FUNDECOOPERACION

Para el Desarrollo Sostenible

San José, 1 de noviembre del 2001
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Señora
Emma Torres
Coordinadora Ejecutiva y Oficial a Cargo
Fondo Para el Medio Ambiental Mundial
New York, USA

Estimada señora:

La Junta Administrativa de Fundecooperación Punto Focal Técnico del GEF en sesión No. 14-01, de fecha 30 de octubre del 2001, acordó:

A. Avalar las propuestas ante el GEF de los siguientes proyectos: "Costa Rica: Segunda Comisión Nacional en el Marco de la Convención sobre cambios Climáticos de las Naciones Unidas" (05-GEF-01) y "Mejoramiento de la Capacidad para la Reducción de las Emisiones de Gases de Efecto Invernadero" (11-GEF-01), por la importancia que los mismos tienen para el país.

B. Acuerdo firme.

FUNDECOOPERACION
Para el Desarrollo
Sostenible

Cordialmente,

Licda. Guaria Vargas A.
Delegada Ejecutiva

GVA/ldr.
CC: Archivo.

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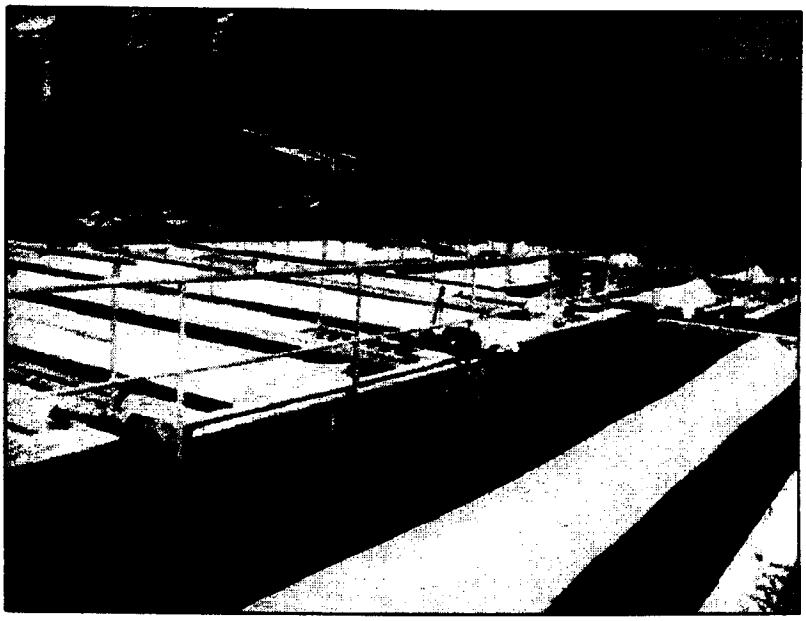
Executive Summary



Executive Summary

Costa Rica has taken part in climate change activities for over a decade. It ratified the United Nations Framework Convention on Climate Change on October 13, 1994, and accordingly, it has conducted different initiatives.

The First National Communication on Climate Change summarizes most of the activities carried out in the country in conformity with this commitment.

1 National Circumstances

Costa Rica is located in Central America and has an area of 51.100 square kilometers. It lies between the Caribbean Sea and the Pacific Ocean. Nicaragua is on the north border while Panama is on the south.

Even though Costa Rica constitutes 0.034% of the total Earth surface, its habitat constitutes around 5% of the planet biodiversity. The natural richness of this country is not only reflected in its forest, but also in its diverse flora and fauna. Besides, it is characterized by its diverse climate, resulting from the interaction of the atmospheric circulation with the volcanic mountain range that crosses the country northeast to southeast, and its highest peak reaches 3.820 above sea level.

The rainfall regime of this country exhibits well-defined dry and wet seasons. There are also important differences in weather conditions between the lowlands and highlands.

The population of Costa Rica reached 3.432.665 inhabitants in 1997. The population growth rate went from 2.38% to 1.84% during 1990-1997, which evidences an significant reduction.

Life expectancy at birth is estimated in 79.2 year for women and 74.5 years for men. The infant mortality rate has also improved since it went from 14.78 to 14.2 per thousand during 1990-1997. Indeed, the lowest rate of the decade was registered in 1996 with 11.8 per thousand. These parameters show an important betterment in the quality of life of the Costa Rican population.

Primary education is obligatory while both preschool and secondary education are financed by the State. The literacy rate is approximately 95.2%.

In 1997, production increased 3.2% as compared to 1996; this helped generate employment opportunities and decreased unemployment from 6.2% to 5.7%. Foreign investment has definitely contributed to this recovery. Furthermore, exportation increased, but so did importation, given the reliance of

the Costa Rican production system on imported raw material and products. In 1997, GDP per capita augmented 1%, reaching US$2,722.

In 1997, the share of agriculture[1] (primary sector) to the GDP was 18%, the secondary sector, conformed by industry[2] and construction, stood at 25% while the tertiary sector (services, transportation and commerce, among others) represented 57%.

It is important to stand out the growth of tourism during 1990-1994. In 1993, this sector constituted the main source of foreign currency. However, one of the main concerns of the government is to control the negative effects that tourism has on the environment. In that sense, the national agenda is oriented to fostering eco-tourism as a source of social welfare and environmental protection.

Costa Rica is a country with forest vocation though only 37.1% of the territory is currently covered with different forest types. Agricultural development provoked land use change in forest areas. The cultivated area has remained around 10% of the Costa Rican territory; this corresponds to 585.000 ha approximately. On the other hand, the area dedicated to livestock activities reaches 1.000.000 ha with a population of nearly 1,700,000 heads in 1996.

Even though water availability is good, the population needs have not been fully satisfied given the seasonal rainfall patterns (occurring dry spells) and because of the lack of integral water management policies. In 1996, 95% of the residential sector had access to fresh water.

Energy consumption in Costa Rica employs three energy sources: oil products, electricity and biomass. In 1997, consumption per sector reached 87.200 terajoules, out of which 46.4% corresponds to transportation, 26.4% relates to the residential, commercial and public sectors, 26.1% concerns the industrial and agricultural sectors and 1.1% refers to other activities.

In 1997, 93.2% of the population had access to electricity. The principal energy resources to generate electricity were hydropower (81%), thermal (7.7%), geothermal (10.10%) and wind (1.1) energy.

