



UNION OF THE COMOROS
Unity – Solidarity- Development

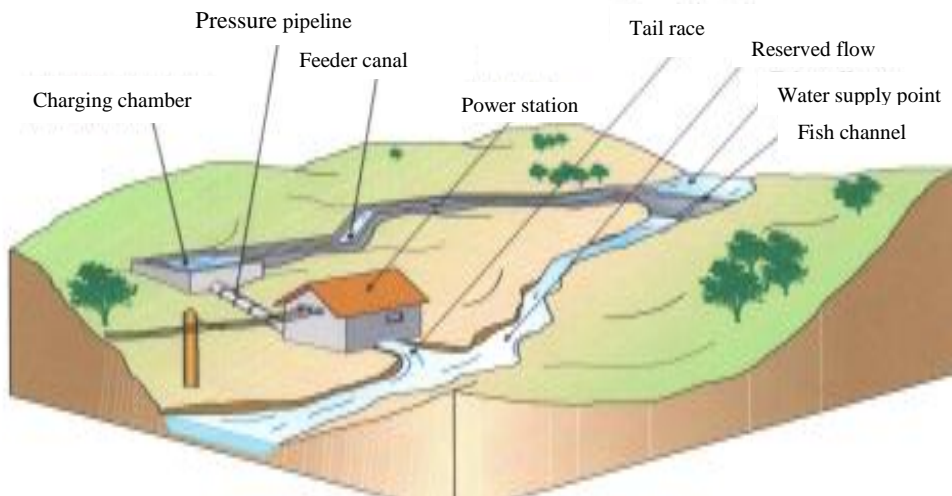
Ministry of Rural Development, Fishing, Handicraft and Environment

Technologies needs assessment in the priority areas



House made of bricks consolidated (case study)

Power station of medium and high fall



January 2006

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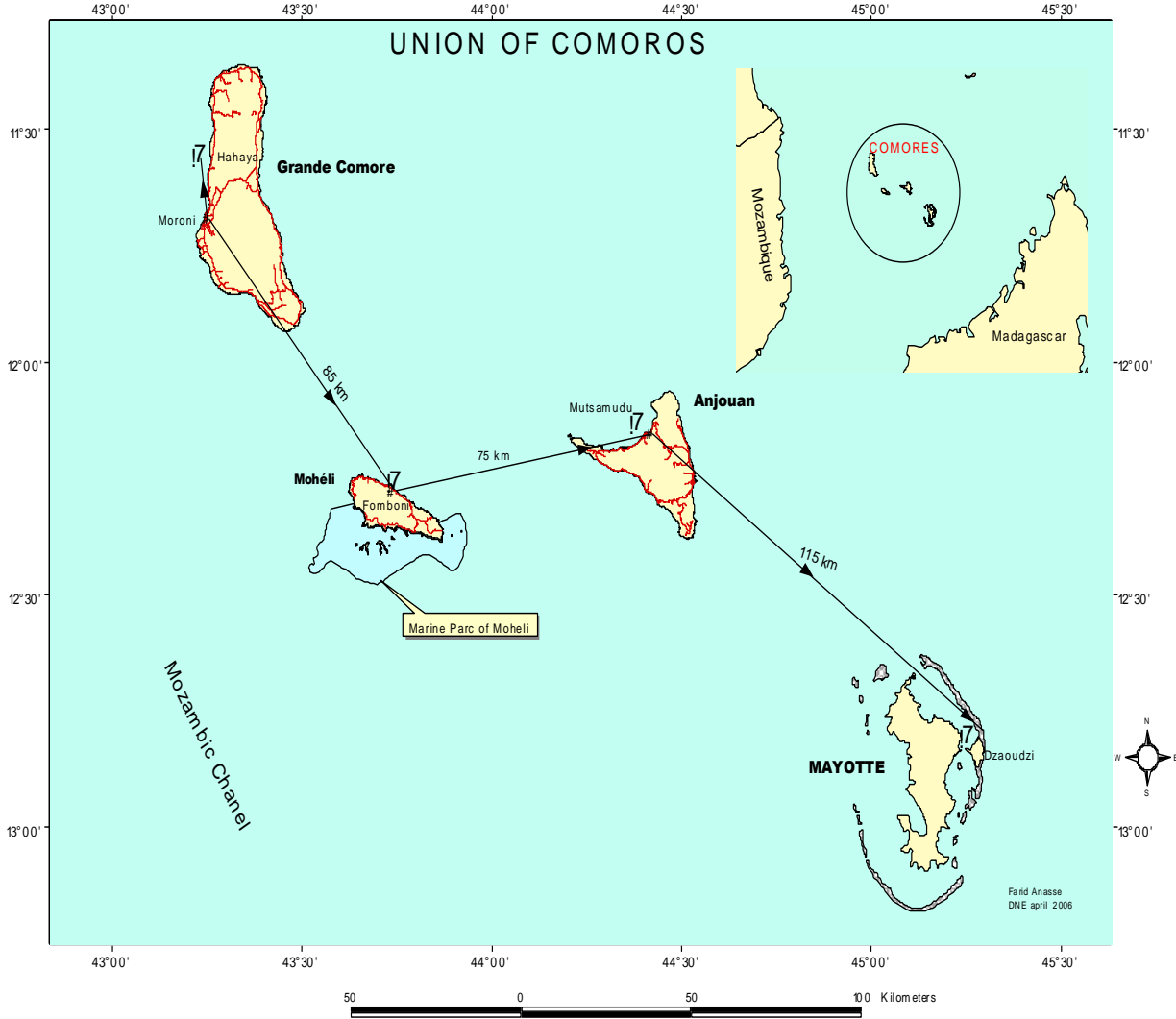
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Acronyms

| | |
|------------|--|
| LV | Low voltage |
| PRSP | Poverty Reduction Strategy Paper |
| EIS | Households Integral Survey |
| FSCD | Support Funds to Community Development |
| CF | Comorian Franc |
| GG | Greenhouse gas |
| IEGCE | Inter departmental Experts Group on Climate Evolution |
| GOOS | Global Ocean Observation System |
| PI | Plasticity Index |
| KWh | Kilo Watt hour |
| MCD | Mecanism for Clean Development |
| MT | Mid Tension |
| MW | Mega Watt |
| NEPAD | New Partnership for Africa's Development |
| OECD | Organisation for Economic Cooperation and Development |
| ODINAFRICA | Ocean Data and Information Network for Africa |
| MDG | Millennium Development Goals |
| NGO | Non-Gouvernemental Organisation |
| GDP | Gross Domestic Product |
| LDC | Least Developed Countries |
| GSPH | General Census on Population and Housing |
| UNESCO | United Nations Education, Scientific and Cultural Organisation |
| US | United States |
| USD | United States Dollars |

Pict. 1 : Map of the Comoros archipelago



EXECUTIVE SUMMARY

The geographic situation of the Union of the Comoros predisposes the country to tropical cyclones and the following natural disasters: volcanic eruptions, landslides and rock fall.

The rise in sea level requires the transfer of some populations and leads to the destruction of social and economic infrastructures, mainly those located on the coastal areas. It also leads to the salinisation of aquiferous coasts. The country does not have mineral resources. The economy largely depends on the unique agricultural sector, which covers only 40% of the food needs of the population. This sector contributes to nearly 44% of the GDP and 98% of the exports revenues of a range of cash crops, which are directly submitted to the unfavorable effects of the terms of exchange.

The current development situation of the Comoros largely depends on the performances of a less diversified economy, which is characterised by a very low growth, and which is enduring a lot of structural imbalances. It is further submitted to natural and external constraints beyond its control. Although the annual average growth rate of the GDP per capita is estimated at 2,9%, it is necessary to reduce by half, the monetary poverty by the year 2015. Growth was established to -1,3% between 1990 and 2004, this rate compromises the possibility to reach the first target of the Millennium Development Goals.

The variability and the ongoing and envisaged climate change are likely to sign away any development perspective and to increase the current poverty level (45%) and the dependence on imports and widen the chronic deficit of the commercial balance which reached 219, 88 million Comorian francs in 2004 (14,9% of GDP) meaning 63 million US\$, in the face of a high external debt and a significant reduction of public aid to development, over the past years.

The studies made, as part of the first national communication on climate change have shown a great vulnerability of the social and economic infrastructures, in the absence of rules and standards for protection and maintenance. The possible impacts are a salinisation of the aquiferous coasts, the destruction of roads, ports, airports, hydraulic plants, hydrocarbons warehouses and historical monuments through flooding, a total paralysis of the economic activity, the transfer of at least 10% of the population, a reduction of the hydroelectricity potential and a loss of 734 acres of cultivable lands.

The studies have also underlined the reduction in water resources, the deterioration of their quality as well as the vulnerability of the soils to erosion and the tectonic instability associated to the **subsidence** phenomenon.

It is under constraint and urgency that the country has requested and obtained from the World Environment Fund (WEF), some funding to make the evaluation of its needs in transfer of environmentally sound technologies in the priority sectors, with the technical support of the United Nations Environment Programme (UNEP) This document is the synthesis of this evaluation which contains technological choices both for mitigation and adaptation.

Biomass: more than 90% of the households and ylang ylang distilleries use wood as source of energy. Woody biomass covers 71% of the energy needs of households and ylang distilleries. Considering the high level of poverty and the costs of electrical energy, the use of wood in the distilleries, as source of energy, is likely to lead to the disappearance of the the remaining forest and the woody spaces and to, therefore, reduce the capacity to absorb CO₂.

This is the reason why this sector has been targeted to reduce forest clearing and deforestation. The accepted options consist in the replacement of the fuel mechanism in the distilleries by consolidated brick-made ovens. These ovens allow a reduction of more than 50 to 60% of the wood consumption and may last 20 times longer than the currently used mechanisms.

Hydroelectricity: The country has a hydroelectric potential, which can cover 90% of the current needs on the island of Mohéli and 100% of the needs of Anjouan.

In Anjouan, two options are possible:

- (i) big hydro-electricity (centralised production)
- (ii) small hydro-electricity (decentralised production).

In Mohéli: The small hydro-electricity option is accepted because of the level of the potential. The development of this new and renewable energy source allows limiting forest clearing and deforestation and to facilitate the access of the majority of the population to electrical energy at a lesser cost.

Controlling energy: the policy aiming at controlling the proposed energy, saving it and using it in an efficient way allows reducing consumption and to therefore to reduce the level of the emissions.

However, the extension and the improvement of the distribution networks through their standardisation, would allow limiting the deterioration of the technical capacity and the loss of lines.

Infrastructures:

- (i.) Technologies for the manufacture of consolidated or baked clay bricks for the construction as well as the production of sand from volcanic rocks, are relevant choices to replace traditional cob or straw-made houses;
- (ii.) Technologies for the construction of works to protect key economic infrastructures (roads, ports, power plants, hydrocarbons warehouses, hotels...) have also been identified;
- (iii.) Technologies for the construction of inland roads have furthermore been identified;
- (iv.) For the management and maintenance of the networks and the supply of drinking water, the technologies identified involve:
 - Equipments and facilities to pump, harness, distribute and control the quality of the resource;
 - The protection of the basin slopes;
 - The increase of the water storage capacity.
- (v.) In the field related to the systematic observation of climate change, the needs in technologies transfer, particularly the measurement networks, have been identified for meteorology, hydrology and oceans observation system.

Finally, the technologies for the development of a national programme on disasters preparedness have also been identified.

