Using CDM for Development in Sub-Saharan Africa

Sub-Saharan Africa has so far been sidelined by the CDM. Its share in number of projects and projected CERs is just 1.5% of the world's total. Moreover, this is dominated by large gas flaring reduction projects from Nigeria. How can African participation in the CDM be strengthened and yield development benefits? GTZ has been supporting CDM capacity building in Western Africa for several years and first lessons can be drawn.

Given the lack of modern energy services in most sub-Saharan countries, the development challenge is to expand modern energy services to the rural population. From a greenhouse gas perspective, renewable electricity generation for grids should also play a role. With the recent reform in the rules for CDM programmes, small decentralized activities start to become attractive in the CDM. In the West African context, the following project types could become relevant under the CDM:

- Introduction of energy efficient charcoal / wood stoves. They would replace extremely inefficient traditional stoves.
- Electricity generation from agricultural bio mass residues. In West Africa, residues from cotton, groundnut, rice and cereal production are widely available.
- Wind power, to serve coastal grids in trade wind areas that allow to reach high plant load factors.

gtz Climate Protection Programme

On behalf of
Federal Ministry
for Economic Cooperation
and Development

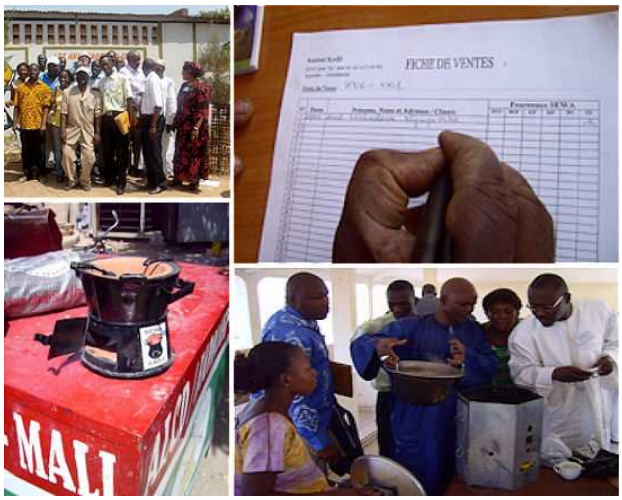
Three workshops in spring 2009 served to assess the potential and barriers of those project types. Regarding stoves, it so far has not been possible to mobilize large-scale industrial stove production that could guarantee stable quality. Except for one factory in Mali, which was visited by the workshop participants, stove production is done by small artisans using recycled material. Generally, lacking availability of local capital is a major obstacle. The few local CDM experts are frequently "poached" by international organizations or carbon market companies, as we could witness in the case of the local expert serving as resource person for our workshops.

Data for baseline setting are generally not available and need to be collected with a high effort. While local CDM approval authorities are generally supportive, they lack the resources to engage in targeted training of possible CDM entrepreneurs.

As regards electricity generation from agricultural residues, these projects are often not put into practice because there is no regulatory framework for power purchase from renewable energy sources. For this reason, the purchase price offered by power utilities is often too low for the realisation of power plants on the basis of agricultural residues. Furthermore, the utilisation of agricultural residues or wind power for electricity generation is a rather new technology in this area, with few experiences. Generally, electric utilities are not willing to invest in such projects since the overall budget for rural electrification is limited, which means that overall beneficial projects, but with high initial investment costs (such as for agricultural residues and wind power), are often discarded.

The way forward

The workshop participants from the five partner countries Benin, Burkina Faso, Mali, Senegal and Rwanda have been sensitized for the CDM potential of the three technologies. They also can assess the methodological challenges before a CDM project is registered by the CDM Executive Board. It is likely that a CDM stove project will be launched in Senegal which could be the starting point for a CDM programme. Given that an efficient stove can generate 0.5-1 emissions credits per year, a stove programme could reach an order of magnitude that becomes interesting for large buyers of CDM emissions credits. As next step, mobilization of finance for activities in the electricity sector needs to be addressed. Both biomass residue as well as wind CDM projects are developed in large numbers in Asia and Latin America.



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Ostafrika: Möglichkeiten der Verringerung von Treibhausgas-Emissionen durch Power Pooling in Ostafrika

Partnerorganisation: Tanzanian Ministry for Energy and Mineral Resources
Projektzeitraum: April 1999 - Dezember 2001
Finanzierungsbeitrag: DM 550 000

Kurzbeschreibung des Vorhabens

Neben der Nutzung von Holz gehört auch in Afrika die Verbrennung von fossilen Energieträgern zu den Hauptursachen von Treibhausgas-Emissionen.

Seit einigen Jahren arbeiten die ostafrikanischen Staaten Kenia, Uganda und Tansania auf politischer und wirtschaftlicher Ebene stärker zusammen, unter anderem auch im Energiesektor. Im März 1998 beschlossen die Regierungen der drei Länder, einen regionalen Masterplan für den Elektrizitätssektor aufzulegen. Ziel dieses von der Weltbank finanzierten Planes war die Ermittlung, inwieweit durch eine Zusammenarbeit im Elektrizitätssektor sowohl Treibhausgase reduziert als auch andere ökologische und ökonomische Vorteile genutzt werden können.

Der im März 2003 veröffentlichte Abschlussbericht kam zu dem Ergebnis, dass die Minderung von Emissionen im ostafrikanischen Stromverbund auch wirtschaftlich attraktiv sein. Da der Energiesektor in Ostafrika aufgrund von Liberalisierungsprozessen im Umbruch ist, bietet sich im Moment auch eine gute Gelegenheit für eine Implementierung von Maßnahmen zur Emissionsminderung.

Neben der wirtschaftlich interessanten Minderung von Emissionen hat ein solches "no-regret"- Projekt weitere Vorteile einer Bündelung des Energiesektors ermittelt. Die Umsetzung des Masterplans kann auch dazu beitragen, die Versorgungssicherheit im Energiebereich zu erhöhen und durch eine veränderte Energieproduktion lokale Umweltschäden zu reduzieren. Nicht zuletzt ist die Bereitstellung von preiswerter und sicherer Energie einen Beitrag zur Armutsminderung in den betroffenen Ländern.

Als positiven "Nebeneffekt" ermittelte das Projekt Möglichkeiten für die Durchführung von CDM-Projekten in der Region. Es wurden sowohl größere als auch mehrere Kleinprojekte (weniger als 15 MW) - besonders im Bereich der Wasserkraft - identifiziert. Der Abschlussbericht enthält eine Liste von möglichen CDM-Projekten.

Allerdings werden die Länder bei der Durchführung dieser Maßnahme mit institutionellen, technischen, politischen und nicht zuletzt finanziellen Probleme konfrontiert sein, zu deren Überwindung der Aufbau von Kapazitäten und den Transfer moderner Technologien notwendig ist. Die Nutzung finanzieller Ressourcen der Klimarahmenkonvention und des Kyoto-Protokolls können die Umsetzung des Masterplans entscheidend unterstützen.

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Projektkurzbeschreibung

Bezeichnung: Aufbau einer nationalen Genehmigungsbehörde für CDM-Projekte, Designated National Authority (DNA)

Auftraggeber: Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)

Land: Ghana

Politischer Träger: Umweltministerium von Ghana

Gesamtlaufzeit: September 2004 bis September 2005

Ausgangssituation

Im Rahmen des Kyoto-Protokolls verpflichtet sich die internationale Staatengemeinschaften zur Minderung von Treibhausgasemissionen. Bis Ende 2005 konnten sog. CDM-Projekte beim Sekretariat der VN-Klimakonventionen (UNFCCC) registriert und somit unterstützt werden. In Afrika gilt Ghana als vielversprechendes Gastland für den Mechanismus für umweltverträgliche Entwicklung (Clean Development Mechanism, CDM). Es besitzt Potenziale in verschiedenen Sektoren, wie z.B. Energieeffizienz oder Kleinwasserkraft. Um den CDM-Prozess in Ghana voran zu bringen, musste die nationale Genehmigungsbehörde (Designated National Authority, DNA) zügig aufgebaut und die Phasen der Projektidentifikation und -entwicklung begleitet werden. Darüber hinaus war es erforderlich, die vorhandenen Kenntnisse des Privatsektors z.B. mit Trainingsseminaren zu Planung, Durchführung und Kontrolle von nationalen CDM-Projekten zu erweitern.

