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Source: BioScience, 58(4) : 376

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1641/B580419

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Global Human Impacts

THE WEALTH—AND ECOLOGICAL INDEBTEDNESS—OF NATIONS

Whenever ecologists and conservationists discuss issues as diverse as protected areas, consumption of rare sea animals, and rising sea levels, equity concerns arise. Systematically measuring the damage that wealthy countries' consumption and policies impose on ecosystem services in poorer countries is a daunting task, but that is just what a new study in the 5 February issue of the *Proceedings of the National Academy of Sciences* does. A team of authors from the Pacific Ecoinformatics and Computational Ecology Lab, the Energy and Resources Group at the University of California–Berkeley, and the University of British Columbia analyzed the impact of low-, medium-, and high-income nations on the ecosystems of other nations, also ranked by income group, offering "important implications for 'ecological debts' between groups."

Focusing on climate change, ozone depletion, agriculture expansion, deforestation, overfishing, and mangrove conversion, the study considers the human-driven ecological damages within and across country groupings for the period 1961 to 2000, with estimates for climate change and ozone depletion extending to 2100. Calculating a net present value for ecological impacts (with human health impacts measured for ozone depletion), the authors employ important economics principles such as purchasing power parity (using measures of general well-being rather than exchange rates for comparative valuing) and the discount rate, which is intended to integrate future implications and costs into a natural resources decision. Importantly, the authors eschew aggregate calculations of ecosystem services and focus on impacts and marginal changes, around which they premise policy decisions are made.

From these calculations, a second metric is derived that measures how much, in loss of ecological services, one group of countries imposes on other groups. For example, for mangrove conversion the authors calculated the cost from ecosystem services losses, such as storm protection, fishery nurseries, timber, and rice farming, figuring in human population densities, the proportion of mangroves lost to shrimp aquaculture, and price statistics of the shrimp trade. The authors estimate that high-income nations' tastes and policies cost low-income countries ecosystem services losses of $34 billion while only costing themselves a loss of $9.1 billion.

Portentously, the estimations of losses are much greater for climate change. The authors hope that this study will be a beginning framework for "an emerging discussion of...ecological drivers and impacts, and the relationship of these issues with the responsibilities and debts between nations."

MAPPING OCEAN DAMAGE 1 SQUARE KILOMETER AT A TIME

A new map of the world has been made. It shows the ecological impact of 17 anthropogenic drivers on 20 marine ecosystems of the world. The authors, with the National Center for Ecological Analysis and Synthesis at the University of California–Santa Barbara as the lead, offered this metric of human impacts on marine ecosystems to "help improve and rationalize spatial management of human activities" that bear on marine ecosystems. The article appears in the 15 February issue of *Science.*

With a resolution of 1 square kilometer of marine space, the measurement incorporates a weight for the anthropogenic driver, considers ecosystem sensitivity, and arrives at six groupings ranging from very low to very high impact. Central to their findings is that the authors based their calculations on the sums of impacts on different ecosystems within each examined area, instead of simply averaging human influences in each area. Acknowledging potential overestimation, the authors nonetheless point out that averaging impacts across ecosystems produced similar results, and that the incorporation of other drivers and synergisms not yet examined will most likely further increase estimated impacts.

The dramatic findings indicate that "every square kilometer [is] affected by some anthropogenic driver of ecological change." The study characterized 41 percent of the world's oceans as medium-high to very high impact, with low-impact areas concentrated in the Arctic and Antarctic. One unique finding is the serious degradation that occurs at seamounts, which are sites of rich fisheries and endemism.

The authors posit that their approach "provides a structured framework for quantifying the ecological trade-offs associated with different human uses of marine ecosystems and for identifying locations and strategies to minimize ecological impact and maintain sustainable use." They conclude by calling for more research.

Maybe, for the oceans, assessing almost every square kilometer of marine space is necessary to understand what Rachel Carson considered the "curious situation that the sea, from which life first arose, should now be threatened by the activities of one form of that life."

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doi:10.1641/B580419
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