

# FORMATH SAPPORO 2024

## Program: March 16 (Sat) - 17 (Sun)

**March 16, 2024**

<b>09:50 ~ 10:00 Opening Remarks</b>		Dr. Matsumura	
<b>1.</b>	<b>Session 1</b>	Coordinator: Dr. Sokh	
<b>10:00 ~ 10:30</b>	Improving rice production estimates using hybrid method of multivariate time series and machine learning	Bustanul Arifin*, Warsono, Dian Kurniasari, Rinin Aristiyani, Fitri Yunilestari	University of Lampung, Indonesia
<b>10:30 ~ 11:00</b>	Forecasting of Cocoa beans export-import values of Indonesia and exchange rate data using vector error-correction and long short term memory hybrid models	Warsono*, Dian Kurniasari, Mawar Alhani	University of Lampung, Indonesia
<b>11:00 ~ 11:10 Break</b>			
<b>2.</b>	<b>Session 2</b>	Coordinator: Dr. Takahashi	
<b>11:10 ~ 11:40</b>	Intensive monitoring plots in forest ecosystems: Data rational and first results in cork oak forest systems	Nuno de Almeida Ribeiro*	University of Evora, Portugal
<b>11:40 ~ 12:10</b>	Competition indices further improve the model's predictive ability	Shes Kanta Bhandari**	Tribhuvan University, Nepal
<b>12:10 ~ 13:30 Lunch</b>			
<b>3.</b>	<b>Session 3</b>	Coordinator: Dr. Ribeiro	
<b>13:30 ~ 14:00</b>	Measurement and calculation of emissions reduction in the North Central Coast region of Vietnam to help receiving REDD+ result-based payment	Nguyen Dinh Hung*	Forestry Inventory and Planning Institute, Viet Nam
<b>14:00 ~ 14:30</b>	Countries understanding of current and future GHG emissions for the Agriculture, Forestry and Other Land use sector	Nicklas Forsell*	International Institute of Applied Systems Analysis, Austria
<b>14:30 ~ 15:00</b>	Impact of carbon market on timber and non-timber resources under sustainable forest ecosystem management	Patrick Asante*	Ministry of Forests, BC, Canada
<b>15:00 ~ 15:20 Break</b>			
<b>4.</b>	<b>Session 4</b>	Coordinator: Dr. Konoshima	
<b>15:20 ~ 15:50</b>	Optimal Reserve Site Selection of Gotjawal Forests in Jeju Island, Korea	Ara Seol*	National Institute of Forest Science, Korea
<b>15:50 ~ 16:20</b>	Distance Constraints to Create Green-Pathway as Environmental Concerns for Spatially Constrained Harvest Scheduling	Atsushi Yoshimoto*	Institute of Statistical Mathematics, Japan
<b>16:20 ~ 16:30 Break</b>			
<b>5.</b>	<b>Session 5</b>	Coordinator: Dr. Surovy	
<b>16:30 ~ 17:00</b>	Has Economic Growth Been Reducing Natural Disaster Damages in Vietnam?	Tetsuya Michinaka*, Ehara Makoto, VU Tan Phuong, Nguyen Thuy My Linh, Okamoto Takashi, Shimizu Katsuto, HA Van Tiep, VU Van Tuan	FFPRI, Japan
<b>17:00 ~ 17:30</b>	Developing a Landslide Probability Model Using Similarity-Based Sampling of Absence Data: A Case Study in Itsuki Village, Kumamoto Prefecture, Japan	Yasushi Mitsuda*	Univ. of Miyazaki, Japan
<b>17:30 ~ 19:00 Dinner</b>			
<b>19:00 ~ 20:30 FORMATH Research Society Annual General Meeting</b>			

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<b>6.</b>	<b>Session 6</b>	<b>Coordinator: Dr. Mitsuda</b>	
<b>10:00 ~10:25</b>	Using social media big data to assess tourism pressure and its impact on conserved animals - Shei-Pa National Park as an example	Chih-Lin Liu*	National Chung Hsing University, Taiwan
<b>10:25 ~10:50</b>	Analysis of Economic Utilization on Domestic Timber of <i>Larix kaempferi</i> in South Korea	Hee Han*	Seoul National University, Korea
<b>10:50 ~11:15</b>	Spatial and temporal pattern of wildlife mortality in vehicle collisions in Nepal	Narayan Prasad Gautam*	Tribhuvan University, Nepal
<b>11:15 ~11:40</b>	Analysis of the geographic and vegetation factors influencing predation damage on sea turtle eggs by alien Japanese wild boar ( <i>Sus scrofa leucomystax</i> ) on Tokashiki Island, Okinawa, Japan	Takahiro Hirai, Masashi Konoshima*, Takeshi Eto, Ikuo Ota	University of the Ryukyus, Japan

