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Towards an environmentally-adjusted macroeconomic index for land degradation

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ABSTRACT

Land degradation is the single and greatest threat to the integrity of ecosystems that affect directly the food security and welfare of local populations (FAO Factsheet 2). Intergovernmental consultations on addressing the global threat of land degradation are conducted within the Convention to Combat Desertification (UNCCD). The effectiveness of the efforts to combat land degradation globally, depends on a well-established set of targets and indicators, ideally to be linked to the targets as closely as possible.

Substantial efforts made by international organizations, research and private sector entities in providing scientific evidence of cause-effects relationships of land degradation. Nonetheless, the impact of land degradation is still very poorly monitored with even in the best of indices currently being developed. This is mainly because scientific studies on land degradation have focused on the driving forces of land degradation from a biophysical factor perspective with insufficient focus on socio-economics impact.

This paper makes the case, recognizes and documents the need to establish an environmentally-adjusted macroeconomic index for land degradation, with the purpose of assisting intergovernmental processes in navigation through options and choices for planning and policy. We do not aim to put forward a one particular index but rather we identify specific requirements using a combination of up to date, relevant scientific literature and economic analysis. We base our approach on the advantageous facts that economic indices indeed make use of value-measures in order to aggregate dissimilar categories and therefore are considered as being more holistic than physical/scientific measures alone.

Our findings suggest that - much in the same way that the traditional GDP index has done in globally influencing policy making - the endeavors in establishing a macroeconomic index for land degradation are not unviable nor irresolvable.

Finally, given that land degradation is of special concern not only to the UNCCD but also other multilateral environmental agreements including the Convention on Biodiversity (CBD): some of the indicators developed for CBD targets might well be appropriate and relevant for the inclusion to form a land degradation index of interest to also the UNCCD, such as the CBD's indicator of 'health and well-being' (Biodiversity Indicators Partnership 2010). At the same time, land degradation indicators developed within the UNCCD could be valuable in monitoring synergies and tradeoffs in progress towards other targets coming out of the Millennium Development Goals (MDG).

1. INTRODUCTION

According to UNCCD (INCD, 1994, "land degradation" means reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical and biological or economic properties of soil; and (iii) long-term loss of natural vegetation.

To this inherent complexity of the problem, many scientific studies on land degradation conducted in the last decades have focused on driving forces of desertification, mostly addressing biophysical factors. Very often, these studies led to visualizations of outcomes - usually maps - which are very powerful means of communication but they have not really served the purpose of intergovernmental consultations nor have they facilitated the setting of thresholds, indicators and targets.

At the same time, scientific studies have taken into account the parallel work on statistic standards only to a limited extent, particularly those of the Systems of National Accounts (SNA, 2008) and the System for Integrated Environmental and Economic Accounting (SEEA, 2003).

More recently, effects of land degradation have also been addressed but always as a means to integrate elements relating to the assessment of land degradation. It is particularly with the new initiative on “economics of land degradation” (Von Braun 2011), that the loss of ecosystem services and the benefits that human beings derive from them - i.e. the direct and indirect costs of land degradation - will be fully accounted for (Nkonya et al, 2011) through the establishment of a global dollar value.

The outcome document adopted at the UN Conference on Sustainable Development (UNCSD) recognizes “the need for urgent action to reverse land degradation” and a pledge to “strive to achieve a land degradation neutral world in the context of sustainable development” (UNGA, 2012).

At present there are no targets directly relating to combating desertification and land degradation in the Millennium Development Goals (MDGs). Member States at the UNCSD agreed to launch a process to develop a set of sustainable development goals (SDGs) as a tool for pursuing focused and coherent action; they resolved to establish an inclusive and transparent intergovernmental process open to all stakeholders, with a view to developing global sustainable development goals to be agreed by the General Assembly (UNDESA, 2012).

The effectiveness of the efforts to combat land degradation depends on establishment of targets, and these will require indicators. So the question is which indicators correspond to what targets.