Electricity demand has increased in accordance to the country development and the expanding coverage in rural areas. In 1980, consumption reached 1893 GWh, and in 1998 it reached 5,112 GWh; it is believed that this value will augment to 11,116 GWh by 2010. It is supposed that in the coming decade 1,100 MW will be required to generate electricity; it will use 80-90% renewable resources and the remaining 20-10% will be taken from complementary thermal plants.

[1] Includes agriculture, forestry, hunting and fishing.
[2] Includes manufacturing industries as well as quarry and mining development

2 Legislation affecting greenhouse gas emissions

Environment-related topics are broadly considered in the Costa Rican legal system.

In 1994, Costa Rica ratified the United Nations Framework Convention on Climate Change and correspondingly promulgated it as a Superior Law of the Republic. In this connection, the country continued engaging in international compromises especially the United Nations Framework Convention on Climate Change and its Agenda 21. Furthermore, an important number of laws, decrees, agreements and administrative acts broaden the understanding of this position nationwide. This has caused an important legal revolution and has constituted an environment-friendly Costa Rican legal system.

These efforts were reinforced with the enactment of the Environmental Organic Law, the Law and regulations on the Rational Energy Use and a new Forestry Law, and others. Also, in 1998, the Consultative Climate Change Committee is created through an executive decree in order arrange and maintain an open dialogue among all sectors, regarding policies, mitigation and adaptation options to climate change.

3 Greenhouse-gas emissions inventory

In compliance with the compromises established with the ratification of the United Nations Framework Convention on Climate Change, Costa Rica completed the first inventory on greenhouse emissions, and the reference year was 1990. Given the contribution of this inventory for subsequent mitigation and vulnerability studies, it has been updated to 1996.

The inventory evaluation was charged to the National Meteorological Institute, which coordinated it with an experts team from different institutions related to the areas of energy, industrial processes, agriculture, land use and waste management.

The inventory included six gases: carbon dioxide (CO_2), methane (CH_4), carbon monoxide (CO), nitrous oxide (N_2O), nitrogen oxides (NO_x) and nonmethane volatile organic compounds (NMVOCs).

The results obtained in the 1990 inventory are displayed in the next table.

TABLE 3.1
Total greenhouse gas emissions, 1990

	2,391.4	215.4	5.32	0.12	30.05	33.33	2,665.6
	367.9	—	—	—	—	—	367.9
	—	14.26	124.52	0.48	0.55	—	139.81
	1,094.2	101.75	11.63	0.08	2.89	—	1,210.6
	—	—	20.5	—	—	—	20.5
	3,843.5	331.41	161.97	0.68	33.49	33.33	4,404.4
	3,843.5	—	10,204.1	183.6	—	—	14,231.2
	3,843.5	—	3,401.4	197.2	—	—	7,442.1

Source: National Meteorological Institute, 1995

The update of this inventory was based on the IPCC-OECD guidelines and the reference year was 1996.

The same six gases were included in the analysis, but in some cases, sulfur dioxide (SO_2), particles and hydrofluorocarbons (HFCs) were also evaluated.

Total greenhouse emissions for 1996 reached a net value of 4,047.5 Gg (4,047,700 tons). This can be broken down as follows: Energy 4,287.5 Gg (4,287,500 t); industrial processes 431.0 Gg (431,000 t), agriculture 152.4 Gg (152,400 t), land use change has a net fixation of –864.6 Gg (-864,600 t); and waste 41.4 Gg (41,400 t). These values are detailed per sector and gas in table 3.2

TABLE 3.2
Total greenhouse gas emissions, 1996

	4,137.6	101.3	0.5	0.1	24.7	21.6	1.8	0	4,287.5
	417.1	0	0	0.498	0.05	12.32	0.27	0.724	431.0
	0	11.96	133.2	6.73	0.476	0	0	0	152.4
	-971.2	93.2	10.65	0.074	2.648	0	0	0	-864.6
	0	0	41.44	0	0	0	0	0	41.4
	[redacted]	298.4	185.8	7.4	27.9	33.9	2.1	0.724	4,047.7
	3,583.5	—	10,404.8	2,072.0	—	—	—	540.1	16,600.4
	3,583.5	—	3,901.8	2,294	—	—	—	212.1	9,991.4

Source: National Meteorological Institute, 1995

4 Vulnerability to climate change

In order to determine the potential impacts and establish the best mitigation and adaptation options, Costa Rica has carried out studies on four specific sectors: water resources, coastal areas, agriculture and forest ecosystems. Since it is still not possible to carry out reliable predictions about future climate conditions, this study was based on potential climate scenarios.

4.1 Climate scenarios

This study on climate scenarios in Costa Rica describes the potential changes that may occur in the most important climate parameters: air temperature, precipitation and cloudiness, as a response to global warming.

Climate measurement data from selected meteorological stations representing Costa Rican climate regions were compared with the results from the available general circulation models. The Hadley Centre Models displayed the best results. Once the Hadley Models calibration was done, the results were entered into the MAGICC and SCENGEN models.

To determine the potential climate conditions of Costa Rica for years 2010, 2030, 2070 and 2100, three scenarios displaying the increase of greenhouse gases were used. The scenarios are known as IS-92a, IS-92c and IS-92d.

Results divide the country into four regions (see figure 4.1.1). By 2100, region I shows the largest temperature increments during May and June (up to +3,8°C). Precipitation decreases in this region from December through April, showing a maximum in March (-63%). It seems that this will be the most affected region.

In region II, the biggest temperature increments are registered from May to June and from December to January, reaching +3,2°C. Meanwhile, precipitation diminishes in the driest part of the year (April) up to -49%.

In region IV, the biggest temperature increments were registered in May, reaching +3.5°C. Precipitation drops in the first part of the year, up to -46% in March.

