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# An assessment of environmental-resources base for the development and well-being in Eritrea: a case study of Adi keih subzone

**Md. Minhajul Hoda[1*] and Zeba Siddiqui[2]**

[1]Department of Geography, College of Arts and Social Sciences, Adikeih, Eritrea, EAST AFRICA
[2]Department of Social Science Education, College of Education, Eritrea Institute of Technology, Mai Nefhi, Eritrea, EAST AFRICA

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## ABSTRACT

People in developing countries are most part agrarian and pastoral folk. They heavily rely on the bio-mass-based subsistence economies around them. The rural folk eke out a living from products obtained directly from plants and animals. This is particularly significant for marginal groups, who tend to rely more directly on their environment for survival. In this research paper researchers have tried to assess environmental resource base in Adi Keih subzone of Zoba Dobub (Eritrea) and their effects on the well-being and development of the people. Study is based on both primary and secondary sources of information. Study reveals that current available resource-base in the study region is impoverished. Only 10 per cent of the area has potentiality for the farming activities. Among them 80 per cent are poor quality agricultural lands. Farming activity supports only 1/3 of household income. In totality immediate environment supports merely average 50% of household income requirements. This problem has compounded due to environmental degradation. The study highlights micro level relationship between environmental degradation, and resulting in poverty.

## 1) INTRODUCTION

Everyone in this world depends completely on the ecosystem and the services they provide such as food, water, disease management, climate regulation, spiritual fulfilment and aesthetic enjoyment. Over the past fifty years, human beings have changed the ecosystem more rapidly and extensively than in any comparable period of time in human history [1, 2]. This is largely in order to meet rapidly growing demands for water, energy food, fresh water, timber, fibre and fuel by the ever-growing population.

The transformation of ecosystem has contributed to substantial net gains in human wellbeing and economic development. But not all regions and groups of people have benefited from this process. The development has not been shared adequately and in fact many have been harmed, particularly the poor or the third world countries. This is particularly significant for the marginal groups, who tend to rely more directly on their environment for survival. An erosion of the environmental base can make certain categories of people destitute even while the economy as a whole grows [3].

Eritrea located in the sub-Saharan region of Africa is one of the naturally endowed regions facing severe problem of natural resource degradation. Major parts of the country are mountainous, and the removal of vegetation cover has caused for depletion of soil cover [4, 5]. Consequently, the forest removal reduces underground water recharge. Moreover, due to global climatic change in temperature, the normal rainfall pattern in the country is affected increasing aridity. The environmental conditions of the region overall affect availability of water, wood and food. Scarcity of all the three livelihood elements is intensifying the pressure over the local resources. More recently, the environment has been closely linked with the human security concept; [6, 7] specifically states environmental and food security as components of human development and wellbeing.

Economic development and human development efforts are increasingly constrained by environmental concerns, including degradation of forests, soil erosion, and ground water depletion [1, 2, 8, 9, 10]. Keeping in mind that environmental resource directly affects peoples' wellbeing and development; the researchers have tried to assess the following objectives:

(i) To assess the human pressure over environmental resource base in the study area;
(ii) To examine the resources base for the livelihood and economic development of people in the study region;
(iii) To expose various resource base problem for the human development of the region.

## 2) SPATIAL EXTENT OF THE STUDY AREA

To understand the role of immediate environment on the livelihood and human development, Adi Keih sub zone of Zoba Dobub (The State of Eritrea, East Africa) has been

* Corresponding Author: **Dr. Md. Minhajul Hoda**
*Email address:* minhajulhoda@redifffmail.com

selected (Figure 1). The reason for the selection of this site for field study is that the region is one among the environmentally fragile drought prone regions where severity of natural environment is high over farming, pastoralism and livelihood.

Adi Keih subzone is one among the twelve sub-zobas of Zoba Dobub. It is situated at an elevation of 2470 meters above sea level. Presently, the total population of Adi-Keih is about 63,944 in which *Saho* and *Tigrina* are the main ethnic groups. The total area of the sub zone is about 7161.45 km², out of which 7000 hectares of land is currently used for agriculture. The climate ranges from moderate to somewhat semi-wet and it is highly influenced by altitude. The higher areas are more moderate, with temperature generally not exceeding 35° C and rainfall is from 400 mm to more than 700 mm [11]. In general rainfall is not much reliable in most of the areas in the region. More than 82 per cent of the people earn their livelihood from farming and pastoralism and other related activities in the region employing sedentary ways of farming. The region supports different types of crops in different agro-ecological sub zones of the region. Maize, sorghum, and wheat are common crops grown here. Agro-pastoralists also herd cattle, goats, sheep and camels. But productivity is generally very low.

