Final report

GOFC-GOLD Regional Networks

SCERIN virtual seminar on bark beetle damage
21-22 January 2021

The seminar was organised by SCERIN and was open to all GOFC-GOLD RINs.

The virtual hosts of the seminar were: Jon Padgham and Clay Oboth; START. The organizers include: Petya Campbell, Jana Albrechtová, Lucie Kupková, Petr Lukeš and Mihai Nita; SCERIN.

Environment: online ZOOM meeting facilitated by Clay Oboth

The seminar was held during two consecutive days from (*14:00-16:30 CET; 8:00-10:30 EST)* convenient to U.S. and European participants.

Agenda of the meeting during the DAY 1, January 21, 2021:

	Country	Presenter(s)	Association (e-mail)
DAY 1: January 21, 2021 (14:00-16:30 CET; 8-10:30 EST)		

	Country	Presenter(s)	Association (e-mail)
		DAY 1: January 21, 2021 (14:00-16:30 CET; 8-10:30 EST) **Topics:** SCERIN background; Beetle damage status, detection and monitoring in SCERIN *Summaries by country (5<7 min.). Please place questions in the chat addressed to all.*		
	Country	Presenter(s)	Association (e-mail)
	Opening - Jon Padgham, START; **SCERIN background** - Petya Campbell; **Introductions** - Jana Albrechtova **Questions** in the Chat - Lucie Kupkova & Petya Campbell		
1	Bulgaria	Lachezar Filtchev	Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, BG (lachezarhf@gmail.com)
2	Chechia	Filip Hájek	Photogrammetry and Remote Sensing, Forest Management Institute, Brandys and Labem, CZ (filip.hajek@uhul.cz)
3	Croatia	Ivan Pilas	Croatian Forest Research Institute, Jastrebarsko, Croatia (ivanp@sumins.hr)
4	Greece	Asterios Tselepis & Ioannis Gitas	School of Forestry and Natural Environment, Aristotle University, Thessaloniki, Greece (atselepis27@gmail.com; igitas@ for.auth.gr)
5	Poland	Piotr Wezyk	Dept. of Forest Resources, University of Agriculture in Krakow, Poland (wezyk.piotr@gmail.com)
	Discussion - Questions from Chat (15 min.) + break (5 min.) + PICTURE		
6	Romania	Marius Paraschiv & Mihai Nita	National Institute for R&D in Forestry (marius_par@yahoo.com); Transylvania University, Brasov, (nita.mihai.daniel@gmail.com)
7	Serbia	Minučer Mesaroš and Dejan Stojanović	Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia (minucher@gmail.com)
8	Slovenia	Mitja Skudnik and Tatjana Veljanovski	Forestry Institute and Znanstveno Raziskovalni Center, Slovenia (mitja.skudnik@gozdis.si; tatjana.veljanovski@zrc-sazu.si)
9	Ukraine	Oleh Chaskov & Serhii Havryliuk	National Forestry University, Ukraine (oleh.chaskov@googlemail.com; serhiy_havrylyuk@nltu.edu.ua)
	Discussion - Questions from the Chat (10 min.); SCERIN joint activities (30 min.)		

Day 1 focused on short presentations of the SCERIN countries representatives on bark beetle damage status. The meeting was opened by the GOFC-GOLD START lead Jon Padgham and attended by the GOFC-GOLD leads Garik Gutman, Chris Justice and Krishna Vadrevu, who also addressed the participants and provided inputs during the discussions. After the introduction of SCERIN and its activities by Petya Campbell, thematic contributions from Bulgaria, Czechia, Croatia, Greece, Poland, Romania, Serbia, Slovenia and Ukraine were presented. Jana Albrechtová briefly introduced each presenter.

Two discussion sessions led by Lucie Kupková addressed questions from the chat. At the end of Day 1, a proposal for joint SCERIN activities and intention to develop a joint manuscript on bark beetle situation in the SCERIN region were introduced by Petya Campbell and Lucie Kupková, respectively. Participants expressed their intention to contribute to a joint manuscript, which Lucie Kupková volunteered to lead. Participants were encouraged to send their reactions to both proposals by email before the next day's session. The discussion was lively and productive. 63 participants (including hosts and organizers) attended the seminar (see the list of participants is in ***Appendix 2***).

Background information on all speakers is provided in ***Appendix 1***. The material presented in Appendix 1 was prepared 2 days before the seminar and sent together with an invitation for the seminar to all members of the GOFC-GOLD RINs. The members of RINs were asked to spread the information amongst their collaborators.

Agenda of the meeting during the DAY 2, January 22, 2021:

DAY2: January 22, 2021 (14:00-16:30 CET; 8:00-10:30 EST) Topics: Remote sensing for beetle damage detection, monitoring and predictive modeling Presentations (10<15 min.). Please place questions in the chat addressed to all.	
Title	Presenter; Association (e-mail)
Introductions - Jana Albrechtova, **Questions** and **Discussion** - Petya Campbell & Lucie Kupkova	
1 Early detection of beetle infestations using dense time series of Sentinel-2 data	Petr Lukes; Global change research institute, Brno, CZ (lukes.p@czechglobe.cz)
2 Bark beetle damage detection from UAV	Mihai Nita and Marius Paraschiv; Transylvania University, Brasov, (nita.mihai.daniel@gmail.com); National Institute for R&D in Forestry (marius_par@yahoo.com)
3 Scaling bark beetle damage from the country- to regional- and local levels	Andrej Kobler and Nikica Ogris; Slovenian Forestry Institute, Slovenia (andrej.kobler@gozdis.si; nikica.ogris@gozdis.si)
4 Spruce decline monitoring using hyperspectral airborne data	Olga Brovkina; Global change research institute, Brno, CZ (brovkina.o@czechglobe.cz)
Discussion - Questions from the Chat (10 min.) + break (5 min.) + PICTURE	
5 Predictive modeling of the first bark-beetle outbreaks and links to remote sensing	Maarten de Groot and Nikica Ogris; Slovenian Forestry Institute, Slovenia (maarten.degroot@gozdis.si; nikica.ogris@gozdis.si)
6 Using LiDAR and photogrammetry approach for bark beetle infestations detection	Piotr Wezyk, Dept. of Forest Resources; University of Agriculture in Krakow, Poland (piotr.wezyk@urk.edu.pl)
7 A comparison of WV2 and L-8 classification of bark beetle outbreaks using a SVM and a NNs in the Sumava mountains	Premysl Stych; Charles University, Prague, CZ (stych@natur.cuni.cz)
8 Using Sentinel-2 data for bark beetle detection in Europe, focus on SCERIN	Ángel Fernández; Remote Sensing and Geospatial Analytics Division, GMV, Spain; H2020 (aafernandez@gmv.com)
Discussion - Questions from the Chat (10 min.); SCERIN future activities and venues (30 min.) **Closing Remarks** (START, SCERIN)	

Day 2 of the meeting focused on the current state of knowledge of remote sensing methods for bark beetle damage detection, monitoring and predictive modelling. The presentations included multiple case studies on bark beetle forest damage in the SCERIN region. A list of the presentations and a summary for each of them can be found in ***Appendix 1***. Once again, Jana Albrechtová briefly introduced and provided a brief background for each presenter.