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**11:40 ~12:40 Lunch**

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<b>7.</b>	<b>Session 7</b>	<b>Coordinator: Dr. Han</b>	
<b>12:40 ~13:05</b>	Seed Orchard Establishment in Cambodia: Experiences and Challenge	Heng Sokh*	Institute of Forest and Wildlife Research and Development, Cambodia
<b>13:05 ~13:30</b>	Establishment of High Value Tree Species Breeding Center in Cambodia.	Ma Vuthy*	Institute of Forest and Wildlife Research and Development, Cambodia
<b>13:30 ~13:55</b>	Potential improving of local livelihood relating to Non-Timber Forest Products (NTFPs) commercial utilization in Laos: A case study in the northern part of Laos, Phiang District Xayaboury Province.	Phongxiong Wanneng*	National University of Laos, Laos

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**13:55 ~14:15 Break**

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<b>8.</b>	<b>Session 8</b>	<b>Coordinator: Dr. Forsell</b>	
<b>14:15 ~14:40</b>	Estimation tree growth from bitemporal LiDAR data: A case study in the Bohemian Switzerland National Park	Zlatica Melichová*	Czech University of Life Sciences Prague, Czech Republic
<b>14:40 ~15:05</b>	Remote sensing-based monitoring of natural disturbances in forest ecosystem using modern high-tech data	Tereza Hüttnerová*	Czech University of Life Sciences Prague, Czech Republic
<b>15:05 ~15:30</b>	Applications of AI in forest management. Examples and opinions	Peter Surový*	Czech University of Life Sciences Prague, Czech Republic
<b>15:30 ~15:55</b>	Selection of time varying Height-Diameter curves	Tetsuji Tonda*	Prefectural University of Hiroshima, Japan
<b>15:55 ~16:00</b>	<b>Closing Remarks</b>	Dr. Yoshimoto	ISM, Japan

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**16:00 ~19:00 Dinner**

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\* indicates those invited speaker, while \*\* indicates online presentation.

ONLINE:Topic FORMATH 2024 SAPPORO, Date: 2024/3/16-17 09:00 - 18:00

<https://us06web.zoom.us/j/84685191514?pwd=c2t5sKHGrPS8libt4bZrFmwUeEmbGn.1>

Meeting ID: 846 8519 1514, Passcode: 917799

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**March 16, 2024**  
**Session 1**

**Improving Rice Production Estimates Using Hybrid Method of Multivariate Time Series and Machine Learning**  
*Bustanul Arifin (University of Lampung, Indonesia), Warsono, Dian Kurniasari, Ririn Aristiyani, Fitri Yunilestar*

The objective of this study is to improve rice production estimates using a hybrid method of multivariate time series and machine learning. Specifically, the study reviews the potential figures for rice production for the past 6 years, which are calculated using the area sampling frame (KSA) method, and examines the pattern of relationship between several variables that determine the figures of harvested areas, productivity, and rice production. The study employs a hybrid method of multivariate time series techniques and machine learning by analyzing monthly data on harvested area, productivity, and rice production collected from over 23 thousand segment samples across Indonesia. The study finds that the existing actual and potential data on harvested area of rice, productivity, and rice production is problematic because the deviation from the actual figures is quite large. The performance of productivity and technological changes has not been fully captured in the rice production figures and other relevant publications on the Indonesian rice economy. The new rice estimates using a hybrid method of multivariate time series and machine learning have improved the consistency of potential and actual data of harvested areas, thereby improving productivity and rice production estimates. The new estimates using the hybrid method are also able to capture the farmers' initiatives, community efforts, and government programs to increase rice productivity, thereby reflecting the efficiency of productivity-increasing and farmers' welfare-improving programs in Indonesia.

**Forecasting of Cocoa beans export-import values of Indonesia and exchange rate data using vector error-correction and long short term memory hybrid models**  
*Warsono (Department of Mathematics, University of Lampung, Indonesia), Dian Kurniasari, Mawar Alhani*

In this research, we investigate the predictive capability of a hybrid model combining Vector Error Correction Model (VECM) and Long Short-Term Memory (LSTM) networks for forecasting the dynamics of cocoa export-import value and exchange rate of Indonesia fluctuations. The study employs monthly data on cocoa export and import values from major producing and consuming countries, alongside exchange rate fluctuations, spanning from 2010 to 2023. Our evaluation focuses on forecasting accuracy, using metrics such as Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), and Accuracy. The VECM-LSTM hybrid model produces an RMSE of 8040.11, a MAPE of 0.595, and Accuracy of 99.405 with 80% training data and 20% testing data.

