curriculum up to international standard giving due attention to concrete local conditions. In the technology sphere, the technical and vocational education and training (TVET) colleges, as centers of technology capability accumulation and transfer, are entrusted with the responsibility to ‘replicate new and selected technologies and transfer the same to the relevant industry according to international standards’ (MoE, 2008). Moreover, the TVETs would also link with micro and small enterprise (MSE) as testing grounds for the adapted technology. The TVET-MSE link is based on the conviction that the latter would serve as ‘instrument for bringing about economic transition by effectively using the skill and talent of the people without requesting high-level training, much capital and sophisticated technology’ (Ministry of Trade and Industry, MoTI, 1997). However, there is no data available yet to show of such technology linkages between the two.

The expectation is that, experts who know the Country well enough will carve out locally appropriate tools from borrowed technology. However, one statement in the strategy document does not give room for optimism that the aspiration will be realized. If the Ethiopian teachers and trainers are to be ‘capacitated by hiring foreign experts’, it is highly unrealistic to expect hired foreign teachers, who are educated in the technologies prevailing in their home countries, to effectively guide Ethiopian students to engage in adapting technologies to local realities. There is no evidence that neither the TVETs nor the faculties, colleges and institutes of technology throughout Ethiopia, including the specialized water technology institute in Arbaminch, are engaged in research and development on the adaptation of rainwater-harvesting technologies to local conditions. For instance, the only rainwater-harvesting technology pilot testing center during the mammoth pond programme implementation was a tiny experimental station at Adama.

The failure of transfer of adapted technology is reflected in the National Science, Technology and Innovation Policy of Ethiopia (Ethiopian Science and Technology Agency, ESTA, 2010) as a ‘lack of systematic transfer and weak technological capability for the effective absorption of foreign technology based on the demands of the various social and economic sectors’. There should be little wonder that this happened because of the fact that the curriculum of most academic programs, both in

the graduate and undergraduate levels are largely replicas of the course catalogues of the developed world universities. Moreover, the opening of academic programs and research projects are more often than not donor-driven with a greater degree of influence on their contents and approaches. As graduates educated in this less appropriate contexts populate the water resources and other related ministries the official desire for local or adapted technology increasingly becomes a nuisance. How much small-scale and locally adapted technologies like rainwater-harvesting have fallen out of favor is manifested by the absence of documents on rainwater-harvesting in the library of the Ministry of Water and Energy. (MoWE) Moreover, there is neither a department nor employment opportunity for rainwater-harvesting. The Ministry very much unlike its own policy is staffed almost entirely by graduates trained in high-tech waterworks.

The importance of rainwater-harvesting is not only implied in the policy document but also directly stated. General policy No. 15 states the need to “promote and enhance traditional and localized water harvesting techniques in view of the advantages provided by the schemes’ dependence on local resources and indigenous skills”. In the Ethiopian Water Sector Strategy (MoWR, 2001) ‘harvesting rainwater’ is lauded as the most sustainable and cost effective technology that could be planned, implemented and managed with the involvement of local communities. The Strategy is even more forceful with regard to the expressed readiness to implement in-situ, ex-situ, and biological rainwater-harvesting and associated systems especially in the areas where drought is more frequent.

However, without a coordinating department and staff for rainwater-harvesting in the Ministry, it is hard to understand how the policy and strategy statement can be realized. There is a problem of semantics in the policy as well as the strategy statements quoted above. General policy No.15 has failed to reason out why the term ‘water harvesting’ was used in place of ‘rainwater-harvesting’. No definition of ‘water harvesting’ is given in the glossary section of the policy document. While the prevailing tendency is to pick up and use one of them arbitrarily rather than rationally, the use of ‘water harvesting’ without operational definition in a policy document will simply add to the confusion. There is also a usage inconsistency in the strategy document where the phrase

“harvesting rain” is used in one page and “water harvesting” in another. This seems to prove that the two are considered as synonyms when they are not.

The impact of climate change on water resources, development and management, and the indispensable adaptation response, has become an important subject in policymaking debate. However, in spite of the great significance of the issue, there is no mention of it in the policy document. This is understandable on the ground that until the time the policy came into effect climate change was more of a scientific rather than a policy agenda. The policy may have outlived its importance in this regard.

- *Disaster Risk Management Policy and Strategy*

In view of the value of rainwater-harvesting for adaptation to climate change, variability and extremes, which is the subject of this research, policies, strategies and laws that pertain to disaster risk management, are deemed relevant. The frequent exposure of the environment, the people and the economy to drought had obliged the EPRDF-led government to formulate disaster policy soon after it assumed state power. The National Policy on Disaster Prevention and Management (TGE, 1993) focused more on drought and “aimed to gear all efforts towards eliminating the root causes of vulnerability” to the disaster. However, the policy document fell short of mentioning what specifically such efforts are. A draft policy on disaster risk management (FDRE, 2009), which is not approved until this research started, is claimed to be fundamentally different from its predecessor.

What is considered a “paradigm shift” in the draft policy is the adoption of multiple-disaster approach and a full disaster management cycle (prevention, mitigation, preparedness, recovery and rehabilitation). To some degree, these components of the cycle were also addressed in the previous policy although the reactive response in the form of distribution of relief may have outweighed the others. The shift from drought-focus to multi-disaster approach may be taken as a matter of fairness in policymaking. However, any attempt to take away the larger share of attention given to date to drought disaster could turnout to be more hazardous than the hazard itself. Sometimes, individual bias associated with the drought-prone areas may dangerously sneak into the policy making process. Towards the end of his regime the

former military ruler of the Country said with impunity, “The reason why Ethiopia is called hungry is because of the drought in the north; there is no hunger in Ethiopia”. In fact, there is a lack of unanimity with regard to the status of drought as a disaster. In a surprising turn of events, Mitiku Kasa the head of the very organization that drafted the new policy, unequivocally stated while opening a conference on May 2, 2013, that drought is a major hazard in Ethiopia. Earlier, the National Adaptation Programme of Action (NMA, 2007) had also maintained this position by stating that drought is the single most important climate related natural hazard affecting the country. The program of action recommended rainwater-harvesting for the arid, semi arid and dry sub humid areas of Ethiopia that are drought-prone and more likely to be affected by climate change. Relegating drought to the status of any other disaster, among other consequences, has caused the absence of updated drought-prone area map. Whatever updated maps are available are choropleths by district administrative units or aggregations of ‘disaster’ areas or food insecure zones. This could make targeting drought as a manifestation of the general climate change trends very difficult.

While the 1993 policy is not yet replaced by the new draft policy, the 1995 proclamation on disaster prevention was repealed by Proclamation No. 593/2008. Before the draft policy is approved, a Disaster Risk Management Strategic Programme and Investment Framework (DRMSPIF) was issued. Nevertheless, the content of the new framework can be appreciated for pressing on the right buttons. The framework integrates disaster risk reduction and climate change adaptation by applying the principles of a ‘climate-smart’ disaster risk management approach, and mainstreaming disaster risk and climate change into development planning. However, if this appropriately designed framework is to have any success it has to be laid on relevant policy and legislation. No such policy and legislation yet exists to provide neither for the integration of adaptation and disaster risk management nor for the mainstreaming into development planning of the two. The draft disaster risk management policy, which was completed in 2009, did not include the contents of DRMSPIF. Such non-inclusion cannot be justified on the ground that adaptation to climate change, by the time the policy draft was completed, had already become a global as well as a National agenda. In connection with this, the NWP in 2005 and the NAPA in 2007 can be mentioned.

The list of proposed partners for the implementation of the integrated disaster risk and climate change framework includes the Environmental Protection Authority (EPA) and the National Meteorological Agency (NMA). Since the Disaster Risk Management Food Security Sector (DRMFSS) is not an implementation organization, it relies on partner government ministries and agencies for the realization of its objectives. There are areas of overlap, between EPA and DRMFSS, on climate change adaptation where ‘building resilience to a changing climate is inextricably linked with efforts to reduce vulnerability to current climate hazards and variability’. Nevertheless, there is no policy or legislation that provides for the coordination of the activities of EPA and DRMFSS on this particular issue. Hence, the EPA has gone its own way implementing adaptation programs ‘with limited sharing of data and expertise with the DRMFSS’. In view of the pervasiveness of climate change impacts in all sectors, EPA ought to integrate mitigation and adaptation activities with all ministries and agencies both governmental and non-governmental. Moreover, enabling policies and legislation to this effect have to be put in place.

- *Environment Policy and Strategy of Ethiopia*

The EPA is given the task of coordinating Ethiopia’s climate change activities, including international negotiations, climate change mitigation and adaptation. This had been the responsibility of the NMA before it was moved to the EPA. Both do not have policies or legislation providing for the assumption of the responsibility. The Environmental Policy of Ethiopia (EPA, 1997) came into effect when climate change mitigation was a more dominant global agenda in climate change negotiations. This was the time of the Kyoto Protocol. Climate change is included in the document as one of the sectoral policies, associated with atmospheric pollution. The policy statements comprise almost entirely of environmental actions that contribute to climate change mitigation, although actions like reforestation, agro-forestry, rehabilitation of degraded land, and general re-vegetation of the land have a great deal of adaptation benefits.

Although not directly mentioned rainwater-harvesting for climate change adaptation is implied in the key guiding principles of the policy: ‘promote water conservation in drought-prone and low rainfall areas’. The water sector policy also provides for promoting artificial recharge of ground and surface water, the greatest contribution of

which more often comes from rainwater-harvesting. There is an indirect reference to the use of rainwater-harvesting to fight desertification in the National Action Programme to Combat Desertification, NAPCD (EPA, 1998), through the “construction of earth dams and ponds for small-scale irrigation”. The policy making process in the environment sector is a litmus test for the appropriateness of policies to domestic realities. The contribution of Ethiopia to the global emission of greenhouse gases is negligible. Hence, one would normally expect climate change policies and strategies to be skewed towards adaptation. Adaptation actions are like two-edged sword. They not only reduce vulnerability to the direct effects of a changing climate but also assist the efforts to solve human induced degradation of the environment even in the absence of climate change.