The program once again included two discussion sessions led by Lucie Kupková and Petya Campbell. The final discussion focused on SCERIN's future activities, including interest by network members to present their research and discuss topics of joint interest with MedRIN at the forthcoming Joint SCERIN and MedRIN workshop planned for June 2021. Intention to work on a joint manuscript of co-authors based on the bark beetle SCERIN seminar was approved by the participants and Lucie Kupková agreed to work on coordination of the effort. The final discussion was again lively and fruitful. The meeting ended with closing remarks from Jon Padgham. 56 participants (including hosts and organizers) attended the seminar (see the list of participants is in *Appendix 2*).

Link to folder with presentations:

https://drive.google.com/drive/folders/1CUXHE3_Te0kbdAWL1H2eLZrW5v9qQXIZ?usp=sharing

Link to presenter's information and talks summaries:

https://docs.google.com/document/d/1U6GWP6P1O8Y5NgG_-Lw_hCzc_T5L5AGVxeK9f9v5jNU/edit

Full list of participants including name, affiliation, and email address

Full list of participants of Day 1 and Day 2 is in *Appendix 2*.

Partner institutions associated with the organisation of the meeting

- University of Maryland Baltimore County and NASA/Goddard Space Flight Center, Greenbelt, MD, USA
- Charles University, Prague, Faculty of Science, CZ
- Global Change Research Institute of Czech Academy of Sciences (CzechGlobe, Brno, CZ)
- Transylvania University of Brasov, Faculty of Silviculture, RO

Scientific communications that came out of the meeting

Based on the proposal presented during DAY 1 of the seminar by Lucie Kupková on behalf of SCERIN leaders, 7 participants of the workshop (from Spain, Czechia, Slovakia, Slovenia, Bulgaria) decided to participate in the proposed joint review article focused on *Remote Sensing on bark beetle outbreaks monitoring*. Lucie Kupková volunteered to coordinate the SCERIN effort and contacted interested contributors. They reacted by email and some of them proposed their potential focus/role in the framework of the article.

## *Future actions identified by the network*

A review paper led by Lucie Kupková and other SCERIN leaders, including Petya Campbell and Jana Albrechtová, on "Remote Sensing on bark beetle outbreaks monitoring" will be prepared as a follow-up to the meeting by participants who expressed interest in participating. Expanding beyond a single paper, a suggestion was also made to consider producing a special issue on bark beetle in the SCERIN

countries to feature in a remote sensing journal or applied forestry journal. Other tentative suggestions for action items included:

- Producing a sentinel and Landsat archive for the last 10 years, map of situation and its development;
- Developing an early warning system, nested in the predictive models that currently exist and advancing those models further;
- Expanding predictive models, begining with a larger view of situation;
- Developing a SCERIN educational component on bark beetle damage detection using Sentinel and Landsat (develop tools and products) coupled with training;
- Organizing virtual trainings with ESA and NASA while noting the challenges of remote work / virtual training but also the opportunities afforded by a remote format to expand training to a larger group of people. Involving PhD students in research in google earth, process data and other scientific activities.

The next SCERIN meeting will be held together with the MedRIN network in June 2021. The form, focus and organization of the joint meeting will be discussed by the leaders of both networks in February 2021.