**Intensive monitoring plots in forest ecosystems: Data rational and first results in cork oak forest systems**

*Nuno de Almeida Ribeiro (University of Évora, Portugal)*

In Iberian Peninsula, the effects of climate change altered both precipitation and temperature regimes increasing the aridity in all territory. The extreme events are also increased with particular relevance to high temperature periods and prolonged drought. The new climatic dynamics and its unknown contribution to the forest systems functioning led to the necessity of new modelling approaches based on structural functional rational, more in line with basic sciences. For that modelling purpose, a set of intensive monitoring plots were installed with continuous monitoring systems of radiation absorption, interception of precipitation, evapotranspiration, nutrient uptake, photosynthesis, respiration, photosynthate allocation, senescence and mortality in addition with the tree 3D periodic dendrometric data all collected in long term ecological Mediterranean forest research plots. In the present work it is presented the complex data structure rational and the synchronic/diachronic statistics used for the presentation and analysis of the first results in cork oak forest systems. The results show the contribution of the functional structural variables on tree growth responses and permitted to develop presented new with modelling strategies.

**Competition indices further improve the model's predictive ability**

*Shes Kanta Bhandari (Tribhuvan University, Nepal)*

This study aims to analyse the growth of individual trees of jarrah (*Eucalyptus marginata*), a wide-spread species having ecological and economic importance in Western Australia. Specifically, tried to find 1) Does tree size predict the tree growth, 2) whether this prediction could be improved by accounting for competition, 3) how many neighbouring trees or what neighbourhood distance needed to be considered when accounting for competition; and 4) whether neighbouring tree growth could be a potential predictor variable. Tree size was significantly predicted the growth. Prediction was improved when competition was included in the models. A new spatial competition index (CI) developed in this study performed better than previously developed CIs. Prediction of diameter growth was optimized by accounting for competition from the 10 to 12 closest competitors or competitors within ~10 m from the base of the subject tree. As competition from neighbours had a significant negative effect on growth, we recommend including neighbourhood competition when explaining/predicting growth and considering thinning treatments to minimize the effect of competition on growth. The modelling approaches developed in this study are likely to be useful tools for understanding and managing individual tree growth of any species in the world where competition among trees restricts individual growth. Novelty includes the first model explaining individual jarrah growth; an effective new competition index; an approach to testing how many neighbouring trees or what neighbourhood distance needs to be considered when accounting for competition.

Key words: competition, growth, jarrah, model, thinning.

**Measurement and Calculation of emissions reduction in the North Central Coast region of Vietnam to help receiving REDD+ result-based payment**

*Nguyen Dinh Hung (Forest Inventory and Planning Institute, Vietnam)*

In this work, we used the sample plots data collected in the North Central Coast region of Vietnam during periods 2001-2005, 2006-2010 and 2016-2020 taken from the national forest inventory, monitoring and assessment project to calculate the emission/removal factors and the regional forest cover maps of the years 2005, 2010, 2015 and 2019 to generate the activity data. The emission/removal factors were then used in combination with the activity data to calculate the emissions reduction for the period 2018-2019. To meet the requirement from the Forest Carbon Partnership Facility (FCPF), the uncertainty of the emission reduction was calculated using the Monte Carlo simulation method. The results of this work have helped Vietnam to get the first REDD+ result-based payment of 51.5 million USD, which will be used to promote better forest protection and management in Vietnam.

**Countries understanding of current and future GHG emissions for the Agriculture, Forestry and Other Land use sector**

*Nicklas Forsell (International Institute of Applied Systems Analysis, Austria)*

In this presentation I will share our latest work related to the global GHG emissions for the Agriculture, Forestry and Other Land use (AFOLU) sector. We have created a database of countries historically reported estimates and targets as submitted to the UNFCCC in terms of their Nationally Determined Contribution (NDCs) and Long-Term strategies (LTS). From these databases we will discuss the current state of the sector and which countries/regions are taking real actions in terms of setting ambitious and real targets for the sector.

**Impact of carbon market on timber and non-timber resources under sustainable forest ecosystem management**

*Patrick Asante (Ministry of Forests, Government of British Columbia, Canada)*

Although there is considerable interest in the potential for forests to sequester carbon in British Columbia, Canada, the impact of carbon market on timber and non-timber resources has received relatively little attention in literature. This paper examines the impact of a particular form of carbon market on timber and non-timber values when sustainable forest ecosystem management is practiced. Using a forest in Northeastern British Columbia as a study area and a constrained optimization model, the results show that the presence of co-benefits depends upon ecological parameters, the harvest flow regulation faced by the landowner and the incentives for timber supply provided by the carbon market. The results also show that a landowner who agrees to enter contracts for carbon sequestration will do so at the expense of a decline in timber supply.

