Newsletter of China-EU Project

中欧项目通讯（eco2adapt）

典型森林生态系统韧性调控机制与适应性管理项目
Regulation Mechanism of Ecosystem Resilience and Adaptive Forest Management (2023YFE0105100)

第四期
Fourth Issue

▌ 任务 4 中国林科院热林中心召开"森林生态系统韧性与质量提升技术模式" 2024 年度进展交流会

任务 4 年度进展交流会在热林中心召开
Task 4' s annual progress exchange meeting at the CAF ECTF

　　2024 年 5 月 30 日，任务 4"森林生态系统韧性与质量提升技术模式"采取线上与线下相结合的方式在热林中心召开了 2024 年度进展交流会。热林中心副主任贾宏炎主持会议。会上，7 个子任务负责人针对任务研究目标、研究内容、考核指标、研究基础、人员分工和经费预算等方面介绍了细化实施方案，汇报了工作进展，并且针对项目执行过程中遇到的主要问题，提出了相应的解决方案和工作计划。参会代表实地考察了松杉近自然化改造示范林、红锥大径材培育示范林、桉树与多树种混交，以及红锥人工林干旱和增温模拟实验点，近距离了解了热带和南亚热带典型人工林在森林韧性与质量提升方面的实践经验和显著成效。

▌ Task 4 The Experimental Center of Tropical Forestry (ECTF) held the 2024 annual progress exchange meeting of Technical model of resilience and quality improvement of forest ecosystem

On 30th May 2024, the ECTF of Chinese Academy of Forestry (CAF ECTF) held the annual progress exchange meeting of Task 4 - Technical model of resilience and quality improvement of forest ecosystem in a hybrid virtual and face-to-face format. Dr. Hongyan JIA, deputy director of the ECTF, presided over the meeting. In the meeting , 7 sub-task leaders briefed their detailed implementation plan from the aspects of research objectives, research content, evaluation indicators, foundation of research, personnel responsibilities and budget, reported the work progress, and came up with corresponding solutions and work plans in view of the main problems encountered in the process of the project implementation. Participants visited a number of demonstration sites to investigate the near-nature improvement of pine and fir, the large diameter cultivation of *Castanopsis hystrix* Hook., the mixed forest establishment of eucalyptus and multiple species , and the *Castanopsis hystrix* Hook plantation for drought and warming simulation. Through the visits, participants gained deeper understandings of the practical experience and remarkable achievements in forest resilience and quality improvement of typical tropical and southern subtropical plantations.

参会代表实地考察了热林中心 LL
Field trips to the Living Lab hosted by the CAF ECTF

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■ 中国林科院热林中心召开任务 4 与任务 5 协调会

任务 4 与任务 5 在热林中心召开任务间协调会
Inter-task coordination meeting at the CAF ECTF

6 月 12 日，任务 4 与任务 5"森林生态系统适应性管理决策支持系统"在热林中心召开任务间协调会。两项任务负责人分别汇报了各自的研究目标、任务间衔接点、软件开发应用、所需数据内容与开放共享以及工作计划等，针对各任务的需求支持进行了深入交流和探讨，表示近期共同将开展样地数据调查、数据收集、软件开发与应用，实现资源共享、优势互补等工作任务，加快推进研究进度，确保项目能够按照既定计划顺利完成年度任务。

■ 任务 4 中国林科院科信所团队在河北木兰林场开展森林多目标近自然经营及韧性提升现场调研与研讨

在全球气候变化大背景下，如何通过科学经营增强森林韧性、提升固碳增汇能力和生物多样性等，是国内外理论与实践的关注焦点。中国林科院科信所在木兰林场开展温带典型人工林生态系统韧性及固碳增汇提升技术研究及示范，营建或改造具有气候韧性的试验示范林。

■ CAF ECTF held the inter-task coordination meeting between Task 4 and Task 5

On 12th June 2024, the CAF ECTF held the inter-task coordination meeting to build the synergy between Task 4 and Task 5 - Decision Support System for Adaptive Management of Forest Ecosystem. The leaders of Task 4 and Task 5 briefed the research objectives, the niches between the two tasks, the progress on software development and application, data needed and their sharing and workplans. The two task team made in-depth exchanges and discussions on the supports they both need, and expressed their willingness to jointly implement the project activities such as investigation and data collection in sample plots and development and application of software, for achieving resource sharing and complementary advantages, so as to accelerate the project implementation progress, and ensure the completion of the annual activities and outputs in accordance with the agreed project workplan.

■ Task 4 CAF RIFPI Team made field trips and held seminar on multi-objective near-nature forest management and resilience improvement at Mulan Forest Farm in Hebei Province

In the context of global climate change, how to enhance forest resilience, improve forest capacity in carbon sequestration and sink, and conserve biodiversity through science-based forest management is the theoretical and practical concern at home and abroad. Research Institute of Forestry

专家团队参观新丰分场生物多样性提升经营示范点
Visit to biodiversity improvement LL at Xinfeng Branch

2024 年 6 月 5-9 日，科信所任务 4-3 负责人吴水荣研究员、海因里希·施皮克尔客座研究员、张超博士等一行 5 人到河北木兰林场开展森林多目标近自然经营及韧性提升现场调研与研讨。木兰林场副场长赵久宇全程陪同。

专家团队一行先后前往新丰分场、良繁场和五道沟分场，实地调研了生物多样性提升、杨桦矮林转化经营、落叶松人工林目标树经营、落叶松人工林全林经营、落叶松人工林均质经营以及油松人工林异龄复层林经营等典型模式经营示范点。调研后，在木兰林场召开了"变化环境下森林多目标近自然经营及韧性提升研讨会"。会上，科信所与木兰林场示范林专家就森林多目标近自然经营及韧性提升的技术路线与措施、森林经营提质增汇成效等深入开展了研讨。通过此次现场调研与研讨，双方进一步明确了项目建设内容、地点和规模，促进了项目实施有序推进。

Policy and Information (CAF RIFPI) has carried out research and demonstration on the technologies on the enhancement of resilience and carbon sequestration of typical temperate artificial forest ecosystems at the Mulan Forest Farm LL, and establish or transform experimental demonstration forests for resilience .

On 5th-9th June 2024, Prof. Shuirong WU, the task 4-3 leader, Prof. Heinrich Spiegel, and Dr. Chao ZHANG conducted a field investigation and held a seminar on multi-objective near-nature forest management and resilience improvement at Mulan Forest Farm in Hebei Province. Mr. Jiuyu ZHAO, Deputy Director of Mulan Forest Farm, accompanied during the entire investigation.

The team went to Xinfeng Branch, Liangfan Branch, and Wudaogou Branch to make the investigation at the demonstration sites for typical forest management models such as biodiversity enhancement, transformation-oriented management of poplar and dwarf birch forests, target tree management for larix plantations, whole forest management of larix plantations, homogeneous management of larix plantations, and management of uneven-aged and multi-layer *Pinus tabuliformis* plantations. After the field investigation, a seminar on *Multi-objective near-nature forest management and resilience enhancement under changing environments* was held. In the meeting, in-depth exchanges and discussions were made on the technical routes and measures for multi-objective near-nature forest management and resilience enhancement, and on the effectiveness of forest management in quality improvement and carbon sink increase. Through this field investigation and seminar, both parties have further clarified the content, location and scale for the project work, which promoted the organized implementation of the project.

