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Climate Change and Environmental Assessments: Issues in an African Perspective

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ABSTRACT

The present study discusses the potential for integrating climate change issues into environmental assessments (EAs) of development actions, with emphasis on sub-Sahara Africa. The study is motivated by the fact that future climate change could give significant adverse impacts on the natural and socio-economic environment in Africa. Yet, global change issues – including climate change – have to date largely been overlooked in the process of improving EA procedures and methodologies. The study argues that even though emissions of greenhouse gases (GHGs) in Africa are negligible today, it is highly relevant to include this aspect in the planning of long-term development strategies. The study discusses potential areas of conflicts and synergies between climate change and development goals. The general conclusion emerging from the study is that EA *per se* could be an appropriate tool for addressing climate change issues, while there are still several obstacles to its practical implementation. Four priority areas are suggested for further work: (1) Environmental accounting, (2) harmonisation and standard-setting, (3) implementation, and (4) risk management.

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ACRONYMS AND ABBREVIATIONS

AfDB	African Development Bank
AFTES	Africa Technical Department, Environmentally Sustainable Development Division
CH_4	Methane
CO_2	Carbon dioxide
DANIDA	Danish International Development Assistance
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
GCM	Global Circulation Model
GEF	Global Environment Facility
GHG	Greenhouse Gases
GIS	Geographical Information Systems
GtC	Gigatonnes of Carbon (1 GtC = 3.7 Gt carbon dioxide)
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
IRA	Institute of Resource Assessment
NEPA	National Environmental Policy Act of the USA
NGO	Non-Governmental Organisation
NORAD	Norwegian Agency for Development Cooperation
OD	Operational Directive of the World Bank
ODA	Official Development Assistance
SEA	Strategic Environmental Assessment
SIDA	Swedish International Development Cooperation Agency
SSA	Sub-Sahara Africa
ToR	Terms of Reference
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WCED	World Commission on Environment and Development
WMO	World Meteorological Organization

1. INTRODUCTION

1.1 Background

Environmental assessment (EA[1]) can be defined as "a structured approach for obtaining and evaluating environmental information prior to its use in decision-making in the development process" (IRA/IIED, 1995). Since its introduction in 1969 through the National Environmental Policy Act (NEPA) of the United States, EA has mainly had a "react and cure" approach, i.e. to mitigate impacts of already planned projects largely without being involved in project selection or design. As a response to this, efforts are now being made to expand the scope and application of EA towards a mechanism for assuring sustainable development.

The report of the Brundtland Commission (WCED, 1987) was central to the process leading to a wide recognition of the "sustainability" concept as the guiding rule for future planning. IUCN (1980) defines sustainable development as "the management of human use of the biospheres so that it may yield the greatest potential to present generations while maintaining its potential to meet the needs and aspirations of future generations". Two key elements in planning for sustainable development are the precautionary principle and the internalisation of external effects. *The precautionary principle* states that any development action should take into account future risks, hazards, and adverse impacts. In the absence of clear evidence, the principle emphasises safety considerations (Gilpin, 1995). *Internalisation of external effects* means that positive or negative non-market effects affecting other than those creating the effect should be fully accounted for in the calculation of costs and benefits.

Using EA as a mechanism for assuring sustainable development implies first that global-scale effects of local actions should be accounted for. Secondly, it is now widely recognised that there is a need to change the focus of EA towards an "anticipate and prevent" approach (see, e.g., Goodland and Tillman, 1995). In practice, this means that EAs should not only be a correction to individual projects but also be actively involved in designing policies, plans and programmes. The rationale for applying environmental assessments to climate change includes the following:[2]

- Given the large potential impacts of climate change, the issue is not adequately addressed in current EAs of development projects. Two aspects need consideration: *causes*, how projects affect emissions and uptake of greenhouse gases (GHGs), and *effects:* how climate change would affect projects and sectors (vulnerability, resilience or adaptation capacity).
- EA is a well-established instrument and could be "an entry point" for incorporating climate change issues into the mainstream of development planning and decision making (Sadler, 1996; Rees, C., 1995).
- Article 4 (1) of the UN Framework Convention on Climate Change (UNFCCC) identifies EA as one method for implementation of measures to counteract climate

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[1] EA will be used here to describe all terms used for assessments of environmental impacts of development actions, including e.g. Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA) and Impact Assessments (IA). EA and EIA will be used interchangeably in the report.
[2] See also Bisset (1996); Malvern et al. (1996); Canter (1996); World Bank (1995)

change and adapt to its impacts[3]. To date however, few studies have investigated how EA could achieve this role in practice (Sadler, 1996).

1.2 Objectives of this study

This study examines the role of EA of development projects in dealing with the issue of climate change, giving particular attention to sub-Saharan Africa (SSA). The principal objectives are:

1. To investigate the potential of existing EA procedures and methodologies to address climate change issues, with emphasis on Africa south of the Sahara
2. To assess the needs and challenges for future work, including methodological aspects, legislation, institutions, capacity building, and the role of EA in implementing the UN Framework Convention on Climate Change (UNFCCC).

1.3 Target groups

The study is primarily targeted towards countries of sub-Saharan Africa and donor agencies involved in development efforts in Africa.

1.4 Report structure

The following chapters include among other topics; (i) discussions of the links between climate change and development projects in Africa, (ii) challenges for environmental assessment procedures and methodologies for addressing climate change issues, and (iii) examination of present practices and identification of future needs regarding legislation, administrative and institutional strengthening and capacity building.

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[3] "All parties (…) shall (...) Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example **impact assessments**, formulated and determined nationally, with a view to minimising adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change;"

2. CLIMATE CHANGE AND ENVIRONMENTAL ASSESSMENT

There is increasing evidence of a human influence on the global climate through emissions of greenhouse gases (GHGs) and *aerosols* (IPCC, 1996a). A successful response to any potential threat of climate change depends on a good understanding of cause-effect relationships and knowledge of appropriate instruments for implementation. Over the last years there has been increasing attention given to environmental assessment (EA) as a tool for achieving environmental sustainability and for addressing global concerns, including climate change issues (Bisset, 1995; Sadler, 1996).

2.1 Climate change: challenges for EA

There is a number of issues which need to be discussed: (1) do current EAs "catch" the relevant climate change parameters; (2) are they included at the right stage in the process, (3) will these be appropriately accounted for in selection, design and monitoring of projects, and (4) if not, is this due to inappropriateness of the EA process *per se*, or could methodologies be modified in order to take climate change into account? Several characteristics of the climate change problem give challenges to the EAs as currently undertaken:

- Climate change is a transboundary problem, whereas EAs rarely include impacts at the international or global level (Bisset, 1995).
- Climate change is a cumulative effect of a large number of individually insignificant GHG emissions. EAs normally focus on local and regional effects of individual projects. Thus, even though GHG emissions were accounted for they would be negligible at this level.
- The complex cause-effect relationship makes it difficult to assess magnitude and direction of climate change impacts, particularly at the regional level.
- Response strategies to climate change will require international efforts that at the national level may challenge existing sector policies and institutional framework (Sadler, 1996; Bisset, 1995).
- Due to time lags climate change impacts of present emissions may not be evident for many decades to come, whereas irreversible impacts can only be avoided by anticipatory measures. Traditional project-level EAs, however, tend to be reactive and more concerned with mitigation[4] of impacts than selection and design of alternative projects or strategies.
- It is anticipated that climate change may have significant impacts on the social and economic environment, while EAs traditionally have concentrated on impacts on the natural biophysical environment.

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[4] Note that the term "mitigation" is used differently in the climate change terminology and in the EA process. When discussing climate change "mitigation" describes measures reducing (net) emissions of greenhouse gases (GHGs). In the EA process, however, mitigation means modifications that minimise adverse effects and enhance positive effects of projects, plans, policies etc. Thus, mitigation could here mean both emission-reduction and adaptation measures.

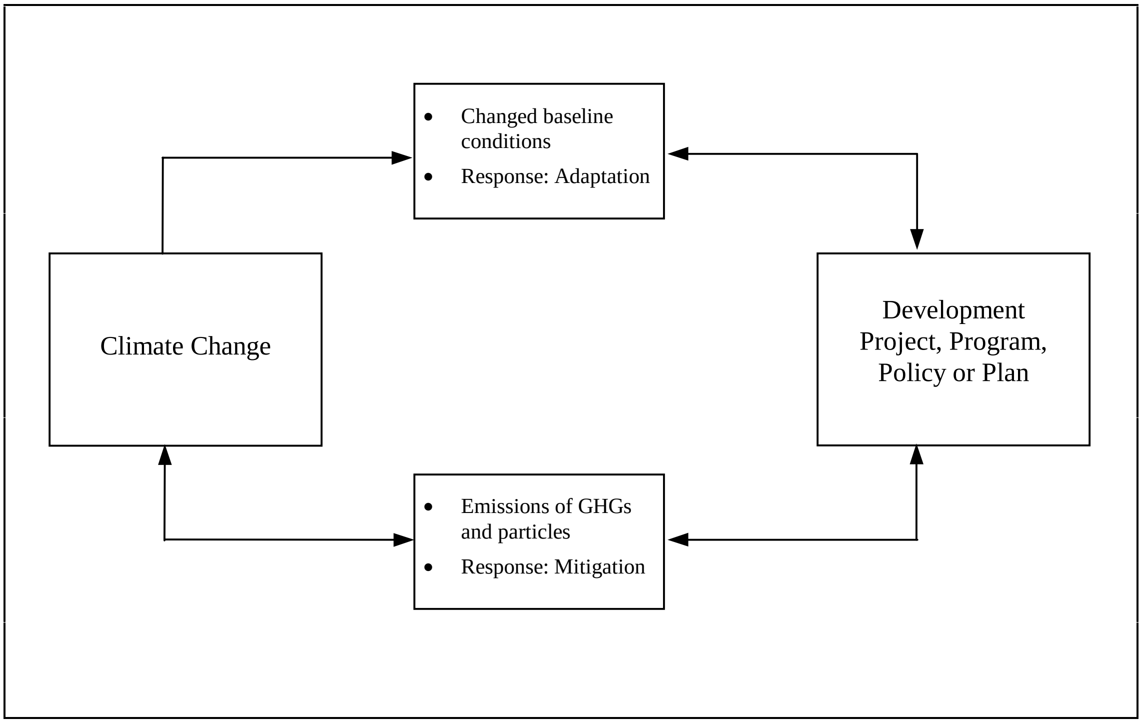

Figure 2.1. Potential linkages between climate change and development projects.

