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# **ADVANCES IN FOREST FIRE RESEARCH**

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**DOMINGOS XAVIER VIEGAS  
LUÍS MÁRIO RIBEIRO**

# A study on urban forest fire risk analysis and forest fire management plan suitable for each region -Focus on Nowongu Seoul

Donghyun Kim

*Jeonju University, Jeonju-si Jeonbuk-do, Rep. of Korea, {72donghyunkim@jj.ac.kr}*  
*IIASA(International Institute for Applied Systems Analysis). Laxenburg, Austria, {dhkim@iiasa.ac.at}*

## Keywords

WUI (Wildland Urban Interface), Urban Forest Fire Management, Fire Risk Analysis, Fire Policy, Fire Management

## Abstract

The risk of fire in urban forests is high due to housing and living infrastructure adjacent to the forest, resulting in large human and property damage and high frequency of occurrence. It is very important to identify the forest fire environment and potential risk factors for each city in order to manage the forest fire risk in the cities adjacent to the forest. In this study, urban forest fire management measures were suggested by conducting a survey on the causes of forest fires and the entire adjacent forests in Nowon-gu, which has the most urban-forest adjacent areas in terms of administrative districts among Seoul, which has the highest population density in Korea. The forest fire investigation has been conducted for the last 5 years, and in addition to analyzing the forest, topography, and meteorological environment, an analysis of fire-vulnerable areas in the event of a forest fire in downtown Seoul was conducted. Eight action plans were presented by dividing the actionable forest fire management into prevention, preparation, and response stages for areas adjacent to forests and areas vulnerable to forest fire risk. First, in prevention, fuel management that can reduce the risk of forest fires, map production and risk reduction management for temples in the forest, and selection of appropriate locations to install forest fire long-distance around monitoring cameras and drone autonomous monitoring stations were suggested. Second, in the preparation stage, a fuel blocking method was presented to establish a safe zone for hiking trails, prepare a mountaineering safety map for forest fire evacuation, and prevent the spread of residential fires in forest interface area. Third, in the response stage, the installation of a multi-purpose outdoor fire hydrant for suppression of forest fires and house fires adjacent to the forest, the activities of forest fire extinguishing vehicles and marking of the entry area, and the establishment of an urban forest disaster integrated control system were suggested.

## 1. Introduction

As forests and adjacent forests are developed as residential or commercial areas due to urban expansion, the number of cases in which forest fires become urban fires and building fires spread into forest fires is increasing. In the case of WUI forest fires, due to spatial characteristics, not only forest fires, but also complex fire-fighting activities such as the evacuation of people, extinguishing fires in buildings, and protection of dangerous facilities are required, and organic cooperation between the forestry department and the urban fire-fighting department is more necessary. In the case of the United States and Canada, community-based forest fire management is implemented according to the FireWise and FireSmart programs, respectively. In Korea, the risk of forest fires is high due to the continuous increase in urban expansion and use of urban forests, but there are no forest fire management activities and programs in the local community. Therefore, this study intends to propose a forest fire management plan for the forest adjacent to the Nowon-gu of Seoul, which has the highest population density in Korea. In Nowon-gu, the forest area occupies 1,546ha, which is 44% of the total administrative district, and a total of 18 forest fires have occurred since 2015 in forest. In Nowon-gu, 7 cultural assets including the royal tombs of the Joseon Dynasty, designated as UNESCO cultural assets, and 26 temples are distributed in the adjacent forest area.

## 2. Methods

### 2.1. Forest fire risk analysis to Nowon-gu WUI

Forest fire risk analysis was conducted on the forests of Bulam Mt. and Surak Mt. of 1,456 ha in Nowon-gu, WUI houses and buildings, temples and facilities in the forest, and shelters on hiking trails. The following four items were investigated.

- ① Forest fuel density and forest fuel type
- ② Risk of fire spread due to forest fires in WUI houses and structures
- ③ Possibility of casualties during forest fire spread
- ④ Ease of firefighting environment

WUI forest fire risk analysis was conducted by analyzing correlations with topography, weather, and forests along with past forest fire cases to select areas vulnerable to forest fires. was classified, and predictive factors such as topography, forest, and weather were quantified using a spatial analysis program.