The need to elevate the status of adaptation in policymaking notwithstanding, a 20-year long strategy, known as Climate-Resilient Green Economy, CRGE (FDRE, 2011) was launched with the exclusive mission of mitigating climate change by creating extensive systems of clean energy sources and carbon sinks. Seen from a different angle, this move may be a tactical one. The brevity for adaptation and the abundance for mitigation of global funds may understandably compel policy makers and planners to use the ‘trophy of mitigation’ to finance adaptation. Incorporating rainwater-harvesting into the CRGE could have been useful. Rainwater-harvesting, which incurs a relatively low total cost and a much lower life-cycle cost, is better known not only for its adaptation but also for its mitigation benefits. Rainwater-harvesting replaces centralized water distribution systems reducing energy requirements. Moreover, the in-situ systems improve soil moisture allowing a greater density of trees and shrubs, which can serve as carbon sinks. The zero or minimum tillage, a method of conservation agriculture in rainwater-harvesting also reduces the amount of carbon released from the soil.

- *Rural Development Policy and Strategy of Ethiopia*

Ethiopia is overwhelmingly rural Country. Its population is predominantly agricultural, pastoral and agro-pastoral. These subsistence-based and highly vulnerable livelihoods have been bearing the greatest brunt of recurring drought for ages. They are also the ones that are expected to receive the most severe impact of current and future climate change, variabilities and extremes. There is little wonder that the ADLI, food security, and other strategies are more rural and agricultural. It is for this simple reason that the

government has been pushing rainwater-harvesting for drought buffering program implementations to the agricultural and rural development spheres. The traditionally held responsibility for rainwater-harvesting of the Ministry of Agriculture and the recent act of Parliament (FDRE, 2008) to merge the Disaster Risk Management and Food Security Sector (DRMFSS) with the Ministry of Agriculture (MoA) is a case in point. Ensuring food security is one of the main pillars of sustainable rural development in Ethiopia. A National Food Security Strategy was designed (Ministry of Finance and Economic Development, MoFED, 2002) to help attain the goal of ensuring food security. The strategy is targeted mainly at the chronically food insecure moisture deficit and pastoral areas with a clear focus on environmental rehabilitation as a measure to reverse the current trend in land degradation. The major departure from the 1996 version is that water harvesting and the introduction of high value crops, livestock and agro-forestry development have become new elements of the revised strategy.

Drought-prone regions of Ethiopia are given special attention in the Rural Development Policy and Strategies (MoFED, 2003) and development intervention is centered on ensuring food security. The strategy is based on small-scale water resources development including water conservation and medium-size irrigation dam construction for growing high value products and sedentary livestock production for the pastoral areas. This is again an indirect reference to the use of rainwater-harvesting. The only sustainable way that water conservation and irrigation can be done in such localities is by way of harvesting rainwater. The modified Participatory Agricultural Development Extension and Training System, PADETS (MoA, 2004) is more explicit in the sense that, in the rain deficit areas the 'point of entry for extension is water harvesting'. The public works component of the Productive Safety-Net Programme (FDRE, 2005) mobilizes communities in the food insecure areas for soil and water conservation and development of ponds, which are largely rainwater-harvesting activities. The PSNP is a core component of Ethiopia's food security strategy. The Draft Policy Statement for the Sustainable Development of Pastoral and Agro-Pastoral Areas of Ethiopia (Ministry of Federal Affairs, MoFA, 2008) envisaged resettlement along major riverbanks for the people in the drought-prone predominantly pastoral areas. The plans, at least in the short-term, will not be favorable for the development of rainwater-harvesting, as the

‘luxury’ of using the water from the rivers will not create any urgency for the technology.

● *Urban Development Policies*

The level of urbanization in Ethiopia is very low, but its demand for water is more challenging to the system of supply. The rapidly increasing household demand for water as a result of the sheer increase in population, changes in the waters-use lifestyles, and the rise in water demand in the booming construction, industrial and service sectors is putting a great deal of pressure on the centralized water systems, which depend on the highly vulnerable ground and surface water resources. There is no promotion of any significance for the adoption of rainwater-harvesting, which could have alleviated the burden on the overstretched and inadequate conventional systems. The situation is more serious in the Capital, a primate city of the Country. It uses a few reservoirs and well fields located in the rural outskirts of the City. The supply sources are unable to cope with the accelerating demand for water. Hence, water supply outages are very common. The usual response is to go for greater extraction of the available ground and surface sources at an increasingly higher cost. The trend is becoming environmentally hazardous. A city in eastern Ethiopia has sucked an entire lake dry. The largest city in northern Ethiopia, located in a semi-arid and drought-prone climatic zone is also fast depleting its groundwater resources. The problem of water supply of these and all other urban centers of Ethiopia is expected to worsen with climate change induced increase in urban temperature, and alternating shortage and excess of rainwater.

In spite of the urgent need for it, rainwater-harvesting is mentioned neither in the Urban Development Policy (Ministry of Urban Development and Construction, MOUDC, 2004) nor in the earlier Urban Land Development and Management Policy, Strategy and Capacity Building Framework (MOUDC, 2003). However, there is a possible entry point, which can be utilized. The urban development policy requires ‘families and organizations to take their share of planting seedlings and care for them until they establish in organizations, residential areas, road-sides, parks, and watersheds’. The expectation is that the seedlings will be nurtured using the water from the central sources. In a situation where one experiences shortage of water even for drinking using water for urban forestry from these sources would be a luxury. Probably discouraged by this there

is little sign of enforcing this policy for the last ten years since it came into effect.

The planting of seedlings in the cities' open places was stated more strongly in the policy for urban land development. Urban land use is envisaged based on the 'garden-city' principle, and the development of the green area to be organized in such a way that the micro and small enterprises (MSE) participate. The best way the micro and small enterprises can participate is in the water supply technology, especially in roof catchment rainwater-harvesting. In view of their experiences in small-scale operations, they could produce and install low-cost components of rainwater-harvesting systems for public places, urban gardens, organizations, business centers, and households. This would not only help the diversion of water supply for many other critical purposes including drinking but also create employment opportunities for the graduates of junior technical schools. In order to realize this there is a need for the urban development as well as the urban land development policies to be amended.

There is also a need for specific legislation that makes rainwater-harvesting mandatory with a good mix of incentive mechanisms. The incentive schemes may apply to both the microenterprises and the domestic and institutional users. The existing law on construction has a few statements upon which detailed urban rainwater-harvesting law can be built. The Ethiopian Building Proclamation (FDRE, 2009) states that 'any building intended for occupancy by people shall be provided with adequate water supply, which shall have adequate distribution and storage system' and 'the owner of any site shall provide suitable means to absorb part of the runoff water within the site'. These are some of the opportunities than can be grasped by which the participation of the domestic private sector in sustainable development can be ensured. However, the regulations of the Council of Ministers on Investment Incentives (FDRE, 2003), almost exclusively favor those producing items for export rather than those producing for domestic market.

- *Health Policy and Strategy*

The Intergovernmental Panel on Climate Change (IPCC) projections indicate that, with increased drought the incidence of mosquito-borne diseases such as malaria decreases because mosquito abundance is reduced, although epidemics may still occur when suitable climate conditions occur (Bates et al, 2008). The dilemma for adaptation to

climate change is that, while the decrease of the amount of water, due to increased drought, reduces the incidence of malaria, the responses to alleviate the shortage of water increases it. Rainwater-harvesting, though an effective response to water shortages creates conducive environment for the breeding of malaria-spreading mosquitoes. In warmer temperature conditions, which is characteristic of the arid, semi-arid, and sub-humid areas prone to drought, open ponds, gutter systems, and even in-situ systems such as trenches and micro-basins could be conducive for mosquito breeding. A few studies, two of which are reviewed in the literature section, have shown the potential benefits of rainwater-harvesting in the northern region of Ethiopia that was lost partly because of this problem.

The Health Policy of the Transitional Government of Ethiopia (TGE, 1993) has the necessary raw materials for a future of protection from malaria epidemics. Some of the pertinent policy statements are ‘the prominence given to the enhancement of health awareness and the propagation of important concepts and practices of self-responsibility in health; development of preventive and promotive components of health care; and decentralization of the health service system’. The National Hygiene and Sanitation Strategy (Ministry of Health, MoH, 2005), which came into effect more than a decade after the health policy, is focused on water-based hygiene and sanitation. This is where the support provided by rainwater-harvesting could be vital. All seems to be set for rainwater-harvesting in the following statement in the strategy document: ‘strengthen the supply of sanitation through appropriate technology solutions, products and project development, and support to local producers and artisans’.

- *National Plans*

It is more than half a century since the first National planning started in Ethiopia. Dejene (1990) has described in detail of the plan years until the downfall of the Military regime. In 1954, a National Economic Council was established as a policy making body to coordinate the development plans chaired by the King. The first five-year plan (1957-61) targeted industry and infrastructure. It was only in the second five-year plan (1962-67) that attention was paid to agriculture, but to the commercial one. Whatever was done during the two plan years was based on donor recommendations. There seemed to be no interest in improving the backward subsistence livelihoods of the vast

majority of the agrarian population toiling under the landlord-tenant relationship of the then feudal economic system. When a greater shift to agriculture was suggested, by the Swedish International Development Agency (SIDA), the World Bank, UN-FAO, and US-based organizations, for the third five-year plan (1967-72) it fell short of addressing the problems of the poverty-ridden smallholder agriculture. The Package Approach, as it came to be known, concentrated its efforts on the more promising or high potential regions. Before the planning year ended, there was some realization that more has to be done and thus a Minimum Package Program (MPP) was introduced to provide critical services like fertilizers and credit in all parts the Country.

The long neglect of the subsistence smallholder agriculture, and the feudal land tenure system made the people vulnerable. A devastating drought occurred soon after the third five-year plan ended, with had far reaching consequences of abolishing the ages-old Monarchy and installing a Military-junta in its place. It was hard for the Military rule to establish itself due to internal opposition and war with Somalia. Hence, it was not possible for the promises made to improve the livelihoods of the people and increase their resilience to drought to be realized. After over half-a-decade of turmoil National planning was re-instated in 1978 with the establishment of the Central Planning Council. This time the plans took the forms of annual economic “campaigns” for the following six years. The memory of the 1973 severe drought seemed to have been lost obscured by the continuous good rains for the six annual plan years.

