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博　士　論　文　の　要　旨

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博士論文題名　Development of visual sensitivity assessment as a quantifiable method to preserve integrity between the mountain and historic city

（山麓と歴史都市との統一性保全のための視覚的感度評価手法の開発）

The visual integrity of mountains contributing to cultural landscape as nature-culture attributes is often obscured by the vertical intrusive built environment, especially in buffer areas of protected heritage zones. Recently, numerous cultural landscapes have been endangered or removed from the WH List because of the inappropriate built environment located in the crucial view zone. Urbanization is the primary reason for the decrease in the cultural landscape's values and integrity because it results in intrusive buildings and development, which potentially contributes to adverse impacts on the interlinkage of natural–cultural heritages and breaks up the skyline. Urbanization will mostly take place in ancient towns in the mountainous region. There are concerns that the rapidly growing infrastructure and development will accelerate the vulnerability of the cultural landscape, especially in historical cities that are not yet well-prepared.

This dissertation's aim is to develop a quantifiable methodology to assess visual sensitive areas and to measure changes in the historic city with mountain landscape. The overall results to support visual integrity preservation.

There are six chapters were comprised in the thesis. Chapter 1 explains background of the research. In this section, primary literature relevant to the field of research is examined. Several gaps in the current literature are identified, which this study aims to contribute. It also explains various research methodologies and strategies which were employed in prior research defined gaps for this research.

Chapter 2 is the theoretical background/literature review focuses on three major areas: HUL approach for cultural landscape conservation; visual aspects; and 3D-GIS based visibility analysis. The related research was concluded and summarized to establish the framework for this study.

Chapter 3 is the research methodology, explains a multi-stage research design is proposed to conduct the research to achieve the aim. Also, the site study is determined the area to study, described its characteristics and current situation. Determination of the input parameter and scientific tools used to facilitate testing visual-related theories are determined. In this chapter, Chiang Mai historic city was selected as the study area. The elements contributing integrity of the cultural landscape characterized by mountain-culture heritage as well as the elements representing conservation and development dimensions according to HUL concept was identified utilizing GIS. The sensitive areas need to manage as a result of building height impacts on visual integrity of the historic city with mountain landscape were identified. Two methods to protect visual

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integrity and to determine development zoning for the historic city with mountain landscape were proposed.

Chapter 4 The first method is mountain-view corridor sensitivity analysis was proposed. This chapter analyzes the sensitivity of the observe location along the route that provide a mountain-view corridor, using GIS-based visibility analysis to calculate the visible area of the mountain as a baseline and comparing them to areas with visible buildings using statistical correlation to define a strong negative correlation as the visual sensitive areas. The analysis took place in the cultural routes – Suthep and Rachadamnoen roads. The viewpoint was placed as serrated locations along the north and south of two roads considering activity mode of pedestrians. To assess the areas sensitive to visual impacts of building structures, the view cone was created to evaluate the observer's perception of different visual elements on its amount regarding human visual field and visual limitation. The visible mountain areas (VMA) and the visible building areas (VBA) were measured of each viewpoint separately in the first phase using viewshed and skyline analyses, respectively. After that, VBA were divided its visible areas for calculation by visual sections using the unwrapped skyline graph method. The visible areas of both aspects were examined their relationship by using statistical correlation. The sensitivity was defined according to strong negative correlation between VMA and VBA. The results revealed that because of the observer's proximity to the mountain, the buffer zone was found to contain more areas with visual sensitivity levels. The close-range zone sensitivity is due to the observer location being closer to the buildings that are located in the same direction as the mountain, resulting in more visible obstructed regions, although having lower building heights, density, and BCR. For farther distance zones sensitivity in the core region because to high density and building coverage ratios.

Chapter 5 This chapter assesses visual integrity impact of the mountain skyline considering the observe location in the historic places – temples, utilizing the different height levels of the mountain ridgeline to identify the obstructed building and its heights within the buffer zone of different scenarios using computer-generated 3D city modeling. The result will indicate changes in each scenario, its level through the number of obstructions, and the protected and development areas. Whereas the sensitive areas will be assessed due to building obstruction. The study area included the mountain, the city wall, and the buffer zone area that lies between them. Because of the city's cultural landscape represented by the mountain and the old city, the mountain was determined as the target view, and the city wall area was chosen as the viewpoint location, while all buildings in the buffer zone were defined as obstacles. The impacts of building height on the mountain skyline were assessed by utilizing the locations

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of the temples that located at different mountain ridgeline levels – 350, 550, and 950 m, and evaluate visibility of the observer standing at the access point of the historic temples located within the city walls. The analysis conducted through three different scenarios: Actual condition scenario (ACS) considering current conditions, Land use scenario (LUS) considering land use ordinance, and Proposed scenario (PPS) considering mountain skyline protection using the computer-generated 3D city modeling. The comparative analysis to measure and investigate changes in the urban landscape based on the results of obstructed building locations and number by Linear Line of Sight analysis, the amount protected areas of mountain calculated using the viewshed analysis and the building development areas calculated in GIS-based application. The results revealed the areas sensitive to visual integrity by the obstructed building locations in each level. As well as the amount of protected and development areas occurred contributing to changes in each scenario. The number of obstructing buildings was less significantly changed (%) at all levels, except the 950 m elevation surface. The number of obstructing buildings in the LUS decreased to nearly half the number in the ACS and in the PPS decreased 77%. At 550 m elevation levels, the LUS decreased 7.95%, the PPS decreased 24% and at 350 m 7.2% respectively, whereas the LUS had no change. In terms of the protected and development areas, the results showed that the visible mountain area of the LUS and the PPS were increased 21.56 and 24.52% from the ACS, respectively. While development areas increase 66% in both the LUS and PPS. This indicated that the land use regulation can protect the visual integrity of the city's cultural landscape, at the same time can encourage development growth in the city area. However, as illustrated by the results of obstructed building locations and density, the area near the city wall - especially in the northwest were critical and be stricter controlled mid-rise and high-rise buildings. But farther distance away from the historical city are possibly increasing the height for development. The reason why the visual impacts were densified in this area could be that because of the mountain positioned northeast of the city wall. So that the buildings being inside the mountain's visual radius.

Chapter 6 Conclusion the finding of the study, significance results are highlighted as the study implication. Recommendation and Limitation of the study are also shown and discussed to provide continuity of the further study. The overall result provides visual sensitivity analysis and building height impacts assessment for the city characterized by mountains and historic settlement. The findings in both analyses to discuss optimum value from an existing building that affects, as adverse impacts to the scenic and interconnection between nature-culture, mountain-urban heritage, which could

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incorporate the results into implementation to support cultural landscape conservation in the context of Chiang Mai city. The identification can be useful for city planning and conservation in Chiang Mai, as well as other cities with significant natural and cultural heritage landscapes. The results identify the area and what to conserve in which location, which can result in a future baseline for the built environment. Because a decrease of visible significant areas mean a decrease in connectivity between them, which results in a decrease in cultural landscape values. Cities must find a balance between conservation and development, especially in historic neighborhoods in a rapidly growing city, and this is especially important in mountainous regions. The built environment should be carefully planned to be harmonious with cultural and historical characteristics of the city and in respect to its wider setting.