Joint International Symposium on Sustainable Forest Ecosystem Management (SFEM) by Japan, Taiwan and Korea
- SFEM 2022 Hybrid -

Organizers: Japan Society of Forest Planning
Taiwan Society of Forest Ecosystem (TWFEM)
Korean Society of Forest Management and Iformatic
Risk Analysis Research Center (RARC), ISM
FORMATH Research Society, Japan
Co-Organizer: Graduate School of Biosources, Mie University, Japan

Date September 1 (Thu) - 2 (Fri), 2022
Venue Mie University Onsite with Zoom Online

President

Naoto Matsumura, Ph.D. (Mie Univ.)

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Committee

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Masayoshi Takahashi, Ph.D. (FFPRI)

Chao-Huan Wang, Ph.D. (National Ilan Univ.)

Program & Abstract

SFEM 2022 Hybrid

Date			**September 1 (Thu), 2022**		
9:00	～	9:10	Opening Remarks	Naoto Matsumura	Mie Univ., Japan
1.			**Management**	Coordinator: Yusuke Yamada	FFPRI
9:10	～	9:40	The impact of agroforestry adoption on the welfare condition of smallholders' farmers in East Java of Indonesia	Hari Wahyu Wijayanto	National Pingtung University of Science and Technology, Taiwan
9:40	～	10:10	DX of forest management in the LiDAR era From forest stand polygons to Tile polygons	Kazuhiro Tanaka	Kyoto University of Advanced Science, Japan
10:10	**～**	**10:30**	**Break**		
2.			**UAV**	Coordinator: Masayoshi Takahashi	FFPRI, Japan
10:30	～	11:00	Drone-based photogrammetry for recording the individual old-growth and giant trees -Analysis of the influence of photography methods on reconstruction	Kaili HUANG	Mie University, Japan
11:00	～	11:30	Application of thermal sensing and water indices for drought monitoring: A case study in Lishan, Taiwan	Nova D. Doyog	National Chiayi University, Taiwan
11:30	**～**	**13:00**	**Lunch Break**		
13:00	**～**	**14:00**	**Poster Session** Masashi Konoshima	Hiroyuki Matsunaga Han-Ching Hsieh	
Date			**September 2 (Fri), 2022**		
3.			**Measurement**	Coordinator: Hee Han	Institute of Statistical Mathematics, Japan
13:00	～	13:30	Long-term aboveground biomass changes in a monsoon wind-shaped forest	Chen-Chia Ku	National Chiayi University, Taiwan
13:30	～	14:00	Artificial intelligence with deep learning technique as a tool in tree stem volume estimation	Chao-Huan Wang	National Ilan Univ., Taiwan
4.			**Inventory**	Coordinator: Yasushi Mitsuda	Miyazaki University, Japan
14:00	～	14:30	Effect of Samples Not Including Short Trees on Estimation for Tree Height in Pinus koraiensis plantation	Joonghoon Shin	National Institute of Forest Science, Republic of Korea
14:30	**～**	**14:50**	**Break**		
5			**Monitoring**	Coordinator: Masayoshi Takahashi	FFPRI, Japan
14:50	～	15:20	Forest dynamic in Hehuan plot, Taiwan	Chieh-Yu Liao	National Chiayi University, Taiwan
15:20	～	15:50	Effect of GCPs on Performance of UAV-SfM-based Point Cloud Data in Forest Inventory	Tatsuki Yoshii	National Chiayi University, Taiwan
15:50	～	16:00	Closing	Prof. Chinsu Lin	National Chiayi University, Taiwan

September 1 (Thu)
9:10～10:10 Management

The impact of agroforestry adoption on the welfare condition of smallholders' farmers in East Java of Indonesia

Hari Wahyu Wijayanto (National Pingtung University of Science and Technology)
Kai-An Lo (National Pingtung University of Science and Technology)

