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Perspective

The research priorities of Resources and Environmental Sciences

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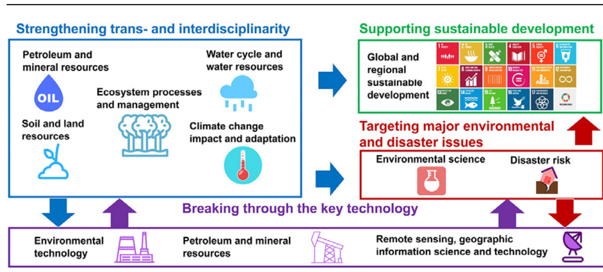
HIGHLIGHTS

- Resources and environmental problems drive the discipline development.
- Resources and Environmental Sciences fundamentally guide sustainable development.
- Four research requirements and nine critical scientific issues were proposed.
- Four recommendations were provided to support science based policymaking.

GRAPHICAL ABSTRACT



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ABSTRACT

The great challenges of sustainable development highlight an urgent need to systematically understand the mechanisms linking humans and nature. Resources and Environmental Sciences are a broad and practical discipline focused on coupled human and natural systems. They aim to study the formation and evolution of resources in the earth system, the drivers of various environmental problems, processes and relationships between resources and the environment, particularly under the combined impacts of natural conditions and human activities. The major resources and environmental problems drive the discipline development; international science programmes guide the direction of the discipline; interdisciplinary and transdisciplinary integration promotes new branches of the discipline; and technological progress results in a research paradigm shift. Facing the critical research requirements of strengthening trans- and interdisciplinarity, breaking through the key technology, targeting major environmental and disaster issues, and supporting sustainable development, nine critical scientific issues should be focused on climate change impact and adaptation, petroleum and mineral resources, water cycle and water resources, soil and land resources, ecosystems, remote sensing and geographic information science, environmental science and technology, disaster risk, and global and regional sustainable development. Suggestions to enhancing funding systems, improve talent cultivation, develop scientific platforms, and strength international cooperation are provided in this study to support scientific policymaking. The promotion of Resources and Environmental Sciences enables a more comprehensive and in-depth understanding of economic development and environmental changes relevant to assure a more sustainable global development.

1. Introduction

The world has witnessed an exponential growth of the human population and rapid increases in industrial manufacturing, food production, resources consumption, and environmental pollution since the Industrial Revolution, over the past 200 years (Meadows et al., 2004; Motesharrei et al., 2017). Humanity has been using more resources and producing more waste and pollution than the natural Earth's replenishment and self-purification capacity. The Earth faces the "Anthropocene" and the tremendous impacts of human activities that have been driven global environmental changes (Lewis and Maslin, 2015; Waters et al., 2016). Anthropogenic perturbation has resulted in unprecedented stresses on the Earth planet, leading to numerous ecological and environmental problems such as global warming, sea-level rise, increased flooding and extreme drought events, biodiversity loss and massive emissions of pollutants (Rockström et al., 2009a; Rockström et al., 2009b). Several key earth system processes, namely, climate change,

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Table 1
The top 40 words from the search results of "Resources and Environmental Sciences" in Web of Science database in January 2021.

Terms	Frequency	Terms	Frequency
science	226	health	33
management	170	quality	33
conservation	100	climate	28
climate change	92	participation	28
policy	84	system	28
sustainability	67	risk	27
knowledge	65	dynamics	25
framework	60	energy	25
governance	55	behaviour	24
resources	49	community	24
challenges	47	design	24
biodiversity	46	resilience	23
model	46	uncertainty	23
ecology	44	environment	21
systems	43	fisheries	21
ecosystem services	38	land-use	21
future	38	decision-making	20
water	38	models	20
impact	37	river	20
information	35	diversity	19

biosphere integrity, biogeochemical flows, and land system change, have exceeded the safe levels of planetary boundaries for humanity (Steffen et al., 2015).

