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Knowledge gaps to manage Caucasian forests: What do Georgian forest scientists and foresters want to know and how to answer such questions?

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Abstract

First, we introduce to the forest sector of Georgia and to the Caucasus region. During a forest research sector conference in 2020, questions were raised by Georgian forest scientists to identify important knowledge gaps of the forest research sector. Nine IUFRO divisions served well to summarize these into 20 important questions presented here. The questions were divided into forest management-related questions, questions that require multi-disciplinary approaches, and those questions related to forest policy. Also, the IUFRO classification was helpful to distinguish between biodiversity research and forest sciences. The questions were ranked by forest practitioners in terms of their importance at work. Climate change, forest landscape degradation, forest productivity, assessment of ecosystem services, and employment were ranked the highest among the practitioners.

These questions were briefly discussed. The collected questions could also serve in the future to derive a public forest research agenda. By this paper, we aim to streamline applied research and raise interest to explore this scientific discipline. The need for well-educated foresters and forest researchers will not diminish in the next decade. Many challenges will occur in other European countries as well, and Georgian forest scientists would benefit from international collaboration in the forests rather than on paper.

Keywords

Forest sector; forest sciences; IUFRO, capacity building; Georgia; knowledge gaps.

Introduction

Georgia is located between the Greater and Lesser Caucasus Mountain ranges with

highly diverse landscapes and climatic conditions from very warm, wet summers in the Colchic lowlands to short, cool summers in the high mountains (Zazanashvili *et al.*, 2000; Schäfer, 2003). Average elevation of the country is 1.432 m a.s.l. Compared to other countries in Europe, a large proportion of forests are largely inaccessible for management due to the poor network of forest roads, rough terrain with steep slopes and erosion risks in the mountains (Lomsadze, 2019). More than 40% of forest cover in Georgia is different from the neighboring countries of Turkey, Armenia and Azerbaijan (Akhalkatsi *et al.*, 2010; UNECE, 2019). Georgia is listed with two global biodiversity hotspots (Olsson *et al.*, 1998). Some parts of the forests were a refugium for tree species during the last ice age that resulted in high biodiversity conservation values (Dolukhanov, 1980).

Most forests grow in temperate climate, dominated by Oriental beech but also various oak and hornbeam species in lower or coniferous trees in higher altitude (Nakhutsrishvili, 2013; Novak *et al.*, 2020). Georgian forests contain 400 wooden species (Gigauri, 2000). Half of the forest are beech forest types (*Fagus orientalis* Lipsky). Forest types with Caucasian fir (*Abies nordmanniana* Spach.) and Oriental spruce (*Picea orientalis* (L.) Link) cover about 15% of the forest area. Oak forests cover 10% (seven oak species according to Ekhvaia *et al.* 2018), and pine (varieties of *Pinus silvestris* L. syn. *Pinus sosnowskyi* N.) about 4% of the forest area (Nakhutsrishvili, 2013). Most forest stands are uneven-aged after selective cuttings or untouched. They

contain a larger proportion of mixed tree species, deadwood and high biodiversity conservation values compared to European beech stands (Urushadze *et al.*, 2011). Contrary to central European forest management regimes, elective cutting of large trees with good quality can result in a higher relative proportion of deadwood compared to untouched old-growth forest (Wolff, 2021). Closer to settlements, low and high coppice are still common practices.

The collapse of the Soviet Union and subsequent economic recession in Georgia, socio-economic and political changes had significant impact on the forests (Sayadyan *et al.*, 2006; Dear *et al.*, 2012; Quinn, 2017), however there is still a knowledge gap about impact drivers (Cortner *et al.*, 2022). Degradation in the Caucasus can be both legal and illegal domestic fuelwood extraction, which increased 250% after independence, with the majority of the increase occurring after 2000 (Garforth *et al.*, 2016). A considerable part of accessible forests became heavily exploited in the vicinity of villages (Beil, 2019). However, some of these forests regenerated naturally and are now young forests where a first thinning could be applied.

