BOOK OF ABSTRACTS

1. SESSION DESCRIPTION

ID: T13

Title of session:

Ecological restoration across technologies, regions, and ecosystem services

Hosts:

	Title	Name	Organisation	E-mail
Host:	Prof.	Yihe Lü	Research Center for Eco-Environmental Sciences	lyh@rcees.ac.cn
Host:	Prof.	Lin Zhen	Institute of Geographical Science and Natural Resources Research	zhenl@igsnrr.ac.cn
Co-host:	Prof.	Huimin Yan	Institute of Geographical Science and Natural Resources Research	yanhm@igsnrr.ac.cn
Co-host:	Prof.	Xianli Xu	Institute of Subtropical Agriculture, Chinese Academy of Sciences	xianlixu@isa.ac.cn
Co-host:	Prof.	Wenwu Zhao	Beijing Normal University	zhaoww@bnu.edu.cn

Session description:

As human development pressures to the environment continue to grow and the increasing demands for improved environmental conditions that supports high level human well-being, ecological restoration has already become both a vigorous scientific discipline and a practical approach for healing the degraded ecosystems. Studies have revealed that many ecosystem services of the degraded ecosystems have been improved through the application of restoration technologies, which include, but not limited to, food production, soil and water conservation, soil support, carbon sequestration, and landscape beauty and cultural services. However, many key issues concerning ecological restoration still remain unresolved. Academic debates are still hot on topics such as the suitable use of active or passive restoration approaches, spatiotemporal scales, the biodiversity-ecosystem structure-spatial pattern-ecological functioning-ecosystem service relationships, and performance assessment. On a regional scale, ecological restoration can be very complex owing to the interactions of socioeconomic and biophysical patterns and processes.

Ecosystem service has been recognized as a bridging concept between human and nature that underpins the long term and strong sustainability of socio-ecological systems across scales. More specifically, it is also critical for systematical analysis of location specific technologies that have been adapted to the restoration practices, and their interrelations to and impact on the nature's delivery of ecosystem services. Therefore, this session will bring about experts with both theoretical and practical backgrounds to discuss the state-of-the-art ecological restoration from site specific technological, regional and ecosystem service perspectives.

To be more focused under such a broad topic, this session is divided into two parts. The first part is ecological restoration technology-oriented, which aims to introduce the general trend of ecosystem degradation in various spatial and temporal scales across the nations, to explore the key

technologies developed and adopted to the restoration of these degraded ecosystems, to present the methodology and indicator systems that could be used to assess the effectiveness of the restoration technologies in terms of the improvement of provisioning, regulation, supporting and cultural services, and to evaluate the effects of the restoration technology on key ecosystem services. The second part is planned to synthesize the evidences and research experiences on regional ecological restoration with ecosystem service approaches internationally to represent key ecoregions such as drylands, karst areas, mountainous areas, and urbanizing environments.

It is expected that the session will synthesis the major progress on the restoration efforts that have been made over the past decades, and to recommend the best practices and technologies for long-term ecological rehabilitation. Special issues in peer-reviewed journals are planned for disseminating the results of the session.

Goals and objectives of the session:

- To characterize the general trend and hotpots of ecosystem degradation in various spatial and temporal scales across the nations as a basis for restoration planning;
- To explore key technologies for ecological restoration and their effectiveness on improving ecosystem services;
- To share global experiences of regional scale ecological restoration;
- To analyse regional ecological restoration using ecosystem service approach with a socio-ecological system perspective;
- To make up-to-date overview of the integrative research progress on the coupling of regional ecological restoration and ecosystem services and outlook for future research frontiers.

Planned output / Deliverables:

Special issues in peer-reviewed international journals are planned to summarize the topics and collect high quality research findings as one of the concrete ESP output to international audience to extend the impacts beyond the conference.