During the last 50 years, although enormous human efforts have been devoted to environmental protection, the earth system continues to deteriorate at high speed (Steffen et al., 2020; Tortell, 2020). Human activities have significantly changed all ecosystems on the planet, and 60% of the ecosystem services (15 out of 24) have been degraded to unsustainable levels (Millennium Ecosystem Assessment, 2005). The 2019 report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) found that 78% (14 out of 18) of the benefits that humans obtain from nature are rapidly declining due to intensified human activities such as land-use change, population growth, economic development, and technical progress (IPBES, 2019). A safe and just space for humanity defines the space between the environmental and social boundaries and emphasizes the need to achieve sustainable development (Raworth, 2012). O'Neill et al. (2018) evaluated safe and just space for 150 countries and found that no country is able to meet the basic needs of residents while ensuring a sustainable utilization. They further suggested that the current level of resources utilization should be increased by at least 2–6 times to fully achieve social equity.

In 2015, the United Nations Sustainable Development Summit released the 2030 Agenda for Sustainable Development and proposed a collection of 17 sustainable development goals and 169 specific goals, requiring innovative models and ways to achieve these goals (United Nations 2016). The great challenges of achieving sustainable development goals highlight an urgent need for a systematic understanding of the mechanisms linking humans and nature (Fu et al., 2019), in order to improve human wellbeing and maintain sustainable resource utilization and environmental integrity (Wu, 2019).

The science of resources and the environment is a comprehensive and practical discipline focused on coupled human and natural systems and aims to study the formation and evolution of resources in the earth system, the drivers of various environmental problems, the processes and relationships between resources and the environment, particularly under the combined impacts of natural conditions and human activities. The methodologies and techniques used generally include a combination of various knowledge and technical methods covering earth sciences, chemistry, biology, computer science, engineering science and social science. Scientific research on resources and the environment covers different aspects of geography (i.e., water cycle, soil and land resources, atmospheric science, human geography, remote sensing, and geographic information science), ecosystems (i.e., ecosystem services, biodiversity, and macrosystems ecology), the environment (i.e., pollution and infectious diseases), natural hazards (i.e., processes, patterns and drivers of disasters, and measures to prevent disasters), and sustainable development (i.e., sustainable development goals).

Scientific research on resources and the environment is of great significance to promote the development of other disciplines and related technologies and implement regional, national and global science and technology development plans and policy objectives. In addition, Resources and Environmental Sciences provide scientific support for rational utilization of soil, water and other resources, resolving major bottleneck problems of sustainable development, safeguarding ecological security, and improving people's livelihood. Therefore, it is important to develop future perspectives on the characteristics, key areas, and future scientific research directions on resources and the environment. This paper aims to: 1) summarize the characteristics of Resources and Environmental Sciences, 2) identify the key areas and directions for Resources and Environmental Sciences, and 3) propose funding mechanisms and policies for developing Resources and Environmental Sciences.

2. The discipline development

The key topics of the Resources and Environmental Sciences were searched by extracting the information from the titles, keywords, and abstracts of the articles published in the Web of Science database (accessed in Jan 9, 2021). The filter rule was set as "Topic = (resource AND environment)". The number of published articles since 1960 to 2021 was counted, and the most frequent words were extracted (Table 1). The number of publications increased gradually from 1960 to 2000. The "Silent Spring" by Rachel Carson in 1962 was the first to tell the public that nature was vulnerable to human impacts (Carson, 2002) (Fig. 1). During this period (1962–2000), "Limits to Growth" (Meadows et al., 1972), "Only One Earth" (Ward and Dubos, 1972), "Our Common Future" (World Commission on Environment and Development, 1987), and "Agenda 21" (United Nations, 1992) promoted public awareness of how humans are changing the earth system, and that the resources and carrying capacity of the earth are limited. Since the United Nations put forward the "Millennium Development Goals" (United Nations, 2000) in 2000, the concept of sustainable development has been gradually gaining global consensus. Since then, studies on resources and the environment have been accelerating, as the science of resources and the environment could guide how to attain harmony between humans and nature. From the 40 top most frequent words extracted by the WordCloud map, "science", "management", "conservation", "climate change", "policy", "sustainability", "knowledge", "framework", "governance" and "resources" were the most frequent (Table 1). This showed that the core of Resources and Environmental Sciences was to manage human behaviour and activities within Earth's resource limits and environmental carrying capacity. Optimization of the resource management is necessary to ensure the sustainability of the system and reconcile the tradeoffs between socioeconomic development and protection of resources and the environment (Steffen et al., 2015; D'Odorico et al., 2018; Konduracka, 2019).