Pictures from the seminar
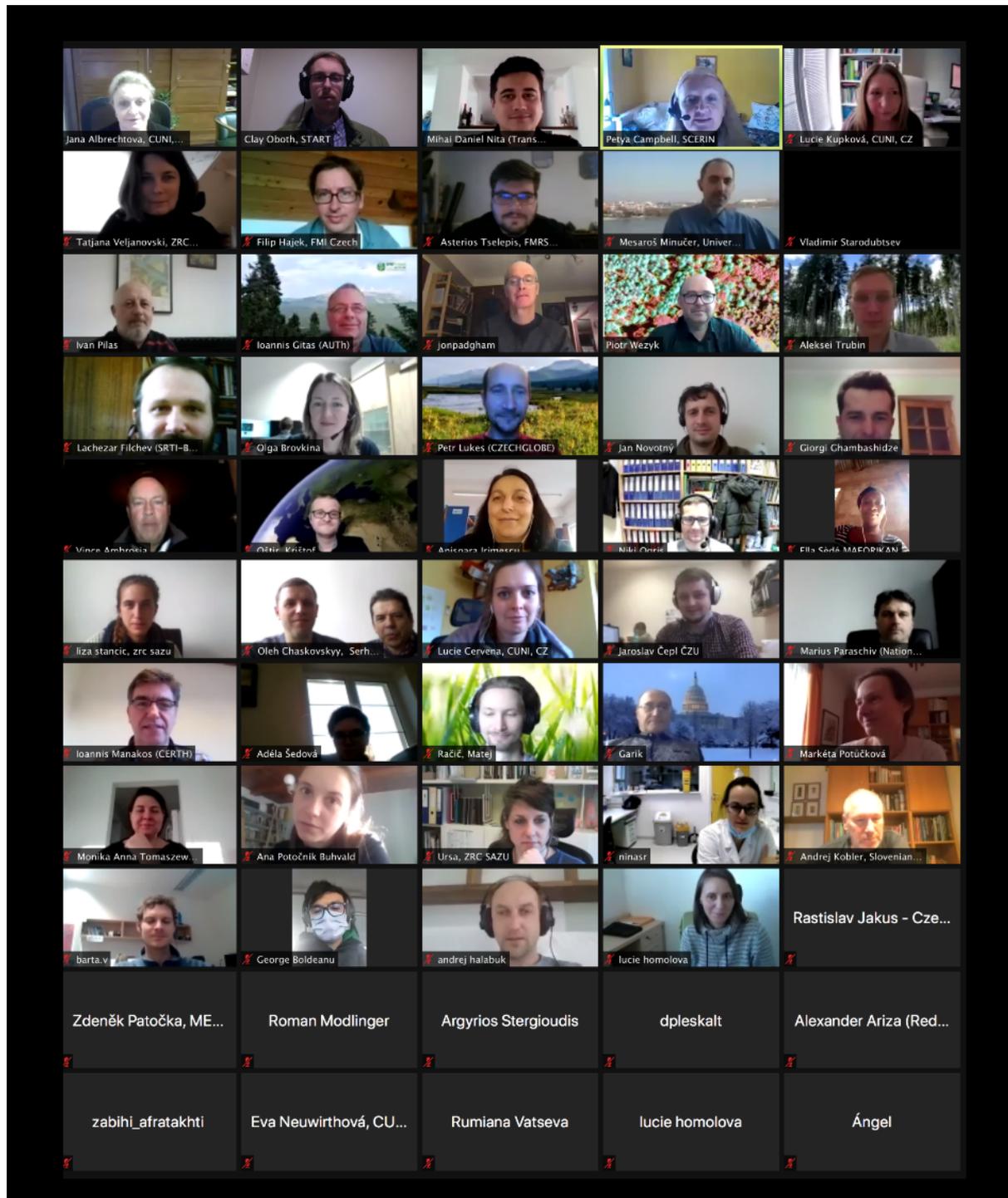
DAY 1 Group Photo
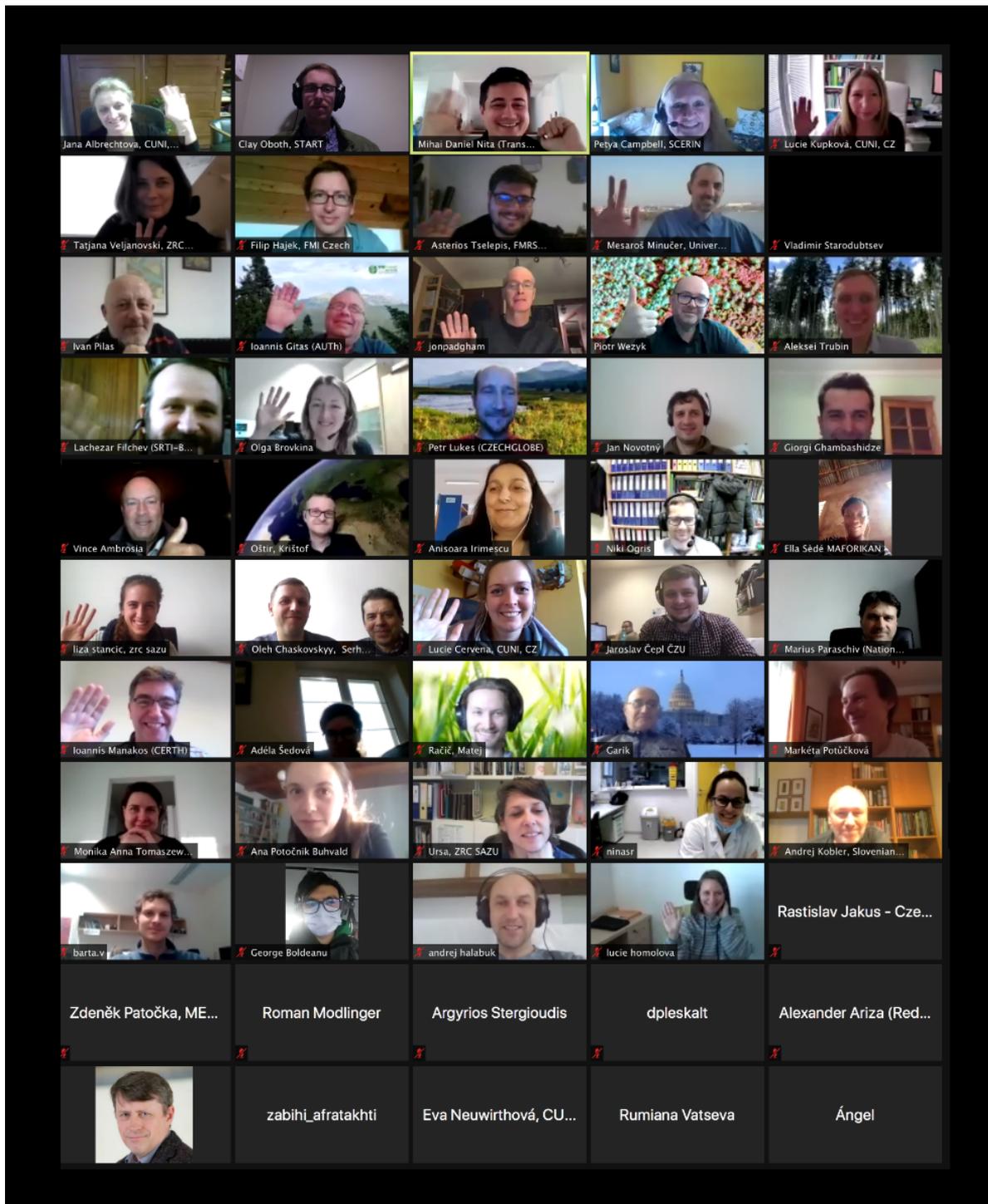
DAY 2 Group Photo

APPENDIX 1:

Material prepared and sent to invited participants from GAFC-GOLD RINs in advance

SCERIN Seminar 21-22 January 2021

(14:00-16:30 CET; 8:00-10:30 EST)

All GOFC-GOLD Regional Information Networks (RINs) Invited

Seminar Title:

Bark Beetle Damage in the SCERIN domain - detection, monitoring and associated LCC dynamics

Hosts: Jon Padgham and Clay Oboth, START
Organisers: Petya Campbell, Jana Albrechtová, Lucie Kupková, Petr Lukes and Mihai Nita, SCERIN

ZOOM Link to join https://us02web.zoom.us/j/88400774541, active ½ hour before the start

