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Prioritizing and Selection of Adaption Technologies to Climate Change using Analytical Hierarchy Process Method in Agricultural Community of Enderta District, Tigray, Northern Ethiopia.

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Abstract - *Rural communities in Ethiopia are vulnerable to climate change.* As communities used more adaption technologies the way to cope up to climate change is increases. *The study deals with Prioritizing and selection of adaption technologies to climate change using Analytical hierarchy process method in Agricultural community of Enderta district, Tigray, Northern Ethiopia. The adaption technologies were weighted using expert judgment and the fundamental scale of pair wise matrix. Thus, are weighted and determined the relative importance to prioritize and select the most relevant adaption technologies of agriculture in the district. The results showed that diversified of crop, adjustment to livestock management, soil conservation and tree planting as the most important adaption technologies respectively. While, irrigation, application of fertilizer were ranked as least important based on the expert judgement. Analytical hierarchy method* can be successfully used to *prioritize potential adaptation measures to climate change. It was used with weighted the scores and ranking with great importance attached to some of the criteria as proposed by the experts.*

Key words; *Adaption, climate change, Analytical hierarchy method, Prioritization, Adaption technologies, selection*

1. INTRODUCTION

Climate change is one of the most urgent and complex challenge for societies and economies [1-3].Climate change is a key challenge posing many great threats to societies. The consequences of climate change are already experienced all over the world. It is expected that climate change will further "amplify existing climate-related risks and create new risks for natural and human systems [4]. Climate change is likely to have a major impact on biological and socioeconomic systems, and developing countries particularly those in Africa will be disproportionately affected. This is due to the economic importance of climate-sensitive sectors for these countries and to their limited human, institutional and financial capacity to anticipate and respond to the direct and indirect effects of climate change and variability[5]. It disproportionately impacts developing countries and vulnerable communities. Countries need to adapt and increase resilience[6]. Adaptation and mitigation are already occurring. Future climate-related risks would be reduced by the upscaling and acceleration of far-reaching, multilevel and cross-sectoral climate mitigation and by both incremental and transformational adaptation[7]. Adaptation to climate change has been a fundamental issue in both research and practice [8].

Prioritization is a process whereby an individual or group places a number of items in rank order based on their perceived or measured importance or significance .Due to time and budget constraints, it is often difficult to implement all the requirements that have been elicited for a system. It may also be the case that requirements are to be implemented in stages, and prioritization can help to determine which ones should be implemented first [9]. The fundamental aim of prioritization and selection is to provide a ranking with respect to clear corresponding weights. Various approaches and methods have been suggested for this [10, 11]. According to [12], an adaptation measures is considered a "no regrets" measure if there is no reason to regret the decision even if the risk it was designed to counter fails to materialize. That means that there are reasons to carry out the measure besides simply adaptation. For example, the reduction of greenhouse gas emissions to lessen the impact of climate change is a "no regrets" measure because this reduction has other positive effects such as the concomitant improvement of air quality which has a direct impact on health. Employing the same logic, the upgrading of rainwater runoff systems is also a "no regrets" measure.

2. Methodology

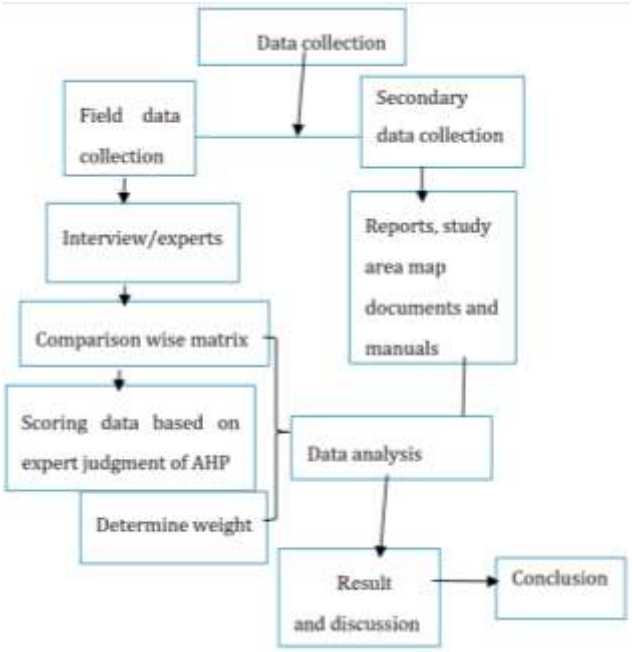

Fig -1: methodology technical route

2.1. Site location of study area

Enderta District is one of the four Districts of Southern East Zone, Tigray Regional State. It is bounded by Hintalo wajerat in the South, Samre-seharti and Degua-tembien District's in the West, kilte awlealo district in the north and Afar Region in the east. Geographically, Enderta is located between 13^0-14^0 North and 39^0-40^0 30" East. The district covers total land area of 1446.49 square kilometers. The study area carried out in Enderta district northern Ethiopia was chosen as study site because of the drought prone area that confront the farmers. The rationales for selecting the study are includes drought prone and food insecure areas of the district. Most people in the district are either seasonally and chronically food insecure due to recurrent drought.