The development of Resources and Environmental Sciences revealed the following characteristics of the discipline development. Major resources and environmental problems drive discipline development. Due to the increasing anthropogenic influence on global weather patterns, climate, land surface, cryosphere, and deep-sea, global changes have increased the environmental risk across all scales and negatively impacted regional social and economic development. Thus, the concept of sustainable development emerged to solve resources and environmental problems. The realization of sustainable development goals (SDGs) requires insights from the science of resources and the environment, such as the concept of "planetary boundaries" (Rockström et al., 2009b) and regime shift theory (Scheffer and Carpenter, 2003), which could provide early

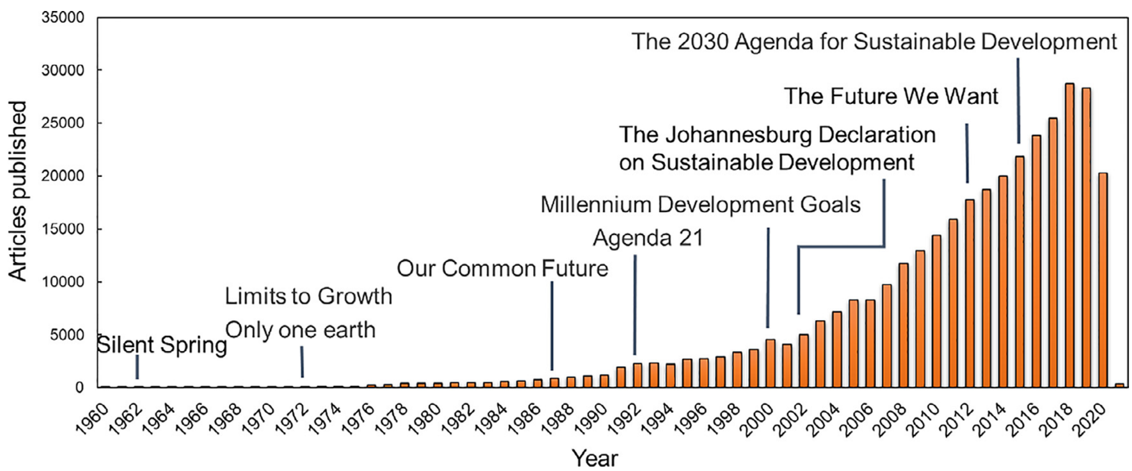

Fig. 1. The number of publications since 1960 and the seminal work from the search results of "Resources and Environmental Sciences" from Web of Science.

warnings of resource and environmental risk and help develop adaptive measures. Moreover, as a bridge between both nature and society, ecosystem services have been promoted as a management tool closely linked to sustainability (Abson et al., 2014). The major environmental and resource problems at local and global scales would directly drive the innovation and development of the Resources and Environmental Sciences theories and methods.

International science programmes guide the direction of the discipline. Interdisciplinary and transdisciplinary research involving experts from natural, social, economic, engineering and other disciplinary fields and policymakers is important to solve environmental and resource problems. Major international research projects launched by governmental organizations and research institutions can integrate multidisciplinary directions and enable cross-disciplinary research, consistent with the highly interdisciplinary and transdisciplinary nature of Resources and Environmental Sciences. In recent decades, a series of international scientific programmes on climate change, biodiversity, land-use change, global environmental change, and sustainable development have drawn the research direction of Resources and Environmental Sciences. For example, the Future Earth (Rockström, 2016), an the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Díaz et al., 2015) and the Zero Net Land Degradation (ZNLD) (UNCCD, 2012) have joined international researchers and guided the development of the Resources and Environmental Sciences.

