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Climate change adaptation and mitigation measures in Ethiopia: Review

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Abstract
Climate change refers to future fluctuations of temperature, precipitation, wind and alternative components of Earth's climate system. Global climate change within the style of higher temperature, reduced downfall, and inflated downfall variability reduces crop yield and threatens food security in low financial gain and agriculture primarily based economies. Ethiopia is one of the most vulnerable countries experiencing drought and floods as a result of climate variability and change. The general objective of this review is to administer and summary on adaptation and mitigation measures initiative in Ethiopia in response to climate change. In Ethiopia the foremost vulnerable sectors to global climate change and variability are agriculture, road, water energy and health. Thus Mitigation and adaptation measures pursued to effectively address climate change. In Ethiopian farming communities have important indigenous knowledge, skills and technologies that are essential for tackling hazardous environmental conditions including climate variability and change. They employ a number of short- and long-term climate change mitigation and adaptation measures to cope with and overcome the impacts of climate variability and change. On the opposite hand, Ethiopia has shown both conservation and policy responses to combat climate change. Protected area systems, a forestation and reforestation programmes, renewable energy sources and energy efficiency, ecological agriculture, flexible livestock production, agro forestry systems, harvesting and climate change education, are all feasible strategies for mitigating and adapting climate change.

Keywords: Adaptation, climate change, mitigation, vulnerability, indigenous knowledge

Introduction
Globally, climate change has become over associate abstract drawback to be mentioned at international conferences or debated within the media: its associate everyday reality with implications for people's livelihoods and lives. It's an amendment that's knowledgeable each through slow semi-permanent method in ecological conditions both through semi-permanent method in ecological conditions and through extreme climate events (SREX 2012 [34]; IPCC 2014a [35]).

The Intergovernmental Panel on Climate Change's (2007) findings suggests that developing countries like Ethiopia will be more vulnerable to climate change. Ethiopia's is vulnerability to the impacts of climate change is due to social, economic and environmental factors, Like high levels of poverty, rapid population growth, high level of reliance on rain-fed agriculture, high levels of environmental degradation, chronic food insecurity and frequent natural drought cycles increase climate change vulnerability within the country (Aklilu *et al.*, 2009) [36]. In Ethiopia, the most vulnerable sectors to climate change and variability are agriculture, road, water energy and health.

In terms of support approach granger rain-fed farmers and pastoralists are found to be the most vulnerable. The increasing temperature and the variability of rain fall were a cause for frequent drought and famine. Climate change may reduce Ethiopia's GDP compared to a baseline scenario by 2-6% by 2015, and by up to 10% by 2045. Therefore, mitigation and adaptation measures are meaningful to cope up the effects of climate change World Bank (2010) [37].

Adaptation live are often thought-about as either progressive adaptation (actions wherever the central aim is to keep up the essence and integrity of a system) or transformational adaptation (actions that amendment the basic attributes of a system in response to temperature change and its impacts).

Things like building defenses to shield coastal areas from rising seas, switch to drought or flood resistant crop varieties, and rising systems to warn of heat-waves, unwellness outbreaks, droughts and floods. While, mitigation refers actions supposed to cut back anthropogenetic web emissions of GHGs. Generally, this web reduction will occur in two ways that through minimized outputs or through carbon capture. Common types of minimized GHG output embrace victimization renewable energy sources that avoid the burning of fossil fuels; lifestyle changes that decrease the overall amount of energy use; and the use of materials that reduce energy needs (Shanahan *et al.*, 2013) [38].

Historically, societies have tailored to natural climate variability by fixing settlement and agricultural patterns and different aspects of their economies and lifestyles (Meseret, 2009) [39]. In current years, adaptation to climate change has received increasing attention, especially in the United Nations Framework Convention on Climate Change (UNFCCC) and among development and disaster specialists (Maarten *et al.*, 2007) [40].