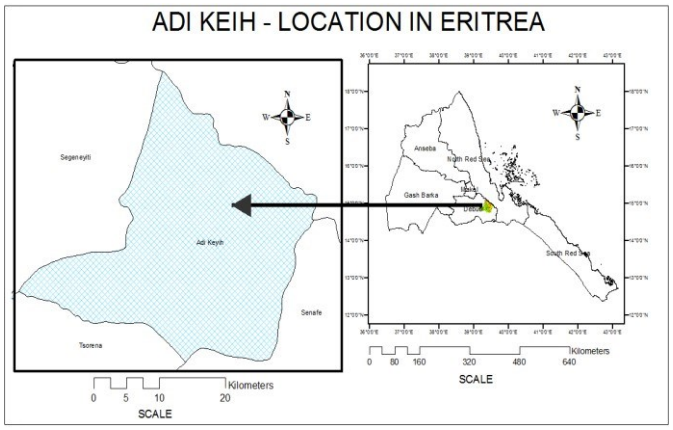



**Figure 1:** Location map of Adi-Keih

## 3) METHODOLOGY AND DATA COLLECTION

The present study is based on primary and secondary sources of information. Primary data have been collected from two tires of study region. Adi Keih as well as four different surrounding villages have been selected for intensive investigation. Selections of villages are based upon their location, environmental resource availability and their utility in the villages. Data was collected from household survey based on random stratified sampling techniques. Open discussions (face-to-face interviews) with the sampled population of the region have been conducted. The survey was designed to gather data about people's perceptions and their engagement in different activities as well as sources of livelihood.

The questionnaire consists of eight (8) sections and a total of sixty (60) main questions dealing with different issues related to household resources, natural resources and its utilities: such as land, water and forests in the surrounding regions. Moreover, focus has also been made over the environmental problems facing the villages. Various kinds of questions such as distance scale, frequency scale, intensity scale and ranking scale, have been framed to acquire required answer from the respondents. A total of 50 questionnaires have been filled from the sub-zoba of Adi Keih including Adi Keih town and four sampled villages. From each sample area, 10 questionnaires have been filled.

Secondary sources of data have been collected from the sub-zone of agriculture, Ministry of Agriculture reports, documents, archives, internet and books have been used. The data were simply processed into simple table formats using simple percentage and bar graph to understand the overall available natural resources and their utility and capacity in the study region.

## 4) LAND USE AND ENVIRONMENTAL RESOURCE BASE

***Land use*:** Knowledge about land use system provides valuable information about human activities. It will help to understand how people make land use decision (decision making process) and how specific environmental and social facts influence these decisions (decision making context). The information obtained for land use would help to optimize sustainable land use practices.

The study region is mainly pastoral and agrarian where livestock and crop production constitutes one of the basic livelihood resources. In the study region, the grazing land occupies almost 80 per cent of total land, while crop farming occupies a total of 10 per cent of land area, in which the high potential agricultural land occupies less than one per cent of total land. Water bodies, river bed and seasonal wet land occupy negligible proportion of total area. The land use and land cover analysis shows that there is a very limited scope of crop farming in the study region (**Figure 2** and **Table 1**).

**Table 1: Landuse of Adi Keih sub zone**

| Land use type | Area (hectares) | Land use type | Area (hectares) |
|---|---|---|---|
| High potential Agricultural land | 654.31 | Gravel road | 187.17 |
| Moderate potential Agricultural land | 1637.55 | Tessa | 155.82 |
| Low potential Agricultural land | 5224.47 | Industrial zone | 4.99 |
| Grazing land | 59,337.84 | Schools | 32.23 |
| Planted area | 473,29 | Churches | 12.93 |
| Seasonal wet land | 48.37 | Mosques | 2.99 |
| Water body | 42.47 | Health station | 3.85 |
| River base | 1326.37 | Archeological site | 0.2752 |
| Existing villages | 108.90 | cemetery | 3.88 |
| Asphalt road | 36.48 | Build up area | 1.09 |
| **Source: MOA, ADI- KEIH subzone** | | **Total** | **70,195.36** |