Before the Republic was founded in 1991, a strict top-down decision process related to the forest management system was applied to assure future wood supply in the Soviet Union. In the Georgian Soviet Socialist Republic (1922-1991), 2 million m³ of wood (including wood for heating and cellulose) were annually imported during the 1980ies (SFA, 1990). Most of the forests fulfilled

primarily protective functions rather than wood production, while manganese, subtropical fruits, and wine for export and tourism have been economically more important.

The economic decline after the collapse, a war and governmental changes weakened the forest sector. Nowadays, the top-down approach is less strict and developmental aid wants to promote sustainable forest management and protected areas locally and at landscape level. However, the country is lacking forest specialists who are 30 to 60 years old to implement ambitious development plans. Beside forest planning and silvicultural skills, the management goal for a particular forest is sometimes lacking. 76% of the forests are managed by the National Forestry Agency, 6% by the Adjara forestry agency, small proportions by a few municipalities and the church. Only a tiny proportion is private (mostly very young forest on abandoned fields where succession took place). Protected areas are managed by the Agency of Protected Areas (11% of the total forest area, (Geostat, 2021)).

Forest is the main source of income (45%) in villages located in forests where half of the people live with a revenue below the National poverty line of 130 GEL (\$40) per month (World Bank Forests, Livelihoods, and Poverty Linkages in the Forest Communities of Georgia, 2018). For 2010, Garforth *et al.* (Garforth *et al.*, 2016) estimated that 75% of harvested trees was cut illegally. The annual demand for firewood is estimated to be 2-3 million m³ (Garforth *et*

al., 2016). The legal sector is still struggling with the bad image of the forester's profession and recruitment of forest experts, while the top-down forest administration is transforming to serve their administrative tasks and improve control. Still in 2020, there were forest districts where forest management bodies were not in control of tree cuttings while combating illegal harvest was more successful in other regions. Currently, each family receives vouchers for 7 m³ of firewood. In the mountains, families get 15 m³ firewood per year. Until 2022, the logging was carried out by local private companies. Such logging interventions were typically carried out by the driver of an old Russian truck with four-wheel drive and a logger with chainsaw who enter the forest in the morning and stop the truck close to the tree after 2-3 hours of driving in the mountains. Regardless wood quality, the tree is often cut into firewood lengths, manually loaded on the truck, and the same day unloaded in front of the customer's yard. After 2022, only forestry agencies are supposed to carry out harvest interventions which remains a huge challenge in many places.

Study context

In the past, forest management bodies in Georgia aimed primarily to maintain and protect forest, while foreign development aid and some NGOs push them to improve sustainable forest management. Competing universities and different NGOs are carrying out studies (often desk research) to back up nature conservation, environmental or forest policies. After 20 years, we can

sometimes find contradictory conclusions after similar research which causes problems to govern and manage nature and forest resources. It also hampers the development of a stronger forest research capacity needed by the sector.

Forest ecosystems are complex, especially with the human interventions. Research methods became more advanced. A long time ago, single scholars could cover almost all forestry subjects (for instance in Central Europe 200 years ago). Nowadays, the website of the International Union of Forest Research Organizations gives an overview about the spectrum of modern forest sciences (www.iufro.org/science/divisions). Currently, there are several universities, NGOs, companies and governmental organizations in Georgia who carry out some research, while the Department of Forestry of the Georgian Academy of Agricultural Sciences is supposed to coordinate forest research activities. In May 2020, the Academy and forest research institutions organized the first online workshop 'Forest research potential in Georgia and perspectives' in Georgian language to present good examples of forest research and share the existing knowledge. Major forest research institutions were the Agricultural University of Georgia, Ilia State University, the Georgian Technical University, Telavi State University, Botanical garden of Batumi, and the Agroforestry Research Division of the Scientific-Research Center of Agriculture. By this workshop, we collected, synthesized and translated the most important forest research questions formulated by Georgian forest scientists.