This paper is not designed to provide a blueprint solution. Rather, it intends to cast light on several elements that deserve attention and which would need to be considered towards the development of a metric that could be reliably used as a government statistic or environmental-adjusted macroeconomic index. We argue and point towards a possible economics approach that would have to be holistic, innovative, inclusive of key disciplines and one which should capitalize on, and reinforce the knowledge so far acquired on a cross-cutting problem like land degradation. Unless a discussion process is urgently initiated in this direction and with reference to the ensuing MDG, countries will never know towards where and what exact target should their policies fighting land degradation be geared to.

1.1 Studies and indicators of land degradation

There are over ten comprehensive global land degradation assessment studies displaying the extent and severity of land degradation worldwide applying various techniques (von Braun, 2011; Pillido et al, 2011). Such studies differ in their approach, techniques and scales of application. The assessments are often how particular land change categories are measured.

Table 1 - **Methodologies, indicators and indices relevant to land degradation**

What is being measured? *[corresponding to the dimensions of land degradation]*	**How it is measured?**	**Appropriate indicator(s)/ indices?**
Soil Loss	Through the Universal Soil Loss Equation (USLE). It is a mathematical model used since the ’30 that describes soil erosion processes in temperate agriculture. The USLE was developed and further refined for use at the farm-plot level through the Soil Loss Estimation Model for Southern Africa and revised further into the Revised Universal Soil Loss Equation (RUSEL). (Wishmeier, 1976).	Erosivity of rainfall, erodibility of soil, soil slope length, crop cover, management and conservation practices factor.
Net Domestic Product (adjusted environmentally) - to facilitate the assessment of sectoral distortions in the economy.	By subtracting the costs of natural resource depletion and environmental degradation from net domestic product (NDP) and dividing it by the total population of the country of reference. An upward trend of EDP would imply a more sustainable economic growth. Nonetheless, the issue of soil depletion is not accounted for.	Environmental costs estimates such as degradation and depletion of water, air, forests, and wilderness species.
Land degradation and land improvement	Global Land Degradation Assessment (GLADA) using satellite remote sensing imagery.	Mainly changes in Net Primary (ecosystem) Productivity, NPP. Other related indicators are rainfall use efficiency (RUE), aridity index (AI) and rainfall variability and erosion. These indicators were interpreted based on a global land use system map, which also adds socio economic determinants. How the various indicators are related and combined is still debated among scientist (Nkonya et al, 2011).
Global land degradation ‘hotpots’ (i.e. status of land resources including biophysical and socio-economic processes affecting land degradation).	Through the Global Land Degradation Information Systems (GLADIS) which combines pre-existing and newly developed global databases to inform decision makers on all aspects of land degradation.	Land Degradation Index This uses six categories: biomass, soil health, water resources, biodiversity, economic production, social and cultural. Current work strives to incorporate socio-economic factors and not only physical determinants of land degradation (Nachtergale, 2010). Likewise, the Land Degradation Impact Index is a Land Degradation Index weighted by population and poverty. Nonetheless, this index aims at a global assessment and cannot be used for national and subnational planning (Kellner, 2011). For a nationally applied Land Degradation Index, see Abiodun et al (2008).
Agricultural productivity, taking into account damage done to the environment through use of pesticides, and accounting for consumer welfare changes.	Through the production function model called ‘Aigner-Chu non-stochastic linear programming’ (Rezek et al, 2004). This index however only uses nitrogen and pesticides in the production-function simulator.	Environmentally Adjusted Productivity Index
Dynamics in land productivity	Satellite observations from the Joint Research Centre of the European Commission (Cherlet et. al, 2012) Elements that influence biomass production of an ecosystem and its variations in the rate, quantity and timing, are factored in.	Land productivity Although Land-Productivity Dynamics provides a consistent overview across European countries, the use of this new metric cannot be applied to highly localized decision making (Cherlet et al, 2012).

Source: Self elaboration based on sources quoted on the table.