Group photos of seminar participants will be taken each day after break

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Introduction of Seminar Presenters

Bulgaria

Lachezar Filchev is an Associate Professor and Head of the Remote Sensing and GIS Department at the Space Research and Technology Institute, Bulgarian Academy of Sciences (SRTI-BAS). He holds a M.Sc. in Physical Geography and Landscape Ecology (2006, "St. Kliment Ohridski" University of Sofia) and a PhD in "Remote sensing of the Earth and planets" (2012, BAS). His main research interests are in the applications of optical remote sensing and GIS in landscape ecology and vegetation studies. He is a member of special interest groups (SIGs) of EARSeL and International Geographical Union (IGU) on land use land cover change (LULCC); of editorial boards of journals: European Journal of Remote Sensing, Aerospace Research in Bulgaria, and Remote Sensing of Land. He is a Copernicus Academy contact person of SRTI-BAS and an alternate of the Bulgarian representative at the Copernicus User Forum (CUF). He is also one of the Bulgarian representatives at GEO High Level Working Group (HLWG) at EC. Since 2019 he is a member of the Mission Board "Soil health and food" (Horizon Europe, EC, 2021-2027).

Czech Republic

Olga Brovkina is a scientist at the Department of Remote Sensing at the Global Change Research Institute CAS (CzechGlobe), Brno. She held a PhD in "Aerospace methods for Earth research" (2011, Russian Academy of Sciences). Her main research interests are in processing and application of airborne hyperspectral and satellite multispectral data for: estimation of forest/tree inventory parameters, monitoring of landscape disturbances, and complex assessment of ecosystem state.

Filip Hájek is a remote sensing expert and the leading analyst at the Department of photogrammetry and remote sensing of Forest management institute (FMI), Czech Republic. His background is forestry, but has experience also with the remote sensing analysis of vegetation and land use/landcover since 2002. At FMI, he started the remote sensing support of the National Forest Inventory (NFI2 - since 2010) and established the photogrammetry group of both visual stereoscopic interpretation, and automated analysis of 3D and multispectral Earth observation data. The main results of this group include repeated stereoscopic assessment of the NFI plots and countrywide (wall-to-wall) maps of woody vegetation, periodic detection of timber cutting, tree species composition, forest health status and bark-beetle infestation.

Petr Lukeš is a scientist at the Department of Remote Sensing at the Global Change Research Institute CAS (Czechglobe, Brno) and remote sensing developer at Forest Management Institute (FMI), Czech Republic. He received his PhD at the Mendel University in Brno in 2012 with a thesis focused on retrieval of forest quantitative parameters from satellite data using radiative transfer models. His main scientific interests include remote sensing of vegetation with particular focus on satellite data interpretation, radiative transfer in forest canopies and leaf optical properties.

Přemysl Štych Associate Professor at the Department of Applied Geoinformatics and Cartography of Faculty of Science, Charles University, Prague. His field of interest is Land Use/Land Cover Change, GIS, Earth Observation and regional geography. He has been a coordinator of several international projects, e.g. 7th FP Projects, ERASMUS+ or H2020.

Croatia

Ivan Pilas is a senior researcher (scientific advisor) in the Division of ecology, Croatian Forest Research Institute. He has a Ph.D. (2006) in silviculture in the Faculty of Forestry, University of Zagreb. His basic expertise has been soil genesis, classification and monitoring, lowland hydrology, monitoring and modelling of the groundwater processes in hydromorphic soils and their impacts on forests. He was also involved in deposition and soil solution studies as a national expert in the UNECE ICP Forest Programme. He was a secretary of the Croatian Soil Science Society and IUFRO – INTERNATIONAL COUNCIL – Alternate representative Croatia. Recently he participated in various international projects; IPA Adriatic "HOLISTIC- seismic and wildfire risks", INTERREG CROATIA - HUNGARY – "Oak protection", "Advanced FORest ENvironmental Services Assessment-AFORENSA", H2020 project "MySustainableForest" - Earth observation for silviculture.

Greece

Prof. Ioannis Gitas is Director of the Laboratory of Forest Management and Remote Sensing and the Chairman of the Aristotle University Forest Administration and Management Fund. Ioannis, an elected fellow of the Cambridge Philosophical Society, received his PhD and MPhil degrees in GIS and Remote Sensing from the Department of Geography, Cambridge University U.K. His research has focused on remote sensing and GIS applications in environmental monitoring. He is the author or co-author of more than 200 papers in peer-reviewed journals and international conferences. Prof. Gitas

is an Associate Editor of MDPI Remote Sensing, MDPI Earth and PeerJ journals and has edited special issues for a number of high impact factor journals. Ioannis is currently the Chair of the EARSeL SIG on Forest Fires, the FAO Forest Resources Assessment – Remote Sensing Survey contact point for Greece, a member of the GOFC-GOLD Fire Implementation Team, a member of GEO's GWIS, and the first term co-leader of the NASA LCLUC Mediterranean Regional Information Network (MedRIN).

Asterios Tselepis is currently a postgraduate student at the School of Agriculture, Forestry and Natural Environment that belongs to Aristotle University of Thessaloniki in Greece. He received the Master's Degree in Environmental Protection and Sustainable Development from the Aristotle University of Thessaloniki, Greece. Asterios is an HCAA Certified UAS Pilot. His interests extend to remote sensing methods and the use of new technologies for environmental monitoring.

Dimitrios N. Avtzis (Dr. rer. nat. / FRES) is Main Researcher in Forest Entomology (FRI – HAO Demeter) since 2010. He has participated and coordinated 7 international and 12 national research projects, and has published 55 articles in SCI journals. He has numerous contributions in national and international conferences, and has served both as Reviewer and Editor in high ranked journals in Forest Entomology and Biology in general.

Poland

Piotr Wężyk is a UR professor at Laboratory of Geomatics, Dept. of Forest Resources Management, Faculty of Forestry, University of Agriculture in Krakow, Poland. Professional experience in international research and development projects on: LiDAR, GIS, UAV-Photogrammetry, Remote Sensing, Image Processing (GEOBIA) and GNSS applications in: monitoring and management of the forest environment, nature protection, natural hazards in forestry. Chairman of the SIG Forestry EARSeL and FORESTSAT 2020. Involved in several national-wide projects in Poland: training of using the aerial photos (PHARE PL 1997-98), LiDAR (GUGiK 2015) and Remote Sensing application (2020, PAK), Geoportal.gov.pl (INSPIRE), Information System of Country Protection Against Extraordinary Hazards (ISOK) and cooperation with: Ministry of Environment, Head Office of Geodesy and Cartography, Polish State Forest, General Directorate of Nature Protection, National Parks and the public administration bodies.