Objectives and methods

The goal of this paper is to present the important questions raised by Georgian forest scientists and highlight possible differences between the forest research community and forest practitioners. Also, we tested how useful the nine IUFRO divisions are to cover various research questions that came up during the workshop. We test if they could help as a framework to coordinate forest research in the region. The latter includes the potential to derive a forest research agenda and install mechanisms to avoid parallel studies of researchers working on the same topic without communicating to each other while research resources are very limited.

After all, we strive to streamline applied forestry research in the Caucasus for the next decade with the intention to start perhaps an own National forest research program funded by international donor organizations. At least, we want to provide a catalogue of important forest research questions of the region anchored in the Georgian forestry sector rather than in confounding policies from abroad. Hence, this paper may also contribute to improved proposal writing that can adopt better the actual situation. We intend to highlight the importance of forest sciences for the Caucasus region to succeed with the ambitious forest and nature conservation policies.

Questions by Georgian forest scientists

All Georgian research institution who carried out forest research and stakeholders interested in future forest research were

invited to a scientific online workshop on May 4, 2020. Four universities (3 state and 1 private university in Tbilisi and Telavi), the governmental Research Centre of Agriculture, and the Botanical Garden in Batumi participated. Working language was Georgian. We asked all workshop participants to provide a list of the 5–10 key questions about future forest research to identify crucial knowledge gaps that hamper the implementation of sustainable forest management in practice (preferably in the form of an interrogative sentence). 19 respondents representing the forest research sector provided 60 questions (Fig. 1). Half of the respondents were 31–60 years old, two respondents were older than 60 years. Only 5 respondents were female. The largest fraction of respondents were researchers (8), followed by NGO representatives (6), the Adjara and National forestry agencies, and the Ministry of Environmental Protection and Agriculture (4).

Each question was classified by the authors into nine broad themes according to the nine IUFRO divisions (www.iufro.org/science/divisions/). Respondents also were asked to rank these divisions and share their own research (namely list of publications, coordinates and contact person of field trials).

The classified questions were validated by a group of forest practitioners representing the National forestry agency, the Georgian Ministry of Environmental Protection and Agriculture, Global Forest Watch, and a free-lanced forest consultant. Questions within each theme were then combined

(when overlapping) and rephrased by this group (if they were unclearly formulated or related to a very specific study). The list of questions was shared with all workshop participants to comment on the new questions, asking if their original question is still sufficiently covered. Not participating researchers were asked by an additional email with this list of questions to participate in the questionnaire survey, with time to response within one week. Finally, we interviewed two representatives from each forest research institution to check terminology and accept the final questions.

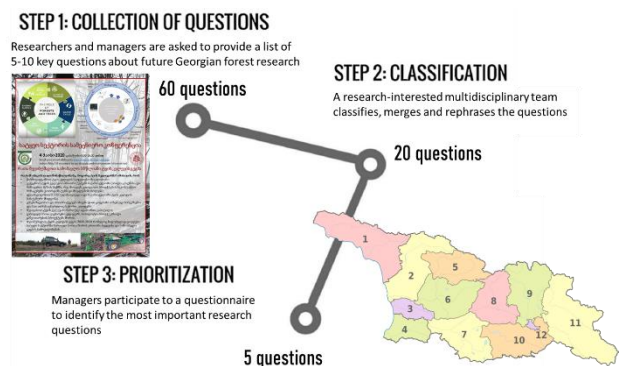


Figure 1. Schematic representation of the participatory process conducted with Georgian forest scientists and forest managers for the selection of the 5 questions used to structure the review. The country is divided in 10 administrative forest regions (with Tbilisi and the occupied areas Abkhazia and South Ossetia).

Questionnaire for forest managers

In a second step, we visited local foresters across all nine administrative forestry regions of the country and asked them to rank the formulated questions according to their relevance for forestry practice. Semi-

structured in-depth interviews were conducted with a minimum of two foresters from each region. In total, 52 foresters participated. The choices for answers ranged on a 5-point Likert scale from "not important (0)" to "I cannot work without it (5)". Responses with "I don't know" were not ranked. Then we ranked average scores of each question that we present below.