Keywords: Carbon Market, Non-Timber Values, Co-Benefits, Sustainable Ecosystem Management, Constraint Optimization

**Optimal Reserve Site Selection of Gotjawal Forests in Jeju Island, Korea**

*Ara Seol (National Institute of Forest Science, Korea)*

Gotjawal is a forest created on volcanic land, playing a crucial role as a biodiversity hotspot and ecologically very important forest in Jeju Island, South Korea. About 76.5% of Gotjawal is privately owned forests, but there is a prevalent atmosphere of inadequate forest management and a tendency to develop or use it for other purposes. To conserve Gotjawal, the Korea Forest Service and the Jeju Provincial Government have been making efforts to purchase private Gotjawal forests and manage them as national forests. Fixed budgets are allocated annually, and within the limited budgets, priority areas are purchased based on policymakers' judgment. However, there is a lack of a clear roadmap for purchase decisions so dissatisfaction with the results of acquisitions has been raised. This study aimed to provide an objective roadmap using optimization techniques to assist in the decision-making process for acquiring privately owned forests in Gotjawal.

**Distance Constraints to Create Green-Pathway as Environmental Concerns for Spatially Constrained Harvest Scheduling**

*Atsushi Yoshimoto (Institute of Statistical Mathematics, Japan)*

During last few decades, harvest scheduling has drastically changed as forest ecosystem and environmental conflicts are taken into account deeply in the management scheme. Adjacency came in 1980's, followed by green-up, and maximum opening size constraints. Recent challenge is creation of wildlife corridor and buffer zone for protected area within harvesting zones, which often disjoints continuous harvesting operation. On the one side, the problem sounds nicely stated for environmental preservation movement, but on the other side, solution searching becomes very difficult. Distance constraint is to keep some distance among concurrent harvesting spots. By the distance constraint, green-pathway in the harvesting zone is guaranteed to be created by harvesting activities. In this presentation, I propose a model to solve spatially constrained harvest scheduling with distance constraint within the aggregation framework.

### **Has Economic Growth Been Reducing Natural Disaster Damages in Vietnam?**

*Tetsuya Michinaka (Forestry and Forest Products Research Institute, Japan), Ehara Makoto, VU Tan Phuong, Nguyen Thuy My Linh, Okamoto Takashi, Shimizu Katsuto, HA Van Tiep, VU Van Tuan*

Natural disasters, including floods, storms, typhoons, landslides, etc., pose significant threats, causing loss of life, injuries, and extensive damage to property, capital, and lifeline infrastructure. While existing research indicates that developing nations tend to experience more adverse effects caused by natural disasters, it remains crucial to examine the specific impacts within a country. This study focuses on Vietnam, a nation prone to natural disasters, utilizing annual panel data from 2010 to 2020 at the provincial level (63 cities and provinces) sourced from GSO, Vietnam and GIS.

Analyzing both natural and human factors, including elevation, Terrain Ruggedness Index (TRI), land area, precipitation, forest coverage, plantation forest area, population density, per capita gross regional domestic product (GRDP), and agricultural GRDP, we employed various statistical models such as the Poisson model, zero-inflated Poisson model, and Bayesian Poisson regression model to analyze the number of deaths and missing caused by natural disasters in Vietnam.

Scatterplot analysis revealed that higher occurrences of deaths and missing persons were observed in provinces with lower per capita GRDP. In model selection, the Poisson Pseudo Maximum Likelihood (PPML) regression with High-Dimensional Fixed Effects model yielded the best results. However, it did not confirm the mitigating role of economic development indicated by per capita GRDP. Instead, agricultural GRDP was found to mitigate damages. Higher precipitation and plantation forests were identified as contributors to damages. Other models show that TRI and land area were associated with higher damages. Surprisingly, population density was not found to be a driver of damages. The finding that plantation forests could not mitigate damages may be attributed to the weak protective function of planted trees at lower level of age classes against disasters.

However, further exploration is required to elucidate the nuanced effects of natural disasters on socioeconomic development in Vietnam. This research contributes to our understanding of the complex interplay between economic factors and disaster impacts, offering valuable insights for policymakers and disaster management authorities.

### **Developing a Landslide Probability Model Using Similarity-Based Sampling of Absence Data: A Case Study in Itsuki Village, Kumamoto Prefecture, Japan**

*Yasushi Mitsuda (University of Miyazaki, Japan)*

Landslide susceptibility maps are essential for sustainable forest management. In order to produce these maps, we developed a landslide probability model using time-series LiDAR data in Itsuki Village, Kumamoto Prefecture, Japan. To model landslide probability, both landslide presence data and landslide absence data (areas where landslides did not occur) are necessary. The quality of the landslide presence/absence sample data is crucial for developing a reliable landslide probability model. The landslides that occurred in July 2020 were detected by comparing high-resolution digital elevation models (DEMs) before and after the landslide hazard, derived from airborne LiDAR data. To generate high-quality landslide absence data, a similarity-based sampling method was applied. Additionally, we generated another landslide absence sample dataset using simple random sampling. Logistic regression analysis was conducted on the landslide presence/absence sample datasets, using topographic factors (slope, roughness, curvature, topographic position index, topographic relief index, standard deviation of horizontal curvature, flow accumulation, and topographic wetness index) as explanatory variables. Our results indicate that a landslide probability model developed using a dataset derived from a similarity-based sampling method had a better performance in predicting landslide occurrence than another model using a dataset derived from simple random sampling for generating a landslide absent dataset.

