

EXECUTIVE SUMMARY

1. Introduction

It is widely agreed today that anthropogenic greenhouse gas (GHG) concentrations in the atmosphere is creating imbalances in the natural cycle of the earth's climate, best known as climate change. Scientific evidence has shown that the earth has been increasingly getting warmer and warmer. Nine of the ten warmest years, for example, have occurred since 1990. The resultant global change of climate has been of major concern to the international community and the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 at the Earth Summit held in Rio de Janeiro, Brazil, was a big step forward in the challenges to mitigate climate change. Today more than 180 States and regional economic integration organizations are Parties to the UNFCCC, under the principle of common but differentiated responsibilities to mitigate climate change.

Eritrea acceded to the UNFCCC on 24 April 1995 to join hands with the international community in the mitigation of climate change. Pursuant to Article 12 of the UNFCCC each Party should communicate information relating to its commitments under the Convention. This national communication has therefore been prepared in this context in accordance with the guidelines of the Non-Annex I Parties for preparing their national communications. The main issues addressed in this report include inventory of GHG, vulnerability and adaptation assessment studies, education and public awareness and systematic observation and research.

2. National Circumstances

Eritrea is located in the Horn of Africa between 12^o 22' and 18^o 02' north and between 36^o 26' and 43^o 13' east. It is bordering with the Sudan in the west, Ethiopia in the south, Djibouti in the southeast and with the Red Sea in the east. Eritrea has a total land area of 124,300 km² with a coastline of 1900 kilometers. The Eritrean territorial waters are around 120,000 km², stretching out to the Red Sea Central Rift. There are around 390 islands in the Eritrean Red Sea zone, the prominent being the Dahelak Archipelago.

The population of Eritrea, which is estimated at 3.5x10⁶, is growing between 2.7 and 3 % annually. Population is unevenly distributed, with settlements highly concentrated in the cooler climates of the central highlands. Eritrea has diverse ethnic groups, which are classified into nine nationalities, namely the Afar, Bilen,

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Hidarb, Kunama, Nara, Rashaida, Saho, Tigre and Tigryna, with the last two nationalities constituting the majority of the population.

Although Eritrea appears to be small in land area, it has diverse climatic zones, mainly due to its high topographic variations. In physio-graphic terms the country is roughly divided into the Central Highlands (above 2000 m from sea level), the Midlands (1500-2000 m from sea level) and the Lowlands (below 1500 m from sea). The topographic variations have considerable effect on the rainfall pattern of the country. The major rainfall of the Central Highlands and the Western Lowlands takes place during the months of June and September, with much of the rain falling in August. The south- westerly monsoon winds are responsible for the summer rain. The eastern lowland and the escarpments facing these lowlands have rainfall between November and March, which is caused by the northeast continental winds blowing over the Red Sea. Due to orographic effect the escarpments receive high rainfall and since it also gets rain in summer it is the wettest part of Eritrea. Annual rainfall in Eritrea vary from about 100mm in the lowlands to about 700mm in the central highlands, and because of its bi-modal rainfall some places in the escarpment receive more than 700mm of rain annually.

When climate, soil types and other parameters are taken into account Eritrea is divided into six agro-ecological zones, namely, the Moist Highland, Arid Highland, Sub-Humid, Moist Lowland, Arid Lowland and the Semi-Desert. In terms of elevation they range from 100 in the Semi-Desert to 3018 m.a.s.l. in the Moist Highland areas. The variations in mean annual temperature range from 15 °C in the Moist and Arid Highlands to 32 °C in the Semi-Desert. Annual precipitation varies from less than 200 mm in the Semi-Desert to 1100 mm in the sub-humid zone.

The Government has been actively working to rehabilitate and reconstruct the economy, which has been very much damaged during the war of independence, which lasted for 30 years (1961-1991). To guide the country's economic activities the Government has formulated in 1994 its economic policy in a Macro-Policy Paper. Based on the economic macro-policy framework the Government pursues a policy of export oriented market economy with the private sector playing the leading role. Moreover, the policy does not make differentiation between domestic and foreign investment. To promote this policy further the Government accords high priority to the construction of infrastructure facilities, such as power generation, transport and communications.