PREAMBLE

This document is the summary of the needs in transfer of environmentally sound technologies in the priority fields of the Comoros. It was elaborated as part of the activities of phase II of the Climate Change project, carried out by the Ministry of Rural Development Fisheries, Handicrafts and Environment, with the financial support of the Global Environment Fund (GEF), under the technical supervision of the United Nations Environment Programme (UNEP) in its quality as Execution Agency.

The Ministry of Rural Development, Fisheries, Handicraft and Environment avails itself of this opportunity to renew its deep gratitude to the Global Environment Fund for its financial support and conveys its warm and sincere thanks to UNEP for the wise advice provided to the Project national coordination, during all the stages of the process. It also wishes to pay great and sincere tribute to the national committee, to the project coordination and to all the stakeholders involved in this process.

The identified needs for transfer of technologies involved, among others, the mitigation of greenhouse gases and the adaptation of the key economic infrastructures and the most important social and economic sectors, to climate change. On the one hand, it is a matter of reinforcing the existing economic infrastructures and creating others in prospect of the evolution of climate conditions, and on the other hand, it is a matter of replacing obsolete technologies which do not respect the environment, and which are still being used in some sectors, particularly the distillation of Ylang Ylang, the first industrial sector of the Comoros and energy consumer.

It is also a matter of developing the different new and renewable energy sources available in the country, in order to meet the needs for the mitigation of greenhouse gazes and the goals set in the Poverty Reduction and Growth Paper.

The technologies needs required for the follow-up of the climate parameters in favour of agriculture, the follow-up of rivers for a rational management of the resource and the participation to the systematic observation of climate change have also been identified and assessed.

The advocated technologies have been classified by priority order, in relation with the immediate impact on mitigation, adaptation and poverty reduction, but also due to their facility of absorption and their ability to involve stakeholders.

The transfer of the technologies identified is a necessary prerequisite to the transition of the country towards sustainable development. In this prospect, the support of the international cooperation and the promotion of private investments are prerequisites to the future, if not the survival of the archipelago, in the face of climate change.

1. INTRODUCTION

The Union of the Comoros has endorsed the recommendations on Environment and Development made by the World Conference, held in Rio in 1992. The elaboration of a national policy on Environment in 1993 has materialised the commitment of the country. Furthermore, this policy comes within the scope of the current economic context and meets the requirements of the degradation of the state of the Environment as well as the economic policy defined by the government. The national policy provides the required strategic and operational framework for the effective implementation of Agenda 21, at the national level.

The country has further ratified several international Conventions on Environment, such as the United Nations Framework-Convention on Climate Change, in October 1994. In order to implement this Convention, the country has made the inventory of the anthropic sources and the shafts that absorb greenhouse gas (GHG), for the year 1994. The analysis of the emissions and the absorptions was conducted in the following sectors: energy, agriculture, wastes, as well as the change in the allocation of lands and forests. The outcome of the inventory shows that the sector related to the change in the allocation of lands and forests is the first responsible for the emissions of greenhouse gas, followed by agriculture. However, the country's level of emissions is relatively low, indeed insignificant (2,63 T Eq 2/person).

On the contrary, the vulnerability and adaptation study conducted shows that the key social and economic sectors of the country are very vulnerable. They are agriculture, health, water resources, infrastructures and coastal ecosystems. The outcomes of greenhouse gas inventory have allowed the evaluation of the options related to the reduction of the emissions, at the national level.

Therefore, in accordance with article: 4.1, indentified lines g);h) and j) ; 4.4 ; 4.5 ; 4.8 ; 4.9 ; 5 and 12.4 of the Framework-Convention of the United Nations on Climate Change, this document offers to assess the needs related to the transfer of environmentally sound technologies in the priority sectors, in order to contribute to the national Development Goals and to the realisation of the objectives of the Convention, particularly the chapters related to mitigation and adaptation.

According to IPCC (Intergovernmental Panel on Climate Change) the transfer of technologies constitutes more than a mere transposition of equipments in a developing country. It should include:

(i) A better use of the transferred technology (ii) an adaptation of this technology to the local needs and conditions; (iii) a field reproduction of the technology; (iv) a large integration of the different stakeholders which are the governments, the private sector, the financial bodies, NGOs and the institutions in charge of research and education.

The transfer of technologies is therefore a process, which must allow the population to take over the technology, to reproduce it, including the ability to chose it and integrate it to the autochthonous technologies.

2. METHODOLOGICAL APPROACH

Although the contribution of the Union of the Comoros to the emission of greenhouse gas is low, the country wants to pursue the objective set to remain a carbon shaft and to participate in the world effort to eliminate carbon from the planet.

To this end, the selection of the priority sectors that require a transfer of environmentally sound technologies was made on the basis of the outcome of the national inventory of the greenhouse gas and the vulnerability and adaptation studies. It is from this selection that the technologic options have been identified in order to increase the efforts for GHG mitigation and for adaptation to the adverse effects of climate change.

The assessment of the needs in transfer of clean technologies also relied on the methodology proposed by the United Nations Development Programme (UNDP) in the report entitled «Assessing Technology Needs for Climate Change» which guided the countries that are committed in this exercise, in addition to their initial national communication. Therefore, this document completes the initial national communication of the Comoros, which was submitted to the Conference of the Parties in 2003, in accordance with article 12 of the United Nations Framework-Convention on Climate Change. The study was also inspired by experts' opinion.

. The priority sectors accepted are: **(i)** Hydro-electricity; **(ii)** Alternative technologies to reduce the use of firewood in the Ylang Ylang distilleries; **(iii)** The promotion of non-metallic local materials to replace timber **(iv)** Technologies (breakwater, levies) for the protection of key economic infrastructures of the country (hydro electric plants, ports, hydrocarbons warehouses, airports; **(v)** Technologies related to alternative roads works; **(vi)** Technologies for a national programme on disasters preparedness; **(vii)** Management and maintenance of water supply systems; **(viii)** Capacity-building for the participation in the network for the systematic observation of climate change.

These choices have also been guided by their contribution to:

1. The Development Goals targeted in the sectoral strategies and policies defined by the government;
2. The fight against greenhouse effect
3. The mitigation of the vulnerability of the country to the adverse effects of climate change.

The choice of the technological options for the mitigation and adaptation has been confirmed by: (i) experts opinion, (ii) the priorities set by the national programmes and strategies for social and economic development in the involved sectors, (iii) the opinions expressed by the stakeholders during the different consultation workshops held on the issue.

3. OVERALL CONTEXT

The Union of the Comoros is composed of four volcanic islands which are the followings: from East to West, Mayotte (370 square kilometres), Anjouan (424), Mohéli (290) and Grand Comoro (1148). The country is located in the Indian Ocean, in the North of the Mozambique Channel, between Madagascar and the eastern coast of Africa. The distance between the islands is approximately 30 to 40 kilometres separated by deep submarine channels. Although the country attained international sovereignty in 1975, Mayotte is still under French rule. Therefore, this document refers only to three islands with a total area of 1862 square kilometres.

The main wealth of the country is the diversity of its biological resources. However, this potential is fragile and is now highly threatened by human activities, which are closely linked to the ecologic specificities of the islands (steep slopes sensitive to erosion), the social situation and the economic conditions of the population, marked by:

(i) A rapid population growth (2,1% per annum) and a human pressure which varies according to the islands and the rural areas, (ii) high poverty, (iii) inadequate economic growth and agricultural production, (iv) land instability which undermines long term investment and macroeconomic imbalances at the expense of natural resources. This potential is also weakened by the climate conditions of the archipelago: heavy rains, pronounced dry seasons which favour fire and cyclones, reefs threatened by the rise of deep cold sea levels (upwellings), abnormal rise in the ocean upper temperatures. All these events are translated into a general degradation of the natural resources.

The Comoros is one of the Least Developed Countries (LDC). It ranks 136 out of 177 countries under the UNDP Human Development Indicia of 1997. The Gross Domestic Product (GDP) in 2000 was estimated at 376 US\$, per capita.

The complete survey on households conducted in 2004 shows that 36,9% of the families, at the national level, live in poverty. However, the poverty level varies according to the islands. The number of poor is therefore as follows: Grand Comoro 35,3%, Anjouan 38,4%, and Mohéli 37,8%.

The situation is characterised by a reduced level of technologies, an inadequate information system, inadequate infrastructures, institutional weaknesses and modest means of action.

Like most of the LDCs, we note a low literacy rate (more than half the adult population are illiterate, 65% of them are women) and a population in bad health (the infant mortality rate is 115 out of 1000, the existence of significant malnutrition problems in women and children).

4. SOCIAL AND ECONOMIC INDICATORS

Chart 1 : Demographic profile of the Comoros

| Indicators 2004 | Comoros | G-Comoro | Anjouan | Mohéli |
|--|---------|------------|-----------|-----------|
| Total population | 587749 | 302397 | 248850 | 36502 |
| Growth rate | 2,1% | 2,0% | 2,1% | 3,3% |
| Men proportion | 49,6% | 49,4% | 49,6% | 51,3% |
| Ratio of Men to women | 0,98 | 0,98 | 0,99 | 1,05 |
| Density | 309 | 258 | 575 | 123 |
| Population under 20 years | 53,0% | | | |
| Urban population | 30% | 24,2 | 31,7 | 50,2 |
| Coastal Population | 65% | | | |
| Malaria prevalence rate | 34,6% | | | |
| % of underweight children under 5 years | 24,9% | 13,2% | 32,4% | 23,1% |
| % of undergrowth children under 5 years | 44,0% | 44,2% | 51,3% | 32,3% |
| Proportion of children under 5 years suffering from emaciation | 7,9% | 4,8% | 10,3% | 5,1% |
| Proportion of households living in precarious houses | 10% | 30 to 40 % | 50 to 60% | 25 to 30% |
| Poverty line in Cf ¹ (per person and per annum) | 285144 | 285144 | 217287 | 274725 |
| Incidence of the overall poverty of the individuals | 44,8% | 42,7% | 46,4% | 49,1% |
| Incidence of the overall poverty of households | 36,9% | 35,3% | 38,4% | 37,8% |
| Incidence of the poverty of individuals in the rural area | | 45,4% | 52,1% | 50,2% |
| Unemployment rate | 13,5% | 14,9% | 12,1% | 15,0% |

Source : General Commissariat for Planning RGPB 2003 and EIM 2004

The demographic profile of the Comoros shows that the population of the Comoros is extremely young, it also shows a relatively high growth rate. The rapid growth of the population leads to imbalances in the use of the already limited resources, which are threatened by climate instability. This results in a high incidence of poverty and malnutrition, especially in the rural area where the contribution to family poverty is 78,8%.

It is in this context that most of the development efforts are guided primarily towards the countryside, through many programmes and projects.

5. ECONOMY

The economy of the Comoros is dominated by agriculture, with an extremely low annual income per person estimated at 450 US\$. For this reason, the Comoros ranks among the Least Developed Countries, with a population that grows faster than the country's resources. The primary sector's contribution was of nearly 44,3% of the GDP in 2004, it employs 70 to 80% of the active population and provides the quasi totality (98%) of the exports revenues of a limited range of cash crops. It is directly submitted to the consequences of the unfavourable terms of exchange. The agricultural sector encompasses 66,9% of jobs occupied by women and 51,2% of those occupied by men and covers only 40% of the food needs of the country. The secondary sector is largely based on Handicraft. It represented about 12,4% of the GDP in 2004. The services sector is dominated by the sale of imported commodities with an average annual increase rate of 3%,

¹ CF = Comorian franc
1 USD = 350 CF

per year, thus increasing the trade deficit of the country. The ongoing and foreseen climate change is likely to sign away the primary sector, which is already going through difficulties and could (i) exacerbate food insecurity, (ii) increase the poverty level of individuals and households, (iii) increase dependency on imported foodstuffs which already absorb more than the $\frac{3}{4}$ of the export revenues and, widen the chronic deficit of the commercial balance which in 2004, was of 21.888 millions Comorian francs (14,9% of the GDP), that is to say 63 millions US\$, in the face of a high external debt and a significant decrease of public aid to development, over the past ten years.