2.2 Development and climate change

There is a long and complex chain of cause and effect between development efforts and climate change. A simplified flow chart of interlinkages can be seen in Figure 2.1. Development actions may affect GHG sources and sinks and thus contribute to increasing or reducing the build-up of greenhouse gases in the atmosphere. Major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Climate change on the other hand is likely to have a number of direct and indirect impacts on development efforts. The magnitude, direction and significance of these impacts depend on the sensitivity of the environment and vulnerability of people. In this report particular attention will be given to the energy and forest sectors, where adaptation and mitigation options related to development projects in Africa will be discussed.

2.3 EA procedure and methodologies

2.3.1 Procedure

The responsibility of conducting an EA is normally with the proponent. The way environmental assessments are carried out depends on laws or guidelines of the country and donor agencies involved. In some countries EA is a direct legal requirement while in others it is enforced indirectly, such as under general planning, health or pollution control powers (Clark, 1994). However, most EA guidelines have a common structure that involves the following stages (based upon UNEP, 1996 and World Bank, OD 4.01):

1. *Environmental screening.* The purpose is to decide whether a project requires further investigation in an EA, and at what level. According to the World Bank EA guidelines projects should be screened for environmental issues and assigned to one of three categories, based upon expected environmental impacts: “A” (significant and serious

impacts expected, full EA required), “B” (moderate impacts anticipated, only environmental analysis is required), or “C” (insignificant impacts, no EA or environmental analysis necessary except a justification for selecting the C category).

2. *Scoping and preparation of Terms of Reference (ToR)*. The aim of scoping is to identify key environmental impacts requiring further investigation, including time scales and geographic coverage. The ToR should provide for adequate interagency coordination as well as consultation with affected groups and local NGOs.
3. *EA preparation.* The EA itself should ideally form part of the project work so that the EA findings are directly integrated into project design. EA work involves identification, analysis and evaluation of the anticipated impacts. There are various methods available for this purpose, from simple checklists to complex computer models (see Table 2.1 below).
4. *Institutional strengthening and training:* Identification of relevant environmental agencies and their capacity to carry out required EA activities. This stage commonly involves strengthening of institutional capacity, training of staff, and development of appropriate legal or regulatory measures.
5. *EA review and project appraisal.* The EA review contains an assessment of the adequacy of the EA report, taking account of the points of view of stakeholders and assessing the acceptability of the proposal in terms of existing plans, policies and standards. The project appraisal mission, when undertaken, is meant to ensure an appropriate incorporation of EA findings into the project. Included is, among other things, mitigation measures to prevent, reduce or compensate for adverse impacts.
6. *Information distribution and project supervision.* The EA findings should be presented in a useful format and distributed to decision-makers and affected parties. EA recommendations then form the basis for supervising the environmental aspects during project implementation. This involves control of implementation of mitigation measures and reporting on compliance with environmental commitments. Where necessary, actions should be taken to ameliorate any problems.
7. *Ex post evaluation*. This includes an evaluation of environmental impacts actually happening, effectiveness of mitigatory measures taken, and institutional development and training.

2.3.2 Methodology

The underlying principle of environmental assessments is optimisation of the resource use through a balancing of conservation and utilisation. The term “optimisation” is normally based upon human preferences. Optimal resource allocation, among groups (spatial scale) and between present and future generations (temporal scale), is determined on the basis of various criteria that have been developed for that purpose.

Identification and valuation of impacts are key elements in enabling a balanced selection of the preferred development efforts. Table 2.1 shows commonly used methods for impact identification and their main advantages and disadvantages. Impacts can be measured in physical or monetary terms. Crucial in EA methodology is the assessment or valuation of non-economic goods and services, i.e. those that are not traded in markets. Several methods are available, including interview methods and observing behaviour of the groups that use the resources. Ranking is made on the basis of highest possible net social benefits, cost-effectiveness, or criteria that also consider the distribution of costs and benefits among various groups.

2.4 Reasons for applying environmental assessments

Benefits. EAs provide a comprehensive set of information for better management and development decisions. The EA process often leads to savings in capital and operating costs, as well as reduced costs of approvals of development applications. The *indirect* benefits, however, are difficult to quantify. Potential benefits of including climate change mitigation in EAs are the avoided future costs of changes in climatic conditions. Other potential benefits as identified by UNEP (1996) are increasing awareness on environmental issues, promoting environmentally sustainable development, better compliance with environmental standards and increased project acceptance by the public.

Costs. Direct costs of preparing an EA rarely exceed one per cent of total project costs (World Bank, 1991b; Gilpin, 1995), and are often much lower. In an examination of water resource projects in Thailand, it was found that EA costs ranged from 0.01 to 0.11 per cent of total project costs (UNEP, 1996). However, the indirect costs resulting from EAs may become considerably higher, for example as a result of delays in the procedures or due to control measures which must be included e.g. to control pollution.

Table 2.1 Main advantages and disadvantages of impact identification methods.

Impact identification method	Advantages	Disadvantages
Checklists -simple -ranking and weighing	• simple to understand and use • good for site selection and priority setting	• do not distinguish between direct and indirect impacts • do not link action and impact • the process of incorporating values can be controversial
Matrices	• link action to impact • good method for displaying EA results	• difficult to distinguish direct and indirect impacts • significant potential for double-counting of impacts
Networks	• link action to impact • useful in simplified form for checking for second order impacts • handles direct and indirect impacts	• can become very complex if used beyond simplified version
Overlays	• easy to understand • good display method • good siting tool	• address only direct impacts • do not address impact duration or probability
GIS and computer expert systems	• excellent for impact identification and analysis • good for experimenting	• heavy reliance on knowledge and data • often complex and expensive

Source: UNEP (1996)

2.5 Types of EA and their application

Figure 2.2 shows the two major types of EA: (1) Project oriented, traditional reactive EA, mainly concerned with individual projects, and (2) Strategic environmental assessment (SEA), a more recently introduced type addressing policies, plans and programmes.

2.5.1 Traditional reactive EA

This is the traditional and still dominating method for impact assessments, focusing on impacts of individual projects. Many donor countries and agencies require such EAs prior to funding and implementation of development projects in Africa (Rees, C., 1995; Roe et

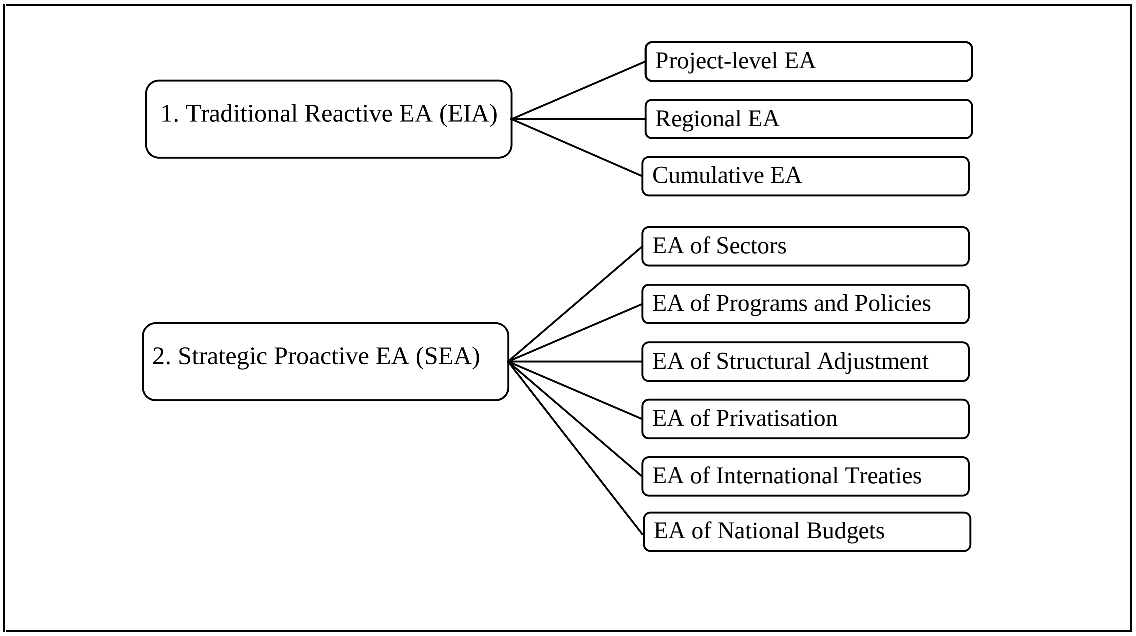

Figure 2.2. Types and sub-types of environmental assessment. (Goodland and Tillman, 1996).

al., 1995). The major weakness of this type of EA as implemented is that it is often undertaken at a late stage in the planning process. Furthermore, it is mainly concerned with mitigation of impacts of already planned projects. Thus, EA has to date had little influence on the choice or design of alternatives and has given few incentives for linking projects to strategies for sustainable development. Many potential cost and benefit factors are omitted when only individual projects are considered, including cumulative effects of groups of projects.

2.5.2 Strategic environmental assessment (SEA)

SEA differs from traditional EAs in having a more comprehensive perspective on development efforts. Instead of focusing on individual projects, SEA is concerned with policies, plans and programs. Because of this approach, SEA is regarded as more appropriate than conventional EAs in dealing with climate change (Bisset, 1995; Sadler, 1995). Another major advantage is that environmental issues are considered early in the process, thus facilitating strategic thinking in relation to sustainability issues (Sadler, op.cit.). SEA of policies, plans or programmes will often need project-specific EA as a second step (see e.g. UNEP, 1996:140). Although SEA was included already in the 1969 US National Environmental Policy Act (NEPA), the practical use has been limited so far (Gilpin, 1995), and there are many unresolved questions. For a recent and comprehensive review of SEA and its strengths, weaknesses and directions for the future, see Partidário (1996).

2.5.3 Application to climate change

Table 2.2 presents a methodological comparison of traditional EA and Strategic EA with regard to their applicability to climate change, based on recent literature.

Table 2.2 Methodological comparison of traditional EA and SEA regarding applicability to climate change, with special reference to the African situation.

