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The changing balance sheet of nature - Findings of the Millennium Ecosystem Assessment

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In the current “age of global stock-taking assessments” the Millennium Ecosystem Assessment (MA) represents the first comprehensive multi-disciplinary assessment of the global state of nature. It was undertaken to create a mechanism to increase the quantity, quality and credibility of policy-relevant scientific research findings concerning ecosystems and human well-being used by decision-makers.

The MA was called for by the UN Secretary General in 2000 and carried out by some 1360 experts from 95 countries organized in global and sub-global working groups. Finally it was authorized by countries through the four ecosystem-related conventions: CBD, RAMSAR, UNCCD and UNFCCC.

The MA defines ecosystem services as benefits that society derives from ecosystems. They can be classified into supporting (e.g. nutrient cycling, primary production), provisioning (e.g. water, fuel, food, fiber, wood), regulating (e.g. climate) and cultural (e.g. aesthetic, spiritual, recreational) services.

The MA shows that in the past increases in the exploitation of ecosystem services have brought substantial gains in human well-being at a cost for the ecosystems that provide these services. These gains and costs have, however, not been distributed evenly around the globe, and it is important to note that the MA does not embrace explicitly the concept of an overall carrying capacity of the globe. Human population has doubled and economic activity has increased six fold since the 1960s, but at the same time destruction and degradation of the Earth’s ecosystems has reached unprecedented levels and rates. For example, 20% of the coral reefs have been destructed and another 20% degraded in the past several decades. Also, human water use and, in turn, water withdrawals from rivers and lakes have doubled, with severe impacts on freshwater habitats and species around the world. Significant and often irreversible changes have occurred in global species diversity. Species extinction rates have risen to levels 1000 times higher than natural background extinction rates and 10-30% of the mammal, bird and amphibian species are currently threatened with extinction. Finally, 60% of the 24 ecosystem services identified by the MA are currently being degraded or used unsustainably, which already harms people and their livelihoods around the globe: Diseases have spread due to the reduced quality and quantity of available freshwater and fisheries have collapsed.

The objectives of the MA global scenario analysis for the future were 1) to identify and quantify the major changes in ecosystem services that are to be expected by 2050; 2) to investigate the effects of different developments in human population, technology and socio-economic conditions on the expected changes in ecosystem services; and 3) to provide ideas about future policy options.

Starting from present conditions, storylines for four global scenarios were developed, each based on a different value system. Hence the scenarios differ in the degree of globalization vs. regionalization and in terms of reactive vs. proactive approaches to ecosystem problems. The Global Orchestration scenario, for example, represents a globally connected society with intensified global trade but a

reactive approach to ecosystem problems. Under the Techno-Garden scenario, the globally connected society relies strongly on environmentally sound technology and employs a proactive approach to ecosystem problems, including ecosystem engineering. The Order from Strength scenario represents a rather fragmented world with strong regional markets, is concerned with security rather than connectivity, and employs a reactive approach to ecosystem problems. Finally, under the Adapting Mosaic scenario, regional watershed-scale ecosystems are the focus of socio-economic activity, with a strongly proactive approach to ecosystem problems.

The storylines for the four global scenarios were then translated into numbers for the modeling exercise. A global model system integrated existing models such EcoSim, IMAGE, IMPACT and WaterGAP as well as new models for changes in biodiversity. It is important to note, however, that changes in extreme events were not taken into account in the modeling exercise.

According to the MA global scenario analysis, global food production is expected to increase by up to 70-85% by 2050 under three of the four scenarios, with a maximum increase under the Global Orchestration scenario, but to decrease under the Order from Strength scenario. The increased food production will, however, come at a cost to other ecosystem services, for example when agricultural land expands into ecosystems. By 2050, the expansion of agricultural land will be the main cause of a 10-20% loss of grasslands and forests, potentially resulting in the loss of ecosystem services associated with these ecosystems. Similarly, water withdrawals from rivers and lakes are expected to increase by 50-85% by 2050, again involving important tradeoffs such as a loss of biodiversity that might reduce the resilience of these freshwater systems. This might in turn accelerate the occurrence of further nonlinear changes such as the collapse of fisheries.

The MA global scenario analysis concludes that the exploitation of ecosystem services is very likely to further increase in the future, with intensifying tradeoffs between different services, and that in turn the likelihood of abrupt changes in the world's ecosystems is increasing. As Stefan Rahmstorf noted, these abrupt changes might, however, be much more important in shaping the world's future than the smooth changes modeled in the MA global scenario analysis.

The MA has led to a better understanding of the Earth system and the tradeoffs involved in the use of the ecosystem services provided by its ecosystems. By linking ecosystem services with human well-being, the MA has further built a bridge to those who still believe environmental protection must be sacrificed for the sake of economic development. Its assessment of the current and future status of ecosystems shows in fact that economic development could be consistent with environmental protection, but that there are always tradeoffs involved which need to be considered cautiously in decision-making. The MA did, however, not investigate the issue of vulnerability.