

SUMMARY OF DOCTORAL THESIS

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Title: Fire effects on structure and species composition of mixed deciduous forest in Doi Suthep-Pui National Park, Chiang Mai, Thailand

(タイ、ドイステープ・プイ国立公園の落葉混交樹林の構造と種組成に対する山火事の影響)

Thailand has two main forest ecosystems: evergreen forest and deciduous forest, which are classified as fire sensitive ecosystems and fire dependent ecosystems, respectively. The deciduous forests, which cover approximately 56% of the forested area in Thailand include deciduous dipterocarp forest (DDF; 21%), mixed deciduous forest (MDF; 34%) and pine forest (1%). The majority of deciduous forest is MDF, which has developed throughout the country, especially in the north, northeast, western and central regions. This forest type has been further divided into 2 dominant types: the *Tectona grandis* type and the *Lagerstroemia calyculata* type. Forest fires generally occur during the dry season, which begins from December, peaks in March, and ends in May. Deciduous forests, including DDF and MDF, are the most threatened by fire. In the last decade (2008-2017), MODIS hotspot statistics have illustrated that in northern Thailand, approximately 77% of annual fire incidents occurred in forested areas and that 99% of fire incidents were caused by human activities, including the gathering of non-timber forest products, illegal hunting, burning of agricultural debris, raising cattle, carelessness, illegal logging, arson, and tourism. From 2007 until now, these forest fire incidents have also been a major cause of the annual haze pollution in the far north of the country, which has serious direct effects on respiratory health of the local population and which also impacts the tourism industry and aerial transportation in this region. Even though fire frequency is a basic element of the fire regime, which is the most significant factor influencing the structure and function of the ecosystem, if fires occur too frequently in fire-dependent ecosystems, including MDF, ecosystem degradation may occur. The only previous study in Doi Suthep-Pui National Park (DSP) to analyze the vegetation structure in burned and unburned areas of MDF was conducted in 1985. Since then, the impact of fire on the floristic composition and forest structure of MDF in this area has been unknown. It is a concern that the current heavy burns in the last decade have damaged the original structure and plant diversity in MDF, transforming it into another type of dry ecosystem. This study aims to (1) Investigate fire history in the past decade by investigated latest 10 years fire history from Landsat 7 and 8 imageries via dNBR index and generated fire frequency map. (2) Describe the current status of floristics composition and forest structure of MDF in different fire frequency areas, by established sample plots for collected floristic characteristic and forest structure data, and (3) Describe the present fuel characteristic and fire behavior of MFD in different fire frequency areas, by established sample plots for collected fuel characteristic data and applied burning experiment for collected fire behavior data.

The study was carried out in areas of MDF within DSP, Chiang Mai, Northern Thailand. The area lies on the west side of Chiang Mai city at 18°50'N latitude and 98°50'E longitude. The forest received protection as a National Park in 1981 and covers an area 261 km². The average annual rainfall of the area is between 1,350 and 2,500 mm, the warm index is 257.7 and the average maximum and minimum temperature are 32.2 and 20.8°C, respectively. The area has 3 seasons: summer (mid of February to mid of May), rainy season (mid of May to mid of October) and winter (mid of October to mid of February). The topography of the area is mountainous, with an elevation of 330 – 1,685 m. This protected area includes 4 forest types: deciduous dipterocarp forest, mixed deciduous

forest, dry evergreen forest and hill evergreen forest. The dominant species in the MDF of DSP are *Tectona grandis*, *Lagerstroemia calyculata*, *Xylocarpus xylocarpa*, and *Pterocarpus macrocarpus*. DSP is located 5 km at the western side of Chiang Mai Metropolitan Area which has a population of nearly one million people. There are villages, temples, University, Military area, etc. located along the northeast through the east, south and southeast boundary of DSP. There is no clear evidence on the earliest fire incident in DSP, but forest fires have been recognized in this area for many decades. The average MODIS hotspot count of DSP has been 16 times for each year from 2008 to 2017, which represents an increase from the previous period, in which the average was 12 times.

In October 2017, a ten-year fire frequency map was generated based on satellite data and areas with low and high fire frequency were identified. The results of the ten-year (2008-2017) Landsat imagery analysis showed that all areas of deciduous forest in DSP had experienced at least one fire. The total burned area was 10,940 ha, which amounted to 41.9% of the DSP area. The high fire frequency areas which has fire repeated 6-10 times in a decade were located in the northeast and southwest areas, covering approximately 13.92% of the total burned area in DSP. The remaining 86.02% of the burned area had a low fire frequency which fire occurred 1-5 times within a decade. In December 2017, two sample plots of 50 m x 50 m were established in each site. The flora species, floristic characteristics and forest structure were identified and calculated. The results of floristic characteristics showed that a low fire frequency encouraged the abundance of species diversity in all flora layers which in contrast to a high-frequency fires that caused the extreme diminishment of species diversity, especially in the sapling and seedling layers. Even though the light condition under the canopy in high fire frequency area was better than the low fire frequency area and may encourage the seedlings develop in the rainy season, however, it had been burned back by fire in the following dry season. The high frequent fire affects the plants could not grow beyond the seedling stage. The current floristic composition and forest structure of MDF shows clear evidence of degradation from long-term high fire frequency disturbance.

In February 2018, the study of fuel characteristics was conducted by using twenty quadrats, each 1 m x 1 m, were used to collect data regarding fuel characteristics, and 50 m x 50 m quadrats were used to study fire behavior in low and high fire-frequency areas. The fuel load data were collected every month for a period of one year. The results illustrate that the MDF of DSP had similar fuel characteristics in both the low and high fire frequency areas. The main fuel component in the two fire-frequency areas of this forest type was litter (leaves) which fall from the top layer of trees to accumulate on the forest floor. Fire consumed approximately 60–70% of the total fuel loads, and fuel recovery to the original level was predicted to take around two years. All the fire behavior features in the low and high fire frequency area showed similar characteristics due to the stand structure, the fuel properties, topography, and weather conditions were similar in both areas. The fire type in both areas was defined as surface fire with low intensity, which usually occurs in deciduous forests of Thailand. The results for soil temperature and critical duration in both areas were slightly different due to the influence of fuel load, which was greater in the high fire frequency area than in the low fire frequency area. However, both areas showed that only the surface level of the soil was affected by the fire and did not cause any problems in deeper layers. For improving and maintaining a good condition to this protected area, a suitable fire-free interval must be introduced. Thus, a further study of long-period dynamics of the understory vegetation after burning is recommended.