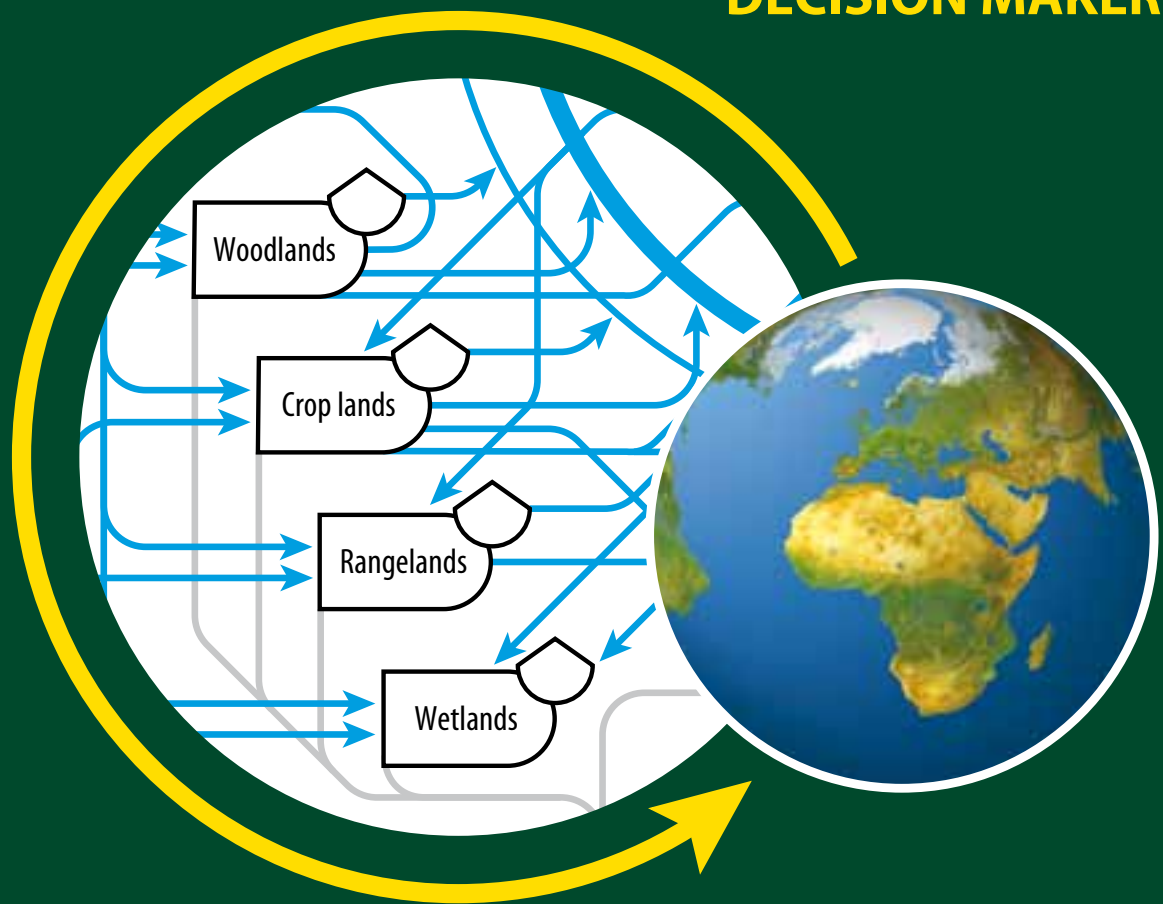


ENVIRONMENTAL ACCOUNTING

of National Economic Systems

*An Analysis of West African Dryland Countries
within a Global Context*

**SUMMARY FOR
DECISION MAKERS**



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This report should be cited as:

UNEP (2012). Environmental Accounting of National Economic Systems: An Analysis of West African Dryland Countries within a Global Context. Summary for Decision Makers. United Nations Environment Programme, Nairobi.

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This Summary for Decision Makers synthesizes the findings of the main report: *Environmental Accounting of National Economic Systems: An Analysis of West African Dryland Countries within a Global Context*. United Nations Environment Programme, Nairobi.

Acknowledgements

This document is a product of UNEP's project "An Ecosystem Approach to Restoring West African Drylands and Improving Rural Livelihoods through Agroforestry-based Land Management Interventions".

We gratefully acknowledge the Governments of Burkina Faso, Mali, Mauritania, Niger and Senegal for their participation in this project, and particularly the Government of Mali for hosting the project. We thank the Government of Norway for providing the principal funding for this project.