**Using social media big data to assess tourism pressure and its impact on conserved animals - Shei-Pa National Park as an example**

*Chih-Lin Liu (National Chung Hsing University, Taiwan)*

Taiwan's Shei-Pa National Park has magnificent mountains, diverse ecosystems and unique biodiversity. This study aims to analyze the pressure of tourism on conserved organisms in Shei-Pa National Park. We use Flickr data, MaxEnt biological prediction model, and geographic information system (GIS) to understand the spatial distribution of tourists and their impact on the conserved organisms in Shei-Pa National Park. The results of the study are the predicted distribution of 16 species of protected organisms (levels one to three), and overlay of the spatial distribution of tourists within ten years (2008 to 2017). The analysis results of this study show that tourism pressure is in the recreation areas and where the infrastructure is more convenient. The pressure in the areas (hotels, roads, trails) is relatively high and pose the most serious threat to conserved organisms. On the contrary, peaks with steep altitudes are difficult to reach due to human footprints, which provides better habitat protection for most of the second-level protected animals, including eagles. This study provides a reference for future management policy for sustainable tourism in Shei-Pa National Park by analyzing the magnitude and distribution of tourism pressure.

**Analysis of Economic Utilization on Domestic Timber of *Larix kaempferi* in South Korea**

*Hee Han (Seoul National University, Korea)*

This study aimed to evaluate the economic utilization system to enhance the value addition of domestic *Larix kaempferi* timber. Through simulation analysis of the milling process, this study identified the types and volumes of wood products that could be generated from larch logs of various dimensions and evaluated the economic gains from different application scenarios. The findings showed that the production of utility timber could multiply the total product value by 6, and structural timber by as much as 8 times, in contrast to the production of solely temporary construction materials. Moreover, larch logs with a diameter at breast height (DBH) of 26 cm or more were deemed appropriate for structural timber use, though the spectrum of viable wood products shifted with the dimensions of the milled logs. Consequently, it is crucial to classify logs during harvesting based on their future application and distribute them to the appropriate consumers to maximize the value chain of domestic timber.



**Spatial and temporal pattern of wildlife mortality in vehicle collisions in Nepal**

*Narayan Prasad Gautam (Tribhuvan University, Institute of Forestry, Nepal)*

Wildlife-vehicle collision is a major conservation issue globally. In Nepal, wildlife mortality along the roads passing through protected areas has been an emerging conservation problem where related studies are scanty. Therefore, the study aims to assess ecological and anthropogenic factors affecting wildlife roadkills and to understand its spatial and temporal pattern in Banke (BaNP)-Bardia National Park (BNP) complex of Nepal. A 124 km long highway passed through the study area, which was divided into 62 segments (2km each) for roadkill surveys where GPS points of roadkills were recorded. Altogether, 101 instances of roadkills were observed, with birds being the most affected taxa (41%). Besides these, five years (till 2022) of wildlife roadkill data were gathered from the park office, which revealed 331 roadkills, with Poisson regression modelling indicating higher likelihood near water holes ( $\beta_{river} = 0.39$ ,  $p = 0.003$ ) and lower in areas with higher visibility ( $\beta_{visibility} = -0.20$ ,  $p = 0.001$ ) and human settlements ( $\beta_{settlement} = -0.24$ ,  $p = 0.0001$ ) where eight candidate models were developed and compared using the AIC. The relative roadkill per km was higher in BaNP (0.14) than in BNP (0.13). One-way ANOVA showed no significant difference in season-wise roadkills in BNP, but BaNP had significantly higher roadkills in winter. Kernel density estimation in ArcGIS was used for hotspot identification and mapping of the risk zones. The findings suggest that hotspots should be identified and prioritized for wildlife-friendly infrastructures, and for better visibility, roadside vegetation should be managed. Further, it suggests creating wildlife passages, speed-breakers, and warning signs in susceptible areas to mitigate roadkill.