2. MACROECONOMIC INDICES AND THEIR RELEVANCE TO LAND DEGRADATION

2.1 GDP and green GDP

It is internationally acknowledged that GDP is a poor welfare measure of economic performance or society wellbeing - as it often ignores the true values of non-renewable resources - and ultimately people aim at false targets (Stiglitz, 2008). Since the ’70, researchers have worked towards generating methodologies to better reflect these missing GDP values into actual development indexes (Measure of Economic Welfare, 1973; Index of Sustainable Economic Welfare, 1989; Genuine Progress Indicator, 1990). Fast growing economies have felt necessary migrating from traditional to Green GDP (GGDP), which includes unaccounted loss of assets. There was much debate in Rio+20 and the ensuing review of MDGs, as to how and which particular indicators should be included in a Green GDP (Lomborg, 2012), but this would require a balanced judgment to establish a comprehensive integrated sustainable development index. Green GDP accounting doesn’t include land depreciation (Zhishen, 2011): it only attributes on-site value to land. Also, externalities and land services beyond agricultural productions - such as common ecosystem services - are usually not accounted for. When marginal social costs of land degradation are higher than marginal private costs, the resulting rate of degradation is higher than socially optimal, and total social welfare is suboptimal (von Braun, 2011).

As we strive to move towards more eco-friendly production and consumption patterns, the modern notion of “green growth” in particular its “green GDP” measure, have received particular attention (UNEP, 2009). An internationally agreed definition of a “Green GDP” index is to date lacking and how to effectively implement it still remains an academic exercise in most countries, despite the guidelines provided in the System for Integrated Environmental and Economic Accounting (SEEA). Broadly speaking, Green GDP refers to a wide array of adjusted GDP metrics that correct for social and environmental costs that traditionally have no monetary values. Since Green GDP is still a fresh concept in economics literature, it understandably does not yet include costs born to society as a result of land degradation. These costs can be perceived as the impact of siltation on the longevity of dams and electricity production including availability of wood-based fuel sources. These unintended costs – or alternatively called ‘externalities’ – are difficult to measure because in practice they are not included in the price of the commodities produced by companies, farmers or herders who process the primary products. In fact, such off-site externalities are seldom captured in the depreciation measures of GDP or green GDP (Zhishen, 2011). This is particularly true of land in public ownership, common property or beyond national jurisdiction and well documented (Berry, L. et al 2003).

2.2 Basics of macroeconomic indices

In general terms, an indicator is a quantitative or a qualitative measure derived from a series of observed facts that can reveal relative positions and directions of change through time. An “index”, also referred to as “composite indicator”, is formed when several individual indicators are compiled together (OECD, 2005). The purpose of a composite indicator is to measure multi-dimensional concepts that cannot be captured by a single indicator alone. In this way, composite indicators, reduce unwieldy business or scientific data into easily understood terms. The multi-dimensions inherent in a composite index typically represent a set of most important and representative parameters and therefore are bound to always have assigned weightings based on personal subjectivity (Nardo, Saisana et al, 2005). When these multi-dimensions are referring to the current status of particular areas of the country’s economy it is commonly referred to as “macroeconomic index". The usefulness of economic indices is that they use price/value measures to aggregate across dissimilar categories.

An often arbitrary figure used as the initial value of an index, is called the baseline value and it is usually equated to 100 as a point of departure to examine trends and for ease of international comparisons. All future values of the index are then, comparisons against the base value. An adjustment is nothing more than a subtraction, or addition or multiplication or division applied to a variable or number, in order to account for imbalances in baseline variables. Carrying out an adjustment on an index reduces unnecessary data variability so that more precise comparisons across groups can be made and therefore helps a group's predisposition to behave differently from the outset.

There is a vast range of well documented literature on how to systematically enhance the construction of an index or composite indicators, for analytical and policy making purposes. An outstanding methodology is that contained in the report of OECD (2005) and the Joint Research Center (2005). These documentations show the many methods available to assign weights to indices such as principles component analysis, to normalize indicators, to adjust them with "equivalence scales" (FAO, 2005) and to rank them using "Borda ranking" schemes (Emerson, 2011). SEEA also offers guidance in setting up a system of environmental accounting, which was used in China to arrive at its own Green GDP measure (Rauch, Chin, 2010).

