EU-China Cooperation on Climate Mitigation and Adaptation in the LULUCF Sector

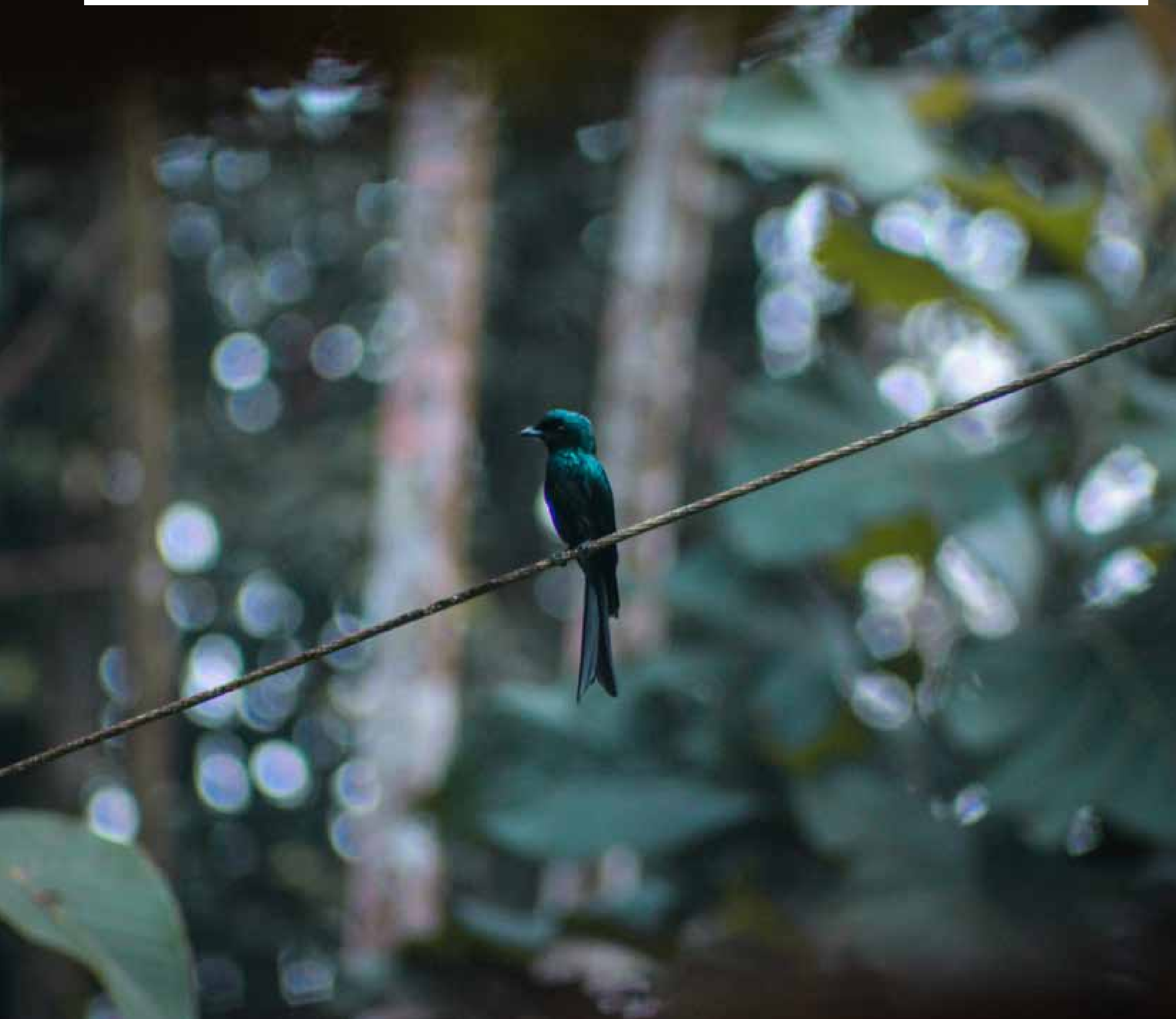
EU-China Expert Dialogues:

Improve Joint Monitoring and Modelling between Biodiversity Conservation and Climate Action

Synthesis Report of Expert Dialogues

Between May and September of 2021

Report edited by Florian Claeys, Guo Rui, Liu Xiaojuan, Yang Jun, Zhang Xiaoquan



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FOREWORD

This series of expert dialogues, namely "Improve Joint Monitoring and Modelling between Biodiversity Conservation and Climate Actions", aimed at promoting EU-China cooperation on climate mitigation and adaptation in the LULUCF sector. These dialogues took place between May and September 2021, as a preparatory activity in the run-up to COP26. The objective was to maintain a high level of engagement between the EU and Chinese relevant stakeholders on climate action, taking into account that this policy area currently holds the most significant potential for mutually and globally beneficial cooperation between the European Union and China.

The high-quality content of the presentations made during these meetings and substantive dialogues that followed (amongst European and Chinese researchers, academic experts etc.) demonstrated the capacity on both sides to provide the necessary scientific and technical support in upholding the current respective public policies on the right course, thereby fulfilling their commitments under The Paris Agreement.

Making informed decisions in a complex multidimensional policy area such as, climate action, requires accurate and timely input from cross-sectoral scientific research, analysis and projections. In this context, exchanges between researchers from two of the most important contributors to global climate action are of critical importance. They provide great opportunities to compare approaches and various options, identify alternative solutions, and approximate methodologies adopted. The ultimate goal would be to reach greater understanding on both sides and develop a common narrative that would facilitate preparation of domestic policy proposals or resolutions in international policy, which are more likely to receive endorsement or to be agreed upon by decision makers on all sides.

The Delegation of the European Union to China has always attached great importance and will continue to extend its support to these types of events through contacting, communicating, creating networks, and building trust (among prominent experts, researchers, members of academic institutions) between Europe and China. For the success of the present exercise, credit goes largely to the strong involvement of DG CLIMA, JRC, other EU entities, as well of the Chinese partners, from relevant institutions. Nothing would have been possible without the relentless efforts of the SPIPA Project Team at GIZ China.

Even though the work of the climate researchers would not always find itself under the spotlight, it is undeniable that the science-based policymaking in the field of climate action originates in their circles, and contains precisely the knowledge that is essential, under the present circumstance, to deal effectively with the existential challenges that climate change represents for the humanity as a whole.

Delegation of the European Union to China

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PART I
Expert Dialogue 1: Synergies between Climate and Biodiversity and Major Challenges in the Agriculture Sector

Summary of the workshop

The first of a series of workshops aiming at promoting EU-China Cooperation on Climate Mitigation and Adaptation in the LULUCF sector, was successfully held on 26th May 2021 in hybrid form with EU experts joining in online and Chinese counterparts in Beijing. Two sides presented their research and exchanged their views on climate actions and biodiversity conservation: the synergies and challenges between them, in the agriculture sector. The focus was on two main issues:

1. Interactions of mitigation measures with food production and security.

2. Best practice in adaptation and its influence on biodiversity conservation.

Experts from both sides also expressed collaboration intents in identified areas.

The dialogue was composed of two sessions addressing each of the two corresponding issues above and structured to address mainly the following questions:

- What are the best practices and technical challenges in sustainable agriculture, and their co-benefits on climate and biodiversity?
- How to balance the synergies and trade-offs between upscaling mitigation and ensuring food security?
- How to protect and manage vulnerable ecosystems?
- How to evaluate adaptation efficacy and what are the implications on biodiversity?