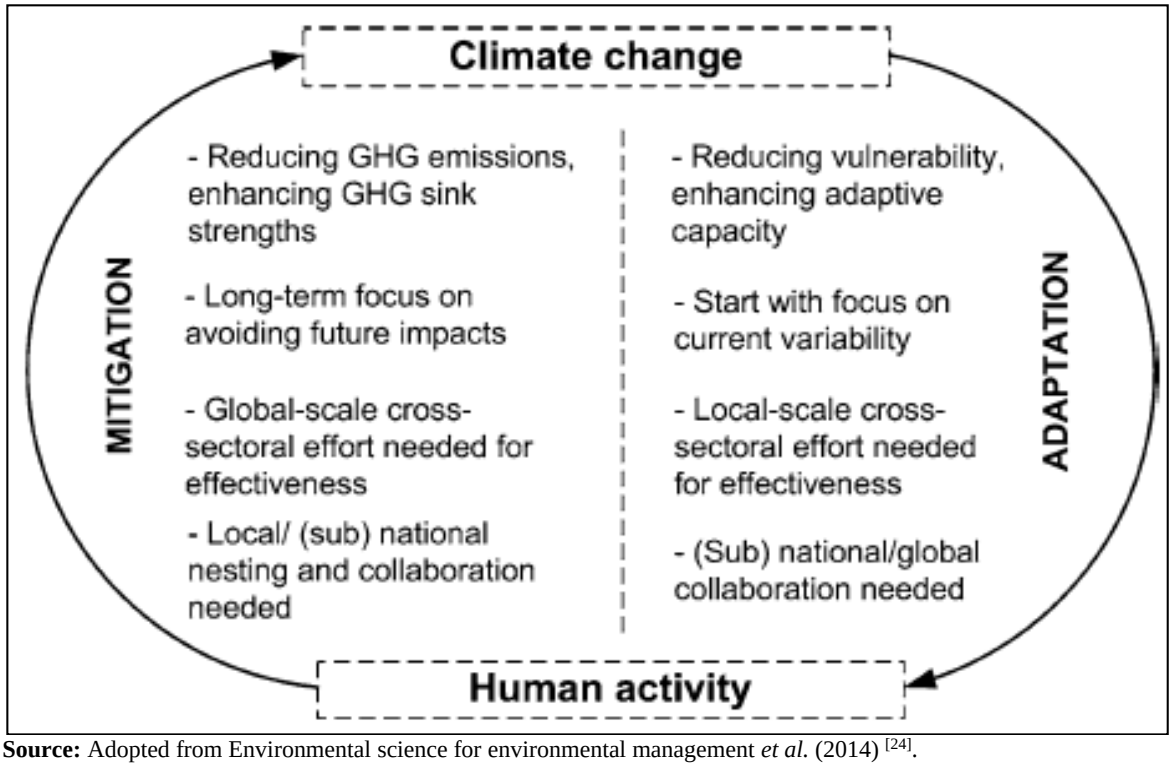
Through the National Adaptation Program of Action process, in Ethiopia, twenty priority project ideas were identified that address immediate climate change adaptation needs of the country. It's broadly focus in the areas of human and institutional capacity building, improving natural resource management, enhancing irrigation agriculture and water harvesting, strengthening early warning systems (Kidane *et al.*, 2009) [41].

In line with (EPA, 2011) [42] the thought of mitigation is comparatively new thought, and it primarily concentrate on limiting the emission of greenhouse gases. For this portion, Ethiopia has developing the green economy strategy. So as to handle climate change, mitigation and adaptation measures pursued effectively and negotiated beneath the UNFCCC have attended focus totally on efforts to cut back greenhouse emission emissions (Parry *et al.*, 2005) [43]. Therefore, this paper aims to review on to climate change adaptation and mitigation measures in Ethiopia.