Engaging more than 80 % of the population, agriculture is the main economic stay of the country. Subsistence agriculture, however, is the dominant mode of production and hence the contribution of the agricultural sector to GDP has not been quite significant, which was on average 19 % for the period 1992-1997.

Commercial agriculture is at its early stage and efforts are being made to develop and expand it.

Eritrea has a great potential to sustainably exploit its marine and coastal resources, particularly fisheries. The Eritrean Red Sea zone has the potential to sustainably harvest about 70,000 tones of fish as compared to the current fish catch of around 13,000 tones per year. Its long and pristine coastline of 1900 km also provides a good opportunity for tourism and other economic development activities.

Although the country had a good industrial base in the past, the war had rendered these industries non functional. Moreover, the technologies have become outdated and required considerable investments to replace them. Nonetheless, within a relatively short period of time the Government has made much effort to rehabilitate the industrial sector. Gross out put from the industrial sector almost tripled between 1992. Eritrea's industrial base constitutes medium-and small-scale industries, including food, beverages, textiles and leather.

Mining has good prospects in contributing to the economic development of the country. Some companies have been given concessions in different parts of the country for petroleum, gas and gold explorations. The potential of petroleum and gas is believed to be high.

The energy sector is critical to the development of the other sectors already mentioned above. Hence the Government has focused much attention on this sector. The energy balance for Eritrea is, however, dominated by the use of biomass fuels, accounting more than 70 % of the total energy out put in 1994. The energy balance for 1996 (no similar data existed for 1994) indicated that 77.3 % of the total final energy supply (TFES) was covered by biomass, oil products covered 21.3 %, and the rest was covered from electricity. From the TFES, 77.8 %, 14.9 %, 4.8 % and only 2.4 % was consumed by the household, transport, public and commercial, and the industrial sectors, respectively. Of the total primary energy supply (TPES) biomass accounted for 75.5 % and oil products accounted for 24.5 %. It should be noted that petroleum is the second major source of energy and the only fossil fuel at present in Eritrea.

3. National Inventory of Greenhouse Gases (GHG)

Eritrea's inventory of greenhouse gases (GHG) was conducted using the revised 1996 IPCC guideline. The inventory of GHG emissions by sources and the removals by sinks was carried out, taking 1994 as the base year for Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), Carbon Monoxide (CO), Nitrogen Oxides (NO_x) and Non-Methane Volatile Compounds (NMVOCs). CO₂, CH₄ and N₂O are the major GHG emissions in Eritrea as briefly discussed below.

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The inventory addressed six sectors, namely, energy, transport, industry, agriculture, land use change and forestry and municipal solid waste.

3.1 Carbon dioxide (CO₂)

Carbon dioxide (CO₂) emissions amounted to 2396 Gg in 1994. The major share of this emission came from LUCF and mainly from burning of fuel wood for energy uses. So it can be argued that LUCF sector in Eritrea was a net contributor of emissions rather than being a sink of CO₂.

The second major source of CO₂ is from fuel combustion of petroleum products, which amounted to 687.5 Gg of CO₂ in 1994. The major share of this emission is attributed by the road transport and the energy industries, accounting for about 283 and 241 Gg of CO₂ respectively.

3.2 Methane (CH₄)

National methane (CH₄) emission in 1994 is estimated at about 74 Gg. The main source was from agriculture and mainly from enteric fermentation. The energy and waste sectors also contributed small amounts of CH₄ emissions.

3.3 Nitrous Oxide (N₂O)

National emission of N₂O, which came from the energy sector, is not more than 6 Gg. Estimation of N₂O emissions from manure management and from fertilizer applications was found to be negligible.