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专家团队参观新丰分场杨桦林转化经营示范点

Visit to improvement-oriented birch forest management LL at Xinfeng Branch

专家团队参观良繁场落叶松人工林
不同经营模式示范点

Visit to *Larix gmelinii* plantation management LL

专家团队参观良繁场落叶松人工林不同经营模式示范点

Visit to *Larix gmelinii* plantation management LL
at Liangfan Branch

召开变化环境下森林多目标近自然经营及
韧性提升研讨会

Seminar on *Multi-goal near-nature forest management and resilience improvement under changing environments*

专家团队参观五道沟分场油松人工林异龄复层林经营模式示范点

Visit to uneven-aged and multi-layer *Pinus tabuliformis* plantation management LL at Wudaokou Branch

▍苏黎世大学团队在瑞士塞尔瓦山谷示范林的研究取得初步成果

不同森林景观在气候变化条件下如何提供不同组合的生态系统服务是 eco2adapt 项目的一个核心问题。据研究，气候变化将会影响山地森林生态功能，从而打破森林状况和气候条件之间的平衡，形成新的甚至不同以往的由不同树种组成的森林结构。因此，未来变化环境下如何采取适应性经营策略，值得深入研究。

瑞士塞尔瓦山谷示范林地处阿尔卑斯山，主要树种是挪威云杉、落叶松和瑞士松等典型高山树种，在低海拔地区也有一些阔叶树。该地区地形陡峭，多种生态系统类型并存，为评估森林的气候韧性及其适应性经营策略提供了理想的实验场景。该示范林以如何兼顾森林防护功能和木材产量作为研究目标。为了调研气候变化和森林的相互影响，采用景观动态植被模型 LANDCLIM，模拟三种气候情景，包括历史气候*（1950-1980年）、RCP 4.5 和 RCP 8.5。每个情景均采用模型预热（"Spin-Up"），即从裸地条件开始模拟在没有开展经营措施条件下 2000 年的森林演替情况。

*注：排除了 1980 年之后变得明显的人为气候变化的第一个早期信号

▍EU Swiss Living Lab in the Surselva valley shows preliminary results

The main overarching question for the eco2adapt project is "How can different forest landscapes provide different bundles of ecosystem services under climate change?" Climate change is expected to impact the functioning of mountain forests, altering the equilibrium between forest state and climatic conditions, leading to new and sometimes novel forest structures that include different species composition. Therefore, it is worthy of further study to adopt adaptive management strategy for future changes.

The Swiss Living Lab in the Surselva valley is located in Alps, with typical Alpine species such as Norway spruce (*Picea abies (L.) Karst*), larch (*Larix decidua Mill.*) and Swiss stone pine (*Pinus cembra L.*) and some broadleaves at lower altitudes. The steep terrain and multiple ecosystem types within a short distance provide an ideal living laboratory for assessing forest resilience to climate change and related adaptive management approaches. The specific research objective for the Living Lab is how to balance the protective function of the forest with timber production. To investigate the interactions between climate change and forests, the landscape dynamic vegetational model LANDCLIM is used. The first exploratory simulations are based on three climatic scenarios: historical climate (1950-1980), RCP 4.5 and RCP 8.5. A spin-up was run for each scenario, i.e. starting from bare ground the model runs for 2000 years, with no management.

Overall, the simulation shows the following two characteristics. Generally, the simulations feature higher C storage in the landscape under climate change (higher amount of biomass), with higher productivity at higher elevations,

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　　总体上，模拟呈现出以下两个特点。首先，森林景观在气候变化下其碳储存更高（即生物量更高），且海拔越高，生产力更高，但是较低海拔地区的森林景观干旱敏感度更高。其次，模拟显示树种组成将发生变化。潜在天然植被（PNV）的模拟结果显示，在历史气候情景下，山毛榉（*Fagus sylvatica L.*）是阿尔卑斯低海拔地区的"经典"高山植被，然而随着时间推移该树种逐渐被挪威云杉所取代；气候变化情景显示，阔叶树种在演替后期占绝对优势，在RCP 4.5情境下植被以云杉为主，在RCP 8.5情境下由更多阔叶树种组成（如图所示）。因此，如果气候持续暖干化，瑞士塞尔瓦山谷示范林可能会从针叶林景观转变为阔叶林景观，且针叶林仅能在更高海拔地区生长。

　　下一步，研究团队将在模拟过程中引入森林经营，以研究替代经营战略和目标。目前，正与当地利益相关者积极合作，以更好地设计森林经营场景和战略。为了更好评价模拟的不同结果，将计算生态服务指数，引入不同天然扰动机制。此外，将基于森林调查数据建立"树木初始状态数据文件"，以更精确地呈现塞尔瓦山谷的森林状况。
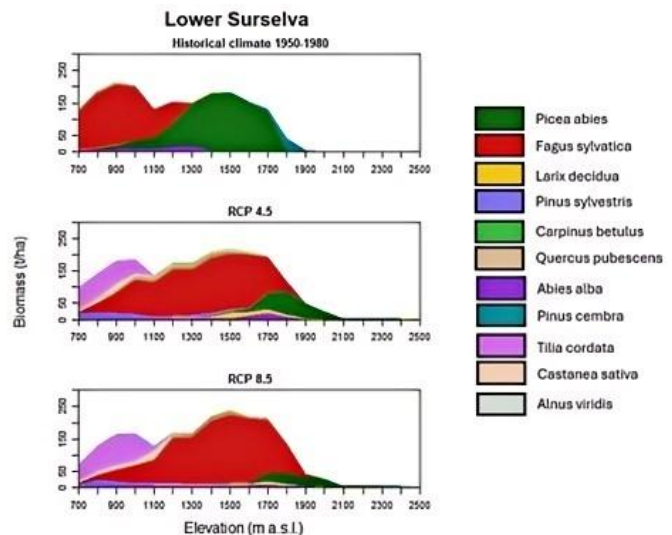
三种情景下潜在天然植被演替模拟
Simulation of PNV succession in three scenarios

but more drought sensitivity at lower elevations. The simulation results also suggest that species composition will change. Under the historical climate, Potential Natural Vegetation (PNV) well represents the 'classic' Alpine vegetation with some beech (*Fagus sylvatica L.*) at lower elevations, which is substituted by the main species that are also dominating the current landscape: Norway spruce. The climate change scenarios show a complete switch to a dominance of broad-leaves, with mostly spruce in RCP 4.5 and a wider variety of species in RCP 8.5. In this sense, the Living Lab will likely move from a conifer-dominated landscape to a broad-leaf-dominated one when being subject to a warmer and drier climate, and conifers will be limited to higher elevations.

The next steps of the analysis will focus on the integration of forest management in the simulations, in order to investigate alternative strategies and objectives. An active collaboration with local stakeholder is ongoing to better design these management scenarios and strategies. To better evaluate the different outputs of simulations, ecosystem services indices will be computed, and different natural disturbances regimes will also be included. A "tree initialization file" derived from inventory data will be also used to more accurately represent the current forest state in the Surselva valley.

■ 芬兰森林中心和 Sitowise Oy 团队
针对森林活力发展监测在
阿卡累阿示范林绘制时间序列地图

　　按照芬兰《森林信息法》，芬兰森林中心负责开展森林清查，以此收集维护森林数据，帮助广大林主和林业公司利用这些公开数据开展森林规划、木材采购及木材贸易。鉴于 eco2adapt 项目强调气候变化影响和森林韧性的建模，芬兰森林中心和芬兰森林中心和 Sitowise Oy 团队在芬兰北卡累利阿针对森林活力和树皮小蠹损害开展监测与研究，旨在通过监测森林扰动，迅速采取行动，避免树皮小蠹造成更大的损害。

　　根据早期经验，研究团队在健康云杉林和遭受虫害的云杉林中设立样地，收集参考数据，基于数据对森林扰动进行建模。对欧洲云杉树皮小蠹造成的损害进行了测量，其中健康林木、受损树木及枯死树木各占 1/3。在以半径 9 米划定的圆形测量地，采用 3.5m 高的 Topcon 定位器测量位置，使用 Masser 测径仪进行样地信息采集和树木测量（树种、树木状况和树木直径），同时使用 Vertex 测斜仪测量了单木与样地中心点的距离及树木高度。测量范围包括所有胸径超过 10cm 的树木以及开阔地带的树木。

■ **Finnish Forest Center and Sitowise Oy team draw a time series map monitoring forest vitality development in Akalea LL**

Finnish Forest Centre collects and maintains forest data from forest inventories in accordance with Forest Information Act, which is widely utilized in forest planning, wood procurement and timber trade by forest owners and companies. As the eco2adapt project focuses examining modeling of impacts of climate change and forest resilience, Finnish Forest Centre and Sitowise Oy from Finland have been studying especially mapping of forest vitality and bark beetle damages in North Carelia, Finland. The objective is to take quick action and further avoid the bark beetle damages through monitoring the forest disturbances.

As based on their earlier experience, their forest disturbance modeling study started with collecting field reference data from sample plots representing both healthy and suffered spruce forest sites. European spruce bark beetle damage measurements was conducted so that the aim was that 1/3 of the measurement sites would be healthy, 1/3 weakened and 1/3 dead. Measurement sites were circles with nine-meter radius. Location was measured with 3,5-meter-high Topcon locator, site information and tree measurements (tree species, condition of tree and tree diameter) was made with Masser measuring scissors, and Vertex was used to measure distance from the center of site and to measure height of trees. All trees at least 10 cm thick were measured, and trees under that if they were in open area.