The negative economic growth per person which results in an increase of poverty, combined to climate variability, deteriorate the living conditions and make difficult the access to basic social services such as health or drinking water, and contribute to increase the vulnerability of the population to the negative consequences of climate change.

Chart 2 : Macroeconomic Aggregates 2001 – 2004

| Aggregates | 2001 | 2002 | 2003 | 2004 |
|--|---------------|---------------|---------------|----------------|
| Primary (Agriculture/breeding/fishing) (1) | 41% | 42% | 43,20% | 44,30% |
| Agriculture Contribution to the total income of the households | - | - | - | 39,4% |
| Secondary (Industry/building industry/Electricity) | 11,60% | 11,80% | 12,10% | 12,40% |
| Tertiary (Commerce/service/administration) | 47,40% | 46,20% | 44,70% | 43,30% |
| GDP - Current in millions CF (2) | 131823 | 131117 | 135091 | 140699 |
| GDP - Constant in 1990 in millions CF | 92743 | 94931 | 97470 | 99835 |
| GDP per capita – current prices in CF | 235020 | 205317 | 205262 | 207562 |
| GDP per capita - constant prices in 1990 in CF | 165346 | 148654 | 148099 | 147278 |
| Exports (in millions CF) | 7120 | 4707 | 4105 | 3086 |
| Imports (in millions CF) | 23070 | 25451 | 21059 | 24974 |
| Commercial balance | -12,1% | -15,8% | -12,4% | |
| Balance of payment (in millions CF) | 8926 | 1750 | -3212 | |
| HDI (Human Development Indicia) | 0,528 | 0,53 | | 136 out of 177 |

Source : Commissariat General for Planning and Central Bank of the Comoros, 2004

(1) Primary sectors 'contributions to GDP (2) CF : Comorian Francs

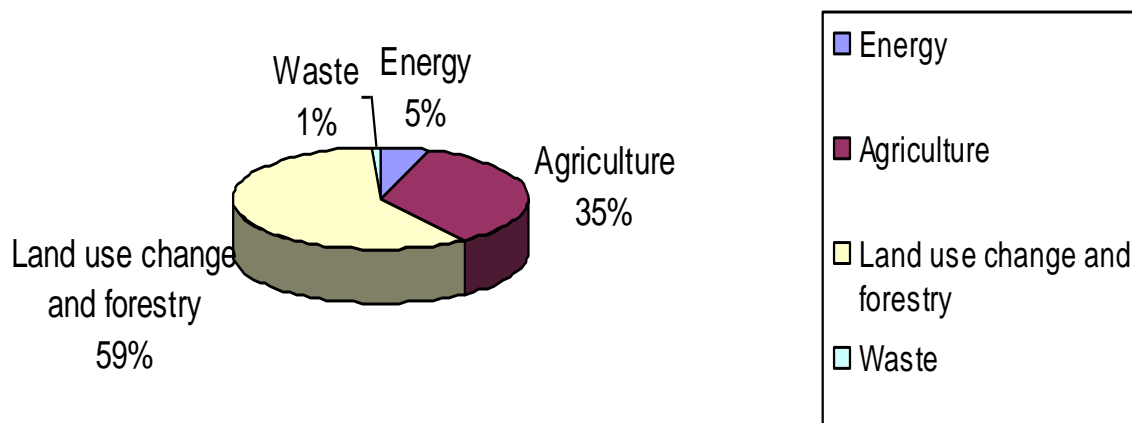
The current development situation in the Comoros is largely dependent on the performances of a less diversified economy, with a very weak growth potential. These performances are submitted to a lot of macroeconomic and structural imbalances. Development is also highly dependent on natural and external constraints that the country has no hold of: geographic isolation, distant location from international markets, high transportation costs, insurance and reinsurance costs, small local market in a context of limited resources, lack of scale economy. The low income that the population earns from economic activity together with a high demographic growth (2,3 %) and the weak means of the State, on which the population depends for the provision of most of the basic services, are some of the causes of a poverty which has reached a level of concern (44,8 % at the national level).

6. SYNTHESIS OF THE EMISSION OF GREENHOUSE GAS IN 1994

Chart 3 & 4 : Emissions ckecklist

| GHG | Tuns Eq. CO₂ | GHG | Tons Eq.CO₂ |
|-----------------------|--------------------------------|------------------------------------|--|
| CO₂ | 835 757 | Absorption | - 1 670 566 |
| CH₄ | 73 660 | Global checklist | - 354 678 |
| N₂O | 406 471 | Net absorption / per person | - 354678 / 500000 = - 0,71 tons Eq.CO ₂ |
| Net emissions | 1 315 888 | | |

6.1. Emissions per source:



The emissions per source show that the sector related to the change of the allocation of lands and forests represents the main source of emissions with 775.454 tons Eq-CO₂, followed by agriculture: 459.957 tons Eq-CO₂, energy: 70 524 tones Eq-CO₂, the industrial sector of the Comoros.

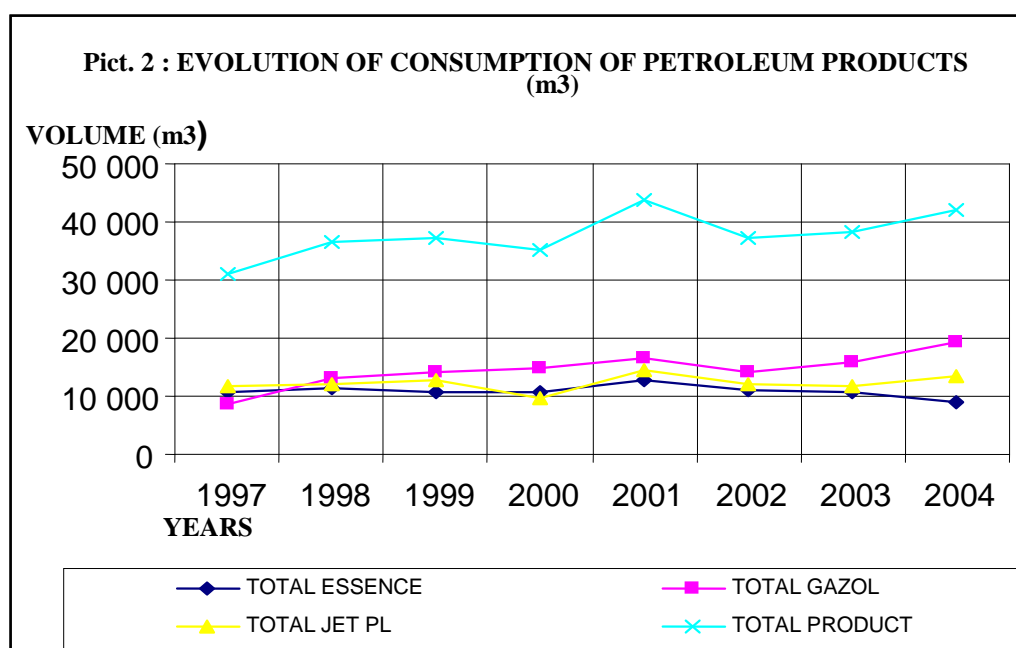
7. ENERGY SECTOR

In the Comoros, the specific energy consumption, for all fields, remains relatively low and far below the world and/or regional average. The total energy consumption per person is about 0.2 tons, the equivalent in kerosene and the energy sector contributes to 1.5% to the GDP. The most important consumption sectors are the Residential flats/Tertiary, Transportation (sea, air and land) and Industry/Handicraft.

The energy situation is characterised by a great dependence on two sources of ordinary fuel which are the woody fuel (71% of the energy needs) and petroleum products, which cover only 29% of the energy needs.

7.1. Petroleum products

Petroleum products, which represent 29% of the total energy consumption, are used as fuel in transportation and are also transformed into electricity. Transportation absorbs about 60% of the petroleum products; the residential flats/tertiary and the industry sectors share together the remaining part. The subsoil does not conceal any mineral or oil deposits. The petroleum products are imported.



The consumption of commercial energy per person is about 0,06 tep, it is below world and regional average. The analysis of the file of the consumers and the customers of the national company producing and supplying electricity shows a comparatively low average electricity consumption per customer (40 kWh), which confirms the prevalence of the use of woody fuels. The production of electricity is mainly thermic (diesel). The equipped power is 25 MW.

7.2. Electricity production

In spite of the high production capacity (25 MW) in comparison with the energy demand (63G Wh), access to electricity still remains difficult for most of the households, mainly because of the limited network and the high costs, in comparison with the households' income.

Only 25% of the households are connected to the electricity network, therefore an important part of the demand is still to be met.

The populations, mainly the rural ones, which are located far from the electricity supply networks have little chance to be connected before a number of years, due to the low investment capabilities for the extension of the networks and the costs of the kilowatt per hour, which is one of the highest in the Indian Ocean sub-region (0.3 against 0.1 US\$/KWH).

Grand Comoro: Most of the island production is estimated at 30. GWh, and is covered by the Power Plant located in Voidjou. There are also 5 scattered micro plants with a total power of about a thousand Kw. These micro plants function in difficult conditions. The electricity company is planning to eliminate them gradually and supply the network from the Voidjou Plant. A geo thermic potential is possible on the island, but the cost of the identification and evaluation studies did not enable us to study it, as part of the elaboration of this document. This energy source constitutes, however, an alternative source of energy than can be envisaged in the mid and long term.

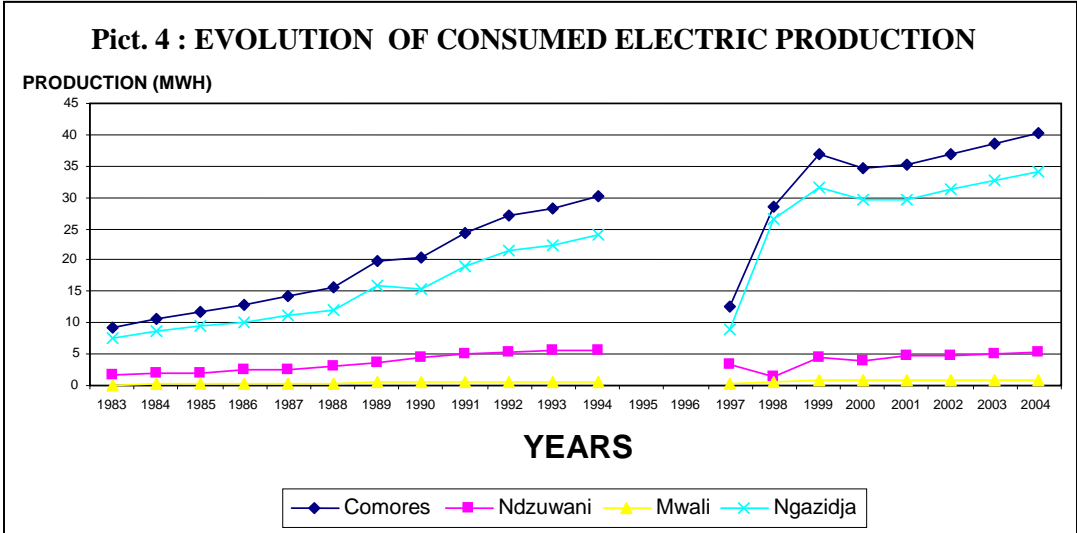
Anjouan: Most of the production is estimated at 10 GWh, and is covered by the power station located in Trénani. But there are two additional micro hydroelectric plants of an equipped power

of some dozen kilowatts, whereas the total hydroelectric potential of the island is estimated at several Megawatts. The studies conducted show that the potential will be enough to meet the current needs of the island for several years, with the same growth level and demand.