Drought was forgotten, but it did not forget. Probably enjoying the ease and the political benefits of the good weather, which boosted agricultural production, little was prepared to withstand the more devastating drought that occurred when the seventh annual plan, transformed into a ten-year perspective plan, was about to be launched. The drought of 1984, and the hundreds of thousands of human lives that perished as a result, shook the foundations of Military rule. It was overthrown five years later. This is a story of the downfall of two regimes due to climate related hazards the severity of which could have been reduced drastically by labor-intensive and low-cost ins-situ and ex-situ rainwater-harvesting systems among many other measures. The approaches for drought preparedness were less realistic because they were based on boosting agricultural production at national level instead of at local appropriate level, moving people out of

the drought-prone areas to settle in the more productive regions, and a neglect that is alleged to have been used as a weapon of war to weaken the rebellion in the drought-prone northern Ethiopia.

The EPRDF took power in 1991, but National planning was resumed ten years later. This time the gap was not created by political turmoil as it did in the early years of the previous Military rule, but by the difficult transition from a command to a new genre of market economy. A new constitution had to be drafted and approved; the process of devolution of central power had to be accomplished based on a federal arrangement, and ADLI had to be laid down as the political economy underpinning development planning. The first planning period, better known as a 'programme period', lasted for three years between 2002/3 to 2004/5. The Sustainable Development and Poverty Reduction Programme, SDPRP (MoFED, 2002), which is also referred to as Plan for Accelerated and Sustained Development to End Poverty, (PASDEP), for the first time in over four decades of National planning, listed rainwater-harvesting alongside small-scale irrigation as one of the major thrusts of Ethiopia's sustainable development and poverty reduction program.

PASDEP I years were full of events with regards to rainwater-harvesting. The widespread pond program was not a successful endeavor in many places creating among policy makers and planners a sense of disillusionment with the technology. At the end of the final year of PASDEP I, PASDEP II (MoFED, 2006) was launched for the following five years (2004/5-2009/10). Unlike the previous, rainwater-harvesting was just mentioned as one of the several development approaches in the moisture stressed areas. The current National plan period (2010/11-2014/5), PASDP III is known as the Growth and Transformation Plan, GTP, (FDRE, 2010). The main objectives to be attained during this plan period are poverty eradication and the Millennium Development Goals. Rainwater-harvesting is barely named in the plan document. It can only be implied from the planned small-scale irrigation, and soil and water conservation activities mentioned in the context of interventions into the moisture deficit areas.

Rainwater-harvesting is not a quick techno-fix solution to the problems of drought-prone areas. Such kinds of technological solutions take time to show satisfactory results in the economy and the environment. Planners could understandably

be frustrated by the failure to attain short-term targets with the help of such long-term approaches. A statement in the Plan document is quite revealing in this connection: “While giving appropriate focus to the use of rainwater in places where there is easy access to groundwater farmers will be supported to construct hand dug wells”. The GTP is the National plan, which for the first time devoted a section for climate change related plans. Nevertheless, although it mentions adaptation and mitigation as key issues in the building of a green, climate change resilient economy, and that adaptation strategy is a critical issue worth putting in place during the plan period, all the 20 climate change plan targets are related mitigation alone.

4. Implementation and Institutional Analysis

The implementation of rainwater-harvesting policies, strategies, programs, and plans, in the last half a century, has been a complex history of determination, enthusiasm, haste, failures, perseverance, confusion and disillusionment. The following discussion is based on the interviews with key informants and personal observation of the author for the last three to four decades. The phases which have served as a temporal framework for the discussion are categorized by the author, the beginning and end of the phases being the occurrence of major drought and resumption of normal rains, changes in government and/or failure of programs.

4.1. Implementation of Rainwater-harvesting Programs

4.1.1. Rainwater-harvesting vis-à-vis Soil and Water Conservation

Rainwater-harvesting did not start as part of a broader water management strategy, but as an appendage to soil conservation. Soil and water conservation (SWC) is the name given to this particular ‘union of unequals’. The main purpose of SWC has been saving the soil from erosion, but many of the methods of conserving the soil are also methods of harvesting rainwater. It can be argued that ‘soil and water conservation’ is a misnomer because the water conservation side of the nomenclature is inherently much wider than the meaning it is intended to convey in this particular context. The Environmental Engineering Dictionary defines water conservation as “the physical control, protection, management, and use of water resources in such a way as to maintain crop, grazing, and forest lands, vegetative cover, wildlife, and wildlife habitat for maximum sustained benefits to people, agriculture, industry, commerce, and other segments of the national economy.” In short, water conservation is an attempt to reduce water usage; the methods of which include widely ranging measures from efficiency in household, agricultural and industrial water use to harvesting rainwater. Water conservation can be broadly categorized into measures to minimize water use and measures that enable access to new and sustainable sources of water. Rainwater-harvesting falls in the second category of water conservation along with desalination and wastewater reuse. This indicates that rainwater-harvesting, which plays a key role in soil conservation, is only one of the several water conservation methods. It

would have served the purpose well if soil and water conservation could be renamed 'Soil Conservation through Rainwater-harvesting' (SCRH). The proposal may seem to be unnecessary given the age and the pervasive use of the existing nomenclature. Moreover, it may also be defended on the ground that the 'devil lies in the details'. However, at least in Ethiopia, the existing nomenclature has been causing a great deal of confusion as a result of the lost identity of rainwater-harvesting in the conceptualization of soil and water conservation.

The story of government development intervention in soil and water conservation began in the late 1960s. Structures both physical and biological were built in many parts of Ethiopia, especially in the semi-arid and sub-humid drought-prone and environmentally degraded areas. For over a decade of such intervention, the reports were exclusively about how much soil was saved from erosion and as a result, how much increase in land/crop productivity was achieved. Water conservation was considered useful so long as it controlled the velocity of rain droplets and the ensuing runoff. The water is said to be 'conserved' not for its own sake but as long as it provided additional moisture to the soil in the root zone of cultivated crops. No reports were compiled about how much rainwater was allowed to recharge groundwater, how much ecosystem regeneration occurred because of the contribution of rainwater capture.

Water conservation (in-situ rainwater-harvesting) helps reduce soil loss; soil conservation in turn helps reduce water loss by reducing the draining away of groundwater in areas where there has been deep gulley development. Conserving water in Ethiopia is more of a research problem rather than a public agenda and a social norm. The illusion of abundance of water resources in the perceptions of policy makers and ordinary people alike seems to equate water conservation with pessimism. Therefore, during soil and water conservation what planners, extension agents, and beneficiaries feel is that they are engaged in saving the soil not saving water. They did not consider the soil conservation methods as rainwater-harvesting. Rainwater-harvesting or 'water harvesting', as many prefer to call it, is perceived to be limited to the construction of micro-dams, ponds and tanks for collecting rain event induced runoff.

4.1.2. Phases of Rainwater-harvesting Interventions

Four distinct phases of development intervention in rainwater-harvesting can be identified, namely, the early revolutionary-phase, the later revolutionary-phase, the EPRDF up-scaling-phase, and the post up scaling-phase.

- *The Early Revolutionary-phase*

Development intervention in rainwater-harvesting in the early phase was relatively low key. It started in 1973 with the construction of earth dams and ponds in the Fedis area of eastern Ethiopia, by the soil and water conservation team. This was the year when the most severe drought in more than half a century, hit the northern, north-central and eastern regions of the Country. It was also a year of political upheavals, which eventually ended Monarchical rule. The earth dams and ponds, which were constructed in Wello and Tigray of northern Ethiopia as well, were intended for drinking water for people and animals. Since the intervention was ill planned without adequate knowledge of the areas' hydrological characteristics, and without any catchment treatment, the earth dams were overtopped and destroyed by floods. This was mainly because the soil and water conservation activities and the construction of earth dams were not coordinated. They were undertaken in different locations. The consolation is that some earth dams and ponds in Tigray and Eritrea survived, though provided limited services as cattle water points.

As memories of the 1973 drought faded away partly due to the resumption of the normal rains. The interest in the construction of earth-dams and ponds also faded away until it was triggered again by another even more severe drought. If at all, a continued preparation for any next drought, through well-planned intervention in rainwater-harvesting was envisaged, it was not possible to realize it. The Military rule never got a breathing space for that. The Country was at war from the east, from the north, and from the center. Even when the Military government got some transitory relief from internal insurgence and external war of aggression, in the late 1970 and early 1980s, it became more focused on state owned commercial farms, agricultural cooperativization after the Soviet model. It was also too engrossed in resettlement of

population from the drought-prone areas into the more productive regions, rather than helping farmers to reduce their vulnerability to drought in-situ.

● *The Later Revolutionary-phase*

When the Government was busy with ambitious one-year, three-year, and ten-year plans, probably assuming that drought had become history, it was overwhelmed by the 1984 drought. Since the Government was ill prepared to cope with the need for relief supplies, the whole world came to Ethiopia's help. On the part of the government, another cycle of the same drought-triggered strategy was adopted. Small earth dams and ponds were constructed in many parts of the drought stricken areas this time more for the purpose small-scale irrigation than for domestic water supply. The usual 'campaign-approach' was applied and administrative and party officials, all over Ethiopia were ordered from the center to encourage farmers to develop the schemes for food production. Political cadres, without any technical rainwater-harvesting knowledge, were in the forefront of the awareness creation campaigns as well as the selection of sites for earth-dams and ponds. Each district had quotas to fulfill at all costs. Hence, construction was done with a great deal of haste just to attain quotas without any knowledge of how to avoid erosion and siltation. The new enthusiasm for earth-dams and ponds created more questions than answers. The action was analogous to 'a port after a storm'. There was an obvious problem of timing of the intervention. It should have been done before the drought. Many lives could have been saved. After the drought is over and good rains come, constructing earth dams and ponds would not reverse the problem created by the previous drought. In post-drought years, rain-fed farmers would normally return to their ages-old practices of growing rain fed crops.