There is also much to learn from the example given by the Intergovernmental Oceanographic Committee of UNESCO (2004), which made progress in implementing an operation ecosystem approach to fisheries crafting indices and indicators applied within their framework, in order to communicate these effectively to policy makers.

3. TOWARDS DEFINING A HOLISTIC INDEX ON LAND DEGRADATION

3.1 Why a composite indicator for land degradation?

The purpose of the indices is ultimately to inform individuals of "unsustainable" behavior, shifting attention from national income accounting/scientific-based, to people-centered policies.

Ideally, the approach in developing such an index should include taking into account experts' opinion as well as perception of local people, building on existing pools of knowledge, using qualitative and quantitative data applicable to global and local scales. As earlier mentioned, the purpose of a composite indicator is to measure multi-dimensional concepts that cannot be captured by a single indicator alone.

The need to have an overarching index for land degradation, versus a set of single indicators is justified under the following three premises:

1. There are various elements that characterize land degradation causes and consequences which can only be technically conveyed through the multi-dimensions inherent in a composite index, that typically represent a set of most important and representative parameters and therefore are bound to always have assigned weightings based on personal subjectivity (Nardo, Saisana et al, 2005);
2. Desertification is a slow process and the effects of its consequences and causes - in this case typically captured as several indicators within the index - do not move quickly through time and it will be necessary to wait a few years before such an index is informative of the extent of policy success;

3. Although an index cannot really explain processes involved in determining outcomes, two distinct advantages of indices that rely on economics literature are that (a) they use price/value measures to aggregate across dissimilar categories and (b) they can combine measures of physical change and the value of change perceived to people; as such, they are considered to be more holistic than physical measures alone. Moreover, an index can be "accompanied" by another time-trend index that could be selected as the one thought to be largely responsible for explaining progress and processes (Masset, 2010).

More and more attention is now being paid to incorporating socio-economic factors and not only physical determinants of land degradation as the aforementioned GLADIS example. But more work still needs to be done to ascertain which socio-economic factors to select and how to include them in an economic assessment of land degradation (von Braun, 2012). This paper should be also seen as a complementary contribution to the current efforts made in the economics of land degradation initiative principally carried out by the Centre for Development Research (ZEF) of the University of Bonn (Germany).

3.2 Potential variables to consider, supported by welfare economics

Land degradation undermines many of the fundamental biophysical processes, especially nutrient, water and carbon cycling, which undermine the integrity of ecosystems. Many of these processes are already well researched and understood (GEF, 2006). Our intention would be to capture in this index, those important end-effects that impinge on the *well-being* of society as a result of land degradation. If land and soils are being overexploited to the detriment of present and future welfare, then, this should be made visible today in national welfare accounts. To this end, available principles of national income accounting must be at best integrated with those from existing environmental economics: The World Bank, in recognition of a lack of measure of natural capital and goods, it has constructed a comprehensive wealth of accounts, including natural capital accounts for agricultural land, forests and protected areas and subsoil assets (World Bank 2012). Furthermore, a new and original framework to determine whether a given nation satisfies a reasonable criterion for sustainability in growth accounting (which incorporates population growth, environmental quality, human capital, environmental quality and technological change) can be found in Arrow et al (2012). In connection, the Inclusive Wealth Index (UNU-IHDP) provides quantitative information and analysis that present a long-term perspective on human well-being through the use of wealth accounting.

In selecting the socio-economic variables to better understand and define *well-being*, we argue that the discipline of *welfare economics* has ample sound theory and tools to offer in understanding the plurality of welfare conceptions, including what variables could be counted and measured; Osberg (1998) specifies four main dimensions of economic well-being that can be operationalized, showing how these can be summarized in an index for the purpose of policy debate. Other measures of welfare in a dynamic context are given by Fleurbaey (2009) and Jones (2011). An applied case study for a developing country making use of the International Well Being Index is also documented in Tililouni et al. (2006) and current policy attention is being geared towards new developments in measuring well-being (Haut Commissariat Au Plan, 2012) and through interdisciplinary approaches among at least researchers from 49 countries (International Well Being Group, 2010).