Related to ESP Working Group or National Network:

TWG 13 – Role of ES in Ecosystem restoration

2. SESSION PROGRAM

Date of session: 12 December 2017
Time of session: 14:00 – 17:30

Timetable speakers

Time	First name	Name	Organization	Title of presentation
14:00	Lin	Zhen	Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences	Overview of ecological restoration technologies and evaluation systems

Time	First name	Name	Organization	Title of presentation
14:10	Wenwu	Zhao	Faculty of Geographical Science, Beijing Normal University	Hypothesis of disturbance effect transmutation and its application in ecosystem services trade-off analysis
14:20	Yuehan	Dou	Wageningen University	Assessing the influences of ecological restoration on cultural ecosystem services in agricultural landscapes
14:30	Shaoshan	An	College of Resource and Environment, Northwest A&F University	Ecosystem service functions affected by Grain for Green project in small catchment on the Loess Plateau
14:40	Stefani	Daryanto	Beijing Normal University	The ecosystem service of cover crops in agro-ecosystems: improving the water quality benefits of no-till management

Time	First name	Name	Organization	Title of presentation
14:50	Xiaofeng; Yuan	Wang; Zhang	School of Earth Sciences and Resources, Chang'an University	Assessing the ecosystem service values in Shaanxi Province based on terrain
15:00	Xiaolin	Dou	State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences	Shifts in soil organic carbon and nitrogen dynamics for afforestation in central China
15:10	Qin	Li	Center for Watershed Ecology, Nanchang University	Coupling study of spatial pattern of biodiversity and layout of main economic and social development in Poyang Lake Basin

Time	First name	Name	Organization	Title of presentation
15:20	Ting	Li	State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences	Gauging policy-driven large-scale vegetation restoration programmes under a changing environment: their effectiveness and socio-economic relationships
16:00	Fei	Lu	Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences	Net effects of China's five national ecological restoration projects on carbon sequestration in 2001-2010
16:10	Xutong	Wu	Peking University	Land use optimization based on ecosystem service assessment: a case Study in Yanhe watershed

Time	First name	Name	Organization	Title of presentation
16:20	Yanjiao	Ren	Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences	Biodiversity and ecosystem functional enhancement by forest restoration: a meta-analysis in China
16:30	Nikolay	Kazakov	Pacific National University	A complex of wind power plant for precipitation of atmospheric pollution
16:40	Kremena	Gocheva	Institute of Biodiversity and Ecosystem Research at the Bulgarian Academy of Sciences	Tools for obtaining restoration directions, refining approaches and technologies in socio-ecological systems – analogies to Traditional Chinese Medicine

Time	First name	Name	Organization	Title of presentation
16:50	Qiang	Yu	Beijing Forestry University	Optimization of ecological node layout and stability analysis of ecological network in desert oasis：a typical case study of ecological fragile zone located at Deng Kou County (Inner Mongolia)
17:00	Zhiming; Hu	Zhang; Sun	School of Ecology and Environmental Science, Yunnan University	Karst rocky desertification assessment using Unmanned Aerial vehicles (UAV) photogrammetry in southwest of China
17:10	Runsheng; Can	Yin; Liu	Michigan State University, Center for Forest Economic & Development Research, SFA	Evaluating and enhancing the performances of China's ecosystem restoration programs
17:20	Discussion			

3. ABSTRACTS

Type of submission: *Abstract*

T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Ecosystem service functions affected by Grain for Green project in small catchment on the Loess Plateau

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On the Loess Plateau, revegetation is generally achieved by establishing artificial forests or shrubs and natural succession within enclosed area. Furthermore, revegetation is a traditional practice widely used for soil and water conservation on the Loess Plateau, which resulted in the increase of vegetation cover, improvement of ecosystem service functions. In disturbed ecosystems, revegetation plays an important role in the ecological integrity of the

system. In order to compare the effect of the Grain for Green project on the ecosystem service functions in a small catchment. Our objectives were: (1) to develop some models for carbon-water trade-off that were based on the balance of carbon and water, (2) to calculate all the kinds of ecosystem service functions to provide the threshold value for ecological security assessment in the small catchment and (3) to understand the historical ecosystem service function changes in the progress of revegetation. In our research, two small catchment were selected, Fangta and Zhifang Gou in Yanhe catchment on the Loess Plateau. We measured the ecosystem service functions including water conservation, soil conservation, soil erosion, carbon fixation, biodiversity, supply service and regulating service by the field investigation, digital simulation model, and remote sensing inversion in different scale. The result showed that Grain for Green project can improve water conservation, soil conservation, soil erosion, carbon fixation, biodiversity, supply service and regulating service. Although our study area located in the Yanhe catchment, we believe we will set up a reliable evaluation scheme to provide the practical value for the government and the health of people in this small catchment on the Loess Plateau.

