Climate change and poor management of natural resources as binding constraint to growth in Mali – an annex to the Integrated Economic Analysis[1]

Executive summary

An overriding constraint to development and pro-poor growth is the low investment in environmental and natural resource capital causing low agricultural productivity, poor health and a reduced safety net. With the exception of rice cultivation, agricultural productivity has been low or even declining in recent years. As much as 7-15 % of agricultural lands have been abandoned and forest resources are shrinking. The large majority of the poor are self-employed and for many, their natural assets (soils, grazing lands, water resources) are declining in quality and/or quantity. The most detrimental consequence of this is that the barriers for poor households' to exit from non-sustainable income strategies increases.

Climate change adds to existing stresses and is expected to negatively impact on agricultural productivity; public health and risk create macro-economic shocks due to more frequent natural disasters. Already vulnerable groups in rural areas are expected to be most affected by climate change. Altogether this makes achievements of Mali's ambitious growth strategy (growth in cereal output by roughly 40 %, cotton and livestock 30 % etc) particularly challenging.

Improved property rights, increased investments in natural capital and institutional strengthening of the planning and implementation of climate risks, opportunities and adaptation measures are suggestions to remove the existing binding constraints to sustainable and inclusive economic growth.

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1 This desk study is prepared by Olof Drakenberg (University of Göteborg) and Jessica Andersson (Sida) to complement the Integrated Economic Analysis for Mali already prepared by Sida (Bourdet, 2007). It is part of a process for developing methods for improved integration of climate change in Sida's analytical work. The objective and approach of an Integrated Economic Analysis (Lundström and Ronnås, 2006) is to take the economic actors, including poor men and women, as the starting point and to operationalise pro-poor growth by integrating employment analysis, macro economic analysis and business environment analysis. This note place particular focus on the role of climate change and the environment as drivers and constraints to pro-poor economic growth in Mali. Given the inherent climatic variability and climatic risks for many of the pro-poor growth related activities in Mali including farming and livestock, climate change unavoidably becomes an important focus in the note.

Part 1: Development dynamics

Overview

Part one provides a broad overview of key environmental challenges for Mali in relation to the objectives of the Poverty Reduction Strategy (CSLP) and projected impacts of climate change on poverty reduction and economic growth. Focus is given to impacts on the agricultural sector from which a large majority of poor men and women derive their livelihood.

Economic growth in Mali has averaged 5 % for the period 1996-2007[2]. However, poverty levels have not been reduced to the extent expected and income inequality between the rural and urban areas has increased.[3] The growth strategies in the Poverty Reduction Strategy (CSLP) are above all based on natural resources sectors such as agriculture, livestock, fisheries, mining and energy. By 2011 cereal output is planned to grow by 38%, cotton 29%, livestock 31 %, fisheries exports 12% whereas gold output in tonnes are projected to remain on the current level.[4] Environmental degradation and climate change risk threaten these economic targets and the attainment of the Millennium development goals.

Key environmental problems include land degradation, water pollution, deforestation and biodiversity loss. Rather than adding new stresses on Mali, climate change put additional burden on existing stresses like poverty, water scarcity, soil erosion, desertification, bush fires and the destructive creation of sand dunes along the river Niger. Environmental institutions are weak. A main challenge is the implementation of policies rather than development of new policies.[5]

The effects of Climate change in Mali

Mali has always been exposed to climate risks such as drought, erratic rainfall, floods and desert storms. Farmers have long traditions in coping with climate variability. Since a severe drought in the 1970's the government and the international community have developed early warning systems to improve food security. Climate change is expected to increase vulnerability through rising temperature and more erratic rainfall that risk having dramatic consequences on people's lives and economic growth. Projections on future rainfall are less certain than those on temperature rise.[6] A small majority of projections find that the agricultural areas of Mali will become drier.[7]

The projected costs of climate change to Mali heavily depend on the success of global mitigation. According to the Stern review a temperature rise of 5-6 % would result in costs of 5-10% of global GDP and for poor countries costs in excess of 10%. If mitigation efforts can reduce global warming to 2 degrees at 2050 costs would be substantially lower. The uncertainty in climate projections and impacts are large and few studies have taken on the task of assessing the impacts for Mali. The governments National Adaptation Programme of Action identifies agriculture, health, fishery, energy and water as the sectors being most at risk from climate change. Major non-agricultural impacts of climate change include reduced hydropower generation, increased burden of disease due to malnourishment and diarrhoeal diseases.[8] The impacts of climate change induced natural disasters for Mali have not been calculated and risks underestimate the potential costs of climate change.