Tree condition included normal living tree, damaged living tree, dead tree and other more specific classes. Information of damage (pitch leak, bark damage, holes in

树木状况包括正常活立木、受损活立木、枯死木和其他具体类别。除了正常活立木之外，针对其他状况的树木，还收集了树木受损信息，如树脂渗出、树皮损坏、树皮破洞、树冠色变和针叶凋落等。拍照记录每个样地及其树木损害。共计测量了 226 个样地。

利用以上实地调查数据建立不同模型，并结合哨兵 2 号卫星数据，评估森林活力。同时，根据正射图像检验了不健康或死亡的树木的点位。结果表明，分辨率为 10 m 的哨兵 2 号卫星图像因分辨率太低无法验证受损单木点位，尤其是幼树和树冠下林木。正射影像分辨率较高，更适合单木定位，但由于芬兰森林航拍以 3 年为一期，部分地区正射影像数据时效性不足。此前，研究团队在芬兰东南部研究发现，正射影像在枯死树/树群检测方面的精度（F1 分值）可达到 70%~80%。最终，研究团队为北卡累利阿试验区绘制了森林活力发展时间序列地图，该地图可以通过 Sitowise 的 Foresta 网络进行实际使用演示。下一步将在位于北卡累利阿的 eco2adapt 示范林中对地图应用进行测试。

bark, change of canopy color and dripping of needles) was added to other than normal living trees. Every site and possible tree damages were photographed. In total 226 sites were measured.

The field survey data was then applied to creating different variants of models for estimating forest vitality based on Sentinel 2 satellite data. Also detecting unhealthy or dead trees based on orthoimages was examined. The results indicate that Sentinel 2 images with 10 m resolution are too coarse for detecting damaged single trees, especially the small ones and those under bigger tree crowns. Orthoimages with high resolution are better for that purpose, but the disadvantage with them is that they are always outdated for some regions in Finland since their survey cycle is 3 years. Based on their findings in Southeastern Finland so far, orthoimage-based estimates have around 70-80 % of performance (F1-score) in detecting dead trees/tree groups. As a result of this study, maps showing forest vitality development in the time series was created for the test area in North Carelia. The maps can be demonstrated in real use via Sitowise's Foresta web application. Next steps will include testing using of the maps with eco2adapt Living Lab in North Carelia.

使用 Masser 测径仪进行样地信息采集和树木测量
Site information and tree measurements was made with Masser measuring scissors

▌Eco2adapt 中方项目负责人庞勇研究员及研究人员参加罗马尼亚举办的欧方第 2 次项目年会

2024 年 7 月 2-4 日，eco2adapt 中欧合作项目在罗马尼布拉索夫市举办了第 2 次项目年会。会议由亚特兰西瓦尼亚大学营林和森林工程学院具体承办。来自欧洲和中国 31 个大学和研究院约 60 名教授、研究人员和研究生参加了本次会议。

中欧双方在会上汇报了项目工作进展及取得的相应成果，并分别参加了相关研讨会，就具体工作任务，特别是未来合作需求、项目工作必要调整和必须取得的成果等，进行深入沟通交流。庞勇研究员作为中方项目负责人，介绍了中方项目各团队的进展成果以及未来需要完成的工作任务，并且强调与欧方各研究团队进一步开展合作的必要性和重要性。eco2adapt 中方项目研究人员以线上形式参与了多个工作讨论会的交流。

他还参加了会议组织的实地调研。不但调研了达姆波维恰县的伊德拉示范林的经营及相关研究，而且还走访了森林设计公司，深入了解了该公司开发的激光扫描等创新技术及其在森林清查规划中的应用。在调研中，

▌Prof. Yong PANG and researchers from the eco2adapt China project participated in the 2nd annual meeting of the eco2adapt project in Brasov, Romania

On 2nd to 4th July 2024, the second annual meeting of the eco2adapt project took place in Brașov, Romania, which is organized by the Faculty of Silviculture and Forest Engineering at Transilvania University of Brașov. Approximately 60 professors, researchers, and postgraduate students from 31 international universities and research centers across Europe and China participated in the event.

In this meeting, updates and provisional results for work packages from the EU and tasks from China as well as an overview of the project's overall progress were presented. Workshops were conducted to emphasize specific working tasks, with the discussions focused on future needs, necessary adjustments, and objectives that must be accomplished. Prof. Yong PANG, as the coordinator of the eco2adapt China project, briefed the updates and progress made by the Chinese team and future tasks that need to be accomplished. He also emphasized the necessity and importance to promote future cooperation with the EU counterparts. Researchers from the Eco2adapt Chinese project participated in multiple working seminars online.

He also joined the visit to the Living Lab Iedera in Dâmbovița County and the private company ForestDesign, which showcased the methods used for forest inventory and planning, including innovative laser scanning techniques. During the visit, he made a fruitful exchanges on GIS-based investigation on forest resilience and quality improvement.

他与相关人员就地理信息技术在森林提质增汇的应用开展了富有成效的交流。

本次年会圆满成功，不但分享了当前项目工作状况，而且在下一步工作和未来实施方面也达成了一致。会议还决定，将于2025年11月中旬在立陶宛维陶塔斯马格纳斯大学举办第3次项目年会。

The meeting was a resounding success, featuring presentations and discussions on the current progress of the project and significant work was accomplished regarding the next steps and further development of the project. It is decided that the 3rd Annual eco2adapt meeting will take place in mid of November, 2025, at Vytautas Magnus University's Agricultural Academy in Kaunas, Lithuania.
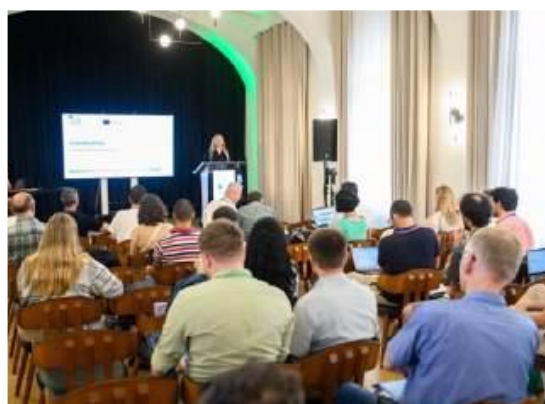
Eco2adapt 中欧合作项目在罗马尼亚布拉索夫市举办
第 2 次项目年会
The second annual meeting of the eco2adapt project took place in Brașov, Romania

▌ 任务 6 负责人受邀前往芬兰和德国开展学术交流与合作

2024 年 4 月 23 日-30 日，任务 6 负责人吴水荣研究员受邀参加东芬兰大学举办的"欧洲林业与可持续发展目标（SGD）全球研讨会"，并以"林业对 2030 可持续发展目标的贡献——从中国的角度"为题做口头学术报告。同时，紧密围绕 eco2adapt 中欧项目工作任务，与欧方项目单位探讨推进合作事宜。

在芬兰访问期间，吴水荣研究员首先拜访了东芬兰大学 Frank Berninger 教授及其团队，共同就"气候变化和森林生态系统适应性"比较研究及相关调查问卷制作进行了深入交流，细化合作任务。随后，与欧洲林业研究所 Jo Van Brusselen 博士及其团队围绕生物经济政策比较研究事宜讨论推进合作。在德国交流期间，拜访了弗莱堡大学的 Heinrich Spiecker 教授及其团队和 Daniela Kleinschmit 教授带领的研究团队，共同探讨未来森林韧性经营提质增汇与林业政策领域的合作前景。此次交流访问务实高效，为任务 6 取得更为丰硕的成果打下良好基础。

▌ Task 6 Leader visited Finland and Germany for exchanges

From 23rd to 30th April 2024, Prof. Shuirong WU, the leader of Task 6, was invited to participate in the "European Forestry and Sustainable Development Goals (SGD) Global Seminar" held by the University of Eastern Finland and gave an oral report of "The Contribution of Forest Sector to 2030 SDGs-China's View". Closely around the tasks and activities of the eco2adapt project, this visit promoted the cooperation with the EU partners.

During the visit to Finland, the team leader of Task 6 first visited the team led by Prof. Frank Berninger from the University of Eastern Finland to make in-depth exchanges on the comparative research and questionnaire development on "Climate Change and Forest Ecosystem Adaptability", and discussed the details of cooperation. Subsequently, Prof. Wu visited Dr. Jo Van Brusselen and his team from the European Forest Institute to talk about the cooperation on comparative research on bioeconomy policies. In her visit to Germany, She visited Professor Heinrich Spiecker and Professor Daniela Kleinschmit from the University of Freiburg to discuss the prospects for further cooperation in the research on resilience enhancement oriented forest management and forestry policy. These visits, made pragmatic and efficient progress, laying a good foundation for Task 6 to achieve more fruitful results.