Ziel

Ziel der Maßnahme war es, zügige und transparente Entscheidungen der ghanaischen DNA über Projektvorschläge zu fördern, so dass durch deren Umsetzung ein Beitrag zur Begrenzung von Treibhausgasemissionen und zur nachhaltigen Entwicklung des Landes geleistet werden kann.

Vorgehensweise

Die Maßnahmen wurden im Wesentlichen von der Ghanaischen Umweltbehörde (EPA) in drei Schritten umgesetzt:

- Beratung bei den rechtlichen Grundlagen der Genehmigungsbehörde;
- Sensibilisierung und Information von politischen Entscheidungsträgern;
- Fortbildung und Information des Privatsektors zu umweltverträglichen Mechanismen und daraus resultierenden Potenzialen.

Wirkung – Was bisher erreicht wurde

Ende 2004 erfolgte eine juristische Prüfung der ghanaischen DNA durch internationale Experten. Im August 2005 wurde ein Workshop mit Parlamentarien zu rechtlichen und verfahrenstechnischen Grundlagen des CDM und den Aufgaben nationaler DNAs, wie auch vorbereitende Gespräche mit Unternehmen im Bereich lebensmittelverarbeitender Industrie und dem Energiesektor durchgeführt. Unter Beteiligung deutscher Experten wurden mögliche CDM-Projekte in den beteiligten Betrieben identifiziert, detaillierte Projektbeschreibungen entwickelt und der potentielle Emissionsrückgang errechnet.

Ghanas DNA wurde im September 2005 eingerichtet, institutionell verankert und beim UNFCCC registriert. Die vorgesehenen Ziele der Einzelmaßnahme wurden erreicht.

Namibia: Country Study for Implementation of the Convention on Climate Change

Partner Organisation: Ministry of Environment and Tourism (MET): Desert Research Foundation Namibia,Windhoek
Project Period: January 1997 - June 1998
Financial Contribution: DM 320,000

Project Brief

Namibia ratified the UNFCCC in 1996 and, by doing so, committed itself to presenting an inventory of GHGs within three years as well as to reporting on the vulnerabilities of Namibia and adaptive measures and mitigation strategies that could be undertaken. These exercises combined represent Namibia's Country Study on Climate Change.In view of this sensitive context it is advisable - not only on the grounds of the obligation under international law - to implement a country study with all the components (inventory, options for reduction, sensitivity and adaptation studies) in order to obtain important base-line data. On the basis of this data, concrete measures could be launched to reduce the rise in greenhouse gas emissions or at least alleviate the consequences of climate change.

The GHG inventory for 1994 of the Country Study shows Namibia as a net sink of CO_2, with carbon removals exceeding emissions. However, the carbon sink consists of biomass increases on bush-encroached land - an area of great uncertainty.

Phase 2: Namibia is extremely sensitive to global warming and, due to human resource, institutional and financial constraints, is considered highly vulnerable to the effects of climate change. The direct impacts of global warming on each of the economic sectors have the potential to create ripple effects on each other, ultimately reducing productivity, sustainable development options and social stability. If, as currently suggested by some regional scenarios, the country's climate continues to become hotter, drier and more variable (with the exception of Caprivi, where it may become wetter), it is clear that marginalised rural and urban populations will suffer the most.

The National Standing Committee on Climate Change was established as a result of the project under the Directorate of Environmental Affairs, contributing to the creation of a national strategy to address climate change.

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NAMIBIA

COUNTRY STUDY FOR THE IMPLEMENTATION OF THE CONVENTION ON CLIMATE CHANGE

Partner Organisation:	*Ministry of Environment and Tourism (MET)* *Desert Research Foundation Namibia, Windhoek*
Project Period:	*January 1997 – March 1999*
Financial Contribution:	*DM 320 000*

BACKGROUND

As a sparsely populated state with a small industrial sector, Namibia contributes only minimally to global greenhouse gas (GHG) emissions. However, it is all the more susceptible to the consequences of climate change. 21% of Namibia's foreign exchange revenues are obtained from fishing, and thus changes in ocean currents, for instance, could lead to disastrous macro-economic consequences. In addition, the semi-arid and arid zones in the interior of the country are highly susceptible to desertification and the loss of biodiversity.

In view of this sensitive context, it was advisable to conduct a country study that comprises all components (inventory of emissions, mitigation options, vulnerability and adaptation to climate change) in order to obtain important baseline information. On the basis of this information concrete measures can be launched to reduce the increase in GHG emissions or at least alleviate the consequences of climate change. Furthermore, the country study can point out possibilities for reducing emissions, above all in the sectors of energy, transport and industry, and for improving energy efficiency. Possibilities for substituting fuels that have a harmful effect on the climate and for strengthening sinks by sustainable management can also be identified.

Moreover, Namibia is surrounded by neighbour states that have already implemented country studies, the results of which are being considered in the relevant national development plans. The members of the Southern African Development Community intend to cooperate more closely in economic matters in future. They recently formalised the setting up of a regional electricity grid, the Southern African Power Pool (SAPP). Namibia should therefore also have at its disposal important baseline information relevant to climate issues in order to be able to cooperate more closely in regional climate protection activities.

Mesa in Namibia

GTZ

OBJECTIVE

The objective of the German funded project was to

enable Namibia to meet its obligations to report in accordance with the Convention on Climate Change and to initiate implementation measures to reduce GHG emissions.

MAIN ACTIVITIES

The project was implemented in three phases:

Phase 1: An inventory was compiled of sources and sinks of GHG following the IPCC guidelines, and options for reduction were identified.

Phase 2: The sensitivity of the country to possible climate change was appraised and potential adjustment measures were identified.

Phase 3: A national mechanism for climate relevant decision-making was established.

SUMMARY OF FINDINGS

Phase 1: The **GHG inventory for 1994** shows Namibia as a net sink of CO_2, with carbon removals exceeding emissions. However, the carbon sink consists of biomass increases on bush-encroached land – an area of great uncertainty.

The country emits CO_2 mainly as a result of fossil fuel use, with transport accounting for almost half of the total. The quantity of CO_2 emitted as a result of biomass burning almost equals that emitted by fossil fuels, but is reported for memo purposes only and not included in the national total. Enteric fermentation in livestock is the most important emission source of methane in Namibia.

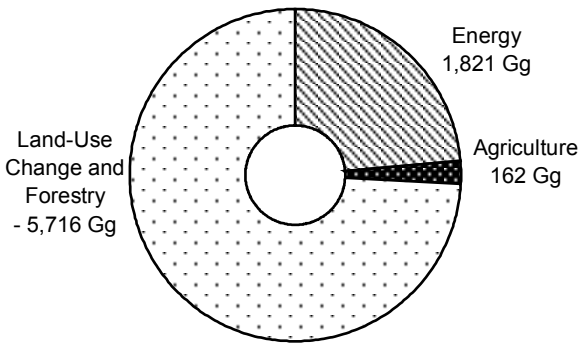
As the first exercise of this kind in Namibia, compiling the inventory was also an investigation into the availability of applicable national data on factors that affect emissions and removals of GHGs. Many data gaps were identified in the process, however, the absence of reliable statistics on land use changes and other factors that effect changes in woody biomass was the most serious instance of absolute data unavailability. The potential effect of such changes on CO_2 release and uptake is of major importance in Namibia, with its small industrial base and low total fossil fuel consumption. A major study on bush encroachment currently in the pipeline, as well as the compilation of a national Forest Inventory by the Department of Forestry, will hopefully shed a brighter light on this crucial area. Due to the above-mentioned problem and others, the overall uncertainty of this inventory, although not quantified exactly, is considered to be high.

Based on two possible economic scenarios, **emission scenarios** and mitigation options were compiled up to 2017 to complement the GHG inventory. The two economic scenarios do not precisely try to model the impact of different economic situations, but rather take into account that there is huge uncertainty as to performance in these three areas:

- Recovery of fish stocks after the exploitative practices of colonial times
- Growth of the manufacturing Industry
- Impact of HIV/AIDS on population growth and the demand for social services

Due to the uncertainties, only statements on emission trends were made. Transport and energy are felt to be the main sectors in which emission growth will occur. In the case of energy, emission growth is dependent on the realisation of the Kudu

GHG Emissions and Sinks in 1994



gas plant and Kunene hydro power schemes.