2 CIA World Fact book (2008)

3 Bourdet (2007)

4 Republicque du Mali (2006)

5 ODI (2007)

6 Boko et al (2007)

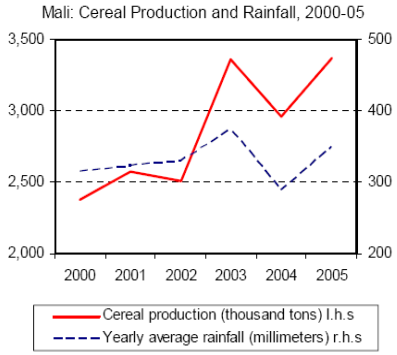
7 Govermnent of Denmark (2008) Even without a reduction in rainfall water scarcity will increase as the higher temperatures lead to higher levels of evapotranspiration.

8 Ministère de l'Equipment et des Transports (2007)

Agricultural productivity

Growth in the agricultural sector is constrained by low and irregular rainfall, poor and fragile soils, as well as generally low productivity due to the widespread use of traditional techniques.[9] The climate in Mali has large regional differences. The most productive region is Sikasso in southern Mali with rainfall between 800-1100 mm. However, most Malian agricultural areas receive around 400-600 mm. Rainfall has decreased significantly since 1950. In Sikasso, the reduction is 13% compared with 26% in the northern part of the country, Tessalit.[10] The correlation between rainfall and agricultural production is strong and explain up to 29% of the value added by agriculture to the economy.[11] See also figure 1.

Figure 1. Link between agricultural production and rainfall



Source: International Monetary Fund, 2006

In a study on agricultural impacts of climate change the temperature was projected to rise 1,7 degrees with slightly reduced levels of rainfall by 2030 (Box 1).[12] According to the study, major impacts include lower agricultural yields, food insecurity and malnutrition. Almost two thirds of the populations risk being mal nourished and the economic costs due to reduced agricultural yields are in the area of 1% of GDP if no adaptation policies are undertaken. Impacts will be most severely felt by poor subsistence farmers. Other studies indicate lower yields of cotton, millet, sorghum and rice.[13] Conditions in already water scarce regions of Mali are likely to deteriorate thus contributing to larger temporary or permanent migration to urban centres, more humid areas or abroad.

Box 1. Agricultural impacts of climate change

Impacts of climate change will differ among regions and within regions. In a study where temperature is rising with 1,7 degrees, rainfall is slightly reduced and no adaptatation policies are implemented the impacts were estimated to create:

-changes in agricultural yields ranging from a decline by 17% to an increase by 6%.
-a decline in forage between 5-36%
- a reduction of the weight of livestock by 14-16%
- a decrease of sorghum yields in drier areas with 18% and with 5-7%. in sub humid areas

As a consequence the percentage of the population found to be at risk of hunger rises from 34 to 64-72% and the economic losses are estimated in the order of 161 Million USD or approximately 1% of GDP.

The study also reveal that 2/3 of the costs of climate change could be recovered if the government undertake a mix of policies such as promotion of better crop varieties, improved soil management, free trade and expanding cropland.

Source: Butt et al, 2006

A recent study in the neighbouring country Burkina Faso showed great discrepancy in outcome depending on different climatic scenarios ranging from improved farm incomes to completely wiping out farm incomes in a scenario with reduced rainfall and significantly higher temperatures.[14]

It must be underlined that these studies are based on different scenarios and should be treated with caution. A recent Danish study questions if rainfall projections for Mali can be used for adaptation

9 World Bank (2007a)

10 Ministère de l'environnement et de l'assainissement (2006)

11 World Bank (2006a)

12 Butt et al (2006)

13 Ministère de l'Equipment et des Transports (2007)

14 Hassan (2006)

planning given these uncertainties. Instead the study proposes to focus on impacts from changes for which there is high certainty: rising temperatures, extreme weather and variability [15].
All in all, the findings of various studies send a strong signal of the potential risks associated with climate change notably for the rural poor.