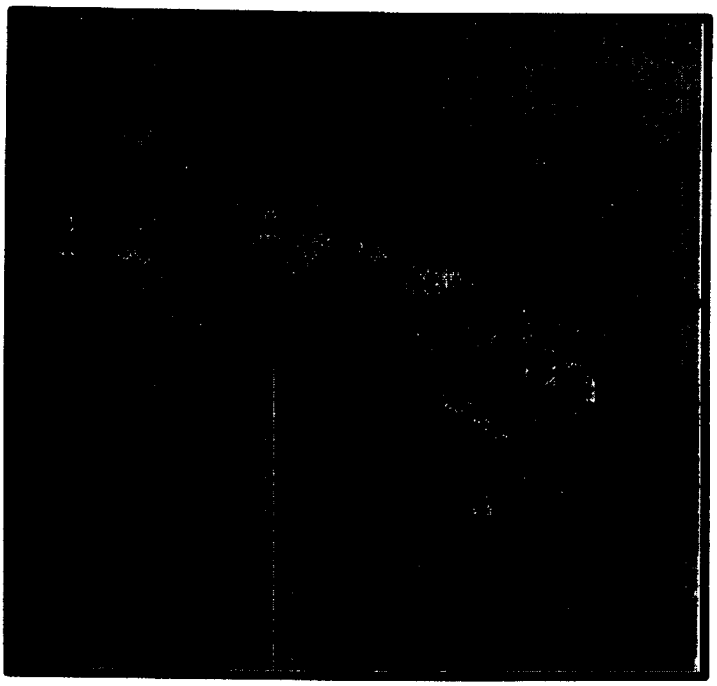


Figure 4.1.1 Study regions in Costa Rica according to the SCENGEN model

Based on the models run, it can be concluded that despite the measures given by the IPCC scenarios to control and reduce GHG, climate change will unavoidably affect human activities and resources locally.

4.2 Vulnerability of water resources

The study on the vulnerability of water resources was focused on the simulated response of three river basins that are critical to the economic and social development of Costa Rica, considering the following potential climate change scenarios: variations in temperature (1 and 2 °C) and precipitation (+/- 15%). The basins of the three most important rivers of Costa Rica were selected: Reventazón, Térraba and Grande de Tárcoles river basins.

The records from different hydro-meteorological variables were used in order to calibrate the CLIRUN3 hydrological model. Results show important runoff variations in all basins. Water runoff increased between 23.8 and 75.5%, given a precipitation increment of 10% to 15%. On the other hand water runoff decreases between 5 and 29% when precipitation diminishes between 10 and 15%, respectively. The model appears more sensitive during the rainy season, showing most changes during the rainiest months.

According to this study, alterations in the water cycle could affect water runoff, erosion and sediment carrying, thus causing severe flood-related problems. Impacts would also be reflected in the exploitation of water resources to generate hydroelectricity, irrigation systems, aqueducts and sewer systems.

4.3 Vulnerability of coastal resources

The Costa Rican coastal line is constituted of over 1,100 km coastal line in the Pacific Ocean and 200 km coastal line in the Caribbean Sea. The recent emergence of these coasts, their proximity to a mountain range, the multiple lava filtering and perpendicular folds to the coastline, as well as high precipitation have caused morphological and environmental variability. Alluvial plains prevail and there are basically no cliffs. This makes the coast very attractive. Inside the gulf and the main estuaries, the coast has been enlarged by vegetation (mangrove swamps) where characteristic ecosystems develop and nurture juvenile species.

In Costa Rica, this change in sea level will provoke transgressions in the current coastal line and widen the areas subject to tidal floods in almost all the 1,300 km of coastal line. The predominant coast types of the country: beaches in front of alluvial plains and salt marshes (mangrove swamps), will be vulnerable to an accelerated rise in the sea level. The increase will provoke a transgression (setback) of the coastal line to reach equilibrium again in those beaches located

in front of alluvial plains, while it will provoke an extension of the areas prone to tidal floods in salt marshes.

In Puntarenas (figure 4.3.1), given a rise in the high waters full and change of 0.3m, high waters would penetrate 150 meters. This means that the entire tidal flood will affect around 105 ha, which constitutes 60% of the current residential area of this suburb.

If sea level rise reaches 1.0 m (pessimistic scenario), high waters would penetrate 500 m in average from the border and would provoke floods in 300 ha that are currently dry. This constitutes 90% of the current residential area.

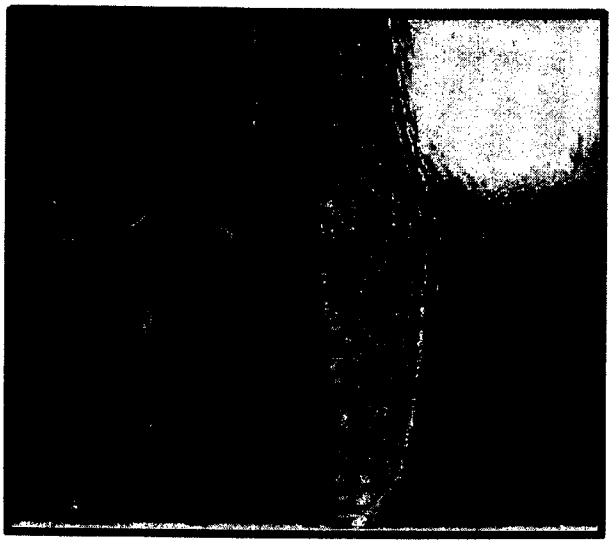


Figure 4.3.1 Puntarenas, high waters with an increment from 30 to 100 cm

4.4 Vulnerability of agriculture

Costa Rica has carried out vulnerability studies in four crops and in different parts of the country: rice, beans, potatoes and coffee. The purpose of such studies was to simulate with agricultural models the response of those crops to different climate scenarios that represent the characteristics of global warming. These studies used the Decision Support System for Agrotechnology Transfer (DSSAT) which requires information on soil type, climate, crop variety and management.

For the climate analysis, daily data on precipitation, maximum temperature, minimum temperature and sunshine were used (30 years). Each region identified and analyzed the most representative soil type. Each model was calibrated and validated with the yield information.

Rice cultivation

Results show that there are yield reductions in dry-land rice as precipitation decreases. High temperatures also provoke considerable yield drops. The crop cycle shortens with high temperatures; plants do not use the available moisture efficiently and the energy needed in the transpiration process increases. All this results in low yields. It may be necessary to adapt sowing dates and possibly the crop zoning

Bean and potato cultivation

Bean cultivation is a traditional agricultural activity of great socioeconomic importance because it is the most consumed leguminous plant. On the other hand, potato production is located in the central region and it is the third most important product because of its consumption.

In order to study the effects of climate variations on the productive physiology of these crops, two computer growth simulation models were used: the CROPGRO-Dry bean and the SUBSTORE-Potato; these models are included in the DDSAT.

Results indicate that both potatoes and beans show an important decrease in yields with increasing temperature and precipitation variations; but temperature appears to be the most important element causing this effect. The most important reductions are obtained with the modifications of +2° C.