Mitigation options thus focused on the energy and transport sector. Options for the **energy** sector included:

- Replacement of diesel water pumps with photovoltaic (PV) pumps on commercial farms
- Cost recovery in communal area water supply
- Kudu gas plant project
- Lower Kunene hydropower scheme
- Use of solar stoves and solar water heaters in households
- Water pumping and desalination electricity use

Mitigation options for the **transport** sector focused mainly on **sea fishing** and **cars**:

- More efficient fishing vessels (purse seiners and longliners used instead of trawlers)
- Freezing and processing fish on shore
- Different spatial fishing efforts which concentrate on fishing when fish are close to harbours
- Higher catch rates per day
- Modernisation of the horse mackerel fleet
- Catalytic converters for cars
- Raising petrol costs to encourage use of more fuel-efficient cars

Phase 2: Namibia is extremely sensitive to global warming and, due to human resource, institutional and financial constraints, is considered highly vulnerable to the effects of climate change. The direct impacts of global warming on each of the economic sectors have the potential to create ripple effects on each other, ultimately reducing productivity, sustainable development options and social stability. If, as currently suggested by some regional scenarios, the country's climate continues to become hotter, drier and more variable (with the exception of Caprivi, where it may become wetter), it is clear that marginalized rural and urban populations will suffer the most.

Significant links and overlaps occur between the effects of climate change, biodiversity loss, ozone depletion and desertification. Thus, national and international action must be integrated and coordinated to avoid the duplication of programmes and activities.

Vulnerable sectors identified in the study were water resources, marine resources, agriculture, biodiversity and ecosystems, coastal zones and sys-

CO_2 Mitigation Options – Discounted Values at 10% up to 2017

Option	Potential Savings: Physical Quantities versus Base Case	Potential Savings: Gg CO_2	Incremental Cost: N$ mio	N$ mio Gg averted
Kudu Gas		45,574	Negative	Negative
Lower Kunene hydro		11,691	-195.8	-2,290,000
Commercial borehole conversion to PV	13.7 mio litres of diesel/year	39	4.4	0.113
Communal borehole conversion to PV	4.6 mio litres of diesel/year	12	1.5	0.13
Solar water heaters	Up to 40% of household electricity use			
Solar ovens	Up to 25% of wood use	33	0.6	0.18
1,000 catalytic converters (50,000 km version)	NO_X	97	10	0.1
1,000 catalytic converters (25,000 km version)	NO_X	49	10	0.2
1,000 catalytic converters (10,000 km version)	NO_X	19	10	0.53

tems, health and energy. To adapt to future climate changes, more research is needed in the areas of **baseline scenarios** for future sectoral vulnerability studies, **climate modelling**, as well as an in-depth assessment of the potential **socio-economic and biophysical impacts** of climate change on Namibia's water resources and human livelihoods and well-being. In addition, cost-effective **adaptive management approaches** need to be identified. As a final component, in addition to informing policy makers about the possible effects of climate change, decision-makers at all levels including government officials, local and traditional authorities, farmers and the general public should be kept informed about Namibia's interseasonal and interannual climatic variability.

Phase 3: The **National Standing Committee on Climate Change** was established as a result of the project under the Directorate of Environmental Affairs. The role of the committee will be to:

- Guide the Initial Communication and act as a focal point for climate change
- Create awareness
- Oversee Namibia's commitments to the Convention
- Keep the "Conventions Committee" informed
- Identify and initiate climate change projects and research
- Promote joint planning on climate change issues

OUTLOOK

The Climate Change Project has ensured that climate change is placed on the agenda in Namibia. It is vitally important that the momentum generated during this project is maintained and that a concerted effort is made to implement the recommendations put forward during the course of the project. Additionally, the following is recommended:

- That Namibia not be a silent signatory to the Convention and that a team or individual be put in place to attend the Conference of Parties (CoP) so that Namibia can be more proactive in the negotiating process. This needs to be done in order to be in a position to put more pressure on developed countries to meet their obligations in terms of the Convention, especially with respect to the reduction of GHG.
- That planning at all levels, both in terms of policy and legislation development include aspects of climate change that are relevant, thereby contributing to the creation of a national strategy to address climate change.
- That a mechanism be developed to coordinate the different data requirements of the various conventions Namibia is party to. This would ensure greater integration and assist in planning.
- That the GHG inventory be updated as soon as possible to especially include aspects of changes in woody biomass. The updating of the inventory should however be preceded by input with respect to the recording of data by the various relevant institutions. This is to ensure that the data is available and in a form that can be used once the update is completed.

Projektkurzbeschreibung

Bezeichnung: Lokale Lehrpläne zu Katastrophenrisiko-Management (Teilprojekt)

Auftraggeber: Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)

Land: Mosambik

Politischer Träger: Provinzregierung Sofala und Distriktadministration Búzi (Mosambik), sowie nationales NAPA-Komitee und Katastrophenschutzbehörde INGC

Gesamtlaufzeit: Februar bis März 2005

Ausgangssituation

Seit der Flutkatastrophe von 2000 wird die Katastrophenvorsorge in Mosambik stetig verbessert und ausgebaut. Maßnahmen des Katastrophen-Risikomanagements (KRM) in für Naturkatastrophen besonders anfälligen Gebieten sollen zukünftige Schäden für die Bevölkerung verhindern bzw. verringern. Im Búzi-Flusseinzugsgebiet tragen sowohl die nationalen Institute für KRM, Meteorologie und Wasserverwaltung sowie auch die Dorfbewohner aktiv zum Aufbau eines KRM-Systems bei.

Ziel

Ziel des Teilvorhabens ist es die Distriktverwaltung und Schulen im Distrikt Búzi in das KRM einzubeziehen. Kinder und Jugendliche werden mit einer nachhaltigen Katastrophenvorsorge und der Anpassung an den Klimawandel vertraut gemacht, so dass sie die wesentlichen Inhalte von KRM kennen und sich im Fall einer Evakuierung richtig verhalten. Es soll ihnen ermöglicht werden, selbst zu Katastrophenvorsorge und -management beizutragen, z.B. durch Beteiligung an der Arbeit der KRM Komitees und der Durchführung von Wasserstandsmessungen.

Vorgehensweise

An vier Schulen werden Lehrpläne zu KRM ausgearbeitet. Bereits existierende KRM Komitees sollen die LehrerInnen in den ländlichen Gebieten bei diesem Vorhaben inhaltlich und methodisch unterstützen. In der Distrikthauptstadt wird die Gemeindeverwaltung eng in die Arbeit mit den Schulen einbezogen.
Die Lehrplaninhalte der Grund- und Sekundarschulen werden gemeinsam mit den LehrerInnen ausgewählt, zu lokalen Unterrichtsprogrammen zusammengestellt und die Unterrichtsmaterialien in Ausbildungsworkshops erprobt. Die Erfahrungen der LehrerInnen und KRM Komitees im Unterricht, z.B. mit einer Simulationsübung zu Evakuierung im Katastrophenfall, werden dokumentiert und ausgewertet. Sie können damit auch an anderen Schulen verbreitet werden.

Wirkung – Was bisher erreicht wurde

Im Rahmen des Gesamtvorhabens wurde in den betroffenen Gemeinden im Búzi-Flusseinzugsgebiet bereits ein distriktübergreifendes KRM-System eingerichtet: Wasserstandsmessungen, Datenverarbeitung, Frühwarnung, Evakuierungsübungen, etc.. Es wird in Zusammenarbeit mit den zuständigen nationalen Institutionen von den lokalen KRM Komitees betreut.
Hauptwirkung dieses Vorhabens ist die Dezentralisierung der Verantwortlichkeiten in der Katastrophenvorsorge auf die Distriktregierungs- und Dorfebene sowie eine Stärkung der Dorfgemeinschaften. Die Übertragbarkeit dieses Ansatzes auf andere Distrikte wird daher von der nationalen Ebene stark gefördert.