***Environmental Resource Base*:** The environmental resources upon which all economic activity ultimately depends, includes ecological systems that produce a wide variety of services. It provides food, water, air, building materials etc. The overall land area of the region is highly undulating. Almost 80 per cent of this region has mountainous feature and 7 per cent has hilly track, while 13 per cent of region (sub zoba) is flat land. Soil cover is almost absent on the mountainous slopes. Only a few valleys have soils for farming and grazing activities. Absence of natural vegetations in the region is affecting the

quantity of organic matter in the soils. Relatively arid climatic conditions exist throughout the year which reduces the propagation of vegetation cover in the region and making soil coarse. Overall, poor natural environmental conditions affect the carrying capacity of the study region. The concept of carrying capacity is well rooted in biological science, which describes maximum population size of the species (human and animal) that the environment can sustain indefinitely. It clarifies that there is a limit to the growth of any biological population, and identifies some of the parameters that determine the pattern of population rise and its collapse.

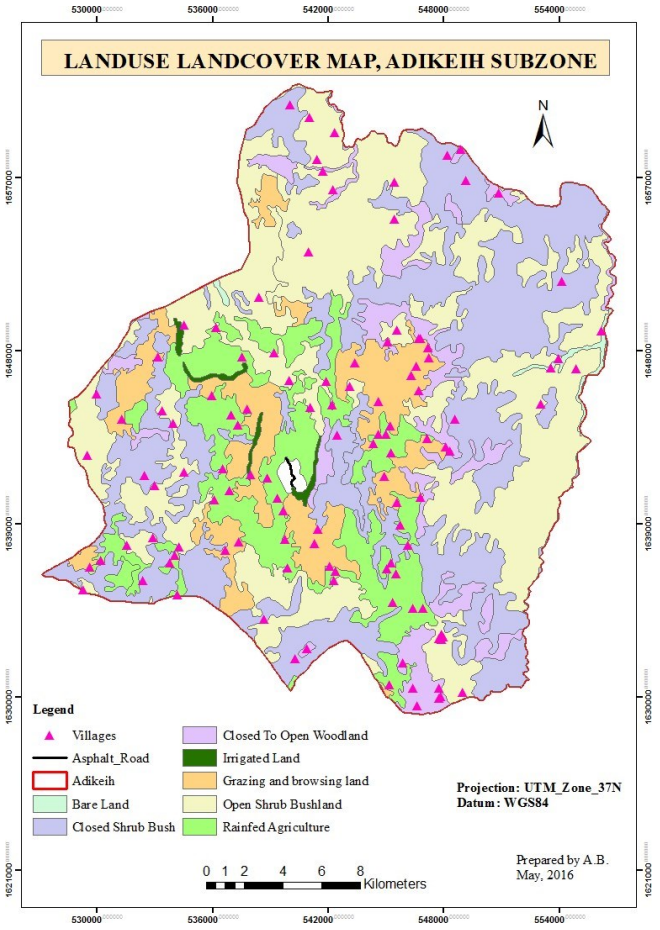



**Figure 2:** Landuse Map of Adi Keih Sub Zone

## 5) STRESS OVER ENVIRONMENTAL RESOURCES

Humans are the greatest changing agents on this planet. They change their surroundings for their wellbeing and its development is also ancient. But during the last 50 years impact of human activities on natural environment have intensified enormously and have caused significant changes in our ecosystem functions [2]. Following and documenting this idea, scientists Paul Crutzen and Eugene Stoermer have coined the term *Anthropocene*, analogous to a geological period, denoting the period after the Second World War when human impacts on the environment had intensified and even exceeded the capacity of the natural processes to recover [12, 13]. Stresses over immediate natural environmental resources comprise: grazing pressure, farming pressure, extraction of fuel wood and over exploitation of water resources in unnatural farming and household requirement.

***Grazing Pressure*:** It is postulated that rates of plant removal by livestock are related to their density and the edible feed quantity per unit area. Thus, feed supply and demand ratios can be estimated from feed assessments and livestock numbers. Feed supplies generally increases with higher rainfall and longer growing period LGP [14, 15]. The grazing pressure can be calculated if it is assumed that livestock are allowed to consume about 30% of the annual biomass, 5.3 t of dry feed is required per Tropical Livestock Unit (TLU of 250 kg) per year. Thus, at livestock densities of 5 and 20 TLU/km² available feed should approximate 0.3 and 1.1 t DM per ha of accessible grazing land. Minimum permissible herbage yields would be lower if a less conservative "proper use" factor is allowed [14, 15].