Furthermore, it was observed that the higher the concentration of CO_2, the higher the yields. This occurs because CO_2 has a natural fertilizing effect, which reacts positively to atmospheric nitrogen fixation and soil phosphate release. Furthermore, the photosynthesis rate and the production of biomass in the C_3 plants increase; this enhances water use efficiency. Despite this effect, when increasing temperature was incorporated in the tests, only potatoes displayed yields higher than the reference.

Coffee cultivation

Coffee cultivation is the most important socioeconomic activity of the country. It constitutes 20% of GDP and generates employment opportunities. The Central region is the most important coffee producer.

The COFFEA model, which was developed in Costa Rica, was used to carry out the coffee evaluation. This model has three modules (growth, phenology and water balance) and allows the estimation of biomass in grains; accordingly, it is possible to estimate yields too.

The increase of environmental temperature tends to augment coffee yields especially when it surpasses maximum temperature in +2°C. In regard to precipitation, it was observed that an increase in precipitation is translated into higher yields. In summary, the best results are achieved with elevated day temperatures and an adequate availability of water to stimulate flowering.

Analyses indicate that the effect of meteorological parameters on yields is differential and depends on water availability during the crop cycle. The models assume that temperature affects the development of the crop in all the phenological phases while the quantity of water has different effects depending on the crop cycle phase. Moisture deficit may also diminish water use efficiency and reduce biomass production. On the other hand, yields also decrease because of the loss of nutrients that are not absorbed due to the low maintenance transpiration.

The meteorological parameter that caused the main yield increase was temperature. Maximum temperature had the most important impact on the biomass formation. It is clear that maximum temperature results from a high evaporation demand, thus reducing water use efficiency and affecting foliage expansion, which in turn limits the interception of radiation and transpiration. For this reason, it can be concluded that the reduction of foliage expansion and transpiration are related with water availability, which depends on the evaporation demand in a given moment. In this manner, scenarios with increasing precipitation show more biomass production.

CO_2 scenarios show a positive effect on crops. Indeed, yields increase in all cases. This occurs because CO_2 augments the photosynthesis rate and the production of biomass in the plant. For this reason, water use efficiency increases. It is important to keep in mind that the biological environment will also be affected; accordingly, it is possible that the production of biomass in competitive plants (weeds) increase. These may reduce growth and the analyzed crop yields.

4.5 Forest vulnerability

The Costa Rican territory is characterized for its diversity. It has twelve life zones, wide biodiversity and an important hydrological potential, linked to the existing forests. In the evaluation of forest vulnerability to climate change, the Costa Rican climate scenarios and forest scenarios were used; they were determined according to land ownership, the conflict of use and the value of the forest and land.

Maps of future forests were designed and they were compared with the existing ones. With this information, it was possible to identify which forests would be most affected.

The three climate scenarios (see section 4.1) show that the tropical and montane life zones seem to diminish while they tend to increase in the premontane. Rain forest life zones diminish in all levels. Dry, moist and wet tropical forests diminish significantly. But premontane moist and wet forests as well as lower montane moist forests augment.

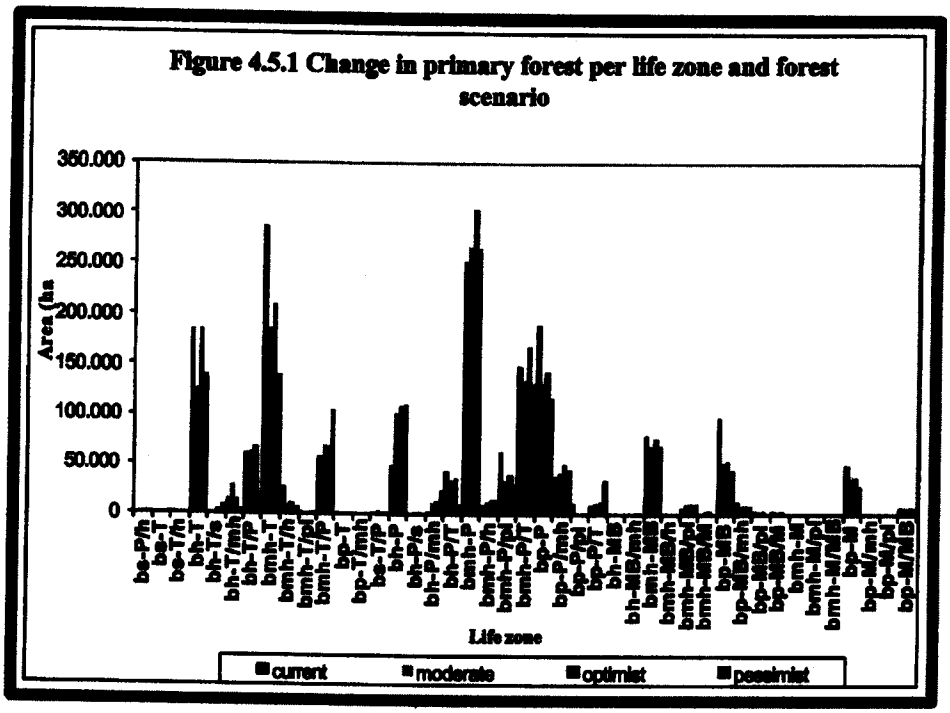
Some of the most evident changes are the appearance of the premontane dry forest transition to premontane moist forest in the three scenarios. The tropical dry forest reduces from 20% to 30% in the three scenarios, but it increases in the transition to premontane. The tropical wet forest decreases significantly under the three scenarios while the transition to premontane increases. Tropical rain forest and transition to wet forest disappear while premontane wet forest transition to tropical forest augments. The premontane moist and wet forests increase considerably. Premontane, lower montane and montane wet forests diminish enormously.

Taking into consideration biodiversity and wild life, tropical wet life zones and tropical dry life zones will be severely affected even under the optimistic scenario. Given the variety of biodiversity, several species from the tropical wet forest will need to adapt or move to the remaining forests that keep the former conditions around those life zones.

The present analysis is preliminary and only considers the vulnerability of species in regard to the existence of habitats (forests). In this sense, not all the species are affected by the direct loss of forests. Some will survive in lagoons, incipient secondary forests, pastures or others. However, flora and fauna species whose range of action is located in the basal or tropical levels will be more vulnerable to climate change. This will force them to adapt or move to nearby forests.