Agroforestry has an essential role to reduce global poverty and maintaining environmental sustainability. However, little is known about the association between agroforestry and farmers' welfare condition. This study aims to estimate the factors affecting agroforestry adoption and investigate the welfare effect of agroforestry adoption on smallholder farmers. The cross-sectional data were collected from 301 potato farmers in East Java of Indonesia. A logit regression analysis was used to estimate the factors affecting farmers' decision to adopt agroforestry, and propensity score matching (PSM) to investigate the welfare effect of agroforestry adoption, which was measured by farming income and non-farming income. The finding inculcated that agroforestry adoption was highly influenced by education, farming experience, and farmers' ethnicity. Furthermore, the PSM analysis shows that agroforestry adoption has a significant and positive impact on farming income. Farmers who adopt agroforestry have a higher farming income than the farmers who did not adopt. However, the agroforestry adoption did not significantly impact the non-farm income. Therefore, these findings imply that farmers should implement agroforestry continuously to improve their welfare conditions.

DX of forest management in the LiDAR era From forest stand polygons to Tile polygons

Kazuhiro Tanaka (Kyoto University of Advanced Science)

From now on, 3D point cloud data will become the mainstream of forest information. We need DX that breaks conventional forest management based on breast-height diameter, and to change to a new forest management based on tree height and stand density. If LiDAR data can be used, it will be possible to conduct more detailed forest management, including thinning plans using data on stand density. DCHM makes it possible to understand the tree height according to the local topography, so it is possible to grasp site quality of the land as a surface. In order to respond to various changes surrounding forestry, it is necessary to reconsider forest management as land use management. In the case of land use management, it is necessary to subdivide the interior of the forest stand, so it is better to manage the forest in a mesh that matches the land use management. A tile polygon is a mesh-like grid-type polygon, and it is square or rectangular. Forest information represented by tile polygons can be easily analyzed. Forest information represented by tile polygons is also useful in combination with other GIS information. In the era of global warming, there is concern about an increase in mountainous disasters and the like. To promote joint research with other research areas, it is necessary to convert forest information into open data based on tile polygons.

September 1 (Thu)
10:30～11:30 UAV

Drone-based photogrammetry for recording the individual old-growth and giant trees -Analysis of the influence of photography methods on reconstruction

Kaili Huang (Mie University)

The old-growth and giant tree is a nonrenewable resource with great biological and cultural value. Our goal is to apply photogrammetry techniques to record and measure entire old-growth and giant trees using UAV images taken from multiple directions. Our previous studies showed that UAVs could measure tree height and DBH with relatively high accuracy. However, except for some trees that grow alone in open areas, there is always a possibility that trees will be affected by other trees or other obstacles. The purpose of this study was to understand the effect of shooting conditions, thus the distance from target trees, on reconstructed orthophotos, dense clouds, and 3D models. An open-grown Japanese cedar (Cryptomeria japonica) was chosen within the grounds of the Mie University Forest. UAV was flown vertically around the target tree from multiple distances and directions manually. Orthophotos, Dense Clouds and 3D Models were generated from UAV images taken at different distances by SfM technology, and tree height and DBH were measured from each. Orthophotos, Dense Clouds and 3D Models obtained from images taken at 7 or 8 m and 10 m, and from all directions of the target tree were compared. As a result, the difference from the DBH measured with a measuring tape at the site was 0.08 - 0.17m, 0.07 - 0.10m respectively. The difference from the tree height measured with a Vertex at the site was 1.5 - 8.8m, 1.8 - 9.1m, respectively. The differences were similar at 7 or 8 m and 10 m.

Effect of GCPs on Performance of UAV-SfM-based Point Cloud Data in Forest Inventory

Tatsuki Yoshii (National Chiayi University)

For forest management are low cost, time flexibility, and high resolution compared to other remote sensing platforms. Because the structure-from-motion (SfM) and multi-view-stereo (MVS) techniques have been successfully developed in computer vision, the algorithms can help to generate high-quality 3D point cloud data, digital surface model (DSM), and orthoimage from very high-resolution UAV images. In general, the UAV-SfM technique requires ground control points (GCPs) collected mainly by GNSS on-site for georeferencing the point cloud data. However, it is challenging to completely manage GCPs in a natural environment because of the signal disturbance caused by the dense canopy and terrain topography. This study investigates the performance of an approach that integrates the UAV-SfM technique and the iterative closest point (ICP) method to generate point cloud data in the circumstances with/without GCPs via RTK-based UAV lidar data. The result can benefit the UAV-based forest inventory by utilizing a consumer-grade non-RTK-based UAV system.