During the workshop experts from both sides reflected on the following topics:

- The science and practice to increase rice production while lowering the related Global Greenhouse Gas (GHG) emissions
- The credibility of adopting agroecology in Europe, and the importance of dietary change to its success
- The interactions between mitigation measures and food security, from cost and technology perspectives
- The impacts of climate change and Representative Concentration Pathways (RCPs) on germplasm diversity in China, and possible responses
- The cost and types of cover crops as well as their utilisation in Europe
- The vital role of adaptation in agriculture despite the mitigation efforts, and the complexity of adaptative solutions at farm level
- The technological progress of agriculture adaptation in China and the exploration of evaluation methods
- The adaptative management of alpine grassland ecosystem in Tibet including husbandry development
- An EU project (LIFE PASTORALP) aiming at lowering the climate vulnerability of high mountain pastures of Alps

Current Status of work in the EU and China

Guarding food security while mitigating climate impacts

In both the EU and China, food security is of paramount importance. Meanwhile, GHG emissions associated with agricultural activities are a prominent contributor to climate change, which will in turn impact food productions. In other words, the agriculture sector is both a driving force and a victim in the climate context. On the other hand, biodiversity is not only a production factor for agriculture, and the embedded conservation value means it should be explicitly considered in agriculture mitigation and adaptation strategies. The dialogue highlighted some cutting-edge research efforts in building best practice and models

Agriculture is one of the main sources of global greenhouse gas (GHG) emissions, and its impact on global warming should be emphasised. About 20% of the GHG emissions come from the agriculture sector globally, which were mainly attributed to CH_4 and N_2O. In the case of rice, the staple food that feeds half of the world population, rice paddy is the main source of CH_4 and N_2O. With projected rising demand for rice, the key therefore lies in how to curb the related GHG emission while increasing the productivity. Despite the positive feedback loop between CO_2 concentration as well as temperature and GHG emission for producing one unit of rice grain, it was found that controlled release of urea, water-saving irrigation and application of urease and nitrification inhibitors can increase the yield while reducing carbon emission intensity by 20-40%. The same practice and integrated rice-crayfish system can also increase farmers' profit and reduce the corresponding economic carbon intensity. The economic benefits would facilitate the implementation of such mitigation measures. Apart from these promising practices that have multiple climate and economic benefits, organic farming and combining rice planting with animal feeding further promote soil carbon sequestration and increase biodiversity. An integrated approach considering all the practices gained from field experiments is needed for optimising the climate and biodiversity potential in rice paddies and meet the rising demand for rice at the same time.

Specific agricultural activities such as rice paddy cultivation, when done smartly, exhibited great potential to mitigate climate impacts while enhancing food security, as well as conserving biodiversity. Hence, other activities should be investigated as well for forming broader agriculture mitigation strategy. Modelling at larger scale provide a unique opportunity in this regard. The 'Ten Years for Agroecology' (TYFA) biotechnical modelling at the EU scale applied agroecology principles to jointly address climate change issues and biodiversity challenges. This is particularly relevant given in the EU biodiversity in the past 50 years has declined and agricultural yield stagnant. From analyses of cropping systems, livestock systems, diets to waste and losses and non-food-uses, it is evident that agroecology is the credible option for the EU in terms of biodiversity restoration and farmers work conditions, and at the same time offers significant GHG emission reduction potentials. Equally importantly, the EU can become a net calorie exporter rather than importer as it is now hence lowering its food insecurity. These multi-benefits are mainly manifested in nitrogen (e.g. N_2O) reduction and autonomy, and high carbon sequestration potential. A lower input-output system also has adaptative advantages. Among all the model hypotheses, changes in diet are a prerequisite to drive the positive outcomes.

While the socio-economic and policy aspects of the TYFA model are still to be worked out, other studies on the costs of mitigation technologies and their adoption can have meaningful implications for mitigation strategies and food security concerns. Marginal abatement cost (MAC) curves show that almost all existing agriculture mitigation technologies have a positive cost, hence, significant mitigation adoption can only be achieved at a meaningful carbon price of about €50/t CO_2 eq. at the EU level. While taking the impacts on the mitigation potentials and costs due to technology interactions and regional variations into account, it should be noted that stringent mitigation policies relying on mix and level of production in agriculture and LULUCF at higher carbon prices could threaten food security. Similar to the TYFA findings, a shift in less livestock-based diets will not only be vital to achieve GHG reduction consistent with the 2 target, as well as striving for the 1.5 target, but alleviate the impacts of mitigation policies on food availability, which is applicable globally. Besides, a trade-adjusted impact analysis shows that flexible trade policies for the EU and national contingency plans are also important for reducing food insecurity on top of their adaptation benefits.

Urgency of adaptation and challenges in assessment of implementation

Climate change affects agriculture in several ways. In Europe, changes in temperature, precipitation, and extreme weather influence crop yields, livestock productivity and water availability etc. Such impacts mean a great deal to the corresponding commodity prices hence economy of the farmers. Since 1980, the total economic loss amount to about 450 billion € of which only one third were insured. On the other hand, production activities and farmers in different regions are affected by climate change in different ways. For example, both the crop production and farmland value will be heavier impacted in southern Europe than in the north, but nowhere is exempted from more extreme weathers hence the concurrent economic loss.

While the impacts vary considerably across Europe, EU-level adaptation strategies exist such as the future Common Agricultural Plan and EU Adaptation Strategy (agriculture), which have enabled agricultural adaptation actions. In the meantime, almost all the EU member states have set agriculture as a priority sector in their respective national adaptation strategy with measures including but not limited to raising public awareness, practical measures to reduce extreme weather impacts and risks, risk-sharing strategies and infrastructure for irrigation and flood protection. However, the diverse nature of national plans/strategies/actions and lack of measurement tools for their effectiveness have led to the gaps to implementation. Apart from systemic approaches at national and continental levels, farm-level measures are part of the solution, too. Those aiming at sustaining resilience and conserving soil and water resources can in some ways reduce the impacts of climate threats, among which those provide adaptation, mitigation, and biodiversity as well as economic benefits should be promoted and financed by EU funds. At all levels focused on adaptation, it is crucial to make right investments in effort and money to scale up implementation of current solutions and for new and transformative ones.

Agriculture adaptation in China comes realistically and urgently. Now, despite an adaptation policy system has been established at all levels, specialised, and regionally adjusted policies have not been clearly made or implemented, based on the real needs of key areas of adaptation. Moreover, the current evaluation method of agricultural policy effectiveness is unable to capture key progress or gaps. From a technological perspective, for the purpose of reducing climate risk agriculture-related adaptive technology development is the most predominant of all sectors and have gained enormous attention. What is urgently needed, similar to the EU, is a set of scientific and viable evaluation methods to assess the effectiveness of adaptive policies and developments. Some case studies on small-scale farmers' adaptive response to climate change reveal that while some individual spontaneous actions are effective in resisting direct/indirect climate change impacts, it is difficult to monitor and evaluate the combined effect when considering multiple driving factors such as crop growth and economic change, due to a lack of reliable database and technical assistance. In developing monitoring and evaluation tools, synergies between adaptation and reducing emissions should be considered on the basis of food security.

Meanwhile, as outlined, biodiversity is a production factor in agriculture in addition to its conservation value. In this regard, germplasm resources form the basis for agriculture development. Under the impact of climate change, it is found that plant breeds richness has increased in north-eastern China and declined in parts of the south and southwest. Animals have been affected too. Yaks, for example, the distribution of several breeds has shifted towards north or west relating to the thermal index. For pigs and sheep, the changes in their richness seem to have followed the pattern of plant breeds. Future climate change and mitigation scenarios will modify the suitable distribution areas of fruit trees in some tropical areas. For some, more under higher RCPs and less for others, and change the abundance of crop varieties. For animal germplasm, though, higher RCP scenarios would with no exception lead to higher loss in the richness of the animals mentioned above as well as poultries. Hence, from the perspective of security of supply, specific adaptive measures such as rewilding and restoration of populations and developing rotational grazing technologies are urgently needed while monitoring system development remains a priority.