Conceptual Literature Review

Climate change is the long-term alteration of temperature and typical weather patterns in a place. Climate change could refer to a particular location or the planet as a whole. Climate change may cause weather patterns to be less predictable. These unexpected weather patterns can make it difficult to maintain and grow crops in regions that rely on farming because expected temperature and rainfall levels can no longer be relied on. Climate change has also been connected with other damaging weather events such as more frequent and more intense hurricanes, floods, downpours, and winter storms (Al-Ahmad, *ET AL.*, 2015) [6].

Climate change adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities but mitigation refers to reducing climate change by reducing the GHG emissions (UNFCCC, 2007) [22].



Source: Adopted from Environmental science for environmental management *et al.* (2014) [24].

Fig 1: Climate change mitigation and adaptation as distinct interventions in the two-way relationship between human activity and global climate change

Empirical literature review

Adaptation Measures of Climate Change

Climate change causes wide-ranging effects on the surroundings, and on socioeconomic and related sectors, together with water resources, agriculture and food security, human health, terrestrial ecosystems, and biodiversity (Belay and Getaneh, 2016) [44].

According to Haileab, (2018) [45] study shows that Ethiopian farming communities have vital indigenous knowledge, skills and technologies that are essential for tackling dangerous environmental conditions together with climate

variability and alter. They use variety of short- and long-run climate change adaptation measures deal with and overcome the impacts of climate variability and alter. The methods are the majority ancient.

By mistreatment house survey strategies, the study of (Deressa, *et al.*, 2009) [8] revealed that, use of various crops or crop varieties, planting trees, conservation, dynamic planting dates, and irrigation are the foremost adaptation strategies in the Ethiopia. Despite the fact that, having perceived changes in temperature and rainfall, a large percentage of farmers in Ethiopia did not make any adjustments to their farming practices.

In line with Deressa, the foremost outstanding climate change adaptation measures are soil and water conservation (terracing, crop rotation, intercropping, mulching, crop residue retention, use of animal dung, composting, use of synthetic fertilizers, etc.); Tree planting (home horticulture, ancient agro forestry); Crop and Livestock diversification; Small-scale irrigation; dynamic crop sowing dates; Grain storage and reduction of postharvest loss; Collection of wild foods (edible fruits and vegetables, fish); Traditional water harvesting and storage; Rangeland management; Management of wildfires; Indigenous forecasting and early warning systems; Growing fruit plants; Livelihood diversification and adjustment; Involvement of traditional institutions (Edir, Equb, religious institutions) and social networks; Looking for assistance from the government and international agencies (e.g. food aid) (Haileab, 2018) cited in Bryan *et al.* (2009) [5], Deressa *et al.* (2011) [46], Riché *et al.* (2010) [47].

According to Asrat and Simane (2018), studies revealed that the utilization of improved crop varieties, agroforestry practices, soil conservation practices, irrigation practices, and adjusting planting dates are the most important adaptation strategies by smallholder farmers. However, adaptation decision is location-specific and influenced by key drivers such as socioeconomic, environmental, and institutional factors.

Crop diversification

Analysis conducted by (Legesse B. *et al.* (2013) [16] Smallholder farmers' perceptions and adaptation to climate variability and climate change in Doba district, west Hararghe, Ethiopia releaved that, this strategy seeks to avoid risks of total crop failure rather than maximizing yields of one particular crop. In Ethiopia, crop diversification is widespread. Crop diversification is the most commonly used method to overcome climate changes in Ethiopia. Greater use of different crop varieties in the same season could be associated with lower expenses and ease of access by farmers noted that crop diversification together with soil and water conservation and water harvesting practices were commonly used climate change adaptation strategies in eastern Ethiopia.

Tree planting and climate change adaptation

According to Kristiansen (2011) [48], tree planting to be one in every of the main ways utilized by farmers to adapt to climate changes within the Nile Basin of Federal Democratic Republic of Ethiopia. Vegetation like trees, plants, and grass are area unit valuable as a result of the roots defend the soil from erosion. Trees are valuable throughout floods and droughts, and many trees together might give lower temperatures in the near area, a fresher air, and also shadow.

