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Ways to Shape Systems in Response to Global Environmental Change

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Abstract: Global environmental change has a direct impact on human life. Climate change, ecological degradation, and the depletion of natural resources are major contributing factors. This article explores the development of information systems based on ICT to monitor, analyze, and forecast global environmental issues. The structure of ecological information systems and technologies for data collection, processing, and visualization are examined. Furthermore, the integration of artificial intelligence, big data, and geographic information systems (GIS) in identifying and mitigating environmental threats is discussed. The article also addresses the challenges and solutions in implementing such systems in developing countries. The findings highlight the role of digital technologies in ensuring environmental sustainability.

Keywords: Information systems, environmental monitoring, global warming, artificial intelligence, big data, GIS, sustainable development.

Introduction: In the 21st century, environmental problems on a global scale have become one of the most important and urgent issues of human progress. Factors such as climate change, global warming, melting glaciers, biodiversity loss, emissions of harmful gases into the atmosphere, and water and air pollution pose a direct threat to human life. In particular, the rapid development of these processes requires the introduction of new approaches and technologies in the field of environmental sustainability. Modern information and communication technologies, especially information systems, play an important role in this.

Information systems can be used to collect, analyze, visualize and forecast environmental data in a comprehensive and accurate way. Also, through such systems, states, international organizations and the public will be able to identify environmental risks and take prompt action. In particular, the integration of artificial intelligence, big data (big data) and geographic information systems (GIS) will increase the effectiveness of environmental monitoring.

Relevancy of the article. The formation of information systems in the fight against global environmental change is important not only scientifically, but also practically. Today, every state is striving to introduce digital technologies to ensure environmental security. This is especially important for the regions most affected by climate change. Also, these systems serve as an important tool in environmental policy-making, decision-making, and environmental awareness of the population.

The purpose of the article. The main goal of this study is to identify ways to form information systems that allow monitoring, analysis and forecasting of changes in the global environment and to develop proposals to improve their effectiveness.

The functions of the article. analysis of the main directions of global environmental change; • Studying the structure of environmental information systems; assessment of the capabilities of artificial intelligence and GIS technologies; Identification of problems encountered in the formation of information systems; To offer a customized model for developing countries.

METHODOLOGY

In the study, systematic analysis, comparison, model creation, statistical data analysis, visualization and forecasting based on GIS technologies were used. It is also carried out comparative analysis based on advanced foreign experience and practical projects.

Scientific novelty. As a result of the study, an integrated information system model was proposed that serves to identify and forecast global environmental problems. This model serves to increase the effectiveness of environmental monitoring by combining artificial intelligence, big data and GIS technologies. Moreover, practical proposals have been developed for the implementation of such systems in the context of developing countries.

The broad goal of sustainable development is to meet the needs of current and future generations. Supporting this goal requires knowledge generation and close attention to the nature of the processes involved in the creation and validation of knowledge claims. There is a strong consensus that scientific knowledge has played an important role in shaping global sustainability problems and that it plays an important role in informing society's responses to these problems, attracting significant research investment and scientific efforts around the world. Yet, to a large extent, older knowledge systems are still applicable to these emerging social and environmental problems. This means that urgent knowledge needs are not well met, resources are at risk of being depleted, and vital skills and capacities are not developed or adequately supported. Here, we identify how structures and processes at interfaces between issues identification, production, and knowledge use can be modified to encourage a more active and reflexive role of science in a "knowledge democracy" more focused on sustainability in the context of accelerating global socio-environmental change. This paper builds on work done at the European Science Foundation/COST Frontiers of Science Forward Look at "Responses to Environmental and Social Challenges for a Sustainable Earth" [RESCUE;www.esf.org/rescue, 2009–2011]. It builds on discussions by an international working group engaged in reviewing the current state of interactions and looking at improved approaches at the interface between science and politics, communication and advocacy.