Results and Analysis

Questions formulated by Georgian forest scientists

Table 1 shows 20 summarized questions translated from Georgian into English language. The nine IUFRO divisions offered a logical framework to classify each of the 60 raised research questions, only the two divisions 3 (Forest operations, engineering and management) and 4 (Forest assessment, modelling and management) had an overlap related to forest management issues in between the sphere of operational forest planning, large-scale inventory and remote sensing. All divisions were covered, more than half of the original questions related to division 4, 8 and 9. General agreement was achieved about the knowledge gaps regarding tree species ecology and forest restoration measures in degraded forests (division 1). Other divisions were addressed by 1 to 2 out of the totally 60 questions. During the participatory process, the research community as well as practitioners appreciated the wording and translation as an efficient learning process. Foresters expressed their will to address such questions by joint field

excursions in the forest regions, and learn from each other.

The first seven questions reflect silvicultural and forest management-related topics. Question 8-15 point towards more multidisciplinary research approaches that are needed to advance forest sciences. Questions 16 to 20 are challenging the scholars in forest policy and forest economics as both are interwoven with each other.

Questions 2, 6, 7, 17 and 19 were highlighted by practitioners and are explained in the next section.

The highest ranked questions by forest practitioners

The section starts with the two highest ranked question (same score).

Q. 7 What is the impact of climate change on forest productivity and carbon sequestration potential?

The question aims at understanding how climate change can impact different forest types in Georgia. Generally, climate in Georgia depends on distance from the Black Sea and the orography of the Greater and Lesser Caucasus. While an increase of temperature was reported for eastern Georgia, a decrease during recent decades was reported in the west (Amiranashvili *et al.*, 2011-2012). For the future, a moderate increase of precipitation is expected (Nurtaev & Nurtaev, 2016). Depending on solar irradiance, a temperature decrease is expected by Nurtaev and Nurtaev (Nurtaev & Nurtaev, 2016). However, local climate

expectations and extremes are ambiguous, and forests may suffer from drought or heat also in Georgia. Regarding specific forest types, the evolutionary heritage and ecological uniqueness of pine and sweet chestnut are at risk (Dering *et al.*, 2021; Beridze *et al.*, 2023). Also, there have been debates about the transition of sub-alpine meadows to pine forests, however empirical evidence is lacking (Akobia *et al.*, 2022).

Q. 11 How adequate are the measures against existing pest-disease problems (incl. sufficient management guidelines)?

Sanitary cuttings are popular in Georgian forestry. Basically, every sick tree regardless species can be cut, if not on the red-list. Frequent forest protection measures are fighting bark beetles and measures against the Sweet chestnut disease. Bark beetle outbreaks occur across the country in conifer-dominated forests (mostly *Ips sexdentatus* and *I. typographus*). Despite limited forest access, large efforts were taken in the central and western forest regions of Borjomi and Adjara to harvest freshly infected Oriental spruce and remove the bark from logs. Bark beetle traps were also used to monitor bark beetle population. Sweet chestnut disease can be partly treated, for instance by injecting a hypovirulent virus in small wounds of infected young trees (there are international studies with Georgian scientists, e.g. the works of Supatashvili A. and Tavadze B., see (Rigling *et al.*, 2018)). With existing pilot studies, the experience by the forestry agency and planned activities to fight pest-diseases are a good basis to study

the efficiency of such measures in the field over years.

Q. 19 How could the forestry sector provide additional jobs (i.e. green jobs), especially through encouraging interns and researchers developing innovative business fields?