Interdisciplinary and transdisciplinary integration promotes new branches of the discipline. Human and natural systems have formed an integrated and complex system with a high degree of uncertainty and multilayer nested characteristics. To solve the complex issues in coupled human and natural systems, it is necessary to further enhance interdisciplinary and transdisciplinary integration to accurately characterize the coupling relationship between human activities and the natural environment using new methods from the social sciences (e.g., anthropology, economics and political science) and natural sciences (e.g., information technology, geography and remote sensing technology). System coupling integration and multiscale synthesis have promoted the development of new disciplines such as ecohydrology (Baird and Wilby, 1999), social hydrology (Sivapalan et al., 2012), food-water-ecology-energy nexuses (Shi et al., 2020), EcoHealth (Harrison et al., 2019), and sustainability science (Kates et al., 2001).

Technological advances result in a research paradigm shift. The real-time observation networks of the earth system provide data to support understanding on the interactions among the lithosphere, hydrosphere, biosphere, atmosphere, and human sphere. Benefiting from computer and communication technologies, crowdsourcing geographic data have become a novel way to monitor the resources and environment on the earth's surface, and cloud computing makes it more convenient to process big data generated from multiple sources (Wu et al., 2020). Geographic information systems, remote sensing, computer science, big data, and other technologies have shifted the research paradigm of Resources and Environmental Sciences from qualitative and statistical analysis to modelling and prediction.

3. Characteristics of the discipline

3.1. The comprehensive, systematic and multidisciplinary nature

Resources and Environmental Sciences emphasize comprehensive, systematic and interdisciplinary or transdisciplinary research, as the research subject involves a variety of complex systems with high heterogeneity in space and time. Therefore, it is necessary to apply multidisciplinary theories and approaches to solve real-world problems. For example, theories such as complex adaptive systems, alternative stable states, and critical mutualisms have been applied to examine the complexity, systematicness and sustainability of Resources and Environmental Sciences (Blindow et al., 1993; Ghazoul and Chazdon, 2017). New approaches such as artificial neural networks and simulation modelling have also been developed. With the application of these integrated theories and models, Resources and Environmental Sciences combine the "top-down" and "bottom-up" methods to guide land management and restoration, resource planning, forest management, and nature conservation.

3.2. A regional and application-driven focus

The research topics of Resources and Environmental Sciences focus on regional needs and real-world application. The long-term regional development and utilization of ecosystems under increasing population pressures have seriously degraded ecosystems and their services (Foley et al., 2005). The resulting environmental problems, such as water shortages, soil erosion, desertification and biodiversity loss, pose a serious threat to regional ecological security and sustainability. The tradeoffs between resources and the environment and sustainable development have become major challenges for human society. However, the relationship between environmental change and regional development is complex. The distribution of natural resources and environmental problems exhibit considerable spatial variations, and an effective solution (e.g., ecological restoration) for one region may not work in another region. Solving these problems and providing region-specific solutions are the main research goals of Resources and Environmental Sciences.

3.3. Complexity at the different spatial and temporal scales

The research objects and processes in Resources and Environmental Sciences exist and operate at different scales. Resource and environmental problems, such as those caused by industrialization, often exist across the world and are hierarchically nested at multiple scales. The resources and services provided by the natural system depend on the ecosystem structure and ecological process at a certain time and space, and the human wellbeing obtained from the ecological system is also scale-dependent. Some ecological processes operate globally, while their products, services, materials, and energy are often transported across regions and utilized at the regional level. The scale effects and multiscale connections of resources and environmental problems are the focus of Resources and Environmental Sciences.

3.4. Key role of technological advances

Technological advances create new research approaches. The development of scientific research needs the support of external technologies, which in turn drive the research paradigm shift. In the early stage, the research paradigm of Resources and Environmental Sciences was qualitative, mainly describing the distribution of natural resources such as vegetation, soil, rivers, and mountains. The pattern and processes were coupled in the resources and environment to examine the formation and evolution of resources. Therefore, modelling complex human-earth systems and sustainable development systems for decision-making is critical. This paradigm shift is facilitated by technological developments such as geographic information systems, remote sensing, and computer science.