The EU's good foundation and experience on database building, indicator construction and tools for monitoring and evaluation, are valuable assets for China's development on its own agriculture adaptation strategy.

Co-benefits of protecting vulnerable landscapes

Vulnerable landscapes suffer from climate change disproportionately. Some of these areas are of particular interest to agriculture and ecosystem stability. In the EU and China, both Tibetan Plateau and Alps are regions of such nature. Tibetan Plateau is an important ecological security shelter for China, which is cold and at high altitude. Alpine grassland is suffering from above-average increase in temperature and precipitation, which further threatens ecological protection and animal husbandry in the region. Long-term field monitoring and manipulative experiments have enabled us to uncover some of the climate change impacts. Generally, high temperatures lead to low stability and diversity in grassland and soil moisture predominantly determines the carbon flux direction affected by warming. Besides, warming and overgrazing have profound impacts on plant phenology which governs biomass production and soil conditions (nutrients and moisture content). Proper adaptive measures will not only enhance the ecological functions including climate resilience but upgrade the grassland-based husbandry. These include grazing management, degraded grassland restoration, grass planting (foraging) and yak breeding, among others.

Likewise, Alps pastures are more prone to climate change impacts than many other landscapes in Europe. A reduction of summer precipitation, winter snow cover, and an increase in extreme events have direct impacts e.g. loss of biodiversity and indirect impacts e.g. changes in socio-economy of local communities, on pastures. The PASTORALP LIFE project aims to reduce the vulnerability and increase the resilience of alpine pasture agriculture by assessing impacts and testing adaptation measures in two areas in the Alps, ultimately transferring research and changing policies. Modelling of the current climate condition and future climate scenarios suggests a reduction of snow cover and lengthening of the growing season, among others. Such phenomena in high mountain pastures would increase the risk of early or late frost and long summer droughts while increasing the potential biomass production. Similar to adaptation measures proposed at Tibetan Plateau, better managing forage availability and increasing grazing efficiency by better management of pastoral resources would have dual benefits on biodiversity conservation and protecting the Alps pastures. Coordination of ecological protection and agricultural production in alpine regions are important to both China and the EU, which are covered by a large area of alpine grasslands.

Knowledge and Policy Gaps

Based on the experts' reflection and exchanges on the current status of work in the EU and China, there are a few knowledge and/or policy gaps identified that are important for better understanding and balancing agriculture mitigation and food security, as well as facilitating implementation of adaptation measures that are beneficial to biodiversity conservation, including:

- An integrated mitigation strategy in agriculture sector rather than sparse individual measures is needed. Economic and human factors should be incorporated in future mitigation pathway analysis for viability
- Further research is needed in the analysis of climate extremes when it comes to MAC, since agriculture is especially prone to their impacts.
- A systemic agriculture adaptation approach that also positively affects mitigation and biodiversity needs to be developed in Europe. Besides, EU national strategies/plans need clarification and coordination to facilitate implementation and right investments
- In China, a monitoring and evaluation framework for the effectiveness of current agriculture adaptation policies is lacking, one that considers regional variation and synergy between mitigation and adaptation for agriculture
- Long-term experiments should be set up in vulnerable landscapes e.g., Alps and Tibetan Plateau to investigate the temperature effects in a controlled manner

Next steps

During the expert dialogue, both sides expressed interests and willingness to scale up such effort in promoting exchanges and collaborations between the EU and China on agriculture mitigation and adaptation research, as well as developing tools to increase monitoring and modelling efforts. There are a few suggestions on next steps to take in this regard.

To make informed policies, both sides feel the need to have more reliable data for modelling and evaluation work, it was suggested online survey with different stakeholders, including government, academia and farmers should be interviewed to collect basic information. It is also necessary to consider regional variation and starting pilot projects at regional level, an area both sides can collaborate on by sharing experience.

Due to the drastically different characteristics of agriculture between the EU and China, comparative studies and analyses could yield important knowledge, which could in turn provide alternative solutions to respective issues. A good example is in developing integrated mitigation and/or adaptation strategy, where trade policy regarding agriculture commodities from each other is important. China is also keen to learn from common good practice from the EU such as the Climate Adapt platform, similar monitoring tools could facilitate China developing its agriculture adaptation evaluation framework.

Policy Recommendations

From the experts' presentations and exchanges, it is evident that the agriculture sector is at the heart of climate mitigation and adaptation both in the EU and China, especially considering its fundamental role in safeguarding people's basic needs and nations' security. Despite further research is needed, some policy recommendations were suggested:

- Both mitigation and adaptation policies in the agriculture sector must be made in an integrated approach because of the biodiversity, economic and security implications.
- Improving N use efficiency through modified fertilization and combining rice planting and animal feeding are key to reduce GHG emission and conserving biodiversity.
- Implement agroecology practices in Europe for its reduction in N2O emission and high sequestration potential.
- Adopt flexible trade policies and specific national contingency plans for key food commodities for adapting to climate adversities and reducing food security.
- Develop perennial artificial grassland in a family ranch scale and ecological resowing in a regional scale for grassland restoration and animal husbandry production.

PART II
Expert Dialogue 2:
Significance of NbS to Climate Change Solutions and Its MRV and Modelling

Summary of the workshop

The second workshop in the 'EU-China Cooperation on Climate Mitigation and Adaptation in the LULUCF sector' framework, was successfully held on the 8th Jul 2021 in hybrid form with the participation of EU experts online and Chinese counterparts on-site in Beijing. Both sides presented their research and exchanged their views on using NbS as an important climate action and biodiversity conservation tool. The focus was on two main topics:

1. city-level ecosystem management and afforestation/reforestation as a means of NbS
2. status of MRV, modelling and case studies of NbS.

- Experts from both sides also expressed collaboration intents in identified areas.
- The dialogue was composed of two sessions of the above two topics and structured to address mainly the following questions:
- How to make cities a frontline for implementing climate NbS and what are the roles of urban plantation?
- What are the co-benefits on climate and biodiversity, by forestation and broader ecosystem restoration effort?
- What is the most recent progress in NbS projects and how to scientifically evaluate their efficacy?
- How to use state-of-the-art models to track both biodiversity and the climate indicators?

During the workshop experts from both sides reflected on the following issues:

- The importance of spatial and temporal variation and stakeholders' preferences in making urban NbS plans
- The effect of climate change on the emission of the biogenic volatile organic compounds (BVOC)
- The Climate Smart Forestry (CSF) approach in Europe and the related climate benefits including material substitution
- The relationship between carbon cycling and storage, and species richness
- The adaptation benefits of multi-plantation and the implications for afforestation strategies
- The nationwide ecological restoration campaign in China - the global vanguard of national NbS initiative
- The carbon sequestration benefits of different techniques depending on the cases
- The science based MRV principles in NbS evaluation
- The integrated modelling practice to better understand the nature's role in ecosystem functioning
- An EU project BIOCLIMA: modelling the existing biodiversity and LULUCF climate policies to assess the aimed conservation and reduction goals

Current Status of work in the EU and China

Ecosystem management at city level and in protected areas

NbS in metropolitan areas are nothing new, though using NbS as a measure to reduce natural disaster risk and increase resilience to climate change is relatively new. The challenges remain, though, in how to tailor NbS strategies to a venue's needs. In face of climate change, an issue pertinent to urban NbS is the emission of biogenic volatile organic compounds (BVOC), which are a precursor to ozone (O3) (along with CO2 and CH4). Plantation is the primary source of such compounds and excessive amounts of O3 can lead to photochemical smog and detrimentally impact human health in urban spaces. Therefore, the plant species used in urban NbS need to be chosen judiciously. In this regard, more than 20 types of city greening tree species in China were analysed/modelled with respect to different climate change scenarios (RCPs), and the modelling results illustrate a general increasing trend of annual BVOCs emission and rate of change. Moreover, the results indicate that emissions tend to peak in the summer and the absolute variability is highest between May and September while the relative variation is the highest from November to March. Together with regional differences, importance should be attached to urban NbS by considering the impact of tree species on BOVC emissions on the atmospheric environment.