	Advantages (conceptual, practical)	Limitations (conceptual, practical)
Traditional EA	• Well established and well-known procedures • Relatively easy to communicate with affected parties • Could be one mechanism for implementation of sound climate policies at the local level • A "bottom-up" approach is appropriate as individual actions have macro-level implications	• Does not normally include interrelations and feedback mechanisms • EAs are already large and burdensome, other issues may be considered more important • Does not normally take cumulative effects into account • Reactive rather than proactive
Strategic EA	• Climate change included earlier in the process than traditional EAs. • Based on a holistic approach and encourages long-term strategic thinking • Links climate change with other policy aims • Facilitates regional co-operation • Encourages a focus on cause instead of effects	• Recent and still unfinished concept, not many experiences in Africa • May lead to bias in development funding towards global environmental concerns and an overemphasis on climate change issues • To be effective, SEA must be translated and communicated to the local level (e.g. through project-level EA)

Sources: Based on Sadler (1996), Bisset (1995), Partidário (1996)

3. IDENTIFICATION OF KEY ISSUES

The present chapter intends to identify key issues and challenges with regard to climate change and EA, using the stages in the EA procedure listed in chapter 2.3 above as a point of departure. We will concentrate on three major and cross-cutting issues in EAs; (1) examination of impact characteristics and importance, (2) evaluation of impact significance, and (3) management issues.

As noted above, the inclusion of climate change issues will give several challenges to the current EA system, particularly project-level EAs. Whether an EA is required, and if so at what level, will normally be decided through an initial assessment or screening process. Individual projects will hardly give any significant GHG emissions at the global level, and climate change impacts are difficult to assess at the project level. Moreover, the scoping process of traditional EAs will normally be too narrow to include transboundary or global-scale effects or effects that may not be visible for still many decades. Thus, climate change, intentional or not, are easily left out in this process.

3.1 Impact characteristics and importance

Figure 3.1 outlines the relation between characteristics, importance and significance of environmental impacts as examined in EAs.

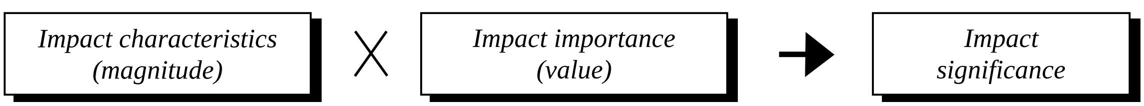

Figure 3.1 The relation between characteristics, importance and significance of impacts (UNEP, 1996:342).

3.1.1 Impacts of development projects on GHG sources and sinks

Present anthropogenic emissions of GHGs from Sub-Sahara Africa (SSA) are lower than for any other continent, both regarding total and per capita emissions. Emissions mainly stem from land use change (for the most part deforestation without immediate regrowth) and industrial sources (largely energy and transport). Africa south of the Sahara currently contributes about 4.4% of global emissions of carbon dioxide (CO_2) from industrial sources and land use change (Table 3.1). CO_2 is by far the most important of the GHGs. South Africa is responsible for 26% of the CO_2 emissions from SSA, of which about 95% stem from industrial processes. Marland et al. (1994) calculated per capita industrial CO_2 emissions in Africa for 1991 at 0.28 metric tons per year, compared to 5.22 for North America and 1.15 for the world as a whole[5]. Methane (CH_4) is the second most important of the anthropogenic greenhouse gases. In World Resources 1996-97 it is estimated that the African contribution to CH_4 emissions from anthropogenic sources (mainly livestock and oil and gas production) is 7.8% of the global total.

[5] Per capita figures do not include CO_2 emissions from land use changes.

Table 3.1. CO_2 emissions from industrial sources and land use change, 1991-1992.

	Industry (000 metric tons)	Land use change (000 metric tons)	Total (000 metric tons)	GtC	% of world total
Africa, North[†]	243,593	12,316	255,909	0.07	1.0
Africa, Sub-Sahara	472,180	717,684	1189,864	0.32	4.4
North & Central America	5715,466	190,000	5905,466	1.61	22.3
South America	605,029	1800,000	2405,029	0.66	9.1
Asia	7118,317	1300,000	8418,317	2.30	31.9
Oceania	297,246	38,000	335,246	0.09	1.2
Europe	6866,494	11,000	6877,494	1.88	26.0
World	22339,408	4100,000	26439,408	7.22	96[††]

[†]Includes Algeria, Egypt, Libya, Morocco and Tunisia
[††]World totals include countries not listed in World Resources 1996-97.
Source: WRI/UNEP/UNDP/WB (1996)

Current GHG emissions from Africa are thus of little importance on a global scale, and emissions from Africa have contributed only a negligible share of the build-up of GHGs in the atmosphere so far. Still, Africa's share of global emissions may increase considerably in the future (see e.g. Hulme, 1996). Figure 3.2 shows non-intervention emission scenarios (IPCC and other recently published scenarios) of anthropogenic CO_2 emissions per year (GtC/year) for Africa and three other important regions: USA, Central & Eastern Europe and former Soviet Union, and China & centrally planned Asia. The figure highlights the tremendous scenario variations, but also reveals that in a "worst case" scenario, African emissions could become comparable to or even higher than those of the other regions towards the end of next century. Variables that produce the scenario variations include (1) population growth, (2) economic growth, (3) energy intensity, i.e. the amount of energy consumed per unit output, (4) use of fossil fuels, and (5) deforestation rates. The assumptions behind the "reference" scenario (IS92a) are (after Ojwang et al., 1995):

(1) population growth as predicted in the World Development Report for 1991 (World Bank, 1991c),
(2) economic growth rates in the low end of the forecast range of World Bank (op.cit.),
(3) energy intensity declining sharply after the year 2025,
(4) natural gas and petroleum: increased reliance until 2025 and then declining consumption; coal: increased consumption throughout next century, and
(5) deforestation rates at roughly one Gt/year until 2025, and then declining rates.

The "worst case" scenario (IS92e) can be seen in the figure as the upper end of the IPCC range. It differs from the "reference" scenario in that it assumes twice as high coal consumption and five times greater oil consumption, as well as somewhat higher economic growth rates.

It is commonly argued that GHG emissions from development projects in Africa should be given only minor attention due to three main factors: (1) Present GHG emissions from Africa are negligible on a global scale; (2) climate change is a problem that is largely caused by developed countries' GHG emissions, and hence, these countries should have the main responsibility and bear the major costs of reducing emissions; and (3) the cause-effect relationship is complex and much is still uncertain about climate change and its potential impacts. There is thus a danger of misinterpretation and overemphasis on actions to limit emissions, which in turn may limit African countries' development pace.

However, these factors do not necessarily mean that emissions are irrelevant in a planning context. Firstly, as indicated above it is clear that continued high rates of population growth would lead to considerable increases in African GHG emissions, even if per capita emissions are kept at a low level. Secondly, African countries will make a number of strategic decisions through the development process that will significantly affect emissions. One example is the choice of energy source (non-renewables versus renewables). Thirdly, land use change, largely deforestation, is the dominant source of GHG emissions in Africa. Land use changes have at the same time significant implications for soil productivity, water supply, and in turn human welfare, as well as deleterious and in many cases irreversible impacts on biological diversity.

There are thus strong arguments for internalising the global consequences of development actions in Africa in order to avoid a “tragedy of the commons” situation (Rees, W.E., 1995; Hardin, 1968). This does not, however, imply a judgement of which part should be responsible for bearing the costs. The reluctance of African countries to undertake GHG emission-reducing actions seems to be partly based on a view that African countries should not act before developed countries have taken the leading position they are obligated to under the Climate Convention (UNFCCC). Another aspect is that mitigation measures are expected to require considerable technology transfers, for which the benefits are uncertain and the funding mechanisms (as stipulated in the Convention, cf. the concept of “incremental costs”) are still unclear (see e.g. Okoth-Ogendo, 1995).

3.1.2 Impacts of climate change on development projects

Climate change may affect project performance directly through changes in temperature, rainfall, sea level rise, and changes in the occurrence of extreme weather events (floods, droughts, storms). Current climate models (for the most part GCMs) can only provide rather rough predictions of the magnitude, direction and the time of occurrence of changes in climate parameters, and even more so when it comes to impacts on primary production, ecological systems or the society. While there has been progress on developing a methodology framework for climate impact studies (see Carter et al., 1994), there is still little field experience in Africa (see review studies by Hulme et al., 1995 and Hernes et al., 1995). Case studies on impacts and adaptation strategies have been published by the US Country Studies Program (see, e.g., Smith and Lenhart, 1996).

Human-induced climate change can to some extent be seen as a change in *baseline conditions*. Baseline conditions represent the reference situation against which the costs and benefits of a project alternative are measured. Climate change scenarios are based on both Global Circulation Models (GCMs) and records of observed climates. It is important to note that these are not *predictions*, but only scenarios for the future situation under a set of variables with given values. Model results can nevertheless provide insight into which are the important factors and their interdependencies and sensitivities.

It is anticipated that a given change in climate will result in more adverse socio-economic impacts in Africa than in other parts of the world. This relates to several factors regarding vulnerability of the society and sensitivity of the environment. Important factors are high dependency on bio-fuels, high dependency on the agriculture and forest sectors, restricted mobility of the population, poor health facilities, high population growth rates and low material standards (cf. Hernes et al., 1995). Furthermore, countries in Africa tend to have a much higher share of their economy in climate-sensitive sectors such as agriculture than on other continents (Smith and Lenhart, 1996). Problems are exacerbated by the fact that African countries in general have low institutional and financial capacity to adapt to

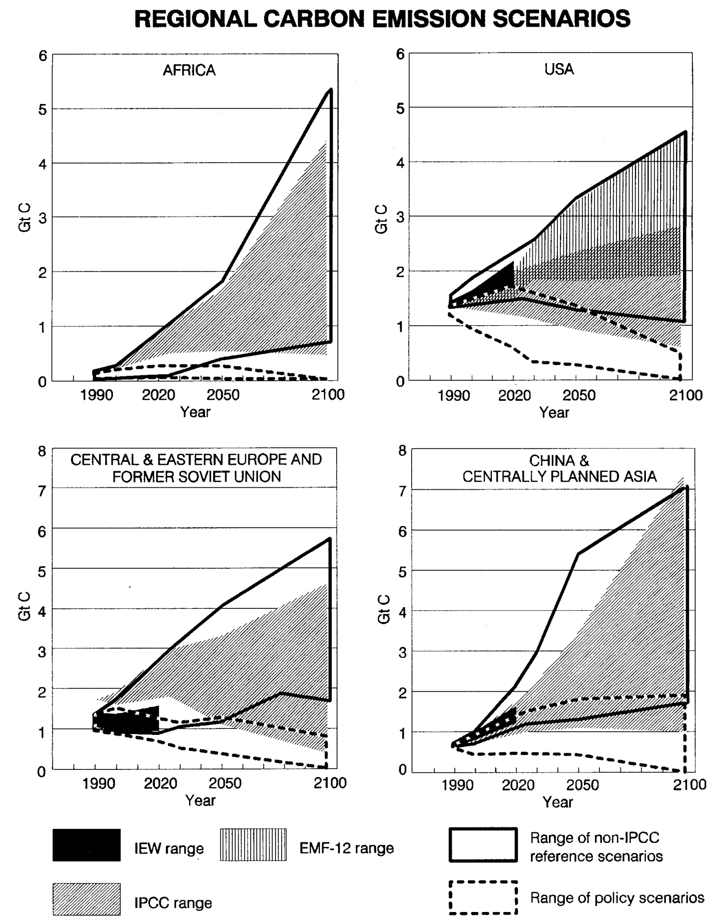

Figure 3.2 Range of regional CO_2 emissions from IS92 and other published scenarios (IPCC, 1995).

changes. Thus, it seems obvious that adaptation will be of higher priority than GHG emission reductions among African countries (e.g. Okoth-Ogendo, 1995). This is, however, not only due to high vulnerability. Perhaps equally important is the legitimate concern that global GHG emission reduction strategies may hamper African countries' own development.