3.5. Model simulation to support decision-making

The rapid development of model simulation supports decision-making. Emerging new technologies such as big data, artificial intelligence, and machine learning have made it possible to model the complex interactions between global and local elements of the resources and environmental system. In water resource management, the simulation and prediction of hydrological cycles with higher resolution at basin, regional and global scales provide reliable water availability and fluxes estimates as a basis for sustainable water management and decision making. Complex system models can capture the interactions and mechanisms between various natural processes, human activities, and their consequences. These models are indispensable tools for testing scenarios and support policies to address climate change and environmental problems. Extending the research methods by combining the processes-based models and machine learning can improve models' capability for decision-making and management in various fields of Resources and Environmental Sciences.

4. The research priorities

Resources and Environmental Sciences are an essential interface for regulating the conflicts between humans and the environment. They should pay attention not only to a single environmental issue but also to the nexus among the economy, society and environment and the collaborative governance of social ecosystems (Schmidt-Traub et al., 2017; Liu et al., 2018). Therefore, Resources and Environmental Sciences need to deepen the integration with other disciplines and to better serve global sustainable development. Research priorities in Resources and Environmental Sciences can be summarized into four critical research requirements and nine scientific research areas (Fig. 2).

4.1. The critical research requirements

4.1.1. Strengthening trans- and interdisciplinarity

As the interface among the atmosphere, lithosphere, soil sphere, hydrosphere, and biosphere, the earth's surface is closely related to human survival and development and thus should be coupled with various physical, chemical, and biological processes. Integrating the earth surface system and its patterns, processes, and functions can expand the depth of research in subdisciplines of Resources and Environmental Sciences. Moreover, disciplines such as anthropology, cultural geography, economics, sociology are all important in addressing sustainable development issues. With the strengthening of trans- and interdisciplinarity, the mechanism of the human-earth coupling system with multiscale and multiprocess characteristics can be better analysed.

4.1.2. Breaking through the key technology

The monitoring of the quantity and quality of natural resources and their dynamics requires enriching the technological analyses on different spatiotemporal scales. Resources and Environmental Sciences should focus on key technologies, especially those supporting high-resolution spatiotemporal monitoring and intelligent spatial analysis systems around the earth's surface.

4.1.3. Targeting major environmental and disaster issues

Human activities such as agricultural production, industrialization, and urbanization have led to increasing water, soil, and air pollution, with serious effects on the ecosystems and human health. Moreover, global climate change can lead to an increasing frequency and intensity of extreme events. Resources and Environmental Sciences should target key environmental issues, provide scientific solutions to reduce disaster risks, and support effective environmental management.

4.1.4. Supporting sustainable development

The core elements of Resources and Environmental Sciences, including climate, soil, water, energy, and biodiversity, are all relevant to the sustainable development goals. Therefore, the future development of Resources and Environmental Sciences should focus on sustainable development and make efforts to provide regional solutions to achieving sustainable development (Fu, 2020).

4.2. The critical scientific research areas

4.2.1. Climate change impact and adaptation

Facing the grand challenge of global climate change, adaptation has received increasing attention from the general public and policymakers (Smith et al., 2009). As a transdisciplinary issue, adaptive capacity to climate change, especially in developing countries, has raised extensive attention. Therefore, the key research directions in this area include (1) the scientific basis of climate change; (2) the impacts of climate change on natural systems and adaptation; and (3) the impacts of climate change on social and economic systems and adaptation. In particular, special attention needs to be given to climate change reanalysis, risk of extreme events, simulation and prediction of climate change, and the impact of climate change on human health and wellbeing.

4.2.2. Petroleum and mineral resources

Petroleum and mineral resources are pivotal materials to support human survival and socioeconomic development at present. Recently, the supply and demand of petroleum and mineral resources have led to tense situations due to climate crises and political conflicts. The growth of renewable energies becomes a desirable trend for sustainable development. The critical scientific research areas for petroleum and mineral resources are (1) the relationship between deep earth processes and mineralization; (2) the security of essential mineral resources; (3) mineral exploration techniques; (4) the prediction of mineralization processes; and (5) renewable energy technology.