Keywords: ecosystem service functions, small catchment, Loess Plateau

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

The ecosystem service of cover crops in agro-ecosystems: improving the water quality benefits of no-till management

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With the recognition that nutrient excess in aquatic systems primarily originates from agro-ecosystems, different conservation agricultural practices have been proposed as options to mitigate nitrate (NO3-) and phosphorus (P) export, with no-till (NT or zero tillage) being the foundation of this farming philosophy. Although NT has been promoted as an alternative land management

practice to conventional tillage (CT), its impact on water quality, especially NO3-and P loss remain controversial. Our meta-analysis results, which compared NO3- and P (dissolved P, particulate P and total P) concentration and load in NT and CT systems, showed that NT increased the amount of dissolved nutrient loss (both NO3- and P), but reduced that of particulate nutrient (particulate P). The limited impact of NT on dissolved nutrient loss (both NO3- and P) remains a serious impediment toward harnessing the water quality benefits of this management practice and suggests that NT needs to be complemented with other management practices (i.e., cover crops). Using a data synthesis approach, we found that in comparison to fallow condition, the use of cover crops could reduce the amount of NO3- loss by 29% annually across different cash crop-cover crop combinations, climate or land management. The extent of reduction was even larger (44%) when winter-only NO3- loss was considered. Although the effects of cover crops on the yield of the cash crops were more variable, there was a tendency that leguminous cover crops could increase the yield of the cash crops under low-input agro-ecosystems (e.g., organic farming). By increasing the amount of nutrients and soil organic matter in degraded

soils, using cover crops as complementary management strategy to NT is therefore worth consideration to increase the ecosystem services of agricultural systems.

Keywords: cover crop, nitrate, no-till, phosphorus, tillage

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Assessing the influences of ecological restoration on cultural ecosystem services in agricultural landscapes

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As the non-material benefits people gain from ecosystems, cultural ecosystem service plays essential role in the human-nature interaction. It is likely to be more sensitive to the changes on landscapes than other services because its identity is strongly associated with the ways in which people interact with their landscapes. However, these non-material links between people and the landscapes they are living in are undervalued within the existing Ecosystem

Services frameworks and often are underrepresented in land use decision-making until now. One important challenge is how to assess the influences of land use changes on cultural ecosystem services CES as perceived by local communities. This study aims to solve this problem by giving more emphasis on the perspective of local rural communities and assigning their perception with key types of landscapes that closely related to ecological restoration, such as Green for Grain programme in Guyuan city, Ningxia Province. The data are collected by social household survey among the rural communities who are living within the landscapes that changed and shaped by ecological restoration programme. By analyzing the interactions between key types of landscapes and people's perception, a method is developed to evaluate the effects of the restoration technology on cultural ecosystem services.

Keywords: cultural ecosystem services, human perception, agricultural landscapes, ecological restoration

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Shifts in soil organic carbon and nitrogen dynamics for afforestation in central China

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The afforestation has been proposed as a primary means of sequestering carbon (C) from the atmosphere, thereby mitigating climate change. However, consequences of afforestation on soil organic C and nitrogen (N) dynamics due to spatial heterogeneity are not fully understood. The objectives of this study were to identify the consequences of 18 years of afforestation on C and N dynamics in the Danjiangkou Reservoir area of central China. Soil samples

from the woodland, shrubland, cropland and adjacent open area soils (i.e. the control) were separated into four aggregate sizes (> 2000 μm, 250 – 2000 μm, 53 – 250 μm and < 53 μm), and three density fractions [free light fraction (LF), intra-aggregate particulate organic matter (iPOM) and mineral-associated organic matter (mSOM)]. All fractions were analyzed for their C and N content, and δ 13C and δ 15N values. Afforestation enhanced the soil C and N storage, primarily due to increases in soil C and N storage of macroaggregates (> 2000 μm) with the largest (65%–87%) fraction in iPOM. The C: N ratios generally increased from the cropland to shrubland to woodland across all fractions. The 13C values indicated that the fastest decay rates (k=0.024 yr−1) in LF of macroaggregates (> 2000 μm) was in woodland, but the fastest decay rates (0.114–0.137 yr−1) in iPOM of all aggregates were observed in cropland. Meanwhile, the most enriched δ15N values (0.87–3.81) were found in cropland soil. Our results suggest that a shift in vegetation following land use conversion could alter soil aggregate weight distribution and/or C and N storage, consequently affecting soil C and N pools dynamics in the terrestrial ecosystem. The study is helpful for long-term carbon and

ecosystem services management.