September 1 (Thu)
13:00～14:00 Poster Session

Using Multi-temporal Infrared Aerial Photos and Very-high-resolution Satellite Images to Evaluate the vegetation restorations in Taimali Coastal Experimental Forest

Han-Ching Hsieh (Taiwan Forestry Research Institute)
Chun-Yuan Huang (Taiwan Forestry Research Institute)

After the serious hit by the Morakot typhoon during August 8 to 10 in 2009, to evaluate the effects of vegetation restoration of manmade restoration and spontaneous succession areas from August 2009 to November 2019 in the Taimali Coastal Experimental Forest (an experimental forest belonging to Taiwan Forestry Research Institute, located near the south-eastern coast of Taiwan), 7 dates of four-band high-resolution aerial orthophotos from 2009 to 2019 collected by the Forest Aerial Survey of the Forest Bureau and two WoldVew2 satellite images obtained in 2011 and 2018 were used in this study for monitoring the changes of vegetation coverage. After establishing NDVI vegetation index with a spatial resolution of 0.25m to each date's image, the object-based mean shift image segmentation and thresholding classification procedure was implemented to extract the green vegetation coverage areas of the whole experimental forest. Finally, the area of vegetation coverage and covered rates of the manmade restoration area and spontaneous succession area were calculated and the change trends were compared with each year. The study results shows that the vegetation coverage rate of the whole district has increased year by year from 7.4% in 2009 to 84.6% in 2019. The change trend of the vegetation coverage rate in the spontaneous succession area is consistent with the whole area, from 10.1% in 2009 to 90.0% in 2019. In the manmade restoration area, only 2.5% of the green coverage remained in 2009, and the average vegetation coverage rate was less than 10% during the period from 2012 to 2014. Since 2015, The Taimali Research Center started the afforestation experiments, from only 7.1% of the beginning of land preparation to the year of 2019, it increased significantly reach to 74.5% in 3.5 years. The image processing methods and results of this study can be used as a verification of the restoration effect of the Taimali Coastal Experimental Forest and a reference for subsequent restoration strategies.

Effect of outer bark surface roughness and thickness on liquid-phase water permeation into the bark blocks of tropical deciduous teak

Hiroyuki Matsunaga[1], Naoko Matsuo[1], Takahisa Nakai[1], Hisashi Abe[1,2]

[1]Mie University, Japan
[2]Forest and Forest Products Research Institute, Japan

Understanding the water use strategies of teak, a tropical deciduous tree, is necessary to predict the impacts of climate change on teak plantations in the Asian monsoon region. We observed changes in teak stem circumference in response to temporary rainfalls during the dry season in northern Thailand, and demonstrated that these changes can be attributed partly to water vapor exchange at the outer bark surface by experiments using teak bark blocks. These findings suggest that the water absorption through the stem surface during the dry season may be one of the water use strategies of teak. In this study, we quantified the characteristics of liquid-phase water permeation from the outer bark surface in teak and determined the effect of bark morphology on these characteristics. Distilled water was absorbed from the outer bark side of teak bark blocks enclosed in silicon frames, and the parameters of the water permeation characteristics were calculated from the time-course changes in weight. The surface roughness and thickness of the outer bark were evaluated by processing the cross-sectional images of the bark blocks. The results showed that both the amount of water retained on the outer bark surface and the maximum amount of water permeated into the bark were significantly positively correlated with the surface roughness of the outer bark. Although there was a strong positive correlation between the minimum and average thickness of the outer bark of each bark blocks, the rate of water permeation into the bark had a significant negative correlation only with the minimum thickness of the outer bark.