4.2.3. Water cycle and water resources

The water cycle and water resources are closely coupled with ecological, hydrological, geomorphic, and biogeochemical processes and human activities. The critical scientific research areas include (1) global

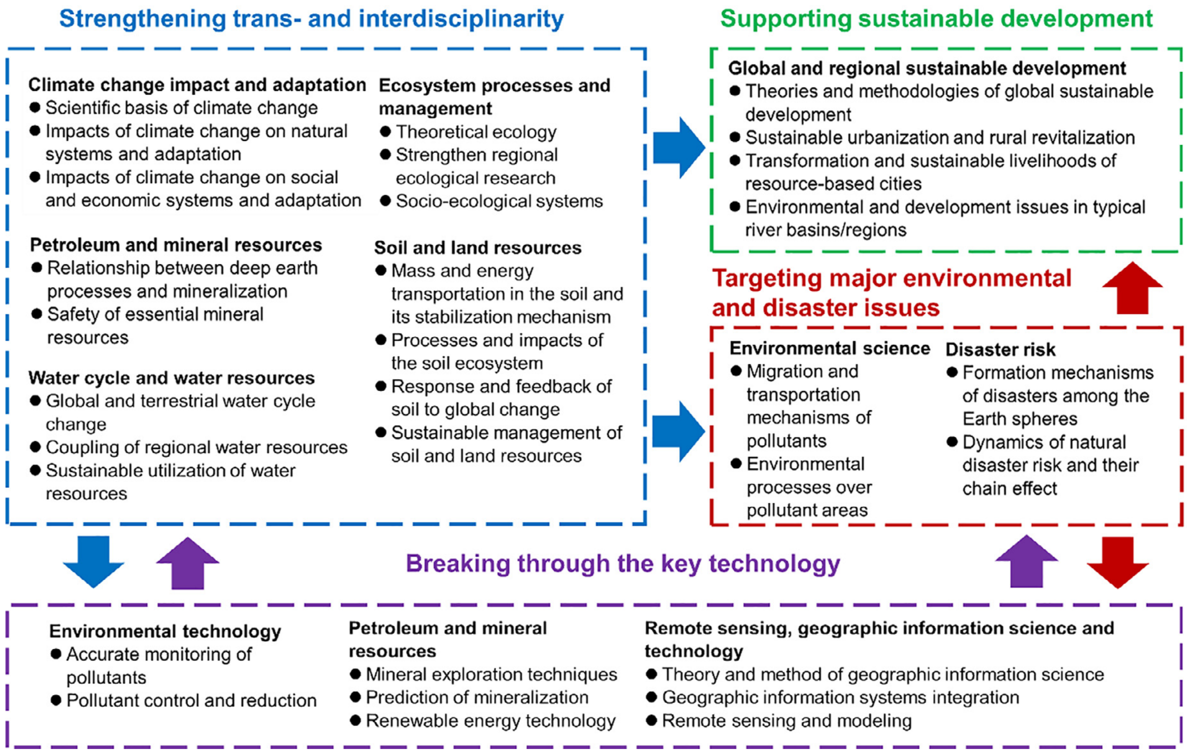

Fig. 2. Research priorities in Resources and Environmental Sciences.

and terrestrial water cycle change; (2) coupling of regional water resources; and (3) sustainable utilization of water resources. It is necessary to separate the contributions of climate change from those derived by the human activities on terrestrial water cycle changes, and develop hydrological models considering the influence and feedback of both natural and human factors. It is also essential to elucidate the coupling and feedback mechanisms of water-food-energy to advance the theoretical understanding of water resources.

4.2.4. Soil and land resources

Soil is the most active layer on the earth's surface and is the material basis for terrestrial ecosystems and agriculture. It is also a key element in land resource management. The critical scientific research areas in the future are as follows: (1) mass and energy transportation in the soil and its stabilization mechanisms; (2) processes and impacts on the soil ecosystem; (3) response and feedback of soil to global changes; and (4) sustainable management of soil and land resources.

4.2.5. Ecosystem processes and management

Climate change affects the structure, composition, and function of ecosystems (Holmgren and Hirota, 2013; Pederson, 2014; Doughty, 2015; Uriarte et al., 2016). The interactions among climate change, ecosystems, and human wellbeing are of great importance (Liu, 2020). The following research areas for ecosystems should be considered in the future: (1) theoretical ecology; (2) strengthened regional ecological research; and (3) socioecological systems.