**Analysis of the Geographic and Vegetation Factors Influencing Predation Damage on Sea Turtle Eggs by Alien Japanese Wild Boar (*Sus scrofa leucomystax*) on Tokashiki Island, Okinawa, Japan**

*Takahiro Hirai, Masashi Konoshima\* (University of the Ryukyus, Japan), Takeshi Eto, Ikuo Ota*

Tokashiki Island with convenient access from urban areas and blessed with rich marine resources, attracts numerous tourists seeking recreational activities such as diving and snorkeling. The island heavily relies on a tourism industry centered around marine resources. However, with the escape and rapid increase in the population of Japanese wild boars, which were initially introduced as livestock, various damages have become evident. Particularly in recent years, a major concern for local tourism industry stakeholders is the predation of sea turtle eggs by wild boars because sea turtles are highly popular marine creatures among snorkelers and divers. Identifying the locations of sea turtle egg predation by wild boars and examining the conditions and situations that increase the likelihood of damage are crucial tasks in considering measures to mitigate the impact. Therefore, in this study, we analyze the factors influencing egg predation using a two-variable logistic regression model. The damage site data from on-site surveys conducted during the 2023 nesting season were utilized along with topographical, land-use, and vegetation data. Explanatory variables included in the regression analysis are the average slope angle around the damage site, predominant vegetation around the damage site, distance from residential areas, distance from roads, distance from rivers, and depth of the sandy beach. Results from the regression analysis revealed that the predominant vegetation surrounding the damage site and the depth of the sandy beach significantly influence the risk of damage. Despite encountering challenges during the regression analysis, such as utilizing data from a single year's nesting season, relatively coarse geographical information, and limited explanatory variables, future endeavors should focus on collecting and accumulating more data for a more comprehensive analysis. Nevertheless, this analysis underscores the value of information provided by such studies in establishing spatial priorities for implementing measures to capture wild boars and protect sea turtle eggs in the future.

### **Seed Orchard Establishment in Cambodia: Experiences and Challenges**

*Heng Sokh (Institute of Forest and Wildlife Research and Development, Cambodia)*

Amidst the alarming rates of deforestation in Cambodia, the government has undertaken a nationwide initiative to replenish the depleted forestlands. However, this endeavor has highlighted a pressing need for adequate planting materials to support the restoration efforts. The scarcity of high-quality germplasm for large-scale seedling production has emerged as a significant hurdle within the forestry sector. To address this critical issue, the Institute of Forest and Wildlife Research and Development (IRD) of Cambodia is spearheading the project titled "Establishment of Forest Genetics Research Center for Restoration of Major Timber Species in Cambodia," generously funded by ASEAN-ROK Forest Cooperation (AFoCO). This landmark project aims to execute partly a comprehensive long-term tree breeding plan, aligning with Cambodia's broader initiatives to rehabilitate degraded and deforested areas. As a starting point, the project targets three key species: *Dalbergia cochinchinensis*, *Pterocarpus macrocarpus*, and *Dipterocarpus intricatus*. During the establishment of the seed orchard, IRD conducted a series of meticulous experiments to determine the most effective methods for asexual propagation of the priority species, comparing cutting and grafting techniques. While *P. macrocarpus* and *D. cochinchinensis* exhibited higher success rates, *D. intricatus* presented formidable challenges. Efforts to induce root development through cutting experiments proved futile, and successful grafting proved to be elusive. Consequently, grafted seedlings were utilized for *D. cochinchinensis* and *P. macrocarpus*, while seedlings for *D. intricatus* were sourced from superior plus trees. The endeavor has already borne fruit, with the seed orchard, now in its fifth year, demonstrating promising results. Despite encountering adverse weather conditions such as strong winds and unpredictable rainfalls, the orchard has yielded moderately strong and healthy grafts. Looking ahead, the project seeks to evaluate the viability and performance of seeds produced by grafted mother trees, including assessing seed germination and growth in field conditions. However, several challenges persist, including the biennial fruiting patterns of certain species and the susceptibility of grafted plants to climate change-induced factors such as prolonged droughts. Moreover, the risk of pollen contamination, particularly from naturally growing targeted tree species. Addressing these challenges necessitates ongoing research, collaboration, and adaptive management strategies to ensure the success of reforestation endeavors and sustainable forest management practices in Cambodia.