中欧交流活动
China EU Exchanges

■ 任务 4 热林中心团队举办中德森林韧性和质量提升学术交流会

2024 年 6 月 2-3 日，热林中心召开中德森林韧性和质量提升学术交流会，德国弗莱堡大学环境与自然资源学院森林生长研究所前所长 Heinrich Spiecker 教授应邀出席。Spiecker 教授以"森林恢复和气候变化——中欧森林历史经验教训"为题，系统回顾了中欧森林史的发展历程，从森林开发、森林恢复到森林转化三个阶段分析了面临的挑战和采取的经营措施。在考察松杉近自然化改造示范林、红锥大径材培育示范林和马尾松大径材培育等示范林过程中，Spiecker 教授对热林中心在珍贵树种大径材多功能森林经营方面的探索与实践给予了高度评价，建议进一步加强混交林树种选择、混交比例控制、经营管理措施优化，以促进森林健康，提高森林生产力。中国和欧洲在森林发展时间尺度有所不同，但面临的问题和挑战相似，近自

■ CAF ECTF held China-Germany academic exchange meeting on improving forest resilience and quality

中德森林韧性和质量提升学术交流会在热林中心召开
China-Germany academic exchange meeting on improving forest resilience and quality held at the CAF ECTF

On 2nd -3rd June, 2024, the CAF ECTF held a China-Germany academic exchange meeting on forest resilience and quality improvement. Prof. Heinrich Spiecker, former director of the Institute for Forest Growth, Faculty of Environment and Natural Resources, University of Freiburg in Germany, accepted the invitation to attend the meeting. Themed with *Forest Restoration and Climate Change - Experience and Lessons of Forest History in Central Europe*, Prof. Spiecker systematically reviewed the forest history in Central Europe, and analyzed the challenges encountered and management measures taken in the three stages of forest development, forest restoration and forest transformation. In his visit to the pine-fir near-nature transformation LL, the large diameter *Castanopsis hystrix* Hook. Cultivation LL, the large diameter Masson pine cultivation LL, Prof. Spiecker spoke high of the explorations and practices of the CAF ECTF in developing multifunctional forest management of valuable tree species to achieve large-diameter timber production, and he suggested that the future research could focus on boosting tree species selection, controlling mixture proportion and optimizing management measures in mixed forest, so

然森林经营作为中欧双方的共同选择,是提升森林韧性和质量的有效路径,对于实现森林可持续经营和应对全球气候变化具有重要意义。

as to increase forest health and productivity. Although with different time scales in terms of forest development, China and Europe face similar issues and challenges. near-nature forest management is the common choice of China and Europe, providing an effective pathway to improve forest resilience and quality. It is of great significance to realize forest sustainability and address global climate change.

Spiecker 教授考察松杉近自然化改造示范林
Prof. Spiecker made a visit to pine-fir near-nature improvement LL

■ 中方多个任务成员参加国际林业研究组织联盟（IUFRO）第 26 届世界大会

2024 年 6 月 22 日至 30 日，国际林联第 26 届世界大会在瑞典首都斯德哥尔摩举行。本次大会的主题是"迈向 2050 年的林业与社会"，来自全世界约 4300 多位代表参加本次大会。

6 月 25 至 29 日，中方任务 3 负责人周国模教授和两名任务成员组织了主题为"亚洲气候变化下的森林恢复：创新工具、模型和方法"的分会场。周国模教授担任共同主持人并作总结发言，任务成员喻蓉和梅婷婷博士分别就"热带亚热带森林生

■ Task members of eco2adapt China project participated in the 26th IUFRO World Congress

From 22nd to 30th June 2024, the 26th World Congress of the International Union of Forest Research Organization was held in Stockholm, Sweden. with the theme of "Forestry and Society Towards 2050". More than 4,300 delegates from all over the world attended this Congress.

During 25th-29th June, Professor Guomo ZHOU, the Task 3 leader of the eco2adapt China project, and two task members organized a session on the theme of "Forest Restoration under Asian Climate Change: Innovative Tools, Models, and

态系统对干旱的响应"及"竹林干旱韧性研究"作了专题报告，展示了团队在森林韧性领域的最新研究成果，会后实地考察了当地特色的麋鹿农场和以北欧赤松、欧洲云杉和白桦为主要建群种的次生林。

Methods". Professor ZHOU co-hosed the session and delivered a concluding speech. Dr. Rong YU and Dr. Tingting MEI, the Task 3 members, presented the reports of *Response of Tropical and Subtropical Forest Ecosystems to Drought* and *Research on Bamboo Forest Drought Resilience*, showcasing the latest research results related to forest resilience. After the meeting, experts of task 3 participated in a field complain to visit locally-featured elk farms and secondary forests mainly composed of Nordic red pine, European spruce, and birch.

周国模教授共同主持的林联会议分会场并做总结报告
Prof. Guomo ZHOU co-hosted the session and delivered the concluding remarks

实地考察北欧次生林
Field investigation of secondary forests in Northern Europe

梅婷婷博士报告
Dr. Tingting MEI gave the report

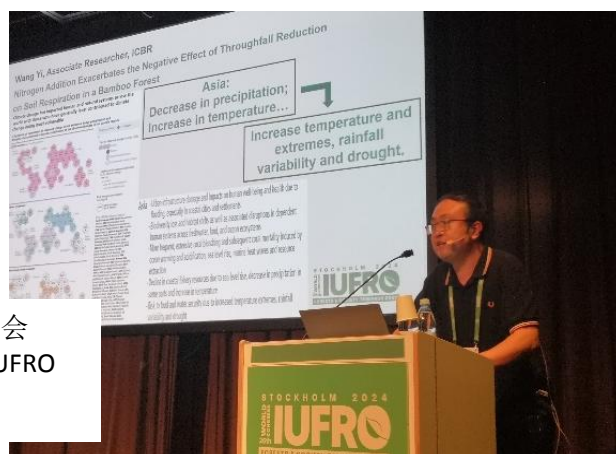会议期间，中方代表团与参会欧方项目成员毛准博士等人进行了交流和讨论产，并促成为了进一步交流合作的相关机会。

任务 2 负责人王一副研究员在"T3.11 从地下角度探究森林韧性"分会场做题为"氮添加加剧穿透雨减少对毛竹林土壤呼吸的消极影响"口头报告，向致力于森林生态系统韧性研究的国内外学者展示了最新研究成果。会后就森林生态系统韧性调控机制的研究现状和研究方法同与会人员开展了充分讨论，拓宽了研究思路，进一步深化了国际合作基础。

The projects members took advantage of the event to communicate and exchange with Dr. Zhun MAO and the EU counterparts, and promoted the further exchanges and cooperation after the event.

Associate Researcher Yi WANG, the Task 2 leader, gave an oral report entitled *Negative Effects of Nitrogen Addition Intensifying Penetrating Rain Reduction on Soil Respiration of Phyllostachys pubescens Forest* at "T3.11 Exploring Forest Resilience from an Underground Perspective", showcasing the latest research results to national and international scientists engaging the forest resilience research. After the meeting, he made exchanges with the participants on the progress and methods of the research on forest resilience regulation mechanism, which broadened the view of research and further deepened the international cooperation.

ICBR 王一副研究员参加 IUFRO 第 26 届世界大会
Associate Researcher Yi WANG from ICBR in 26th IUFRO World Congress

任务 6 负责人吴水荣研究员以"气候变化下生态系统服务多目标森林经营管理（Managing Forests for Multiple Ecosystem Services under Changing Climate）"技术分会负责人的身份，联合主持了会议 。同时，受邀在亚全体会议"未来森林"做了题为

Task 6 leader Dr. Shuirong WU from CAF RIFPI, co-chaired the technical plenary meeting of "Managing Forests for Multiple Ecosystem Services under Changing Climate". She was also invited to present *2050: Forest management in multiple ways and for multiple purposes* in the session of "Forest Future" and *Evolution of cooperation networks of forest governance system in China: Based on Bibliometric Analysis of 2571 Policy Documents, 1949-2020* in the session of "Towards Quantitative Explanations of Forest Governance and Its Complexity". The 3 Task 6 members from the CAF

中欧交流活动
China EU Exchanges

"2050：多种方式多种目标的森林经营"的专题报告，在"森林治理及其复杂性计量分析"技术分会上分享了"中国森林治理体系合作网络的演变：基于 1949-2020 年 2571 份政策文件的文献计量分析"。其团队的 3 名成员也在会上做口头报告和口述墙报展示。张超助理研究员、邹文涛副研究员和博士研究生郭同方分别以"基于星地协同的森林资源资产和生态产品价值综合评估——以鄂温克族自治旗为例"、"基于 InVEST 模型的森林生态系统固碳能力评价"和"塞罕坝机械林场接受生态系统服务付费的意愿及影响因素研究"做了口头报告。

RIFPI gave short oral presentation in poster sessions. Dr. Chao ZHANG, Dr Wentao ZOU and PhD candidate Tongfang GUO presented their research on *Comprehensive evaluation of forest assets and ecological products values based on satellite-ground data integration in Ewenki Autonomous Banner, Evaluation of carbon sequestration capacity of Forest Ecosystem based on the InVEST model* and "*Measurement and influencing factors of willingness to accept payment for ecosystem service provision: A case study of a leading forest farm in China*", respectively.