This is a forest policy and economic question, but covers also social aspects of forestry important for rural development. Before exploring new business ideas, existing core forestry business like the provisioning of firewood and construction timber, forest planning, and planting of trees bear large potential for improvement in Georgia. Site assessment and planting of site-adapted tree species (i.e. fast-growing tree species for biomass production in humid climate, Black locust or native chestnut to produce durable fence posts in wine regions, or pioneer tree and shrub species to prevent erosion in the mountains) are a long-term investment requiring knowledge, skills and labour ("green jobs"), but contribute considerably to sustainable rural development. Forest researchers can contribute by planting trials testing various tree species, proveniences and tree species mixtures (i.e. native *Pinus silvestris* from different regions), recording climate (i.e. precipitation, air temperature, soil moisture) in forest stands where seeds of drought-resistant tree species can be collected and sold for scientific test trials in other countries. - Furthermore, stand inventories and silvicultural planning to manage uneven-aged forest and tree species mixture require knowledge, training and labour, but management of forest can be profitable and can improve both natural

values within a decent time to start-up forestry business. Apart from improved forestry equipment and labour safety, more innovative business ideas should also consider a) the IT development of the Georgian land-use sector, b) less constraints on privacy protection and c) higher flexibility than in western European countries. However, regulations to manage forests are currently difficult to follow which hampers start-ups and leads to other business fields in agroforestry and landscape restoration - outside the area of the National forest fund.

Q. 17 How to monetarily evaluate forest ecosystem services?

Ecosystems can be seen as part of our natural capital, while ecosystem services can be considered as the “interest” on that capital (Constanza & Daly, 1992). The economic value of ecosystem services is a quantitative measure of the contribution of these services to human wellbeing (Pascual *et al.*, 2012). Expressed in monetary units, it allows to economically compare the total value of ecosystem services versus other economic values, notably offered by infrastructure development. - There are many forest ecosystem services and different evaluation methods. In a first step, these services need to be specified and prioritized. Forest functions may serve for the latter and to gain an overview. We suggest to split forest ecosystem services into three groups: 1) ecosystem services quoted in the market like raw wood, food, medicine, water, soil protection and carbon sequestration, 2) ecosystem services that may or may not be quoted by the market: tourism and

recreation activities, and 3) ecosystem services that can be quoted by the willingness to pay or willingness to accept like forest landscape. However, the value of such goods and services can increase dramatically when becoming scarce (water, red-listed species, timber). Cost-benefit analyses are another mean to list all possible forest ecosystem services and risks before a decision is taken.

Q. 6 What is the productivity of the forest (both, wood and net primary production)?

The net primary production (NPP total = aboveground + belowground) of a forest consists of the accumulation of stem wood in standing trees plus the growth of all the other tissues or components including those that are short lived (Ruimy *et al.*, 1994). Georgian yield tables of Oriental beech and other tree species made by Gigauri and Dzebisashvili (Gigauri *et al.*, 1990) indicate a similar range of site qualities and wood production as Central European yield tables of beech and oak. Also, Iranian and Romanian studies in Oriental and European beech stands show a mean annual increment of wood of 4-9 m³ ha⁻¹ (Bayat *et al.*, 2021). To support these growth estimates or prove them wrong, a stand growth analysis by the extracted increment bore cores of single trees of the recently finalized first National forest inventory of the country would be an important research task: first a regression to calculate radial growth per tree species and tree size, and secondly using the regression functions to calculate stand growth. Also, permanent study plots as established by Wolff (Wolff,

2021) or Pretzsch *et al.* (Pretzsch *et al.*, 2019) in Georgia would be valuable in the future to validate growth models. Very low yield can be true in old traditional coppice after many times of repeated cuttings, and in very dry areas. In natural forests with beech or fir, a steady state with equal growth and natural mortality can be expected (Stillhard *et al.*, 2022).