According to [13], the total population of enderta district is 73,975 and the average family size is five and population density of the district is 79 people per square kilometer. 85% of the district is living in rural area and 15% living in urban areas.

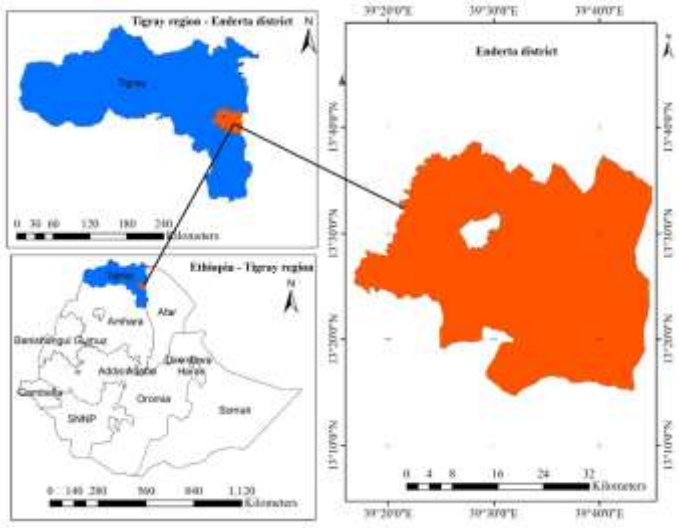

Fig -1: Study area map

2.2 Materials and methods

The data were collected through valid field visits, interviews, and focus group discussions with the six experts to determine the relative importance of adaption measures. A consolidated framework, research was then conducted in the district based on the existing drought problem. Identified to select the local based prioritization of adaption measures. The first step in determine the adaption measure is putting the hierarchy structure at the top level. Secondly, pair wise comparison matrix. The ratings were using the pairwise comparison matrix is created with the help of scale of relative importance. The consistency ratio must be less than 0.10 unless the matrix comparison is inconsistent. The method of Analytic Hierarchy Process and These experts' ratings were then used to generate the weights of each indicator using analytic hierarchy process. The multi criteria analysis tool is introduced by [14]. Fundamental scale of analytical hierarchy method helps to weight and select adaption measures that obtained through expert judgments.

The main objective is to prioritize adaption measures to climate change using analytical hierarchy process tool that would be very helpful for planners and decision makers.

Table -1: .Analytical hierarchy process fundamental scale for pairwise comparisons

Intensity of importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Somewhat more important	Experience and judgement slightly favor one over the other.
5	Much more important	Experience and judgement strongly favor one over the other.

7	Very much more important	Experience and judgement very strongly favor one over the other. Its importance is demonstrated in practice.
9	Absolutely more important.	The evidence favoring one over the other is of the highest possible validity.
2,4,6,8	Intermediate values	When compromise is needed

Source[14]

2.3 Agro-ecology

The study area is comprised of two major agro climatic zones. A greater portion lies in the '*Weyna Dega*' altitudinal climatic zone with an elevation range between 1500-2300m (temperate) while a smaller portion in the eastern and western parts lay in the '*Kolla*' altitudinal climatic zone with elevation between 500-1500m (hot) [15].The most common soils of the study area are: Arenosols, Calcisols, Cambisols, Kastanozems, Leptosols, Luvisols, Phaozems, Regosols, Vertisols and Fluvisols. The Fluvisols are mainly confined to the alluvial deposits along the river valley. The topography of the area flat, plain lands rugged valley, gorges and hill areas. As a result of continues land exploitation by manmade and natural calamities, the land is severely eroded and the soils are low in fertility. The terrain is mostly plains and hills, with bush scrub vegetation.

2.5 Land use and economic activity

Land use in the study area includes agriculture, livestock grazing, urbanization and low-density residential development. The type of land use varies with the topography or landform. Most of the hill tops are occupied by the churches and villages while the almost flat level areas are used for agriculture and urbanization. Agriculture and livestock are the backbone of the economy in this area. Agricultural land occupies an area of about 59,260 hectares which is approximately 49% of the total surface of the study area. Most of the crops are grown by local farmers who use traditional farming methods and the crops are mainly rain fed annual crops[15].

3. Result and discussion

3.1 Adaption technologies to climate change in agriculture

3.1.1 Crop Diversification

Crop diversification is the most important adaption technology to climate change in the agricultural communities of Enderta and the weighted score for this were 21.5%.Similarly according to [16]Crop-based approaches include growing improved crop varieties and using different crop varieties that survive in adverse climatic conditions. Growing early maturing crop varieties and increasing diversification by planting crops that are drought tolerant and/or resistant to temperature stresses serves as an important form of insurance against rainfall fluctuations.