Pict. 3: Lingoni River, 2005

Mohéli: The Fomboni power station covers the quasi totality of the island production, 1GWh. There is a second isolated micro power station of a total power of 70 kVA. A very low power hydroelectric micro plant (14 kW equipped) supplies the village of Miringoni. The hydroelectric potential available on the island is estimated at 900 KW, and represents about 90% of the islands needs.



(source :Comoros Water and Electricity company, Ma-Mwe)

Although the electricity production has increased by 12% every year over the past five years, the electricity sector is confronted to the age of its transportation and supply equipment. This has resulted in losses estimated at about 40% of the production.

Therefore, the main challenge that the country will have to take up remains the reactivation of the energy sector, which constitutes an indispensable prerequisite for its social and economic development.

The objective is, on the one hand, to ensure to the majority of the population access to energy and to meet the legitimate economic growth needs and the fight against poverty, on the other hand.

In this perspective, it is necessary to diversify the new and renewable energy resources, to extend the networks and to control energy, in order to meet the immediate and future needs.

These choices will allow the mitigation of the economic and social consequences of the increase of the prices of the conventional energies and the increased scarcity of wood used as energy.

Chart 5 : Scenarios to reduce GHG

| Year | Reference Scenario | | | | Reduction scenario | | | |
|---|--------------------|--------|---------|---------|--------------------|--------|---------|---------|
| | 2005 | 2010 | 2015 | 2020 | 2005 | 2010 | 2015 | 2020 |
| A. Evolution of the electricity Demand (MWh) | 63 269 | 92 464 | 148 814 | 218 657 | 63 269 | 92 464 | 148 814 | 218 657 |
| B. Equipped power (MW) | 25.45 | 30 | 35 | 46 | 25.45 | 30 | 35 | 46 |
| C. Equipped power per type of production (MW) | - | - | - | - | - | - | - | - |
| Hydroelectricity (MW) | 0.45 | 0.159 | 0.159 | 0.159 | 0.45 | 2 | 5 | 6 |
| Thermic (MW) | 25 | 30 | 35 | 46 | 25 | 28 | 30 | 39 |
| Fuel consumption (1000 litres) | 17 170 | 22 901 | 35 851 | 49 696 | 16 170 | 21 109 | 29 720 | 39 061 |
| D. Emissions (CO₂ tons) | 54 944 | 73 286 | 114 722 | 159 026 | 51 002 | 66 066 | 93 654 | 123 396 |
| Total of the emissions for the analysed period (t CO₂ tons) | 401 978 | | | | 334 118 | | | |
| 17% reduction with comparison to the reference scenario | | | | | | | | |

The options to be developed in order to succeed remain **hydroelectricity in Anjouan and Mohéli and the rehabilitation and extension of the electricity network in the entire country, in the short and long term**. The solar energy is certainly a viable and ecologic option, but its access is difficult due to the investment costs, in comparison with the purchasing power of the households. As for wind energy, it is certainly of interest, but the potential has not yet been studied. The same thing applies to geothermic energy. However, these options should be supported by actions in order to control energy and use it efficiently.

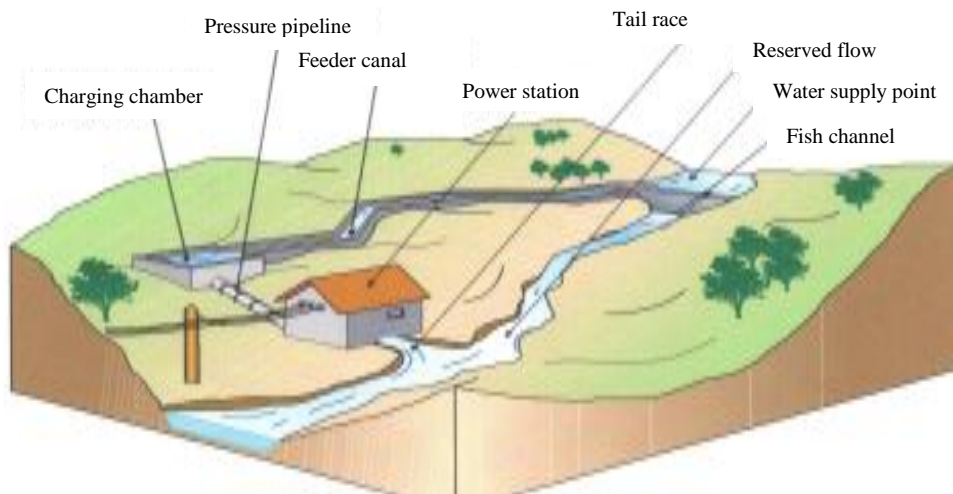
7.3. Needs in transfer of technologies

7.3.1. Electricity energy

a) Hydroelectricity

Hydroelectricity is one of the main sources of local, economic, clean and renewable energy. The development of this source of energy is part of the policy which aims at ensuring the security and the diversification of the sources of energy, in order to allow the majority of the population to have access to electricity energy, to participate in the world effort on the reduction of the emissions of greenhouse gas and to reduce dependency on fossil sources that the country does not possess. This policy comes within the scope of the Poverty Reduction Strategy Paper (PRSP) and the Millennium Development Goals (MDG) to be reached by the year 2015.

Pict. 5 : Medium and high fall plant



The development of hydraulic plants is the appropriate choice with regards to the hydroelectric potential, which differs from few kilos-to some Megawatts per site. Hydroelectricity offers:

- A viable solution in the short, mid and long term, to the energy issue that the country has always been confronted to;
- An alternative to the high prices in petroleum products and a decrease of the deficit of the commercial balance;
- A low servicing cost and a long duration – from 20 to 30 years.
- The possibility to support development and ensure its security, and encourage foreign investments, which will lead to other economic activities.

b) Extension and improvement of the transportation /distribution networks

The first sections of the networks, which carry and distribute electricity, date back to many years. Since then, the demand for a connection to the networks has continued to increase. The poor development planning of these networks has resulted in the breach of the technical standards in force and has resulted in the loss of lines. The networking structure itself also contributes to the deterioration of the technical capacity.

Furthermore, the displaying of networks near the sea exposes the facilities to deterioration due to the salt air from the sea. Several areas and districts served are supplied by low voltage from weak section bare cables, which cause considerable losses. These bare cables are often the cause of short-circuits; deadly accidents and they trap several birds such as *livingstone* bats (*Pteroptus livingstonii*), a endangered species which is one of the emblematic species of the biodiversity of the Comoros. In this context, it is absolutely necessary to implement a programme for the rehabilitation and extension of the electric network.

The level of electrification of the country is weak; population access to the networks in the served areas is also weak. Therefore, it is a national priority, as mentioned in the Action Plan 2006/2009, to increase the access rate to electricity in the areas served and to extend the national network to the areas that have not yet been covered.

The total length of the extension for the average tension network (MT/20kV) is estimated at nearly 400 km, almost the same length for low voltage (LV). A reasonable rehabilitation programme would cover 30 % of the length in mid tension and more than half in low voltage,

which is currently exploited in the country. The cost is estimated at: (i) 8,54 Millions US\$ for the extensions of the networks (ii) 6,14 Millions US\$ for rehabilitation.

c) Controlling the energy

The programme related to controlling, saving and using energy efficiently does not aim at imposing restrictions on the consumers. It rather aims at meeting the current and future demand, on the basis of a reasonable use of the different forms of energy. The strategy to be developed is to train and educate consumers on the need to control energy and use it efficiently, through education campaigns aiming at changing the behaviour and the choice of equipments that consume less energy.

An essential part of the strategy is to classify these equipments through an encouraging taxation system and to have them labelled by a national authorised body. The creation of a national agency to control and save energy, with regional branches, will guaranty the success of the programme.

The objectives of the programme are both environmental and economic. They allow the slowing down of deforestation, the control of the emissions of greenhouse gas and the reduction of expenses related to the energy bills, both at the national and individual levels. This move always leads to the delay of the investment needs for the strengthening and the security of the production capacity.

The money thus saved could constitute important resources for the security of the offer and for the strengthening of the capacity, in order to meet the demand.

The involved priority sectors of intervention, as part of this programme, are: road transportation (particularly a strict regulation on the import of vehicles according to their specific consumption and emissions) and the residential flats/tertiary sectors, where significant energy savings can be made.

d) Acquisition and absorption

The hydraulic equipment can be obtained through the Mechanism for Environmentally Sound Development (MESD) of the Kyoto Protocol, as part of NEPAD, but also through a public/private partnership and/or private funds or bilateral and multilateral cooperation. The equipment and the material can come whether from OECD countries or emerging countries (South-East Asia or Latin America). There is no major problem with regards to the absorption of this technology. Indeed, the location of the sources and sites to develop, will not affect the economic activity and the housing areas of the populations living along them. On the contrary, the transfer of this technology would have beneficial consequences at the economic and social levels. The work of low volume and regulation dams would, indeed, allow a better electricity supply in the islands and would favour the irrigation and development of fish farming. If this energy source is valued, it can constitute the engine for the different sectors that favour growth, for the fight against poverty and will set a good example of an integrated project. It has the support of both the authorities and the recipient communities, and it therefore ensures good sustainability, through the protection and preservation of the resource.

e) Costs

As a rule, basic costs for the hydroelectric works remain high (civil engineering, installations and electromechanical and electric equipments, reinforcement and protection measures of the basin slopes, including other ecologic systems as well as post measures. On the other hand, compared to power stations using different kinds of fuel, the annual operation costs, servicing and maintenance are very low. It was proved that for the same investment, the hydroelectric installations produce much more energy during their duration of operation than other types of plants.

In general, the costs depend strongly on the characteristic of the site where the work is set up. However, the total cost may vary between 2 000 to 3000 US\$ KW of the equipped power, but it depends on the size and the choice of the site. The geographic isolation, the fact that the country is constituted of isolated islands leads to high transport costs and request international expertise. A protection component of the basin slopes and an optimal management of the resource will lead to additional costs.

In this context, and according to the evolution of the consumption demand and the choices made, a several millions dollars investment is necessary. This will allow the implementation of an integrated and sustained programme for the valorisation of the hydraulic potential that can be exploited in the two autonomous islands of Anjouan and Mohéli. It is estimated that a gradual development, in stages of 3 to 5 MW every five years till the saturation level, remains defensible.

7.3.2. Biomass Energy

a) Situation



Households use three quarter of the biomass that is to say 170.000 m³, as main source of energy. The remainder, meaning 55.000 m³, is used in ylang ylang distilleries, the biggest energy consumer in the Comorian energy sector. The energy needs of the households and distilleries have caused the scarcity of woody fuels, and have led to the increase of the energy dependence towards the import of petroleum products. In 1997, 400 stills have been identified in Anjouan and they represent 90% of the annual national production of essential oil, estimated at a total of 80 tons.

The Comoros exports mainly Ylang Ylang essence used to make perfumes. Ylang Ylang flowers are distilled in wood-heated stills. The production and the distillation of Ylang flowers are important sources of income, for a large part of the population.