[Meadows et al. 1982] observed: 'It is better to express your own biases than to think you don't have one'. We can't easily list them all, but we can say that we had a wide variety of biases in this working group, and we had to confront our own profound differences in worldview throughout our discussions. In this article we will try to reveal the main areas of discussion. In terms of our early scientific formation, our group had an equal number of social scientists and natural scientists, but we all now work across disciplinary divisions and work at the interface between science, politics, and society at large. We work with the general assumption that research can and should be expected to have a positive social impact.

Before proceeding, some initial explanations are needed. First, we use the wordCatechism In a sense, it involves both the body of knowledge about the world we live in and the systematic and accumulated research processes to achieve that knowledge. This meaning encompasses all scientific disciplines of the natural, physical, and social sciences. The defining feature of this knowledge (and the practices that underpin it) is that it is "belonged" to universities and other specialized knowledge institutions that have traditionally been "owned". It is in these areas that procedures are designed to select, produce, document, discuss, and ultimately accept or reject what is understood as true knowledge. In this traditional system, interfaces with other actors in society are geared towards the post-hoc dissemination of this knowledge. There is growing top-down pressure from funders and research policymakers who want to have more impact on social and economic research for change in this regard [Einon, 2012But this has not yet led to widespread changes in practice. Therefore, one of our main areas of focus in this article is the institutional aspect of research.

Creating Knowledge Fields for Sustainability. Open knowledge systems capable of addressing the complex socio-environmental challenges of global change and addressing sustainability require broad social participation, ideally through all existing avenues of participation, rather than changes in practices and assumptions in the scientific community. The institutional structures of science within the current disciplines and boundaries affect the relationship between science, politics, and society, and many of the shortcomings are now well known. Before addressing the barriers to these changes, our priorities for modified participation processes are outlined below.

Ensuring accountabilityIt is important among actors involved in knowledge fields because it lies at the heart of building the trust and legitimacy necessary for effective negotiation and inclusive processes in environmental decision-making [Munton, 2003 yil]. We need to recognize the deep-seated norms and power relations of scientific institutions within knowledge systems, while also paying more attention to the individual responsibilities of scientists in these systems.

Facilitating participation and communication includes using spaces and forms that are familiar and open to participants from different communities, and taking time to learn and reflect. Knowledge fields can take many forms, depending on the actors involved and the issues and interests at stake. They should be focused on achieving credibility, legitimacy and fairness for the most participants.

Innovation for communication and communication involves experimenting with new social media and technologies such as visualization and miniaturized sensing technologies. These offer many new ways to engage people in knowledge spaces in ways that emphasize collaboration and co-design solutions and reduce barriers to participation and learning.

Strengthening the competencies of 'knowledge integrators' includes the recognition and institutionalization of more resilient mechanisms in education and research to support the understanding, assessment, and management of complex socio-ecological systems.

Barriers affecting science in general. Much of the current scientific practice is organized in what we describe as a closed knowledge system: self-governing; organized by subjects; independently set the research agenda; and significantly disconnected from society, politics, and the media. In this mode, science has specific, limited ways of dealing with societal demands on knowledge and social discourse, but usually on its own terms and through intermediaries, including through the media and think tanks. Transdiscrimination, a vital condition for participation in the fields of knowledge, is still poorly institutionalized compared to traditional discipline [Scholz et al., 2006], and is indeed seen as contrary to the basic principles of the closed model.Figure 3It shows an "institutional roadmap" to help remedy the situation.