4.2.6. Remote sensing, geographic information science and technology

Remote sensing and geographic information science underpin the reliable and timely observation of terrestrial and marine ecosystems from space, sky and ground (Guo, 2018; Li et al., 2019). Priority research areas for remote sensing, geographic information science and technology are (1) theories and methods from the geographic information science; (2) integration of geographic information systems; and (3) remote sensing and modelling.

4.2.7. Environmental science and technology

Environmental science and technology research should focus on technology development, major environmental issues, and the linkage between environmental issues (e.g., air pollution, water pollution, soil contamination) and human health. The critical research areas include (1) migration and transportation mechanisms of pollutants; (2) environmental processes over polluted areas; (3) accurate monitoring of pollutants; and (4) pollution control and reduction. Developing a novel research methodology for pollutant behaviour is necessary to reveal the mechanisms of polluted multimedia interfaces, migration and transformation and their interactions with environmental processes and climate change.

4.2.8. Disaster risk

Disaster risk prevention, preparedness, mitigation, and relief are key measures to build a safer world and achieve sustainable development. The future critical research areas of this direction include (1) formation mechanisms of disasters among the earth spheres, and (2) dynamics of natural disaster risk and their chain effects. Specifically, important research topics include the mechanisms and prediction of earthquake disasters, the lithosphere-hydrosphere interaction, the mechanism of marine disasters, flood and drought disasters and their sphere of interaction, climate change impacts on major natural disasters, mechanisms and precursors of major geological disasters, and the mechanisms and risks of forest and grass fires. Predicting the risks of certain natural disasters (e.g., earthquakes) is still difficult, and predictions should be made based on sufficient knowledge about the formation mechanisms.

4.2.9. Global and regional sustainable development

The complex human-environmental interactions with SDGs require a transdisciplinary approach (Fu et al., 2019). The critical research areas are (1) theories and methodologies for global sustainable development; (2) sustainable urbanization and rural revitalization; (3) transformation and sustainable livelihoods of resource-based cities; and (4) environmental and development issues in typical river basins/regions. It is important to monitor and evaluate the interactions among sustainable development goals at the regional scale, establish regional sustainable development theories, develop mechanisms and evaluation systems, and clarify the main drivers and interactions of regional sustainable development.

5. Policy recommendations

5.1. Funding systems

Optimizing funding systems is essential to satisfy national needs and solve bottleneck problems. Funding directions should be adjusted to research areas that are international research frontiers and major national strategic needs, such as regional response and adaptation to global changes, ecological restoration of fragile regions, biodiversity and ecosystem services.

Funding to support data platforms and organizational coordination should be strengthened. The collection of basic data and information supports quantitative studies. A comprehensive platform involving essential resources, including water, land, energy, and biodiversity, and population, urbanization, industrial structure, and climate information, is the foundation for Resources and Environmental Sciences.

The systems evaluation should be improved to encourage innovation and credits. Fund evaluation mechanisms need to emphasize innovations and originality, increase support for potentially pioneering projects, and establish credit files to allow “error tolerance” in the final review of the outcomes.

The funding structure needs to promote interdisciplinary and transdisciplinary research. The funding system should have a clear position, effective coordinated cooperation, and reasonable discipline classification. It should also accept new funding sources such as private funding and international cooperation to encourage interdisciplinary and transdisciplinary research.

5.2. Talent cultivation

A stable supporting mechanism for outstanding researchers at different ages should be considered to stimulate explorative and innovative research. Diversified, regional and international talent teams should be constructed. Regional talent funding can provide stable support for talent teams in critical regions and cooperative research with world-class experts. Meanwhile, attention should be given to the training of application-oriented talent, the recruitment of talent in resource and environmental engineering areas, and the cultivation of supervisors with resource and environmental engineering experience.

The policy system should focus on personnel training for technology development for interdisciplinary and transdisciplinary research. It is recommended to build a funding system that targets resource and environmental technology development and support personnel and form technical support personnel teams. Special funding can be established to cultivate interdisciplinary or transdisciplinary scientific knowledge for training through investing in basic education and construction of education bases.