Forest loss is mainly caused by the use of firewood for the stills. Indeed, the thermic capacity of the systems used is very weak because of the technical system used (fuel conditions, oven, equipments).

The distillation process reveals flaws at the level of the stills. The fuel system used loses a lot of heat because the fireplace does not have a thermic isolation system and most of the time it has cracks. The stills made of copper/or-galvanised steel and its accessories rapidly deteriorate. The angular structures of the cones and the cooling system do not allow a good circulation of the heat. Moreover, some of the essential oil is lost through the steam that comes out of the cooling system.

Pict. 6 : Fuel systems used in the distilleries

| Material used for the work of the oven | Material used for the work of the oven |
|---|--|
| Ordinary work bricks  | Consolidated clay bricks  |
| Cost : 500 000 CF (1300 US\$) duration: 06 months | Cost : 350 000 CF (1000 US\$) duration: 09 to 12 months |

b) Needs in transfer of technologies


It is necessary to improve the distillation systems currently used, in order to optimise the energy capacity, avoid production losses and reduce wood consumption.

This improvement involves:

- (i) The energy source must be environmentally sound (gas, solar, ...), controllable with limited losses;
- (ii) The stills should be made with stainless steel, with rounded cones so as to eliminate the right angles, which do not allow the free circulation of the steam;
- (iii) The cooling system so as to minimise the leak of steam and oil;
- (iv) The thermic isolation by modifying the internal architecture of the fireplaces, which should be made with resistant bricks. The fireplace door is steel-made.

This technology allows a reduction of 50 to 60% in the energy losses. It is financially accessible by the distillers, with a longer lifetime and will have a significant positive impact on the environment.

Pict. 7: The newly proposed system

| <i>The material used for the work of the oven</i> | <i>Cost of the fireplaces</i> | <i>lifetime</i> | <i>Environmental Impact</i> |
|---|-------------------------------|----------------------------|--|
| Resistant Bricks  | 2,5 millions CF (6 600 US\$) | Several years (+ 20 years) | Reduction of more than 50 to 60% of wood consumption |

The choice of the technology proposed takes into account the less encouraging results obtained from the tests made with gas oil and coal. Gas oil proves to be too expensive and the material used for the work of the stills does not resist coal heat. But, the stills made of steel are gas-resistant, they can furthermore, be adjusted. But it would be interesting to make a test with the sun as energy source.

8. PROMOTION OF NON-METALLIC MINERAL MATERIAL TO REPLACE TIMBER

8.1. Context:

About 30 to 40%, 50 to 60%, 25 to 30% of the Comorian families respectively in Grand Comoro, Anjouan and Mohéli live in cob or straw-made houses, with a woody frame which does not stand bad weathers (MICS 2000).

The increase trend in extreme climate events observed over the past years is likely to jeopardise the life of these families. Indeed, 30% of the works are made of concrete and half concrete and 70% s of them are made of weak structure which therefore make them precarious.

Nearly 6.000 houses are built every year on the three islands, 4.200 with weak structure. With a total poverty incidence of the individuals of 44,8% and a total poverty incidence of households of 36,9% and an unemployment rate of 13,5%, the access to concrete houses remains limited to the rich families, due to the high costs of this kind of work. The outcome of the census conducted in 1991 foresees, between 1991 and 2010, an evolution of the number of houses estimated at 246.977 in comparison with the demographic projections during this period. The use of new material produced locally will lead to a significant decrease of the work costs. The work made with concrete through non-metallic mineral materials better resists wind and heavy rain, and can last for several decades, whereas cob or straw-made works must be renewed almost every year. Due to the limited availability of woody resources, it is urgent to resort to an alternative solution to prevent the use of timber and to preserve the forest resources. The use of these materials would contribute to improve the comfort of the houses.

The promotion of the non-metallic sector is also indispensable in order to preserve the local soils and rivers, aquiferous layers and biodiversity, as well as climate balance. The development of the non-metallic sector allows the emergence of entrepreneurs in the ceramic sector, job creation, the

limitation of rural exodus, the increase of concrete works and the gradual disappearance of precarious housing, the reduction of deforestation, the development of commercial perspectives. Granulates, sand, puzzolane, silt and clay are used not only for housing but also in infrastructures such as roads, bridges, airports, ports, schools, tanks etc. and in the manufacture of a variety of products in ceramic which offer interesting perspectives for economic growth.

Furthermore, bricks (consolidated or baked) present thermic characteristics conducive to energy efficiency in buildings.

Finally, the production of bricks made with consolidated or baked clay requires easy moulding, press and baking procedures. It is an adapted technology that can be controlled and reproduced on the field.

8.2. Natural potential

Chart 6: Natural potentiel

| Localisation | Available material |
|---------------------|---|
| Grand Comoro | <u>Cinérites</u> sand Basaltic black sand from rivers Pouzzolaniques material seam Scoria materials and porous lava flows Material from dense basalt flows Altered pouzzolanic Materials |
| Anjouan | Pouzzolanic steam Sands and black basalt pebbles Roulés from rivers or coastal silts, silt sand, and silt and gravel colluvions and allied products Basalt massifs providing excellent granulates for concrete works in civil engineering |
| Mohéli | Pouzzolanic materials Pebbles rolled sands from rivers or coasts Clay materials, silts, silt sand and silt and gravel colluvions and allied products Basalt massifs providing excellent granulates for concrete works in civil engineering works |

In the perspective of the promotion of local material for work, the national laboratory of the Public Works and Housing has:

1. Confirmed the performance of different materials;
2. Identified and classified pouzzolanic and assimilated materials for their use as granulates in the different categories of concrete;
3. Identified pouzzolanic sand to replace coral sand;
4. Conducted tests on the production through crushing and grinding;
5. Studied the pouzzolanic activity of fine particles from volcanic materials, as well as the mineralogical composition for the production of a binder of a weak dosage to replace lime;
6. Made a study of the altered muddy clay;
7. The degree of alteration of the materials is higher in Mohéli than in the other islands due to the age of the volcano
8. Established that the granulometry of material fits in the granulometric category of clay-made bricks
9. Determined and showed that the plasticity (IP) indicia of the materials is higher than the recommended values.

As the outcomes of the conducted studies were encouraging, a manual on the manufacture of consolidated clay bricks has been elaborated in 1976 and experimental operations on economical housings made with local materials was made from 1983 to 1986.

8.3. Assessment of the needs for the transfer of technologies

For the manufacture of consolidated clay bricks, the followings are needed:

Presses, mixers, tractors, shovels and various tools.

The equipment is available in Madagascar, South Africa, India, etc

They can be absorbed through the creation of community micro enterprises.

The equipment needs of a production unit are estimated at: 462 000 US\$.

9. TECHNOLOGIES FOR THE WORK OF WORKS FOR THE PROTECTION OF KEY ECONOMIC INFRASTRUCTURES

The key economic infrastructures are located in the coastal zone. They are exposed to extreme events. The biggest challenge is to reinforce these infrastructures through appropriate technologies, on the one hand, and build alternative inland roads, on the other hand.

The most exposed key economic infrastructures are: the national coastal roads, the hydrocarbons warehouses, airports, hotels and ports works.

9.1. Coastal national roads

The coastal roads are in some areas protected by works, which are near the sea. More than half of the roadway is destroyed, and therefore disturbs road traffic. These roads and works must be rehabilitated and new works must be built to complete this rehabilitation.

9.2. Hydrocarbons warehouses and power stations

All the hydrocarbons warehouses and the main power plant are located near the sea. It is necessary to build works to protect them against rises in the sea levels. It is preferable to build protecting walls or levies.

9.3. Airport works

The runway of the airport of Anjouan is the most damaged, by the rise of the sea level, along 50 m.

9.4. Port works

The most vulnerable work is the sea access in Mohéli. It needs to be protected because it may also be used as a harbour for the fishing boats. Although it has resisted bad weather (cyclones and heavy swells) over the past years, it must be protected to prevent its likely destruction by extreme climate events.

9.5. Hotels and human establishments

The destruction of human housing is among the number of anticipated impacts of climate change. It is believed to affect at least 10% of the population and the hotel infrastructures.

The search for technologies to protect and reinforce economic and social infrastructures constitutes one of the priorities that will allow reaching the Objectives set in the Poverty Reduction Strategy Paper (PRSP) and the Millennium Development Goals.

Chart 7: Technologies to be implemented

| Infrastructures | Technology | Length per island (km) | | | Cost per unit (million US\$) | Total km | Amount (million US\$) |
|-------------------------|---|------------------------|------|------|------------------------------|----------|-----------------------|
| | | G-C | Anj | Moh | | | |
| Urban area | -Levies | 7 | 8.5 | 1.5 | 1.09 | 17 | 18.53 |
| | -Dams | 0.2 | - | - | 0.97 | 0.2 | 0.194 |
| | -Gabionnages | - | 2.7 | 1.8 | 0.45 | 4.5 | 2.025 |
| | -Protections | 6 | 3 | - | 0.34 | 9 | 3.06 |
| | -Cubic or tetrapod concrete blocks | - | 8 | - | 2.52 | 8 | 20.16 |
| | - Channels for the draining of superficial and released waters | 6.3 | 7 | 5 | 0.20 | 18.3 | 3.66 |
| Coastal roads | -Levies (Protections or concrete blocks) | 11 | 12 | 10 | 1.94 | 33 | 64.02 |
| Airport works | -Levies (Protections or concrete blocks) | - | 0.25 | - | 2.00 | 0.25 | 0.5 |
| Port works | - envelopped levies | - | - | 0.4 | 14.3 | 0.4 | 5.72 |
| Hydrocarbons warehouses | -Protections | - | - | 0.15 | 0.34 | 0.15 | 0.051 |
| TOTAL | | | | | | | 117.92 |

10. NEEDS FOR THE TRANSFER OF TECHNOLOGIES FOR THE WORK OF ALTERNATIVE INLAND ROADS

Most of the road infrastructures are on the coastal zone. They are threatened by coastal erosion and the rise in sea levels. One of the solutions to this problem is to protect, on the one hand, those roads by technologies, which take into account the increase of road traffic and the economic conditions of the country, and the work of alternative inland roads, on the other hand.

The available materials for the work of roads depend on the status of the evolution of volcanism in each island. Grand Comoro, where volcanism is recent allows access to resistant work materials, whereas in Anjouan and Mohéli, where volcanism is old, the materials are more altered and therefore, the soils are more fragile. The vulnerability of the soils and the fact that these islands are hilly require a more adapted and more expensive layout and technical choices than in Grand Comoro, due also to the need to carry out evacuation works for the running waters and the protection of the excavation and embankment slopes.

10.1. Choice of the structure of the roadways and the inland roads.

The choice takes into account the lifting elements of the courses, the calculation of the ideal dimensions of the work and the geo technical characteristics of the materials. The definition of the proposed structures for the roadway takes into account the traffic hypotheses, the results of the geo technical tests and the characteristic of the materials.

