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How would big data support societal development and environmental sustainability? Insights and practices

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ABSTRACT

The theme of this Special Volume (SV) focuses on improving natural resource management and human health to ensure sustainable societal development. Natural resources have been exploited unduly regardless of the consequences, which has resulted in inappropriate management natural resources and has caused severe environmental degradation. Contributions in this SV addressed improved environmental management, utilization, and allocation of natural resources; evaluation of sustainable natural resource management; pollution prevention and treatment; and evaluation and suggestions for improved natural resource-related policies. The authors presented an inspiring panorama of the initiatives that have been developed throughout the world for sustainable natural resource management and improve societal development. Theoretically, new approaches to bridge the gaps between the economic development and environmental protection were increasingly dominant. Empirically, many of the papers provided case studies of regions in China and other regions. The authorship reflected growing collaboration between researchers from many different countries or universities. While the great diversity of contributions on the topic reflected the wealth of insights generated on the topic in recent years, there is much more that must be done to achieve societal sustainability in natural resource management.

1. Introduction and context

Environmental issues related to resources, bio-diversity, food security, climate changes and global population growth are a few of the crucial, inter-connected dimensions that must be addressed in increasingly effective, systematic and holistic ways with the objective of preventing crises such as the 2013 giant, multi-regional smog that evolved in China. That smog event and subsequent severe air quality problems, combined with severe water and soil pollution problems have elicited positive responses from many within the Chinese Government, industry, academia and by citizens more broadly.

This Special Volume (SV) was envisioned, planned and developed to help China and other nations globally, to be able to make improved decisions for prevention and correction of problems, based upon the evolving analytical power of 'Big Data.'

In the broader historical context our natural resources had evolved for millions of years before humans began using them. Those resources were rich in biodiversity and geodiversity, and human society was/is totally dependent upon local, regional, and global ecosystems. However, current world population has exceeded seven billion, and is projected to reach nine billion in the near future. Growth of the human population has surpassed the carrying-capacity of global eco-systems and has caused biodiversity losses, resource exhaustion, atmospheric, water and soil pollution and dramatic global climate changes (Cherniwchan, 2012).

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It is predicted that climate change will severely affect not only the diverse ecosystems upon which agriculture, forestry, and fisheries are dependent, but also industry, commerce, personal residences, and transportation, upon which all societies in developing and developed countries are dependent. Climate change is and will increasingly be directly related to food and water insecurity and other demands upon ecosystems of which boundaries have already been surpassed. Thus, challenges related to climate changes are attracting increasing attention globally from research scholars, governments, businesses, religious groups, environmental NGOs and other social leaders.

In global economic competition, every country tends to pursue short-term economic growth rather than also being responsible for the long-term, sustainable management of global eco-system resources. This is particularly notable in most developing countries. They usually seek to maximize, short-term agricultural and industrial transformations with little attention the longer-term consequences and impacts upon society and upon the eco-systems upon which all of us are totally interdependent.

During the development process, governments and companies often exploit minerals, forests and grasslands, wetlands, rivers, lakes and the ocean in totally unsustainable ways. Although they may achieve short-term benefits, the worldwide environmental problems such as serious atmospheric and water pollution, reduction of tropical forests and land desertification are resulting in rapid decline of the global eco-system's carrying capacity and are also causing rapid increases in the global greenhouse gases, which are causing increases in global atmospheric and oceanic temperatures.

As illustrative of this, the environmental and human health burdens have been externalized upon Chinese society during recent decades, due to a narrow focus upon rapid economic development (Wong, 2013). In China, the industry-caused smog pollution issues, which mainly resulted from emissions from coal-fired power plants, industrial processes, and transportation-related sources, have dramatically increased in the last two decades. In recent years, the smog issues have become more severe and widespread throughout China (Wang et al., 2014). This is seriously threatening human health as atmospheric concentrations of particulate matter 2.5 (PM 2.5) soar, regularly to concentrations far above The World Health Organization's 'safe air' standards. The PM 2.5 particulates are absorbed through the lungs and cause asthma, lung diseases, and heart attacks. Such problems are also increasingly prevalent in India and other developing countries.