It is necessary to identify the primary tropical wet forests that would be affected by climate change and to adopt protection measures. It is also indispensable to identify primary premontane moist forests and adopt protection measures since these areas are specially threatened by deforestation.

Figure 4.5.1 displays forest variation per life zone and forest scenario.



5 Mitigation options

In accordance to the compromises established in the UNFCCC, Costa Rica has developed a National Program on Climate Change (Fig. 5.1). In this connection, it carried out the project: Costa Rica Building National Technical Capacity for Developing Options for Greenhouse Gas Emissions Reductions and Sinks (UNDP/GEF, COS/95/G31). This project was aimed at identifying and analyzing feasible mitigation options in different sectors of the economy; these options had to be consistent with national circumstances and priorities and must support the identification and strengthening of national policies that pursue the ultimate Convention goal.

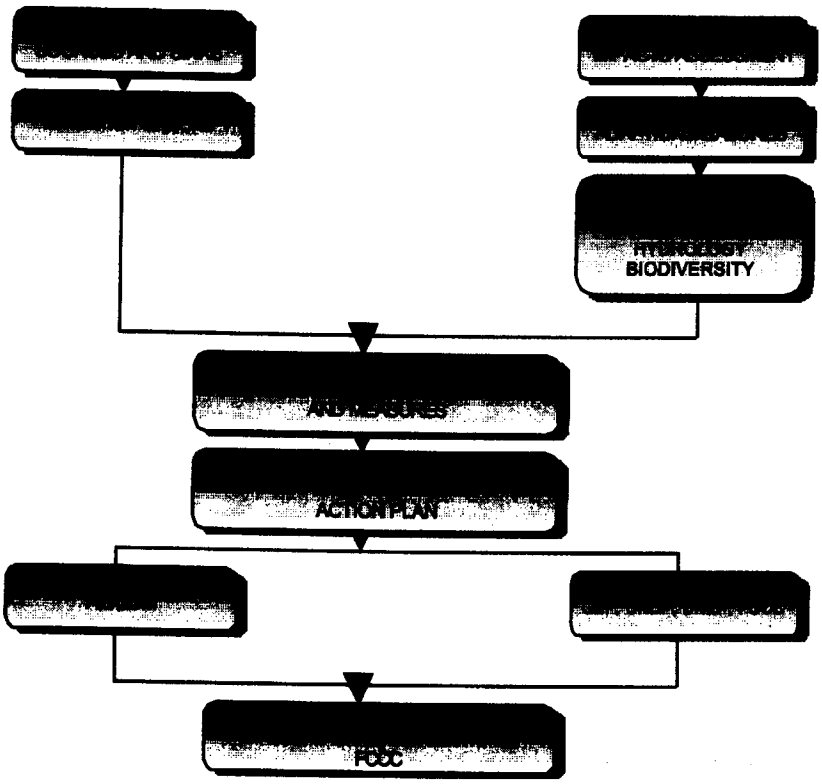


Figure 5.1 National Program on Climate Change

5.1 Economic scenarios and projected national emissions

Economic scenarios were determined in order to estimate the temporary tendency of greenhouse gas emissions, expressed in CO_2 equivalent for a horizon of 20 years (figure 5.2). A base income scenario was considered (Gross Domestic Product, GDP) at an annual growth rate of 4.5% (average 1957-1996) and two alternative scenarios (3.5% and 5.5%). Under the base scenario, it is estimated that by 2015, national emissions would be 26.8 thousand Gg in CO_2 equivalent.

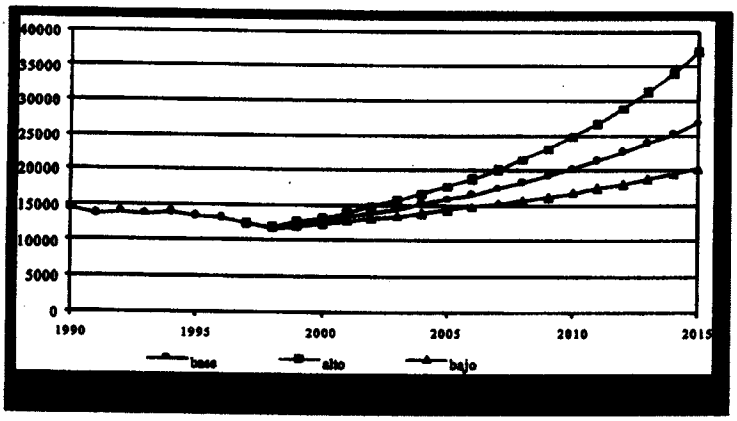


Figure 5.1.1 Total GHG emissions per income scenario (Gigagrams of CO_2 equivalent, Gg)

Per capita emissions by production scenario

Between 1990 and 1996, per capita income increased and per capita emissions decreased. This is the result of the stabilization of the deforestation rate in natural forests, as well as the uptake in secondary forests and forest plantations, which compensated for the emissions increase in the remaining sectors. Per capita emissions projections by 2015 lie within 1.8 and 3.4 t per inhabitant in CO_2 equivalent (20-year horizon).

Projections of national emissions per economic sectors (according to IPCC)

In regard to the relative contribution of economic activities to the evolution of domestic greenhouse gas emissions (in CO_2 equivalent) projected for year 2015 (figure 5.1.2), agriculture, which includes methane emissions from enteric fermentation in livestock would constitute the main emission source by 2007. Nonetheless, during the horizon projection, it is not likely to have a considerable change in regard to 1996 emissions. This occurs because the annual growth rate of livestock will be 0.7%.

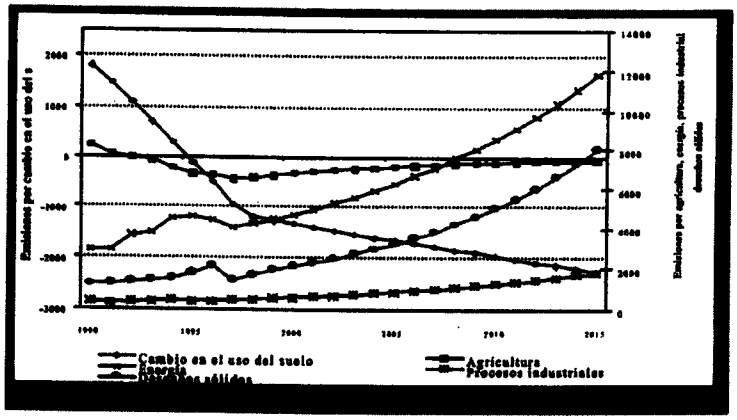


Figure 5.1.2 Evolution and base scenario per sector (according to IPCC), 1990-2015 (Gg of CO_2 equivalent in a 20-year horizon).