Similarly, at urban level, the REGREEN project was initiated in a Sino-European urban planning consortium aiming at improving co-creation of NbS in cities, developing support systems for policymakers and devising business models, which can economically sustain NbS. Six cities/municipalities including Paris region, Velika Gorica, Aarhus (European) and Ningbo, Beijing, Shanghai are the objects of the study. It was identified that spatial and temporal variation in pressures as well as sociodemographic and socioeconomic contextual data is important, to devise bespoke urban NbS. Both remote sensing and modelling are powerful tools in developing NbS and evaluating their values e.g. varying vegetation levels to see their impacts on land surface temperature, and analysing PM2.5 removal by evergreen and deciduous trees taking into account service through the year. In terms of biodiversity, both generic habitat quality models and detailed analysis on communities of plants and animals have been used. Residents' perception of biodiversity is the key for conservation in urban areas. It is concluded that for devising informed NbS for cities, spatial and temporal variation in pressure, potential service, and demand matters and both synergies and trade-offs need to be considered. Additionally, to sustain any specific NbS projects it is important to take stakeholders' preferences into account.

The Chinese government places national ecological security as a high priority. A series of policies and legislation have been established to protect important ecologically functional zones and fragile and sensitive areas. In 2015, the MEE revised the Ecological Function Regionalization of 2008, in which 63 important ecological function zones were selected for protection. In addition, the State Council issued a list of the major function orientated zones defining 1,443 areas prohibited from development covering 12.5% of the total land area. Since 2007, the government promoted the construction of natural protected area system with national parks as the main body, through integration, optimization and adjustment of the former nature reserves, forest parks, scenic parks and wetland parks. By the end of 2019, China has established 11,800 natural protected areas at all levels, accounting for 18% of the territorial land area.

These national strategies and plans for ecological protection and restoration not only serve to ensure ecological security, but also set the examples for NbS in response to climate and biodiversity crisis. The research based on the natural forests and plantations both proved that biodiversity promotes ecosystem carbon storage. One research on subtropical natural forests in Qianjiangyuan National Park demonstrated that more diverse forests give rise to faster carbon cycling as well as more carbon being stored in above- and below-ground ecosystem compartments including trees, herbs, roots, litter, deadwood, and soil than less diverse forests. Therefore, afforestation policies in China and elsewhere should change from the current focus on monocultures to multi-species plantations to increase carbon fixation. Another research from a large forest biodiversity experiment established in the exceptionally species-rich subtropics (BEF-China), which trees comprising different numbers of species-from monocultures to 16 different tree species plots-were planted in an area of 670 square meters, showed that forests with higher diversity accumulates more carbon. After 8 years, species-rich forest plots stored an average of 32 tons of carbon per hectare in above ground biomass, more than doubling that of the monoculture plots. Besides, the former is also less vulnerable to diseases and extreme weather events, which are becoming increasingly frequent as a result of climate change. These findings encourage multispecies afforestation strategies to conserve biodiversity and mitigate climate change.

NbS case studies and related MRV development

China in recent years have launched the so-called 'Full-array Ecological Protection and Restoration Project' with a total of 330 billion RMB investment covering four batches of 35 projects, the largest NbS campaign which has been placed at the global vanguard. Full array is defined as: 'Mountain, River, Forest, Field, Lake, Grass and Sand', and this plain wording is important because it is easier for the local stakeholders to grasp and identify with the term 'eco-restoration'. The campaign is highly diverse where ecological, blended and destroyed spaces are all targeted for protection and restoration. Systematic vegetation restoration along Yangtze River in Chongqing municipality and mangrove forestation in Shenzhen promoting blue carbon are typical cases in the ecological space. In both projects, carbon stock has seen steady rise and the number of black-faced spoonbills increased by more than 1.5 times during the course of the latter project. As the typical examples of blended space projects, land consolidation in Changsha County using novel low-carbon technologies and black-soil protection in Heilongjiang Province using the 'Lishu' Model. The Hunan project was evaluated to have made the first systematic attempt in low-carbon land consolidation with multiple ecological benefits, among which enhanced carbon sequestration capacity and reduced soil carbon loss in the protected area are prominent. The cultivated land carbon storage and soil carbon density could increase too by applying the Lishu Model, which achieves synergies between food security and climate change mitigation. Other projects in damaged space also promotes carbon stock and animal species richness as the main co-benefits of ecological restoration. These successful cases exemplify nature as the solutions to many climate-related issues.

In Europe, the Climate Smart Forestry (CSF) project which concerned itself with Catalonia, Czech Republic and Republic Ireland, adopted a silvicultural management approach that tries to maximise the climate-related benefits of forests by increasing carbon storage, combining mitigation and adaptation measures and using wood to substitute non-renewable carbon intensive materials in those places. Like the nationwide NbS campaign in China, several measures were applied but in simulations to project the corresponding climate benefits. Those measures include conserving carbon stock in old forests and on sensitive sites, activating and improving fire-prone forests management and protection, optimising silvicultural techniques to promote a carbon-efficient management scheme, and increasing the share of broadleaves to increase resilience to disturbances etc. Comparing with the baseline scenario, which means following current trends in management and harvest over the study of 50 years, an additional 7.4 MtCO2/y is achieved in the 4.1 Mha area in the three regions. While CO2 mitigation through biomass would decrease due to conversion and increased harvest, the losses are recouped more than threefold through harvested wood products (HWP) and substitution. It should be noted that substitution benefits are not accounted or reported in the forestry sector and these effects are particularly high in the textile industry. In this regard, the mitigation potential of surrogate materials is still underutilised. Investing forests and nature in general, as the true engine of sustainable economy while tackling climate issues is the core of NbS.

Assessing NbS projects such as those outlined above, requires establishing a well-accepted scientific approach, which is essential for upscaling. By following IPCC guidelines, monitoring, reporting and verification (MRV) of carbon emission by sources and removal by sinks, as part of the national GHG inventory, has been well-established. These guidelines have been regularly reviewed and subject to consultation to improve/update the methods, and in China they have been adopted even at subnational levels. However, in the face of NbS projects where anthropogenic changes in carbon stocks and non-CO2 GHG emissions/removals are concerned, MRV framework designed for national inventories might not be appropriate. In developing the MRV framework for NbS projects, principles of completeness, accuracy, conservativeness, transparency and verifiable should be complied with. Specifically, all sources/sinks under baseline and project scenarios within and outside project boundary must be accounted for while other categories with accumulated source/sink over 95% may be neglected. Monitoring system should be set up aiming to achieve 10% precision at 90% confidence level as a minimum standard. Conservativeness indicates that carbon removals in project scenarios or carbon emission in baseline scenarios should be underestimated or overestimated, where possible, based on completeness and accuracy. Importantly, from a scientific perspective, other elements in NbS projects such as boundary setting, stratification method, number of sampling and alignment should be verifiable, and results must be repeatable. As the basis for monitoring, sampling needs careful consideration. Number of samplings must be determined based on required precision level and spatial variability of carbon stock changes. In the meantime, sampling points should be preferably aligned systematically with a random start for the verification purpose. These principles serve as the scientific foundation of MRV framework for NbS projects, stakeholders including policymakers, regulators and scientists etc. are encouraged to engage with them.