Two studies presented by Pearce et al. (1996) give some indications on the potential economic damages of climate change in Africa. A case study in Nigeria showed that a 1-m rise in sea level[6] could, in the absence of protection, flood over 18,000 km^2 of the land area, damaging assets currently worth at least US$18 billion. In addition, over 3 million people would have to be relocated. For Senegal, it was found that over 6,000 km^2 or some 3% of the country's total area would be lost under a 1-m sea level rise. The cost of protecting these areas was estimated at US$250-850 million.

[6] It should be noted that the latest scenarios for sea level rise from the present to the year 2100 are in the range 15 cm (low) to 95 cm (high), with a "best estimate" of 50 cm (IPCC, 1996a).

Global marginal damage arising from a $2xCO_2$ scenario[7] is estimated at US$5-125 per tonne of carbon emitted now (Pearce et al., 1996). This wide range is a result of variations in model assumptions, as well as the high sensitivity of figures to the choice of discount rate. Coal-fired projects in Africa (as well as in other parts of the world) commonly use zero CO_2 costs by default (Goodland and Tillman, 1996). Clearly, internalisation of CO_2 emission costs could raise the project costs considerably and thus have a large impact on project profitability.

Table 3.2. Famine Early Warning System (FEWS) Vulnerability Index.

Level of Vulner-ability	**Conditions of Vulnerability**	**Typical Coping Strategies and/or Behaviours**	**Interventions to Consider**
Slightly vulnerable	Maintaining or accumulating assets and Maintaining preferred production strategy	**Assets/resources/wealth:** either accumulating additional assets/resources/wealth or only minimal net change (normal "belt-tightening" or seasonal variations) in assets, resources or wealth over a season/year. I.e., coping to minimise risk. **Production strategy:** any changes in production strategy are largely volitional for perceived gain, and not stress related	Developmental programs
Moderately vulnerable	Drawing down assets and Maintaining preferred production strategy	**Assets/resources/wealth:** coping measures include drawing down or liquidating less important assets, husbanding resources, minimising rate of expenditure of wealth, unseasonable "belt-tightening" (e.g. drawing down food stores, reducing amount of food consumed, sale of goats or sheep **Production strategy:** only minor stress-related change in overall production/income strategy (e.g., minor changes in cropping/planting practices, modest gathering of wild food, interhousehold transfers and loans, etc.).	Mitigation and/or development asset support (release food price-stabilisation stocks, sell animal fodder at "social prices", community grain bank, etc.)
Highly vulnerable	Depleting assets and Disrupting preferred production strategy	**Assets/resources/wealth:** liquidating the more important investments, but not yet "production" assets (e.g. sale of cattle, sale of bicycle, sale of possessions such as jewellery) **Production strategy:** coping measures being used have a significantly costly or disruptive character to the usual/preferred household and individual life-styles, to the environment, etc.	Mitigation and/or relief: Income and asset support (Food-for-Work, Cash-for-Work, etc.)
Extremely vulnerable or At-risk	Liquidating means of production and Abandoning preferred production strategy	**Assets/resources/wealth:** liquidating "production" resources (e.g. sale of planting seed, hoes, oxen, land prime breeding animals, whole herds). **Production strategy:** seeking non-traditional sources of income, employment, or production that preclude continuing with preferred/usual ones (e.g., migration of whole families).	Relief and/or mitigation: Nutrition, income and asset support (food relief, seed packs, etc.)
Famine	Destitute	**Coping Strategies Exhausted:** no significant assets, resources, or wealth; no income/production.	Emergency relief

Source: FEWS (1994)

There are different ways of estimating the population's vulnerability towards changes in climate. One example is the Famine Early Warning System (FEWS), which use several observable characteristics to determine level of vulnerability and what responses should be considered (Table 3.2). FEWS (1994) uses the index to assess vulnerability of the population in Malawi, Zambia and Zimbabwe.

[7] "$2xCO_2$" describes a situation with doubling of the preindustrial CO_2-equivalent concentration of all greenhouse gases.

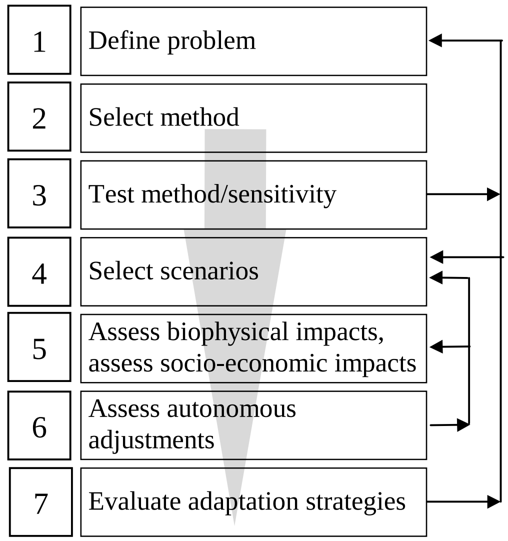

Figure 3.3. Seven steps of climate impact assessment (Carter et al., 1994).

Carter et al. (1994) present a seven-step methodology framework for climate impact studies (Figure 3.3). Climate impact studies could give important contributions to the process of integrating climate aspects into EAs. They give a consistent methodology for assessing impacts and evaluating adaptation strategies that could be used in various regions and countries. The main difference between this framework and the EA methodology is that the latter is more closely linked to management and implementation. Moreover, EA has the advantage of being an established and well-known instrument. See Table 3.3.

Table 3.3. Comparison of Climate Impact Assessment and Environmental Assessment.

	Climate Impact Assessment	**Environmental assessment**
Methodology for identifying and assessing impacts	Models, matrices	Networks, matrices, overlays, computer models
Focus	Impacts of changes in climate parameters and climate variability	Impacts of projects, programmes, plans, policies
Response	adaptation[†]	adaptation or mitigation
User groups	Higher level decision-makers	Decision-makers at all levels and the affected public
Public participation	Passive	Passive to active involvement
Managers	Experts	Experts and non-experts

[†]Note: options to curb GHG emissions are identified in *climate mitigation assessments* (cf. e.g. Tirpak, 1996).

3.1.3 Mitigation and adaptation options and their impacts

Mitigation options are measures to reduce emissions or enhance uptake of GHGs. *Adaptation* options focus on ways of adjusting to the impacts of climatic changes. In an EA context, mitigation and adaptation options must be evaluated due to their contributions to national development priorities. Furthermore, it is necessary to establish at what level such measures should be undertaken. An underlying premise of climate policies is that one should primarily focus on measures which yield net benefits irrespective of climate change considerations, i.e. so-called “no-regrets” measures.

Mitigation options

It seems clear that to be viable in the African situation any mitigation strategy must be linked to the countries’ overall development plan. Analysts must determine which mitigation options are consistent with, and complementary to, national development plans, and focus on those (Braatz et al., 1995). It is anticipated that the largest potential for reducing GHG emissions is found in the energy and forestry sectors, which is further discussed in section 3.2. (see also Table 3.5).

Joint Implementation (JI), now referred to as Activities Implemented Jointly (AIJ) has been presented as a potential instrument for facilitating GHG mitigation measures. AIJ implies cooperation between parties to the Convention on actions to reduce or absorb emissions. A three year pilot phase for AIJ activities was approved at the first Conference of the Parties to the UNFCCC in Berlin 1995. African countries had mixed feelings to this due to uncertainties regarding credit, cost-effectiveness and equity considerations (Churie, 1996). AIJ has been criticised for being merely an instrument for the developed world to invest in low cost emission-reduction projects in the developing world, instead of reducing emissions within their own borders (cf. Goodland and Tillman, 1996). At the same time it is anticipated that developing countries would be the greatest losers in the event of JI/AIJ failing.

It has therefore been argued that African countries should use the opportunity in the pilot phase to identify acceptable projects and prepare themselves domestically for AIJ activities that could produce both local and national benefits (Maya and Gupta, 1996; Churie, 1996). Suggested areas for AIJ activities in Africa include energy efficiency improvements, developments of renewable energy alternatives and industrial development to reduce wood dependency. Forestry options, such as reforestation and afforestation, are generally regarded as less interesting, but could be undertaken in cases where there are direct and clear local benefits (Maya and Gupta, op.cit.)

Adaptation options

Adjusting to climate change has been the priority climate policy issue for African countries. Adaptation options are of two main types: *reactive*, which are measures taken as a response to climate change, and *anticipatory*, measures taken in advance of climate change to minimise or offset adverse effects (Smith and Lenhart, 1996). Suggested adaptation strategies for Africa concentrate on the reduction of vulnerability to current climatic events, as well as inclusion of adaptation policies in planning for long-term sustainable development (Table 3.4). None of the general policy options listed is strictly related to climate, and could easily be incorporated in general planning policies. Adaptation measures could be undertaken for a variety of natural resources and socio-economic sectors such as natural ecosystems, agriculture, managed forests, water resources, coastal zone, energy, and infrastructure (Smith and Lenhart, 1996; Ringius et al., 1996). Adaptation options in the energy and forestry sectors are elaborated in the next chapter (3.2).

Smith and Lenhart (1996) discuss anticipatory adaptation options on the basis of two basic criteria, namely flexibility and the potential for net benefits. Adaptation options should be implemented now if they yield net benefits independent of climate change ("no-regrets"). High priority should be given to the anticipatory adaptation options that would not be effective if implemented as reactive policies. The authors found a large potential for "no-regrets", both for general policies and sector-specific measures. Examples of situations where anticipatory policies are needed are irreversible or catastrophic impacts, long-term decisions, and unfavourable trends.