Such interventions could be effective only if they are proactive. The earth-dams and ponds must be constructed with the future drought in mind supported by adequate information about its severity and the level of vulnerability of the affected. Irrespective of when the rainwater-harvesting schemes are built, the purpose for which they were built was not the one at the top of the priority list as far as short-term response to drought is concerned. During drought emergencies, more people die of thirst than hunger. The criteria for the selection of target areas for intervention were not only vague but also had political overtones. The 'food for work' based campaigns to build

earth-dams and ponds for small-scale irrigation also had a number of other disruptive interventions; the most notorious of which were the villagization and population resettlement programs. Even where the schemes were successfully built, there were some disincentives, which forced the beneficiaries to abandon them too soon. Decreasing the vulnerability of communities was thought to come by way of growing higher value crops like vegetables and fruits. However, the high cost of fertilizers and the lack of proper storage and transport facilities for perishables created disillusionment with the 'drought-buffer'. The seriousness on the part of the government to bring about long-term drought resilience of the smallholder subsistence farmers and pastoralists through rainwater-harvesting was questionable. The ruling Marxist-Leninist ideology considered the smallholder subsistence farmers as 'vacillating petty-bourgeoisie', which has to be eliminated as a social class. In order to accomplish this, proletarianization of the 'rural masses' through agricultural cooperatives and land consolidation was taken to be the key strategy.

- *The EPRDF up scaling-phase*

Military rule in Ethiopia ended when rebels from the north fought their way into the Capital in 1991. The EPRDF government, which replaced Military rule, had its own conception of the right path to development. While operating in the rural areas of northern Ethiopia for nearly two decades the former rebels now in power were much closer to the smallholder subsistence farmers than their urban-based predecessors were. They did not need the usual 'drought-trigger' to start developing rainwater-harvesting systems. This was a boom period for rainwater-harvesting because the subject dominated much of the economic, social and political agenda of the time. One of the major deficiencies of the entire plan was the absence of thorough study about the successes and failures of previous intervention programs in rainwater-harvesting development. The preferred strategy was to 'start from scratch'. This phase can be divided into two sub-phases; namely, the micro-dam sub-phase and the pond sub-phase.

- a. Micro-dam sub-phase*

In the second half of the 1990s a Sustainable Agriculture and Environmental Rehabilitation Program (SAERP) was launched in the northern region of Ethiopia. The

core component of the multi-million dollar program was the construction of hundreds micro-dams to harvest runoff throughout the region. However, the fervor to solve the ages old problems of water shortage and vulnerability to recurring drought of the region was not accompanied by adequate feasibility studies, appropriately skilled human resource, and measured actions. The micro-dam program included the reconstruction of the previously built earth-dams. The program was expanded to other regions and organizations were established to organize the construction of micro-dams. However, before the other regions could go ahead with the micro-dams schemes, the experiences in Tigray became a food for second thoughts. The same old problems started to surface soon after a small percentage of the planned micro-dams were constructed. Siltation and seepage were the two major problems that plagued the micro-dams. The treatment of catchments above the micro-dams was the responsibility of the regional bureau of agriculture. However, the bureau was not a part of the micro-dam program. There were many cases of constructing extensive canal system on rain-fed farmlands with concrete and masonry before it was known whether the dams are able to hold enough water. In some cases, even pasturelands were already drained by the canal systems where there was not to be a drop of water available in the micro-dams for the dry season irrigation. The failures set-off widespread disillusionment with micro-dams, which were perceived as capital-intensive schemes. The micro-dam program, which was the only pre-drought development intervention in rainwater-harvesting ever undertaken, was called-off. A year or so later in 2003, another drought struck Ethiopia. Like in the old days, this invited another cycle of passion for rainwater-harvesting; and this time, it was for ponds.

b. Ponds sub-phase

The new enthusiasm for ponds was justified on the ground that they were cheaper than micro-dams, do not need unaffordable heavy-duty machinery, and are much closer to the users in terms of physical distance. The ultimate vision was to provide each household with its own pond. Although this can be considered as a noble mission, the manner by which it was being implemented was very far from ensuring its success. Once again, the ‘campaign approach’ and the ‘quota system’ were applied to accomplish the mammoth pond program. In a matter of only three years, between 2003 and 2006,

close to a million ponds were constructed in the four more densely populated regions of the Country at the cost of hundreds of millions of Birr. Even more were planned for the following years. Unfortunately, the dream of ‘millions of ponds’ turned from an instrument to end the chronic food insecurity to a costly nightmare within less than 5 years. Most of the major reasons for the failure were associated with the system of quota. For the administrative bodies at the implementation levels the most important thing was to construct and report. There was no time for setting up as many pilot trial sites as was required given the great physical and cultural diversity of the Country. There was only one trial site for all. Hence, inappropriateness of the pond and tank designs to the local geology, soil properties and erosion rates, temperature and evaporation rates, rainfall amount and intensity, and cultural values and perceptions became the logical outcomes. In addition, the system of quota gave no allowance of time to prepare adequate technical human resource resulting in unsuitable site selection, wrong construction material choice, and poor workmanship.

The system of quota had its own contradictions. While the various administrative and political bodies at all levels of implementation were expected to complete the construction at or before the deadline dates, incapacitating delays in the supply of construction materials and budget were adding fuel to the existing rush to fulfill quotas. The urge to attain quotas was so decisive that there were several cases in which the mission of the program itself was compromised. The situation could be described as ‘throwing the baby out with the bath water’. There were reports of selecting ‘industrious’ and willing farmers to the projects rather than the poorest. The hardworking farmers, irrespective of their food security status, were expected to help fulfill quotas. Moreover, the more accessible mid-elevation areas were preferred to the water-deficit, but less accessible lowlands. With widespread failure of the schemes in all regions, the pond program quietly withered away. There was but one consolation for the implementing political and administrative bodies. The digging for the ponds and tanks was in many places striking shallow groundwater aquifers to the relief of everyone involved. It was after all water that was needed to ensure food security. There was no problem of justifying the use of groundwater as the technology was called ‘water harvesting’ instead of rainwater-harvesting. The former includes the use of groundwater.

This shakes the foundation upon which rainwater-harvesting is built. Rainwater is harvested in order to alleviate blue water depletion, which of course includes groundwater. Government initiatives shifted to well-digging abandoning ponds and tanks.

- *The Post up scaling-phase*

This is where rainwater-harvesting in Ethiopia is situated since the second half of the last decade. Failure of the pond program created an atmosphere of despondency and silent withdrawal at all levels of government except for the evaluative journal articles or consultancy reports that sprouted from everywhere. This time there is no more National level planning for rainwater-harvesting. It is left for lower administrative levels as well as NGOs to go their own ways. The three major areas of activity, which characterize this phase, are small-scale NGO operations in rainwater-harvesting, widespread groundwater use for small-scale irrigation, and the renewed government interest in soil and water conservation. Many NGOs, including the Ethiopian Rainwater-harvesting Association (ERHA) are almost fully engaged in sand-dam construction in the dry pastoral lowlands of eastern and southern Ethiopia. The sand-dams are not immune from problems either. There are reports of construction skill problems, flood damage, inadequacy of finance, lack of local community participation and, hence, lack of maintenance and protection of sand-dams after construction. The latter is a common phenomenon in NGO operations in Ethiopia. In most cases, project financing has a limited period and rarely caters for the post-construction activities. Some NGOs are also building rain-tanks for institutions and communities and also involved in the construction of in-situ rainwater-harvesting structures to a limited extent. The later is more extensively undertaken by the Relief Society of Tigray (REST) in the northern region of Ethiopia. The spread of shallow well digging to exploit groundwater, without coextensive recharge mechanisms, has become a dangerous lapse into un-sustainability. The 3Rs (Retention, Recharge and Reuse), which has become a favorite maxim for some NGOs is what is needed for sustainable groundwater use. A locality known as Abraha-we-Atsebeha in northern Ethiopia a UNDP Equator Award winner has become exemplary in this regard.

Although the work of soil and water conservation has never stopped, it was made to be more noticeable by the launching of the Sustainable Land Management Programme (SLMP) from 2008 to 2013. One of the objectives of the SLMP was to reduce land degradation in agricultural landscapes with particular focus on the areas of high agricultural potential, which are facing a threat of food insecurity. The construction of the new dam on the Blue Nile River has also given a new impetus for soil and water conservation in the entire Basin to save the dam from future siltation.

4.2. Institutional Analysis of Rainwater-harvesting Development Intervention

In order to understand the contexts of the institutional dynamism that occurred in the course of the implementation of rainwater-harvesting to alleviate the problems of drought and degradation, the analysis will be divided into periods coinciding with the implementation phases used in the preceding section. Accordingly, the periods are the early revolutionary, the later revolutionary, the early EPRDF, the later EPRDF, and the recent EPRDF periods.

4.2.1. The Early Revolutionary-period

The first institutional setup for rainwater-harvesting intervention was for soil conservation undertakings in which in-situ rainwater-harvesting was the core component. As a gesture of readiness, to solve the widespread problem of land degradation, which was previously neglected by the Monarchial government, the new Military government tasked the Soil and Water Conservation Department, within the Ministry of Agriculture, to implement soil and water conservation on a wide scale. Large areas, in many parts of the drought-prone and degraded areas of the Country, were covered by terraces, soil and stone bunds. In spite of the fact that the project was a good beginning the way the implementation was organized lacked sustainability. The arrangement is that, the Soil and Water Conservation Department at the top planned, designed, and assigned in a top-down manner without involving the beneficiaries. For the short-term, all seemed to go well because of the food-for-work labor power arrangement. Instead of distributing food aid to the people freely, able-bodied recipients were required to construct the soil and water conservation structures and get food as a reward. The misconception on the part of the institutional arrangement was that the

food-for-work project participants would have a feeling of belongingness to the structures they built. Contrary to such belief, the farmers considered the conservation work as a source of food rather than as a long-term solution for their problems. Many were destroying the structures in the hope of being paid in food for repairing them. When the projects ended and the farmers had to produce food for themselves on the land where the conservation structures were built, the structures had already taken significant proportion of their already small plots. The temptation to reclaim their farm plots by destroying the structures was high.

The other major problem of the institutional setup was that the Soil and Water Conservation Department had no research wing. Designs of soil and water conservation structures were replicated everywhere irrespective of the topographic, edaphic, climatic and cultural peculiarities of localities. The action to bridge this crucial institutional gap came in the form of a temporary projects rather than a permanent division within the Soil and Water Conservation Department. A Soil Conservation Research Project was launched with financial support from Government of Switzerland and collaboration with Swiss researchers. Experimental research was done on sites in different agro-ecologies involving graduate students from Addis Ababa University. As a project, not as an integral part of the broader institutional arrangement, it ended after almost a decade of operation.