Romania

Mihai-Daniel Niță is a Professor at the Faculty of Silviculture, the Transylvania University of Brasov. His subjects are Remote Sensing, GIS and Watershed Management. As a researcher he is involved in projects regarding forest management and monitoring, mainly as RS-GIS expert on topics like LULUCF (land use, land-use change, and forestry) using remote sensing and drone mapping, modeling habitat distributions for species and evaluating Forest Ecosystem Services (FES).

Marius Paraschiv is a forest entomologist. He has been working in the Forest Protection Department at National Institute for Research and development in Forestry from Brasov-Romania since 2015. His current work focuses on conifer pests - bark beetle, defoliators and weevils. He also has a specialization in nursery quarantine pathogens and invasive species. Was involved in European projects like Cost Actions and he has contributions in national and international conferences and has served as Reviewer journals in Forestry and Entomology.

Serbia

Minučer Mesaroš is an Associate Professor at the Faculty of Sciences, University of Novi Sad, where he is the head of the Geoinformatics Study Program. He received his PhD in Geoscience at the University of Szeged, Hungary. His main research interest is application of GIS, remote sensing and machine learning in multidisciplinary research of environmental problems, natural hazards, climate change and Earth System Science. He coordinated and participated in international projects related to research of droughts, inland flooding and climate extremes (IPA Interreg, H2020).

Dejan Stojanović is Senior Research Associate at the Institute of Lowland Forestry and Environment, University of Novi Sad, Serbia, where he has been employed since 2012. Dr. Stojanovic graduated from the Faculty of Sciences in 2010. In 2014, he defended his PhD thesis at the same faculty. Dr. Stojanovic has been working in a research group for forest ecology, dendrochronology and climate change impact on forests. He has co-authored more than 25 papers in impact journal papers with more than 800 citations. He has been involved in number domestic and international projects (e.g. IPA, COST, and Interreg Danube).

Slovenia

Maarten de Groot is a researcher employed at the Department of Forest protection at the Slovenian Forestry Institute. He is a forest entomologist with research interests in identifying drivers of large scale insect outbreaks and insect invasions, ecological modeling and integrated forest pest management. He is involved in predictive modeling of bark beetle outbreaks for the forest public service, an editor for the on-line journal Forecasts in Forest health, leading several national and international projects and coordinator of several survey programs of quarantine pests.

Nikica Ogris employed at Department of Forest protection at Slovenian Forestry Institute for 19 years. He is forest pathologist, forest health expert, expert for ecological modelling and modelling of forest health issues, custos of Mycotheca and Herbarium of Slovenian Forestry Institute, editor of the on-line journal Forecasts about forest health and the journal News from forest protection, guest editor at the journal Forests, software developer, SQL Server and ArcGIS Server Administrator, developer and administrator for many information systems, e.g. Forest Protection, Invazivke, Boletus informaticus, Danube Forest Health, Zdravko.

Andrej Kobler is a research fellow at the Slovenian Forestry Institute. He graduated in forestry at the Biotechnical Faculty, University of Ljubljana (UL BF) in 1995, received his MSc in spatial planning in 2001 at UL BF, and his PhD in remote sensing at Faculty of Civil and Geodetic Engineering, University of Ljubljana (UL FGG) in 2011. His research interests are focused on model-based mapping of forest- and semi-natural ecosystems using remotely sensed data and ancillary data. He is the author and co-author of over 140 scientific publications in journals and at international conferences.

Mitja Skudnik is a researcher in the Department of Forest and Landscape Planning and Monitoring at Slovenian Forestry Institute and an associate lecturer at the University of Ljubljana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources. His research focuses on the forest monitoring concepts and ecological modeling. At the SFI, he is responsible for the organization of National Forest Inventory (NFI) (methodology, calculation, data management). Additional research focuses are on forest mensuration, ecological monitoring, remote sensing and geographic information system analysis.

Tatjana Veljanovski is a research fellow at the Department of Remote Sensing at the Research Centre of the Slovenian Academy of Sciences and Arts. She holds a PhD in remote sensing (University

of Ljubljana, Faculty of Civil and Geodetic Engineering). She works on data preprocessing, interpretation and applications of remote sensing data. Her main research interest is in detection and monitoring of natural disasters, the landscape development, disturbances and changes. She participates in several national and international projects in the field of remote sensing and GIS.

Spain

Ángel Fernández is an Earth Observation Engineer at GMV. Ángel holds a BSc in Geography and Spatial Planning from the University of Seville (2016), a MSc in Geographic Information Technologies (2017) and a MSc in Deep Learning (2019), from the University of Alcalá. He has 5 years of experience in remote sensing of vegetation, Artificial Intelligence and Machine Learning applications for satellite imagery. In 2016 he worked as a remote sensing intern at the Spanish National Research Council (CSIC) and in 2017-2018 he held a position as research assistant at the University of Alcalá. During this time, his research activity was focused in burned area detection, fire severity and forest recovery using remote sensing and Machine Learning algorithms within the ESA's Climate Change Initiative and the Copernicus CS3 project. At GMV he works at developing novel AI-based algorithms to provide geo-information services for sustainable forest management (MySustainableForest project).

Ukraine

Oleh Chaskovskyy is Associate Professor at the Department of Forest Inventory and Forest Management department at Ukrainian National Forestry University (Lviv, Ukraine). He has expertise in automatic processing of images and methodical bases of their use at forest inventory, application of methods of satellite image processing for the purposes of problems of forest inventory. He also has experience in GIS-Modeling in different areas of national economy. The researcher has a PhD in the field of forest inventory. He was a participant of a few international projects, leader of project DIABOLO (Distributed, Integrated and Harmonized Forest Information for Bioeconomy Outlooks, Horizon-2020) and was a participant and leader of internal Ukrainian projects, supported under the Ministry of Education and Science of Ukraine.