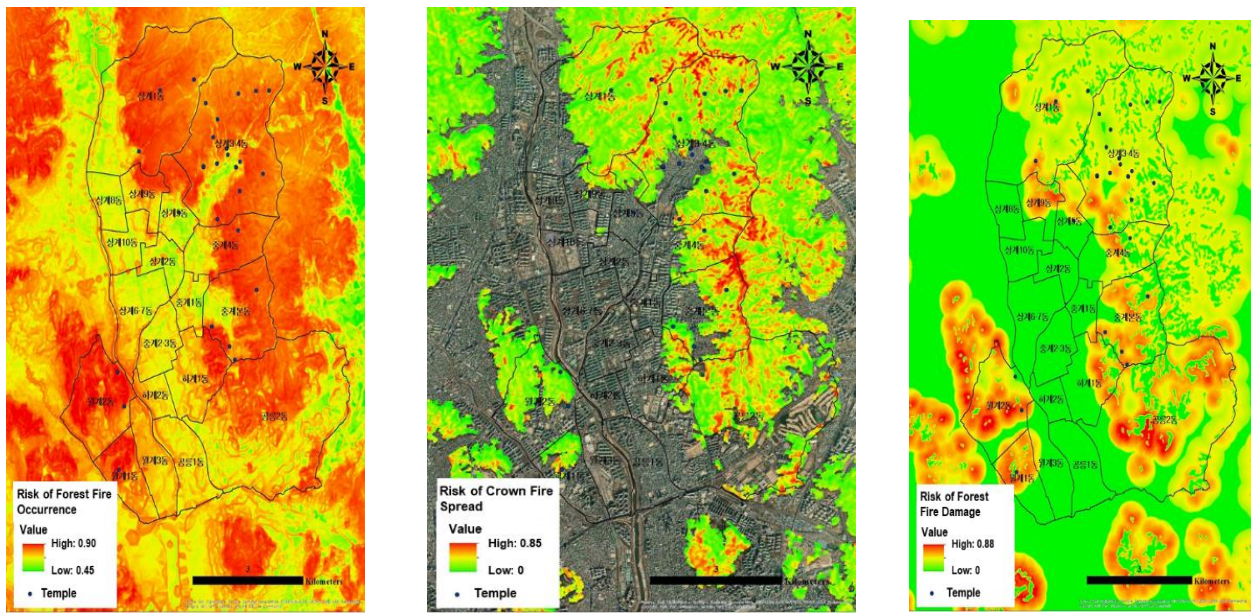
## 2.2. Forest Fire Management Plans to Nowon-gu WUI

Nowon-gu WUI forest fire management measures were divided into three stages: prevention, preparation, and response, and the existing countermeasures and activities of local administrative agencies were analyzed and methods to reduce and prevent risks were suggested based on the results of analysis of areas vulnerable to forest fire risk. The risk felt by residents was investigated through the on-site residents briefing session, and WUI risk environment improvements were heard to manage the risk of forest fires.

## 3. Study Results

### 3.1. Standard scenario

As shown in Figure 1, the risk of release of forest fires in the forest adjacent to Nowon-gu was classified on a scale of 0 to 1, and the maximum risk of forest fire occurred within a radius of 300m of the WUI. As for the risk of spreading of crown fire, the area with the highest risk was found to be around 20 m in the lower radius of the ridge. The risk of damage from forest fires was analyzed as high risk 9, high risk 6, moderate 5, and low 6.



(a) Risk Map Forest Fire Occurrence

(b) Risk Map of Crown Fire

(c) Temple fire damage risk map

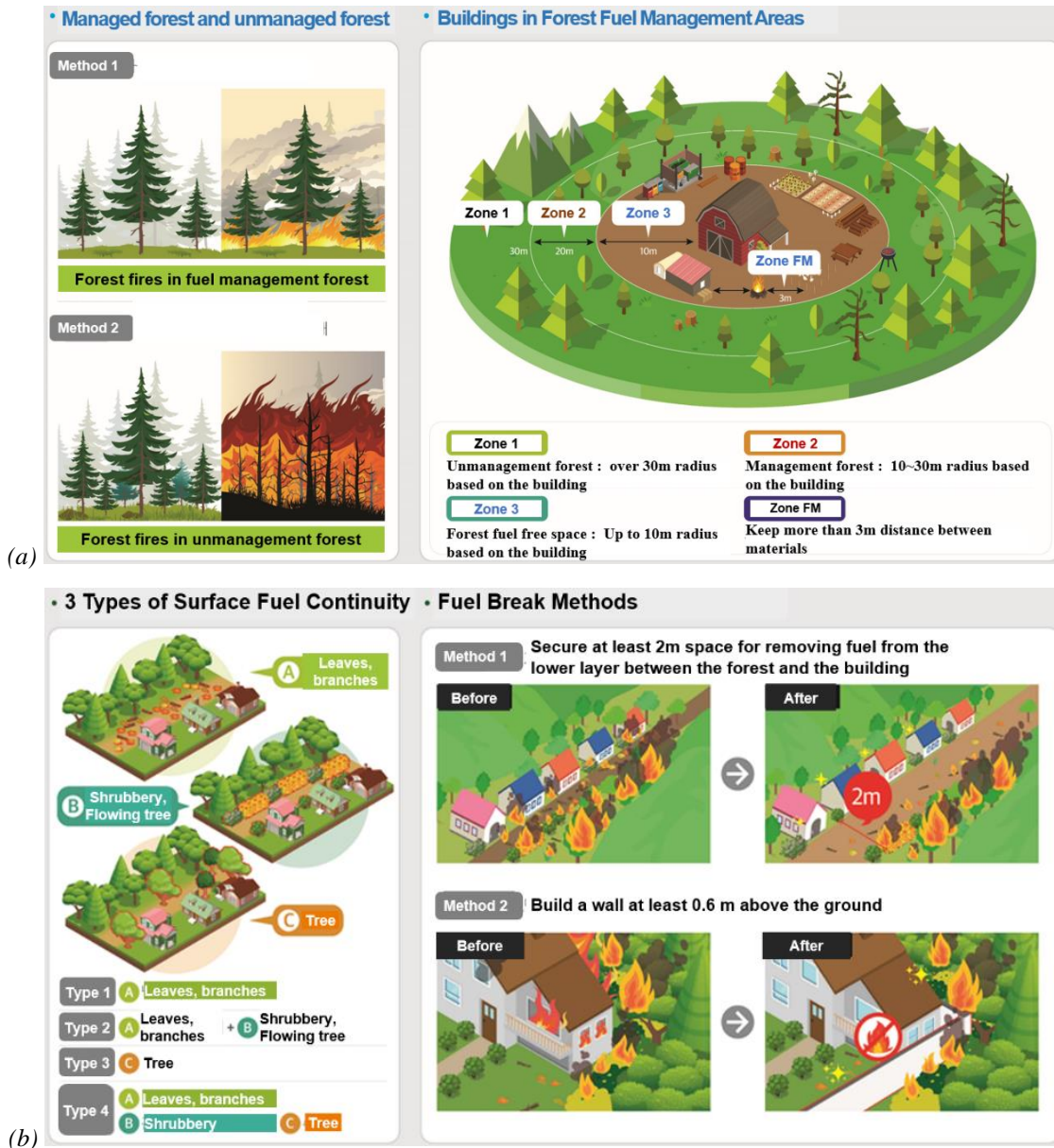
Figure 1- Results of forest fire risk analysis in Nowon-gu, Seoul