The construction of ponds and earth dams for small-scale irrigation was the responsibility of a division within the Soil and Water Conservation Department, known as the Surface Water Development Division. This shows that rainwater-harvesting activities were separated into two different institutional setups. The Surface Water Development Division, which was expected to provide technical assistance to farmers, was not effective. Its assistance was not based on research results. It did not have a research project like the one for soil and water conservation let alone a permanent research wing.

The most conspicuous absence from the institutional setup for rainwater-harvesting for drought is that of a water resources management organization. An organization for the water resources sector first came to the scene as early as the mid-fifties, as a small department within the Ministry of Public Works and Communications, to undertake

Blue Nile Basin studies. Then the National Water Resources Commission was established over a decade later. Despite the fact that the Commission was given broad powers, it was constrained by financial and skilled work force shortages, and resistance to its authority from other public bodies. In addition, a part of its responsibilities was taken away and given to the Ministry of Agriculture in the mid-seventies. Hence, rainwater-harvesting and small-scale irrigation works came under the Ministry of Agriculture. The National Water Resources Commission continued to experience organizational transformations. Nevertheless, the Commission remained distant to the small-scale water development for drought, which should have been well within its mandate as a sectoral organization for water resources development and management.

4.2.2. The Later Revolutionary-period

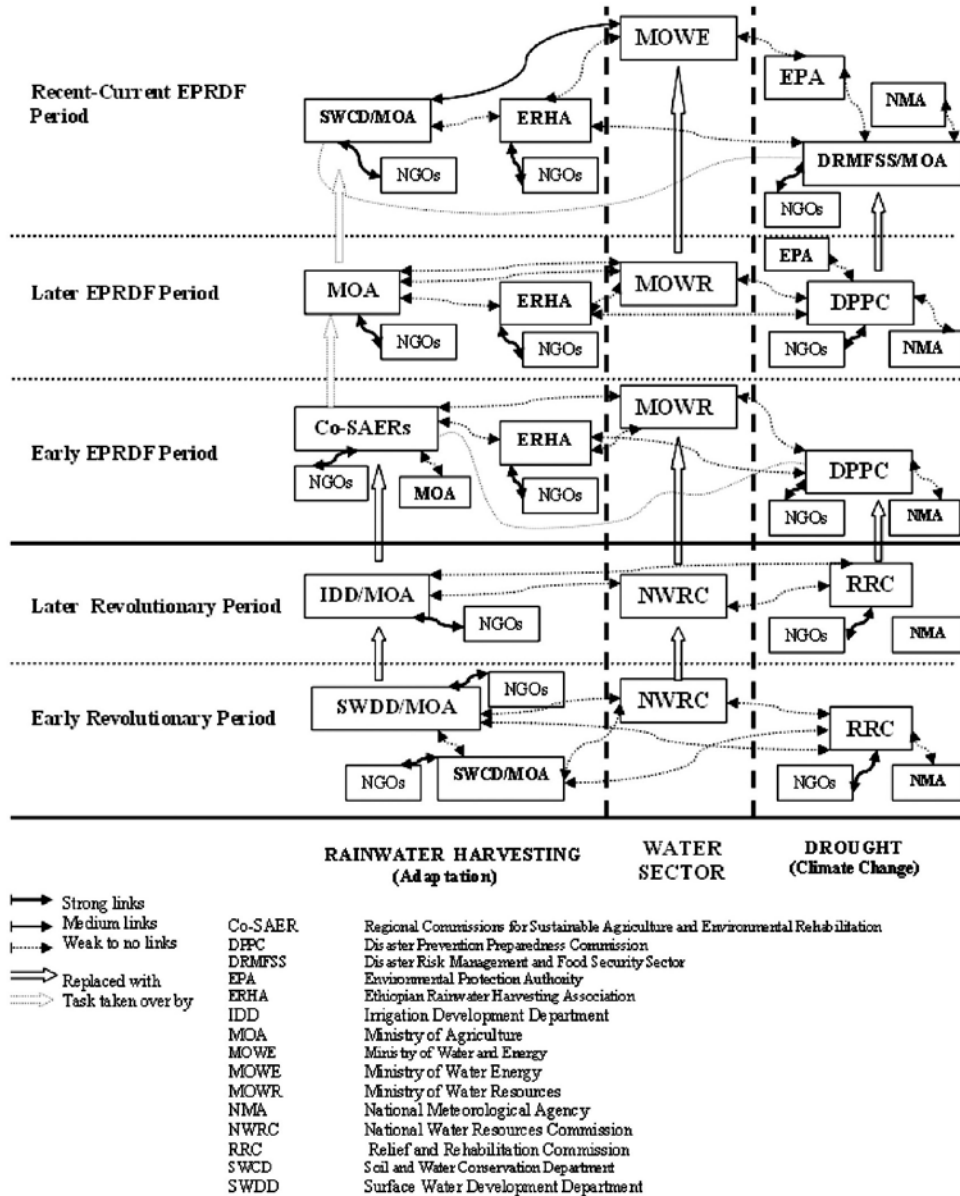
The beginning of this period is marked by the devastating drought that occurred in 1984. A major restructuring took place in the Ministry of Agriculture as part of the response to the drought. A Rural Infrastructure Development Main Department was created as one of the four main departments in the Ministry. Irrigation Development Department was established within the Rural Infrastructure Development Main Department and the Surface Water Development Division was closed. The Surface Water Development Division, which was responsible for the construction of ponds and earth-dams, was replaced by the Irrigation Development Department. There was little difference in what the two did. The change of name, not of function, may have been intended to highlight the greater attention given to small-scale irrigation as a reason for collecting rainwater. The Irrigation Development Department was designing and constructing earth-dams by sending earth-dam construction “brigades” from the center to the zonal administrations. The manual labor was supplied by the local administrations through the food-for-work arrangement. The food that came in the form of international aid was used as wage for laborers with the approval of international organizations. The people remained undernourished and vulnerable because the amount of calories they expend on construction work could not be replenished by the food they “earned”. The financial and human resource development support for the Irrigation Development Department came from World Bank, International Fund for Agricultural Development, and European Economic Community among others.

The Irrigation Development Department and the Rural Infrastructure Development Main Department had parallel organizational links with the zonal Rural Infrastructure Development Departments. Such parallel links often create confusion in the directives given by one or the other higher body. The approach was generally top-down, which did not involve the local stakeholders. The design was done in the center and construction work was led by the brigades sent from the center. While earth-dams were constructed and the poor drought-affected farmers were expected to practice small-scale irrigation from the collected rainwater the priority given to producers' cooperatives in the allotment of the best irrigable land was creating a disabling environment. The organizational restructuring in the Ministry of Agriculture removed the water conservation component from the former Soil and Water Conservation Department and renamed it as Soil Conservation and Community Forestry Main Department. The fact that there had been no clear thoughts about the role of water conservation in the 'pair' became evident from the process of organizational restructuring. The water resources organizational setup during this period continued to be confined to macro level basin studies for large-scale irrigation development. It considered the drought of the mid-eighties as an obstacle to its progress.

Another aspect of the institutional setup is that the affairs of drought and rainwater-harvesting for drought were handled by different organizations. The management of drought as a disaster was assigned as the responsibility to the Relief and Rehabilitation Commission while rainwater-harvesting as a lasting solution to the impacts of drought was within the domain of the Ministry of Agriculture. The role rainwater-harvesting plays in reducing human and ecosystem vulnerability to drought encompasses much more than irrigation. This could have been better accomplished if rainwater-harvesting was recognized as an important tool for a broader and long-term drought-disaster management action and incorporated in the organizational structure of the Relief and Rehabilitation Commission rather than in that of the Ministry of Agriculture. Nevertheless, the Relief and Rehabilitation Commission had neither the institutional mechanism nor the institutional mandate to engage in long-term resilience building activities. It was merely a relief distributing organization until it returns the displaced victims back home. The Ministry of Agriculture, the Relief and Rehabilitation

Commission, and some relief NGOs were in no mood to work in unison. Development planners considered drought just as an ‘obstacle’. Such a lack of intersectoral integration made building long-term drought-resilience out of the question.

Fig. 1 The Evolution of Organizational Setup and Linkages for Climate Change and Rainwater-harvesting



Source : Author

4.2.3. The Early EPRDF-period

This period of institutional change begins from the Ethiopian Peoples' Revolutionary Democratic Forces (EPRDF) takeover of government in 1991. The new government apparently was not interested in retaining the institutional setup of its predecessor. Much of the way things were done in the past was changed. This included the closing of Irrigation Development Department established in the Later Revolutionary-period, without any replacement at the central level. Within the context of the decentralization of central powers to the newly created administrative regions, an organization was evolving in Tigray Region, which had similar objectives to that of the former Irrigation Development Department. A Commission for Sustainable Agriculture and Environmental Rehabilitation (SAERT-Commission) of Tigray was established with the support of the Federal Government and UN organizations. The mission of the SAERT-Commission was to combat drought and enhance drought resilience through the construction rainwater-harvesting micro-dams. The institutional set-up was replicated in the Amhara and other regions. The Commissions so established were autonomous bodies to the extent that the regional bureaus of agriculture, which were more powerful in the past, were left out of the programs. The bureaus of agriculture were expected to run and maintain the schemes after the micro-dams were designed, sites selected for them and completed by the Commissions and handed over to them. The Relief Society of Tigray (REST) is another autonomous organization that was also building micro-dams in the Region although at a much lower scale. This organization is better known for its more successful in-situ rainwater-harvesting activities on a vast scale in the northern Ethiopian region of Tigray. The REST-led in-situ rainwater-harvesting in Tigray, which also involved the Bureau of Agriculture, benefited from its institutional linkages with Mekele University where related applied research was being conducted.

This period was full of events related to the institutional arrangement for the water resources sector. The Water Resources Ministry was established in 1995, followed by a water resources management policy in 1999, water resources management legislation in 2000, and a water sector strategy in 2001. Nevertheless, there was little visible direct involvement of the sectoral organization in rainwater-harvesting for drought. It is a paradox to say the least that the Ministry of Water Resources, which was given

exclusive responsibility by article 8 of the Proclamation to exercise full control over the development and allocation of water resources in Ethiopia, remains detached from rainwater-harvesting. The proclamation does not distinguish blue from green-water if that happens to be the justification for not taking part directly. On the disaster management side, the period has seen policy and legislation in 1993 and 1995 respectively. The name of the organization changed from Relief and Rehabilitation Commission to Disaster Prevention and Preparedness Commission, providing it, at least in name, with better opportunity to work on longer-term solutions. However, this was not reflected in a required level of involvement in rainwater-harvesting.