Table 3.4 Potential cross-sectoral adaptation policy options in sub-Sahara Africa.

- *Improved planning:* Incorporate climate change in long term planning. Monitoring and assessment programmes to provide useful information to resource planners and decision makers. Land use management plans for drought-prone areas and coastal zones
- *Risk management:* Tie disaster relief to hazard-reduction programs. Emergency and disaster preparedness plans to ensure timely assistance that supports development goals
- *Use existing knowledge:* Inventory existing practices and decisions used to adapt to different climates
- *Increase awareness:* Promote awareness of climatic variability and change
- *Explore a range of scenarios:* Research on possible sensitive impacts to increase the range of feasible technological, economic and social options

After Smith and Lenhart (1996) and Ojwang et al. (1995).

3.2 The energy and forestry sectors in sub-Sahara Africa and climate change

To illustrate some of the issues relevant to climate change considerations in environmental assessments, the following paragraphs review the energy and forestry sectors in sub-Saharan Africa (SSA) with respect to climate change issues. The sectors have been selected because they represent two major emitters of greenhouse gases in SSA, and secondly because the sectors are of key importance in any development strategy for African countries.

3.2.1 Energy sector

GHG emissions and mitigation options

Biomass energy accounts for 73% of the total energy consumption in sub-Sahara Africa (Ardayfio-Schandorf, 1993)[8]. The bulk of the biomass energy is used in unprocessed form in the household sector, in traditional and inefficient end-used cooking, space and water heating and lightning devices (Kgathi and Zhou, 1995; Karekezi and Wilson Cornland, 1994). Commonly, more than 80% of the population depends on biomass energy, comprising fuelwood (rural areas) and charcoal (urban areas) (Mwangi, 1995; Sharma et al., 1994).

GHG emissions from the energy sector mainly stem from fossil fuel combustion and biomass energy. Fossil fuels (oil and coal) are mainly used in the transport and industry

[8] Not including South Africa. Here, biomass accounts for only 4.6% of the total energy consumption (Ardayfio-Schandorf, 1993).

sectors. Biomass energy use results in emissions of GHGs such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_x), and ozone (O_3) (Kgathi and Zhou, 1995). If the forest resources are utilised on a sustainable basis there will be no net CO_2 emissions except for the amount emitted from fossil fuel combustion during transport and processing. However, wood resources are in many places harvested at a rate exceeding regrowth. At present wood shortages are mainly localised around the large cities such as Dakar, Kinshasa, Ouagadougou, and Dar Es Salaam, but with current trends in population growth rates and wood consumption it is expected that by 2020 wood shortages will be found over large parts of Africa (Sharma et al., 1994).

Field-Juma and Karani (1995) give a comprehensive overview of climate change mitigation options in the energy sector in Africa. Three main options are outlined, with increasing time horizon: (1) incremental improvements in installed facilities, (2) new technological choices, and (3) planning and redesign processes. The authors recommend a primary focus on the first option (incremental improvements in installed facilities) because of lower costs, less time needed for achieving positive results, and because it is the most suitable option in a situation where capital stock turnover is slow.

(1) These are low cost alternatives that can be undertaken within a short time period, such as improved maintenance of facilities, emission monitoring and waste management. Other measures are fuel switching in the industry (e.g. from gasoline to LPG) in thermal power plants, in the transport sector and for household stoves. Introducing improved household cooking stoves have however in many cases failed, partly due to the expenses and partly because of the multiple functions of traditional woodstoves (lightning, heating). Improved stoves are also found to result in higher methane emissions than open fires (cf. Kgathi and Zhou, 1995). Charcoal is today mainly produced using traditional techniques with low efficiency in the carbonisation process. Improved efficiency could yield large benefits, both for lowering GHG emissions and reducing pressures on forest resources. Removal of petroleum subsidies is another measure that could give large positive effects in that it would promote energy conservation and encourage the use of renewable energy sources. To promote the use of renewables would in some cases require temporary subsidies (Karekezi and Wilson Cornland, 1994).

(2) Introduction of new technology would be a more problematic and time-consuming process. Africa has a large unexplored potential for solar energy, hydropower and in some countries wind, in addition to the above-mentioned potential for technology improvements in the use of biomass. In 1989, it was estimated that less than 4% of the hydropower capacity had been developed (World Bank, 1989[9]). Johansson et al. (1993[10]) estimates that by 2025, available commercial renewable energy resources could be as much as 88 per cent of total primary energy resources in Africa. In practice there are however several barriers to the introduction of renewables, such as large import and sales taxes (Karekezi and Wilson Cornland, 1994). Hydropower installations have also been shown to have considerably higher GHG emissions than earlier assumed.[11]

(3) Long term energy planning is a key instrument for keeping GHG emissions in Africa at a low level. Areas that should be given particular attention are choice of energy sources, location of facilities and coordination of the energy distribution system (Field-Juma and

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[9] cited by Karekezi and Wilson Cornland (1994)
[10] cited by Karekezi and Wilson Cornland (op.cit.)
[11] cf. Pearce (1996)

Karani, 1995). Sound forest management is another important issue. In the short term improved utilisation of biomass energy would be crucial for halting forest destruction. In the longer term, re- or afforestation could be options to enhance carbon sinks, replace fossil fuel consumption, and potentially reduce pressures on natural forests. This issue is further discussed in the next section.

Impacts and adaptation options

Recent droughts have demonstrated that the energy sector in sub-Saharan Africa is sensitive to climatic variations, with far-reaching implications for the economy of the affected countries. During the 1991/92 drought in southern and eastern Africa the water table in Zimbabwe dropped 100-200 m and the productivity in the Lake Kariba dam, from which some 80% of the country's commercial energy originates, dropped to 40% of the capacity. As a result, power had to be imported at great expense from Zaïre, Zambia and South Africa (IUCC, 1994). Due to these problems coal-fired thermal plants are now seen as a more reliable electricity source in Zimbabwe (Field-Juma and Karani, 1995).

The high dependency on biomass energy is another factor that leaves the African energy sector vulnerable to potential future climatic changes. Any disruptions in the biomass productivity or changes in vegetation zones would have large effects on energy availability. Other parts of the energy sector that would be sensitive to climate change include activities and infrastructure located at the coast, and indirectly the energy markets (Moreno and Skea, 1996). Many African countries import petroleum (crude or refined products). This import puts a heavy burden on the convertible currency earnings of the region and leaves the energy sector vulnerability to external chocks (Karekezi and Wilson Cornland, 1995).

Some adaptation within the energy sector is likely to take place autonomously as long as changes in the climate are gradual (cf. Moreno and Skea, 1996). Adaptation would be facilitated by measures such as diversification of the energy sector, increased efficiency in consumption, and increased use of the local renewable energy potential. Biomass energy will likely continue to be a major energy source in SSA, and to secure sustainability important issues are to reduce the wasteful utilisation of wood resources and long term securing of sound forest management.

3.2.2 Forestry sector[12]

GHG emissions and mitigation options

Land use change, which includes deforestation and forest degradation, contributes more than 50% of current CO_2 emissions from Africa (World Resources 1996-97[13]). Deforestation was significantly higher in the 1980s than in the previous decade. Between 1981 and 1990 the forest area in sub-Sahara Africa decreased 7 per cent, equalling an average annual deforestation of 0.7% or 4.1 million hectares (FAO, 1993). Deforestation rates are highest in West Africa. Côte d'Ivoire experienced an annual deforestation rate of 5.2% during the 1980s, which was the highest in SSA and also ranks among the highest in the world. The "worst case" emission scenario of the IPCC (see above) is based upon an assumption of continuing growth in deforestation rates and thus CO_2 emissions, only restricted by diminishing forest areas. Loss (or degradation) of forest areas also implies

[12] emphasis will be given to the tropical part of Africa.
[13] WRI/UNEP/UNDP/WB (1996)

considerable losses in the wealth of resources which forests provide (soil, water and biodiversity).

Mitigation options in the forestry sector are largely concerned with carbon sources and sinks. Options fall into two main categories, (1) those reducing emissions and (2) those enhancing sinks. (1) Emission-reducing options include, firstly, to conserve the carbon pool of existing forests by slowing deforestation. While the major direct agent of deforestation is unsustainable slash-and-burn cultivation, deforestation is caused by a complex set of underlying institutional and economical factors. Absence of a clear and enforced system of property rights is regarded as one major cause. The result is that forests become *de facto* open access resources, with little or no incentives for long term sustainable resource use. Another option to reduce emissions is to use biomass energy in place of fossil fuels. Biomass already accounts for the main share of energy use in Africa (see previous section). Globally, this option is regarded as the forestry option with highest long-term (>50 years) potential for mitigating climate change (Brown, 1996).

(2) The second category, carbon sink enhancements, could be achieved through re-establishment of forest in deforested areas (reforestation), creation of "new" forest areas (afforestation), or to maximise the life-span of timber and other forest products. Practical strategies for re- or afforestation include plantation forestry, agroforestry and natural regeneration. Globally, there is a considerable short- and medium term potential for carbon sequestration using a mix of these strategies (Trexler and Haugen, 1995; Nilsson and Schopfhauser, 1995; Dixon et al., 1994). At the same time, it seems clear that such efforts could give significant local environmental and socio-economic benefits, as well as facilitating biodiversity conservation (e.g. Dalfelt et al., 1996). This requires, however, a careful attention to the local conditions, and such measures cannot be seen only as a short term solution but must form part of a long term sustainable development strategy. Maximising carbon storage in forest products would imply, among other things, an increased use of timber for building purposes.

Impacts and adaptation options

At current rates of deforestation tropical forests are in general expected to be more affected by changes in land use patterns than climate change *per se* (Kirschbaum and Fischlin, 1996). However, elevated CO_2 levels, temperature increases and rainfall changes will be additional stress factors that could result in more frequent disturbance to the forests. For example, any reduction in soil water availability due to decreased rainfall and/or temperature increases will be critical in forests with already marginal water availability (Kirschbaum and Fischlin, op.cit.). It is unclear whether natural forest ecosystems could adapt to the rates of climate change that are predicted. As with climate fluctuations in the past (e.g. during Pleistocene), it is expected that first- and second order effects of climate change would affect a number of intra- and interspecific variations. Species will react differentially to climatic changes and will also differ in the ability to adapt to the changes. Hence, it is anticipated that climate change would lead to a reshuffling of species into new aggregations and ecosystems (Lovejoy and Peters, 1994).