September 2 (Fri)
13:00～14:00 Measurement

Long-term aboveground biomass changes in a monsoon wind-shaped forest

Chen-Chia Ku (National Chiayi University)

Regarded as one of the world's largest carbon pool, tropical forests have different carbon variance under various environmental condition through time due to long-term climatic. The Lanjenchi plot is a tropical forest affected by the northeast monsoon wind, resulting in the varying vegetation structure within three different habitats. We used 22-years census data to understand how aboveground biomass change under different wind stress in different habitat over time. Parameters including the aboveground biomass, individual density, aboveground woody productivity, and aboveground woody mortality within each quadrat were derived from a dataset with the tree DBH ≥ 1 cm in four census years (1997, 2005, 2013, and 2019). The generalized fitness-estimating equations were used to test for differences in the aboveground biomass and stem density among the three habitats (windward, intermediate, and leeward habitats), among small (DBH ≥ 1 cm, DBH < 10 cm), middle (DBH ≥ 10 cm, DBH < 17.2 cm) and big trees (DBH ≥ 17.2 cm), and among census years. Our result showed that the Lanjenchi plot held 128.71 ± 51.10 Mg ha-1 of aboveground biomass. Both individual density and aboveground biomass showed stability in the whole forest from year to year. However, the small trees in the windward habitat, having the highest stem density and lowest aboveground biomass among the three habitats, had a declining trend over time. In contrast, the leeward habitat, dominated by a few big trees, increased the aboveground biomass of small trees while decreasing of big trees. Nevertheless, the middle trees had as few individual densities as big trees and had as much aboveground biomass as small trees, showing the stable changes in three habitats over time. Overall, our research showed that different tree size classes have various aboveground biomass fluctuation in the different wind stress habitats under the seemingly stable state of the whole forest. Thus, we proposed that the magnitude of monsoon wind speed influences the pattern of aboveground biomass dynamic in the Lanjenchi plot.

Artificial intelligence with deep learning technique as a tool in tree stem volume estimation

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Traditionally, the regression models in statistical approach are often used to estimate the relations between various stand or tree attributes. Recently, Artificial intelligence techniques such as artificial neural network (ANN) and deep learning algorithms (DLA) have provided an innovative alternative modeling approach to predict some tree and stand attributes. This paper is concerned with the use of deep learning algorithms (DLA) models for accurate tree stem volume estimation of Taiwanina trees (Taiwania cryptomerioides) in plantation as an alternative to traditional regression models. Data of Taiwanina trees come from plantation permanent plots around Taiwan. Real tree volume is obtained from the stem analysis. 170 trees in total are used, among them 127 trees used for the fitting and 43 trees for the validation purpose. In the statistical approach five regression models are used, and in the deep learning algorithms approach different number of hidden layers (from 3 to 10), and for each hidden layer, different number of neurons ranging from 10 to 100 by increasing by ten in each step are used. Several evaluation criteria including the maximum

absolute error(Max AE), the average absolute error(Mean AE), the root mean squared error(RMSE), percent root mean squared error(RMSE%), the average bias(BIAS), percent average bias(BIAS%), Akaike's information criterion(AIC), and Bayesian information criterion(BIC) are used for the modeling performance evaluation. In the fitting setting, the model 4 is best with the least RMSE 0.04298 in the regression approach. 6 hidden layers with 90 neurons is best the least RMSE 0.03720 in the DLA approach. The comparison of these two approaches showed that DLA can get a higher performance over 13.4% than the regression approach in the RMSE. In other words, this study showed that the superiority of DLA approach in estimating individual tree volume.

September 2 (Fri)
14:20～15:10 Inventory

Effect of Samples Not Including Short Trees on Estimation for Tree Height in Pinus koraiensis plantation

Joonghoon Shin (National Institute of Forest Science)

It takes more time, cost, and effort to measure tree height(TH) compared to diameter at breast height(DBH). Therefore, in large-scale surveys such as the National Forest Inventory, the THs of most standing sample trees are estimated through the height estimation equations using the relationship between TH and DBH. These equations are constructed through the data of subsampled trees at which TH is measured. These subsampled trees should be evenly distributed in DBH, but were preferentially selected from tall trees with good characteristics constituting the upper layer of the stand. According to this selection criterion, it can be seen that although the even distribution of DBH is taken into consideration, it is hard to select a sample tree with short TH. Assuming this situation, we examined the effect on the height estimation depending on whether the sample includes trees with short TH. Using data from a Pinus Koraiensis plantation, we analyzed the performance of estimation according to whether or not trees with short TH were included in 21 TH estimation models. As a result, the models could be classified into two groups based on how much they were affected by the inclusion. The absence of short trees in sample data caused the overestimation of HT for trees with the smallest DBH class and the underestimation of HT for trees with the largest DBH class.