3.1.2 Soil Conservation

The adoption of practices and technologies that enhance vegetative soil coverage and control soil erosion are crucial to ensuring greater resilience of production systems to increased rainfall events, extended intervals between rainfall events, and to potential soil loss from extreme climate events. Improving soil management and conservation techniques assist to restore the soil while also capturing soil carbon and limiting the oxidation of organic matter in the soil.[17].

3.1.3 Irrigation

Improving the use of irrigation is generally perceived as an effective means of smoothing out yield volatility in rainfed systems. It has the potential to improve agricultural productivity through supplementing rainwater during dry spells and lengthening the growing season[16]. In general, improving the use of irrigation aids to avert crop losses in areas subjected to recurrent cycle of drought.

3.1.4 Tree planting and management

This specifically involves planting trees in the farm to serve as shade against severe temperature. Planting trees or afforestation in general provides a particular example of a set of adaptation practices that are intended to enhance productivity in a way that often contributes to climate change mitigation through enhanced carbon sequestration. It also has a role to play in strengthening the system's ability to cope with adverse impacts of changing climate conditions.[17].

3.1.5 Adjustment to livestock management

A few of the interviewed experts sensed the effects of increased and extremely fluctuating temperature on livestock production. According to animal pests and diseases have been proliferated due to increment of temperature in the area. They made it a norm to take animals to the nearby animal health station whenever their animals are felt unwell. They also planted trees to shed their animals from strong sun rays. In addition, they kept their animals in home and feed them through cut and carry system in times of feed and water scarcity.

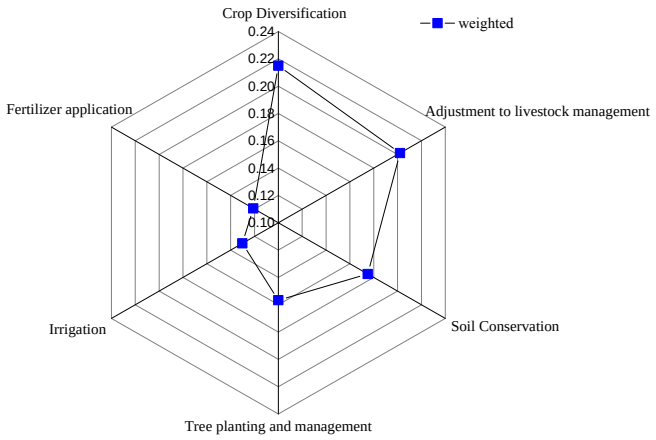

Figure -1: weighted adaption technologies to climate change using analytical hierarchy

Table-2; weight and percentage of Adaption technologies

Adaption technologies	weighted	Percentage
Crop Diversification	0.215	21.5
Adjustment to livestock anagement	0.2021	20.21
Soil Conservation	0.175	17.5
Tree planting and management	0.1567	15.67
Irrigation	0.1302	13.02
Fertilizer application	0.121	12.1
Total	1	100

Crop diversification is one of the most important selected adoption technology that have significant relationship with adaption measures. Among them sources of seasonal crop income is a very importance case while discussing capacity due to sensitivity to climate. Employing more adaption technologies have comparatively high adaptive capacity comparing with unemployed communities. Soil conservation, livestock management, tree planting, irrigation and fertilizer application technologies play a significant role in adapting to climate change in agricultural communities.

CONCLUSION

The objectives of the study were to prioritize and select adaption technologies to climate change in agricultural communities of Enderta and set possible measure that faces to climate shocks. Thus, is selection or prioritization of climate change adaption technologies were based on the expert judgment of analytical hierarchy process multi criteria decision making.

The use of analytical hierarchy process is a method that can be promising for fostering prioritizing of adaptation technologies. . The results showed that diversified of crop, adjustment to livestock management, soil conservation and tree planting as the most important adaption technologies respectively. While irrigation, application of fertilizer were ranked as least important based on the expert judgement. To be able to compare and prioritize adaptation technologies, solid characterization of all the alternatives is necessary. A long list of criteria that may be used in evaluation of the performances of adaptation technologies is available; however, selection of the decision criteria is case-specific and need to involve all stakeholders. It is used as participatory prioritization method, which is explained briefly in this study, and results are presented and analyzed. The fundamental scale are important in ranking matrix represents a very helpful and powerful decision support tool for planners and decision makers. Accordingly, it can predict an integration of qualitative and quantitative criteria involved and thereby take a decisive step towards further efficiency and effectiveness of the adaption measures.

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BIOGRAPHIES

My name is Brhane. I am master student in engineering major environmental science in Tongji university. My experience on publishing articles was good. Besides this, I have two SCI papers under review being as co-author and have other papers published in other international journals.