吴水荣研究员联合主持技术分会并做口头报告
Dr. Shuirong WU co-chaired the technical plenary meeting and gave an oral report
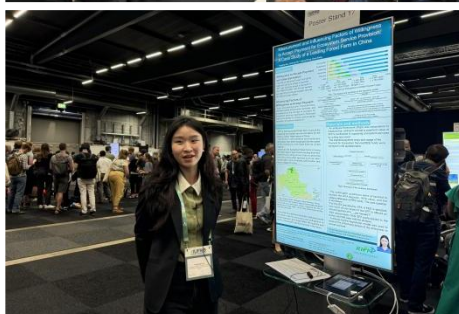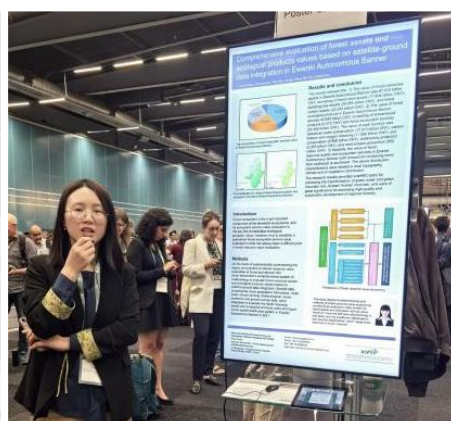
（由左至右）吴水荣研究员（上）、博士研究生郭同方（下）、邹文涛副研究员、张超助理研究员和分别做口头报告
(From left to right) Dr. Shuirong WU (As above), PhD candidate Tongfang GUO (As below), Dr Wentao ZOU and Dr. Chao ZHANG presented their research in poster sessions

■ 会同实验区

位于中国湖南会同县的杉木人工林，主要树种包括杉木、马尾松等。

研究背景：在大面积营建纯林、炼山以及机耕整地等传统杉木人工林经营方式影响下，杉木人工林地力衰退、生产力下降，生态系统稳定性差。因此，如何维持杉木人工林持续生产力和生态系统稳定性是研究目标。

■ Huitong Living Lab

Cunninghamia lanceolata plantations in Huitong, which is located in the west of Hunan, China. The dominant species include *Cunninghamia lanceolata* and Masson pine.

Background

Impacted by the traditional management approaches such as large-area establishment of monoculture, uncontrolled slash burning and machine tillage for site preparation, *C. lanceolata* plantations have suffered from soil degradation, declined productivity and poor ecosystem stability. Herein, how to maintain the sustained high productivity and improve the resilience of *C. lanceolata* plantations is the overarching objective for research.
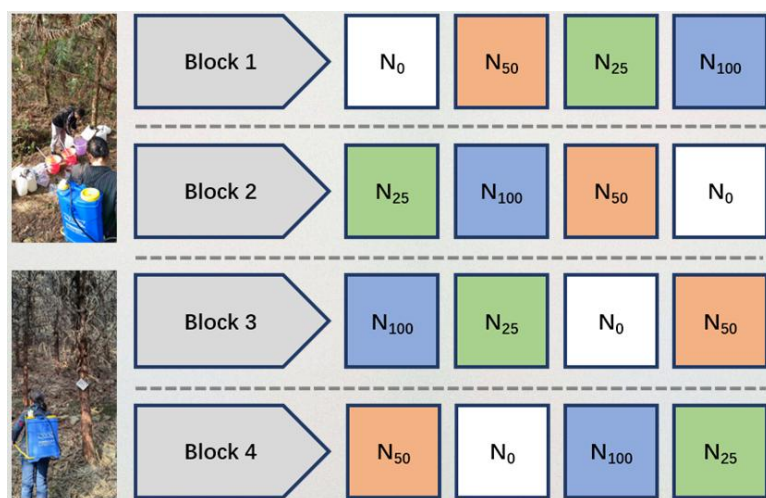
模拟氮沉降和经营措施对杉木人工林生产力
Simulated nitrogen deposition experiment in *Cunninghamia lanceolata* (Lamb.) Hook.

预期成效：项目旨在分析模拟氮沉降和经营措施对杉木人工林生产力、生物多样性及碳氮循环的影响及其作用机理，构建杉木人工林韧性提升经营技术体系，提出我国典型森林类型韧性与质量经营技术模式，并在杉木林主产区开展试验示范。

Expected Results

The project aims to analyze the effects of simulated nitrogen deposition and management measures on productivity, diversity and carbon and nitrogen cycle of *C. lanceolata* plantations and its working mechanism, build the management technology system to enhance the resilience of the plantations, and come up with the optimum management models for typical forest types in China to improve their resilience and quality. Experiments and demonstration will be also conducted in the main production site of *C. lanceolata* plantations.

中方项目典型实验区（下）
Living Labs in China (Part C)

▌ 大兴安岭实验区

属于高纬度多年冻土分布区，位于黑龙江省大兴安岭地区漠河市北极镇。主要森林类型包括兴安落叶松林、白桦林、樟子松林和山杨林等。

研究背景： 在全球变暖、极端降雨等背景下，大兴安岭森林生态系统与气候变化互馈机制、森林水文过程和水量平衡研究及其与森林生态系统管理与可持续经营的关系是目前大兴安岭森林生态系统亟待解决的科学问题。通过对森林生态系统水、土、气、生等各要素的长期定位观测，揭示以上科学问题，对大兴安岭森林生态系统可持续经营具有重要科学意义。

预期成效： 通过开展连续定位观测，获取气候变化影响下单木和林分尺度森林水通量指标，量化和确定兴安落叶松林和白桦林生态系统的水分利用特征。基于获取的指标，综合评价兴安落叶松林和白桦林的水分利用机制，构建水通量模型，模拟不同影响下的蒸散过程，评估两种林分对气候变化的响应差异，为天然林恢复及经营管理方案制定提供理论和数据支持。

▌ Daxing'anling Living Lab

The LL is located in high-latitude permafrost area, at Arctic Town of Mohe City in the Daxing'anling region, Heilongjiang Province. The main forest types include larch (*Larix gmelinii*), birch (*Betula platyphylla*), sylvestris pine (*Pinus sylvestris var. mongolica*) and aspen forests (*Populus davidiana*).

Background

Under the backdrop of global warming and extreme rainfall, the mutual feedback mechanism between forest ecosystem and climate change, the research on forest hydrological process and water balance and their relationship with forest ecosystem management and sustainability are the scientific issues that need to be urgently solved for Daxing'anling forests. Revealing the above scientific issues through long-term positioning observations of various elements such as water, soil, air, and life in the forest ecosystem has important scientific significance for the sustainable ecosystem management of Daxing'anling forests.

Expected Results

Continuous positioning observations have been carried out in the Daxing'anling Living Lab to obtain forest water flux indicators at the scale of individual trees and forest stands under climate change, and to quantify and determine the water utilization characteristics of larch forest and birch forest. Based on the obtained indicators, the water utilization mechanism of larch and birch forests was comprehensively evaluated, and a water flux model was constructed to simulate evapotranspiration process under the influences of environmental factors and evaluate the differences in the responses of the two forest stands to climate change, which would provide theoretical and data support for natural forest restoration and forest management plan development.

涡动相关系统
Eddy Correlation System

树干液流计
Sap Flow Meter

基于树干液流计的单木尺度和涡动相关系统的林分尺度对落叶松林、白桦林的水通量进行连续定位监测

Based on the individual tree scale of stem sap flow meter and the stand scale of eddy covariance system, the water flux of larch forest and birch forest was continuously monitored.