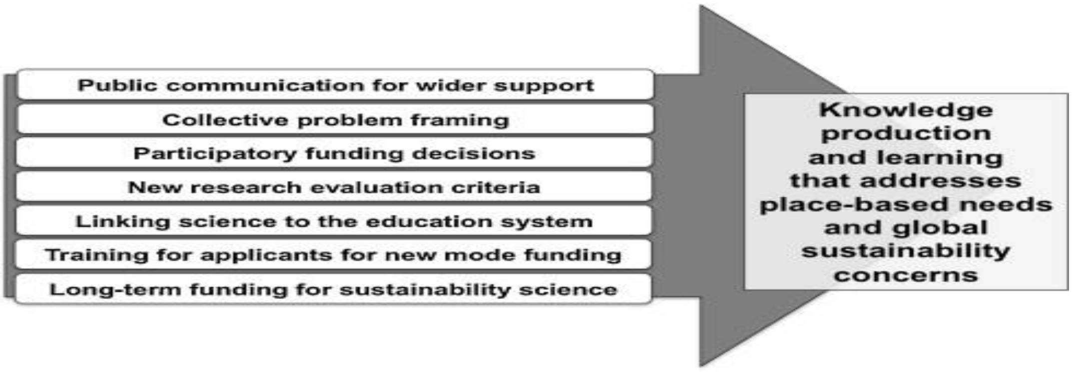

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Figure 1. An institutional roadmap for unlocking knowledge systems for sustainability.

Many of the structures and beliefs inherent in the "closed" model of science seem to be open to stability, diverse, but at odds with the development of integrated science. Practical, policy-oriented, and user-engaged research is often seen as a low-value activity than basic science, which is why academics nowadays put relatively little effort into advocacy and engagement. Addressing procedural, political, institutional, and cultural barriers requires a change in the mandate of science. We need to see science as more than just a set of rules and practices set up to understand the world, but rather as part of a chain of thinking, interaction, and action within knowledge systems. To address sustainability challenges, the purpose of these systems is to create robust and valid representations of the many constraints that affect socio-ecological systems and to negotiate informed pathways through them.

Evaluating research that crosses disciplinary boundaries is problematic when existing scientific cultures agree on established criteria for quality. There is a general tendency toward using fixed quantitative indicators to assess the quality of a research, and the "impact agenda" for publicly funded research is now a growing trend (e.g.,Filipp, 2010 yil,Einon, 2012), but the current assessment indicators do not correspond to the open knowledge system. They are controversial even for the existing system (e.g.Kapeller, 2010 yil-Bibliometrics, for example, shows a weak correlation between publication results and research budget - and the expansion of impact factors already threatens sustainability research (e.g.,Monasterskiy, 2005 yil,Holden et al., 2006). The focus on impact brings new challenges and new opportunities for sustainability science. Assessing the "research impact" in economic terms is difficult for individual projects; A strong focus on short-term technological or economic advances favors certain types of technologically oriented research, as well as prioritizing private incomes over public benefits that provide sustainability. In many cases, sustainability research relies on the resources of various public and private organizations, resulting in the decentralization of research funding. This is not an undesirable situation (synergies are possible, and the commitment of multiple actors fits well with our conceptualization of knowledge areas), but it does introduce new challenges for assessing cost-effectiveness and requires a different set of skills when accessing resources from such different funding streams. If "political influence" is sought, then the research-driven links are to some extent weak and difficult to observe. For example, a study in the United Kingdom (Eftec, 2006 yil), in terms of ecosystem services, which are the "poster child" for evidence-based policy, policymakers address information gaps through "informed assumptions" and conversations with peers, rather than reviewing existing research.

We believe that the evaluation of research and scientific institutions should include useful measures of public participation outcomes. In particular, they must recognize that changes in attitudes, behaviors, and policies may not be obvious in the short term. Incentives should reward academic faculty and corporate researchers for their significant and good engagement with the public and policymakers. In short, an open knowledge system requires:

– to consider processes that go beyond and expand beyond traditional disciplinary introductions;

– broader and more sophisticated but transparent indicators for assessment over time that better reflect social learning and change processes;