Serhii Havryliuk is an Associate Professor of Forest Inventory and Forest Management Department at Ukrainian National Forestry University (Lviv, Ukraine). Ph.D. (Candidate of Science) in Agricultural Sciences (Forest Management and Forest Inventory), Deputy of Director of Education and Research Institute of Forestry and Park Gardening. He had published more than 40 articles including international journals which are indexing in SCOPUS and Web of Science. Dr. Havryliuk had some scientific trainings at EU universities and organizations like WSL, Freie University, University of Freiburg, etc. He was a participant in few international projects, like QUARSU, DIABOLO (Distributed, Integrated and Harmonized Forest Information for Bioeconomy Outlooks, Horizon-2020), FORZA and was a participant and leader of internal Ukrainian projects, supported under the Ministry of Education and Science of Ukraine. Serhii Havryliuk's areas of scientific interest are using GIS and remote sensing data in forestry.

SCERIN Coordinators

Petya Campbell, SCERIN US Coordinator, Associate Research Professor at [University of Maryland Baltimore C](#)ounty and at [NASA/Goddard Space Flight C](#)enter, Greenbelt, MD, USA. Dr. Campbell's research combines forest ecology and silviculture with plant physiology and remote sensing. Her experience includes collaborative interdisciplinary research in remote sensing for assessment of

vegetation function and early detection of vegetation stress based on its spectral reflectance, fluorescence and thermal characteristics.

Jana Albrechtová, is a Professor at Charles University (CU), Faculty of Science in Prague, Czech Republic, Department of Experimental Plant Biology. Her research focuses on plant ecophysiological studies employing plant anatomy, physiology, spectroscopy with emphasis given to multidisciplinary approaches. Long-term, she has been studying the monitoring of the physiological status of vegetation using remote sensing methods. She collaborates with GOFC-GOLD and START, being a European leader of SCERIN (South, Central and Eastern Regional Network)https://www.scerin.eu/

Lucie Kupková, is an Associate professor at Charles University Prague, Faculty of Science, a head of the Department of Applied Geoinformatics and Cartography. She is focused mainly on landscape change evaluation, vegetation classification/change detection and health status evaluation using different types of optical remote sensing data (including data from UAV), image and laboratory spectroscopy. She is coordinator of SCERIN (The South, Central and East European Regional Information Network) of the Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD), a member of Steering Committee of International Geographical Union, Commission on Land Use and Land Cover Change, and a member of Eurosite Remote Sensing Support Group for conservation practitioners.

Summary of the presentations of Day 2

1. Petr Lukeš lukes.p@czechglobe.cz

Title: Early detection of beetle infestations using dense time series of Sentinel-2 data

Authors: Vojtěch Bárta, Petr Lukeš, Lucie Homolová (Global Change Research Institute CAS, Brno, Czech Republic)

Summary: This study investigates the potential for using seasonal trajectories of Sentinel-2 bands and selected vegetation indices in early detection of bark beetle infestation (so called green-attack stage detection) in Norway spruce monoculture forests in the Czech Republic. The algorithm for early detection of tree infestation based on the assessment of seasonal changes in TCW was applied on the time series of Sentinel-2 image observations from autumn 2019 and its outputs were subsequently verified using field observations of forest conditions conducted on 80 spruce forest plots. The overall accuracy of 78% was achieved for the separation of healthy and green-attack classes, while the later red and grey attack stages were classified with accuracies higher than 90%. Our study highlights the importance of multi-temporal remote sensing and the use of shortwave infrared wavelengths for early detection of spruce forest decline caused by bark beetle infestation.

2. Mihai Nita nita.mihai.daniel@gmail.com

Title: Bark beetle detection from UAV

Authors: Mihai Nita and Marius Paraschiv

Summary: This study was performed in the Carpathian Mountains, located in central Romania, an area covered with coniferous forests, mainly spruce. This work aimed to evaluate the possibilities of the unmanned aerial vehicle (UAV)-mounted low-cost RGB to identify infested trees or clusters of

trees using very high resolution orthomosaic and pointclouds extracted using Structure from Motion Algorithm. We used a segmentation method to map trees or clusters of trees affected by bark beetle attacks. We set-up a protocol based on 2 tiers (satellite and aerial) to be used by forest managers and decision-makers in controlling and mitigating the bark beetle damage effects.

3. Andrej Kobler and Nikica Ogris   andrej.kobler@gozdis.si; nikica.ogris@gozdis.si

Title: Scaling bark beetle damage from the country- to regional- and local- levels

Authors: A. Kobler, A. Kavčič, M. Čater, Š. Planinšek, J. Žlogar, T. Veljanovski, P. Pehani, Ž. Kokalj, M. Kolšek, K. Kunc, P. Čadež, M. Kozamernik, M. Petretič, G. Senegačnik, B. Slabanja, K. Zalokar, M. Kobal, J. Moderc, J. Langus, R. Valič, P. Gernot, N. Ogris

Summary: We employed machine-learned random forest models using remote sensing data at three spatial scales to predict or detect bark beetle attacks in spruce and fir forests in Slovenia. Firstly, at the country level we used yearly time series (2002 – 2018) of MODIS NDVI and EVI 16-day composites, contemporary meteorological data, and relief elevation, to predict amount of growing stock lost to bark beetle in the next year. The model was learned using yearly aggregations of forest compartment level data on sanitary felling. Secondly, at the regional level we used 10-day time series of 20-meter Sentinel-2A and Sentinel-2B data to detect recent bark beetle attack at resolutions of single pixel, 3x3 pixels, and 5x5 pixels. The model was trained using field-acquired date- and location data of growing stock attacked. Thirdly, we classified different stages of on-going bark beetle attack (target variables: tree crown discoloration and defoliation) at the single tree level using UAV-based MicaSense imagery, aggregated within the tree crown segments. The models were trained on tree-level field inventory of 15 hot spots. A classification accuracy of 74.7 % for tree crown discoloration was achieved, and 51.1 % for defoliation. It is our view that using UAV-based hyperspectral imagery would further improve the detection of early attack stages. Still, we conclude that during bark beetle season a repetitive UAV-based sub-meter RGB-IR inventory of bark beetle would have beneficial financial implications. Even a modest improvement of early detection of solitary tree attacks, which are often hard to detect from the ground, should ensure a decrease in the number of- and size of large area attacks and thus enable considerable financial savings.