Evaluating and modelling the climate-biodiversity duality

The complex interplay between climate and biodiversity and other components of ecosystems, at different time and geographic scales requires holistic modelling to elucidate the synergies and compromises between them and help us make more informed policy for tackling climate change and conserving biodiversity. Generally, as biodiversity increases so does ecosystem functioning, as biodiversity itself involves many variations including genes, species, and functional traits. A simultaneous assessment of carbon density and biodiversity potential allows identifying priority areas where biodiversity can be protected or restored while protecting carbon. IPBES harmonised modelling has enabled predicting the development of key biodiversity and ecosystem function indicators e.g. net exchange of carbon from ecosystem to the atmosphere, under different SSPs. The current modelling results suggest that there is a trade-off between nature and function, but it could be erroneous due to our inability to predict the future dynamics of NbS accurately. Current focus is on exploring ecosystems using mechanistic models such as the Madingley model and integrate process-based dynamic model.

At policy level, modelling is also a powerful tool to assess the existing strategies/plans in terms of their trade-offs and synergies, and how well they would achieve the biodiversity and climate goals. BIOCLIMA does exactly that by firstly reviewing a selection of land-use change, LULUCF emission/removals, biodiversity indicators and response models, and then national policies and their implementation in the EU. By improving the current models and updating the data associated, and linking biodiversity, carbon and land-use under combined climate and biodiversity policies, it is then possible to assess the interplay between these two realms, and design and evaluate the corresponding scenarios e.g. biodiversity assessment of climate policy scenarios. As a good example, by combining several models including PREDICTS, IBIS iBds, Farmland Bird Index model, best-of-class predictions for land-use and biodiversity response scenarios are generated in BIOCLIMA.

Knowledge and Policy Gaps

Based on the experts' reflection and exchanges on the current status of work in the EU and China, there are a few information and/or policy gaps identified that are important for better understanding and implementation of climate NbS, including:

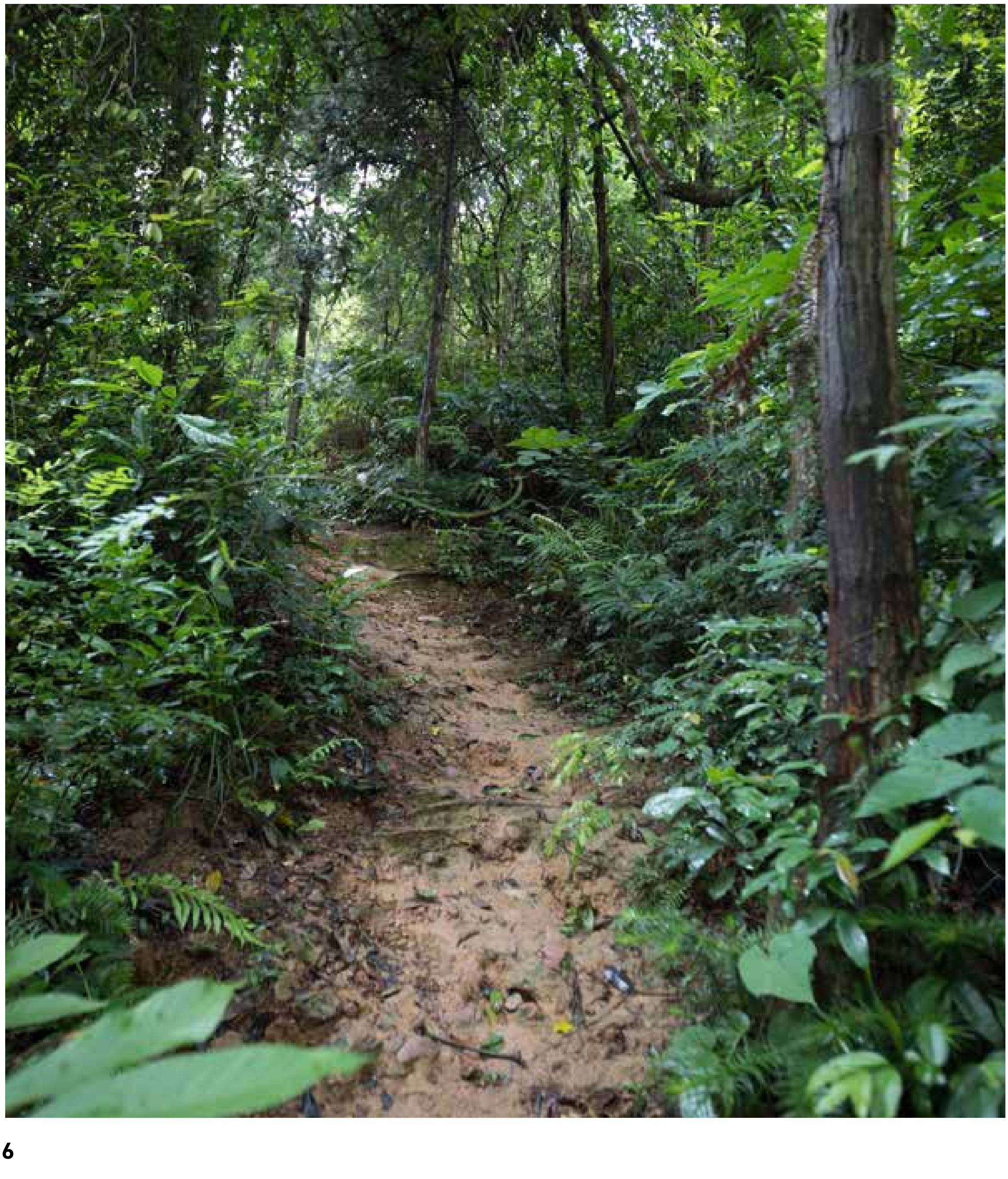
- When designing urban NbS, coordination with local stakeholders should be included in the overall scientific approach as their preferences are important for the sustainability.
- BOVC emission models and sampling methods need to be upgraded, and to combine the response to climate change with the protection of the atmospheric environment.
- The mitigation potential of using wood products as surrogate for carbon-emission-intensive materials should be further studied and scientifically incorporated in evaluation of afforestation/reforestation NbS.
- Trade-offs between carbon reduction and biodiversity targets, and between short-term and long-term goals need further examination.
- To maximise the benefits of NbS and understand the counterfactuals otherwise, a more holistic understanding of nature's role in ecosystem functioning is needed etc.

Next steps

During the expert dialogue, both sides expressed interests and willingness to scale up such effort in promoting exchanges and collaborations between the EU and China on climate NbS-related research. There are a few suggestions on next steps to take in this regard.

At urban level, between the EU and China, to integrate knowledge and evidence on benefits of NbS to address urban challenges and develop and test tools to guide, design and plan NbS. In terms of modelling, knowledge sharing of developed and EU-scale climate-biodiversity models with the Chinese side is desired and envisaged. On the other hand, informal discussions between governments on transparency, like this dialogue, are essential for building a robust biodiversity framework. To facilitate such activities, both sides should join force to design case studies such as REGREEN and BEF-China and coordinate with global targets at international level.

While helpful in furthering understanding of both sides regarding fundamental principles for NbS including monitoring, assessment, ownership, implementation and modelling etc., how to turn this theoretical knowledge into practical action is the most important step now. Since NbS is uniquely able to tackle both biodiversity loss and climate change in an integrated manner, the EU is eager to work with China on promoting the NbS agenda via more dialogues and mutual programs. In the meantime, China desires learning from the EU's experience and lessons from the EU specifically in regard to the experience with MRV and to develop its own in line with its national conditions, which would help manifest the multitudes benefits of the current and future systematic nationwide NbS projects.