Moreover, it is recommended to build a think tank consisting of high-level experts to provide timely guidance for evaluation processes, strengthening the performance evaluation of the national science and technology plans.

5.3. Scientific platform

It is necessary to establish data sharing mechanisms and research facilities, for example, by improving the current data sharing mechanisms and establishing large-scale instrument service centres and public simulation laboratories. The construction of research infrastructures for information and networking can support the building and use of large-scale research platforms, scientific research collaborations and scientific and technological resources sharing.

Long-term observation sites and collaborative observation networks are the basic scientific infrastructures. Various research sites in different regions should be integrated through top-level design and planning to establish a unified standard and system for research design, research methods, data monitoring and sharing, and possibly to incorporate space-sky-ground technologies and multiscale collaborative observation networks.

It is necessary to construct big data platforms to encourage the application of new technologies, the construction of observation and experimental platforms, planning field stations in accordance with the characteristics of each research field, the establishment of major national projects, and the capability of original data collection.

Coupled models and decision support platforms are indispensable tools that require continuous development. Major attention should be given to creating a social-economic-natural coupled model and decision support platform with intellectual property rights and the technology of grid-scale management, multisource big data integration, video recognition and analysis, and the Internet of Things. These platforms will result in an intelligent management of natural resources for regional ecological protection and environmental governance.

In addition, open data are very important in the data-sharing mechanism. The scientific platform in the future should enhance the accessibility to data towards the goal that scientists and non-scientists can access all data. Meanwhile, standards should be established to protect the interests of data producers (e.g., time embargo for data sharing) and ensure the shared quality of data.

5.4. International cooperation

Policymakers, research institutions, universities, enterprise, and scientists should actively participate in dialogues and research on global scientific issues. These global challenges faced by many countries are also their main motivations to conduct international scientific and technological cooperation on topics including sustainable development, food security, energy and water resources, climate change, and poverty reduction. Many efforts are currently being undertaken by the United Nations (UN). However, the UN is unable to fully guide such complicated programmes due to limitations in funding, scientific talent, local knowledge, and national support. A structure of multilateral cooperation is required, such as the Alliance of International Science Organizations (ANSO) (Chan et al., 2020), the Third Pole Environment (TPE) plan (Yao et al., 2012), and the Global Dryland Ecosystem Programme (Global-DEP) (Fu et al., 2021) initiated by China.

The area of international cooperative research projects should be expanded. Policymakers should promote multilateral cooperation programmes in Resources and Environmental Sciences by encouraging researchers to consider global environmental change issues and creating a sound international environment in the context of future political multipolarization, and academic internationalization. Moreover, the strengthening of international cooperation also includes switching from project-oriented to platform-oriented, initiating more international scientific cooperation projects, actively seeking funding from international sources, and providing more support for domestic scholars to lead or participate in the construction of multilateral collaboration platforms.

6. Conclusions

Mankind faces a more crowded world, and the natural environment faces increasing threats of environmental deterioration resulting from the continued growth of the global economy. The research of Resources and Environmental Sciences is multidisciplinary and involves studies of geography, ecosystems, the environment, natural hazards, and sustainable development. Evolutionary methods and techniques for research on resources and the environment enable us to have a more comprehensive and in-depth understanding of economic development and environmental changes in the future.

It has been widely recognized that sustainable development is the golden key to solving global change problems, and the Resources and Environmental Sciences are the basic and supporting discipline for sustainable development. However, the development of resources and environmental research is facing a series of challenges, including inadequate theoretical systems, limitations in observation systems and standardized data collection, and a lack of multiscale simulation platforms.

Future research should be prioritized to analyse the interactions among water, soil, climate, biotic attributes, energy and humanity; identify the mechanisms of multiprocess, multiscale and multifactor interactions under global environmental change; clarify the mechanisms of resource utilization, ecological protection and restoration, and pollution control; develop models for predicting, preventing and managing of environmental change and disaster risks; reveal the dynamics of the coupled human and natural systems; and promote global and regional sustainable development.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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