With the exception of rice cultivation, agricultural productivity per hectare has been low or even declining for key crops such as cotton, millet and sorghum.[16] Growth in agricultural output has mainly been achieved by expansion of agricultural lands, including marginal lands, reaching close to 7% per year in southern parts of the country and thus leading to deforestation and degradation of ecosystems. [17] A low application of fertilizers (organic or chemical) erodes the nutrient content of the soils. In southern Mali the annual nutrient losses of soils have been estimated to be equal to 40% of farmer's incomes.[18] As much as 7-15% of agricultural lands have been abandoned because of land degradation. [19] The combined costs of desertification and other causes of land degradation have been estimated to be equivalent to one fifth of GDP.[20]

Only 7 % of total water resources are used. The potential for increased irrigation is estimated to be 2,2 million hectares compared with 400 000 hectares today. However, some research indicates a decline by 52% in water supply between 1990 and 2020. [21] Expansion of irrigation needs to be a mix of technological, managerial and institutional upgrading that respond to stakeholder needs and integrate irrigation needs hydropower activities, international relations livestock, forest and environmental management.

The energy sector

About 93% of households use fuelwood and the country is annually loosing about 1% of its forest cover. The pressure on forest resources is the highest close to urban areas like Bamako. Bush fires are an important cause of land degradation in the Sudanese region. The frequency of bush fires is expected to rise with higher temperatures thus contributing to increased land degradation, over grazing and more time used to collect fuel wood thus reducing employability. Women are particularly affected by shortage of fuel wood. Access to electricity is an important aspect of the business environment[22] and womens participation in economic activities. In Mali more than 80% of the electricity is generated from hydropower and is dependent on regional rainfall. Hydro power generation is reduced by 20% during drier years compared with the average years. Climate change could reduce hydropower production further thus pushing up the price for business and households.

Frequency and magnitude of Natural disasters

The region is projected to experience more extreme weather due to climate change. Table 1 shows the frequency of natural disasters during the last 20 years. Despite reduced rainfall there has not been any major drought in the last 10 years and on the contrary the number of floods have increased. Mali had the 12th highest frequency of large scale disasters among 48 Least Developed Countries.[23]

15 Government of Denmark, (2008).

16 World Bank (2006a)

17 Ministere de l'environnement et de l'assainissement (2006)

18 Van der Pol et Traore (1993) The annual value of withdrawn nutrients, if related to prices of fertilizers, vary between 40-60 dollars per hectare which is equivalent to 40 % of farmers total income from agricultural services.

19 PNUD (2006)

20 Ministère de l'Equipment et des Transports (2007)It should be noted that this figure is very high in a international comparaison and should be treated with caution. In many African countries the cost of land degradation has been estimated to be in the area of 1-5 % of agricultural GDP.

21 Wong et al (2005)

22 World Business Environment Survey, see http://info.worldbank.org/governance/wbes/questions3.asp

23 Simonsson, 2005, p 3

Table 1 Natural disasters

	1988-1997		1998-2007	
	Number of incidents	Number of people affected	Number of incidents	Number of people affected
Floods	2	24600	10	79513
Epedemic	3	10000	5	1817
Drought	1	302000	0	0

Source: Center for Research on the Epidemiology of Disasters Université Catholique de Lovain

In the case of Mali, the drought during 1977-79 resulted in 20% losses in agricultural yield in the southern part of the country , 40% in the central regions and 60% in the Northern region with large impacts on society. Generally, studies of impacts of climate change underestimate the actual costs by not accounting for issues like flood damage to agriculture and indirect effects on health etc.[24] Low access to water and sanitation increase the risks of water borne diseases. Increased frequency of extreme weather, notably drought, risk being an important constraint to growth.

Vulnerability

To assess vulnerability and risks from climate change it is important to consider the magnitude of impacts, timing, irreversibility, likelihood, potential for adaptation, distributional aspects of impacts and importance of systems at risk.[25] In the sections above we have elaborated on many of these questions like potential impacts, their magnitude and the likelihood. In this section we look at the potential for adaptation and distributional impacts.