Keywords: afforestation, soil organic matter, physical fractionation, δ 13C, δ 15N

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Tools for obtaining restoration directions, refining approaches and technologies in socio-ecological systems – analogies to Traditional Chinese Medicine

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Socio-ecological systems (SES) are complex self organizing systems. Ecosystem restoration is concerned with the management of SES and ecosystem services under uncertainty, with missing data and incompletely defined objectives. It shares a common goal – healing – with Traditional Chinese medicine (TCM). Despite their different

objects, at appropriate level of abstraction TCM principles may inform the systematical approach to ecosystem restoration at different scales and governance levels. Analogy can go deeper due to self-similarity in natural organisms/patterns/cycles, and TCM's view on humans as part of nature.

System, objectives, functioning: A key restoration question is the desired ecosystem state after restoration, especially if restoring the original state is impossible (i.e. with extinct species) or not desired (i.e. land use changes). Since ecosystem balances of energy, water, carbon, etc. are insufficiently understood, some analogy to the conceptual framework of Ying-Yang, Eight principles, Five elements and organs in TCM may prove to be beneficial to functional ecosystem understanding, restoration decision support and benchmarking a desired state. It can help understanding natural ecosystem succession, defining restoration objectives across landscape mosaics and urban environments, conservation, balancing local vs. global human needs.

Diagnostics: Visual examination and pulse taking are key TCM diagnostic tools. Their approach may help simplifying

ecosystem monitoring, integrating remote sensing, better understanding the Index of Performance (IP) used in the Bulgarian ecosystem and ecosystem services mapping and biophysical assessment.

Treatment: Re-introduction of species resembles symptomatic treatment; ecological restoration addresses the root cause of decline to restore the entire ecosystem. In the TCM, internal organs are treated by influencing far away areas (acupuncture, acupressure, moxhibustion points); the quality and timing of influence are key for success. Similarly, successful ecologic restoration must rely on nurturing ecosystem interactions such as trophic cascades or environmental engineering species to achieve ecosystem integrity, improve resilience and ecosystem service provision.

Keywords: trade-offs in socio-ecologic systems, holistic restoration and conservation, index of performance, self-similarity, Traditional Chinese Medicine

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

A complex of wind power plant for precipitation of atmospheric pollution

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The problem of atmospheric pollution has a global scale. A technological solution has been developed for the problem of industrial cleaning of polluted atmosphere air, namely, the mod-ernization of wind power plants (diverging cone type with an exhaust tube) by active systems for the precipitation and disposal of atmospheric pollution. Structurally, the plants do not need to attract additional energy sources, the traditional production of which is one of the main sources of pollution of the environment and the atmosphere. In a constructive way, the plants do not

need to attract additional energy sources, the traditional production of which is one of the main sources of pollution of the environment and the atmosphere. The principle of func-tioning of the proposed plant is the utilization of the concentrated energy of the atmospheric airflows in the exhaust tube and the concomitant extraction of contaminants of various sizes and composition. Pollution is extracted from the airflows processed by the plant through a consistent set of fundamentally different methods of atmospheric pollution precipitation, their collection and utilization respectively. It is allowed to use the precipitation system of atmos-pheric pollution only with a low resistance to the movement of air masses. The first stage of the trap is based on condensation of moistened particles of pollution and their thermal precipi-tation. The use of intermediate stages is determined experimentally, depending on the size and composition of the particles missed by the first stage. The finishing stage is equipped with an electrostatic collector. Landscape airflow control is practiced to improve the efficiency of wind power plants. At the same time, it is promising to use cascades of the proposed self-contained plants in combination with

standing forests of a given shape and composition.

Keywords: autonomous, atmospheric pollution, precipitation, wind power plant, air flow control

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Gauging policy-driven large-scale vegetation restoration programmes under a changing environment: their effectiveness and socio-economic relationships