Q. 2 What types of degraded forest landscapes need restoration, what is missing and how can it be restored?

Perhaps, unsurprisingly, restoration of degraded forests was highlighted as important research topic. There is a broad discussion in Georgia about severe anthropogenic impacts on Georgian forests, especially during the first years of independence and economic recession. Large parts of forests can be considered to be degraded in one way or another, however the scale of degradation is still unknown, mostly due to outdated forest inventories and methodological deficiencies of assessing it. In fact, forest degradation is interpreted differently and there is not a consensus among scientist about how it can be assessed (Simula, 2009; Lund, 2009; Thompson *et al.*, 2013; Ghazoul *et al.*, 2015; Vásquez-Grandón *et al.*, 2018). The primary causes, as argued by Ozdogan *et al.* (Ozdogan *et al.*, 2017) were directly related to the unavailability of imported construction timber from Russia that accounting for more than 85% of local demand (UNECE, 2002), as well as sharp reduction of fuel imports (Jervalidze, 2006), coupled with rural poverty, lack of affordable alternative sources of heating and illegal harvesting by

citizens. Some studies have found that both legal and illegal domestic fuelwood extraction increased 250% after independence, with the majority of the increase occurring after 2000 (Garforth *et al.*, 2016; Torchinava & Iordanishvili, 2010), however there are still a knowledge gaps about impact drivers (Cortner *et al.*, 2022). In regard to forest landscape restoration efforts, a major issue is the desired maintenance of red-listed species in forested landscapes. Other forest restoration efforts focus on planting in deforested areas. The existing forests of Georgia have a good potential to regenerate naturally.

Conclusion

During the workshop, we collected relevant questions for forest sciences of the Caucasus region. Some difficulties emerged from the language and understanding of forest sciences. For instance, ‘natural forest’ was sometimes perceived as ‘forest with native tree species’ or ‘naturally regenerated forest’ due to the native language. Also, Georgian taxation specialists had been told that forest inventory sampling is forest sciences while a stand inventory is forest management. In fact, both can be scientific. The inventory purpose depends on the management or study question. Furthermore, the quality of applied forest research depends on the knowledge of foresters. Without professional knowledge it is difficult to conduct primary research in single stands as well as desk research. This is somewhat contradictory to current trends in western Europe where more biologists, geographers or landscape planners are a real asset for

traditional forest research and in forest enterprises. However, there you have already a large number of forest experiments (see e.g. <http://noltfox.metla.fi/>) and well-established management of stands (with planning cycle and prescribed silviculture).

Comparison between biodiversity research and forest sciences

Comparing biodiversity research with forest sciences in Georgia, most projects funded by international donors highlight biodiversity. Regarding tree species diversity, Georgian and other taxonomists and geneticists argued for decades about species and subspecies of genera like *Quercus*, *Pinus* and *Acer*. As tree species are crucial to define the forest management type, there was a large need for a scientific consensus which could be solved recently by the first National forest inventory where forest management types were defined. This catalogue of forest types is a solid base for future forest management planning and forestry research. Further biodiversity research within the frame of forest sciences may concern provenience trials and assisted migration of trees under changing climate, but such long-term investments would need another infrastructure (forest research station, kiln to dry seeds) and qualified staff. Current biodiversity research is more focused on wildlife and lists of plant species with their occurrence, mostly conducted in protected areas.

Management goals to maintain biodiversity, store carbon and supply firewood will prosper forest sciences because management is local (Blaser & Gregersen, 2013).

Silviculture and integrated forest planning (Lindenmayer *et al.*, 2012; Kraus & Krumm, 2013) are the tools that forest sciences can offer to reach ambitious forest policy goals. These tools and skills are most efficient in combination with forest policy instruments at National level, wise regional forest planning approaches at landscape level, and adequate silviculture at stand level. Old-growth forest, young forest, plantations, windbreaks, wood pasture, and other traditional management types (low and high coppice with and without standards) need specific management, dependent on soil, climate and topography. If forests are owned and managed by one state forest enterprise only and no other forest owners exist, research in Central Europe suggests less biodiversity (Schall *et al.*, 2017; Schulze *et al.*, 2019).

The Forest Europe process and defined criteria & indicators of sustainable forest management are a guide at National level. But stronger involvement of local managers who can develop site-adapted solutions that follow the policy directives will also be needed (Degerman *et al.*, 2004; Angelstam *et al.*, 2017; Bobiec *et al.*, 2019).