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Design and layout:

Bounford.com

Printed and bound in Malta by Progress Press Ltd, Malta Progress Press Ltd, P.O. Box 328, 341 St. Paul Street, Cmr 01 Valletta, Malta

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Abbreviations and acronyms

EER	Emergy Exchange Ratio
EIR	Emergy Investment Ratio
ELR	Environmental Loading Ratio
EMR	Emergy Money Ratio
ESI	Emergy Sustainability Index
EYR	Emergy Yield Ratio
GDP	gross domestic product
HDI	United Nations Development Programme's Human Development Index
NEAD	National Environmental Accounting Database
PPP	Purchasing Power Parity
TSWI	Total System Well-being Index
UEV	Unit Emergy Value
\$	refers to US dollar in this report

Main messages

The threat to sustainable development posed by natural resource degradation and loss of ecosystem services has been recognized for decades, but the fundamental principles of sustainable land and natural resource management are yet to be translated into globally effective policies and tools. Over-emphasis on financial capital optimization, often at the expense of natural and social capital, remains the norm.

Natural resources such as forests and topsoils may accrue over hundreds of years and are effectively non-renewable: they constitute a significant source of national wealth or capital, similar to the stocks of financial capital. However, there are strong incentives to over-exploit land resources because they are effectively free – the costs of their extraction (e.g., soil erosion) are borne by society, now or in the future, and not by individual land users. Levels of exploitation have reached a point where it is now critical to include natural capital and ecosystem services in national accounting.

A number of economic methods for valuation of ecological services have been proposed, and have matured considerably in the last decades. These methods seek to integrate the value of nature's work into decision-making by direct and indirect inference of people's willingness to pay for those services. In this study we take an alternative, biophysical approach to quantifying values of ecological services. Environmental accounting is a tool for holistic evaluation of systems of people and nature, based on our physical understanding of energy and material flow through systems. Accounting for basic physical flows and transformations of energy and materials used in economic processes permits direct linkage with macroeconomic value of flows, both where there is a market (that is, where money is a measure of value) and for flows for which no market exists (that is, where we have previously assumed that services are free).

This study provided detailed environmental accounting of 134 national economies, with a special focus on five dryland countries of the West Africa Sahel. Environmental accounting was used for four primary tasks in this work: 1) understanding

the comparative resource basis of nations, 2) determining the value of global losses of natural capital, 3) quantifying links between a nation's resource basis and indicators of human welfare, and 4) examining implications of biophysical valuation on international trade and debt.

ENVIRONMENTAL ACCOUNTING

- The central premise of environmental accounting is that sunlight, the basic energy source for all global processes, is a useful common currency for all global processes; solar energy is embodied in all goods, whether environmental or economic. All processes rely on energy and are subject to energy laws. Flows in environmental accounting are reported as the quantity of solar energy that went into making them; we call this quantity solar emergy. Emergy is thus taken as a measure of "real" public wealth that complements market-based or use-value measures.
- An advantage of expressing different types of environmental and economic work in the same units is that the impact of alternative policy or intervention options can be evaluated in terms of trade-offs between economy and environment, and between the environmental flows themselves. This aids in the identification of policies and practices that sustain natural resources for long-term societal benefits.
- The environmental accounting steps used in this study were:
 1. Energy systems diagrams were drawn that depict all the major types of natural resources and environmental and economic flows at the national level.
 2. Data on each of the system components and annual flows in the diagram were acquired in standard units. A national environmental accounting database was compiled for 134 nations for the year 2000.
 3. Energy and material flows were converted into emergy units using standard conversion factors.
 4. Emergy stocks and flows were aggregated to provide various indices of environmental sustainability and also expressed in monetary terms.

GLOBAL RESOURCE USE

- Globally there is a need for substantial policy revision to address profoundly unsustainable human development. Humans are nearly 70% reliant on non-renewable resource flows derived from historical accumulations of energy (soils, fuels, minerals) that are now being rapidly depleted. The globe currently relies on energy flows that are three times greater than the annual renewable supply. Efforts to live within the planet's means should be amongst the grand policy challenges of this century.
- Many developed nations derive less than 1% of their energy use from renewable flows, operating instead primarily on imported energy from outside the national system. The staggering degree to which this is unsustainable should be clear, and policy actions to reduce this dependence to the maximum extent possible are urgently needed. Some countries typically regarded as highly sustainable in fact have poor resource sustainability, largely because they rely heavily on non-renewable energy resources.
- Natural capital depletion (i.e., consumption in excess of replacement) was observed to represent an annual global cost of over \$1.5 trillion in 2000. Soil erosion has the largest but hidden cost to society, at about \$640 billion annually, twice that of each of the next most important losses, from deforestation, over-fishing and over-use of water resources.