Dealing with increasingly serious resource and environmental problems is a task that should be shared by the whole international society. At the first World Climate Conference that was held in Geneva in 1979, climate change was first put on the agenda as an issue that should be addressed by the world. Since then, most countries in the world have formulated and are beginning to implement some relevant resource, industry, trade and environmental policies, that are designed to seek to slow-down and to reverse the global climate change processes. Fortunately, a number of important international standardization institutions are developing illustrative governmental and corporate policy frameworks, which if implemented, can help societies to make the urgently needed transitions to post-fossil carbon societies.

Such policy frameworks are designed to encourage sustainable management of natural resources by systematically implementing cleaner production and sustainable consumption. The importance of improved sustainable natural resource management is being increasingly realized by policy makers as evidenced by the inclusion of such emphases in research and policies (Sterner and Coria, 2011). For example, Chinese leaders are increasingly committed to developing and implementing strategies of societal sustainable development, which are designed to help to ensure that ecosystems are managed in sustainable ways to fulfill the needs of present and future generations on the planet.

Many Chinese policies have been developed and implemented to improve the sustainability and effectiveness of natural resource management. For example, legislation such as the 'Water Law of the People's Republic of China' that was passed on October 1, 2002, and the 'Property Law of the People's Republic of China' that was passed on March 16, 2007, are focused on implementing sustainable natural resource management.

In this context, the evolving science of *Big Data* can potentially be used to help scientists, policy makers, and city planners to develop and implement policies, strategies, and practices that will internalize currently externalized environmental and human health burdens on society. Data concerning resource management such as hydrogeological data, environmental surveillance data, economic statistics and meteorological data are not only in large quantity but are also complex temporally and spatially. Types and formats of data are diversified and countless ties interconnections exist within and among these data, which make it difficult or impossible for traditional data analysis methods to be used to adequately analyze them. Hence, Big Data approaches are needed to effectively and efficiently manage and analyze them in order to fulfill the demands for storing, questing and analyzing the data so as to facilitate better decision-making. When Big Data are properly used and analyzed, the results can be more reliable, integral and safe. Therefore, such analyses can help governments and societies to make effective progress at the local, regional, national and global levels in transitioning to become truly sustainable, post-fossil carbon societies.

Cleaner production in the era of Big Data will increasingly depend upon the support of Big Data analyses. In summary, under the pressure of shortages of natural resources and increasingly severe air, water and land quality, with increasing species diversity losses, with dramatically severe climate changes impacts, with continuing human population growth at the rate of a net increase of 70,000,000 per year on planet earth, and with increasing threats of social upheavals and wars, there will be increasing interest in learning how Big Data concepts and approaches can be used to help developed and developing countries learn how to prevent and to correct environmental and human health challenges through cleaner production and by focusing on prevention rather than upon pollution control, pollutant treatment, or pollutant dilution. Relevant, Big Data can be used to adjust production plans or policies, including environmental and resource data pertaining to holistic, and integrative management of minerals, minimization of soil erosion, prevention and/or reduction of water pollution, reduction of geomorphologic and climatological changes. Though proper collection and usage of Big Data, analysts can find the relevance among them through correlation analysis. Thus, causality and necessity among data can be found and accurate predictions and better judgments and decisions can be made. This can result in improved effectiveness in sustainable natural resource management, and will help to reduce risks to human health and negative impacts upon ecosystems and will provide reliable guidance in socio-ecological environmental protection work. Big data can be used to help societies achieve improved and sustainable input-output ratios and performance-price ratios and to improve human and ecosystem health. Learning how to protect human and ecosystem health by improving natural resource management is one of the most important research topics throughout the world. The mismanagement of natural resources has caused and will cause increasing risks to human survival.

To address these challenges, this SV contains more than sixty articles, which are focused upon expanded and improved

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