Chart 8: Costs per kilometre of the surfaced roads, per type of roadway

| Type of roadway pavement structure | U.P. per île (Million US\$) | | |
|---|-----------------------------|--------|--------------|
| | Anjouan | Mohéli | Grand Comoro |
| Surface treatment (double seal with graded crushed gravel in 10/14 and 6/10mm) Base layer with selected natural pouzzolana Subbase layer with natural lava scovia or pouzzolana | 0.21 | 0.20 | 0.17 |
| Surface treatment (double seal with graded crushed gravel in 10/14 and 6/10 mm), Base layer with graded crushed stone 0/31,5 mm, Subbase layer with graded crushed stone 0/80mm or lava sconia, or pouzzolana | 0.34 | 0.342 | NA* |
| Asphalt surfacing continuously graded 0/10 mm, Base layer with selected pouzzolana, Subbase layer with lava sconia or pouzzolana | NA* | NA* | 0.52 |
| Asphalt surfacing continuously graded 0/10 mm, Base layer with graded crushed stone 0/31,5 mm, Subbase layer with graded crushed stone 0/80 or lava sconia or pouzzolana. | 0.528 | NA* | NA* |

* Non applicable

Chart 9: Length and total cost of the alternative roads to be realized

| Venue | Itinerary length km | Unit price US\$ | Amount (Million US\$) |
|--------------|---------------------|-----------------|-----------------------|
| GRAND COMORO | 95 | 0.17 | 16.29 |
| ANJOUAN | 53 | 0.34 | 18.17 |
| MOHELI | 26 | 0.34 | 8.91 |
| Total | | | 43.37 |

Like the protection of economic infrastructures, the transfer of technologies for alternative roads seems difficult to envisage, but it is of some interest for the country. The investment costs are very high for the State and the private sector. In this case, the transfer of technologies can occur through implementation contracts, in joint venture with local and foreign professionals. This move may encourage foreign professional operators to settle down in the country, the specialisation of local executives and enterprises, the absorption of easily assimilated technologies, in order to perpetuate the works and the country's needs.

11. NEED IN TRANSFER OF TECHNOLOGIES FOR THE DEVELOPPEMENT OF A NATIONAL PROGRAMME ON DISASTERS PREPAREDNESS

The geographic situation of the Comoros predisposes the country to different types of natural, climate and accidental disasters.

11.1 Disaster profile

The below charter indicates the foreseen consequences for each type of disaster.

Chart 10. Types of disaster and the foreseen consequences

| Main types of disaster | Scale of occurrence* | Consequences |
|---|----------------------|---|
| Cyclones, tropical storms, sea rise, coastal erosion, flooding, and tidal waves | 3 | <ul style="list-style-type: none"> ▪ Destruction of housings and economic infrastructures ▪ Losses of human lives ▪ Erosions ▪ Destruction of crops ▪ Vessel wreckages ▪ Landslide |
| Drought | 3 | <ul style="list-style-type: none"> ▪ Crops reduction ▪ Health problems |
| Explosions related to hydrocarbons | 2 | <ul style="list-style-type: none"> ▪ Material damage and loss of human lives |
| Wreckages | 5 | <ul style="list-style-type: none"> ▪ Human and material losses |
| Plane crashes | 2 | <ul style="list-style-type: none"> ▪ Human and material losses |
| Hydrocarbons spills | 3 | <ul style="list-style-type: none"> ▪ Health problems |
| Volcanic eruption, Seism and landslide | 4 | <ul style="list-style-type: none"> ▪ Loss of means of subsistence for the affected households (water, food) ▪ Destruction of infrastructures schools, health centres, water supply system, ports, and telecommunications network, roads, electricity networks, housings, etc.). ▪ Intoxication caused by breathing toxic gases ▪ Destruction of land ecosystems, and crops ▪ Loss of human lives |

* Grading scale: 5 = 100% of risks to occur; 3 = 50% risks to occur; 1 = low risk to occur

11.2. National Programme on Disasters Preparedness

The country has already a programme on disasters preparedness. The objective of this programme is to integrate the management of the risks related to disasters in the development process, in order to mitigate its impact.

The components of the programme are:

(i) The updating of the cadastral plan and the space development programme, the management and the updating of the legislation; (ii) The elaboration of a national work policy on the basis of non-metallic local materials, in order to increase the resistance of the local authority housings to

bad weather; (iii) Equipments of the volcano surveillance centre; (iv) Vulnerability and general adaptation studies on all the islands; (v) Reinforcement of human and institutional capacities. (vi) Setting-up of a national coordination that brings together the different national departments and the bilateral and multilateral partners.

11.3. Needs for a transfer of technologies

The identification of the technology needs for the development of a national programme on disasters preparedness meets the need to reinforce and complete the above-mentioned programme.

To that end, there are two levels of needs of technologies transfer:

a. Planning level:

- (i) Realisation of a map based on air and satellite images, as part of the cadastral plan and soil development and occupation,
- (ii) Elaboration of anti cyclones work standards,
- (iii) Equipments to reinforce the volcano surveillance centre (seismologic network, inclinometer network, geo electric measuring equipment, etc.)
- (iv) Equipments for the observation, forecast and warning against extreme meteorological phenomenon (meteorological stations network, capabilities for the acquisition and treatment of satellite images).

b. Intervention level

- (i) Equipments for intervention in case of emergencies (cyclones, scorching heat, wreckages, explosion of hydrocarbons warehouses, plane crashes, etc.)
- (ii) Training of specialists to intervene in case of disasters.

12. DRINKING WATER SUPPLY NETWORKS

With a coverage rate in drinking water of nearly 55 % in the country (35 % in Grand Comoro; 60% in Anjouan and 82 % in Mohéli) only half of the consumption needs, in drinking water, of a great number of households are met.

The currently available water supply systems produce nearly 20 000 m³ per day (11 000 in Grand Comoro, 7 500 in Anjouan and 1 500 in Mohéli) for a demand which is estimated at 57 000 m³ per day. On the assumption that the offer remains unchanged, national demand will reach 103,085m³ per day by 2025.

Chart 11: Evolution of the demand in Water, for the years 2002 and 2025

| | 2002 | | | 2025 | | |
|--------------|----------------|---------------|---------------|------------------|---------------|---------|
| | Population | Offer (m3/j) | Demand (m3/j) | Population | Offer (m3/j) | Demand |
| Grand Comoro | 297 440 | 11 000 | 39 500 | 532 232 | 11 000 | 70 680 |
| Anjouan | 240 240 | 7 500 | 15 000 | 437 988 | 7 500 | 27 347 |
| Mohéli | 34 320 | 1 500 | 2 500 | 64 245 | 1 500 | 4 680 |
| Total | 572 000 | 20 000 | 57 000 | 1 034 465 | 20 000 | 103 085 |

Source : Directorate for energy and water resources (2005)

With the current offer, the specific consumption per person is of only 35 litres per day; therefore, this consumption is below the 50 litres per day and per person, accepted as necessary average for the daily basic needs. In 2025, if we assume that the demand remains the same, the average consumption per person will drop to 19 litres per person and per day. The rehabilitation of the existing networks, their division into sectors and the improvement of their technical capacity in order to increase the extensions and the supply rates, are some of the solutions advocated, in order to improve population access to drinking water.

Furthermore, the marking of the protection perimeter, the preservation of the resource and the basin slopes as well as a sustained management of the sources, remain favoured options in order to preserve the natural balance and control the contribution of the polluting particles which deteriorate the quality of the water (underground and land). Some natural phenomenon, such as rises in the sea levels also constitute a permanent threat, with regards to the vulnerability of the ecosystems in general, and the rivers in particular.

The current vulnerability of the water resource is exacerbated by deforestation and the disappearance of the vegetation, at the level of the basins slopes. This has led to a reduction of the precipitation and the persistence of the dry season as well as the deterioration of the quality of surface waters.

The scenarios for the Comoros foresee an increase in the average annual temperature, which will reach 28°C by 2050. This temperature increase could lead to an increase of the evapotranspiration and will reduce the underground water reserves. This reduction could lead to an overexploitation of the coastal sheets of water, which are particularly used in Grand Comoro, and will upset the fragile balance between fresh and salt water. The sea level which is estimated at 4 – 5 mm/year, as part of the study on the vulnerability of the coastal zone, could also contribute to upset this balance. The water from underground waters, harnessed from wells or drilling, is affected by the tides along more than 2 km inland.

The magnitude of the tides is softened at the level of the wells and drilling, but the fluctuations of the water may provoke an increase of the salt rate, up to or more than the 3g/litre.

The anticipated evapotranspiration would affect the humid zones, which would see the reduction of the rivers contributions. Reduced hydraulic resources could lead to a reduction of the dilution flow in the rivers, downstream polluting agents and pollutions, and worsen the deterioration of the quality of the water.

In case of rise in sea levels, the same surface waters would also be affected by erosion residue. The vulnerability of the soils and the fact that Anjouan is particularly very hilly would facilitate the flowing of these residues into the rivers.

Flooding would also increase the danger of the contamination of the underground waters. In Grand Comoro, the main cause of water pollution would be the use of old pumping equipment, which are not adequately protected and, the lack of a water protection perimeter. In Mohéli and Anjouan, the risk would appear at the level of the septic tanks, which are usually deep enough to reach the underground waters. As a consequence, they would contain more stagnant waters, and this would result in the breeding of mosquitoes, which transmit diseases such as malaria filariosis.

The desirable solution is to increase the access to drinking water and optimise its management.

In this spirit, it is necessary to reconstitute the water outlets and ensure the cleaning of the hydraulic basins beds, first, by mitigating erosion through anti erosion systems, then through upstream dams to limit the flow of sediment.

11.1. Needs for the transfer of technologies

The needs for the transfer of technologies in the sector of water management are: Equipments and installations for the pumping of underground waters, the harnessing of upper waters, the distribution and control of the quality of the water.

Chart 12 : Needs of technologies tranfer

| Technologies | Equipments and Installations | Quantities | | | Cost |
|-------------------------------------|--|------------|---------|--------|------|
| | | Ngazidja | Anjouan | Mohéli | |
| Water treatment | Chlorination, filtering/settling tank, | 9 | 7 | 5 | |
| Control of the quality of the water | Materials and equipments of one of the existing laboratories | 1 | | | |
| Increase of water quantities | Mechanisms for the reinforcement of the collection and storage of rain waters | 10 | 8 | 4 | |
| | | | | | |
| Protection of the basins slopes | Stabilisation of the slopes, draining, making of sidecut, aforestation, restoration of the vegetation, demarcation of the perimeters for the protection and the management of the resource | | | | |

12.2. Acquisition and absorption of technologies

The acquisition of equipments could come from expected funds, as part of the Poverty Reduction Strategy Paper, the Millennium Development Goals, and as part of bilateral agreements.

The experience obtained through FSCD, the several years Programme for Micro Realisation, the Local Development Project and the ongoing effort for the decentralisation of public responsibilities to the basic communities constitute a major absorption asset.

The national and islands administrative institutions responsible for the water issues and the creation within the University of the Comoros of an Institute of Technologies together with the Research existing Institutes guarantees the absorption capacity.

13. CAPACITY-BUILDING FOR THE PARTICIPATION IN THE SYSTEMATIC OBSERVATION NETWORK FOR CLIMATE CHANGE

13.1. Context:

Until 1990, The Comoros had sixteen meteorological stations, four of which were synoptic, 10 climatologic stations and forty-six pluviometric stations. Currently, only the synoptic station of the airport is operational. The successive economic crises that the country is still experiencing did not allow maintaining and renewing the existing stations, and enable the follow-up of these parameters, the treatment and diffusion of data.

The ongoing and foreseen climate change requires the implementation of a follow-up of the meteorological, hydrological and oceanographic programmes, through the setting-up and the operation of an observation network. The envisaged increase of the frequency of tropical cyclones requires, more than ever, a monitoring and warning system for the security of the populations and their goods.