In the second half of this period, an important institutional development for rainwater-harvesting was taking place. It started, independent of governments, as a movement that was initiated by the Regional Land Management (RELMA) of the Swedish International Development Agency (SIDA) for the Eastern and Southern Region of Africa. A call was made for a 'peoples' movement' to promote rainwater-harvesting in the form of national associations. Hence, the Ethiopian Rainwater-harvesting Association (ERHA) was established in 1999. From the outset, ERHA was meant to be a knowledge center, providing environmental, economic, social and technical information about rainwater-harvesting to other individuals and institutions, by way of printed materials, workshops, short-training, awards for best practices and soliciting funding for research. There was some confusion about membership at the beginning. Dominated by water professionals at the time of establishment many preferred to call it a professional association. Many NGOs and other institutions wanted to join the Association. However, they were disallowed at the time of legal registration as non-qualifying. The association had hoped to influence the directions and operations of the member institutions for more sustainable rainwater-harvesting program implementation. ERHA preferred to be an association not an NGO because as an NGO it would be restricted spatially and temporally to highly localized development projects and to limited project periods. Unfortunately, this noble dream could not turn into a material force. The mission of ERHA to coordinate information dissemination, research, and training related to rainwater-harvesting faced funding problems from day one. The prevailing donor preference is for the hardware

rather than the software component of development programs and projects. It became much easier for ERHA to get funds for its direct involvement in the construction of rainwater-harvesting structures than to conduct training for farmers on how to harvest rainwater.

Another challenge for ERHA is its claim to be a National association. The criterion for qualifying as a National association is operating in more than two to three regions. However, ERHA is not operating in all regions of Ethiopia. As a knowledge center, this is what it was expected to do. The fact that it was not getting enough funds for such a wide-scale operation. Nevertheless, there is more to it than what money can buy. The Country has a federal system of administration with a great deal of decentralization of development activities like rainwater-harvesting interventions and more. Any Federal ministerial office cannot go its own way in the regions leave alone a non-governmental association centered in the Federal Capital. A good instance in this regard is the development intervention in rainwater-harvesting in the Northern region of Ethiopia, which is an exclusive domain of the Relief Society of Tigray. Hence, the activities of ERHA are very limited in spatial coverage far from being a National one. Another problem worth noting is that the Ethiopian Rainwater-harvesting Association's organizational objectives seem to have been lost in translation. The Amharic version of the name of the association indicates only the 'use' of rainwater, not harvesting it. Apparently simple though this may seem it could convey confused messages to the public about what the association is all about. One of the greatest benefits of rainwater-harvesting is its ability to create easier access to water for humans and ecosystems during short-term droughts and/or long-term climate change. Strangely enough, climate change has never been an important agenda for ERHA.

4.2.4. The Later EPRDF-period

The failure of the micro-dam experiment brought another change in the approach to institutional development. The drought of 2003 also provided another impetus for change. Soon after the regional commissions for sustainable agriculture and environmental rehabilitation faded from the development stage, the Ministry of Agriculture came at the helm of the next cycle of rainwater-harvesting development interventions. This time, the development of rainwater-harvesting was firmly based on

ensuring food security at household level. This required that individual household ponds and tanks be built. The enormity of the task tested the stamina of the Ministry and its lower levels in the administrative hierarchy.

There was a lack of uniformity between regions about how specific responsibilities are held for the various rainwater-harvesting and small-scale irrigation activities. In Oromia and the Southern Region of Ethiopia irrigation development Authorities did the study, design and construction of ponds and other similar structures and handed it over to their respective bureaus of agriculture. One of the major reasons for the failure of the much endeared pond approach was the flawed organizational linkages between the various levels of government. The Federal Ministry of Agriculture sends quotas and finances to the districts; but there was no system of reporting back directly to the Ministry about the fulfillment of quotas and project financial expenses. The rules of decentralization require them to report to the regional bureaus; but the regional bureaus cannot accept and evaluate reports, which the Ministry should. It was only that part of the expenditure, which was taken from the annual budget, which was reported as a matter of routine. Urban and rural water supply for domestic use was an exclusive territory of the Ministry of Water Resources. The water supply for domestic purposes in urban and rural areas, which could have benefited more from rainwater-harvesting, is dependent on the unsustainable surface and groundwater sources highly vulnerable to climate change and variability.

4.2.5. The Recent-Current EPRDF-period

The failure of the pond program was a major setback for the popularity of rainwater-harvesting as a sustainable technology for adaptation to recurring drought as well as to the longer-term climate change. For the last decade since the mid-2000 ex-situ rainwater-harvesting ceased to be a favorite government strategy. The Ministry of Agriculture more than ever before is engaged in large-scale in-situ rainwater-harvesting in the usual context of soil and water conservation. The main concern, like in the past, is more for the soil than for the water. Now there seems to be a reason for the Ministry of Water Resources and the Ministry of Agriculture to work for a mutual benefit. In-situ rainwater-harvesting saves the soil for the Ministry of Agriculture and saves the dam for the Ministry of Water Resources. The fact that the entire energy sector has been added

to the responsibilities of the Ministry of Water Resources may widen the gap between rainwater-harvesting and the restructured Ministry of Water and Energy. As the Ministry moves more towards climate change mitigation, the more adaptation oriented rainwater-harvesting may not get as much attention as it deserves.

There has been a dramatic change in the institutional setup for disaster management during this period. In 2008, a proclamation joined two organizations that used to go their own ways on what were supposed to be common issues. The former Disaster Prevention and Preparedness Commission is re-established within the Ministry of Agriculture as Disaster Risk Management and Food Security Sector (DRMFSS). It is positioned at the level of vice-ministry and has two directorates under it. One of the two directorates is the Food Security Coordination Directorate. The Directorate is divided into a resettlement and an asset building case teams, which have little to do with using rainwater-harvesting for disaster risk management. The water aspect of disaster risk management is limited to emergency supplies, as non-food emergency contingency stock, in the forms of water bladders, plastic water containers, and trailer-mounted water purification units. DRMFSS envisages adopting a multi-disaster approach, not limited to its traditional focus on drought, when the new policy is approved. However, its location in a single sectoral box may make it difficult to effectively and efficiently deal with multi-sectoral disasters through multiple sectoral organizations.

Climate change issues, which include the management of extreme events such as drought and floods, are not handled by the disaster risk management office. The responsibility was moved from the National Meteorological Agency to the Environmental Protection Authority (EPA). The former had prepared and submitted the first National Communication and the National Adaptation Programme of Action to the UNFCCC. Since the transfer of the responsibility, the EPA has embarked on some climate change adaptation programs and projects. Although the DRMFSS has most recently realized that climate change adaptation and disaster risk reduction must be integrated, and has also become a member of the Africa Climate Change Resilience Alliance, its very weak link with EPA would not allow it to go any meaningful distance in this regard.

The Ethiopian Rainwater-harvesting Association, the only civil-society organization in Ethiopia specializing in rainwater-harvesting, has gone into another crisis during this period. Its mission of being a knowledge center for rainwater-harvesting faced challenges, this time, not from the lack of funds for its non-construction activities, but by legislation, which allegedly failed to consider research, training, and awareness creation for rainwater-harvesting as development program activities. The Proclamation to Provide for the Registration and Regulation of Charities and Societies (**FDRE, 2009**), restricted administrative costs to only 30 percent of the total organizational budget, leaving the rest for ‘the implementation of purposes’. For ERHA the implementation of purposes was supposed to be its educational and informational activities. Since the Association was required to cover this with the share of the budget allotted for administration its program budget is destined to be idle. As a result, ERHA became anomalous as an NGO with a name as an association. It is now engaged in the construction of rainwater-harvesting schemes, such as sand-dams and tanks in limited areas of eastern and southern Ethiopia.

Overall, rainwater-harvesting intervention has continued in Ethiopia, but with a much greater lack of institutional integration. Governmental as well non-governmental organizations are engaged in the construction of different kinds of rainwater-harvesting structures including soil and water conservation as if they belong to different worlds.

5. Setting the Scene for Rainwater-harvesting-based Adaptation

5.1. The Policy and Institutional Backdrop

The analysis of rainwater-harvesting policies and institutions in the previous sections is intended to serve as a backdrop for the major objective of this research: the use of rainwater-harvesting for adaptation to climate change impacts. Intervention into rainwater-harvesting as a drought-buffer has seen vicious cycles of wrong-planning, wrong implementation, and failure. One of the most serious problems has been the timing of interventions. Except for the micro-dam program in northern Ethiopia, all others came soon after the occurrence of droughts. The reactive intervention in rainwater-harvesting development was far from being helpful because rain cannot be harvested in its absence. Moreover, harvesting it after its normality is restored was a waste of time since farmers preferred to continue with the rain-fed routine.

The implementation of rainwater-harvesting has never been a process in stages. Preceding interventions did not suggest succeeding actions. It was neither a phased development from simple to complex nor a scaled one from small to large. The principle of incrementality does not seem to be feasible for governments in view of the unstable political atmosphere in the Country. The experiences of violent changes in government in the last half a century did not allow the development of attitudes, among political circles, favorable for ‘play-your-part-in-a-relay’ type of doing things. This is probably the reason why governments prefer the ‘campaign approach’ to get ‘all’ things done within the time framework under their control. Rainwater-harvesting program implementation has been more ‘mass-produced’ than ‘customized’ the latter requiring prior applied research. To date, research on this particular technology has been more evaluative than prescriptive. Relegating the benefit of rainwater-harvesting mainly to the production of food, and considering it as one of the many tools for agriculture, has resulted in the underutilization of its eclectic nature. In addition, the inconsistency and confusion in the nomenclature and classification of rainwater-harvesting has been drowning its core objectives and paving the way for the maintenance of the harmful water extraction status quo.