Policy Recommendations

It is evident from the experts' exchanges that NbS would play an important role in climate actions portfolio while in some cases promote biodiversity conservation concurrently. Despite further research is needed, some policy recommendations were suggested:

- Promote NbS awareness and institutionalisation in education, governance, and planning. Impacts of BVOC emissions should be considered in parallel with climate change mitigation NbS in cities.
- Switch focus from monocultures to multi-species plantation in ecosystem restoration, when adopting afforestation/reforestation as an NbS. Meanwhile, the carbon offset potential of substitution of carbon-intensive materials with wood products should be gradually incorporated in the evaluation framework.
- Developing MRV system that aligns with national conditions and bases on scientific principles should be sped up, which would facilitate deployment of NbS projects.
- Government should endeavour to build a robust biodiversity framework like the Paris Agreement for climate, which can also provide insights into the relationships between climate and climate goals etc.

PART III
Expert Dialogue 3: Climate actions in the land sector: carbon removal and sustainable sinks

Summary of the workshop

The third workshop in the 'EU-China Cooperation on Climate Mitigation and Adaptation in the LULUCF sector' framework, was successfully held on the 16th September 2021 in hybrid form with the participation of EU experts online and Chinese counterparts on-site in Beijing. Both sides presented their research and exchanged their views on the important role of land sector plays in climate mitigation and adaptation, reflected on the relationship between soil carbon and biodiversity. The focus was placed on two main topics:

1. Modelling of carbon stick/flux on land and due to land-use change

2. Natural and sustainable carbon sinks on land. Experts from both sides also expressed collaboration intents in identified areas.

The dialogue was composed of two sessions of the above two topics and structured to address mainly the following questions:

- What is the state-of-the-art in modelling land carbon and how to deal with the technical challenges associated with different types of land and GHG?
- What are the implications for land sector policy-making in the face of climate change from the modelling results?
- What is the carbon sequestration potential of plantation as a natural carbon sink and what are the contributions of soil management?
- What are the main mechanisms of increasing natural carbon sink and its co-benefits on biodiversity?
-

During the workshop experts from both sides reflected on the following issues:

- The SIEUSOIL and STARGATE projects and related intelligent planning for sustainable soil and microclimate management
- The identification and distinction of soil organic carbon saturation deficit in China under different forms of land use and measures to increase the stock
- The modelling framework GLOBIOM-G4M for estimating LULUCF emissions and removals in the EU
- The N2O emission from agricultural sector in China and its trend
- Monitoring the carbon stock based on land-use change activities in forestry and grassland system
- The significance of soil organic carbon stock in climate mitigation and adaptation
- The management strategy for increasing soil organic carbon stock potential in the EU
- The nationwide ecological restoration campaign in China and its positive impact on increasing land carbon sink
- The necessity towards an integrated climate-environment approach in the AFOLU sector, taking biodiversity into consideration
- The importance of verifiable measurements, transparency, and cooperation in the LULUCF sector internationally

Current Status of work in the EU and China

Soil organic carbon (SOC) and its impact on climate mitigation/adaptation

Soil contains about twice more carbon (in organic forms) compared to how much the atmosphere does, making it the largest carbon stock in the terrestrial ecological system. Land-use change, however, can lead to emission of carbon from the soil. Therefore, soil can act as both a source and a sink depending on the particular land-use contexts. The challenges hence lie in carbon storage as well as sequestration potential. While the former usually refers to the gain in carbon reachable in soil, the latter specifically concerns itself with the allowance for removal of CO2 from the atmosphere.

The '4 per 1000' initiative launched by France aims at increasing SOC by 0.4% annually to offset the GHG emissions due to human activities through science, management, good practice, and cooperation. In China where there are a wide range of ecologically vulnerable areas, the idea behind '4 per 1000' is especially relevant in increasing SOC stock and contributing to the 2060 carbon neutrality goals. To scientifically increase the soil carbon stock, a solid understanding of the SOC saturation is imperative in that extra organic matter input will not bring about increased carbon stock if the soil carbon pool is already saturated. SOC saturation deficit model has been developed in China to assess the difference between the maximum content of potential SOC and the actual content. As a dynamic modelling approach, different climate change scenarios and land-use related vegetation productivity factors are specifically incorporated, and well-established models such as CENTURY and ROTHE are combined, to evaluate the impacts of climate change and land-use change on SOC saturation deficit across China. Selected areas in 11 provinces and regions have been analysed. Generally, in northern China forestry soil contains much higher SOC but is of lower added sequestration potential for having lower saturation deficits. For both types of land-use types, soil in deeper layers is associated with higher deficit values. For grassland, taking Tibet for example, SOC content is prone to tillage activities. A mapping of SOC and deficit spatial distribution in Yunnan province reveals that the variation varies significantly with geographical locations hence a one-for-all approach for increasing SOC is untenable. Analysis of different types of forests in southern China also shows noticeable variations across different species for SOC and saturation deficit, indicating land-use dependent solutions for adding SOC hence mitigating climate change. Therefore, to increase SOC and preserve current soil carbon pool requires case-dependent solutions and building a reliable database is an essential for such practices.

The '4 per 1000' is not only a climate mitigation initiative, increasing SOC could also realise its potential to ensure food security and ecological security such as by increasing water infiltration and reducing superficial water loss, and by increasing crop yields until it plateaus as well as minimising inter-annual yield variation. Both aspects are important indicators of climate adaptation. The maximum potential can be defined as SOC stock in pristine land-use conditions i.e. biophysical storage potential while what we can achieve by techniques e.g. cover crops and agroforestry is the technical storage potential. Similar to the maximum potential calculated in the models developed in China, these provide a benchmark for our understanding of climate potentials of SOC. Case studies and research in France demonstrated the usefulness of applying a data-driven approach, where existing monitoring network and data can suggest what is achievable hence the management options for farmers and landowners. In France, models aiming for 4 per 1000 that calculate and project SOC changes based on the current simulated baseline (data-driven) can identify and quantify the additional carbon storage in soil: in 30 years combination of practices would offset 17% and 40% of national and agricultural emissions, respectively. On a wider European scale, a project estimating the technical carbon sequestration potential involving 23 countries (CarboSeq) is underway using both European and national datasets. The model is also capable of evaluating the economic potential of different practices, which is essential for incentivising farmers and landowners to implement the corresponding measures.

Low-carbon campaign and monitoring & modelling in China

On agricultural lands, such as cropland, N2O emission from the soil is a more prominent GHG source which constitutes approx. 50% of the global emissions. In 2010s, China accounted for approx. 20% of the global total and still rising. Given that N2O's greenhouse effect is about 300 times that of CO2, a close monitoring and modelling, and corresponding curbing of its emission are highly urgent on climate action agenda. More than 800 data records from N2O observation network, N application rate data from nation-scales surveys and time-series of municipal-scale irrigation rate data from provincial surveys, provided the core data needed for modelling the N2O trend from 1990-2014 in China. While the modelling results suggest a turning point of N2O emission in the year 2003 (after calibration) in that the increase of emission slows down considerably, we are further able to identify the causes thanks to the embedded attribution of the drivers. Noticeably, the decline in application rate of N-fertilizer for maize, wheat and paddy rice outweighed the expansion of sowing and all other environmental factors, bringing about the slow-down in N2O emission nationwide. The comparison with other N2O data inventories e.g. EDGAR highlights the importance of using high-resolution spatially explicit data for capturing reliable cropland N2O emissions, from which increasing nitrogen use efficiency is considered the most effective method for limiting future cropland N2O emission, in the premise of ensuring food security.