This observation network allows, on the one hand, a better understanding of the evolution of the weather at the national level, and to be able to participate in the climate global systematic observation network, on the other hand. The obtained data will allow providing support, and particularly guidance to the sectoral strategies for food security and poverty reduction.

13.2. Objectives:

Capacity-building meets a twofold need:

- a) Fill the gaps in the field of meteorology, hydrology and oceanography, in order to meet the pressing needs in agriculture, water, fishing, energy and environment
- b) Participate in the systematic observation network for climate change and develop the scientific and technical knowledge required for the follow-up, the surveillance of natural resources and their evaluation for the vulnerability to change and climate variability.

13.3. Needs for capacity-building

13.3.1. In the field of meteorology

The follow-up of the meteorological parameters requires the setting-up of a network of measurement stations (see attached map) of the following parameters: speed and direction of the wind, air temperature relative humidity, air pressure, visibility and duration of the sun, net radiation, precipitation, soil temperature and humidity.

This network comprises:

1. **Synoptic observation stations** in surface and in altitude; (4 in Anjouan; 3 in Mohéli and 5 in Grand Comoro).
2. **Agro meteorological stations in order to be able to respect the agricultural timeframe** (4 in Anjouan; 3 in Mohéli and 5 in Grand Comoro).

The objective of this observation network is to better understand the evolution of the climate at the national level, on the one hand, and to be able to participate in the global network for systematic observation of the climate, on the other hand (see attached map).

A trained staff is available in the synoptic stations of Hahaya, Moroni, Bandar Salam and Ouani. The agro meteorological stations should be computerised to increase the reliability and the accuracy of the data and to better meet the need to adapt to the agricultural calendar to the evolution of the climate.

13.3.2. In the field of hydrology

The creation of a hydrologic network stations meets the need for a quantitative follow-up of the water resource for a rational management, but also for the development of hydroelectricity as well as the prevention of flooding.

This network will allow the measurement of the sources and rivers flow and to assure the follow-up of the piezometric level of waters. It is also necessary to prospect new underground waters.

In total, it is estimated at 20, the number of permanent rivers, which must be followed up, 3 stations per river (1 upstream, 1 midstream and 1 downstream) for an estimated amount of 150,000 US\$.

As for the ground waters, fifty measurement stations have been accepted on the entire territory.

Considering the high costs of the drilling equipment and the lack of local professionals, it is timely to enlist the services of a foreign professional, to carry out the accepted drilling programme, estimated at 870,000 US\$.

13.4. Oceans observation Systems

The Comoros coastal space is threatened by the terrigen contributions, sand and coral mining used for work, the swell dynamics and the envisaged rise of the sea level. The subsequent erosion is a major threat to the economic and social infrastructure, the ecosystem, the cultural heritage and the historical as well as the overall balance of the islands.

In the same context, it is necessary to ensure the follow-up of the coastal erosion and the status of the reefs as well as the oceanographic parameters, such as water temperature, salt rate, water turbidity, oxygen content, acidity (PH), sea level, the swell dynamics and currents. This data will enable to prevent the risks related to extreme events such as swells, storms, flooding, and also: (i) to develop knowledge on sea and coastal environment; (ii) promote the reasonable use of marine and coastal resources (iii) identify, monitor and foresee extreme events in order to mitigate their effects; (iv) ensure the security and the efficiency of maritime operations and (v) guide development strategies.

13.5. Evaluation of the human and institutional capabilities for the participation in the systematic observation of climate change

There are two national institutions in the field of systematic observation of climate change: (i) the national directorate of meteorology endowed with a technical staff at several levels. However, the rapid evolution of the technologies requires capacity-building at the level of the stakes and needs of the country for the systematic observation of climate change, and (ii) the national centre for ocean data and information (CNDO). This centre was created as part of ODINAFRICA project (Ocean Data and Information Network for Africa).

The project brings together twenty African countries supported by UNESCO Intergovernmental Oceanographic Committee. Since its inception, the centre has developed several activities related to the compilation of existing data and training in the following fields: management of Ocean data and marine information, basic development of national data and index notebooks.

Other activities are related to:

- The elaboration of a database on the national experts on marine and coastal environment,
- The elaboration of a database on Ocean data from special software « Ocean Data View ».

Other activities are envisaged in the next phase of the ODINAFRICA project. They are:

The setting-up of an ocean observation system and proficiency in the management of ocean data and marine information,

Concerning ocean observation, the Comoros appears in the first list of countries that should benefit from equipped maregraphs for meteorological and hydrologic panels. The national meteorological directorate has been designated as focal point for that project.

13.6. Capacity-building needs

Training of technicians in the information system for the gathering, analysis, exploitation, filing of climate, hydrological and ocean data and the maintenance of equipments.

- Installation, functioning and maintenance of the equipment
- Timely gathering and transmission of data
- Data quality control and management
- Data analyses
- Data use and broadcasting in the national and regional ocean programmes

For Oceanography, training will be carried out on the basis of GOOS methodology used (Global Ocean Observation System).

Chart 13. Obstacles and actions to be taken to overcome them

| Sector | Transfer obstacles | To overcome the obstacles |
|---|---|--|
| Electric energy | <ul style="list-style-type: none"> - Weak industrial development - Difficult access to funds - Limited human capabilities - Weakness of the legal and regulatory framework | <ul style="list-style-type: none"> - Promote and reinforce public/private partnership and cooperation with the institutions that support the development of clean energy. - Staff proficiency - Establish technical standards for the installation of electric equipments |
| Biomass | <ul style="list-style-type: none"> - Difficult access to information on economical energy technologies - Relatively high access cost | <ul style="list-style-type: none"> - Inform and educate ylang distillers - Tax exemption on the import of clean technologies |
| Local work material | <ul style="list-style-type: none"> - No systematic resort to a professional qualified for a lasting architectural conception. | Inform, educate and promote architectural conception. |
| Protection of the infrastructures ----- Work of alternative roads | <ul style="list-style-type: none"> - High infrastructures coast in comparison with the means of the country - Lack of equipments and enterprises specialised in the realisation of works and qualified labour | <ul style="list-style-type: none"> - Search for bilateral and multilateral financial support for adaptation - Promote and reinforce regional and international with special enterprises. - Apply the public procurement regulation - Control of the quality of the aggregates and works. |
| Improve the management and the maintenance of clean water networks | <ul style="list-style-type: none"> - Financial resources - Diminution of the resource | <ul style="list-style-type: none"> - Efforts to mobilise financial resources as part of the international initiatives (MDG) - Reconstitution of the vegetation - Exploration of new resources - Constitution of storage reserves |
| National programme on disasters preparedness | <ul style="list-style-type: none"> - Limited State financial resources - Weakness of the capabilities of the institutions in charge of disasters management - Non-respect of urban standards | <ul style="list-style-type: none"> - Reinforce regional and international cooperation in terms of disasters management - Increase the understanding of the communities on the need to adopt the work and urbanism standards |
| Climate observation system | <ul style="list-style-type: none"> - Access costs of the important equipment - Inadequate access to financial information | <ul style="list-style-type: none"> - Reinforce regional and international cooperation in the field of climate systematic observation |

14. INSTITUTIONAL FRAMEWORK FOR THE TRANSFER OF TECHNOLOGIES

There is not yet any institutional and regulatory mechanism for the transfer of technologies in general and the ecologically rational technologies, in particular.

This situation is attributable to the weak economic and industrial development of the country. The geographic isolation and the country being far from international markets do not always favour access to information, in spite of the accession to the new Information, due to high costs and the weak coverage rate of the network.

However, a certain number of actions have already been taken to stop the import of vehicles of more than 7 years and the substances that weaken the ozone layer. Others encourage the import of electrical equipments that consume less energy.

In order to protect the promotion of clean technologies, it is necessary to create a structure responsible for the coordination of the transfer of clean technologies to the public and private sectors.

This coordination would allow the promotion of clean technologies, in order to make viable the development strategies.

This structure could be composed of the Chamber of Commerce, the employers, les consumers and the Groups of Economic Interest, under the supervision of the Ministry of Economy, Commerce and Industry and the Ministry of Environment of the Union of the Comoros.

The role of the structure could be as follows:

1. Make an inventory of the needs in the transfer of clean technologies, in comparison with the national context.

2. Propose measures aiming at creating conditions conducive to the transfer (creation of a conducive environment: improvement of the rules of the local markets, favourable legislation,...) and to reinforce the capabilities of the stakeholders, through training and information.

4. Implementation of the transfer through:

- Patents and Licence contracts and other industrial propriety rights;
- Agreements in the communication of know-how;
- Contracts in technical assistance and vocational training;
- Contracts in the realisation of industrial package works (i.e., contracts "with immediate occupation", partial, complete);
- Direct Investment contracts and others.

The transfer of technologies should therefore be envisaged through the combination of two actions:

- The private sector, which transposes a technology in the country;
- The government, which creates conducive conditions.

Chart 14. Priorisation of the priority needs of technologies transfer

| Components | Technology | Ranking | Cost (US\$) |
|--|---|----------------|--------------------|
| Biomass | Fireplaces made of Resistant bricks, for the stills | 1 | 2 640 000 |
| Hydroelectricity | Hydroelectric power plants | 2 | 15 000 000 |
| Electricity network | Rehabilitation and extension of the network | 3 | 14 680 000 |
| Drinking water coverage | Pumping, harnessing, storage, settling, filtering, chlorination | 4 | 800.000 |
| Climate systematic observation: Agro meteorology | Stations: agro meteorological; hydrologic and oceanographic | 5 | 1020.000 |
| Housing | Consolidated and clay baked bricks, sand crushing | 6 | 1025.000 |
| Protection of the economic infrastructures | Production of granulates by crushing | 7 | 11.7 92.0 00 |
| Disaster prevention | - Volcano surveillance network - Acquisition and treatment of satellite images | 8 | 30000 |
| Work of inland alternative roads | Types of roadways | 9 | 43 370 000 |
| TOTAL | | | 90.357.000 |

15. CONCLUSION AND RECOMMANDATIONS

The elaboration of a document on the evaluation of the needs in technologies transfer has been:

- An additional exercise to the initial national communication on climate change by allowing the identification of technological options for mitigation and adaptation,
- New exercise for the country, which has never had the opportunity to assess its needs in terms of environmentally sound technologies.

The needs expressed in that regard reflect the vulnerability towards the impact of climate change but also at the level of economic development and the vulnerability of the island ecosystem. These factors show the need to integrate the needs in the transfer of environmentally sound technologies in the development programmes.

The priorities identified are placed at the level of the reinforcement and the protection of economic infrastructures (energy, water, roads, ports and airports), housing, and the participation to the systematic network for the observation of climate change and disasters preparedness.