Historic evidence indicates that the major response of species to climate change has been migration (Kristiansen, 1993). One adaptation measure would thus be to provide a suitable migration environment, such as corridors in a north-south direction or along altitude gradients. To be effective this also requires a minimisation of habitat fragmentation. Other adaptation measures include diversification of forestry management practices and increasing the mix of species in managed forests, as well as off-site conservation measures such as seed banks (Smith and Lenhart, 1996).

3.2.3 Summary

As seen above, forest resources are of fundamental importance for the energy sector in Africa, and improving forest management will be a key element for any development strategy at the continent. Environmental assessments have a key role to play in identifying the most appropriate options that ameliorate adverse impacts and enhance benefits. There is a well established link between population welfare and capacity to adapt to climatic changes. Current exploitation of the forest resources, including unsustainable practices in biofuel consumption, commercial forestry and land conversion, threatens the resource base and puts the welfare of future generations at risk. In addition, these practices are responsible for the bulk of current GHG emissions in sub-Saharan Africa. Furthermore, current use of open fires has major adverse health impacts (Karekezi and Wilson Cornland, 1994). It therefore appears to be a potential for joint benefits in facilitating development, curbing GHG emissions and increasing the population's adaptability to climatic changes. Table 3.5 shows selected mitigation and adaptation options for the energy and forest sectors.

Table 3.5 Climate change mitigation and adaptation options for the forest and energy sector in Africa.

Sector	Mitigation	Adaptation
Energy	• Demand side management (size/efficiency, source) • Efficiency in biomass energy consumption • Increased use of renewable energy options	• Diversification of energy sources • Improved communication • Improve use of biomass energy (health problems, fuelwood scarcity)
Forest	• Reduce deforestation • Reforestation and afforestation • Increase carbon storage in wood products • Replace fossil fuels with biomass energy	• Clarification and enforcement of property rights regimes • Sustainable fuelwood and charcoal utilisation • Provision of migration corridors • Diversification of forestry management practices • Forest seed banks

3.3 Evaluation of significance: interpretation of facts and perception of problems

The feasibility of extending EAs to include climate change will to a large extent be determined by the African countries' and external donor agencies' perceptions of both the climate change problem *per se* and which response strategies are needed. Two main issues must then be resolved: (1) What is "significant", and (2) are there conflicting views by African countries and external donors, and if so, what could be the consequences?

(1) The question of when a human-made climate change is "significant" as a future risk to the natural and socio-economic environment has to be defined. The word significance is equal to "meaningful" and "notable", but has not been defined in EA literature (Gilpin, 1995). Gilpin (op.cit.) states that it "remains, therefore, highly subjective, depending perhaps, initially, upon the opinion of an assessment officer". In practice, a judgement of significance is implicit in checklists that define criteria for undertaking an EA. The ultimate objective of the Climate Convention, on the other hand, is to prevent "dangerous

anthropogenic interference with the climate system”. The meaning of “dangerous” is similar to “critical” and is thus a stronger term than “significance”, but it still lacks a clear understanding. Parry et al. (1996) argue that it should be the task of science to provide a basis for judgements of what is a “dangerous climate change” in order to assist the UNFCCC process. Two terms are discussed: (a) thresholds in weather or climate events, and (b) critical levels of climate change. To determine critical levels of climate change within each region and sector, a method involving five steps was set up: (i) identification of impact events, (ii) identification of the weather or climate event thresholds, (iii) identification of critical levels of these impacts, (iv) assessment of the tolerance or adaptability of the system or sector to climate change, and (v) identification of those climate changes which are critical because they exceed the tolerance of the system or sector.

(2) The issue of global priorities versus African priorities has to be dealt with. Today, EAs of development activities in sub-Saharan Africa are largely required and undertaken by external agencies. Adoption of EA principles and practices has been slow in SSA countries, as the EA process is to some extent regarded as complex and burdensome and a constraint to development (e.g. Fuggle, 1992). Furthermore, climate change is regarded as less important – or at least less immediate – than other development and environmental challenges in most African countries. The agenda is however to a large extent set by external donor countries and agencies. An increasing attention towards global concerns (and a change in funding towards projects that give donor countries benefits in return) could lead to a bias in project funding and possibly an overemphasis on climate change issues at the expense of other major development needs. At the same time one could argue that African countries should use this opportunity to explore the potential for achieving joint benefits, e.g. through the Joint Implementation pilot phase (see chapter 3.1.1). Thus, there might be a potential for both conflicts and synergies among the objectives and aims of African countries and donors. Some of these are outlined in Table 3.6 below.

Table 3.6. Potential conflicts and synergies between development and the incorporation of climate change considerations into EAs of development projects in Africa.

Conflicts	Synergies
• Other development needs and issues are perceived as more pressing than climate change • Bias towards climate change response actions may result in locally unwanted projects • Add burdens and complexity to EAs: may result in EAs becoming more difficult and expensive to undertake	• More international attention to Africa and climate change may result in more funding to local development projects that also limit GHG emissions, e.g. through the AIJ mechanism • Climate change inclusion promotes long-term strategic thinking in EAs, and anticipatory rather than reactive approaches • Climate change inclusion could promote better natural resource accounting and multidisciplinary approaches in EAs

3.4 Management issues

3.4.1 Legislation, effectiveness and capacity to conduct EA of SSA countries

EAs have been conducted in sub-Sahara Africa for more than a decade, mostly for projects financed by and under the requirements of external donors and agencies. These include multilateral organisations (e.g. World Bank, IFC, AfDB), bilateral organisations (e.g.

NORAD, SIDA, DANIDA), and NGOs. EAs are implemented as a result of independent acts, sectoral laws, or requirements of external donors. For example, EAs of projects financed by the World Bank are conducted in accordance with the Bank's policies. To our knowledge, no SSA countries have included climate change considerations into EA legislation or guidelines.

While several African countries now have legislative or administrative EA regulations, there is a general lack of the necessary administrative, institutional and procedural frameworks for EA implementation (World Bank, 1991a; Okaru and Barannik, 1996). In particular, there is an absence of effective mechanisms for seeking redress and compensation for environmental harm resulting from development initiatives. Okaru and Barannik (op.cit.) state that "this lack of effective mechanisms undermines implementation of EA mitigation plans". Table 3.7 summarises EA status in selected SSA countries, mainly based on Okaru and Barannik (op.cit.). Other recent reviews of EA status in African countries include World Bank (op.cit.) and Roe et al. (1995).

Table 3.7. EA status in selected SSA countries.

Country	**Legislation (year)**	**Responsible agency and administrative capacity**
Botswana	Legislation in preparation (1995)	National Conservation Strategy (coordination) Agency
Burkina Faso	Code that stipulates environmental impact studies	Ministry of Environment (ME). The Code provides for Bureau of Environment Impact Studies within the ME.
Ethiopia	None	National Environmental Protection Authority (1992). Inadequate institutional framework.
Ghana	No self-standing EA statute, but sector legislation has requirements for EA.	Environmental Protection Council (1974). Replaced 1994 by Environmental Protection Agency.
Kenya	No comprehensive legislation, but the environmental management and coordination bill makes EA a mandatory requirement.	Environmental Impact Assessment Unit under the National Environment Secretariat (NES)
Mauritius	Environment Protection Act, section 17 (1991)	EIA committee under the Ministry of Environment and Quality of Life
Namibia	Environmental assessment policy (1995)	Ministry of Environment and Tourism
Nigeria	Environment Impact Assessment Decree (1992) that makes EIA obligatory	Federal Environmental Protection Agency (FEPA)
South Africa	No comprehensive EA statute, but more formal regulations are underway (1994)	Ministry of Environmental Affairs and Tourism (MET)
Tanzania	No comprehensive EA statute, but some environmental legislation, policies and standards are relevant to EIA	Various ministries and agencies
Zimbabwe	No comprehensive EA statute, but some sector based EA requirements. Proposed (1994) bill to make EA mandatory	Environmental monitoring unit under the Ministry of Environment and Tourism

Source: Okaru and Barannik (1996)

Several public and private sector agencies (NGOs, consultants, ministries etc.) in SSA have technical and managing qualifications regarding EAs (World Bank, 1991a). In Tanzania, it was found that the capacity for environmental and technical EA expertise has not been fully utilised (Okaru and Barannik, 1996). Another major problem is the fragmentation of these skills (World Bank, op.cit.). Okaru and Barannik (op.cit.) judged Mozambique, Burkina Faso, and Mali to have inadequate capacity on EAs, while South Africa, Mauritius, Zimbabwe, Zambia, Nigeria, Ghana, and Seychelles were regarded as having "higher levels of capacity". South Africa does not have a comprehensive EA statute and is not a major borrower, but still has a higher level of consistency with donor EA procedures than countries with comprehensive EA statutes, and has also assisted other countries in the region with EA preparation (Okaru and Barannik, op.cit.).

In South Africa, EA is not mandated by a self-standing statute, and compliance is voluntary. Okaru and Barannik (1996) state however that the country has a relatively well established administrative practice and a more efficient practice than other SSA nations that have EA legislation. The EA concept now widely used in South Africa is called Integrated Environmental Management (IEM). IEM is an environmental assessment procedure designed for the South African situation. The concept shares many of the characteristics of SEA (see above). A major advantage of IEM over conventional EAs is said to be that it is designed to guide and promote rather than impede the country's development process (Preston et al., 1992; Fuggle, 1990). Quinlan (1993a,b), on the other hand, argues that two major barriers for the IEM to achieve its aims of facilitating sustainable development are (1) a lack of legislation to endorse the policy's stated recommendations, and (2) that it does not adequately recognise the role of public involvement in the EA process. The author stresses the need for shifting attention from quantitative assessments, i.e. concrete effects of projects, to the processes through which these effects originate.

IRA/IIED (1995) reviews past experiences of EAs in Tanzania. Some of the main findings from examination of statements of 17 EA studies were: (1) Over three quarters appeared to be undertaken without adequate Terms of Reference (ToR). Furthermore, ToR tended to focus on biophysical aspects, with less attention given to social issues, public health or economic aspects; (2) positive impacts were to a large extent omitted or given superficial attention; (3) only one third provided evaluations that were backed by a clearly defined rationale, which is a prerequisite for being able to make informed decisions; (4) just under half of the statements made some assessment of alternative options; (5) nearly three quarters did not address mitigation; (6) nearly 90% did not include any recommendations for monitoring or only presented non-specific monitoring measures; and (7) more than half did not address local involvement to any significant extent.