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Large-scale ecological restoration has been widely accepted globally as an effective strategy for combating environmental crises and to facilitate sustainability. Assessing the effectiveness of ecological restoration is vital for researchers, practitioners, and policy-makers. However, few practical tools are available to perform such tasks,

particularly for large-scale restoration programmes in complex socio-ecological systems. By taking a “before and after” design, this paper formulates a composite index (Ej) based on comparing the trends of vegetation cover and vegetation productivity to assess ecological restoration effectiveness. The index reveals the dynamic and spatially heterogenic process of vegetation restoration across different time periods, which can be informative for ecological restoration management at regional scales. Effectiveness together with its relationship to socio-economic factors is explored via structural equation modeling for three time periods. The results indicate that the temporal scale is a crucial factor in representing restoration effectiveness, and that the effects of socioeconomic factors can also vary with time providing insight for improving restoration effectiveness. A dualtrack strategy, which promotes the development of tertiary industry in absorbing the rural labor force together with improvements in agricultural practices, is proposed as a promising strategy for enhancing restoration effectiveness. In this process, timely and long-term ecological restoration monitoring is advocated, so that the success and sustainability of such programmes is ensured, together

with more informative decision making where socioecological interactions at differing temporal scales are key concerns.

Keywords: ecological restoration, effectiveness assessment, temporal scale, socio-ecological system, rural economy, structural equation modeling

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Coupling study of spatial pattern of biodiversity and layout of main economic and social development in Poyang Lake Basin

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Biodiversity and ecosystem function and service are the foundations of economic and social development in human beings. According to the history of human civilization development, the spatio-temporal distribution of ecological factors in watershed land is one of the most determinants to the pattern of economic and social development. The significant problems between economic and social development, and ecological benefits in China have been increasing related to character and scale of

watershed. However, it's difficult to solve the key questions in the conflict based on research solely on one system. Poyang Lake Basin is a key spot of biodiversity in the world, also close connected to national strategies, such as the Great Protection of the Yangtze River and the Yangtze River Economic Zone. It is a unique compound ecology system, and relatively independent geographical unit, as it is a geographically systematic, structurally integrated and functionally independent system, composing a mountain-water-forest-cropland-lake complex. In the past three decades, in coupled with accelerated urbanization and high-speed development of economy and society, the conflict between biodiversity conservation and development of economy and society has become increasing severe. Poyang Lake Basin as the study site, the essential space for biodiversity conservation was inferred through the distribution of biodiversity and protected areas, and the evolution of watershed ecology. Based on the status and future planning of economy and society development, we put forward the significant ecological environment problems and key restriction factors. Then, coupling of the pattern of important economy and society development, and three key ecological factors (water, land,

and biodiversity) was analyzed, to discuss the stress and conflict between rapid urbanization, land use change and distribution of some high environmental risk industries on biodiversity conservations. Our study was aimed at the optimization between development of economy and society, and biodiversity conservation.

Keywords: Poyang Lake Basin, biodiversity, regional sustainable development, ecospace, human activity layout

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Net effects of China's five national ecological restoration projects on carbon sequestration in 2001-2010

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The long-term stressful utilization of forests and grasslands has led to ecosystem degradation and carbon (C) loss. Since the late 1970s, China has launched a series of key national ecological restoration projects (e.g. Forest Protection, Grassland Conservation, North Shelter Forest, Sand Control, Grain for Green Project and River Shelter

Forest) to protect its environment and restore degraded ecosystems. Here, we conducted a large-scale field survey and literature survey of the biomass and soil C of China's forest, shrubland and grassland ecosystems. We investigated the changes in C stocks of these ecosystems across the regions where the five projects were implemented to evaluate the contributions of the projects to the country's C sinks between 2001 and 2010. Over this decade, we estimated that the total annual C sink in the regions with these projects was 116 Tg C (1 Tg = 10^12 g), of which approximately one half (59 TgC / yr) was attributed to the implementation of the projects. We further built the methodology of carbon (GHG) accounting and net sequestration of key ecological projects (CANS-KEP) to investigate the net GHG mitigation effects of these projects. The results indicated that the projects would lead to relatively low countervailing effects of leakage and carbon cost compared with some popular carbon sequestration measures in cropland. Our results demonstrate that these restoration projects have substantially contributed to CO2 mitigation in the country.