### **Establishment of High Value Tree Species Breeding Center in Cambodia**

*Ma Vuthy (Institute of Forest and Wildlife Research and Development, Forestry Administration, Cambodia)*

Establishment of High Value Tree Species Breeding Center in Cambodia. The project aims to conserve and develop genetic resources of rare and endangered tree species in Cambodia while promoting green economic development in rural areas. Specific objectives include conserving and developing genetic resources through collection, propagation, and plantation of valuable tree species, enhancing the capacity and knowledge of local government staff and foresters, promoting natural resources conservation through rural economic development via eco-forest farms, and disseminating project experiences for sustainable management. The third year of the project focuses on constructing a high-value tree breeding center and greenhouse, collecting valuable tree germplasm resources, producing seedlings, planting high-value tree species, and maintaining planted trees in eco-forest farms and conservation gardens. The project has made significant strides in advancing tree breeding and conservation efforts in Cambodia, with major accomplishments including the construction of the High Value Tree Species Breeding Center, the establishment of a greenhouse, and the collection of valuable tree germplasm resources. Research and development in tissue culture for eight valuable tree species has shown promise, despite facing budget constraints that have impacted the establishment of demonstration high-value tree species conservation gardens and eco-forest farm projects, resulting in scaled-down planting efforts and postponed accessory facility construction. Nonetheless, progress has been made in cultivating seedlings of precious tree species for ex-situ conservation and cultivation across various planting sites, with a demonstration plantation of precious tree species established to showcase sustainable land use practices. The project has also conducted domestic training sessions for forestry officials and rural communities on various aspects of tree species management, despite postponements of overseas training and exchange visits due to budget limitations. An eco-forest farm has been established as a demonstration site for sustainable land use, focusing on improving livelihoods and environmental sustainability through careful maintenance practices. Challenges faced by the project include limited funding from sponsors and the effects of the COVID-19 pandemic, leading to delays in project activities. However, the project team has responded diligently to these challenges, prioritizing essential activities such as construction works, seed collection, tree planting, and maintenance of tree plantations in Siem Reap. Despite these obstacles, the project is on track to largely achieve its objectives, with significant progress noted in various areas. Moving forward, lessons learned from overcoming challenges such as poor soil quality, extended germplasm collection periods, and the necessity of careful monitoring and technical assistance for tree plantations will be invaluable. Regular monthly meetings and field checks have facilitated progress monitoring and issue resolution, ensuring that the project remains focused on its goals despite obstacles. Overall, the project has demonstrated resilience and determination in the face of adversity, highlighting the importance of flexibility and adaptability in achieving long-term conservation and sustainable land use objectives.

**Potential improving of local livelihood relating to Non-Timber Forest Products (NTFPs) commercial utilization in Laos: A case study in the northern part of Laos, Phieng District Xayaboury Province**  
*Phongxiang Wanneng (Faculty of Forest Science, National University of Laos, Laos)*

The specific purposes of this research are to assess the potential Non-Timber Forest Products (NTFPs) species utilization and their contributing to local people's income in 3 Villages, Phieng District Xayabuli Province. The survey focused on households' interview methods. The finding showed that in general NTFPs have generated a fairly high income to the local people compared to other income sources in the targeted villages. On average, NTFPs shared approximately 8.59% of the total household's income per year by comparing to others higher incomes in the household. These included, such as cassava and jobs tear cultivation 61.18%, cultivation 22.06% per year accordingly. The finding indicated that on average NTFPs contributed to the household's income of 3,249,491 Kip/household/year. The NTFPs species that generated the highest income to the local people are red vine (khuedengdang) following by sugar palm (Maktao), rattan shoots, broom grass flower, wild teas and wild ginger. The results showed that NTFPs promotion in terms of marketing and products adding value in processing in the targeted villages are still limited. The price and value adding to NTFPs species are still low. The marketing chain for NTFPs are still limited. The trading chains in the site are mainly limited within Phieng District and Xayabuli Province. Very few NTFPs are sold in others provinces such as Vientiane Province. There is only sugar palm (Maktao) products are exported to sell in Vientiane Province. However, the amount of product trading is small. The resources of Non-Timber Forest Products in the targeted villages are currently reported in decreasing compared to the previous years due to the change of forest land to agricultural land use and other factors. It highly recommended that the local people and related government agencies should increase NTFPs supporting and promoting in the future. The supporting methods can be included NTFPs natural assisted management and plantation in the suitable sites of villages such as protected forest and village forest areas. However, the supporting program should select only some NTFPs species that have high potential within the village in terms of income and resources generations, for example, sugar palm, wild teas and vine red. These three species have well grown under the shade of trees, which are the best NTFPs species to promote for natural management and plantation under forest shade. The species should be promoted plantation in the Nam Phi national protected area (NPA) where is near at the target villages. In addition, these species will benefit the local people in many ways such as food, generate income and as well as will be an important factor in protecting the forest areas. The finding also revealed that the local people are still lacking knowledge and information relating to NTFPs management, plantation, harvesting techniques and products processing. Therefore, the government agencies should provide these kinds of capacity building skills to the local people. There is also a conflict buying NTFPs in the site between traders who are registered and some people who are not registered. For NTFPs marketing promotion in the site, the project and government agencies should build a shop or point of sale (booth) along the main road (Vientiane-Xayabuli) where is located somewhere in the targeted villages. This sale point should be a nice view and large area for car parking and rest, and also for passengers to drink the wild tea. This wild tea can be promoted as a unique product to Phieng District, Xayabuli Province. This booth can also be used to sell other types of NTFPs.