4. Olga Brovkina brovkina.o@czechglobe.cz

Title: Spruce decline monitoring using hyperspectral airborne data

Authors: Brovkina O., Novotný J., Fabiánek T. (Global Change Research Institute CAS, Brno, Czech Republic)

Summary: The method for identification of spruce health decline from airborne hyperspectral and lidar data is presented. The potential of time-series airborne hyperspectral data is explored to track the changes in spruce health decline. A composite indicator is proposed to identify categories of spruce health decline: healthy, initial decline, and initial to moderate decline.

5. Maarten de Groot and Nikica Ogris   maarten.degroot@gozdis.si ; nikica.ogris@gozdis.si,

Title: Predictive modeling of bark-beetle outbreaks and links to remote sensing

Authors: Maarten de Groot, Nikica Ogris

Summary: In the last decades, bark beetle outbreaks have become more frequent and more intensive due to catastrophic weather events. We present here two modeling methods which are implemented in the Slovenian forestry and how they are and can be connected to remote sensing. The first method used here is a generalized linear model on basis of forest, soil, DEM, and weather characteristics and we predict the probability of an outbreaks of bark beetles on Norway spruce and silver fir. The second method is phenological prediction with the RITY and CHAPY model for the Ips typographus and Pityogenes chalcographus, respectively. For these models INCA data is used which analysis part of the system combines surface station data with remote sensing data in such a way that the observations at the station locations are reproduced, whereas the remote sensing data provide the spatial structure for the interpolation. These methods can be used for the localization and the timing of remote sensing, which can be then used for (early) detection of bark beetle outbreaks, their amount and distribution.

6.   Piotr Wezyk   wezyk.piotr@gmail.com; piotr.wezyk@urk.edu.pl'

Title: Using LiDAR and photogrammetry approach for bark beetle infestation detection

Authors: Piotr Wężyk, Wojciech Krawczyk (wojciech.kravchyk@gmail.com), Karolina Zięba-Kulawik (karolina.anna.zieba@gmail.com)

Summary: The presentation concerns the use of LiDAR point clouds and those generated by photogrammetric methods (IPC, matching) from aerial photos (also UAV) in the analysis of forest areas with gradations of insects from secondary pests. In the analysis of CIR aerial or satellite images of coniferous stands with the bark beetle as well as unfavorable abiotic and anthropogenic factors - so far we have used mainly spectral information related to the content of photosythetic pigments or the anatomical structure of leaves/needles. Advanced image recognition (e.g. GEOBIA) may, however, use additional information related to the vertical structure of vegetation: statistics of tree height (e.g. changes in the 99th percentile of the ALS point cloud of a stand along with its decay), crown closure, penetration and other features like CRR. The geometric features, together with the "spectral" information (also (LiDAR Int.) may serve to better understand the forest stands degradation processes.

7. Premysl Stych   stych@natur.cuni.cz

Title: A Comparison ofWorldView-2 and Landsat 8 Images for the Classification of Forests Affected by Bark Beetle Outbreaks Using a Support Vector Machine and a Neural Network: A Case Study in the Sumava Mountains

Authors: Premysl Stych, Josef Lastovicka, Daniel Paluba

Summary: The objective of this paper is to assess WorldView-2 (WV2) and Landsat OLI (L8) images in the detection of bark beetle outbreaks in the Sumava National Park. WV2 and L8 images were used

for the classification of forests infected by bark beetle outbreaks using a Support Vector Machine (SVM) and a Neural Network (NN). After evaluating all the available results, the SVM can be considered the best method used in this study. This classifier achieved the highest overall accuracy and Kappa index for both classified images. In the cases of WV2 and L8, total overall accuracies of 86% and 71% and Kappa indices of 0.84 and 0.66 were achieved with SVM, respectively. The NN algorithm using WV2 also produced very promising results, with over 80% overall accuracy and a Kappa index of 0.79. The methods used in this study may be inspirational for testing other types of satellite data (e.g., Sentinel-2) or other classification algorithms such as the Random Forest Classifier.

8. Angel Fernandez-Carrillo   aafernandez@gmv.com

Title: Using Sentinel-2 data for bark beetle damage detection in the Czech Republic

Authors: Angel Fernandez-Carrillo[1] , Zdeněk Patočka [2] , Lumír Dobrovolný [3], Antonio Franco-Nieto [1] and Beatriz Revilla-Romero [1]

[1] Remote Sensing and Geospatial Analytics Division, GMV (Spain);[2] Department of Forest Management and Applied Geoinformatics, Faculty of Forestry and Wood Technology, Mendel University in Brno (Czech Republic); [3] University Forest Enterprise Masaryk Forest Křtiny, Mendel University in Brno (Czech Republic)

Summary: The area attacked by the bark beetle *Ips typographus* has steadily increased in Europe over the last years, leading to important economic and environmental losses in areas were the forestry sector plays a key role. The quick extension of this pest hinders the implementation of management actions aiming at preventing and mitigating the damage caused by the insect. Remote Sensing is a valuable tool for forest damage monitoring as it provides periodic data on vegetation condition. In this work we present a case study of the use of Artificial Intelligence to produce bark beetle damage maps using open data from Sentinel-2 satellites in spruce forests of the Czech Republic. The final maps show different level of impact (minor, moderate and severe) with a spatial resolution of 10 m. A novel approach to perform early detection of bark beetle with Sentinel-2 is also explored. The work presented is part of MySustainableForest project (H2020-776045).