Soil and water conservation

(Melese *et al.*, 2019) [19] suggested that in Ethiopia, they have often used different kinds of soil and water conservation strategies since around 1990, and soil and water conservation strategies have probably developed much since that time. Soil and water conservation strategies are mainly used because of soil degradation and soil erosion, and because farmers due to this, want to rehabilitate their fields. These activities area unit progressively vital nowadays as a result of climate changes to some extents area unit fast these processes.

Deressa *et al.* (2009) [8] determine conservation mutually of the main ways farmers use towards the threats of climate change. Additionally, Bulte (2012) [49] argue that adoption of certain farm management strategies reduces exposure to such shocks, as long as agriculture is most exposed to climate change. Supported their study within the Nile Basin of Federal Democratic Republic of Ethiopia, Kato *et al.* (2009) [50] notice that over 30% of farmers adopted soil and conservation measures in response to perceived semi-permanent changes in climate and rain.

Rehabilitation of degraded forest and woodland ecosystems in climate change adaptation

According to Environmental Management (2014) [24] in Ethiopia by Humbo Assisted Natural Regeneration Project the subsequent adaptation measures were play exemplary roles like; Provision of financial gain stream for communities through sustainable harvesting of forest resources, Maintenance of water supply to the community, Promotion of native vegetation and biodiversity conservation and Reduction of soil erosion and flooding.

Mulualem, *et al* (2014) [29] on Rehabilitation of degraded forest and forest systems in Ethiopia for sustenance of livelihoods and ecosystem services relieved that Tree planting, coupled with the natural regeneration of native woody species from the soil seed bank and seed rain, has resulted in the formation of a young secondary forest are more important mitigation measure. The diversity of flora and fauna has increased substantially compared to pre-rehabilitation intervention conditions also. Water runoff and soil erosion have been reduced significantly, due mainly to increased vegetative cover and the physical soil conservation structures, while the soil nutrient status and soil physical properties area unit expected to be ameliorated, primarily, as a results of the rise in soil organic matter (cf. Mekuria *et al.* 2007) [18].

Agro forestry practices and climate change Adaptation

Agro forestry practices that function as adaptation means that of climate change were noted by Yohannes (2016) [33]. These are: modification crop selection involves sterilisation from one crop selection to a different response to climatic changes (for example, introducing Avena species (Gench) as fodder crop in some Ethiopian highlands). Modification in cropping pattern and calendars are the applications of changes in how crops are cycled within a season. This helps greatly for the farmers live in East Gojam (Choke Mountain) and East Hararghe in Ethiopia. Change farm management practices include OA practice focus on maintaining diverse farming systems and source of incomes.

Terracing and different water harvesting practice are widely used in Konso (southern Ethiopia), where it has been registered as United Nations' Educational, Scientific and Cultural Organization UNESCO World Heritage Monuments.

Women and climate change Adaptation

According to (Mersha 2018) [21] the interplay between planned and autonomous adaptation in response to climate change: Insights from rural Ethiopia, The reality in many countries is that women are under-represented in decision-making in areas relevant to climate change adaptation. For instance, in several African countries, the amount of ladies in senior positions within the government is concerning small. And at the household level, decision-making power still usually rests with men. Effective climate change adaptation brings everybody to the table, recognizing the value of their knowledge and their potential as agents of change. The method of adaptation planning is designed to make it possible to invest in concrete actions that reduce vulnerability to climate change. However, there's a risk that adaptation investments really reinforce existing wealth and power structures, instead of benefiting the foremost vulnerable women and men. Adaptation is effective when it is equitable, providing opportunities and benefits for all people.