Public participation in EAs is formally recognised, but in practice "active public participation has been thwarted by a weak system of government transparency, accountability and disclosure" (Okaru and Barannik, 1996). Another constraint to effective implementation is that responsibilities for EA and climate change are often placed in one ministry or department, and there is little co-ordination with the rest of the Government. In practice the most powerful ministries (such as finance and planning) are not committed to conducting EAs, resulting in a weak political status of EA. There are several models on how to solve this problem (e.g. Ebisemiju, 1993).

Three major criticisms of the present application of EAs in SSA are that they lack analysis of alternatives to the proposed projects, follow-up regarding implementation of mitigation plans, and integration of EAs in project economic analysis (World Bank, 1996). For developing countries in general, Sankoh (1996) argues that the slow rate of adopting formal EIA principles and practices is due to an absence of a system which is capable of demonstrating that environmental impact analyses are not difficult to undertake and that, had they been undertaken, adverse effects could have been averted and sustainability achieved. Table 3.8 summarises strengths and weaknesses of EAs in sub-Saharan Africa as currently implemented, identified by recent studies.

Ebisemiju (1993) argues that a main shortcoming of today's EA system is that it uses administrative rather than legislative means of introducing EA into the planning process.

This is because the administrative option often only represents expressions of government concern in response to pressures from donor agencies, without being linked to practical implementation or backed by appropriate administrative and legislative actions. The author reports a large gap between the intent and performance of EA in Africa, using Nigeria as an example. The Guidelines on Nigeria's Fourth National Development Plan (1981-1985) contains a directive that feasibility studies for all projects should be accompanied by an EIS. In 1989, environmental assessment was set out as one of three mechanisms for implementing the country's national policy on the environment (FEPA, 1989[14]). However, it was noted that these guidelines were not adequately adopted in practice (FEPA, op.cit.).

Table 3.8. Major strengths and weaknesses of EAs as implemented to date in SSA.

Strengths	Weaknesses
• EAs have contributed to increased knowledge, capacity and awareness on environmental issues in Africa • Is relatively successful at the project level • EA is less political than many other project analyses	• Lack of local involvement, transparency and accountability • Lack of cross-ministerial co-ordination • Lack of institutional and administrative means of monitoring and enforcement of legislation • Under-utilisation and inadequate mobilisation of human resources and institutional capacity • Alternative options often not considered; EAs are often only reactive and do not promote strategic thinking • Lack of integration in project economic analysis • Lack of harmonisation donor - recipient

Main sources: Goodland and Tillman (1996); Okaru and Barannik (1996); IRA/IIED (1995); Ebisemiju (1993); World Bank (1991a, 1996).

3.4.2 International conventions

The global nature of the climate change problem implies a need for strong international commitments and regulations to secure an equitable distribution of costs and benefits. Conventions signed by African countries give clear responsibilities and often a broad framework for EAs, but have largely failed to influence environmental policies at the national level (World Bank, 1991a).

The UN Framework Climate Convention (UNFCCC) is the primary climate change policy instrument for establishing targets and guiding implementation. The inclusion of working principles into policy and legislation documents and enforcement of these vary between countries and agencies. The main UNFCCC obligations for SSA countries are to inventory greenhouse gas emissions, identify mitigation measures and to contribute in the conservation and enhancement of sinks. One case example is Malawi which has started to address climate change in relation to national development plans (Theu et al., 1996). Although EA is not specifically mentioned in the document op.cit., one of the stated objectives is to "coordinate a review of planned projects to determine how they could be modified to take future climate change into account". It is concluded that "the Convention has become a catalyst for initiating a systematic assessment of policy and investment options that will help the country adapt to the effects of current climate vulnerability and better prepare for future climate change" (Theu et al., op.cit.).

[14] Cited by Ebisemiju (1993).

3.4.3 Requirements by donor agencies

Background

The beginning of EAs in foreign aid can be traced to USA in the late 1970s (Gilpin, 1995). In 1986 the member countries of the OECD (Organisation for Economic Co-operation and Development) agreed to ensure that "development assistance projects and programmes which, because of their nature, size and/or location, could significantly affect the environment, should be assessed at as early a stage as possible and to an appropriate degree from an environmental standpoint". This was later followed up by more specific recommendations concerning the link between environment and development (OECD, 1986, 1992[15]). Since then there has been a general recognition of the need to apply EAs to development aid projects, and the OECD recommendations have been followed up by separate national regulations and guidelines in many of the member countries. Also the need for moving EAs "upstream" to be able to address a wider range of issues and to assure environmentally sound management strategies is now widely recognised among donor agencies (e.g. World Bank 1995).

The World Bank

The World Bank first implemented its environmental assessment for large projects on a selective basis in the early 1970s, but EAs were not formally required until 1989 (Goodland and Tillman, 1996). Requirements for EA are stipulated in the Environmental Assessment Operational Directive (OD) 4.00, 1989, later revised as OD 4.01 in 1991. Full EAs are required for projects that are likely to have significant environmental impacts (Category A). Global issues are just barely mentioned in the directive[16]. Sector-wise EAs are now becoming more common in the World Bank, especially in the power, industry and transport sectors (Goodland and Tillman, 1996).

The first EA directive has been followed up by several guidelines and policy papers for conducting EAs. The Environmental Assessment Sourcebook (World Bank, 1991b:61) recommends that EAs of projects should evaluate emission reduction options that are not "(…) adversely affecting the cost or success of the project". Furthermore, it is advised to assess impacts of climate change on projects, and the effects of existing government policies and institutions on activities contributing to global change. To date, however, no practical guidelines on these issues have been put into practice. A global approach of EAs "(…) is mandated, but not yet achieved under World Bank's policy (OD 10.04)." (Goodland and Tillman, 1996:25). On the basis of achievements of the UNFCCC so far, the authors argue that there is no need for a special expansion of EA into climate change.[17]

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[15] both cited by DANIDA (1994)

[16] "The Bank encourages [global issues] to be considered in EAs where relevant and feasible" (OD 4.01, paragraph 11).

[17] Robert Clement-Jones (AFTES, The World Bank) suggests that one strategy to anticipate climate change would be "applying climate risk factors more systematically to investment decision-making (often as part of the environmental assessment process) to ensure that these risks are fully internalised when examining alternative investment strategies. Priority areas are coastal areas and water/hydroelectricity schemes" (pers.comm.)

Bilateral agencies/donors

• *SIDA* (Swedish International Development Cooperation Agency): Environmental assessments shall in principle be undertaken for all bilateral efforts for which SIDA is responsible (SIDA, 1991, 1996). SIDA uses brief checklists for 13 specified sectors. The guidelines concentrate on project-specific impacts while emphasising, among other factors, impacts on environmentally sensitive areas and on the local communities' possibility to use resources outside the project area.

• *NORAD* (Norwegian Agency for Development Cooperation). The first work on EAs in NORAD started already in 1979 (Dalfelt and Norderhaug, 1979), but was not incorporated in project evaluations before 1984 (FNI/ECON, 1995). Two NORAD strategy documents (Strategies for development co-operation, part I and II) from 1990 and 1992 deal with EA. It is stated in these documents that all assistance projects should be assessed regarding their environmental consequences[18]. The EA system in NORAD consists of three stages: (1) first screening, (2) rough analysis and (3) full EA. Between 1988 and 1994 a total of 14 booklets have been completed. One of these is a checklist for the first screening of projects, the others are guidelines for rough analysis of 13 project categories. The third stage, full EAs, has no specific guidelines.

Several of the above mentioned checklists and guidelines mention in general terms the potential impacts of development projects on GHG emissions and global warming, and vice versa. Examples are CO_2 emissions from forestry projects and projects in the oil and energy sector, impacts on environmentally sensitive areas and vulnerable groups, effects on the demand for energy and choice of energy source (renewables vs. non-renewables), and whether infrastructure projects result in barriers that would hinder movement and migration of plants and animals.

FNI/ECON (1995) concludes that the EA system used by NORAD is still not adequately implemented. A key recommendation of the authors is that more attention should be given to the early stages of the project, in order to be able to influence the design of projects. Another recommendation is that sectoral and regional EAs should be made to facilitate long-term policy planning and to identify possible cumulative effects.

• *DANIDA* (Danish International Development Assistance). DANIDA's guidelines for environmental assessment (DANIDA, 1994) represent a follow-up of the (internal) Memorandum from 1989 which required project categorisation according to anticipated impacts. An evaluation of DANIDA's Plan of Action states that neither of the above mentioned regulations are as yet in full use. Furthermore, there is no sanction for non-compliance with guidelines, procedures or instructions. DANIDA's guidelines cannot therefore be compared to the World Bank ODs which constitute mandatory directives to be fulfilled prior to further project processing. The energy and transport sectors are the only sectors where the need for formal EIAs during project preparation or during reviews have been recognised, albeit not systematically (DANIDA, 1996).

The EA guidelines (DANIDA, 1994) are presented in the form of "tool kits" for each of the stages in the EA procedure. The tool kits contain so-called "support lists" for decision-makers, extracts from checklists and World Bank procedures, and examples from earlier EAs undertaken by DANIDA (project categorisation, ToR). The guidelines are not

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[18] Documents: "NORAD i 90-åra" from 1990 and part II, "Strategier for bilateral bistand" (1992).

addressing climate change in particular. However, regarding ToR for Full-Scale EA it is stated that “off-site effects, including transboundary, delayed and cumulative effects, should be assessed”. The sectoral checklists consider impacts of projects on air pollution, tropical rainforests, non-renewables, as well as sensitive areas and vulnerable groups. The guidelines also give emphasis to general considerations of resilience, thresholds, carrying capacity and reversibility.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The inclusion of climate change considerations into EA implies on one hand to internalise global externalities of local actions, and on the other hand to prepare for possible but uncertain impacts of changes in the global climate. There exists a considerable amount of work on climate change mitigation and adaptation options. There is also general agreement about the need to move EA upstream and include global concerns such as climate change in the analysis. The main question remaining is whether this combination is adequate in the African situation, both regarding the EA system as such and the applicability of EA to the climate change problem. Questions can be raised about the determinants for successful[19] climate change responses, and how these fit into an EA framework in Africa. Table 4.1 attempts to summarise main points from preceding chapters, and to give a tentative judgement of the feasibility of introducing climate change issues. This is organised according to (I) Effectiveness factors, describing the technical, financial and environmental feasibility, and (II) Implementation prospects, involving the social, institutional and political feasibility (modified from UNEP, 1996).

Table 4.1. Determinants for successful response to the climate change problem and tentative judgements of the applicability of EAs in the African situation.