A future forest research agenda

Both, the formulation of questions and the ranking by practitioners across the country is important. It should not depend on the agenda of international donors but consider the local needs and the capacity of the re-emerging Georgian forest research sector, i.e. those who are doing the actual work like conducting empirical field studies and measure trees.

Hypothetically, the forest research agenda could consist of three parts: 1) forest management (silviculture, forest productivity, utilization, restoration), 2) multi-disciplinary forest research, and 3) forest policy and economics. Part 1 would cover tree species ecology (seed dispersal, collection and storage, regeneration, tree growth, competition, mortality), uneven-aged and even-aged silviculture of mixed and pure stands (regeneration methods, promotion of admixed tree species, tree harvest, thinning of young stands) and forest operations (forest planning, access and engineering, harvest technology, wood transport and processing). Part 2 would offer other scientific disciplines to participate and enhance forest research in the country: botanists, geneticists, geographers, landscape architects, etc. Part 3 would help nature resource economists and planners to provide policy makers and international development aid with valuations of different ecosystem services to scrutinize their policy.

International donors could be asked to create a fund for a Georgian forest research program. The program could divide proposed projects in grants for young researchers and senior scientists as practiced in other disciplines. Georgian forest management bodies could write the agenda and distribute grants to back up their management decisions and to show good examples. Before developing such an agenda, examples from Formas in Sweden (Formas, 2022), FNR in Germany (FNR, 2021) or others should be read.

For the first decade of such a research program, silvicultural methods in uneven-aged, mixed forests on steep slopes, coppice and other forms of traditional silviculture would be relevant. Instead of thinning schemes, questions to manage a forest stand or not, and how to extract wood from the forest to the sawmill, should also be prioritized. In addition, pioneering trials of early thinnings 20-30 years after over-exploitation of stands near settlements should be installed to avoid further cutting in protected old-growth forest.

The IUFRO classification gave a baseline to rebuild trust between Georgian forest researchers and can help the Academy of Agricultural Sciences or forest management bodies to coordinate future research that is carried out by different research institutions.

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Conflicts of interest

The authors declare that they do not have any conflicts of interest.

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Table 1. 20 forest research questions formulated by Georgian forest scientists.

Nr.	Question	IUFRO division
1	How to use ecological knowledge for the management of the economically important tree species (beech, oak, pine, dark conifers)?	1
2	What types of degraded forest landscapes need restoration, what is missing, and how can it be restored?	1
3	How to introduce forest plantation systems in the country?	1
4	Where to collect seeds (how many, what species) or transplant seedlings (what size and species, how)? (Div. 2)	2
5	What are good practices to carry out forest operations (extracting wood resources, storage, sorting/selling)?	3
6	What is the productivity of the forest (both, wood and net primary production)?	4
7	What is the impact of climate change on forest productivity and carbon sequestration potential?	4
8	How to use geoinformation and remote sensing technologies to assess forests and model future forest development?	4
9	How to assess quantitatively non-timber forest resources, create a unified map (with a list of non-timber products, quantities), and develop sales packages?	5
10	How to develop eco-tourism and what kind of infrastructure would be appropriate?	6
11	How adequate are the measures against existing pest-disease problems (incl. sufficient management guidelines)?	7
12	How to analyze forest ecosystem services systematically, also in order to assess ecosystem responses to anthropogenic and catastrophic impacts (i.e. infrastructure projects, fire, climate change)?	8
13	How to adapt to and mitigate climate change?	8
14	How to use morphological, genetic and ecological markers to distinguish between species and forest types?	8
15	What are the abundance and conditions of red-listed tree species?	8
16	How to reduce firewood extraction from protected forest?	9
17	How to monetarily evaluate forest ecosystem services?	9
18	How does the forest sector contribute to the country's economy and what can be the large-scale timber resource potential, considering all forest ecosystem functions (nature conservation, recreation, protective)?	9
19	How could the forestry sector provide additional jobs (i.e. green jobs), especially through encouraging interns and researchers developing innovative business fields?	9
20	How does Georgian forest policy respond to current challenges of the sector?	9