Barriers affecting scientists. The skills of many academic scientists are unsuitable to contribute to sustainability [Corcoran va Uols, 2004]. We need researchers and practitioners who are skilled in dealing with the diversity and complexity associated with fields of knowledge as we have described, but for decades university education in most countries has been a funnel towards specialization. Academic scholars are rewarded for being narrow and specialized, and are often ill-equipped to go beyond the boundaries of their specialties. In addition, many scientists often have a superficial understanding of politics, business, and the ways in which society and science can impact society. In this regard, scientific education usually instills professional scientists in the field of their activities, values, and ethics (Stauffacher et al., 2006). The scientists' work concludes with the publication of their findings and does not address the potential implications of applying their research to socio-ecological systems. We argue that the scientific community needs to recognize and accept their social responsibility (indeed, society is already calling for it, and it can go even further in imposing these responsibilities). It involves acknowledging the political nature of knowledge systems that deal with global change.

In terms of the competencies required, scientific and methodological excellence remains important for researchers, but additional skills are needed (Figure 4). Based on our experience, we determine:

– the humility to recognize the limitations of one's own knowledge and perspective in dealing with complex issues;

– active research and openness to other thought systems, disciplines and worldviews, and other sources of knowledge and learning;

– Ability to listen to others, communicate in genuine, multifaceted dialogues;

– A willingness to recognize that the researcher's partial knowledge that leads to the dialogue table changes in the process and gives latitude to the other participants;

– procedural, facilitation, and management skills;

– The ability to share and learn from knowledge rather than the application of knowledge.

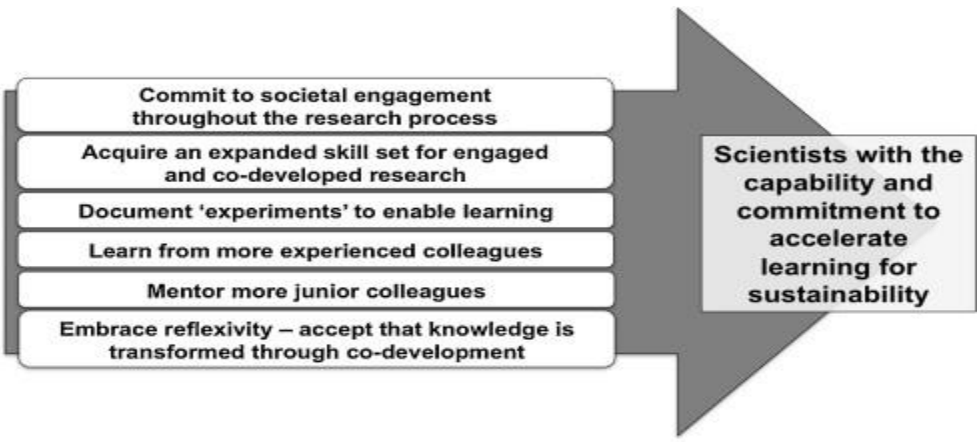

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Figure 2. A roadmap for scientists working in the field of sustainability knowledge.

In general, everyone's educational experience, from childhood to university level and beyond, should develop the skills, inclinations and capacities to deal with complex and socially important issues; With training that includes not only academic theory, methodology, and techniques, but also skills such as negotiation, communication, and integrative research methods and practices. There is a need for training that covers the key problem areas seen as part of implementation-oriented sustainability research projects. Important areas include:

– the powers to see and anticipate the future;
– to manage projects or programs efficiently and effectively;
– specific work on the integration and synthesis of knowledge;
– improve scientific communication;
– long-term continuity of research outcomes and relationships in implementation-oriented work.

CONCLUSIONS

Operating at the interface between science, policy, and society at large, and the incentive for academic participation with sustainability-oriented science is weak and generally temporary—a function of the demand-based nature of transdisciplinary work. The benefits for this kind of work are usually strong and deeply ingrained in an academic culture. There are clear needs for a new phase of "democratizing science," but there is also opposition in the research community. Barriers that arise at the individual level include language and terminology, methodology and techniques, norms and expectations for research development and dissemination, and criteria for reputation and self-expression. Individual scholars working outside the boundaries of discipline must rely on some important features of an academic culture that is still established to secure their reputation and position. It is intellectually and practically difficult to go beyond one's own scientific field. Finally, there are still very few career opportunities for individuals who choose to engage and participate in the risky venture of participatory, integrated, user-engaged research. Academic institutions and science funders have been slow to provide job security to ensure that the skills needed for this job develop throughout their careers.