However, the risk of negative impact from grazing livestock increases with rising densities. The density of livestock is constantly increasing because of the lack of alternative means of livelihood in the study region. Most of the East African highlands including Eritrea where average cattle densities are about 40 head/km² have higher livestock densities. There are some areas where significant impacts of grazing are only exploitable in the dry season. Hence, the livestock density is not fixed, and is subject to change according to wet and drought period.

***Cropping Pressure*:** Pressures on land from farming communities are of two-kinds: First on the arable land as a result of cropping and by constant depletion of soil fertility due to erosion; second over non-arable land due to grazing, fuel wood cutting and harnessing of wild produce. Both kind of pressures are re-enforced by increased human population density. It is a fact that high priority has been given to crop farming to ensure food sufficiency, demand for cropland will further encroach more marginal area of high fragility thereby aggravating environmental risk. In this context intensification of land use is seen as an alternative to increase productivity.

However, intensification of farming is very limited here. Farming is primitive subsistence using very conventional technique due to topographic and climatic conditions. Under these conditions and average of 500 to 600 kg/h of food grains can be produced in 130 person-days. Assuming an individual's average energy requirement is 2,200 kcal per day, a family with five members requires 2 hectares land to remain in energy balance. Inversely, a family of five would be the carrying capacity of 2 hectares of land. It means the study region cannot support more than 5000 of population even if we incorporate low potential agricultural land where population is quite higher.

***Fuel-wood Extraction*:** In rural areas of Eritrea, 80-85% of the energy demand (mostly for food preparation) is derived from the woody vegetation [16]. Generally, for household purpose an ideal fuel preferences are wood-fuels at the bottom and kerosene and electricity is at the top [17]. But due to poor economic conditions and low supply of alternative fuels, wood fuel is one of the major sources of household energy in the study region. Most of the fuel-wood supplies come from close vicinity rural homesteads, either from farmers' own land, or from communally held areas.

One of the best ways to assess the fuel wood production would be to express the total biomass production in a given areal unit and climate. Standing woody biomass depends on vegetation type of the region but generally it increases with the long growing period. However, this relationship is modified by

human action and it is therefore easier to express standing woody biomass in terms of actual vegetation physiognomy or structure (**Table 2**).

**Table 2: Estimated standing woody biomass (t DM/ha) in selected vegetation types**

| Farmland fallows and shrub lands | t DM/ha | Woodlands and dry forests | t DM/ha |
|---|---|---|---|
| Farmlands, semi-arid | 5 | Acacia woodlands, semi-arid | 20 |
| Fallow shrub lands | 8 | Acacia woodland, highlands | 50 |
| Sand dunes, semi-arid | 3 | Woodlands, semi-arid | 30 |
| Recent fallow, sub humid | 7 | Dense shrub lands, sub humid | 33 |
| Open shrub land, sub humid | 22 | Woodland, sub humid | 60 |

*Source: Compiled from Franklin and Hiernaux (1991: Table 2, p. 1393).*

The table shows that fuel-wood resources may vary from 500 to 6000 t of woody dry matter per km². Hence, the fuel-wood support capacity (expressed as rural people/km²) depends on three inter-related attributes: the proportion of uncultivated areas, the vegetation structure, and the annual growth rate of each type. Usually an aggregate growth rate in the drier parts of semi-arid zone is 70 kg/ha.

At an average consumption rate of 0.5 t/caput/a and an assumed proportion of 60% of uncultivated land, fuel wood supporting capacity would increase from 8/km² to 70 persons/km² over this range of annual increase. Though this analysis, it is evident that in the semi-arid zones most of the highlands including *Adi Keih* sub-zone, rural population densities are well above the critical supporting capacity [18, 19]. As a result, rates of extraction are often far in excess of sustained annual increase leading to rapid deforestation [19, 20].

***Water shortages*:** Water is a precious natural resource, vital to sustain life, for economic and social development and for environment protection. There are three major sources of water in the study area: aquifers, seasonal streams (check dam), and rainfall. The water that is available from precipitation comes in two forms: soil moisture, and the annual recharge of terrestrial water systems (aquifers, ponds, lakes, and seasonal rivers). Rain-fed agriculture consumes an amount of water which is roughly proportional to the produced biomass (the water is returned to the atmosphere by plant evapotranspiration). But in semi-arid and arid regions, there is substantial loss due to evaporation from natural vegetation and wet surfaces and little effort is made in the poor dry lands to reduce it (through improved designs of tanks and reservoirs). The mean annual precipitation divided by mean annual potential evapotranspiration. The ratio between them is less than 0.03 in hyper-arid regions (annual rainfall less than 10 cm) between 0.03 and 0.20 in arid regions (annual rainfall between 10 and 30 cm); between 0.20 and 0.50 in semi-arid regions (annual rainfall between 20 and 50 cm); and between 0.50 and 0.75 in sub-humid regions (annual rainfall between 50 and 80 cm). According to most classifications, this set of regions comprises the dry lands. Within the dry lands, rain-fed agriculture is suited only to sub-humid regions. As, the study region practices rain-fed farming modern irrigation facilities are practiced in limited places.