Emissions from the energy sector include those resulting from the use of hydrocarbons in transportation and electricity generation with thermal plants. In 1996, a total of 4.4 thousand Gg of CO_2 equivalent were emitted from hydrocarbon consumption. Projections indicate that by 2015 this sector will emit 11.8 thousand Gg of CO_2 equivalent, out of which 90% will result from diesel and gasoline consumption. From year 2008, the energy sector will become the main source of emissions.

Concerning the land use change and forestry sector, emissions or uptake represents the net variation of emissions from forest deforestation (source) and the uptake in secondary forests and forest plantations (sinks). The projected evolution of the sector's net emission shows a decreasing tendency and becomes negative since 1995. This occurs because uptake from sinks surmounts the emissions by sources.

In regard to solid waste, methane emissions in CO_2 equivalent, resulting from biomass decomposition augmented at a 10% rate between 1990 and 1996. If this trend continues, this sector may become the second source of emissions by 2015.

Emissions from industrial processes result from cement production. These emissions increased at a 16% rate between 1990 and 1996, and it is expected that they continue growing at an annual rate of 8.1%. However, it will still be a secondary source of emissions.

5.2 Mitigation policies and measurements

According to the results of the baseline scenario analysis for the period 2000-2015, the most important sectors subject to mitigation policies and measures were identified. These sectors were identified because of their contribution to the economic development and growth of the country and because of their greenhouse gas emission levels. The principles ruling the identified policies and measures are coherent with the circumstances and priorities in the national environmental agenda.

Transportation

This is the target sector to apply mitigation measures. Inadequate planning and control over public transportation, population and the increasing number of motor vehicles, the massive importation of used vehicles, the growth and concentration of population in urban areas, the poor state of roads, traffic jams and the elimination of train transportation originate most of the sector's emissions.

Policy:

[redacted]

Renewable energy

Costa Rica is one of the countries that has the best hydraulic potential per area. According to preliminary inventories, this potential could cover demand for the following five decades. Furthermore, there are other renewable sources that have been commercially exploited and which may expand; that is the case of geothermal (986 MW) and wind (660 MW) energy. They allow the combination of different renewable sources to improve the national capacity in technical, economical and environmental aspects.

The regionalization of electricity markets in Central America brings on opportunities and threats. It provides the opportunity to commercialize electricity in the region and places renewable energy and/or power in any part of the isthmus. However, in a competitive market and with favorable prices in hydrocarbons, regional thermal generators threaten the national market.

Therefore, additional financial support from the Convention Mechanisms (Activities Implemented Jointly) and its Protocol (Clean Development Mechanism), such as the increasing income from "certified emission reductions"

would favor competitiveness and the introduction of renewable energy from Costa Rica to the region. This is especially important considering that more than 50% of the region's population does not have access to electricity and that it is mostly produced with hydrocarbons.

Policy:

[redacted]

Land use change and forestry

The land use change and forestry sector may permanently become a net carbon sink as a result from the introduction of forest incentives and the payment for environmental services (PES). Nonetheless, the main source of emissions in this sector is still deforestation for profitable purposes.

Even though the country has created the National System of Conservation Areas and has implemented the payment for environmental services, it has not been possible to ensure sustainability in the long term. The Government is still facing difficulties to meet those compromises, particularly the purchase of areas declared under absolute protection and PES.

Policy:

[redacted]

Industrial

Since the industrial sector uses the environment to discharge untreated pollutants (solid wastes, dumping and agricultural runoff), it constitutes one of the main sources of emissions and highly contributes to environmental degradation. The high cost of technological solutions to prevent and diminish air and water pollution related to production processes is the main obstacle to apply policies in this sector.

Policy:

[redacted]

Agriculture

Livestock constitutes over 80% of domestic methane emissions. However, an improved handling in aspects such as diet quality and an adequate grazing management constitute feasible mitigation options.

In this country, the intake of agrochemicals per cultivated hectare is one of the highest among developing countries, and agriculture constitutes the main source of nitrogen oxides emissions. An improved land management (tilling and drainage optimization, watering scheduling, etc) and a better use of fertilizers (superior technologies for the application of nitrogen and equilibrium between crop demand and supply, etc) would enhance agricultural production with positive environmental effects.

Policy:

[redacted]

5.3 National program of Activities Implemented Jointly

Decision 5 of the First Conference of the Parties of the UNFCCC, opened the possibility of having the Parties carry out Activities Implemented Jointly (AIJ) to comply with the ultimate objective of the Convention.

Costa Rica has nine AIJ projects reported to the UNFCCC Secretariat. Four of those projects are related to renewable energy (1 of hydroelectricity and 3 of wind energy); there are also four forestry projects and one on wastewater handling in coffee processing plants[4]. All energy projects have already been implemented and contribute with 8% of the total energy consumed by the country. There are two more forestry projects that have already received funding; this means that AIJ has made possible an investment of 140 million dollars in Costa Rica.

[3] UNEP defines cleaner production as the joint application of an integral and preventive environmental strategy in production processes, products and services to reduce important hazards to the population and environment.

[4] The additional project costs were obtained with methane certified emission reduction units, sold to the Netherlands Government in approximately $400 thousand.

Among the executing projects, the project Ecomercados, developed by the Ministry of Environment and Energy, financed by the World Bank, the Global Environmental Facility (GEF) and the Carbon Prototype Fun of the World Bank, is aimed at developing local and global markets for environmental services derived from forest ecosystems. Furthermore, it will improve the financial competitiveness of hydroelectric projects as compared to thermal generation projects; it will also consolidate the strategic alliance between the conservation of forest ecosystems and the production of hydroelectricity.

Table 5.1
AIJ Projects

Plantas Eólicas	Wind power	30.40	506,720
Tierras Morenas	Wind power	27	562,020
Aeroenergía	Wind power	8.85	148,000
Doña Julia	Hydroelectric power	27	562,020
ECOLAND	Conservation	1	345,648
KLINKI	Reforestation	3.8	1,969,000
GNFL	Conservation Regeneration Reforestation	3.3	313,646
P.A.P.	Conservation	150	18,000,000
EARTH	Reforestation	0.334	4,493
ICAFE/BTG	Wastewater handling	0.973	34,845
Total		256.66	22,443,092

5.4 Mitigation options portfolio

There have been identified a number of potential mitigation projects that may be financed with local financing and/or direct foreign investment, either by putting capital in the project or through the Convention and Protocol Mechanisms.