RESOURCE USE IN SAHELIAN COUNTRIES

- The five focal West African country economies are strongly reliant on natural capital flows while simultaneously depleting their natural capital, rendering them extremely vulnerable to potential shocks. For instance, Mali, Mauritania and Niger obtain around 75% of their total energy use from free environmental flows, while many western European nations derive less than 1% of their energy use from these flows. The five West African nations rely on natural capital depletion for between 5–27% of their total energy use.
- The major source of natural capital depletion is soil erosion, equivalent to \$1.2 billion (in 2000 currency) across the five Sahelian focal nations, and equivalent to nearly 10% of the combined GDP of those nations. These fluxes are comparable in magnitude to the economic value of all national exports from the five nations.
- General trends in various energy metrics for the five Sahelian nations between 1965–2000 indicate increasing total resource use and increasing

reliance on non-renewable sources of energy for the generation of economic product. The energy use per capita has been systematically declining, both overall and in comparison with the global average.

- Increased energy use, including greater use of fossil fuels and electricity generation, will be an essential component of the development of the Sahelian focal nations. Environmental pollution due to industrial development is currently of lower priority for the focal countries than natural resource management, but preventative measures are strongly recommended to ensure environmental loads stay low as these countries develop.
- Large and immediate investments in sustainable natural resource management are vital to the economic and environmental security of these countries. The main priority for investment is in improved soil management in all five focal countries, while in Senegal sustainable fisheries management is also of high priority.

TRADE AND INTERNATIONAL DEBT

- We analysed the balance of trade on a non-monetary, environmental work basis and examined structural sources of inequity embedded in the financial system, both between national trading partners and among commodities. Because prices generally are fundamentally distorted with respect to the environmental work required for the production of goods and services, their exchange has significant resource consequences, structurally disadvantaging one country over another. Among the most disadvantaged nations in this regard are those in sub-Saharan Africa; whereas the United States, Switzerland and Japan are among the main benefactors from this structural trade inequity. For example, when Niger trades with the global economy the resources necessary to generate revenue are 10-fold higher than the resources it receives in return.
- In addition, less developed countries tend to be resource exporters, while highly developed nations tend to be resource importers; this serves to widen the gap in resource endowment over time. A policy implication is that trade agreements should be made more consistent with the real wealth that traded commodities represent, and compensation to resource exporting countries made to more accurately reflect the value of exported goods.

- When we apply the concept of trade equity to international loans, we see that West African countries (and indeed most of the developing world) export large quantities of local environmental capital, either in the form of mined resources, agricultural commodities or other raw goods, in order to generate international currency to make their debt payments. For example, each unit of currency borrowed represents purchasing power in the global market; but to service that debt a country like Niger appropriates approximately 12 times the environmental resource for repayment. Loan interest serves only to exacerbate the problem.
- This inequity becomes clear when debt repayments are compared in energy units. In energy terms, the five targeted West Africa nations have repaid their loans, and have indeed become energy creditors. This is most pronounced for Mauritania and Senegal, who officially owe \$4.8 and \$8.9 billion, respectively, but have overpaid by \$77 and \$18 billion respectively if the flows are examined in energy units. Hence developed country economies are in effect extracting resources from poorer developing countries by receiving debt repayments at inequitable Energy Money Ratios. Thus central to achieving goals of sustainability and equity is support for on-going policies that result in immediate and total debt relief for these five nations. The general framework for assessing inequity is expected to imply the same conclusion for all of sub-Saharan Africa.

POVERTY, RESOURCES AND HUMAN WELL BEING

- We propose that countries should gauge their development progress based not only on measures such as the human development

Development Index (which combines measures of life expectancy, literacy, educational attainment and GDP per capita) for the degree of reliance on locally renewable resources.

- The Sahelian nations are generally in the lower half of TSWI globally. Values have been declining over the period of record. This suggests that despite comparatively high levels of renewable resource use (all five nations fall in the upper 20% of nations globally), recent increases in the Human Development Index have been outpaced by the increasing dependence on non-renewable energy. Moreover, the rate of decline appears to have increased over the last decade. On the other hand, some nations are able to provide a relatively high level of human well-being using a relatively low level of non-renewable resources or total resources per person. Further comparative analysis could provide valuable insights into sustainable policies.
- In summary, by tracking the environmental work necessary to generate ecological services, environmental accounting provides a common framework for analysis for evaluation of systems of people and nature, leading to valuable quantitative insights into sustainable resource use, trade and debt inequities, and human well-being.

APPLICATION OF ENVIRONMENTAL ACCOUNTING

- National environmental accounting tracking systems should be implemented, drawing on the massive improvements in whole-earth surveillance technologies that can help parameterize and refine the simple models used in this study. This kind of integrated thinking – economy, society, environment – when implemented on a project-by-project

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