Losses due to evapotranspiration are dependent upon soil cover. It would appear to be maximum when the soil moisture is at full capacity (the so called 'field capacity') and the soil is fully covered with vegetation [21]. So a reduction in cover would lower evapotranspiration. But this would be so only up to a point: eco-systems are structurally stable only within limited regions of the space of their underlying parameters. The idea of 'thresholds effects' is an instance of this. Thus beyond a point, losses due to evaporation in the dry lands are accelerated by disappearing biomass. For example, only about 10-20 per cent of rainfall finds use in the production of vegetation in the *Sahelian* rangelands (where the annual rainfall is 10-60cm). Almost 60 percent returns to the atmosphere as unproductive evaporation. Irrigation schemes in the dry lands, fetching water from distant parts, are unlikely to be cost-effective. This is a solution more appropriate to temperate zones. It has been argued that, the proportion of rainfall in the dry lands that is productive can be increased to 50 per cent if vegetation is allowed to grow, and if suitable catchments are constructed [22, 23].

Almost 1,250 cubic metres of water per person is required annually for the supply of habitats and for the production of subsistence crops in the dry lands. This does not include the water required for municipal supplies, for industry, and for the production of cash crops. (Agriculture currently uses about 75 per cent of the world's use of fresh water, industry about 20 per cent, and domestic activities use the remaining 5 per cent). A community will experiences water stress. If, 600-1,000 people share 1 million cubic metres of water available annually for use. When more than 1,000 persons are forced to share every 1 million cubic metres of water annually, it will result in acute shortage.

## 6) ENVIRONMENT AND HUMAN WELL-BEING

Environmental and natural resource inputs significantly contributed to human development [24] and on the other hand, deterioration of the quality and quantity of environmental resources worsens the condition of people. The relationship between wellbeing of the people and environment in the study

**Table 3: Population Characteristics of the Study Region**

| Sampled Settlement | Average Household Size | Sex Ratio | Dependency Ratio in % | Livelihood engagement | Livelihood income |
|---|---|---|---|---|---|
| Adi Keih | 4.2 | 105 | 43 | Others, farming | Others, Farming |
| Adi Wegera | 4.6 | 108 | 46 | Farming, livestock | |
| Egla | 5 | 107 | 47 | Farming, Livestock | Others, Farming |
| Maelewya | 4.6 | 110 | 45 | Farming, Livestock | Others, Farming |
| Tekonda | 4.6 | 108 | 46 | Farming, Livestock | Others, Farming |
| Total | 4.6 | 107 | 45 | | |

*Source: Field Survey 2016*

region can be best understood in the context of people's livelihoods and accessibility to resources. Almost 85% of population of this region directly and indirectly depend on agriculture and agro-paternalism activities. Thus, there is need to assess the performance indicators of livelihood activity. It includes productivity of land, accessibility of quality land, access to credit, access to agricultural inputs, access to common agricultural resources including water and fuel wood, access to pure water, and access to sanitation facilities, health and education facilities etc.

***Household Population*:** The household survey shows that an average family size in the study region is 4.6 people; it varies from one village to another. In all sampled area the size of household varies from minimum 1 member to a maximum of 11 members. A huge population of 42% is below 15 years of age, which essentially characterizes the young population base. The sex ratio of the study area was 107 per cent, i.e. for every 107 males, 100 females. However actual sex ratio at the time of survey was quite low due to periodic movement, national service as well as some of them live abroad. The dependency ratio (i.e. the ratio persons in the age groups under 15 and over 64) was 45% (Table 3).

***Livelihood and Income*:** Almost 85% of resident directly engaged in farming and pastoralist. The survey result show that livelihood engagement and livelihood income are the two important characteristic features of local economy. Lands are equally distributed to the inhabitant in every village according to the criteria [25]. Land is one of the major environmental resources in the study region. Moreover, natural forage, wild fruits, vegetation and tree, water, rock-building materials are some of the local resources in the study region that also supports the livelihood of the people.