Group	Determinant	EA and climate change: constraints and challenges
I. Effective-ness	1. Knowledge base	Much uncertainty and lack of knowledge, concerning: regional climatic changes, environmental and socio-economic sensitivity to changes, and cost-effectiveness of adaptation and mitigation strategies.
	2. Technical capacity (including monitoring and management)	Generally low capacity that is unequally distributed. Better co-ordination needed within SSA and between SSA and external donors and development agencies.
	3. Flexibility/adaptability	EAs must focus more on alternatives across sectors to give effective climate change responses.
	4. Benefits other than those related to climate change	There are a number of potential conflict areas, but also many potential areas of joint benefits/synergies. Sustainable development strategies generally seem to be good climate change policy options, but the opposite is not necessarily true.
II. Implemen-tation	1. Sound policy basis in the SSA countries	Aims of sustainable development are recognised at high political level, but there is still reluctance towards climate change policies.
	2. Strong legislation and a legal system to support it	There is an increasing number of countries with EA legislation, but low administrative capacity to support and enforce legislation.
	3. Clear perception of the aims of the process	Climate change is not a top priority issue among SSA countries. Potential conflicts between donors, focusing on climate change *mitigation*, and African countries, focusing on development and climate change *adaptation*.
	4. Political commitment and capacity	Major problem: often politically weak ministries that are responsible for both EAs and climate change policies, with little or no cross-ministerial backing.
	5. Public involvement	Little or only passive public involvement to date, often due to lack of EA enforcement, but also due to inappropriate policies not recognising the role of local communities
	6. Equity aspects	Many unresolved issues regarding burden-sharing and distribution of costs and benefits (global versus national, “North” versus “South”, within-country)

[19] “(…) prevent dangerous anthropogenic interference with the climate system.” (UNFCCC, Article 2).

The general conclusion emerging from the study is that EAs *per se* could represent appropriate tools for addressing climate change issues, while there are still several obstacles to the practical implementation. Many of the problems, such as those mentioned in Table 3.6 are not climate-specific but will influence on the feasibility of including climate change problems in EAs. Climate-specific challenges include aspects of improving the knowledge base on climate change in Africa, the improvement of awareness, understanding and political commitment among decision-makers, resolving of potential conflicts between global and local aims, as well as dealing with risks and uncertainties.

4.2 Recommendations

Based upon the above understanding, four priority areas are suggested for further research: (1) environmental accounting, (2) harmonisation and standard-setting, (3) implementation, and (4) dealing with uncertainties. Below is an attempt to address climate-specific problems while drawing on recommendations put forth in general literature on EA effectiveness in sub-Sahara Africa.

4.2.1 Environmental accounting

The aim of environmental accounting in the context of EA is to provide basic information for the analysis of environmental impacts. Generally, environmental accounting systems provide an overview of resources in terms of stock and flow, and represent a useful tool for measuring changes in the environmental quality of a given area. Hence, in order to assist decision-makers in optimising resource allocation, EA should be linked to national environmental accounting systems (Bisset, 1995). There is a general need for improving the knowledge base of environmental data in Africa, including data quantity, quality and accessibility. A sufficient knowledge base will be crucial for assessing both the GHG emissions (stocks and flows) and climate change impacts (robustness, flexibility). The first step for any move towards sustainability will be to account for depletion of natural capital (Goodland and Tillman, 1996). An example is forest resources, which have both a source and a sink function regarding CO_2 emissions, the former now dominating in sub-Sahara Africa due to high deforestation rates.

For selection and design of projects, data on the following factors are needed: (1) Likely emissions from project alternatives (given a set of indicators, e.g. source of energy, transport needs etc., e.g. through US EPA emission index), (2) likely impacts of climate change on the project (risk assessment; vulnerability index, (3) assessment of adaptation and mitigation options for the alternatives, (4) balancing climate change with other (environmental) objectives (national/global), (5) choice of strategy and the need for clear and just regulations and adequate financial compensation mechanisms globally. Moreover, environmental accounting provides a good basis for judgements of at what level climate change would be “dangerous”, i.e. critical levels of climate change for sectors, following the method set up by Parry et al. (1996) (see above).

4.2.2 Harmonisation and standard-setting

The transboundary nature of the climate change problem implies a need for harmonisation of laws, procedures and requirements among countries, donors and sectors. Potential benefits of EA harmonisation include sound environmental standards, integrating countries into the global market system, promoting sustainable development and economic growth, co-operation and collaboration in lending programs, and enhancing the quality and sustainability of projects (Okaru and Barannik, 1996). Harmonisation does not mean that the same standards should be applied in all countries of SSA; rather that the EA system is used to secure a site-specific compliance with environmental standards.

Setting of environmental standards will demonstrate the environmental implications of different levels of emissions or different impact levels. In turn this could facilitate the identification of desired emission pathways and impact levels (e.g. by defining and finding critical impact levels). Furthermore, it may be a tool for ranking and selecting alternatives. It will be impossible to set precise standards, but some broadly defined reference points or objectives will give guidance to the process. Criteria for standards should be based on impact acceptability among affected groups as well as distribution of responsibility and securing an equitable share of costs and benefits in line with the UNFCCC.

Another benefit of harmonisation may be to resolve goal conflicts. Countries have different interests, preferences and priorities regarding climate change responses. Conflicts may arise both between and within donor and recipient countries. Avoiding goal conflicts and biases in the emphasis of different environmental problems are crucial factors for the credibility of EAs. Already today, African countries often regard conventional EA as a burdensome process and in many cases a constraint to development. Furthermore, few if any SSA countries have effective EA systems and hence, EAs are mainly undertaken by foreign agencies. This might lead to a bias toward the priorities of the donor countries and agencies and an overemphasis on issues that are high on the international agenda, such as climate change, at the expense of local needs and priorities. If local development becomes the ‘victim’ of the process this could not only undermine the already low status of EA but is also likely to weaken African countries’ commitment to the Climate Convention (UNFCCC).

Thus, finding a common ground for actions among donors and recipient countries in Africa will be crucial for the effectiveness of EAs in addressing climate change. Harmonisation may contribute to securing that efforts are directed towards the recipient’s goals for achieving sustainable development. Furthermore, it could help clarify the sharing of responsibilities according to the suggestions of the UNFCCC. Three of the key challenges to the harmonisation process are (1) harmonisation of donor agencies’ requirements, (2) ensuring conformity with local EA laws, policies and procedures, and (3) enhance the institutional will to guarantee accountability, transparency, intellectual freedom and full public awareness (Okaru and Barannik, 1996).

4.2.3 Implementation: legal and institutional aspects

For an EA to be successful the perceptions of the problem of climate change is only a first step. The key challenge is to gain high-level government commitment to establishing a structure that both enables and encourages the implementation of EAs. A problem is that short-term political imperatives often direct and control decision-making (Bisset, 1995:64). Among the determinants of EA success are a sound policy basis, a strong legislation and a legal system to support it (UNEP, 1996). Legislation must be co-ordinated between sectors in order to secure that climate change actions do not counteract developments toward sustainability in other sectors.

To date, few (if any) EAs in Africa have addressed climate change issues explicitly. There exist however sectoral guidelines that include issues related to climate, such as coping with droughts and atmospheric pollution. What is needed is a more systematic approach, seeing development efforts in a global context.

Monitoring of GHG emissions is difficult as impacts are not immediately “visible” and as there are no binding commitments for reducing emissions for developing countries in the UNFCCC. Another important aspect is land tenure arrangements and enforcement of property rights. Although not directly related to climate, property rights have clear impacts on the management of limited resources. Forest management is a good example. Clarification and enforcement of an adequate property right system is one of the major challenges for securing sustainable forest management.

A major problem with present EAs in Africa is that resource management is weak and implementation prospects for recommended impact mitigation strategies are uncertain. These problems can be attributed partly to the legislation and partly to its supporting administrative, institutional and procedural framework. Ebisemiju (1993) states that one main shortcoming of today’s EA system is that it uses administrative rather than legislative means of introducing EA into the planning process. Attention should also be given to how the success of EA/climate change policies differs with which ministries are involved and at what ministerial level the problems are addressed. World Bank (1991a) recommends a focus on central planning ministries.

SEA and project-level EA will be complementary. Gilpin (1995) suggests that future EAs should be conducted as a two step-process: (1) Policy and need inquiry using SEA, and (2) site-specific inquiry, undertaken by project-level EA. This is in line with the proposal of Sadler (1996) for applying EA to climate change. In Africa, the first step could be to include climate change considerations in broad sectoral strategies. Short term plans should focus on adaptation, while long term plans should assess alternatives for reducing (or limiting the growth of) GHG emissions according to the obligations in the UNFCCC. One should focus on broad sector policies rather than project-specific indicators, which would be very complex, and could obscure the interrelations and feedback mechanisms.

4.2.4 Dealing with uncertainties

This is one of the largest challenges to the decision-making process for climate change policies. Risks and uncertainties are related to future (adverse) outcomes. *Risks* are outcomes with a known probability distribution. In cases where incomplete knowledge hinders calculation or the assignment of objective probability values, one talks about *uncertainty*. Uncertainties involved in the climate change issues include (1) the magnitude, direction and rate of climatic changes, (2) the impacts on the human societies and the biosphere, and the interactions between these, and (3) the economic and social welfare effects of measures to counteract climate change (abatement). Ignorance is perhaps a more appropriate concept than uncertainty regarding several of the above-mentioned effects (Munasinghe et al., 1996).

Until recently, risks and uncertainties were largely ignored in EAs (Bisset, 1995). Gilpin (1995) suggests a framework for handling of EAs in conditions of uncertainties and lack of knowledge. Key factors are, firstly, whether uncertainties could be reduced through further investigations, and secondly, how harmful the effects would be if climate change becomes reality. Development applications should be rejected if uncertainties are great and there is no way of reducing uncertainties to acceptable proportions.

Although climate change and its potential effects are uncertain (in many cases largely unknown) they are not likely to be zero. Moreover, the process of climate change is, once started, irreversible in terms of human time perspectives. The challenge facing decision makers is to develop strategies for acting under uncertainty. The precautionary principle (see above) has been widely adopted as a guiding rule. What is needed is a better understanding of uncertain factors and perceptions of risk and uncertainty among decision-makers.

Challenges for future work include (1) how to reduce or minimise uncertainty through increased knowledge of uncertain factors, development of improved scenarios and spreading of risks among several measures (increase flexibility); (2) how to assess risk preferences of decision-makers and population in general, and (3) how to prepare plans for a range of “what if” situations through developing early warning mechanisms such as FEWS and forecasting of climate events (e.g. El Niño), and further development of cost-benefit analyses of various options (including no-action).

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