Weitere Informationen

- Anpassung an den Klimawandel in der Katastrophenvorsorge im Flusseinzugsgebiet Búzi und anderen Regionen im südlichen Afrika

Projektkurzbeschreibung

Bezeichnung: Anpassung an den Klimawandel in der Katastrophenvorsorge im Flusseinzugsgebiet Búzi und anderen Regionen im südlichen Afrika

Auftraggeber: Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)

Land: Mosambik

Politischer Träger: Provinzregierung Sofala

Gesamtlaufzeit: Juni 2004 bis Juni 2006

Ausgangssituation

In den letzten Jahren nahmen sowohl die Häufigkeit als auch die Intensität extremer Wetterereignisse in Mosambik aufgrund des globalen Klimawandels zu. Zwar besteht im Wassereinzugsgebiet des Rio Búzi nach starken Überschwemmungen ein erhöhtes Problembewusstsein und Interesse an Lösungsansätzen wie Frühwarnung und Umsiedlung. Um jedoch langfristig die durch den Klimawandel steigende Katastrophenanfälligkeit zu reduzieren, müssen Maßnahmen des Katastrophen-Risikomanagements (KRM) in die Entwicklungsplanung der Distrikte integriert werden. In diesem Zusammenhang fördert der mosambikanische Aktionsplan für die Reduzierung der absoluten Armut ein aktives KRM.

Ziel

Ziel des Projektes ist, die Bevölkerung in Búzi besser auf Katastrophen durch Wirbelstürme und Überschwemmungen vorzubereiten. Die Entwicklungsplanung des Distriktes Búzi in der Provinz Sofala soll beispielhaft ein umfassendes Katastrophen-Risikomanagement (KRM) enthalten, das die regionale Anpassung an den Klimawandel stärkt. Distriktverwaltung und lokale Katastrophenvorsorge-Komitees werden dafür sensibilisiert, dass sich die klimatischen Verhältnisse dauerhaft verschlechtern werden und das KRM daher für häufigere und größere Katastrophen auszulegen ist.

Vorgehensweise

Zur Erreichung des Ziels werden Planungen angepasst und die entsprechende Infrastruktur geschaffen. Die Distriktverwaltung und die lokalen Komitees werden u.a. durch das Komitee des nationalen Aktionsplans zur Anpassung an den Klimawandel (NAPA) für die Herausforderungen durch den Klimawandel sensibilisiert und dabei beraten, wie sie diese Aufgaben bewältigen können. Da das Katastrophen-Risikomanagement auch den Aufbau und die Konsolidierung eines Frühwarnsystems einschließt, werden im Flusseinzugsgebiet des Búzi die Pegelstände genau bestimmt und für die Vorhersagemodelle erfasst. Die Erfahrungen aus dem Distrikt Búzi werden künftig über das NAPA-Komitee in andere Distrikte übertragen.

Weitere Informationen

- **Disaster Risk Management at the Rio Búzi, Mozambique**
  Case Study on the Background, Concept and Implementation of Disaster Risk Management in the Context of the GTZ-Programme for Rural Development in Central Mozambique (PRODER), 2005
  en-mozambique-disaster-risk-management-2005.pdf, 1,79 MB (english)

Adaptation to Climate Change in Mozambique

Early Warning and Education

Country/region:	Mozambique
Project name:	Integrating adaptation to climate change within disaster risk management systems in the Búzi river catchment area and other regions of Southern Africa
Partner:	Sofala province government, the committee for the National Adaptation Programme of Action (NAPA) and the National Disaster Management Institute (INGC)
Project duration:	June 2004 – December 2006

Scenario

Mozambique is one of the poorest countries in the world and one of the most frequently and worst affected by natural disasters, the majority of which have a direct link to climate change and seem to form part of the El Niño-Southern Oscillation (ENSO). Droughts over consecutive years during El Niño phases alternate with severe flooding during their "El Niña" counterparts. For the future extremely variable climatic conditions including increased frequency of cyclones from the Indian Ocean are predicted, as well as rising land temperatures.

Mozambique is only slowly recovering from 16 years of civil war, which ended in 1992. Life expectancy is around 40 years, with an illiteracy rate of above 50 percent. 78.4 percent of the population live off less than two US dollars a day. The country is ranked 168th out of 177 on the United Nations Development Programme (UNDP) Human Development Index, and is among the world's top ten hotspots for floods, droughts and cyclone disasters. Most of the 150,000 people living in the Búzi district of the central province of Sofala depend on subsistence farming. The success or failure of their crops is strongly influenced by the behaviour of the Búzi river and its main affluents.

At its highest point, the district lies 130 m above sea level, but large proportions of the coastal area are below sea level and are frequently inundated. Floods threaten lives and an already precarious food supply.

In spring 2000 the highest amounts of precipitation for 50 years, in combination with four cyclones, led to a flood disaster of unknown extent which killed around 800 and directly affected 4.5 million people.

Villagers escaping from the floods

Project

In 2001 the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH started a programme of reconstruction, which now forms part of the broader "Programme for Rural Development of Mozambique - (PRODER)". Within this framework, the "People- oriented inter-district early warning system for the catchment area of the Rio Búzi" (SIDPABB) was developed as a pilot project.

gtz CaPP Climate Protection Programme
gtz Disaster Risk Management in Development Cooperation
commissioned by: Federal Ministry for Economic Cooperation and Development

Precipitation measurement by the Early Warning Committee member in charge

Risk analysis meeting in villages of Búzi district

The system was based upon a thorough participatory risk analysis. It identified a third of the district's population, living in nine communities plus the capital Búzi, as being especially disaster-prone. Detailed maps now depict high-risk areas as well as elevated ground for emergency evacuation. Complemented by simple but effective regulations for cyclone-proof building, they also form the basis for the construction of new settlements for some of the families worst affected by the flood. Families may continue to farm the fertile grounds along the riverside, but crucially their family and property are safe.

A series of field workshops and community meetings were then conducted, many of them by local experts from Costa Rica and Honduras who had developed disaster risk management programmes in their own communities.

In a next step, local Disaster Management Committees (Gestão de Risco de Calamidades – GRCs) were established in all nine communities, with the role of fulfilling specific tasks in case of an emergency. These include first of all receiving an early warning, mainly through Radio Comunitario do Búzi (in Portuguese), and then informing the neighbourhood (in the local dialect Ndau), organising transport and evacuation, and maintaining the necessary equipment provided, such as radios, flashlights, shovels, megaphones, bicycles, rescue boats and first-aid kits. Training courses were conducted, including a large-scale simulation of emergency rescue of non-swimmers, who are still in the majority in the villages. An instructional film produced on this occasion is now used for training purposes.

As local leaders, doctors and teachers have all volunteered to serve on the GRCs, taking on responsibility became highly respected in the communities. None of the participants is paid for their duties. This is also the case for participation in the early warning system on floods along the entire river catchment area.

Seven monitoring stations on the upper course of the Búzi and its affluents have been set up. Rainfall and the river level are measured daily using simple and robust equipment. These data are directly transmitted via a direct radio frequency to Búzi, where they are analysed. The District Administrator has ultimate authority to instruct the GRCs via radio about the necessary steps to be taken. He has since become an expert on the issue, and has taken the lead with regard to the integration of disaster management in the development plan of his district.

Impact

This robust system now makes it possible to deliver an early warning on flood events. The system has already proven its efficacy during the 2005 rainy season, and has since been further calibrated and refined. It will also hopefully serve as one component in further initiatives to mitigate the impact of droughts in the region.

In recent years the people of Búzi have shown that climate-driven disasters and threats can be effectively met by concerted, decentralised community action and self-organisation at a low cost. This experience constitutes an important basis for additional steps to improve a still-desperate situation with respect to poverty and hunger. Moreover, it ensures that such improvements will not again be washed away overnight by the next floods of the Búzi, which are certain to come.