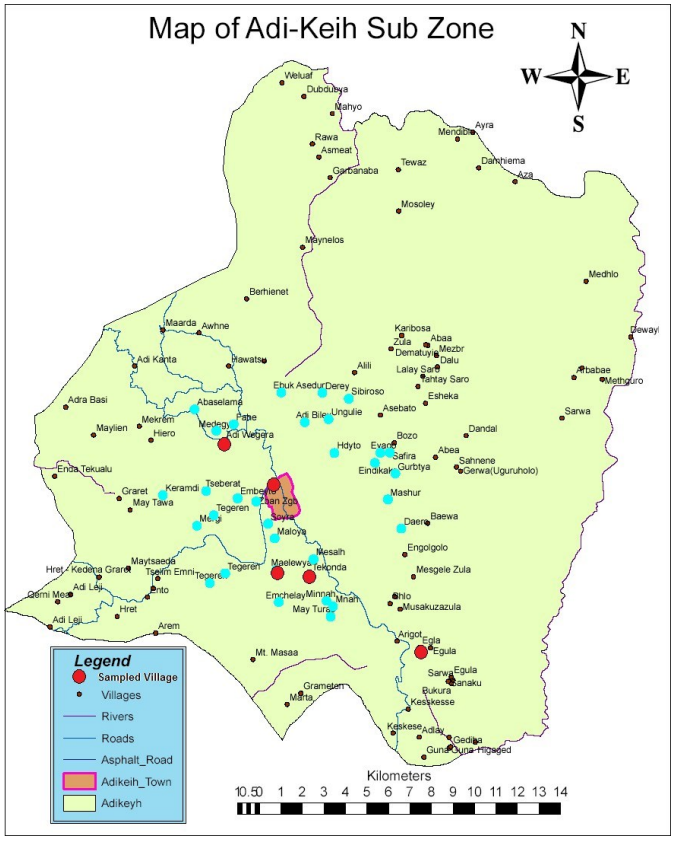



**Figure 3**: Adi Keih town and Sampled Villages

The dependency on the natural resources can also be assessed by total number of working hour devoted by villagers. An average of 20% of the household working hours was engaged in farming activities, 30% in fodder collection or livestock economy of the household, 25% in fuel and water collection and 20 per cent of time was spent on household chores and remaining 5 percent in other activities such as marketing etc. However, environmental resources have limited contribution in overall income of the household. The reason for low income is poor quality of agricultural land, low agricultural yield per hectare; uncertain rainfalls are the other associated factors that affect the farming and livestock performance.

***Quality of Farming Land*:** One of the immediate accessible resources is agricultural land. Most of the farming is traditional and subsistence. One of the important challenge before the farming community is poor quality of farming land. Various kind of farming land according to its utility and productivity locally known as *Gedena, Grat Hamushte, Sinhabera, Aguari, and Kelkel* from high to low quality. In this study, broadly four categories have been identified based on questionnaire:

- High quality loam soil is found in valley bottom nearby catchment area where high productivity average yield of food grain crops is 6 quintal but it varies from crop to crop and area to area;
- Medium quality of land usually found on the valley bottom but without seasonal river catchment area which yields an average of up to 3.4 to 4 quintal if rainfall is adequate;
- Poor quality of land usually on gentle slopes yields an average of 2.5 quintal; and

Very poor quality shallow soil profile yields are less than 2.5 quintal.

**Table 4: Types of Farming land**

| Sampled Settlement | High Quality | Medium quality | Poor Quality | Very poor quality |
|---|---|---|---|---|
| Adi Keih | 5 | 10 | 20 | 65 |
| Adi Wegera | 20 | 20 | 20 | 40 |
| Egula | 5 | 10 | 30 | 55 |
| Maelewya | 25 | 25 | 35 | 15 |
| Tekonda | 10 | 20 | 40 | 30 |
| **Average** | **13** | **17** | **29** | **41** |

*Source: Field Survey 2016*

***Farming land and Agricultural Productivity*:** In the study area, crop production is highly affected by the surface area and quality of land available for household. Relatively, average yield per hectare is low in the study region. This is more intensified by the available quality land for the household. More than 2/3 of land is poor and very poor according to its productivity. Egula and Adi Keih have a very small proportion of high quality land while Maelewya has almost 25% high quality lands (Table 4). It has also been found from the study that most of the poor land farmers are leaving the lands fallow after every three years in order to maintain its fertility.