An integrated traffic system in the Metropolitan Area

The *integrated traffic system in the Metropolitan Area* is oriented to controlling public transportation by bus, which currently has 184 routes and approximately 1,500 units that enter the Metropolitan Area of San Jose everyday.

The objective of this system is to consolidate an integrated transportation network that will be able to compete with other public transportation means and which optimizes routes by using buses efficiently, verifying routes, coordinating schedules and bus change, improving technology and infrastructure and other aspects.

Railroad re-opening

A major option to reduce emissions from transportation is to re-establish railroad freight services and passengers transportation by train. The cessation of the railroad service from the coasts to the capital aggravated road transportation problems.

The national railway system is inter-oceanic and has an extension of 450 kilometers. The Caribbean section has an extension of 300 km; it communicates San Jose and Moin port. The Pacific section has an extension of 150 km and communicates San Jose with Caldera and Puntarenas ports. The Pacific section is electrified and would only use renewable sources. Both sections are linked through an intercity railway of 44 km.

Railroads use and exploitation through public works concession would offer competitive transportation costs because it requires half of the fuel needed with freight transportation by road. It is estimated that greenhouse gas emissions may be reduced in 25,948 tons of CO_2 equivalent per year (20-year horizon).

Renewable sources

In accordance with the National Plan for the Expansion of Electricity Generation of the National Electricity Institute (ICE)[5] for 2000-2010, it is necessary to install a generation capacity of approximately 1,000 MW, out of which 80-90% should originate from renewable sources while the remaining 10-20% would be provided by complementary thermal plants. The operation of renewable electricity plants could avoid the emission of 214,445 tons of CO_2 by year 2009.

The economic valuation and consolidation of an international market of greenhouse gas emission reduction units constitutes a critical element to improve the competitiveness of renewable sources as regards to thermal energy and so turn renewable energy into a mechanism for development.

[5] Expansion plans compare projected demand and electricity supply. When there is not enough reserve or power, available projects are considered and a cost-effectiveness assessment is carried out to minimize investment and long-term costs.

Energy conservation

Concerning demand, those initiatives that pursue rational use and energy saving constitute mitigation options that have been already used. The objective is to diminish the effects of the increasing demand and balance supply sources during maximum demand periods. It is oriented to the residential sector, where energy is mostly used in lighting and cooking.

With regards to energy efficiency, the project of compact fluorescent lamps (CFL) is an initiative oriented to energy saving and is directed to the residential sector, which consumes approximately half of the total electricity supplied through the inter-connected national system. 20% of this consumption is used for lighting. The compact fluorescent lamps project could help avoid the emission of 8,752 tons of CO_2 per year.

Land use change and forestry

Aware of the importance of forest conservation and the need to support forest ecosystems sinks as a way to mitigate climate change, two national forest projects were designed: "Protected Areas Project" (PAP) and "Private Forestry Project" (PFP). Both of them could result in carbon fixation and greenhouse gas emissions reduction.

Nonetheless, it has not been possible to ensure the financial sustainability of both programs in the long term. Therefore, the marketing of certified emission reduction units through the Convention Mechanisms and its Protocol is a feasible option to ensure the sustainability of PES for private forestry activities (PFP) and will help the territorial and financial consolidation of the National System of Conservation Areas. Needless to say, both are essential in the environmental agenda of this country.

Wastewater handling in coffee processing plants

Regarding the control of wastewater discharge, initiatives are oriented to coffee processing plants, where the traditional treatment of wastewater discharged in oxidation lagoons (aerobic process) has been changed to an anaerobic process with biodigestors. These new processes capture methane and use it to generate electricity and/or heat for coffee roasting, and consequently, diminish processing costs.

There are currently ten anaerobic reactors with 30 modules of 250 m^3 each. They serve for the treatment of one third of the discharge from coffee processing plants in Costa Rica; therefore, emissions diminish in 29,036 tons of CO_2 equivalent per year (20-year horizon). Market studies show that it is viable to install 10 more reactors, which will be translated in an emission reduction of 32,784 tons of CO_2 equivalent.

Methane extraction from landfills

A mitigation option in solid waste management is the generation of electricity with natural gas form Río Azul landfill[6]. Solid waste from the Metropolitan Area of San Jose goes to this landfill. It has been estimated that the landfill biogas may contribute with 5 MW and generate 37 GWh/year.

The emission reduction potential of methane attributable to this project is 3,670 t of CH_4/year with an extraction efficiency of 65%, which corresponds to 205,574 tons of CO_2 equivalent/year (20-year horizon), during the project execution. Financial availability depends on the marketing of methane emission reduction units within the Mechanisms of the Convention and its Protocol.

Methane emissions reduction in livestock

Methane emissions reduction in livestock varies according to the fodder species and grazing frequency. Besides, changes in the cattle diet would eventually reduce methane emissions. This option is based on the results obtained from the simulation that considered diet changes and grazing management in non-dairy cattle (males weighing 350-450 kg) and dairy cattle (only adult females).

Grazing considered two fodder species and two different frequencies. Grazing cycles were modified; grazing was scheduled every 21 days in the African Bermudagrass (*Cynodon niemfuensis*) and every 25 days in Kikuyugrass (*Pennisetum clandestinum*). In both cases, the diet included green banana (8 kg/animal/day) and concentrate (2.5 kg/animal/day). A stable population of 100,000 animals was used in both herds.

It was determined that methane emission reduction is very significant; it resulted in 1.09 Gg methane/year for dairy cattle and 1.92 Gg methane/year in non-dairy cattle. t was determined that fodder quality has a direct influence on methane emissions; conversion efficiency (emitted CH_4: obtained product) improves as the diet does.

Cement Industry

CO_2 emissions in the cement industry depend on clinker production and energy consumption during production. The energy employed formerly came from fossil fuels. However, it is still possible to substitute fossil fuels up to 60% for other alternative fuels based on waste.

[6] This landfill has an area of 64 ha and a field capacity of 2,5 million m^3. Its biogas mean production rate is 100 m^3/t of garbage; it has a potential of 1,100 m3 of biogas/day with an extraction efficiency of 65%.