The need for reliable and scientifically sound data to assist climate actions and promote international cooperation, has led to other nationwide carbon monitoring programmes in China due to land-use change activities. The monitoring of carbon stock in forests, grassland, wetland and harvested wood products is indispensable not only for fulfilling China's international climate obligations i.e. IPCC GHG inventory and MRV system, or participating in international climate governance, but crucial for meeting China's own climate and environmental requirements in terms of sustainable development, as well as supporting ETS and CCER platform where voluntary certified emission reduction will inevitably be incorporated. China established the Forestry Carbon Accounting & Monitoring Centre back in 2009 under the National Forestry and Grassland Administration. Since then, research and monitoring pilot and special investigation have been carried out. After the first national forestry carbon sink monitoring effort with 16393 sampling plots, in 2020 a normalised monitoring analysis of forest and grass carbon sink was established with timely carbon sink data production capacity. Closely aligned with UNFCCC requirements and IPCC inventory guidelines, the monitoring framework is being established following the principles of integrity, integration, continuity, comparability. and accuracy. As a core element of the monitoring framework, forest and grass carbon sink activity level data were calculated by applying the forest and grass land-use change matrix (IPCC) from prior zoning and 1996-2016 protection and restoration national statistics. The final results are obtained by multi-stage, multi-level, province-based measurement and statistical analysis. The 2014 data (newest 2016 data are subject to official approval) shows about 9% of the GHG emission was offset by forest and grass sink with 1.63 tonnes increase in stock per hectare stock, despite the unit biomass carbon stock is still below world average. This is where great potential lies in terms of increasing carbon sink in the LULUCF sector.

Indeed, there have been a multitude of ecological restoration and low-carbon land consolidation projects launched in China in recent years. As mentioned in the sections above, ensuring ecological security usually has climate benefits by increasing carbon stocks in soil and plantations on land. Among them, three zones and four belts in China covering mountains, rivers, forests, fields, lakes, and grasslands were identified to form a nationwide ecological protection and restoration map. In terms of the technology, a comprehensive package from carbon source/sink identification method, low-carbon land consolidation engineering technology system, carbon source/sink measurement system, has been developed and trialed. Noticeably, following the consolidation procedure, remote sensing combined with field monitoring showed that an average 0.02t/Ha increase in carbon stock and 0.06t/Ha reduction in soil carbon emission in trialed maize field were achieved. Trench lining and mud stone pavement technologies saved carbon emission during construction and increased carbon stock e.g. about 50 tons per year in the Hunan demonstration area. Such practices have been applied in 6 provinces and covering nearly 300 thousand mu[1] area, the outcome of which was peer-reviewed and regarded the world's first large-scale low-carbon land consolidation project.

EU-wide integrated modelling and practice in LULUCF

In the EU, there is a more integrated action plans for climate targets including for the LULUCF sector. Correspondingly, set up by the European Commission, there is also a modelling framework to assess the impacts of climate change and energy policies across sectors. GLOBIOM (Global Biosphere Management Model) is part of the framework focusing specifically on land-use and forestry, but also connected to the energy sector in an integrated manner. In addition, as the name suggests, trade, markets and demand/supply chain are integral parts of the model to assess the welfare in the corresponding land-use sectors. The model was refined for the EU and its modelling capability for land-use and forestry benefitting from

[1] 1 mu = 666.7 m^2

the data richness and availability in/for the EU. For example, for the agriculture component EUROSTAT replaced FAOSTAT for production/consumption and NUTS2 was used to provide spatial resolution within the EU countries. Such modelling capabilities were compounded with the G4M (Global Forestry Model) to provide information on changes in forest area and management, and impacts of management policies and carbon price, as well as carbon sequestration potential. EU Climate Impact Assessment has been using the results from GLOBIOM-G4M modelling, featuring EU Reference Scenarios, the 2050 Long-term Strategy and the 'Fit for 55', among others. MAC curves from the GLOBIOM-G4M modelling suggests minimum compliance with the current LULUCF regulations are outperformed for the 2030 targets at no additional costs (Fit for 55) and the assigned land-sector's contribution to the 2050 neutrality target at the 5-10 EUR/tCO2e is within grasp. The mitigation option functions embedded in the model are also enabling assessment for land-use impact of mitigation pathways, informing policy making to reach climate neutrality.

The 'Fit for 55' is not only a climate agenda but a holistic blueprint for the transformation needed across the economy, society, and industry to reach 2030 reduction and 2050 neutrality goals, taking also explicit considerations of other environmental parameters. In addition, AFOLU sector, that is 'LULUCF + Agriculture' should be climate neutral by 2035. To assess the impact of EU and member state (MS) policies, the EEA is to set up and develop a thorough MRV system in which each MS reports land management and corresponding GHG emission trends. These reporting will then be checked by using in-situ and satellite data for verification and going through quality control processes organised by the JRC, EEA and EUROSTAT. The major challenges lie in the interplay between other policies and land management choices such as Renewable Energy Directive, Biodiversity Strategy and Common Agriculture Policy. The synergies between these policies need to be carefully assessed and understood to avoid different measures leading to conflicting goals e.g. increasing carbon sequestration causing biodiversity problems. At the moment, activities in the AFOLU sector are an important source of pressure on biodiversity i.e. 21% for agriculture, 11% for forestry and 13% for urbanisation, hence positive impacts on carbon storage by nature restoration should be and can be explored. For another case, many climate adaptation measures outlined in the Climate ADAPT are beneficial to biodiversity: crop, livestock, viniculture, and horticulture production adaptation can increase soil quality hence biodiversity. An integrated perspective on agriculture, forestry and land-use is needed and being developed.

Knowledge and Policy Gaps

Based on the experts' reflection and exchanges on the current status of work in the EU and China, there is some information and/or policy gaps identified that are important for better understanding land sector's contribution to climate, how to increase carbon removal and sustain carbon sinks on land, including:

- Enabling environment is required for farmers to implement practices to increase SOC stock. In the meantime, interactions between SOC sequestration and biodiversity need further research and knowledge.
- Dynamic monitoring technology would be key to informed policy making in land-use. This will depend on the existing natural resource survey and monitoring system, and evaluation and monitoring of the related carbon sink which need further work.
- Defining the policies of and monitoring the synergies between climate mitigation and other, noticeably environmental protection, measures must be established to ensure climate actions are not jeopardizing other ecological systems.
- Independent verification of LULUCF carbon sink, and consistency between national GHG inventories and global models (e.g. IAMs) are lacking. They can lead to large gaps between different sources hence confusing for policy makers at national and international levels.

Next steps

During the dialogue, both sides expressed interests to scale up such effort in promoting exchanges and collaborations between the EU and China on climate actions in the land sector. More importantly, the urgency is recognized and shared among all parties in that concrete actions are being brought forward. There are a few suggestions on next steps to take in this regard.