An environmentally-adjusted macroeconomic index can be used to assess or at best approximate, welfare losses arising from overexploitation and loss of productive land. For instance, according to the Food and Nutrition Library 2.2, welfare effects - as a result of soil degradation - have been measured by the: (a) Changes in the number of food-insecure households or malnourished children; (b) Amount of food consumed from farm production; (c) Level of rural household income or consumption; (d) Degree of community-level food self-sufficiency; and (e) Rates of migration.

Furthermore, when available income and expenditure data for less developed countries are often unreliable or patchy to account for welfare losses (Booysen et al, 2005) alternative approaches exist that avoid money metrics, using instead socio-economic factors such as rates for morbidity, crime, life-expectancy, energy consumption per capita etc.

Effects on agricultural supply have been measured by changes in average crop yields or aggregate crop production, aggregate market supply, export or import levels, and level and variability of crop prices. Economic losses have been assessed by comparing the value of lost production, the value of inputs needed to compensate for lost nutrients, or current or discounted future income streams to farm income, national income, or economic growth rates, or by measuring changes in input efficiency.

Land degradation implies a loss of wealth (frequently public wealth); to this end, recent attempts to develop wealth accounts (UNEP, 2012; Arrow et. Al, 2012) bring the added advantage that their wealth indices and indicators can be applied in the context of land assets since these indicators indeed measure the change in the value of future streams of benefits from a given asset and hence also measure sustainability.

4. CONCLUSIONS

This paper has made a case for establishing an environmental-adjusted macroeconomic index to measure progress towards land degradation targets. We propose the use of a single over-arching index on the basis that a composite indicator measures multi-dimensional concepts - as in relation to this matter - that cannot be captured by a single indicator alone. We have proposed a strand of economics literature supportive of economic indices because they are capable of using price/value measures to aggregate across dissimilar categories.

In developing such an index, this paper has also stressed that - whether wealth-based indices are used such as inclusive wealth, investment/depreciation indices such as adjusted net savings, or composite indices of the kind that we recommend - step one is to identify the key end-effects that impinge on the well-being of society as a result of land degradation.

Potential variables, technical tools, latest economics-scientific supportive literature and proposed criteria relevant to the development of such an index, have been identified. In particular, the pertaining statistical dimensions and criteria are also available and have been thoroughly detailed in sources drawn from IMF, Eurostat and OECD (OECD, 2005). Accordingly and in coherence with their specifications, the environmentally-adjusted macroeconomic index for land degradation sought for in this paper, should build on existing knowledge and expertise to the extent that it can:

(a) Be supported by the most relevant and state-of-the-art knowledge of driving forces, but mainly tailored to the socio-economic effects of land degradation. As such, it should be supported by the ongoing studies on economics of land degradation;

(b) Combine socio-economic variables particularly those relating to welfare economics other than income levels (such as quality of life factors like health, gender equality) with biophysical variables (such as climate, geography etc) to reflect the effects of land degradation;

(c) Take into account soil depreciation due to desertification and land degradation, in order to support land degradation neutrality targets that may be developed within the consultations on sustainable development goals;
(d) Take also into account public, common and communal lands that are not properly accounted for in accounting systems to help visualize reallocations of private land from agriculture to other productive sectors.
(e) Be entirely developed on existing, accredited datasets validated in other international processes, and therefore be reliable and easily developed with limites\d additional costs.
(f) Developed on long-term data series, so as to allow measurement of changes over time and tracking possible trends;
(g) Represent status and evolution of the effects of land degradation at the global, regional and subregional levels, while being consistent with indicators commonly used at national and subnational levels;
(h) Be linked to other global environmental and sustainable development threats, particularly climate change and loss of biodiversity;
(i) Rely on common statistics standards such as the UN System for Integrated Environmental and Economic Accounting.

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