吉林长白山实验区

位于中国吉林省长白山北麓，属于中温带气侯区，主要森林类型包括红松阔叶混交林、硬阔叶混交林、蒙古栎林、云冷杉林和杨桦林。

研究背景： 受采伐和火灾影响，当地天然过伐林与天然次生林的林分质量不高，结构不尽合理，恢复生长缓慢，应对极端气候的韧性较弱。因此，有必要开

Changbai Moutain Living Lab

The LL is located at the northern foothill of Changbai Mountain in Jilin Province, China. Falling in the temperate climate zone, the LL is dominated by Korean pine-broadleaved mixed forest, broadleaved mixed forest, *Quercus mongolica* forest, *Picea asperata-Abies nephrolepis* mixed forest, and *Populus davidiana-Betula platyphylla* mixed forest.

Background

Impacted by logging and fires, the natural over-cut forests and natural secondary forests have lower resilience against extreme weather events because of low stand quality, unreasonable structure and slow restoration and growth. Therefore, it is necessary to study the impact mechanism of forest
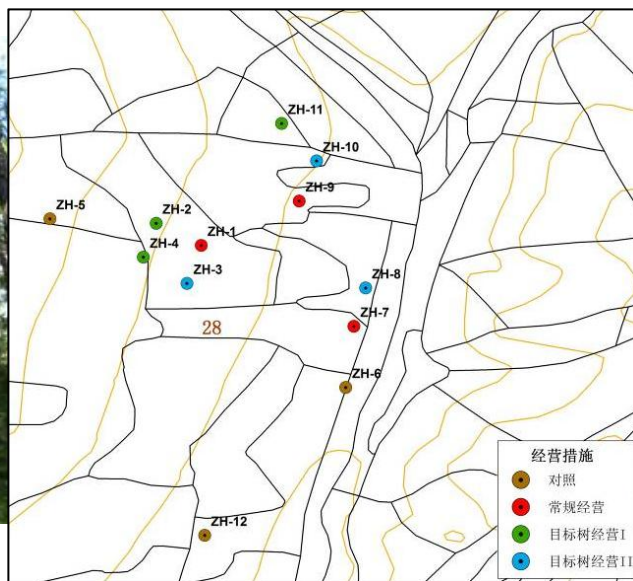
中方项目典型实验区（下）
Living Labs in China (Part C)

长白山蒙古栎次生林林相
Quercus mongolica secondary forest in Changbai Mountain

蒙古栎次生林经营试验样地分布图
Sample plots distribution map of various management in *Quercus mongolica* secondary forest

展气候变化背景下森林经营措施对森林生态系统韧性的影响机制，以精准提升长白山林区典型天然林的韧性和质量。

预期成效： 基于当地典型天然林固定样地的多期数据，以及森林经营试验（包括对照、目标树经营和常规经营）样地的长期观测数据，分析气候变化、森林经营措施与森林生态系统韧性的作用关系，研究典型天然林韧性和质量提升的关键经营参数和控制指标，提出关键树种调控、天然更新促进和结构优化等多种技术，形成长白山典型天然林韧性和质量提升的经营技术模式，并在典型林区开展试验示范。

management measures on forest ecosystem resilience under climate change, with the aim to accurately improve the resilience and quality of typical natural forests in Changbai Mountain.

Expected Results

Multi-period data from the fixed sample plots of typical natural forests in Changbai Mountain and long-term observational data from forest forest management experiments (including control, target tree management, and conventional management) have been collected to analyze the working relationship among climate change, forest management measures, and forest ecosystem resilience, study the key management parameters and control indicators for improving the resilience and quality of typical natural forests in there, and propose a range of technologies such as key species regulation, natural regeneration promotion, and structure optimization, An technical model of forest management will be shaped for improving the resilience and quality of typical natural forests in Changbai Mountain, and experiment and demonstrations will be carried out in typical forest areas.

▌Pierson 等。从土壤角度提升森林韧性，西北林地 (2024)

当前，森林所面临的威胁正在改变。野火发生的频度和强度更高。病虫害由于干旱和过熟林增加日益严重，超级雷暴及其带来的更强降雨导致更严重的水土流失，带来山洪、山体滑坡等危险。自然资源开采、城市扩张等人类活动进一步加剧了森林面临的威胁。为了应对这些日益加剧的威胁，迫切需要识别和监测森林韧性，调整森林管理策略。当前，森林健康保护措施往往集中于地上植被保护修复和可持续经营利用，然而，增强森林韧性最重要的机会是森林土壤。健康的森林土壤为整个生态系统提供了基础，提供了诸如水储存、养分循环和生物生长所需的介质等必要服务。因此，保护和恢复森林土壤健康对加强森林保护经营至关重要。研究团队建议，可通过开展全面、适应性强的森林经营策略，采用生物炭等气候产品及提高投资，以提升气候土壤健康。

首先，维持森林土壤有机物是实现土壤健康管理最关键的因素。在森林生产后，保持土壤的表层有机质层十分重要，可以从程度、时间和强度上减缓土壤压实的影响。同时应在集材道上放置一层树枝和针叶可以缓

▌Pierson et al. Building Forest Resilience from the Ground Up. Northwest Woodlands.(2024)

Threats to our forests are changing. Wildfires are burning hotter and more often. Waves of pests and disease are similarly fueled by drought and overgrowth. Supercharged thunderstorms bring heavier, more intense rains, washing away fertile soil and creating dangers like flash floods and landslides. Human activities build threats as we continue harvesting precious resources and expanding urban interfaces with forested environments. In response to these escalating threats, it's exceedingly important to recognize and monitor forest resilience and adapt forest management strategies. Efforts to protect forest health often focus on above-ground vegetation, but our most significant opportunities to bolster forest resilience are through forest soils. Healthy forest soils provide a foundation for the entire ecosystem, providing essential services like water storage, nutrient cycling, and the growth medium necessary for organisms. Thus, how to protect and rehabilitate forest soil health is essential to enhance forest resilience and protect against threats facing our forested environments. It is suggested that soil health could be enhanced through sound and adaptive forest management strategies, use of biochar and other climate friendly products and increased forest soil health investment.

The critical element is keeping enough organic matter in forest soils. Restoring forests and rebuilding soil health after disturbances often requires replanting native species, installing erosion protection measures, and managing invasive plants. Soils with diverse microbial communities and sufficient nutrients are better equipped to regenerate native species after a disturbance, as well as withstand droughts,

冲机械对土壤的不利影响，并能在森林更新时增强水和养分的供应。在森林及其土壤健康恢复时，应采用乡土树种进行再造林，同时采取防侵蚀措施、入侵植物管理、恢复土壤微生物群落、补充养分，以达到土壤健康恢复目的。此外，采取适当森林经营管理措施，例如间伐和增强生物多样性，可以降低林火烈度，进而减少对土壤的影响。

其次，利用生物炭提升森林土壤健康，是今后发展方向。生物炭是在低氧环境下燃料有机物质形成的木炭类物质。采伐迹地是生物炭生产的理想原料供应地，能将之前视为废弃物的采伐

pests, and disease outbreaks. To build resilient soil after harvesting, it is important to maintain surface organic horizons to limit the extent, duration, andintensity of compaction. Placing a layer of branches and needles on skid trails can buffer the soil from mechanical damage while also enhancing water and nutrient supplies as the stand begins to regenerate. Combining this practice with other methods to minimize heavy machinery and retaining a diverse mix of tree species and age, forest harvest operations can proceed with no lasting effects on forest health. Forest management also plays a vital role in addressing climate change. Thinning crowded stands and fostering diversity help to reduce the risk and severity of fires and their impact on soils.

Biochar is the opportunity to improve forest soil health. Biochar is a charcoal-like substance produced through the combustion of organic materials in a low-oxygen environment (pyrolysis). Forest slash is an ideal feedstock for biochar production, converting it to biochar as a valuable product. Biochar has immense potential in forest

森林土壤中暗含的生物质是森林生态系统的原动力
Hidden life in forest soils serves as the tireless workhorse of a forest ecosystem

真菌与树根间形成的关系能为林木提供养分。
当这种关系到干扰时，会降低林木生长和森林生产力
Fungi form relationships with tree roots and bring nutrients to trees. When disturbed, these relationships can reduce tree growth and productivity of the forest.