***Wealth Category, income and Resources*:** Farming has very limited contribution for income at household level, not more than 30 % of the total income (Table 5). It is also largely affected by the amount of rainfall. Thus, household income in the study area largely depends on other resources and off farm activities. It includes animal rearing, collection of firewood, mining, quarrying and gathering wild fruits. Moreover, non-

natural resources also contribute substantially for household income. It includes business, labor work, and help from neighbors and income from abroad.

**Table 5: Environmental and other income**

| S.No. | Source category of income | % |
|---|---|---|
| 1. | Farming | 30 |
| 2. | Animal rearing | 20 |
| 3. | Fuel wood, mining, gathering | 3 |
| 4. | Other source | 47 |

*Source: Field Survey 2016*

On the basis of total household income, it can be classified into four major categories. The basis of the wealth category is based on the field survey as well as study "Livelihood and Resource Management in the Central Highland of Eritrea Conducted during 2012 [26].

(i) First category is high income group. Enough wealth to sustain life, accessibility of large amount of resources. Self-sufficient in food items (**Table 6**).
(ii) Medium category income people. Uncertainty in income and sources too.
(iii) Low income group struggling for day to day survival.
(iv) Very low income group people, usually dependent on others.

Sources of income depend upon types of settlement and nature of available resources in the study region. Sampled category are different in its nature, i.e., rural and urban and further village economy depends on the resource base from its surroundings. For example Adi Keih is an urban settlement; so, most of the income is from business and exchange while Egula does not have too much farm land. Therefore, major source of income in Egula is from animal rearing. Moreover, Maelewya has large flat productive farming land income.

On the basis of wealth category, it has been concluded that wealthy and high income group people in the sampled region is substantially low a total of 7.2% people. This is the only category of people who have secured food and labor input all the year. More than 90 per cent of the people in the region are insecure to its day to day requirement. Among them more than 50% of people are highly vulnerable who do not secure their day to day food and other basic necessities due to low income (Table 7). The reasons of large number of low income people could be the overall environmental resource base capacity in the study region. The study area have limited farming land, shallow soil, limited water for irrigation and household requirement, low vegetation cover etc.

**Table 7: Proportion of wealthy and poor people in the study region**

| Sampled Settlement | Wealthy | Less wealthy | Poor | Very Poor |
|---|---|---|---|---|
| Adi Keih | 5 | 40 | 45 | 10 |
| Adi Wegera | 8 | 30 | 50 | 12 |
| Egla | 7 | 30 | 55 | 8 |
| Maelewya | 10 | 40 | 30 | 20 |
| Tekonda | 6 | 50 | 30 | 14 |
| **Average** | **7.2** | **38** | **42** | **12.8** |

*Source: Field Survey 2016*

***Linkages between Environmental Resource and Development*:** In subsistence economy, forest, soil and water are the crucial elements in the development. With the destruction of the local forests since ages has gradually destroyed the livelihood of forest dependent communities. At the same time, soil erosion caused by deforestation and drying soil has rendered agriculture unsustainable and pushed the agricultural based community to the margins of existence, and has aggravated the environmental degradation. In all the sampled localities, farming land, pasture and grazing land and marginal forested track are some of the resources helping in

**Table 6: Criteria for wealth classification according to resources in the region**

| Sampled Area | Wealthy High income | Less wealthy Medium income | Poor Low income | Very Poor Very low income |
|---|---|---|---|---|
| **Adi Keih** | • Own more than 2 shops<br>• Own house<br>• Posses an adequate labor input | • Own Shop<br>• Their own house | • Rent house<br>• Help from relatives | • Low Wage<br>• Rented house<br>• Poor standard of living |
| **Adi Wegera** | • More than 2 pair Ox, Own camel<br>• Large farming | • Pair of oxen<br>• Donkey<br>• Medium size land<br>• Help from abroad | • One cow<br>• One ox<br>• 4-5 goat<br>• Small plot | • Own no livestock<br>• Lives with relatives |
| **Egla** | • 30 cows, 50 goat or Shop<br>• Poor small farm land | • 5 cows<br>• 10 goats | • 1 cow<br>• 1 ox<br>• 4-5 goats | • Low Wage people |
| **Maelewya** | • More than 5 Ox<br>• Large plot of land<br>• Secure food for $12^{th}$ months | • Pair of Oxen<br>• Donkey<br>• Help from relatives | • Own cow<br>• 1 donkey<br>• Depends upon the small plot of land | • Own no livestock or farming land<br>• Low wage |
| **Tekonda** | • More than 2 pair of ox<br>• Own cow<br>• Larger farming area | • Donkey<br>• Pair of Ox<br>• Help from abroad | • Ox<br>• Few sheep<br>• Small plot land | • Own no livestock<br>• Very small plot land |

*Source: Field Survey 2016*

livelihood and sustenance of the localities. Due to lack of knowledge and management of surrounding local resources, there is acute pressure on them. Moreover, global change in climate is also affecting temperature and rainfall of the region. In the last two decades the average annual rainfall has shown fluctuations and uncertinities. Extreme variations in rainfall affected the farm and livestock output in the study region.