### 3.2. WUI Forest fire management measures

For the project to strengthen the capacity for forest fire management in Nowon-gu, 8 projects were presented in the areas of prevention, preparation, and response. In the field of prevention, ① fuel reduction project to lower the risk of forest fire, ② the risk rating mapping and risk reduction project for temples, ③ selection of appropriate locations to install forest fire long-distance around monitoring cameras and drone autonomous monitoring stations were presented. In the field of preparation, ① project to establish a safe zone on hiking trail and prepare a mountaineering safety



map for forest fire evacuation, ② a fuel continuity blocking project to prevent house fires in WUI were presented. In response fields, ① a multi-purpose outdoor fire hydrant installation project for suppressing forest fires and house fires to WUI, ② forest fire extinguishing vehicle entry and activity area indication project, ③ urban forest disaster integrated control system construction project were presented. Including the preparation of detailed implementation plans and required budgets for a total of 8 projects in 3 areas, it suggested a method to strengthen forest fire management capabilities in stages by year with the utilization of public workers and public relations for residents from 2021. Figure 2 is a schematic diagram for a total of 8 projects, and is a conceptual diagram of fuel reduction in the prevention field and the construction of a safety zone for hiking trails in the preparedness field.





(c)

**Figure 2- Nowon-gu WUI Forest Fire Management Measures Conceptual Map; (a) Prevention field: Measures to reduce fuel, (b) staging area: WUI fuel continuity cut off, (c) Response field: Fire engine access road marking**

A total of 14 evaluation items for each scenario are as follows.

① Whether or not information on forest fire situation is collected and confirmed, ② Establishment and feasibility of firefighting strategy, ③ Selection of location for firefighting work, ④ Construction of fire line, ⑤ Effect of ground firefighting work, ⑥ Preparation and use of ground firefighting equipment, ⑦ Sudden situation (Spotting fires, Fire Storm, Rolling Stone or wood etc) check and response, ⑧ Use of evacuation equipment, ⑨ Secure an evacuation route and a safe place, ⑩ Feasibility of evacuation judgment and method, ⑪ Arrangement of remaining balance, ⑫ Communication by team, ⑬ Report the situation to the command center and make an emergency request, ⑭ Protection object protection.

In the survey of firefighters on the training evaluation tool, the suitability evaluation was found to be  $97.5 \pm 2.5\%$ .

#### 4. Conclusions

The results of the WUI forest fire risk analysis and risk management measures suitable for the region in Nowon-gu, which has the largest forest area in Seoul, which has the highest population density in Korea, are as follows.

First, a forest fire risk map for the Nowon-gu, a temple fire risk map in the forest, and a tree crown fire occurrence risk map were produced.

Second, for temples with a high risk of forest fires, a risk mitigation method was suggested so that they could be maintained below normal.

Third, a total of 8 countermeasures were presented in the field of prevention (3 items), preparedness (2 items), and response (3 items) as Nowon-gu forest fire management plan.

Based on the method of promoting this research and preparing countermeasures, it is intended to be used in preparing various forest fire prevention measures through application to other regions, thereby contributing to forest fire management in WUI.