Climate change education (CCE)

Deeb *et al.* (2011) [7] pointed out that climate change education is greater than climate science and requires teaching across all people of all ages and engages with formal (that is, schooling), non-formal (for example, training for the workforce) and informal (for example, media) education. To this end, various governmental and non-governmental organizations and professional societies (for example, the Biological Society of Ethiopia) are advocating about climate change and its impacts in Ethiopia. The strategy indicated that CCE is a vital necessity to the success of Ethiopia's drive to build a green and resilient economy by 2030 and beyond.

Health sector and climate change Adaptation

Investigation by (Carina Margonari Diamond State Souza *et al.*, 2015) [31] on climate change and adaptation of the health sector: the case of infectious diseases instructed that, associate adaptation strategy at intervals the health sector ought to be centered each on primary interference (reduction of exposure to infection) and secondary interference (health care). Sweetening of epidemiologic police work actions, targeted to specific territories, because of the expected enlargement of the distribution of endemic infections is that the emergence of diseases in new areas. This could be target-hunting by info from climatically eventualities downscaled to specific regions and their implications in reference to unwellness cycles. One general strategy for adaptation within the health sector is epidemiologic police work which may give associate early detection of changes in incidence, mortality and geographic vary of health outcomes related to climatically modification.

Mitigation Measures of Climate Change

IPCC (2007) [14] defines mitigation as actions intended to reduce anthropogenic net emissions of GHGs. Generally, this net reduction will occur in 2 ways in which through shriveled outputs or through carbon capture. Normal forms of shriveled GHG output include embody victimization renewable energy sources that avoid the burning of fossil fuels (e.g. energy created by star panels); way changes that decrease the general quantity of energy use (e.g. walking rather than driving); and therefore the use of materials that scale back energy wants (e.g. improved housing insulation to cut back heating needs).

Increasing the global storage of carbon in soil

Research conducted by (Gashaw, *et al.*, 2014) [11] on temperature change adaptation and mitigation measures in Abyssinia steered that the simplest projected technique to cut back atmospherically greenhouse emission is to extend the world storage of carbon in soils. Although, soil carbon storage may be a win–win strategy. It mitigates temperature change by compensative phylogeny emissions; improves the setting, particularly the standard of natural waters; enhances soil quality; improves science productivity; associate degreed advances food and quantity that are two occasions larger than the quantity found within the atmospherically carbon pool. Additionally to carbon storage, the turnover time of organic carbon is very important in understanding the role of soils within the world carbon cycle. Thus, soil carbon sequestration through changes in land use and management is one amongst the necessary ways to mitigate the world atmospheric phenomenon.

Using lower emitting energy sources

Work by (Nigussie, *et al.*, 2014) [11] on temperature change Adaptation and Mitigation Measures in Ethiopia revealed that the major mechanisms for reducing the emission of greenhouse gases are victimization lower emitting energy sources. The project to distribute energy-efficient cook stoves was known as a voluntary offset project that may scale back greenhouse emission emissions, unit pollution, and deforestation within the Metekel Zone within the Benishangul-Gumz Regional State in Abyssinia. Voluntary emission reduction (VER) comes, gift corporations, governments and organizations with a chance to buy carbon credits. The developers of this project, Carbon Positive mercantilism (CPT) and therefore the Learning Paper believed that energy-efficient stoves were a perfect means of meeting the standards for a voluntary carbon offset project in Ethiopia. The same as this space, energy saving stoves was additionally introduced in several components of the country before a decade past.

Carbon mercantilism Carbon trading

(Negusu, 2011) [23], explicit that, the other mechanism to mitigate Climate change worldwide is carbon mercantilism. The present carbon mercantilism is one amongst the essential practices within the country to mitigate temperature change. The Humbo natural regeneration (reforestation) project projected by World Vision has already been supported by Ethiopia's in Dec 2006 is one example for carbon mercantilism within the country various and Renewable Energy choices consistent with (Knox-Hayes *et al*, 2013) [52] Understanding attitudes toward energy security: Results of a cross-national survey Gender, energy and temperature change are context specific and powerfully influenced by prevailing socio-economic and environmental factors, that manifests otherwise across countries, regions, communities, households and people.