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Tanzania: Technological and other Options for the Mitigation of Greenhouse Gases in Tanzania

Partner Organisation: Ministry of Tourism, Natural Resources and Environment Department, Tanzania; Centre for Energy, Environment, Science and Technology (CEEST), Dar es Salaam
Project Period: June 1994 - March 1996
Financial Contribution: DM 490,000

Project Brief

Neither the production of greenhouse gases nor their reduction is a technological problem alone. In Tanzania, as well as in many other countries, market and institutional barriers are important obstacles to technological innovation. Because of weak structures, the clear economic and environmental signals have not initiated the necessary impetus to bring about a change of parameters and new developments.

A multicriteria analysis was carried out to produce a ranking of the different mitigation options that are now under consideration. The study identified the characteristics and costs for a number of technological and other measures to reduce the emission of greenhouse gases in Tanzania and came up with several recommendations: First of all, the efficiency of the existing power generating system should be increased by repowering and improving generation and distribution. Second, the implementation of combined-cycle turbines as well as more efficient use of energy in industry should be pursued. Efficiency improvement in electricity generation is ranked highly because of its broad acceptance. Being a large-scale and centralised technology, it is easier to take a decision on implementation than in the case of decentralised technologies.

The highly relevant sector of forest and land management, however, is faced with significant barriers to implementation. Acceptance and dissemination are crucial factors here which have to be taken into account. The same is true for nearly all measures in the household sector. For the industrial sector, on the other hand, efficient energy use is a very significant measure with high additional economic benefits.

Furthermore, it is recommended to develop a mitigation strategy to be implemented by the government in connection with its activities under the United Nations Framework Convention on Climate Change.

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Neither the production of greenhouse gases nor their reduction is a technological problem alone. In Tanzania, as well as in many other countries, market and institutional barriers are important obstacles to technological innovation. Because of weak structures, the clear economic and environmental signals have not initiated the necessary impetus to bring about a change of parameters and new developments.

This is true for the implementation of new and renewable energy technologies as well. An evaluation of projects carried out in Tanzania showed that dissemination of such technologies has to face a number of constraints. Among these, a lack of funds or huge investment costs are quite familiar, however. But very often, implemented systems have failed because of bad maintenance or a sudden change in energy demand and supply.

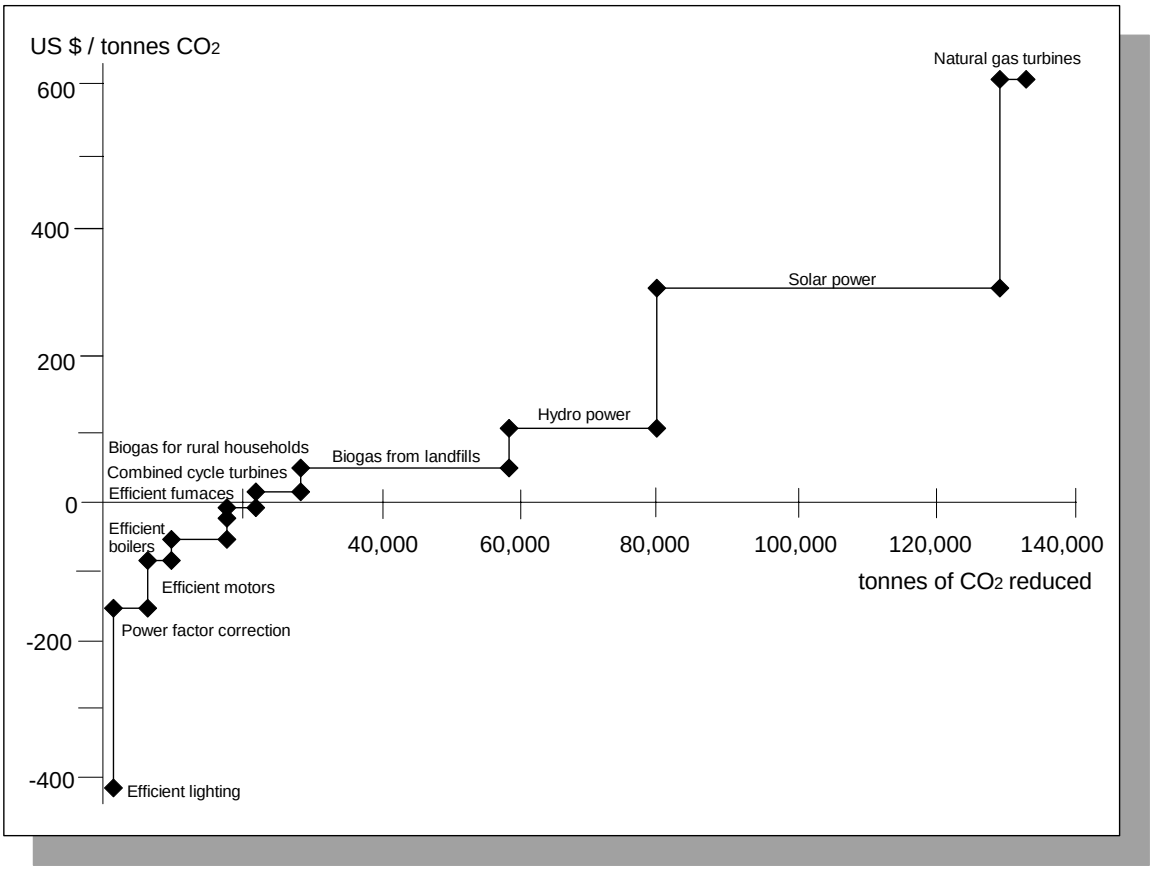
With a view to global warming and climatic changes, the massive employment of such technologies is under discussion again. However, bearing in mind some negative experiences in former projects, each technology should now be considered in a wider context. The necessary know-how for operation of the technology is an important factor, of course, but the expertise to manage such a technology change in its entirety is also a critical factor.

A multicriteria analysis was therefore carried out to produce a ranking of the different mitigation options that are now under consideration. The study identified the characteristics and costs for a number of technological and other measures to reduce the emission of greenhouse gases in Tanzania. For the future, it is intended to combine these findings with scenarios in national development plans. One of the scenarios drawn up now, however, involved regional collaboration, and therefore the effects of such cooperation have to be investigated in addition.

The main objective of the abatement study, as mentioned above, was to evaluate the costs of different options to limit the emission of several greenhouse gases. Furthermore, it may help to develop a mitigation strategy to be implemented by the Government in context with its commitments under the United Nations Framework Convention on Climate Change.

The analysis of Tanzania's economic structures shows a strong dependence on external factors. For the scenarios, two types of trends concerning the external environment were assumed, one relying on improved terms of trade, the other on periodic fluctuations. In other words, the first type represents a balanced growth scenario, whereas the second is more compatible with accelerated structural reforms.

A combination of these two types results in a composite development scenario which is more relevant for Tanzania. It is characterised by a predominance of structural reforms in the short term, followed by a more balanced growth in the long term. It also covers aspects of regional cooperation. Examples of cooperation initiatives between countries are the East African Community and the Southern African Development Community (SADC). Another one includes multilateral and international bodies.



Savings of CO_2-Mitigation

These aspects are included because of the fact that mitigation measures cannot be handled on an isolated national level. In most cases, economic development is associated with technological change, and economic cooperation very often also means technology transfer. However, socio-economic factors are of similar importance. A successful measure depends on the constraints and opportunities for the diffusion of different technologies within sectoral development.

For the composite scenario, certain economic assumptions were made as to growth rates. Though agriculture will increase output, its share in total production will decrease from 47 % (1990) to about 36 % in 2020. The shares of manufacturing and construction as well as the energy sector will increase from 14 % to 23 % during the same period. The economic analysis was carried out for the following sectors in the country: energy, agriculture and livestock, industry, forestry and land, service.

In the context of social and environmental considerations, energy is a key component of the economic development strategy. The power sector, mostly hydro-electric schemes, had an installed capacity of 570 MW in 1994. Nearly one third of stations, however, are grid-connected or isolated thermal power stations, many of which are old. To reduce emissions, a retrofit of these facilities could improve the efficiency of combustion.

Replacement of the old plants with hydropower would be a very effective measure, as would power sharing with neighbouring states. However, implementation of these options is not very likely in the near future because of high costs. Other mitigation options for the energy sector comprise energy efficiency in end-use sectors such as households and industry. In addition, the implementation of clean energy sources such as solar energy and wind power or mini hydro and biomass were considered, and a fuel switch to natural gas was also examined.