Rainwater-harvesting policies, strategies and programs are found dispersed in several

sectoral and intersectoral documents without any mechanism for synergizing them. This frustrated the possibility of mainstreaming rainwater-harvesting, as a drought-buffer, in the National development planning process. Moreover, most of the policies and strategies related to rainwater harvesting date prior to climate change adaptation becoming a global and National agenda. Hence, they did not address climate change to help lay the groundwork for future actions. Another challenge posed for any stable and consistent action is that, organizational responsibilities for rainwater-harvesting as well as for climate change adaptations are allocated and reallocated too frequently and without adequate rationale. In addition, most initiatives for programs and projects come from donors eliminating the possibility of long-term planning and implementation. Government and non-governmental organizations became engrossed in the time and space bound programs and projects without foresight about what the contribution for a sustainable future their actions will have. The multifarious problems they are entangled with notwithstanding, the existing experiences in rainwater-harvesting policymaking and institution building in Ethiopia are useful as launching pad for a more pervasive and more durable adaptation to climate change. Of particular importance for vulnerability and adaptation concerns is the centrality of poverty eradication in most policies.

5.2. Mainstreaming Rainwater Harvesting-based Adaptation into Development

Before embarking on the details of what should and should not be done for the more effective adaptation to climate change impacts the ground has to be cleared about in what climatic regimes adaptation becomes realistic. The truth is that proposals for action about adaptation to climate change are founded on the shaky ground of optimism for a mild enough change in the climate. How mild is mild is hard to tell; but in temperatures departing very widely from the current figures even the best adaptation methods may be destined to fail. The odds against adaptation start from whether there will be climate change in the first place.

Mainstreaming requires a huge sum of money, and above all political will. Policy makers and planners have to be fully convinced that a changing climate is not a myth and the consequences of non-adapting to the changes are much higher than otherwise. This can be accomplished in various ways that target current and future decision makers. The current decision makers have to be provided with authentic information and up to

date results of scientific research about climatic trends and projections. For the future decision makers, who are in the higher institutions of learning, targeting the curricula could be the best approach. The chaotic curriculum development in the higher institutions of learning in Ethiopia, which has turned into individual or group affair, has to be centralized theme wise as a panel in the Ministry of Education. For climate change adaptation, in which rainwater harvesting will be central, a curriculum group has to be set up with membership drawn from the academia, the ministries, NGOs, the private sector, and meritorious individual citizens. Any academic program and its curriculum, at any level, related to climate change adaptation will have to pass through this central system of scrutiny. Knowledge creation as a top-down component must be accompanied by awareness creation as a bottom-up component. Communities and individuals at the spatial-level of implementation should embrace the idea and own it. The top-down only approach of the past, which alienated the ‘beneficiaries’, is a valueless obstruction.

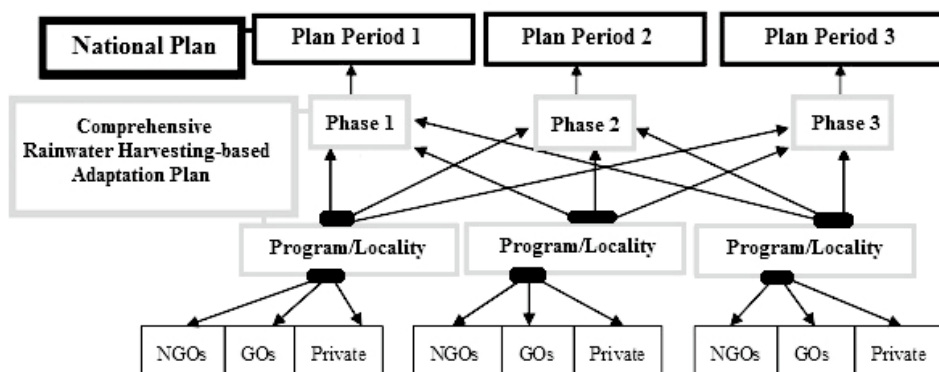
Even when the need for adaptation to climate change, through rainwater-harvesting, is well established in the policy making sphere the manner by which mainstreaming is to be done is not as simple and straightforward as it may appear to be. Mainstreaming should not imply that adaptation to climate change will have its own policy and strategy, is handled by a certain agency or ministry, regularly submits annual plans, and is separately budgeted like all other sector offices. Adaptation to climate change pervades every sphere of life so much that planning for it should be an integral part of the overall national planning, systematically broken down into appropriate spatial, temporal and sectoral units. In order to attain this there is an urgent need for the reformulation or amendment of existing policies, strategies and legislation pertinent to rainwater-harvesting-based climate change adaptation. The drafting of the amendments or reformulations should be done through intensive consultations among governmental and non-governmental organizations in all relevant sectors

5.3. Adaptation as a Phased Process

One of the incapacitating challenges for all development programs, with long-term goals, including climate change adaptation, is the short project-term nature of financing. Since this is unavoidable, adaptation actions can only fit into the pattern through a well-planned adjustment. In its ideal form, this is how the adjustment can be attained. A

comprehensive long-term national plan for adaptation through rainwater-harvesting is prepared. The adaptation plan is segmented into phases each coinciding with a national plan-period. The adaptation plan is also segmented sector or theme wise. Each theme or sector wise segments are allocated to governmental and non-governmental organizations and the private sector based on some criteria such as registered organizational mission, first come first served, assessed capacity, and/or mandatory assignments.

Fig. 2 Planning System for Rainwater harvesting-based Climate Change Adaptation



Source : Author

If this proposal feels like running a command economy, it is not. In climate change adaptation, harmony and a serious element of discipline is necessary. It is not possible to adapt to climate change effectively in a situation of haphazard choice of project ideas, locations, and timing. Hundreds of governmental and non-governmental organizations and private enterprises are planning, implementing, and duplicating in isolation. There should be a different way of doing things in as situation where the fate of humans on this planet is threatened. The comfort in the ‘business-as-usual’ cannot last if what is ‘usual’ becomes ‘unusual’.

5.4. The Mitigation-Adaptation Nexus

Wherever and whenever there is a possibility, the most effective adaptation to climate change impacts is that which at the same time tries to reduce the cause of the change. In the Ethiopian context, the contribution that can be made to the reduction of the cause, in terms of cutting carbon emissions, is quite negligible. The Country is predominantly agrarian, with an economy powered mainly by water. Nevertheless, there are some areas

such as land management practices and the development of forestry and other vegetation cover where sequestration can actively be pursued. Of the four components of the nexus, the one where actions could have both mitigation and adaptation consequences, is most related to what rainwater-harvesting can contribute.

Carbon-dioxide escapes from the soil whenever the land is overturned or plowed for the cultivation of crops. In-situ rainwater-harvesting, which includes conservation agriculture, through zero/minimum tillage practices reduces overturning of the soil and prevents carbon-dioxide from escaping. Large tract of agricultural land area in Ethiopia can be turned into carbon-dioxide storage through zero/minimum tillage. Ethiopia also has a vast potential for carbon sinks by increasing the acreage of forest and other vegetation cover. Rainwater-harvesting can contribute significantly to the increased coverage of vegetation, particularly in the dry lands, by raising the water table through groundwater recharge, creating wetland vegetation and denser growth of larger trees; enhancing tree establishment by increasing soil moisture storage through in-situ systems, and by increasing water availability for tree-seedling stations and bio-fuel production. These actions also enhance adaptation through the increased availability of water for ecosystems, domestic and agricultural use reducing vulnerability to climate change. Another aspect of the nexus is related what mitigation can provide for adaptation. The global carbon-emission trading, which resulted from the Kyoto Protocol has created a source of finance for adaptation actions. The latter is not yet sufficiently funded from international sources. Hence, a conscious and planned integration of both actions is required for best effect.

5.5. Assessment and Mapping of Vulnerability and its Components

For adaptation to be effective, it should be based on adequate data about the degree of vulnerability to the impacts of climate change, which in turn depends on the exposure, the extent of sensitivity, and level of adaptive capacity of ecosystems and human societies. Hence, planning for adaptation should be preceded by a baseline assessment and mapping of the three interacting components of vulnerability at the highest possible spatial resolution. This helps planning and implementation to be more efficient by prioritizing places and communities based on the ranked level of vulnerability. In the context of this research, exposure pertains to the climate change induced drought. As

meteorological drought is more a regional phenomenon than a local one, large segments of countries or continents may be exposed to it.

In Ethiopia, it is possible that climate change induced drought will occur not only in the areas, which are already identified as drought prone, but also in those that are considered drought free. Hence, exposure to climate change induced drought may be taken as a common denominator. The difference in vulnerability to climate change induced drought, between different ecosystems and livelihoods in different regions and localities, would partly arise because of their difference in sensitivity to the impact. Sensitivity could take the form of the lack of adequate freshwater for the normal functioning of ecosystems and livelihoods ranging from minor shortage to crisis level. Unless different geographical areas possess identical physical and socioeconomic characteristics, they will not have the same sensitivity for the same level of exposure. Sensitivity to the occurrence of drought, in terms of water availability, of areas having a high proportion of land-cover, a shallow enough water table, and a relatively large volume of surface water, would be the lowest. The drought prone areas of Ethiopia are the most sensitive because of repeated exposures to drought for several decades added to the degradation of the water resources due to imprudent land use practices. All others fall between these two extremes.

Sensitivity assessment and mapping in this regard require data about the hydrological, hydro-geological and hydro-geographical, hydro-meteorological, as well as historical and the existing water resource use and management. The data on the physical and socioeconomics of water resources are compiled, overlapped into a single composite index of sensitivity, and mapped as choropleths at district (*wereda*) administrative unit level or alternatively as surfaces. Another and probably more decisive component of vulnerability is adaptive capacity. Areas with highest level of sensitivity do not necessarily become the most vulnerable. Vulnerability from a particular combination of exposure and sensitivity can be modified by adaptive capacity. In this research, adaptive capacity is interpreted as the extent of adoption of rainwater harvesting technology for ecosystems and livelihoods. Hence, the assessment and mapping of adaptive capacity require the gathering and compilation of data on the knowledge, attitudes and practices of rainwater-harvesting; the level of success of rainwater-harvesting technology adoption; and how favorable local cultures, institutional environments, governance and the physical geography are.

5.6. Avoid Maladaptation

Actions that are intended to reduce vulnerability might in many cases end up increasing it. This is a situation of maladaptation. Maladaptation could make vulnerabilities of ecosystems and livelihoods much worse than they were before intervention. One cause of maladaptation to climate change impacts is the possibility of the increased use of fossil fuels, as sources of power in rainwater-harvesting systems, contributing to increased carbon-dioxide emissions. Wherever gravity systems of water lifting cannot be employed due to the nature of the local topography, diesel-powered motor pumps may be used to withdraw harvested rainwater from tanks, ponds and dams. It would be wiser to use mechanically operated systems like treadle pumps, hand operated pumps, or human or animal powered shadoofs. Increased greenhouse gas emissions increase the magnitude of climate change and its impacts in turn aggravating vulnerabilities.