Small area estimation on forest inventory analysis

Shingo Obata (Institute of Statistical Mathematics)

The primary purpose of the National Forest Inventory (NFI) is to estimate the national-scale forest distribution. The stakeholders would acquire more benefit from accurate estimates at the higher spatial resolution though estimates for smaller geographic domains inevitably include instability and large variances due to the small sample sizes. To deal with this problem, small area estimation is getting attention in the research field of forest inventory analysis for making inferences over geographic domains smaller than those in which a specific survey dataset was designed to be used. In this presentation, I review the recent research on forest resource estimation using NFI with the small area estimation method. First, small area estimation and other estimation methods in forest inventory and analysis are reviewed. Estimation methodologies investigated in this presentation include direct, indirect, and composite estimation. Then, some of the previous research applied small area estimation is examined to clarify the effect of the method on the improvement of the precision of the estimates. Finally, I argue the possibility of applying various methods covered in this presentation to the data available in Japan.

15:30～16:30 Inventory

Forest dynamic in Hehuan plot, Taiwan

Chieh-Yu Liao (National Chiayi University)

Monitoring the composition and structure of forest is a good way to understand the forest dynamic over the time. Lots of the studies showed that species were gone upward migration along elevation due to the climate warming. Abies kawakamii and Tsuga chinensis var. formosana are the dominant tree species in Hehuan forest dynamic plot, which is a high mountain forests in Central of Taiwan. The plot is a 6.0 ha rectangle with 300 m in length and 200 m in width, sloping toward the east. The altitude of the plot ranges from 2,932 - 3,044 m. There were two census year which is 2008 and 2022.Comparisons of the species dominance (number of stems) and basal area in this 14 years. A total of 3,101 and 2,762 individuals were tagged in this two surveys respectively (2008 & 2022) and represented 14 species, 12 genera and 9 families. The most abundant species was A. kawakamii, accounting for 58.7 % & 59.0 % of the total stem density and T. chinensis var. formosana was the second abundant species (17.6% & 17.3 %). Both A. kawakamii and T. chinensis var. formosana were decreased in stem density in the past 14 years. On the other hand, the basal area of A. kawakamii increased from 48.4 to 54.5 m^2 ha-1(total basal area divided by the 3.91 ha forest area). But the basal area of T. chinensis var. formosana decreased from 30.0 to 28.9 m^2 ha-1 due to many large trees fallen down and only four individuals recruitment.

Application of thermal sensing and water indices for drought monitoring: A case study in Lishan, Taiwan

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This study was conducted to monitor the drought occurrences in Taiwan as indicated by fluctuations in temperature and reservoir water levels from 2014 to 2021 using thermal sensing information and water indices data. Drought monitoring is very necessary as it can provide information that can initiate actions to mitigate the impacts of drought on a community. The drought occurrences were determined from 2014 to 2021 through monitoring of the land surface temperature (LST) and reservoir water level using the thermal bands and water indices from Landsat 8. Supplementary data from the Taiwan central weather bureau such as the precipitation information was also included for the drought monitoring. The LST, water reservoir level, and precipitation for the cold season represented by the months of January and February, and hot seasons represented by the months of August and September were recorded. The LST was calculated using the single window technique. The situation of Lishan, Taiwan was taken as an example for drought monitoring. The result showed fluctuating temperatures, reservoir water level, and amount of precipitation from 2014 to 2021 indicating that the occurrence of the drought phenomenon in Taiwan was only observed for various years. Further, the result also showed that the increase in LST happened both in the forest and bareland area indicating that such an increase is due to a worldwide issue which is climate change. Nevertheless,

the forest area showed a cooling effect to the increasing temperature. This study will be beneficial to environmental planners for drought management.
Keywords: Climate change, drought management, LST monitoring, water level, forest management