Vulnerability is a reflection of human capacity to cope with risks or shocks. Wealth, access to technology and societal and institutional organisation are important determinants of a county's adaptive capacity. A nation's ranking on the Human Development Index (HDI) is a proxy for its ability to cope with shocks as it encompasses important aspects like wealth, education and health issues. Mali is ranked at the lowest end of the index (175 out of 177) indicating very weak adaptive capacity. Vulnerability within the country differs significantly with the Sikasso at the lower end with the capital Bamako being significantly better off. The gap between the HDI score for Bamako and the national average has widened significantly between 1994 and 2003, see table 2.

Table 2. Regional breakdown of human development index, 1994-2003

IDH/années	1994	1996	1998	2001	2003
Kayes	0,277	0,308	0,340	0,339	0,361
Koulikoro	0,250	0,285	0,317	0,311	0,336
Sikasso	0,212	0,283	0,308	0,311	0,308
Ségou	0,208	0,264	0,288	0,321	0,328
Mopti	0,193	0,236	0,251	0,285	0,313
Tombouctou	0,235	0,241	0,259	0,315	0,320
Gao / Kidal	0,230	0,292	0,315	0,361	0,359
Bamako	0,393	0,526	0,588	0,553	0,569
National	0,305	0,323	0,336	0,359	0,371

Source : ODHD-2005

The large majority of the poor are rural where poverty rates are stable around 73%. Major vulnerable groups in Mali are low income households; non-diversified farmers, migrant workers, victims of

24 Boko et al. (2007)

25 Boko et al. (2007)

conflict and marginal populations in urban areas.[26] The National Adaptation Programme of Action identified small farmers and craftsmen to be more exposed to climate risks than commercial farmers, fishermen and tradesmen.

Institutional capacity

Environmental institutions in Mali are weak and implementation of environmental policies is low. [27]A range of development partners are active in the Environment and Natural Resources sector but harmonization is limited which risks to undermine the performance of the sector. [28]

The capacity to adapt to climate change depends on institutional capacity (frameworks and understanding) and the ability to undertake concrete adaptation actions.[29] The Poverty Reduction Strategy (CSLP) does not give explicit priority to measures for reducing risks from climate change. This could be a sign that the government underestimate climate risks. However, food security and rural development are top priorities in the CSLP and many different elements of climate change adaptation appear to be well integrated into the document. Examples include climate specific issues like early warning systems, extension services, drought resistant crops and non climate specific issues like economic diversification and investments in health and education. It is difficult to judge what resources that will be spent on adaptation. A new national committee on climate change has been created to improve management of climate risks in national policy making.

Key adaptation measures proposed in the NAPA include improved crop varieties and drought resistant crops, diversification of livelihoods, irrigation, improved weather services for farmers, awareness raising and to avoid construction of houses in zones prone for floods.[30] However, research from Mali indicate that non climate specific policies such as free trade and reducing soil productivity loss show greater economic benefits than specific climate policies such as development of high temperature resistant crops.[31] Property rights for land and water and institutions for managing these resources will be increasingly important due to climate change.

Denmark identifies capacity development for policy-makers at national, regional and local level a top priority to improve management of climate risks and for successful integration of climate aspects in policy making.[32]

Part two: Identifying binding constraints

Employment analysis

Mali has a very high population growth of 2.7-3%. Among the new members of the labour force the majority remains in rural areas and very few are absorbed by the private or public sector. About 70 % of the labour force is working in the rural area where the majority of the poor are found. Most poor men and women are self employed in the informal sector. Consequently, the largest part of the active population in Mali is to a very large extent directly dependent on the availability and quality of land, water and ecosystem services for income. At a household level the assets for income earnings can be

26 Simonsson (2005)

27 In the World Bank Country Policy and Institutional Assessment on environment Mali scored 3 which is lower than average and indicatesthat " Regulations and policies cover some issues but effectiveness is limited. Implementation is weak. Public information is limited. EA system exists, but capacity and quality is low. Limited data exist but priority setting is weak. Consideration of environmental issues in sector ministries is minimal.**"**