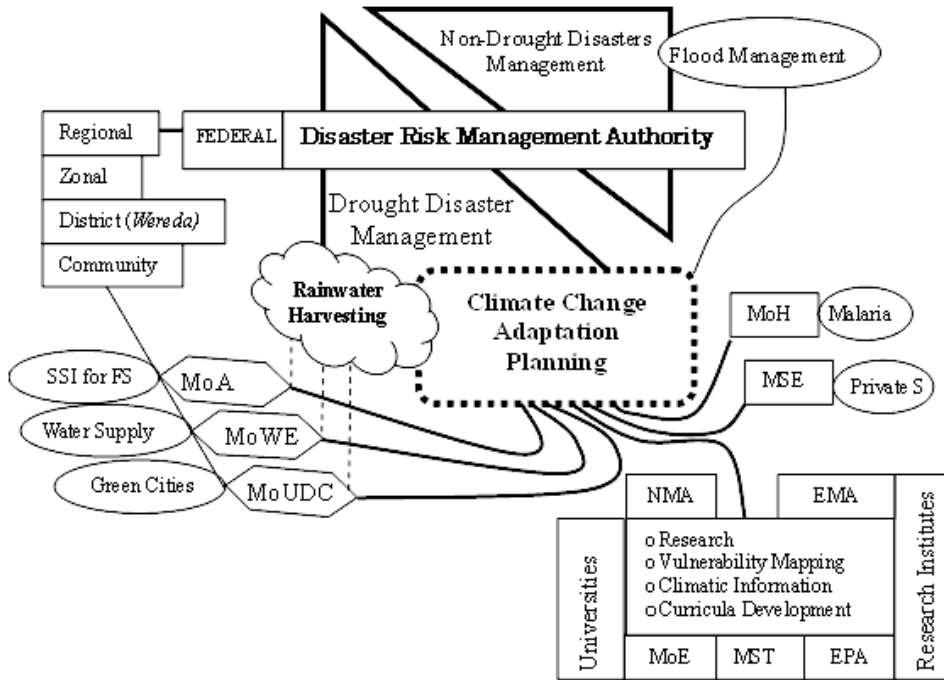
The adoption of rainwater-harvesting technology to facilitate climate change adaptation is not automatic unless it is imposed as mandatory by legislation. Since individual and institutional adoption is more effective when it is voluntary, a system of incentives has to be put in place to encourage widespread acceptance. Like any adoption of innovations rainwater harvesting has early actors who could be penalized for trying in the absence of such incentive and other indemnities. Any erosion of confidence in the adaptation systems, on the part of the beneficiaries, in the early phases could wreck the entire enterprise. The possibility of some stakeholders manifesting rent-seeking behaviors has to be put in check as well. While the primary targets for adaptation planning are the most vulnerable ecosystems and livelihoods, there could be cases where the same group may be forced to bear the burden of program implementation. In the rural context, the time for off-farm jobs for the poor may have to be spent on compulsory construction of rainwater-harvesting systems; the construction of ponds and tanks and the resulting heap of excavated earth may render the already small farm plots less viable; high interest rates and short repayment periods of credit for the purchase of construction materials may ruin the poorest sections of the communities; and drowning and the spread of malaria and other vector borne diseases may result from the installation of rainwater-harvesting systems. Such serious program impediments have to be removed through careful planning, with full involvement of the target communities.

In the planning process for adaptation to climate change, the need for prior research on the choices of appropriate technology and management options becomes quite apparent when programs and projects come face to face with high opportunity costs relative to alternatives. This problem could be manifested in the forms of, for instance, constructing ponds where tanks would be superior and building micro-dams where in-situ storage systems could be more effective and efficient. Path dependency is a maladaptation problem where the absence of a long-term vision in planning adaptation makes structures less flexible for future use. Rainwater-harvesting, in all its forms, is the least susceptible system to path dependency, and hence, one of the best technology choices for water-based adaptation to climate change impacts. There is little in rainwater harvesting that cannot be modified or changed.

5.7. Centrality of Disaster Risk Management in the Institutional Setup

The center of gravity of this research lies here. The core thesis of the review of the literature and the analyses of policy and institutional environments for rainwater-harvesting, in the preceding chapters, is intended to emphasize the centrality of building on drought-disaster management experiences for effective adaptation to climate change impacts. Neither policy makers nor ordinary people can perceive a change in climate average simply because it is an arithmetical construct, which is not perceptible. What they perceive and experience is the variability around that changing average, which comes in the forms of increased frequency, severity and duration of extreme events such as drought and floods. Hence, a disaster-risk management institution may be the most appropriate ‘command-center’ for the planning and implementation of rainwater-harvesting based adaptation to climate change. Organizational setup for rainwater-harvesting based adaptation is proposed to be centered on disaster risk management. In view of the need for involving governmental, and non-governmental organizations and the private sector, and given the nature of climate change adaptation, which requires some regimentation the organization is given the status of an ‘authority’. The shift from a focus on drought only to multiple disaster risk management is not affected, but the centrality of drought as the most important expression of climate change in Ethiopia has to be recognized.

Fig. 3 A Proposed Organizational Setup for Rainwater harvesting-based Adaptation



Source : Author

If the policy environment is to facilitate the proposed organizational setup it has to be overhauled not modified. Policies, strategies and legislation that pertain to rainwater harvesting for climate change (drought) adaptation should be formulated in such a way that synergies and more enduring focus replace sporadic actions and cursory attention. The proposed organizational setup depicted in Fig. 3 accommodates the two opposing standpoints on disaster risk management, vis. drought-centered and multi-disaster centered. There could be two sections in the Disaster Risk Management Authority (DRMA) for each of the two standpoints, with a much more elaboration for drought risk management.

The DRMA should be an autonomous body with the status a ministry and should come under the office of the prime minister. The key tool for adaptation to climate change (drought) is harvesting rainwater. Hence, rainwater harvesting would be incorporated into the climate change adaptation planning of the Ministry of Agriculture (MOA) for small-scale irrigation, the Ministry of Water and Energy (MOWE) for water supply and

sanitation, and the Ministry of Urban Development and Construction (MOUDC) for the envisioned green city development. The ministries would implement their respective plans at the various levels of the administrative hierarchy: regional, zonal, district and community. At every level, representatives of the DRMA would coordinate the plans into harmonious actions.

The Ministry of Health (MOH) would contribute to the plans and their implementation through plans and programs to control malaria and other water-borne diseases that are associated with the development of rainwater harvesting schemes. The role that can be played by the Micro and Small Enterprises (MSE) is significant. Small-scale and appropriate technologies, local skilled work force, as well as the participation of the private sector can be ensured through them.

A key part of the organizational setup is the research, information and education wing (RIE). Effective planning and adaptation to climate change requires prediction about the nature and extent of the change long ahead of time. The accuracy of predictions determines the appropriateness of adaptation actions. A well equipped National Meteorological Agency (NMA) would form a vital component of the RIE wing. So is the Ethiopian Mapping Agency (EMA) which would compile information from research institutions, universities, ministries like Ministry of Science and Technology (MOST) and agencies like Environmental Protection Authority (EPA) and produce vulnerability maps updated before every next planning phase begins. Vulnerability maps, which should be at the 1: 250,000 level of resolution, help in ensuring the efficiency of material, financial and human resource use in time and space for effective adaptation planning and implementation.

The most indispensable aspect of the entire scheme is the human resource needed for planning and implementation. The existing curriculum at all levels of education and training is far from being able to serve the purpose at hand. There should be a curriculum overhaul in all fields of education and training that can cater not only for a technical and managerial human resources for effective adaptation to climate change but also for bringing about attitudinal changes that could induce political will. It may be argued that without the latter all other efforts would be in vain.

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Profile of Key Interviewees:

1. *Habtamu Gessesse*—

Official in the Ministry of Agriculture (MOA) in charge of matters related to rainwater-harvesting for over 20 years until 1991; former director of Water Action; founding chairperson of the Ethiopian Rainwater Harvesting Association (ERHA); rich experiences in rainwater-harvesting and other related development interventions; and knowledgeable about environments in governmental organizations (GOs) and non-governmental organizations (NGOs). Currently, private consultant on matters related to water works.

2. *Ephrem Alamirew*—

Founding managing director of ERHA; rich experiences in rainwater-harvesting; and other related development interventions; and knowledgeable about GO and NGO environments. Currently working for Forum for Environment, Ethiopia.

3. *Abebaw Tezera*—

Current chairperson of ERHA; a private consultant with rich experiences in rainwater-harvesting and other related development interventions; and knowledgeable about GO and NGO environments.

About the Author

Dr. Yohannes Aberra Ayele obtained his B.A. and MA degrees from Addis Ababa University, Ethiopia in Geography; and his PhD from the Delhi School of Economics, Delhi University, India. He is associate professor in the Center for Environment and Development, College of Development Studies, Addis Ababa University. He has been a university teacher and research for the last 25 years. Dr. Yohannes' general research interest is in the areas environmental management and sustainable development with focus on water resources management and climate change adaptation in Ethiopia.

This research output is the result of a five months stay as a visiting research fellow at IDE-JETRO, Japan from June 10 to November 18, 2013.

List of major works:

1. Opportunities and Challenges for the Implementation of Integrated Water Resources Management in the Lake Tana Basin. *In print* Proceedings of the National Workshop on: Challenges and Opportunities of Water Resources Management in Tana Basin, Upper Blue Nile Basin, Ethiopia, 26-27 March 2012.
2. Pastoralism and Climate Change in the Horn of Africa: Comparative Review of Policies and National Adaptation Programs of Action. pp. 231-50, In Mulugeta Gebrehiwot Berhe and Jean-Bosco Butera (eds.) *Climate Change and Pastoralism: Traditional Coping Mechanisms and Conflict in the Horn of Africa*. Addis Ababa: Institute for Peace and Security Studies (IPSS) of the Addis Ababa University and the Africa Programme of the University for Peace (UPEACE).
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