The unit cost of introducing a technology provides a basis for comparing the various options. In this context, costs reflect real prices as well as the social benefits of energy production and utilisation. Cost curves were therefore constructed which allow the identification of least-cost options to meet the reduction goals for greenhouse gases.

The cost curves for the energy sector are shown in the figure. As can be seen, there are five options with negative costs. They include, for example, efficient boilers and lighting, efficient motors and furnaces. However, most industries in Tanzania have to increase productivity and to decrease energy costs. Therefore, such options should be implemented in any case, because total benefits exceed the investment costs.

For the industrial sector, the study identified cement production as well as pulp and paper industries as significant sources of greenhouse gas emissions.

In the cement industry, automatic control systems could reduce fuel consumption and improve productivity. A fuel switch from oil to natural gas and the recovery of waste heat can avoid further emissions. In the pulp and paper industry, optimised recovery boilers can decrease energy consumption.

Greenhouse gas mitigation options in the forestry and land use sector rely on two measures: management of the existing carbon stock, and expansion of carbon sinks. This means, for example, better agricultural and land use management. Agro-forestry can be an answer in some cases, or afforestation and even urban tree-planting. Incidentally, the creation of CO_2 sinks by afforestation also provides new raw material for pulp and paper production.

As a result of the multicriteria analysis, some preliminary suggestions can be made. First of all, the efficiency of the existing power generating system should be increased by repowering and improving generation and distribution. Second, the implementation of combined-cycle turbines as well as more efficient use of energy in industry should be pursued. Efficiency improvement in electricity generation is ranked highly because of its broad acceptance. Being a large-scale and centralised technology, it is easier to take a decision on implementation than in the case of decentralised technologies.

The highly relevant sector of forest and land management, however, is faced with significant barriers to implementation. Acceptance and dissemination are crucial factors here which have to be taken into account. The same is true for nearly all measures in the household sector. For the industrial sector, on the other hand, efficient energy use is a very significant measure with high additional economic benefits.

Zambia: Inventories and Mitigation Analysis

Partner Organisation: Ministry of Energy and Water Development: Center for Energy Environment and Engineering, Zambia, Ltd. (CEEE(Z))
Project Period: September 1994 - March 1996
Financial Contribution: DM 380,000

Project Brief

In 1990, Zambia emitted about 3.2 million tons of CO_2 into the atmosphere. This corresponds to approximately 1% of Africa's total emissions.

Of these national CO_2 emissions, around 88% are due to energy use. Industrial processes contribute another 12%, mainly from production and use of cement and lime. Within the energy sector, transportation was responsible for 29% of CO_2 emissions, followed by mining with 15%.

For CH_4, the total was 457,000 t in 1990; biomass fuels, waste and agriculture are the main sources. Total N_2O emissions amounted to 3,570 t, also originating mainly from agriculture.

Land use change and forestry released a total of 59.4 million t of CO_2, mainly by forest clearing, biomass decay and on-site burning. Unlike the other emissions there was a net negative CO_2 emissions balance resulting form the large woodland forest potential.

These results are part of a project carried out to establish a greenhouse gas inventory for emissions in Zambia. In addition, this cooperation with GTZ identified technological options to reduce such emissions and determined the associated costs and benefits of those measures. The study results enable Zambian planners to find ways of integrating environmentally friendly solutions in the development of the national economy.

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Zambia:

Inventories and Mitigation Analysis

Partner Organisation:	*Ministry of Energy and Water Development: Centre for Energy, Environment and Engineering, Zambia, Ltd. (CEEE(Z)*
Project Period:	*September July 1994 - March 1996*
Financial Contribution:	*DM 380 000*

Of these national CO_2 emissions, around 88 % are due to energy use. Industrial processes contribute another 12 %, mainly from production and use of cement and lime. Within the energy sector, transportation was responsible for 29 % of CO_2 emissions, followed by mining with 15 %.

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Land use change and forestry released a total of 59.4 million t of CO_2, mainly by forest clearing, biomass decay and on-site burning. However, in view of the large woodland forest potential, there was a net balance in favour of CO_2 out of all emissions.

These results are part of a project carried out to establish a greenhouse gas inventory for emissions in Zambia. In addition, this cooperation with the GTZ identified technological options to reduce such emissions and determined the associated costs and benefits of those measures. Now, the study enables Zambian planners to find ways of integrating environmentally friendly solutions in the development of national economies.

As far as energy issues are concerned, the country is self-sufficient to a high degree, apart from in petroleum. Local energy resources include fuelwood, electricity, coal and petroleum products. Renewable energy sources such as wind and solar power are still an option to be developed in the future, however. Up to now, some photovoltaic applications for rural electrification have been installed. It is an option of increasing importance, although it is quite expensive at present.

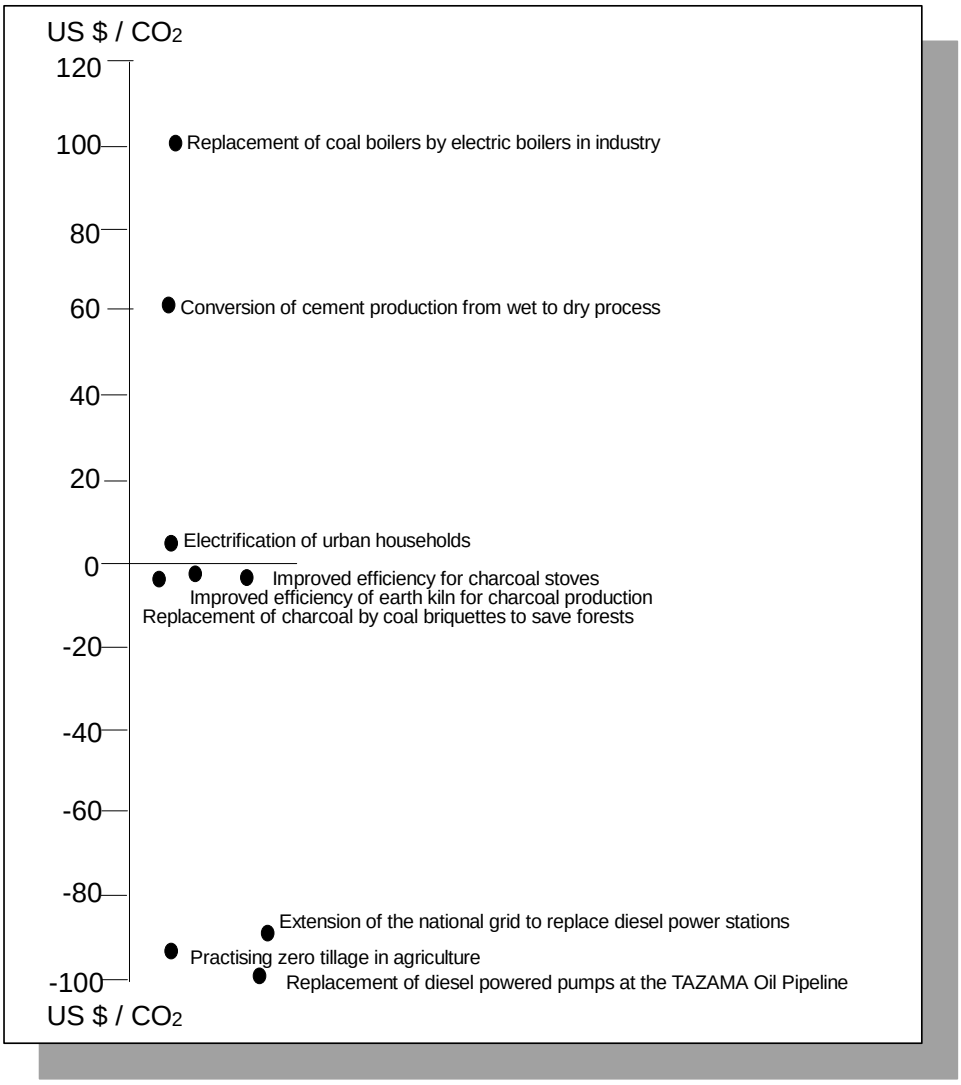
Zambia's unique situation on the supply side is its tremendous dependence on hydroelectric power: 90 % of the electricity supply, amounting to 1,670 MW, is generated by hydro, mainly on the Zambezi and Kafue basins.