Keywords: ecological restoration projects, carbon

sequestration, greenhouse gas, net mitigation, China

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Type of submission: *Abstract*

T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Biodiversity and ecosystem functional enhancement by forest restoration: a meta-analysis in China

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Large-scale forest loss and degradation have dire consequences for biodiversity maintenance and provision of vital ecosystem services. Despite recent increasing efforts for forest restoration and sustainable management, there have been no comparative studies of biological taxonomy and multiple ecosystem functions to assess the effectiveness of forest restoration programs, and how they vary through space and time. Here, we provided a

quantitative assessment of the recovery of biodiversity and ecosystem functions by forest restoration in China using a meta-analysis of 172 studies. We found that biodiversity and ecosystem functions were substantially increased in restored forests comparing with the degraded states. However, these restoration effects varied considerably by degradation origin, restoration approach, restoration age, ecological domains, taxonomic group, and ecosystem function that is measured. Results also revealed that forest restoration from degraded states could not lead to full recovery of biodiversity and ecosystem functions, highlighting the irreplaceability of primary forests. We advocate allowing for natural or passive recovery, especially where biophysical conditions are favorable for spontaneous succession, or too harsh for human-aided restoration, and choosing a combination of passive and active restoration measures based on adaptive management strategies. Our meta-analysis provided fundamental insights into bridging the gap between small-scale experiments and broad-scale management needs towards highly effective and sustainable forest ecosystem restoration.

Keywords: biodiversity conservation, ecosystem functions, forest restoration, meta-analysis, spatiotemporal variability

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Assessing the ecosystem service values in Shaanxi Province based on terrain

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The purpose of this study is to assess the distribution and variation trend of ecosystem services values with terrains in Shaanxi Province. Land use status was evaluated on the basis of land use information and DEM data of 2000 and 2010. The sequential variation as well as spatial distribution pattern of ecosystem services was quantitatively analyzed by reference to "ecosystem service value equivalent per unit area of Chinese terrestrial eco-

system" with ArcGIS. Simultaneously, eco-economic harmony index (EEH) of the province was also evaluated. It is found that from 2000 to 2010, the ecosystem service value had increased 1.09 billion yuan, among which ecosystem service value in forest land and grassland had increased 2.14 billion and 2.32 billion yuan, respectively, while that in cultivated land had decreased 3.42 billion yuan. As regards the terrain and gradient, ecosystem service value shows a decreasing tendency northwards and southwards from the center, and concentrates on the regions with gradient of 0° -14.6° and on the elevation ranges of 1607-1380 m. As for the single ecosystem service value, waste disposal and food production has severely decreased 0.61 billion yuan owing to sharp decline of cultivated land. The results of EEH show that the ecological economy in Shaanxi Province is tending to be no harmonious as a whole. Thus, it is of great necessity to put emphasis up on ecological environmental protection and economy development.

Keywords: terrain gradient, ecosystem service, ecological value, Shaanxi Province

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Land use optimization based on ecosystem service assessment: a case Study in Yanhe watershed

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Regional land use change can significantly change the pattern and process of ecosystem, resulting in unbalanced supply of ecosystem services. Large scale ecological restoration programmes have been implemented in China to restore and sustain ecosystem services. Here we selected Yanhe watershed on China's Loess Plateau, which has experienced Grain for Green Programme (GFGP), as study area, used specialized models to quantify four

ecosystem services (water provision, soil conservation, carbon sequestration, and agricultural production) in 6859 land use scenarios relative to actual land use change from 2000 to 2015. These scenarios were set according to slope, land use type and water constraint of the watershed in an effort to increase water quantity, carbon sequestration while maintaining soil conservation and agricultural production. The results shows that: (1) from 2000 to 2015, 66% of farmland converted to grassland, 12% of farmland converted to forest, farmland proportion declined from 42.0% to 5.3%, while water provision and agricultural production services declined by 12% and 87%, soil conservation and carbon sequestration services increased by 13% and 3%. (2) Under five specific scenarios that convert all retired farmland to grassland at water short area and maintain retired farmland at 0–10° slope at water adequate area, all of the four ecosystem services improved as compared with 2015 levels. Comprehensive analyzing slope, land use type and water constraint of the watershed while choosing land use scenarios for GFGP can effectively resolve trade-offs among multiple ecosystem services and promote regional sustainable development.

Keywords: ecosystem service trade-off, Grain for Green Programme, land use, Yanhe watershed

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Evaluating and enhancing the performances of China's ecosystem restoration programs

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China has been undertaking some major ecosystem restoration programs since the late 1990s, including the Sloping Land Conversion Program (SLCP) and the Natural Forest Protection Program (NFPP). These programs have been expected to not only mitigate the regional ecological degradation and rural poverty but also contribute to the international cause of sustainable development. What are their induced socioeconomic and environmental impacts

and how to improve their performances? This session is proposed to address those two questions based on a large body of empirical evidence the session organizers and their collaborators have obtained from their integrative and interdisciplinary assessment of the programs with panel datasets. The session will feature four linked individual presentations of 25 minute each (20 minutes for presentation and 5 minutes for Q&A) and a 20-minute wrap-up discussion.