**Estimation tree growth from bitemporal LiDAR data: A case study in the Bohemian Switzerland National Park**  
*Zlatica Melichová (Czech University of Life Sciences Prague, Czech Republic)*

The acquisition of forest data using light detection and ranging technology (LiDAR) is currently one of the leading methods in forest mensuration. LiDAR is able to be deployed also in worse light conditions and can even be acquired during night flights, allowing the utilization of airspace when the traffic is lower. The laser beams are able to penetrate canopy even in relatively closed canopies, and so provide detailed information about the ground. The ground information is essential for the height estimation and also other LiDAR metrics. Thanks to the modern precise GPS mensuration the global coordinates of the surface points are also measured with centimeter accuracy. So repeated scans can reveal the increments in the same position and can be helpful for estimating the growth of individual trees and forest stands. In remote sensing two principal methods are used to model the forest parameters. Individual tree approaches, where the aim is to find individual trees and derive the information about each tree separately, and area-based approaches known as ABA, where a given area is evaluated for its parameters and structural characteristics of lidar data (metrics) and correlated with forest stand. In this work we present findings about the estimation of growth using second mentioned approach on unmanaged territory of national park, e.g. forest without any intervention and a possibility of using such bitemporal data for growth estimates. The result indicates that growth curve parameters can be satisfactorily derived from bitemporal Lidar data.

Keywords: LiDAR, airborne laser scanning, area-based approach

**Remote sensing-based monitoring of natural disturbances in forest ecosystem using modern high-tech data**  
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In recent decades, forest ecosystems have been increasingly affected by natural disturbances, including insect pests, wind through events, and forest fires. A very effective method of mapping or detection is remote-sensing images. In the case of recorded stress in the forest stand, in most cases, there is a change in the spectral reflectance of the vegetation; these changes can be detected based on, for example, multispectral images or hyperspectral images. In some cases, the stressed tree can remain spectrally healthy; in these cases, it is impossible to detect the degradation of the forest cover at an early stage based on optical data. A potential stress detection method could be chemical measurement (satellite data Sentinel-5P, electronic nose measurement, or conventional chemical detection methods). We verified the possibility of using chemical data for data-driven natural disturbance maps. We experimented with the 2022 summer forest fire in the Bohemia Switzerland National Park, where around 1,000 ha were disturbed. For data validation, we collected field data on the intensity and location of fire spread. We aimed to find a correlation between the measured chemical data and the burning intensity in the park. Our results promise the suitability of this methodology for mapping stress factors in the forest ecosystem and lead to a more extensive study with diversifying other types of natural disturbances.

Keywords: chemical mapping, natural disturbances, forest fire, satellite data, early detection.

**Applications of AI in forest management. Examples and opinions**

*Peter Surový (Czech University of Life Sciences Prague, Czech Republic)*

Models for artificial intelligence has gained a lot of attention in last years. AI has become a powerful tool in many aspects of human life, and many new innovations are emerging. In forestry one of the most obvious examples of application of AI is in data acquisition, especially in remote sensed materials, where AI is deployed in image analysis, namely classification and more recently object detection and segmentation. In the first part of the presentation we will demonstrate application of two AI models YOLO and Detectron2 for detection of dead trees in aerial remote sensed imagery, and discuss their advantages and disadvantages. Both models perform relatively well achieving the AP50 accuracy of 60 to 80 percent. The individual models perform differently on different datasets however overall accuracy is generally better in images with less objects (with less dead trees per hectare). In second part of the presentation we will present current status of other models emerging from computer research, especially in generative AI research field as image and video or moving image creation and their hypothetical application in forest management. Finally, well known phenomena of large language models (LLM) is going to be presented and described the bases and functionalities. We will focus on transfer learning of the open source models (including lower versions of ChatGPT) and its potential applications in forest management, discussing the potential of this technology together with the cost associated with their utilization.

**Selection of time varying Height-Diameter curves**

*Tetsuji Tonda (Prefectural University of Hiroshima, Japan)*

Height-Diameter curve is a function that defines the relationship between diameter at breast height and tree height. It is the mean trend on a scatter plot of tree height against diameter at breast height for measurements on individual tree growth. Introducing varying coefficients into the Height-Diameter curves, we construct the statistical models to estimate the temporal trend of Height-Diameter curves with aging. To select an appropriate model among multiple candidates, we apply the Cross-Validation (CV) criterion. In particular, the n-fold CV criterion is adopted for the purposes of forecasting the temporal trend. We demonstrate the results for analyzing real data of Sugi (*Cryptomeria japonica*) stands in even aged plantation forest in Japan by preparing five candidate models.