28 ODI (2007)

29 Stern (2006)

30 Ministère de l'Equipment et des Transports (2007)

31 Butt et al (2006) For reference, the Stern review mention studies that suggest that relatively simple and low-cost adaptive measures, such as change in planting date and increased irrigation, could reduce yield losses by at least 30 - 60% compared with no adaptation

32 Ministère des affaires etrangères danois (2008)

divided in natural capital (land, access to forest, grazing land, water etc), human capital (schooling, indigenous knowledge), health, produced capital (irrigation systems, storing facilities etc). Labour productivity and return to labour is closely linked to the quality of these assets and the institutional setting that surrounds them including access to secure land rights. For instance, degradation of forests both increase the time spent for collecting fuel wood thus reducing labour supply and reduce the value of forests as a safety net. As women often have main responsibility for household water supply and energy for heating and cooking, women are disproportionally affected by degraded ecosystems (land, water).

The health situation in Mali is particularly alarming. Under five mortality is extremely high in Mali (rank 175 out 177 countries) and WHO estimates that about 38 000 deaths in Mali annually are attributed to poor water quality and hygiene (53 %) and indoor air pollution (45 %).[33] Only 50% of the population have access to improved water and 46% to improved sanitation. Poor health affects labour productivity in the short term but it also reduces participation in education and development of skills that will have long term effects on the development of the country. Climate change is expected to negatively affect the health situation through increased frequency of natural disasters such as floods that for example risks causing outbreaks of diarrhoeal diseases. It is also expected to have long term effects through reduced nutritional intake caused by lower agricultural yields. However, impacts can be significantly reduced if institutions are strengthened, development policies are implemented and economic actors are provided with information that allows them to factor in climate risks.

Macro economic analysis

Insufficient investment in the country's most important capital, its natural capital, risks undermining the work to reduce poverty and stimulate economic growth for Mali. Key growth sectors expressed in Mali's poverty reduction strategy are agriculture, livestock, mining and manufacturing. Ambitious production targets set for 2011 include cereal production to increase with 39%, cotton 29%, livestock 31% and fish exports 12%. However, current trends point at decreasing agricultural yields per hectare and continued deforestation.[34] As much as between 7-15% of agricultural land has been abandoned due to land degradation.[35] In southern Mali it has been estimated that the annual nutrient losses of soils are equivalent to about 40% of farmer's income. According to World Bank estimations of total wealth per capita including natural capital, produced capital and intangible capital (human skills and know-how) in Mali it is decreasing with 47 US$ per annum[36]. Main reasons for this are the high population growth rate and market and institutional failures leading to land and ecosystem degradation. Climate change and related shocks (drought, floods) are only expected to put additional burdens on poor men and women and the Mali government.

One way of illustrating a country's savings and assessing if the country is following a sustainable economic path is to estimate *adjusted net savings*. It depicts a more accurate level of savings after accounting for depreciation of produced capital, investments in human capital and depletion of natural capital. Even without considering major forms of natural capital such as that of lost soil fertility and forest degradation, the calculations made by the World Bank and the authors' supplementary calculations indicate that Mali has very low adjusted net savings, 2,3% of Gross National Income (see Annex I).

Mali is already highly exposed to macro-economic risks beyond the direct control of government including rainfall and changes in commodity prices for gold and cotton that together account for the lion share of foreign exchange earnings. Again, climate change increases the vulnerability of the budget with increased frequency of droughts and floods and expected lower agricultural yields. At the same time, global attention to climate change provides an opportunity for Mali to attract funds for

33 WHO (2007) Estimated deaths and DALYs attributable to environmental risk factors.

34 World Bank (2007a), Ministère de l'environnement et de l'assainissement (2006)

35 PNUD (2006)

36 World Bank, (2006b)

financing important investments already planned for improved food security, access to water and institutional strengthening.