Tentative titles and speakers:

1. Forest cover and structural changes in northeast China under the NFPP: detection and drivers by Miaoying Shi (Peking University, China);
2. Socioeconomic impacts of the SLCP on land and labor allocation by Hao Liu and Can Liu (National Center for Forest Economic and Development Research, State Forestry Administration, Beijing, China);
3. Households' decisions to participate in SLCP and reallocate their labour times: is there endogeneity bias? by Gang Lu and Runsheng Yin (Michigan State University, USA), and Can Liu (National Center for Forest Economic and Development Research, State Forestry Administration, Beijing, China);

4. "Lessons learned from China on designing and implementing payments for ecosystem service programs" by Runsheng Yin (Michigan State University, USA) and Can Liu (National Center for Forest Economic and Development Research, State Forestry Administration, Beijing, China).

Keywords: ecosystem restoration, payments for ES, ecological, social, and economic impacts, endogenous bias, policy design and implementation

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Restoring connections between people & landscapes through nature-based solutions

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Optimization of ecological node layout and stability analysis of ecological network in desert oasis : a typical case study of ecological fragile zone located at Deng Kou County (Inner Mongolia)

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The excellent ecological network structure, especially in arid and semi-arid regions in northwest China, is the basis of sustainable development of regional ecological environment. Based on this, Deng Kou County, the typical ecological vulnerable zone, was chosen as the study area. Minimum cumulative resistance model improved by emergy

theory was used to extract the ecological network, and a new spatial layout strategy based on Tyson blind zone was constructed to optimize the spatial layout of ecological nodes. In the aspect of ecological network stability, the connectivity robustness and recovery robustness index were used to analyze structural robustness of un-optimized and optimized ecological network. The results showed that the spatial distribution of ecological source nodes at level 3, 4, and 5 with higher emergy value formed the desertification protection pattern. 1058 ecological nodes and 47,466 ecological corridors were extracted at the county level, which formed the ecological network in Deng Kou County. After optimization, the coverage area of ecological nodes reached 1870.03km2, and the area of Tyson blind spot was reduced to 1179.27km2. Compared with the un-optimized ecological nodes, the spatial distribution of the optimized ecological nodes was more homogeneous, the coverage index (CR) of the optimized ecological nodes reached 87.79%, and the distribution uniformity (U) of optimized ecological nodes was reduced to 0.3978. The initial connectivity robustness of the un-optimized ecological network was 0.73, but the optimized ecological network was 1. The optimized network was

more stable than the un-optimized network. For these two kinds of networks, the malicious attack was more destructive than the random attack. The node recovery robustness and edge recovery robustness under random attack were superior to those of the malicious attack. In summary, the spatial layout optimization of the ecological nodes improved the stability of the ecological network in Deng Kou County.

Keywords: ecological node, emergy theory, ecological network analysis, Deng Kou County

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Karst rocky desertification assessment using Unmanned Aerial vehicles (UAV) photogrammetry in southwest of China

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The increasing exploitation of karst resources is leading to severe environmental impacts because karst frequently occurs in the most fragile and vulnerable environments. Traditional image classification is difficult to use to map and assess KRD accurately because land covers in karst regions are often mixed; for instance, woody shrubs are often mixed with grass, trees, and rocks, and no existing

vegetation indices can be directly used as an indicator to assess the degree of KRD due to the mixed land cover and topographic effects (shadow effects) in karst areas. Recently, UAV (Unmanned Aerial Vehicle, UAV) Photogrammetry and remote sensing technology has been rapidly developed. This technology has been widely used in forestry, agriculture and other fields. Due to UAV aerial photography can obtain very high spatial resolution aerial imagery, and generate Digital Surface Model (DSM) automatically based on aerial imagery. The aim of this study was to map KRD by combing land cover information with three dimensional structure of karst landscape, which derived from UAV Remote Sensing images. In this study, the study area is located in Stone Forest county of Yunnan province. The very high resolution images were acquired by using UAV (DJ M600 Pro) with airborne High Resolution Visible Light Camera platform (Figure 1). DSM was derived from the dense point cloud, which generated from the UAV images (Figure 2). The 3D orthophoto of study area was generated based on the DSM (Figure 3 and Figure 4). We divided the orthophoto into cubes in different sizes ($2\times2\times2$ m3 and $30\times30\times30$ m3 respectively). And then, the proportion of fractional land covers, bare soil, exposed

bedrock, and vegetation in every cube were calculated. Based on the proportion of fractional land covers, the degree of KRD maps were generated (Figure 5 and Figure 6). The results indicate that the UAV photogrammetry, can be used to do KRD assessment and can get higher accurate desertification information, and less affected by mixed land covers. The UAV would be a powerful tool for KRD and other environmental issues monitoring.