废弃物变为有价值的产品。生物炭在森林经营方面具有极大潜力，能在森林修复过程中添加进土壤，改善土壤状况，为林木长期提供养分。此外，生物炭还能修复受污染的土壤。因此，只要生产方法行当，推广应用率高，生物炭可以将废弃物变废为宝，提升森林韧性。

最后，加大对森林土壤健康的投资可以获得多方面收益。加大相关投资，可以提高森林生产力和韧性，保证木材可持续生产，提供清洁水源，保护无数特种的福祉，减少洪灾风险，保障食物安全，从而为依赖森林的群体创造各类经济效益。森林土壤具有极高储碳能力，能减少大气中的温室气体浓度。因此，促进林木生长，增强森林土壤健康，将会提升碳捕获能力，并且为创新气候产品生产提供可再生原材料。

■ Giovanni Forzieri 等。生态系统异质性是抑制欧洲森林气候驱动风险增加的关键，One Earth (2024)

气候变化导致的森林扰动增加对关键森林生态系统服务构成了严重威胁，但在欧洲范围内，相关影响和适应评估很少。该研

management. It can be incorporated into soils during restoration activities, providing long-term benefits for re-planted trees as a soil amendment. Additionally, biochar holds promise for remediating contaminated soils. With proper production methods and application rates, biochar presents a multi-faceted opportunity to turn a waste product into benefits for forest resilience and soil-dependent industries.

Investments in forest soil health pay dividends that extend beyond the forest ecosystem. Healthy soils underpin productive and resilient forests, opportunities for sustainable timber harvests, and other long-term economic benefits for forest-dependent communities. In an era of new climate extremes, there is increasing value in maintaining healthy forest soils, especially regarding water. Healthy forest soils protect the well-being of countless species, including our own, by filtering water, reducing flood risk, and supporting a robust food web. Protecting thecarbon-storage capacity of forest soils is critical for mitigating the rise of greenhouse gas concentrations in the atmosphere. Nurturing tree growth and healthy forest soils helps capture carbon and provides raw materials for innovative, climate-smart products like cross-laminated timber. This highlights the exciting potential of sustainable forest management to cultivate new resources and contribute to positive climate action.

■ **Giovanni Forzieri et al. Ecosystem heterogeneity is key to limiting the increasing climate-driven risks to European forests, One Earth (2024)**

The rise in forest disturbances due to climate change poses a serious threat to key forest ecosystem services, yet impact and adaptation assessments are scarce at European scale. Here, we estimate the forest biomass loss in Europe due to fires, wind throws, and insect outbreaks over 1979–2018 and evaluate potential adaptation benefits by

究估算了 1979−2018 年欧洲因火灾、风灾和虫害而遭受的森林生物量损失，并结合机器学习与扰动数据和卫星数据评估了潜在的适应效益。结果显示，欧洲年均生物量损失为 41.6±5.3 公吨，年均增长 2.3 ± 0.3 公吨，主要受气候变化的影响（72%-98%）。与风灾（20%）和火灾（1%）相比，虫害对生物量损失的影响作用最大（79%），这与在 2000 年之后虫害激增相关。然而，欧洲各地所受的影响还受到各地不同环境条件的影响，因此存在差异。研究估计，增强生态系统异质性可减少大约 18% 的生物量损失，因此在森林适应政策应重视强调相关行动。

integrating machine learning with disturbance data and satellite products. Results show an average overall annual biomass loss of 41.6 ± 5.3 Mt at European level subject to a significant rise of 2.3 ± 0.3 Mt year^{-1}, largely influenced by climate change (72%-98%). The contribution of insect outbreaks appears prominent (79%) compared to wind throws (20%) and fires (1%) and linked to their upsurge after the year 2000. However, impacts vary greatly across Europe depending on local environmental conditions. We estimate that enhancing ecosystem heterogeneity could reduce biomass loss by about 18%, and such action should therefore be fostered in forest adaptation policies.
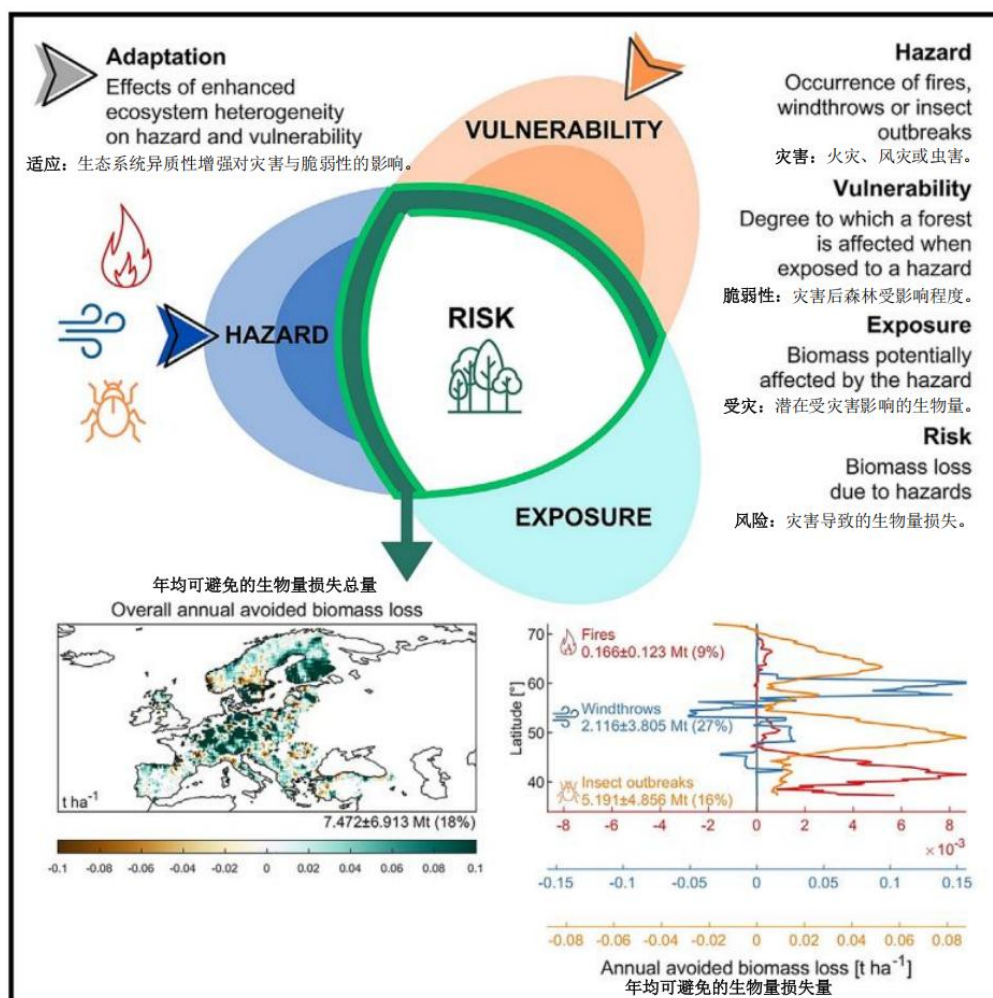
■ 西班牙加泰罗尼亚森林科学与技术中心 LL 引进参与式评估完善适林适用策略

背景目标："适林适用"（FUS）是根据森林生态系统服务供给能力划定森林最适宜用途的管理策略，进一步强调了森林生态系统服务对于营造可森林持续环境以及制定适当管理战略的重要意义。面对自然环境的高度复杂性，围绕森林提供的多重效益，有必要以客观且全面性研究指导管理策略的制定。研究者从客观视角出发，广泛调研专家、利益相关方和森林使用者的意见，据此制定采取森林经营活动。此外，基于多标准空间分析，全面了解相关问题，在区域层面针对森林可持续发展提供清晰的解决方案。

技术方法：基于空间数据可用性分析以及森林生态系统服务供给量化指标的定义，研究者绘制了森林生态系统服务供给地图。研究中，与专业人员、利益相关方和森林使用者共同开展了参与式分析，咨询他们对森林效益重要性的看法，以确定森林用途适宜性。研究定义了五种森林适用性，即生产性（与管理目标相关，旨在将森林经济利润

■ Forest Science and Technology Centre of Catalonia LL incorporate participatory evaluation into Forest use suitability approach

Background: Forest use suitability (FUS) is the most appropriate use assigned to the forests based on their capability to provide forest ecosystem services (benefits to society provided by the forests). This approach was created to reinforce the importance of forest ecosystem services in the creation of sustainable forest environment and assignation of adequate management strategies. Due to the high complexity of natural environment and multiple benefits forest provide, it is necessary to conduct comprehensive and objective research approach. In such a scenario, obtaining opinions from the professionals, stakeholders and forest users offers a strong base to improve forest management actions. Furthermore, multi-criteria spatial-based analysis increases the comprehensiveness of the problem and gives clear territory-focused solutions regarding forest sustainability.