Business environment

About 90 % of the rural men and women are active in the informal sector.[37] From the perspective of the rural poor the above mentioned degradation of soils, forests, grazing lands and limited water availability become an important restriction to exit from a trap of low productivity. Restrictions are mainly attributed to the lack of economic margins which increases the need for income predictability. On a household level climate change therefore has great implication due to the variability it causes. Households do not only care about expected outcomes but also variations in these outcomes. For poor households that are unable to bear shocks a steady but low level of activity may well be the optimal strategy. Such households are simply unwilling or unable to make the change required to build up their assets or improve their productivity to get themselves out of poverty. This can in the worst case force people to adopt short term time horizons and discount rates which result in short sighted decisions in order to either survive or to make a quick profit at the expense of long term sustainable benefits. Unsustainable cultivation of marginal lands is such an example. Population increase and low productivity in agriculture has led to extensive cropland expansion and in some parts competition for land between pastoralists and farmers. This type of situation is further aggravated by climate change. Higher temperatures and changed rainfall patterns are likely to further reduce productivity in some parts of the country with high poverty rates causing permanent or temporary migration to more fertile lands/urban centres.

Returns of economic activity in the primary sector has been low due to a mix of government failures, market failures, low social returns, high costs of finance.[38] Efforts to improve water and soil conservation in the cotton districts have shown good results. However, few poor farmers have applied these methods due to unclear property rights, lack of funds (money and labour) investments etc. Improved property rights are a key factor to stimulate investments along the value chain from farmers to processing and distribution.[39]

Investments in roads, water and electricity are insufficient in Mali. In Mali more than 80% of the electricity is generated from hydropower and depend on regional rainfall. Hydro power generation is reduced by 20% during drier years compared with the average years. Climate change could reduce hydropower production further thus creating an upward push on the price for business and households.

The most populated regions in Mali have rich water resources, mainly through the Senegal and Niger rivers. The potential for increased irrigation, including commercial farming is large but is hampered by weak institutional capacity and lack of funds.

Binding Constraints

An overriding constraint to development and to poverty reduction is the low investment in environmental and natural resource capital causing low agricultural productivity, poor health and a reduced safety net. Household assets are declining and productivity is hampered by degrading soil fertility, institutional failures with regard to secure property rights, poor health, and poor environmental infrastructure such as clean water, sanitation, irrigation and drainage systems. The most detrimental consequence of this is that the barriers for poor households' to exit from non-sustainable income strategies increases. Climate change adds to existing stresses and is expected to negatively impact on agricultural productivity and public health as well as risk to create macro-economic shocks due to more frequent natural disasters. On an aggregate level the country risks to undermine its potential to benefit and grow from the advantage of being endowed with abundant water resources. As

37 Bourdet (2007)

38 World Bank (2007a)

39 World Bank (2007a)

argued above insufficient investments in natural capital (soil, water, grazing lands etc) and weak integration of climate aspects in development strategies constitutes binding constraints to growth. From this follows that increased investments in natural capital and better understanding and integration of climate change can provide an avenue for sustainable and inclusive economic growth.

Annex I Calculating Adjusted Net Savings

Underinvestment in natural resources and ecosystems

Even without considering the most central natural capital (water and soils), calculations of Adjusted Net Savings indicate that Mali has very low genuine savings, 2,3% of Gross National Income in 2006 (see Table). Fluctuations are mainly explained by changes in gross savings whereas other data remain relatively stable.

	1990	2000	2001	2002	2003	2004	2005	2006
Gross savings (% of GNI)	15,16	16,18	13,67	9,65	16,79	11,29	11,30	12,00
Consumption of fixed capital (% of GNI)	4,06	7,87	8,37	8,75	8,75	8,94	8,90	8,70
Education expenditure (% of GNI)	2,33	2,72	2,72	2,72	2,72	2,72	2,70	2,70
Energy depletion (% of GNI)	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Mineral depleation (% of GNI)	n.a	n.a	n.a	n.a	n.a	n.a	n.a	**2,50**
Net forest depletion (% of GNI)	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
CO2 damage (% of GNI)	0,08	0,13	0,13	0,11	0,10	0,09	0,10	0,10
Particulate emission damage (% of GNI)	0,50	0,61	0,63	0,62	0,62	0,62	0,60	1,10
Adjusted net savings (% of GNI)	12,85	10,29	7,26	2,90	10,04	4,36	4,40	2,3

Source: World Bank (2007b) and authors calculations of mineral depletion for 2006

In order to estimate the true adjusted net savings for Mali a number of estimations and measures are required that are not readily available for Mali. The measure arrived at in the above table is therefore an underestimation since a number of important resources known to be depleted are missing. In an attempt to provide a truer picture in assessing if the country is on a sustainable path or not we therefore have a short discussion of the state of these respective resources.