Keywords: UAV, remote sensing, 3D photogrammetry, karst rock desertification

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Hypothesis of disturbance effect transmutation and its application in ecosystem services trade-off analysis

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Geography is an open and complex system. It mainly focuses on studying the interaction between people and the environment, which needs both coupling natural factors and human factors. Ecosystem restoration is a crucial topic in the field of geography, which directly links the natural system and human societies. Although ecosystem restoration brings positive effect, many studies found that these management measures would alters other

ecological or human process which would lead to unexpected disturbance on the human-nature coupled ecosystem. In order to effectively restore the ecosystem and reduce the negative effect of unexpected disturbance, we proposed the hypothesis of disturbance effect transmutation. It means that the human activity could not only bring positive effect but could also affect other ecological process and generate unexpected disturbance on natural system in the process of ecological restoration. In this hypothesis, we divided the disturbance effect into following three categories to better apply this hypothesis in the ecosystem restoration studies: (1) the direct impact of disturbance on the target ecological process; (2) the direct impact of disturbance on non-target ecological processes; (3) the indirect effects of above disturbances on other ecological processes. In addition, we also proposed disturbance effect transmutation indices, such as single effect of human disturbance (SEHD), transfer effect of human disturbance (TEHD) and multi-effect of human disturbance (SEHD) to quantify the disturbance effect transmutation in the process of human-nature interactions. Furthermore, as the target of ecological restoration is not only accurately restore the nature ecosystem, but also

improve the human well-being, we linked the disturbance effect transmutation with ecosystem service and divided the disturbance effect into the positive and negative one regarding whether the effect would satisfy the human need. And we found that the balance between positive and negative effect will varied with the study scale. To better illustrate the application of the hypothesis, we apply it in the study of vegetation recovery in the Loess Plateau. By analyzing the ecosystem services trade-off in different scales (e.g., plot, catchment and region), we comprehensively evaluate the impact of restoration management on the study area and proposed specific management measure at different scales to better restore the ecosystem and reduce the negative effect brought by unexpected disturbance.

Keywords: disturbance effect, transmutation, ecosystem restoration, Loess Plateau

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T. Thematic Working Group sessions: T13 Ecological restoration across technologies, regions, and ecosystem services

Overview of ecological restoration technologies and evaluation systems

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Ecological degradation is a global problem, and ecological restoration technologies have played and will continue to play an important role in its mitigation. However, the lack of systematic research and evaluations of ecological technologies has thus far affected their effective application in ecologically vulnerable regions. This study therefore provides an

overview of the main technologies for remediating soil and water erosion, desertification, and rock desertification in China and throughout the world. It addresses key issues and recommends approaches for evaluating ecological restoration technologies. Restoration technology emerged as early as 1800. Over the years such technology has changed from single objective applications to multi-purpose, multi-objective applications employing strategies that take into account ecosystem rehabilitation and integrated ecological and socioeconomic development. Along with this technological evolution, different countries have taken pertinent actions as part of their restoration initiatives. However, key issues remain, including the lack of location-specific restoration technologies and a methodological strategy to assess and prioritize existing technologies. This study proposes a four-level analytical hierarchical framework in conjunction with an indicator system that highlights the establishment and adaptation of associative indicators, while also recommending a three-phase evaluation method (TheMert), targeting TheMert to qualitative (quick and extensive) and quantitative (detailed) evaluations in order to select

the most appropriate restoration technologies available. This study can also be used as a basis for understanding the evaluation and prioritization of restoration technologies, while increasing the awareness of decision makers and the public on the role of technology in restoring degraded ecosystems.

Keywords: ecological vulnerable regions, ecological restoration technologies, evolution, indicator framework, Three-Phase Evaluation Method (TheMert)