Mitigation choices within the energy sector could also be classified into people who improve energy potency and people that scale back the employment of carbon-intensive fuels.

Paper by (Asumadu-Sarkodie & Owusu, 2016b) [25] on renewable energy sources, property problems and temperature change mitigation unconcealed that; Renewable energy includes a direct relationship with property development through its impact on human development and economic productivity. Renewable energy sources give opportunities in energy security, social and economic development, energy access, temperature change mitigation and reduction of environmental and health.

Forests and Mitigation

The Intergovernmental Panel on temperature change (IPCC), land use, land-use amendment and forest (LULUCF) report distinguishes 3 kinds of mitigation activities within the biological science sector (Watson, et.al 2000) [32]: a forestation (converting long-time non-forested land to forest); re-afforestation (converting recently non-forested land to forest); and avoided deforestation (avoiding the conversion of carbon-rich forests to non-forested land). Deforestation and forest degradation cause about 17% of global GHG emissions. Reducing deforestation and promoting a forestation and re-afforestation might give up to half-hour of the efficient world mitigation potential (Stern, 2006) [51].

According to (Anonymous, 2011) [3] on Ethiopia's Climate-Resilient Green Economy stated that Ethiopia has been an active participant in international climate negotiations, and initiated and implemented a number of climate-related national strategies and programs. Ethiopia is taking the necessary steps to implement the two categories of responses to climate change – mitigation and adaptation. To boost socio-economic development and combat climate change, Ethiopia developed a CRGE strategy in 2011. The climate resilience green economy (CRGE) strategy is based on four pillars:

- Improving crop and livestock production practices for higher food security and farmer income while reducing GHG emissions;
- Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks;
- Expanding electricity generation from renewable sources of energy for domestic and regional markets;
- Leapfrogging to modern and energy-efficient technologies in transport, industry and buildings.

Agro forestry practice use in climate change mitigation

(Meragiaw, M., 2017) [20] on Role of Agro forestry and Plantation on Climate Change Mitigation and Carbon Sequestration in Ethiopia revealed that Agro biological science observe use in climate change mitigation. Agro biological science will contribute sort of temperature change mitigation on to effective, economical and equitable reducing emissions from deforestation and forest degradation (REDD+) as a section of complementary landscape-level actions. Indeed, the environmental services provided by agro biological science mean that its adaptation potential extends well on top of the farm level like addressing a number of the drivers of deforestation associated with energy demand (Mbow *et al.* 2014) [17]. Agro biological science practitioners ought to be connected to carbon credits that farmers will get monetary help to extend their reconciling capability to temperature change (Uisso 2015) [30].

Conclusion and Policy Implication

Climate change refers to future fluctuations of temperature, precipitation, wind and alternative components of earth's climate system. African countries, particularly Ethiopia is one in all the foremost vulnerable country experiencing drought and floods as results of climate variability and alters. The foremost vulnerable sectors to climate change and variability are agriculture, road, water energy and health. Thus Mitigation and adaptation measures pursued to effectively address climate change. Ethiopian farming communities have important indigenous knowledge, skills and technologies for tackling hazardous environmental conditions including climate variability and change. The most common adaptation strategies are crop diversification, use of different crop or animal varieties, planting trees, soil and water conservation, changing planting and harvesting dates, small-scale irrigation, collection of wild foods (edible fruits and vegetables, fish), involvement of traditional institutions. Reducing deforestation and promoting a forestation and reforestation are the most cost effective mitigation options. Renewable energy sources provide an opportunities in energy security, energy access, social and economic development, climate change mitigation and reduction of environmental and health impacts. Gender sensitive is very low in mitigation and adaptation to climate change in Ethiopian, so by considering this Ethiopian government should be focus on creating a sense of gender, and provision of adequate infrastructure when planning interventions that address climate change adaptation and mitigation.

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