APPENDIX 2

List of participants during the DAY 1 : 63 participants

Name	Affiliation
Adéla Šedová	Charles University, CZ
Adrian Lorent	INCDS, Romania
Aleksei Trubin	CZU, CZ
Alexander Ariza	RedLatif, UN-Spider
Alexandra Stefanidou	Aristotle University of Thessaloniki
Ana Potočnik Buhvald	UL FGG
Andrej Kobler	Slovenian Forestry Institute
Ángel Fernández	GMV, MySustainableForest
Anisoara Irimescu	MeteoRomania
Argyrios Stergioudis	Aristotle University of Thessaloniki
Asterios Tselepis	FMRS - AUTh
Barta Vojtech	UVGZ
Chris Justice	UMBC, Maryland USA, LCLUC Program
Clay Oboth	*START*
Darko Pleskalt	Croatian forest Ltd.
Dmitry Schepaschenko	IIASA
Ella Sèdé Maforikan	University of Gambia
Eva Neuwirthová	Charles University, CZ
Filip Hajek	FMI Czech
Garik Gutman	*NASA HQ, LCLUC Program Manager*
George Boldeanu	Meteo Romania
Giorgi Ghambashidze	CAUCRIN, SRCA
Ioannis Gitas	AUTh
Ioannis Manakos	CERTH
Ivan Pilas	Division of Ecology, Croatian Forest Research Institute
Jan Novotný	Mendel University, CZ
Jana Albrechtova	*Charles University, CZ, SCERIN*
Jaroslav Čepl	Czech University of Live Sciences - Prague, CZ
Jon Padgham	*START*
Khoda Zabihi, Ph.D.	Research Scientist, EXTEMIT-K Project, CULS
Krishna Vadrevu	*START, NASA LCLUC Program*
Krištof Oštir	UL FGG
Lachezar Filchev	SRTI-BAS, BG
Liza Stanic	ZRC SAZU, Slovenia
Lucie Cervena	Charles University, CZ
Lucie Homolova	Global Change Research Institute, Czech Academy of Sci., CZ
Lucie Kupkova	*Charles University, CZ, SCERIN leader*
Marius Paraschiv	National Insitute for R&D in Forestry Romania
Markéta Potůčková	Charles University, CZ

Matej Račič	Univrsity of Ljubljana, Slovenia
Mesaros Minucer	University of Novi Sad, Serbia
Mihai Daniel Nita	Transylvania University, Ro
Mitja Skudnik	SFI - Slovenia
Monika Anna Tomaszweska	Michigan State University, USA
Niki Ogris	Slovenian Forestry Institute, Department of Forest Protection
Oleh Chaskovskyy	UNFU, Ukraine
Olga Brovkina	Global Change Research Institute, Czech Academy of Sci., CZ
Paulo Victorino	INPE (Brazil)
Petr Lukes	Global Change Research Institute, Czech Academy of Sci., CZ
Petya Campbell	***UMBC + NASA GSFC, SCERIN leader***
Piotr Wezyk	Faculty of Forestry, University of Agriculture in Krakow, Poland
Ratislav Jakus	Czech University of Live Sciences - Prague, CZ
Roman Modlinger	Czech University of Live Sciences - Prague, CZ
Rumiana Vatseva	NIGGG BAS, BG
Růžena Janoutová	Global Change Research Institute, Czech Academy of Sci., CZ
Serhii Havryliuk	UNFU, Ukraine
Tatjana Veljanovski	ZRC SAZU, Slovenia
Ursa	ZRC SAZU, Slovenia
Vince Ambrosia	(NASA-Ames / CSUMB)
Vladimir Starodubtsev	National University of Life and Environmental Sciences of Ukraine
Zdeněk Patočka	MENDELU, MySustainableForest project
Zuzana Lhotakova	Charles University, CZ

List of participants during the DAY 2: 56 participants

Name	Affiliation
Aleksei Trubin	Czech University of Live Sciences - Prague, CZ
Ana Potočnik Buhvald	UL FGG, slovenia
Andrej Halabuk	Institute of Landscape Ecology, Slovak Academy of Sciences, Slovakia
Andrej Kobler	Slovenian Forestry Institute,
Ángel Fernández	GMV, MySustainableForest, Spain
Anisoara Irimescu	MeteoRomania, Romania
Argyrios Stergioudis	Aristotle University of Thessaloniki, Greece
Asterios Tselepis	FMRS - AUTh, Greece
Barta Vojtech	Global Change Research Institute, Czech Academy of Sci., CZ
Cezary	Poland
Clay Oboth	***START***
Darko Pleskalt	Croatian forest Ltd.
Dmitry Schepaschenko	IIASA, Ukraine
Eva Neuwirthová	Charles University, CZ
Garik Gutman	***NASA HQ, LCLUC Program Manager***

George Boldeanu	Meteo Romania
Giorgi Ghambashidze	CAUCRIN, SRCA
Ioannis Manakos	CERTH, Greece
Ivan Pilas	Division of Ecology, Croatian Forest Research Institute
Jan Novotný	Mendel University, CZ
Jana Albrechtova	*Charles University, CZ, SCERIN leader*
Jon Padgham	*START*
Karolina Zieba-Kulawik	UoA in Krakow, Faculty of Forestry
Khoda Zabihi, Ph.D.	Research Scientist, EXTEMIT-K Project, CULS
Krishna Vadrevu	*START, NASA LCLUC Program*
Lachezar Filchev	SRTI-BAS, Bulgaria
Lena Hunt	Charles University, CZ
Liza Stanic	ZRC SAZU, Slovenia
Lucie Cervena	Charles University, CZ
Lucie Homolova	Global Change Research Institute, Czech Academy of Sci., CZ
Lucie Kupkova	*Charles University, CZ, SCERIN leader*
Maarten de Groot	Slovenian Forestry Institute
Marius Paraschiv	National Insitute for R&D in Forestry, Romania
Michał Fabiszewski	Biebrza National Park, Poland
Mihai Daniel Nita	Transylvania University, Romania
Monika Anna Tomaszweska	Michigan State University, USA
Natalia Kobliuk	Charles University, CZ
Niki Ogris	Slovenian Forestry Institute, Department of Forest Protection
Nina Šramel	Slovenian Forestry Institute
Oleh Chaskovskyy	UNFU, Ukraine
Olga Brovkina	Global Change Research Institute, Czech Academy of Sci., CZ
Petr Lukes	Global Change Research Institute, Czech Academy of Sci., CZ
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Piotr Wezyk	Faculty of Forestry, University of Agriculture in Krakow, Poland
Premek Stych	Charles University, CZ
Rastislav Jakuš	Czech University of Live Sciences - Prague, CZ
Roman Modlinger	Czech University of Live Sciences - Prague, CZ
Růžena Janoutová	Global Change Research Institute, Czech Academy of Sci., CZ
Serhii Havryliuk	UNFU, Ukraine
Tatjana Veljanovski	ZRC SAZU, Slovenia
Viktoria Takacs	University of Life Sciences, Institute of Zoology, Poznan, PL
Vince Ambrosia	(NASA-Ames / CSUMB)
Wojciech Krawczyk	UoA Cracow, PL
Zdeněk Patočka	MENDELU, MySustainableForest project, CZ
Zuzana Lhotakova	Charles University, CZ