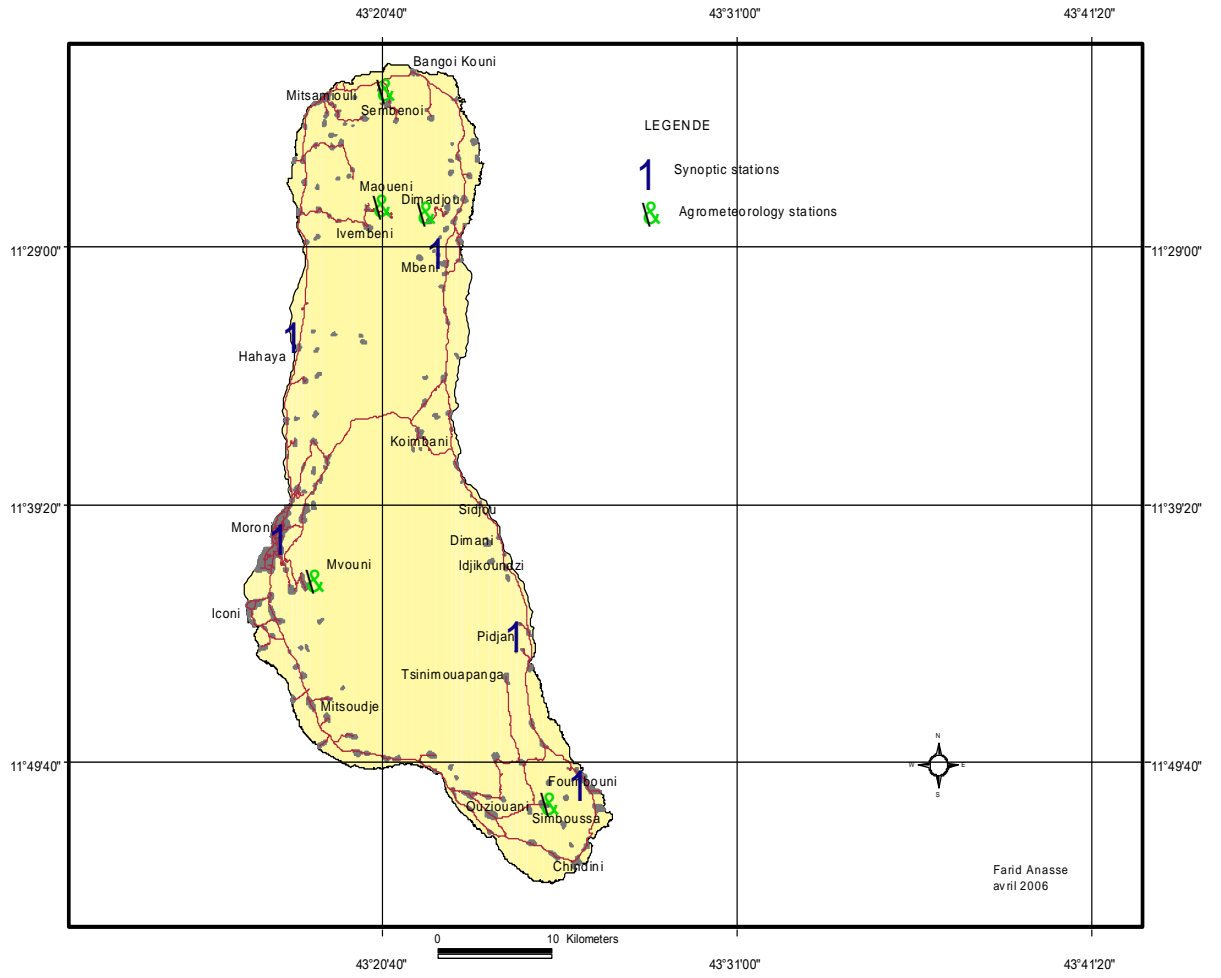
The country has therefore a synthesis document on the priority technologies needs required for its adaptation to climate change and its economic development.

It is therefore recommended to:

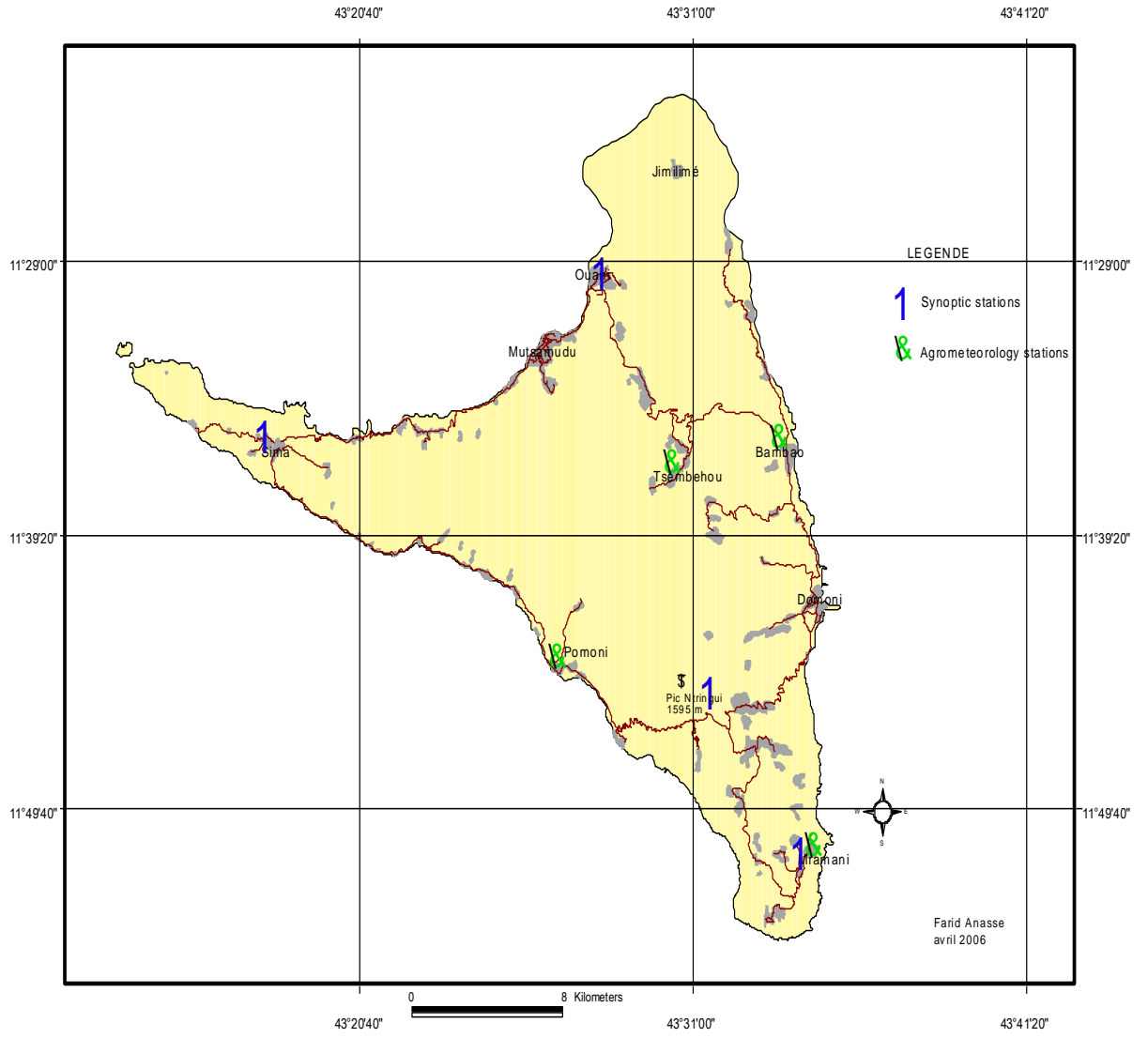
- (i.) Set-up, as soon as possible, the institutional framework for the transfer of technologies as advocated in this document.
- (ii.) Set-up the first three priorities which are: ylang distilleries, the installation and exploitation of hydroelectrical plants, the setting-up of networks for the systematic observation of climate change, particularly the agro meteorologic network in the perspective of controlling agricultural calendar.

**16. ATTACHMENTS: MAPS OF SYNOPTIC AND AGRO
METEOROLOGICAL STATIONS**

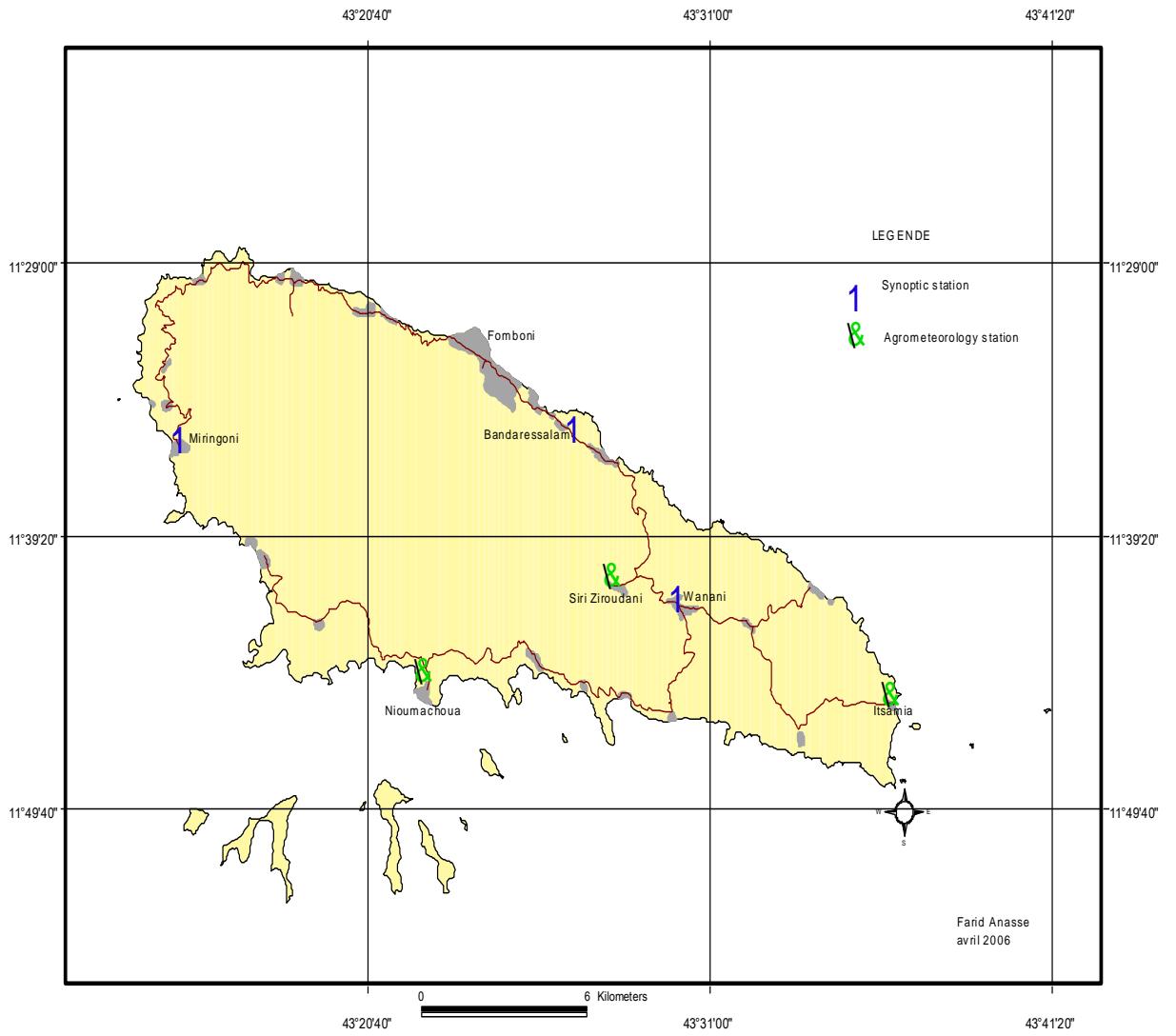
SYNOPTIC AND AGROMETEOROLOGY STATIONS OF THE ISLAND OF GRANDE COMORO



SYNOPTIC AND AGROMETEOROLOGY STATIONS OF THE ISLAND OF ANJOUAN



SYNOPTIC AND AGROMETEOROLOGY STATIONS OF THE ISLAND OF MOHELI



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