Approach: After spatial data availability analysis and definition of metrics to quantify the provision of forest ecosystem services, scientist made a cartographic representation of forest ecosystem services supply. During the research, a participatory analysis is conducted with professionals, stakeholders and forests users to question their perception on the importance of benefits provided by the forests, in order to define forest use suitability (FUS). Each of five defined forest use suitability gives an idea of the adequate management strategies: productive (associated to management goals that maximize the economic profitability of the forest), protective (highlights the actions that mitigate harmful natural processes), conservation-oriented (aims to increase the habitat value of the forest), social (empowers non-material and abstract values that influence human physical and mental health) and multifunctional (where applicable, acts as a

最大化）、保护性（强调减少自然进程损害的行动）、自然保育性(旨在增加森林生境价值）、社会性(有益人类身心健康的非物质或精神价值）和多功能性（在适用的情况下兼顾前述两种或多种适用性），并且针对每一种提出了对应的管理策略，同时，参与者还应评估哪些生态系统服务具有相关性以及相关性程度，以决定森林单位的用途，并且确定最恰当的管理策略。为此,研究运用了生态系统管理决策支持系统（EMDS）。这是一个在多标准森林经营中嵌入空间决策支持的系统,能够将参与式评价进行嵌套,进而在整个研究区域内实现林分用途最优适配。

研究优势：生态系统服务研究中，参与式规划是一种有力工具，能够保证在复杂的多标准评估中保持高度客观性,避免在利益导向作出决策，有助于确定适当的管理活动。利用空间分析和可视化呈现模式,有利于为在有限的森林单元内合理划分用途。结合运用创新方法（EMDS）和"适林适用"（FUS）方法，有助于克服多方面限制，获得全面且适用的区级化管理策略。

a combination of two or more of the previous uses). The participants should value which ecosystem services are relevant, and to what degree, to assign certain use to a forest unit and, consequently, define most appropriate management strategy. To do so, EMDS (Ecosystem Management Decision Support) System is applied, a spatially oriented decision support system for multi-criteria management, enabling to incorporate participatory evaluation. As a result, spatial allocation of the most suitable uses is done in the entire study area.

Advantages: Participatory planning in ecosystem-services oriented studies is a powerful tool to maintain high level of objectivity in complex multi-criteria assessments and avoid interest oriented practices. Such approach helps to define adequate management actions. Strong spatial component and cartographic visualization enable the allocation of spatially limited and more customized actions for each territorial unit. Application of innovative methodological (EMDS) and terminological (FUS) approaches enables to surpass existing constrains and obtain more comprehensive and applicable territory oriented results.
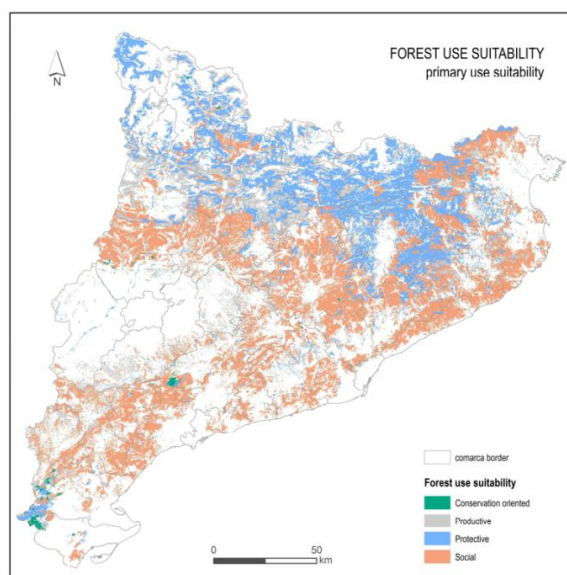
在区域一级使用森林用途适宜性方法的结果示例
Example of results using forest use suitability approach at regional level

▊ 采用多种形式提升林业主题展览对青年群体的吸引力

背景目标： 2023年席尔瓦（Silva）森林展吸引了2.8万林业专业人士、林业学生和所有有意森林工作的人士。北卡累利阿LL在Silva森林展设置"气候与森林"主题展位，展示森林如何适应气候变化以及气候变化如何影响森林，并且通过趣味性和互动性布展，提高展位的吸引力。特别是主办方在展会期间提供的Seppo-game手机应用得到了青年群体的青睐。北卡累利阿LL在此次森林展提升了对青年群体的吸引力，也有效提高了其彰显度。

技术方法： 北卡累利阿LL在展会中利用多种方式提高吸引力。首先是组织一支具有丰富专业知识的团队以每日主题的形式提供讲解、展示等服务。该团队在气候可持续森林经营管理方面拥有极高专业能力，包括混交林培育、异龄林经营及森林放施肥，同时还拥有基于遥感技术解读森林损害的专业知识，例如借助卫星图像检测树皮小蠹虫害。其次，围绕多种现实主题及其实际成果进行介绍，带领公众具象化认知如何通过森林经营管理提高森林气候韧性。其中树皮小蠹损害和森林施肥备受关注。最后通过营造混交林、林龄梯度化和森林施肥，通过森林经营增强森林韧性的全过程；

▊ Silva exhibition made it a success to activate the youth's participation through multiple means

Background: In September 2023 Silva Forest Exhibition brings forestry professionals, forestry students and all forest minded people together, gathered around 28 000 people. North Karelia Living Lab attended Silva Forest Exhibition on a stand called Climate and Forest. The stand presented how forests can adapt to climate change and how climate change affects to forests. With interesting and current theme, the stand attracted large participation. A mobile phone application called Seppo-game was played throughout the event, attracting young people to play, which helped increase the LL's visibility.

Approach: The LL adopted a range of approaches to increase the stand's attractiveness. Theme was wide and it included huge number of practical outcomes. As a result, it was important to assemble a team that works with this topic as a daily basis. It gave synergy benefits. Team had expertise in Climate-sustainable Forest management, such as mixed forest cultivation, uneven aged forestry, and forest fertilization. It also had expertise on forest damage interpretation using remote sensing techniques, such as bark beetle damages' detection from satellite images. Wide and current theme with a few practical outcomes attracted people to visit our stand. People wanted to know how to manage forests so that forests would be resilience in the future. Specially bark beetle damages and forest fertilization interested people. Seppo-game at North Karelia Living Lab stand was about identifying tree species

最后，设计了 Seppo –game 互动性手机应用。这款幼苗树种识别的手机应用，吸引了大量年轻人驻足互动，利用导引图完成各类主题任务。

研究优势：在帮助从业者寻找志同道合的合作伙伴，发布传播林业相关信息等方面，林业展提供一个绝佳的机会。同时，与网络和面对面研讨会相比，林业展能够使人们更加流畅地沟通，更容易对感兴趣的话题畅所欲言。此外，林业展更能抓住年轻人通过手机了解新事物的特点，吸引青年群体关注之前未关注的议题，自然而然的接收新信息。例如，许多年轻人在开始时压根不认识幼苗树种，但在游戏结束后，至少能识别出游戏中出现的树种。在为期两天的展览中，约有 1000 名参观者参观了 e2a 展台，其中手机游戏功不可没。

from seedlings. This turned out to be an interesting task, as it gathered a lot of young to the Stand.

Advantages: Forest Exhibitions are an excellent place to meet people working on the same topic and as a result, find possible partners to the future. It is also a great opportunity to distribute information to forest owners and other forest driven people. The atmosphere at the exhibitions is usually good and relaxed, which allows for casual conversation. Compared to webinars and seminars the conversations are more fluent and people are more active to start a conversation about the topic of interest. It is easier for young people to approach things via mobile phone. Different mobile games are a great way to get attention from youth. Subject may be unfamiliar to young people, which makes it difficult to catch, but through a fun mobile game, information flows completely unnoticed. For example, many young people didn't recognize tree species of the seedlings, but after the game they recognized at least the ones that were included in the game. Other benefits: Seppo-game was utilized by the teachers, so that they let pupils go alone/in small groups to the exhibition. When all the questions are answered, teacher saw that the schoolwork was done, and pupils were free for the weekend. The Seppo-game was one thing to do our stand success: we estimated 1000 visitors in our E2A stand during the 2-day exhibition.

席尔瓦森林展览于 2023 年 9 月 8 日至 9 日在约恩苏举行
Silva Forest Exhibition on 8th-9th September 2023 in Joensuu

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