The consumption of coal, on the other hand, has been declining steadily since 1975. However, this is not because of any particular energy plans but of production constraints in a specific coal mine. Though a rehabilitation programme was initiated in 1985, the colliery still needs further investment to meet local demand.

Up to now, coal has been used only in the mines and the industrial sector. In recent years, however, there have been efforts to produce coal briquettes for domestic use in households. Today, wood is the principal household fuel and the nation's largest source of energy. About 55 % of the total area is covered by woodlands. Fuelwood accounts for about 66 % of total energy consumption, climbing to 88 % in household energy needs. In urban regions it is mostly used in the form of charcoal.

Looked at from the other side, forest biomass production is the major sink for CO_2.

The national emission inventory provided the basis for subsequent mitigation analysis. For the purpose of this analysis, economic development, energy and industrial options were taken into consideration as well as projected emission levels. Some options were analysed with respect to their potential for greenhouse gas reduction and to the costs involved.



Abatement Options and Related Costs

Abatement costs were determined by annualising the capital for implementing the abatement option, and the operation and maintenance costs. These costs are presented as reduction costs per tonne of greenhouse gas in CO_2 equivalents. For the purpose of the analysis it was assumed that lower-cost options will be implemented first before moving to the higher-cost options. However, the model included the financial benefits of implementing an option.

Which options are available now to reduce emissions? There are, for example, plans for the electrification of households. Presently, the electrification rate is only about 12 %. This means that most people have no access to electricity. The ambitious plans for electrification, however, are capital intensive.

Another option aims at the substitution of charcoal by coal briquettes produced from coal dust. Reduced charcoal production could save wood and improve the sinking capacity of the forests. One argument for this option is that the coal used for this production would otherwise spontaneously combust, thus releasing emissions. According to the study, therefore, the use of coal briquettes instead of charcoal can result in an overall reduction of emissions. However, more detailed analysis is necessary here.

The main options for the industrial sector are energy substitutions and improved efficiency. With respect to the special situation described above, it is worth examining the question of replacing coal and oil with electricity. For example, the substitution of 50,000 t of oil annually for steam production would increase electricity demand by some 300 GWh per annum, taking into account the efficiency of boilers.

According to feasibility studies, extending the national grid could also be an option. However, the estimated costs are US$ 105 million with annual operating costs of 1 %. This option is aimed at interconnecting areas that are currently supplied by diesel generators. These stations require more than 15 million l diesel per year for an installed capacity of about 8 MW and an average annual output of 15 GWh. Of course, these diesel engines contribute to emissions, and for a long-term scenario it is feasible to analyse the effects of replacement by hydro-based electricity.

Examination of the abatement cost studies identifies such measures as the negative cost options which conserve diesel fuel. These include the replacement of diesel pumps by electric pumps on an oil pipeline, for example, or extension of the grid to replace diesel generators. Incidentally it is the high costs of maintenance for the diesel engines that are responsible for the negative costs in comparison with the low costs of hydel.

The no-cost options that have been identified are reduced consumption of charcoal in households and the displacement of charcoal by coal briquettes. By making this substitution, 50 % of the trees cut for charcoal production could be saved. The improvement of charcoal kilns has a reduction potential of 6 million t per year due to present great inefficiency in charcoal production. Unfortunately, the sector is dominated by small-scale informal producers who are not able to invest in more efficient kilns.

The high-cost options were found to be in the domestic electrification and industrial sectors, because of the major capital requirements. It should be mentioned, however, that this study did not consider all possible options. The transport sector, for example, was not included.

On the basis of these investigations, total abatement costs for 2010 were calculated to be about US$ 78 million for 27 million t of CO_2. Unlike other states in the region such as Botswana, South Africa and Zimbabwe, the CO_2 emissions of Zambia do not originate so much from the energy sector but from transportation, which contributes nearly 1/3 alone. Within the energy sector, however, coal is the main source, being responsible for 29 % of total emissions.

This difference can be explained by the important role of hydroelectric energy. Even expensive household electrification is therefore considered as an option to be analysed in more detail because the hydroelectric-based power system is already CO_2-neutral. In contrast with the dominance of charcoal today, this option may reduce CO_2 emissions by 3.6 million t if fully implemented.

The mitigation options for Zambia cover a wide range of negative, zero and low-cost options. However, there is a sharp increase in positive costs represented by domestic electrification, cement plant conversion and electric boiler efficiency improvements. These three options together, though, make up 44 % of all greenhouse gas savings.

Zimbabwe: Options for Greenhouse Gases Mitigation under Power Pooling in Southern Africa

Partner Organisation: Ministry of Energy and Transport Southern Centre for Energy and Environment (SCEE)
Project Period: September 1996 - September 1999
Financial Contribution: DM 540,000

Project Brief

The project was conducted by the Zimbabwean Government with technical assistance from GTZ. It identified the extent to which regional cooperation in the electricity sector can be utilised as a vehicle for greenhouse gas mitigation, among all major Southern African Development Community (SADC) states which are members of the Southern African Power Pool (SAPP). If appropriate measures are introduced, local environmental benefits and greenhouse gas (GHG) emissions abatement can be additional benefits to SAPP member states besides regional demand-supply balancing and higher security and quality of supply.

The objective of the project was to enable decision-makers in the SAPP power sector to utilise the options for the reduction of GHG emissions.
The project was implemented in three phases:

Phase 1: An inventory of GHG emissions from the power sector was compiled, using 1994 as the base year.
Phase 2: Regional power sector expansion and baseline GHG emissions were defined.
Phase 3: Proposals for measures to implement regional mitigation options were put forward.

The major options considered for regional mitigation were to be feasible.

1. Substitution of coal with gas and hydro in the business-as-usual (BAU) case,
2. Conjunctive operation of wind and hydro plants,
3. Operation of wind/gas plants used for pumped storage,
4. Residential switch to gas.

The quantified results showing which options have the greatest potential for GHG mitigation are presented in the report available for download. The Environmental Manual for Power Development was used in the project as the major tool to analyse scenarios of various possible power mixes in SADC.

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SOUTHERN AFRICAN POWER POOL

OPTIONS FOR CLIMATE CHANGE MITIGATION UNDER POWER POOLING IN SOUTHERN AFRICA

Partner Organisation:	*Ministry of Energy and Transport, Zimbabwe* *Southern Centre for Energy and Environment (SCEE)*
Project Period:	September 1996 – September 1999
Financial Contribution:	*DM 540 000*

BACKGROUND

Originally known as the Southern African Development Coordination Conference (SADCC), the Southern African Development Community (SADC) was formed in Lusaka, Zambia, on April 1st, 1980, following the adoption of the Lusaka Declaration - **Southern Africa: Towards Economic Liberation** by the nine founding member States. Current member states are Angola, Botswana, Democratic Republic of Congo (DRC), Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. Each member state has responsibility to coordinate a sector or sectors on behalf of the others

The Energy Protocol governs the administration of the SADC energy sector. One of the main objectives of the SADC Energy Protocol is cooperation in the development of energy and power pooling to ensure security and reliability of power supply. In fulfilment of this objective, the electricity utilities in the region have established the Southern African Power Pool (SAPP). The SAPP brings the following advantages to the region:

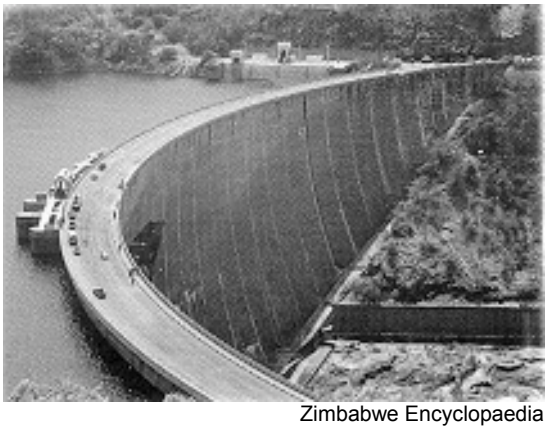
- Demand-supply balancing by facilitating electricity flow from surplus areas to deficit areas in order to cover deficits resulting from unexpected climate variability such as drought or from technical problems
- Economies of scale
- Security and quality of supply

If appropriate measures are introduced, local environmental benefits and mitigating the emission of greenhouse gases (GHG) can be additional benefits.