3.4 Trends of Emissions

The major share of GHG in Eritrea, primarily CO₂, is from LUCF, accounting for about 70 % of the total absolute CO₂ emission in 1994, followed by energy use from fossil fuel combustion accounting 28 % of the total CO₂ emissions. Nonetheless, the IPCC has introduced the notion of global warming potential (GWP), indicating that GHG vary in their GWP. In this respect taking 100 years time horizon for the year 1994 the GWP for CO₂, CH₄ and N₂O is 1, 21 and 310 respectively. The resultant aggregated GHG emission in CO₂ equivalents was thus 7271 Gg. In this context Eritrea's main source of GHG, by sector, was fossil fuel combustion, followed by LUCF and agriculture. By gases CH₄, CO₂ and N₂O were the main polluting gases, in that order.

3.5 Limitation of the National GHG Inventory

Country specific emission factors and emission ratios are critical for undertaking a national GHG inventory. These values were lacking in Eritrea, and hence IPCC default values were adopted to serve a purpose. Lack of time series data was another obstacle to the national inventory of GHG. Relatively speaking the lack of data was more limiting in the agricultural and LUCF sectors than in the energy and industrial processes sectors. In light of this situation the uncertainties could be somewhat high. Future GHG inventory works need to take these issues into consideration.

4. Greenhouse Gas (GHG) Mitigation Options

Greenhouse gas (GHG) mitigation is not a priority for Eritrea, as it is still in its early stage of developing its economy. In the fulfillment of its commitment under the Convention Eritrea's main strategy is therefore adaptation rather than pursuing mitigation options. This is because the primary objective of the country is the realization of food security and the alleviation or eradication of poverty. Nonetheless, if some mitigation options could help promote its sustainable development objectives then Eritrea would exploit such opportunities.

Pursuant to the national inventory of GHG, emissions originate from the burning of biomass related issues, including LUCF, and the consumption of fossil fuel in the energy and transport sectors. It is therefore natural that mitigation options will have to address these sectors if these are to enhance sustainable development issues. In this context the following are some of the potential mitigation options in Eritrea.

- Strengthening further reforestation/afforestation programs, aiming at rehabilitating degraded lands and at the same time solving critical timber and fuel wood supply, as appropriate.
- Expand further the use of closure area system for the regeneration of natural vegetation.
- Strengthen the conservation of natural forest and introduce proper forest management practices, including the establishment of forest reserve areas.
- The introduction and use of energy efficient technologies in the generation of electricity. The Hirghigo Power Plant Project is a good example in this context.
- Introduction of energy efficient devices in cooking, cooling and lighting. These may include the introduction of efficient wood stoves in cooking, introduction of solar cooling devices and increasing lighting efficiency through the use of fluorescent in place of incandescent lamps.

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- The development and expansion of renewable energy supply technologies. In this respect many solar PV systems with an average capacity of over 400 kW have been installed in the rural areas.
- The expansion of the use of liquid petroleum gas (LPG) and kerosene. Currently there is an on going program to increase the supply of kerosene and LPG to rural areas and this needs to be strengthened further in the future.
- Formulations of new energy laws, regulations and standards so as to reform and deregulate the energy sector in order to encourage competition and efficiency.
- Introduction of efficient public transport system, particularly in urban centers
- Introduction of regulatory frames that would ban old cars and also encourage the introduction of efficient vehicles using catalysers and the provision of good quality roads and proper traffic planning.

5. Assessment of Vulnerability and Adaptation to Climate Change

By virtue of its geographical location and also because of its least adaptive capacities, Eritrea is one of the most vulnerable countries of the world to the adverse effects of climate. Due to the changing and unpredictable patterns of precipitation, for example, agricultural production, which is the main economic stay of the country, was severely affected in the past. The assessment of vulnerability and adaptation to climate change is somewhat a complex undertaking but, nonetheless, efforts were made to predict some changes of climate using global circulation models (GCM).

Several methods were use in determining the best GCM for Eritrea and theUK89 model was found to be the best predictor. According to this model, the mean annual temperature for Eritrea is expected to rise at the equilibrium level of 2 x CO₂. There will be an increase of temperature and the range between the monthly mean will vary from 29-37 °C, 28-37 °C and 18-26 °C in the coastal plains, the western lowland and in the central highlands respectively. The increase of temperature due to doubling of GHG concentration across the country is expected to rise by 4.1 °C, well within the IPCC's globally predicted range, i.e. 1.5 to 4.4 °C for effective doubling of CO₂ over the next century. On the other hand precipitation is expected to vary by a ratio of 0.1 to 0.15.