INCSA, a cement production industry, initiated a project to collect used tires and burn them while CEMPASA, another cement industry, launched a program to collect burned oil and introduce it in bunker combustion. Furthermore, they are carrying out studies to use bottles and other disposable recipients (PET). INCSA and CEMPASA are in charge of cement production in Costa Rica.

Clinker substitution for other mineral additives is one of the most effective methods to reduce emissions because of limestone decarbonization and the reduction in fuel consumption. An important percentage of clinker has been substituted with alternative materials such as limestone and mineral additives; this resulted in a reduction of CO_2 production. Presently, the clinker fraction is 70% due to the material substitution.

6 Programs related to sustainable development, research and systematic observation, public awareness education and training

Costa Rica has fostered sustainable development since the beginning of the 90´s. The Conservation Strategy for Sustainable Development (ECODES) was published in 1990, and in 1994 the National System for Sustainable Development was created in order to integrate actions and strategies to promote development in harmony with nature.

A fundamental aspect of the institutions created to encourage sustainable development is to increase the scope and participation mechanisms as well as the structuring of civil society and other academic and business sectors. Accordingly, the Commission of Non-Governmental and Social Organizations for Sustainable Development, which comprise over 600 entities, was conformed. The business sector created a commission and technical unit of sustainable development in the Unión de Cámaras y Asociaciones de la Empresa Privada (Chamber Union and Private Enterprises Association).

The National Meteorological Institute of Costa Rica is responsible for climate observation and monitoring. It has 170 meteorological stations that are needed for the permanent observation of climate parameters throughout the country. Furthermore, there is a station that measures the concentration of ozone, nitrogen oxide and sulfur dioxides in the atmosphere; it has been used to measure the concentration of gases in different parts of the metropolitan area, where population and vehicles are condensed.

There are five tide gauge stations that measure sea level and other oceanic and atmospheric variables.

Some universities have laboratories of atmospheric chemistry and environmental pollution, where people research on greenhouse gas emissions and analyze the

concentration of greenhouse gas emissions in the atmosphere. A monitoring system for air quality was established in 1993.

Costa Rica has been working in climate change since the 80´s with the active participation of the National Meteorological Institute and other national groups in the Intergovernmental Panel on Climate Change (IPCC) sessions, and the Conference of the Parties of the Framework Convention of Climate Change.

Different research on inventories, vulnerability studies, ozone layer and the National Communication have been financed by foreign institutions and are executed within the Costa Rican National Climate Change Program

Climate change has not been included in the academic curricula in this country; nonetheless, the conservation of natural resources, sustainable development, energy conservation and waste management are some of the topics developed by the Ministry of Environment and Energy and the Ministry of Public Education. Some documents aimed at informing people about greenhouse gas emissions and reduction in different sectors have been published.

In regard to research, efforts are oriented to equip installations, provide equipment and train personnel in an energy efficiency laboratory. Moreover, in 1998 the Association for Electric Vehicles was created. It pursues the establishment of a testing laboratory for this kind of transportation and the creation of a development and virtual information center.

Concerning waste management, a joint project between the local government and State universities is being carried out. It includes the education of children through the adequate training of teachers in environmental topics. A series of conferences have also been given the residents within the project area.

It is important to stand out that we are working on a project to strengthen institutions and therefore, train the industrial sector on the use of chlorofluorocarbons. Other efforts are being carried out to generate a project on alternatives to the use of methyl bromide in melons and flowers since these compounds have a devastating impact on the ozone layer and constitute greenhouse gases.

7 Financial assistance and transfer of technology

7.1 Financial assistance

Costa Rica has developed a climate change program since 1991. Its objectives are to generate research and assess the related aspects of this topic. Nonetheless, foreign financial support from international organizations has been fundamental to achieve the established goals and compromises with the United

Nations Framework Convention on Climate Change. This is carried out with different national and regional projects.

The Country Studies Program of the United States financed a Central American project focused on the region's vulnerability in regard to climate change. The Global Environmental Facility provided support to develop the national inventory of sources and sinks of greenhouse gases in Costa Rica, in 1990 and other documents that resulted in the First National Communication of Costa Rica to the Secretariat of the United Nations Framework Convention on Climate Change.

Furthermore, the Institute for Environmental Studies of the University of Vrije in The Netherlands financed the project Climate Change Studies in Costa Rica which consisted of a vulnerability analysis in three areas vulnerable to climate change: coastal zone management, forestry and agriculture.

Costa Rica, within the pilot phase of Joint Implementation has received cooperation from different countries like Norway, Switzerland, Finland, The Netherlands and the United States. This support has helped in the payment for environmental services to landowners located in protected areas and has promoted electricity generation with renewable sources.

Additional support from GEF and the World Bank is currently expected to develop the project Ecomercados.

7.2 Transfer of technology

Costa Rica, like all developing countries, is in a difficult position regarding technology transfer because it has to confront several obstacles to install new and environment-friendly technologies.

The country has the human potential and the adequate characteristics to incentive clean technologies. Novel projects have been designed, especially as demonstrative processes and to analyze their feasibility. However, a successful program of technology transfer needs the financial and logistics support from industrialized countries because implementation costs usually surmount the available resources.

Some sectors, such as energy, have already access to information networks, but it is still necessary to have specific networks in topics related to environment-friendly technology.

Costa Rica is executing a project to generate national capacity; it is training a technical team in different research areas (energy, agriculture, land use, waste management and others).

Following are some of the activities on transfer of technology that are being carried out:

A pilot project has been implemented in electric transportation; its results would be useful to execute a bigger program. The objective of this project is to install ten electric buses in the capital of Costa Rica and five more in other cities, 50 motorcycles and 50 electric vehicles, so that they could work as laboratories and recipients of this technology during the pilot phase.

Transportation is also working on the possible switch to liquefied petroleum gas (LPG); for this purpose, the adequate infrastructure was implanted and people are working on public awareness on the advantages and disadvantages of this kind of technology.

Fuel improvement is a ongoing project of the Costa Rican Oil Refinery, and it has introduced less polluting fuels in recent years.

People are now working in providing electricity for basic needs (lighting, TV, radio) with photovoltaic panels to disperse families located in the rural areas.

The majority of activities are demonstrative programs at a small scale financed with foreign resources. These programs would need the financial support from international organizations and friendly countries to be applied in a nation-wide basis.