The power sector is the leading contributor to GHG emissions in SADC, and it also represents an area where SADC cooperation has been most successful. It was therefore important that this sector's contribution to the regional GHG emissions be properly documented and opportunities for regional cooperation for emissions reduction and avoidance be identified. This was done alongside an assessment of the technological and economic benefits SADC would derive from any activities to mitigate climate change under its power pooling arrangement.

This project sought to identify the extent to which regional cooperation in

Kariba Dam



Zimbabwe Encyclopaedia

the SADC electricity sector could be utilised as a vehicle for GHG mitigation. It was conducted in most SADC states that are members of the SAPP.

OBJECTIVE

The objective of the project was to enable decision-makers in the SAPP power sector to utilise the options for the reduction of GHG emissions.

MAIN ACTIVITIES

The project was implemented in three phases:

Phase 1: An inventory of GHG emissions from the power sector was compiled, using 1994 as the base year.

Phase 2: The regional power sector expansion and baseline GHG emissions were defined.

Phase 3: Proposals for measures for implementing regional mitigation options were put forward.

SUMMARY OF FINDINGS

Phase 1: In the base year for this study (1994), total GHG emissions from the SADC power sector were estimated at 159,555 Gg of CO_2 equivalent, in the form of CO_2 (153,335 Gg or 96.1%), N_2O (1.1%) and the balance made up of methane (2.8%). Coal thermal power plants contributed 98.8% of the CO_2 equivalent emissions. Diesel and gas turbine thermal plants contributed only 0.58% and 0.42%, respectively.

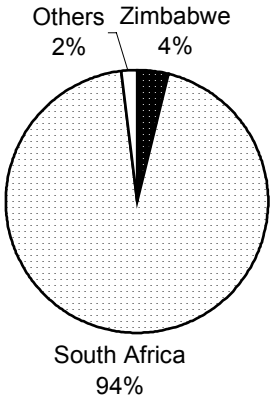
The majority of coal-fired power plants operated in the region use pulverised coal steam turbines. Plant efficiencies range from 23% for small plants to 36% for larger plants. South Africa, with its huge coal thermal plants contributed 94% of the regional CO_2 equivalent emissions, Zimbabwe 4%, with the balance being shared among the remainder (see chart).

Phase 2: The region's energy demand is projected to grow from 205 TWh to 292 TWh in 2020 (an average growth rate of 1.54% p.a.). This is based on the projected population growth rate of 2.9% per annum, the current low (average 7%) access to electricity by the household sector and an average GDP growth rate of about 3.2% per annum (African Development estimates). This is a business-as-usual scenario in which the maximum demand is taken as a summation of the individual utility expansion plans without any deliberate environmental considerations, demand side management nor likely impact of increasing regional electricity trade.

The regional expansion plan was taken as the aggregation of the national plans. The regional load is expected to grow from 31,868 MW in 1997 to about 53,215 MW in the year 2020. The expansion program is dominated by coal-based generation plants. Capacity from new hydro plants over the same period will total 4,047 MW.

There is extensive electricity trading in

SADC Power Sector GHG Emissions



the SADC region already. This trade consists mostly of bilateral arrangements. In 1994, ESKOM of South Africa was the largest exporter, exporting 2,628 GWh, followed by the DRC (1,278 GWh), Zambia (855 GWh), and Namibia (28 GWh). However, with the completion of the inter-connectors to Zimbabwe and South Africa in 1997, Mozambique becomes the second largest exporter.

Dying Trees at Lake Kariba

Holger Liptow

Phase 3: Regional options for GHG mitigation are those that require the participation of two or more countries to be feasible. These include:

- Joint investments in lower carbon or no carbon power plants
- Power import/export agreements from lower carbon sources
- Import/export of low carbon fuels for power generation
- Coordinated system dispatch or control and management to reduce GHG emissions

The baseline (business-as-usual) case requires the installation of 7,068 MW of thermal plant fired on coal and 4,047 MW of hydro plant by 2015. About 863 MW of gas plant is installed in the same period. Based on available resources, there is potential for 18,000 MW of hydro plant and 2,465 MW of gas-fired plant. GHG emissions could thus be reduced by substituting this hydro and/or gas based generation for coal generation. Apart from the prohibitive capital costs, hydro dams are also associated with other negative environmental costs such as displacements of populations, destruction of vegetation and submergence of tourist attractions. The Congo and Zambezi rivers, however, have potential for significant run-of-river power plants with minimal adverse environmental effects. Nuclear power has not been considered as a mitigation option because of the problems of waste disposal and the stigma attached to the technology.

Potential regional mitigation projects will, thus, include hydro, gas, renewable energy (wind) projects and interconnectors for imports/exports. **Mitigation scenarios** were developed through various combinations of the mitigation plants identified, conjunctive operation of wind and hydro plants, operation of wind and gas plants to provide pumped storage, and encouraging the residential sector to use gas for cooking/heating instead of coal-based electricity. The specific options considered were:

1. **Displacement of coal with gas and hydro from the business-as-usual (BAU) case:** This would entail replacing the new coal plants in South Africa after 2004 with gas from Kudu in Namibia and/or Pande in Mozambique. Some coal-fired South African plants would be re-powered with gas.
2. **Conjunctive operation of wind and hydro plants:** A wind farm (350 MW) would be used to enable hydro power stations such as Kariba to run for shorter periods. As a result more water would be stored in Kariba. This increases the generation efficiency of the hydro station.

Coal-based generation would therefore be reduced.

3. **Operation of wind/gas plants used for pumped storage:** This option results in the inefficient coal-fired plants running for shorter hours, leading to an emission reduction of 42%.
4. **Residential de-marketing to gas:** This option would involve the construction of a gas pipeline from Pande in Mozambique to Zimbabwe and South Africa. Households would be encouraged to use the gas for cooking and other heating applications instead of electricity.

GHG Emissions (million tonnes)

	BAU	SC 1	SC 2	SC 3	SC 4
2000	173	173	173	173	173
2005	179	172	177	175	177
2010	189	167	187	183	188
2015	104	161	202	195	202
2020	239	186	236	229	236

Scenario 1 (SC 1) results in the largest reduction in emissions, amounting to 53 million tonnes of CO_2 equivalent or a 22% reduction compared to the reference case. This is due to the large number of hydro and gas options in this scenario. Scenario 3 (SC 3) also provides a significant reduction in emissions (10 million tonnes or 4%). The other two scenarios provide only marginal reductions (3 million tonnes or 1%) annually at the end of the study period in 2020. Scenario 2 (SC 2) is cheapest to implement at -$110/t CO_2. Scenario 4 (SC 4) costs -$107/t CO_2, while both Scenario 1 (SC 1) and Scenario 3 (SC 3) have positive costs of $59/t CO_2 and $74/t CO_2 respectively.

OUTLOOK

This project has demonstrated some of the opportunities that exist for the SADC region for GHG mitigation. These options can be realised by utilising the huge hydro potential in the region, particularly from the Congo and the Zambezi rivers, and through developing the recently discovered gas resources in Namibia, Mozambique and Tanzania. Renewable energy, particularly wind, also has a significant role to play. The huge coal reserves will continue to play a major role in the power sector, especially in light of the droughts that have been experienced in the region in the past.

From the region to benefit from the diversity of its energy resources, more emphasis should be placed on constructing and strengthening interconnectors to facilitate power flow from surplus to deficit areas across the region. More benefits can also accrue to the region from closer cooperation by SADC power utilities through SAPP. International assistance to the region can also be accessed to:

- Strengthen the SAPP to move towards a 'tighter pool' with collaborative planning and smoother operational and electricity trading protocols.
- 'Buy down' the investment costs for inter-connectors and resource development since these bring about global benefits in the form of GHG emission reduction.
- Increase the region's access to modern energy technology for GHG mitigation through improved power generation efficiency.