As part of research funding, support is needed to develop strong interpersonal relationships in more open fields of knowledge that involve scientists and researchers from all disciplines that address sustainability issues. Without these connections, sustainability research efforts run the risk of becoming fragmented and impede the effective dissemination of best practices through the research community. For the necessary interpersonal connections to flourish in these new open spaces, it is critical that improved measures of the quality of meaningful collaboration across science-society interfaces be agreed upon and established to enhance the mobilization of science knowledge into action. Without such measures, there is no cover for academic or agency or corporate managers involved in sustainability processes to justify supporting public engagement and engagement. The formulation of these new assessment criteria is itself a major challenge, as locally tailored solutions are more likely to be optimal for semi-automated quantitative measures of impact than the current trend. Sustainability science benefits from a shift away from focusing on the support of "more knowledge" (information technology can now deliver instantaneously around the world), which includes the targeted participation of the research community in social information spaces organized around social issues.

Comprehensive and transformative institutional change is needed to ensure effective interaction activities to translate knowledge into action. That is why we call for well-designed, properly resourced international education programs. Established structures, institutions, funding channels, and career strategies are at odds with the goals of an active, responsive knowledge system for the sustainability sciences. Today's partial approach should take a step towards broad cross-sectoral collaboration between government, business, industry, civil society, and environmental organizations to support the implementation-oriented nature of the new knowledge system (1). Sustainability has a long-term perspective (decimal and longer), which is at odds with the pace of research strategies and policy cycles. Striking a balance between basic research and science that clearly addresses social needs requires procedures to involve a wide range of social actors in the process of prioritizing research. An effective and fair evaluation system is needed for integrative research on social topics. Engaging in knowledge generation, learning, and evaluation will require a variety of mechanisms to link them to place-based needs and global sustainability challenges. Science still needs to consider the challenges posed by the growth of new information systems and technologies as a means of access to knowledge, a repository of knowledge, a research tool, and an agora, all of which are of profound importance for the production, dissemination, and use of knowledge in responding to social problems.

Profound changes in the ability to study sustainability begin "at home" with the commitment of individual scientists (Figure 2). For sustainability, more integrative and negotiation approaches are needed to address the uncertainty and multiplicity of perspectives in all engagements. It involves the constructive sharing of experience and expertise. Support for the development of scientific literacy and critical assessment of science should be strengthened and expanded to include a more comprehensive and interdisciplinary understanding of global change issues.

Suggestions

1. Creation of integrated ecological information systems. It is desirable to develop and adapt to the conditions of each region the integrated ecological information systems combining artificial intelligence, big data (big data) and GIS technologies.

2. Implementation of national platforms on environmental monitoring. Each country should have its own environmental monitoring platform through which a system of collecting, analyzing and making available to the public information in real time should be established.

3. Strengthening public-private partnerships. In the development and implementation of environmental information systems, it is necessary to create effective mechanisms for cooperation between government agencies, research centers and IT companies.

4. To ensure the transparency of environmental information. Creation of public access environmental information portals should provide transparent and accessible sources of information for citizens, businesses and researchers.

Global environmental change is one of the major challenges facing sustainable development today. The use of modern information systems to effectively manage these processes and ensure environmental safety becomes relevant. During the study, it was revealed that with the help of integrated environmental systems based on information and communication technologies, it is possible to monitor, predict in advance and identify problems in an early manner. It's also in developing countries that convenient and economical technological solutions for their implementation of such systems. The results of this scientific work prove the importance of digital approaches to ensuring environmental sustainability and also contribute practical recommendations to real socio-technological processes.

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