Mineral depletion
Gold mining is very important for Mali and annual extraction rates are in the area of 50 tonnes per year.[40] Due to lack of information about the costs of production in Mali, no figure for mineral depletion is provided by the World Bank. Mineral depletion is equal to the product on unit resource rent and the physical quantities of minerals extracted. Using a standard value for unit rent for gold (845$ per kilo in 2000)) the mineral depletion is estimated to be approximately 42 MUSD per year which is equivalent to 2,5 % Gross National Income. The figure is included in the table for year 2006.

Net forest depletion
The World Bank adjusted net savings does not include data on forest depletion due to lack of data. In principle, the rent is estimated from the product of unit resource rent and the excess of round wood harvest over natural growth. Round wood harvest includes both fuel wood and timber. The forest area in Mali has been reduced by 5% between 1990 and 2005 and is currently reported to be about 29 000 000 hectares. Some reports estimate annual losses due to conversion to farmland alone to 400 000 hectares or 1,4 %.[41] The extent of forest land is not a sufficient indicator of sustainability as it doesn't account for the logging for fuel wood and timber. Rising demand for fuel wood due population growth is expected to surpass production by 2010. A study from 1997 estimates the economic losses due to loss of forests to more than 5 % of GDP.[42] Although the lack of data does not allow for calculations it is clear that the net forest depletion is larger than zero. Climate change could provide an additional

40 Republique du Mali (2006). According to United States Geological Survey Minerals Yearbook 2005 Malian gold production was primarily from the Kalana, the Morila, the Sadiola Hill, and the Yatela Mines. These five mines produced a total of 44,230 kg of gold in 2005.

41 Le Ministère de l'environnement et de l'assainissement (2006)

42 PNUD (2006)

incentive to avoid deforestation and increase afforestation if significant carbon credits are generated and an institutional framework can be established. It is unclear to what extent the poor will be able to participate and benefit of such systems. No figure is added to the table for year 2006.

Land degradation

The World Bank does not include figures for nutrient depletion of soils or land degradation in Adjusted Net Savings due to difficulties in calculating the impacts. Yet, for Mali where land is a key asset for the rural poor the state of soils is of critical importance. As much as 7-15% of agricultural lands have been abandoned because of land degradation.[43] Farm yield partly depends of the nutrient balance of soils. Farmers use low levels of fertilizers which erodes the productivity of land. Research have estimated annual economic losses due to soil erosion to 0,5 % of GDP.[44] Other studies indicate annual losses due to land degradation to be equivalent to one fifth of GDP, a number that by international standards appear to be very high.[45] Climate change can be expected to aggravate the challenges of land degradation due to more extreme weather causing increased erosion and more competition for land (including land unsuitable for farming) following lower agricultural productivity. No figure is added to the table for year 2006.

Water pollution damage

The World Bank does not include figures for nutrient depletion of soils or land degradation in Adjusted Net Savings due to difficulties in calculating the impacts. Yet, water availability and quality is of great importance to the economy. Most densely populated areas of Mali are relatively richly endowed with water resources mainly through the Senegal and Niger rivers. The value of water depends on the quality that decides possible uses for drinking water, irrigation or commercial use. Main pollution sources are:

- households (access to improved sanitation is 46%, 39% rural and 59 % urban)
- industry (about 800 000m3 used water are released into the Niger).
- mining (pollution of heavy metals are mainly local water quality)
- agriculture

For Mali, economic impacts of water pollution are primarily through diarrhoeal diseases caused by poor sanitation that affect mortality, morbidity, employability and educational results. Under 5 mortality is extremely high for Mali, 218 deaths per 1000, compared with 114 for the Low Income Group of countries. No figure is added to the table for year 2006.

43 PNUD (2006)

44 Bishop and Allen (1989)

45 Ministère de l'Equipment et des Transports (2007)

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