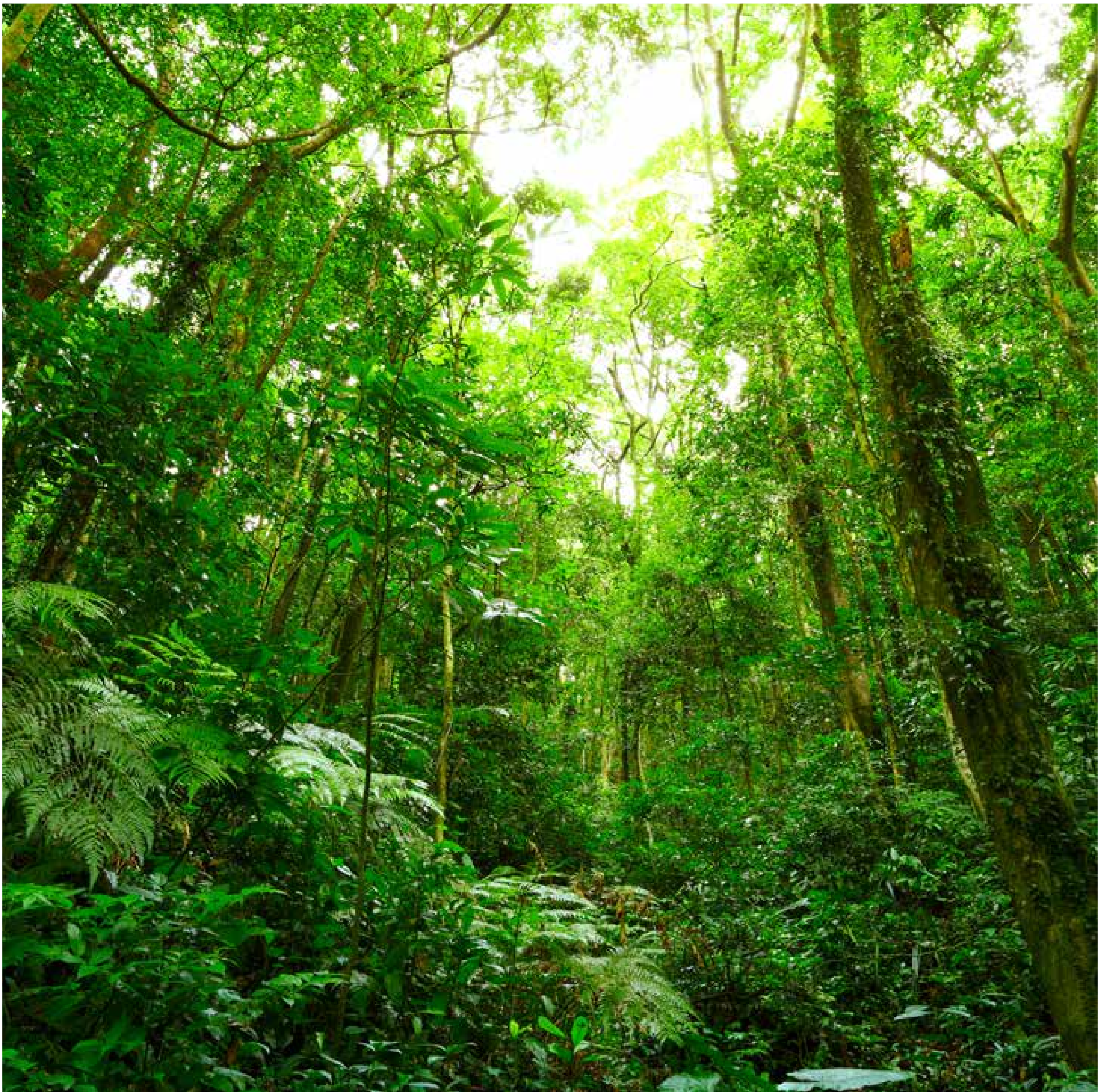
On the note of agricultural land management, projects between the EU and China already exists for promoting intelligent land-use and farming practice for sustainable soil, in production and climate terms. The tools based on a multitude of data sources being developed to inform farmers with microclimate information in short- and medium-terms are gaining credibility and are reaching out to farmers for smart farm management. China is eager to develop similar tools for climate mitigation and keen to learn and collaborate with the EU.

For the important SOC sequestration topic that was extensively discussed in both sessions, both modelling and experimental approaches should be strengthened in the EU and China. The technical aspects of mineralogy, oversaturation and biodiversity concerns can be incorporated into the current modelling approach while the wide and broad data gathering/monitoring capacity can be implemented in the EU as well. Aside from technical details, more collaboration opportunities lie in the area of standards and methods. These include updating IPCC LULUCF models with more land-use types with contributions from the Chinese side, unifying definitions of manmade and natural forests between the two continents, taking experiences from each other on consolidating indicators and targets when working across climate and other environmental issues.

Policy Recommendations

From the experts' presentations and exchanges, it is clear that the land-use sector, that is AFOLU, could make significant contributions to climate mitigation and adaptation both in the EU and China, while some measures on land could have synergic effect with biodiversity conservation. Despite further research is needed, some policy recommendations were suggested:

- To increase soil carbon sequestration, agroforestry management should be strengthened as part of the land-based response to climate change. Economic factors should be considered in the corresponding policies.
- Carbon stock in forest and grass in China can be increased. The focus should be increasing the quality of the biomass with precision, such as promoting fostering and restoring secondary forests and pastureland rehabilitation.
- Keep reducing N-fertiliser application and increasing the nitrogen use efficiency are the key measures to reduce N2O emission from croplands while ensuring food security.
- International community should be cooperatively working on method consolidation in LULUCF GHG monitoring to increase confidence and enable realisation of nature-based solutions' potential, as well as clearing confusions for policy makers.



Conclusion

Climate change and biodiversity loss are mutually reinforcing emergencies and closely interconnected threats. Climate change is indeed one of the main drivers of biodiversity loss, while biodiversity loss and ecosystem degradation contribute to the problems of climate change both through rising greenhouse gas emissions and weakening of carbon sinks and stocks or increased vulnerability to climate impacts.

Just as the problems are related, so are the solutions, and therefore climate change and biodiversity loss need to be tackled together. A large number of scientific studies, including the recent reports from the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), highlight the importance of linking biodiversity protection and restoration, emission reduction and carbon sequestration, and adaptation to climate change. These studies also highlight the importance of better understanding of the synergies and trade-offs between biodiversity conservation and climate action to better guide policy actions. These issues focus on the agriculture and land sector, which is at the intersection of multiple sustainability issues, are increasingly becoming key sectors in climate and biodiversity strategies. This growing importance implies the need for enhanced quality of monitoring and modelling in these sectors becomes more prominent.

The discussions conducted throughout 2021 under the EU-China expert dialogue series have demonstrated the potential of agriculture and land sectors as a source of solutions for biodiversity conservation and climate action. Protecting, restoring and enhancing the climate resilience of carbon-rich ecosystems such as forests, grasslands, wetlands, and peatlands; deploying urban green and blue infrastructure; promoting sustainable land management, including agroecology, agroforestry, and sustainable forest management; improving soil health; these are all solutions that will help mitigate and adapt to climate change while reversing biodiversity loss. Thanks to advancements in land monitoring and modelling technologies there are abundant opportunities to document, implement, and evaluate more ambitious land and agriculture policies for achieving climate neutrality and reversing biodiversity loss.

The work also showed that these solutions, often referred to as "nature-based solutions", are essential for the EU and China, both for their domestic actions and for their international climate and biodiversity commitments. Under the framework of the strategic partnerships for the implementation of the Paris Agreement (SPIPA) with China, this dialogue series shows the vitality and prospect of the long-standing cooperation between the EU and China to further step-up joint efforts and contribute to improving awareness.

The outputs from these expert dialogues are a valuable source of information to guide the continuation and strengthening of EU-China cooperation on climate and biodiversity. The continuation and expansion of these works are particularly relevant in the light of the latest announcements of the EU-China High-Level Environment and Climate Dialogue, in the run-up to the COP 26 of the United Nations Framework Convention on Climate Change, in Glasgow and the COP 15 of the Convention on Biological Diversity in Kunming. A concrete follow-up to the work carried out so far could take place with the EU-China flagship on biodiversity and climate change, as part of the 2023-2024 work programme of Horizon Europe.

Directorate-General for Climate Action, European Commission