Some of the environmental issues that concern the local people in the study region are rainfall, shortages of water, soil erosion, and landslides etc (Table 8). There is a close nexus among all environmental issues and livelihood in the study region. Further intensive investigations are required in order to look closely into these issues, from policy perspectives.

**Table 8: Resource Base and Environmental issues in Selected sampled villages**

| Sampled Settlement | Environmental Resource Base | Environmental Issues |
|---|---|---|
| **Adi Keih** | • Grazing land<br>• Agriculture<br>• Gathering | • Erratic rainfall<br>• Shortages of drinking water |
| **Adi Wegera** | • Agriculture<br>• Grazing land | • Erratic rainfall<br>• Soil erosion<br>• Landslides<br>• Deforestation |
| **Egla** | • Agriculture<br>• Bee farming<br>• Grazing land | • Erratic rainfall<br>• Drinking water scarcity<br>• Crop failure due to water |
| **Maelewya** | • Agriculture<br>• Fuel wood<br>• Gathering | • Uncertain rainfall |
| **Tekonda** | • Agriculture<br>• Quarrying and mining | • Landslides<br>• Erratic rainfall<br>• Drinking water problem<br>• Soil erosion |

*Source: Field Survey 2016*

## 7) CONCLUSION

From the quantification of environmental resources and their effects on the wellbeing and development of people in the study region of Eritrea found huge anthropogenic effects on natural environment. The natural resource base of the study region has been affected by steady increase in human population density and pressure exerted by increasing livestock number. Most of the environment resource base such as water, soil, forests has been exhausted. The destruction of the local forests since ages has gradually destroyed the livelihood of forest dependent communities. At the same time, soil erosion caused by deforestation and drying soil has rendered agriculture unsustainable and pushed the agricultural based settler community to the margins of existence. The continuance of environmental degradation further affecting long term wellbeing and development of the people in the region.

Recent global climatic change models (model (GCMs) from the IPCC AR4) estimate that the effects of climate change will have an adverse impact on the country's agriculture and livestock sector. Insufficient rainfall and a rise in temperature has already increased dry spells and decreased soil moisture in many parts of the country including Adi Keih. Almost 60 per cent of the rural people are dependent on crop cultivation and pastoralism. Global climatic change has significant impacts on increasing land degradation, desertification, bio-diversity loss causing negative impact on human wellbeing and its environment.

From the field investigation it has been found that farming activity supports only 30 per cent of household income. There are also other sources of income such as animal rearing, gathering, forestry, mining etc. The assessment of the research shows that low income of farmers in the study area is due to low quality of agricultural lands. Only 33% of the total farm land is highly suitable for farming activities. While the remaining 70 per cent land is of low quality. On the basis of accessibility of quality land and other resources to people wealth ranking has been determined. Only 7 per cent of the people in the study area have food security and assured labor input, while more than 90 per cent of the people remain insecure in their household and day to day requirements.

It is true communal resources and tenure system benefitted the people to have their own piece of land reducing landless labor. They also allocate the land for protected forested area. It allows the people to transform nature into economic assets. However, most of the land is of poor quality and uncertain rainfall affects the livelihood and economic security of the people in the region. Based on the findings of the study, it is suggested that there is a need to diversify the local economy and improve the existing capacity of livelihood. There are multiple avenues in local economies that demands enlargement and expansion. It includes additional financial, natural or social assets by increasing the productivity of assets. Moreover, there should be short term and long term solutions of various scales and natures. In short term there is a need to improve the knowledge of farmers on the effective utilization of water resources and adopt new irrigation technologies. Improve water harvesting system in the region by constructing additional dams and wells. Introduce and use of drought resistance seeds and to improve grazing and watering management for the livestock sector. In long term goal: reforestation, enforcement of suitable environmental legislation, raising farmers' awareness and given training to them regarding the benefits of trees and soil conservation should be the prime task for the local community based governance. Extension contact with the farmers must be given more emphasis because farmer must be advised, convinced, and trained with the practices of soil conservation.

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