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Land Degradation Research: The Need for a Broader Focus

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Land degradation is a global problem negatively affecting sustainable development and human well-being, and it can be affected by action taken on a very local scale. It is also a tricky problem because it is dynamic, driven by both biophysical and socioeconomic factors simultaneously. The global human appropriation of net primary production (HANPP) doubled in the 20th century, driven by 4-fold and 17-fold human population growth and economic output increase.[1] A conservative projection indicated that there will be a further 18% increase of HANPP from the 2000s to the 2040s.[2] Therefore, the land degradation problem could be more widespread and difficult to tackle as the human population grows and its natural resources use increases pressure, along with the demand for better human welfare. Therefore, land degradation control has been made one of the priorities for action, from farmer household to international levels (e.g., Food and Agricultural Organization and United Nations Convention to Combat Desertification), promoting sustainable land management across all levels. However, we argue that the science for land degradation is premature with insightful conceptual development but mismatched and unbalanced support from practical research, which need to be addressed for a more fruitful land degradation research.

Comprehensive Understanding of Land Degradation and the Lagging of Traditional Research. Although the practical significance for mitigating land degradation has been widely recognized, there is still a lack of common understanding on the definition of "land degradation" as a scientific term in academia. However, there is a trend toward looking at land degradation as a holistic process, represented as long-term decline of ecosystem function, goods, and services that weakens the basis for human well-being in the terrestrial environment.[3] This is evidently a broad definition of land degradation from a functional perspective that makes a close link to the requirement for a sustainable society. It is also an active response of academia to the proliferation of ecosystem service sciences in the 21st century.[4] But, whether or not the scientific research on land degradation catches up with conceptual advancement is not clear.

We thus carried out a literature search in the database of ISI Web of Science—Science Citation Index Expanded for articles and reviews published since 2000 in peer-reviewed journals, in English, with research topics on land degradation and other related themes. The literature search syntax used was "Topic=Land degradation and Topic=*x*", where *x* is a changeable keyword defined for different searches. The results indicate that land degradation research lagged behind conceptual advancement and remain highly unbalanced. From a bioclimate perspective, about 5.6 times the scientific papers were on dry land areas (or arid and semiarid areas) as compared to those on humid and subhumid areas. From an ecosystem-specific perspective, forest ecosystems were the best represented, measured by the number of paper records retrieved (2137), followed by agricultural ecosystems (1934), grassland ecosystems (1085), desert ecosystems (378), shrub ecosystems (342), and wetland ecosystems (330). From the perspective of scientific themes, it is evident that ecosystem services and functions were largely under-represented, whereas, soil, water, and land use as traditional land degradation research themes were highly represented (Figure 1). In an era of mainstreaming ecosystem services in environmental research and policy, land degradation research needs to be expanded to cope with the paradigm shifts in scientific pursuits and policy requirements for a closer linking of nature and human well-being on land across spatiotemporal scales.

Moving toward a Multidimensional Land Degradation Research. Instrumentally, ecosystems are created unequally, as their direct economic benefits to people vary widely, which is also an important cause of the overuse and degradation of high value ecosystems like forests, grasslands, and wetlands. But, from the standpoint of environmental ethics, the rights for all the ecosystems to share a sustainable future are equal, no matter whether natural or human-modified or under what kind of vegetation cover. Most importantly, any degradation of any ecosystems in structure and functionality will eventually result in a loss of human well-being, which should be incorporated into land degradation research in a