After formulating these predictions attempts were made to assess vulnerability and adaptation of some selected sectors and to predict changes of climate. The sectors chosen for the assessment were agriculture, water resources, forestry, coastal zone and human health. Given the diverse nature of these sectors, however, assessment focused on some selected components of the sectors, particularly in agriculture,

water resources and human health. For example, within the agricultural sector vulnerability and adaptation focused on two crops only, namely sorghum and barley.

6. Policy Measures and Programs in the Context of Climate Change

Policy measures and programs focusing on climate change related issues are still being developed in Eritrea. Nonetheless, there are several national policies and programs that address environmental issues in its broad sense, and these policies and programs have a direct bearing on climate change issues. These policy measures and programs address, among others, poverty reduction, environmental management, land degradation, marine and coastal environment, environmental impact assessment, conservation and sustainable use of biodiversity, and the transport and energy sectors.

The fact that Eritrea is Party to three international environmental treaties (the UNFCCC, the CBD and the CCD) is a testimony of Eritrea's commitment to join hands with the international community in protecting global environment from further degradation. At the national level national action plans have been completed for biodiversity conservation and its sustainable use and also for combating desertification. National action plan for climate change is being developed.

7. Public Awareness, Education and Training

The importance of public awareness, education and training in promoting the implementation process of the Convention need not be over emphasized. In Eritrea the level of knowledge and understanding about climate change issues, however, is somewhat limited, and this remains a challenge to the government at large and to concerned institutions such as the Ministry of Land, Water and Environment in particular, which is Eritrea's National Focal Point for the UNFCCC. It should however, be recognized that many important steps have been taken by Eritrea in the areas of public awareness, education and training with respect to the judicious use of natural resources for a sustainable use, including the following:

- The public was greatly mobilized during the process of preparing the National Environmental Management Plan for Eritrea. That was a good opportunity for the public to be aware about the decreasing trend of natural resources and hence the need to be vigilant for its proper conservation and use.
- Efforts are being made by concerned institutions to disseminate information about climate change issues and its effects through the radio and the written media.

- The preparation of Eritrea's initial national communications was a good opportunity to make many stakeholders aware about climate change issues.
- Various efforts are being made by relevant institutions, such as the Ministry of Education, Ministry of Land, Water and Environment and the University of Asmara in the areas of education and training, both formal and informal, on environment and climate change issues.

8. Research and Systematic Observation

For historical and political reasons research and systematic observation in Eritrea is extremely weak. Since independence in 1991, however, the Government has made considerable efforts to establish varying numbers of meteorological and hydrological stations at selected sites. Nonetheless, the attributes such as the location, distribution and type of instruments in each of these stations in many cases may not satisfy the requirement for a national observation network.

The establishment of an effective national observation system will require a strong institutional set up, development of human resources capacity in technical, scientific, and managerial aspects, and the introduction of state-of-the-art communication and information technology, which is quite limiting in Eritrea. The country therefore seeks in its endeavor financial and technical assistance from bilateral and multilateral sources.

With respect to research on climate change, hardly any thing could be done unless the present levels of human and institutional capacity, physical infrastructure and technology are upgraded. In the short-term the country plans to embark upon data collection and analysis to address the immediate social and economic development planning of the country. While engaged in the short- term program, an enabling environment for long term advanced research on climate change and the environment should be created.

9. Financial and Capacity Needs

Since Eritrea's main objective is attainment of food security and poverty reduction, adaptation measures to climate change should complement this objective. Nonetheless, the country's financial and capacity needs are quite limited and hence will require financial support and technology transfer from developed country Parties to enable Eritrea to fully participate in the implementation process of the Convention.

10. Implementation

A Core Planning Team, drawn from relevant institutions, has been coordinating the implementation process of the Convention. The Department of Environment of the Ministry of Land, Water and Environment, as the National Focal Point of the UNFCCC coordinates national efforts. There are plans to strengthen further the national coordination efforts by establishing a national climate change secretariat under the Department of Environment.