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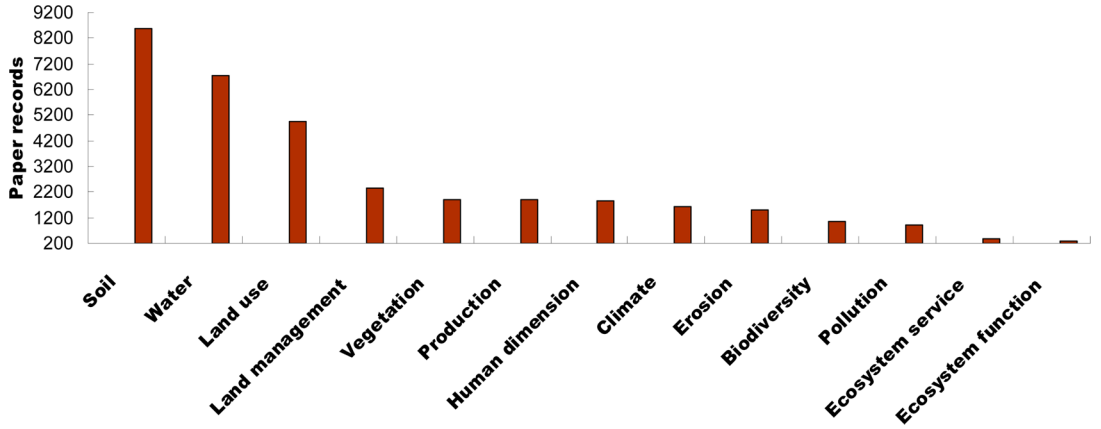

Figure 1. Number of published journal papers by theme on land degradation since 2000.

more balanced manner. More specifically, the land degradation problems in subhumid and humid areas and the degradation of wetland ecosystems, aquatic ecosystems, shrub ecosystems, and desert ecosystems need more research attention and action.

Practically speaking, land degradation research needs to be aligned and upgraded with a new agenda incorporating ecosystem services into monitoring and assessments. For this task, ecosystem services indicator systems at different spatiotemporal scales and geographical regions are required for data acquisition and results integration. Accordingly, a comprehensive ground-based and remote sensing-based monitoring and observation network needs to be established for tracking the dynamics of land degradation or restoration and their impact on ecosystem services. This is not necessarily a task that requires establishing new networks; to be more cost-effective, the new system can be integrated into other monitoring and research networks, such as the International Long-term Ecological Research Network and the Global Earth Observation System of Systems. As land degradation is a global environmental issue, a newly advocated collaborative approach, termed Coordinated Distributed Experiments,[5] which requires, at least, standardized and controlled protocols, is suitable for the monitoring, research, and applications of land degradation and restoration.

The roles of the human dimension, which are closely connected to ecosystem services, need to be highly valued in land degradation research. Poverty and resource-intensive rapid economic growth are important driving forces for land degradation, especially in the developing world. On the other hand, land restoration from a degraded state depends finally on the behavior changes of the resource users toward environmentally friendly habits. This transition is difficult, but possible, with functioning incentive mechanisms such as payment for ecosystem services, mass environmental education, environmental law enforcement, and international collaboration. Only with broadened research and coordinated efforts can we expect to reach the target of no net land degradation and sustainable land management for a sustainable future on local and global scales.

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Notes

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REFERENCES

(1) Krausmann, F.; Erb, K. H.; Gingrich, S.; Haberl, H.; Bondeau, A.; Gaube, V.; Lauk, C.; Plutzar, C.; Searchinger, T. D. Global human appropriation of net primary production doubled in the 20th century. *Proc. Natl. Acad. Sci. U.S.A.* **2013**, *110*, 10324−10329.

(2) Ma, T.; Zhou, C. H.; Pei, T. Simulating and estimating tempo-spatial patterns in global human appropriation of net primary production (HANPP): A consumption-based approach. *Ecol. Indic.* **2012**, *23*, 660−667.

(3) de Jong, R.; de Bruin, S.; Schaepman, M.; Dent, D. Quantitative mapping of global land degradation using Earth observations. *Int. J. Remote Sens.* **2012**, *32*, 6823−6853.

(4) Lü, Y.; Liu, S.; Fu, B. Ecosystem Service: From Virtual Reality to Ground Truth. *Environ. Sci. Technol.* **2012**, *46*, 2492−2493.

(5) Fraser, L. H.; Henry, H. A. L.; Carlyle, C. N.; White, S. R.; Beierkuhnlein, C.; Cahill, J. F., Jr.; Casper, B. B.; Cleland, E.; Collins, S. L.; Dukes, J. S.; Knapp, A. K.; Lind, E.; Long, R.; Luo, Y.; Reich, P. B.; Smith, M. D.; Sternberg, M.; Turkington, R. Coordinated distributed experiments: anemerging tool for testing global hypotheses in ecology and environmental science. *Front. Ecol. Environ.* **2013**, *11* (3), 147−155.

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