Plinius Conference Abstracts
Vol. 19, Plinius19-56, 2026, updated on 17 Jul 2026
https://doi.org/10.5194/egusphere-plinius19-56
19th Plinius Conference on Mediterranean Risks
© Author(s) 2026. This work is distributed under
the Creative Commons Attribution 4.0 License.

National-Scale GIS-Based Visibility Analysis of Fire Lookout Towers and Identification of Surveillance Deficit Zones in Türkiye

Mehmet Altuğ Küçükosmanoğlu[1] and Muhittin İnan[2]
[1]Vocational School of Technical Sciences, Istanbul University - Cerrahpaşa, Istanbul, Türkiye (m.kucukosmanoglu@iuc.edu.tr)
[2]Faculty of Forestry, Istanbul University - Cerrahpaşa, Istanbul, Türkiye (inan@iuc.edu.tr)

Fire lookout towers remain a critical component of early detection systems in Mediterranean countries. However, the effectiveness of tower networks is constrained by topographic visibility limitations, creating significant surveillance gaps in forested landscapes. This study presents a national-scale GIS-based visibility analysis of Türkiye's 548 forest fire lookout towers and identifies priority surveillance deficit zones by integrating historical fire records, forest stand characteristics, and road network accessibility.

Viewshed analysis was conducted using a 30-metre resolution NASA SRTM digital elevation model under curved-earth parameters, with an observer height of 6 metres and a smoke detection height of 100 metres, consistent with operational standards defined in the General Directorate of Forestry's Communiqué No. 285. The resulting binary visibility surface was overlaid with three datasets: the 12 regional forest directorate boundaries, a national forest stand map comprising 3,998,699 polygons with species composition and structural attributes, and a georeferenced dataset of 30,883 wildfire incidents recorded between 2013 and 2023.

Results indicate that the existing tower network provides visibility coverage over 47.6% of Türkiye's forested territory, leaving 52.4% as blind spots. Regional analysis reveals substantial disparities, ranging from near-complete coverage in the Aegean and Marmara regions (Kütahya 99.2%, Çanakkale 98.5%) to near-zero coverage in northeastern regions (Artvin 0.0%, Erzurum 0.1%). Species-level analysis shows that fire-prone pine species such as Pinus brutia (86.6%) and Pinus nigra (87.8%) are relatively well covered, whereas Picea orientalis (0.2%) and Pinus sylvestris (43.5%) stands fall predominantly within blind spots. Analysis of historical fire records reveals that 75.1% of all recorded fires occurred within visible zones, while 24.9% (n=7,618) originated in areas invisible to any tower.

Optimized Hot Spot Analysis (Getis-Ord Gi*) applied to 5,356 wildfire incidents occurring in forested blind spots identified 251 statistically significant priority surveillance deficit zones. These zones are concentrated predominantly in Şanlıurfa (69 hotspots, 502 fires), Elazığ (46 hotspots, 381 fires), Adana, Trabzon, and Hatay. Road network accessibility analysis using OpenStreetMap data confirmed that 99.2% of identified hotspot zones are accessible via the existing road network, based on a connectivity threshold of 4,000 metres derived from the road-access pattern of the existing tower network.

These findings reveal structural surveillance gaps in Türkiye's fire detection network, particularly in southeastern and eastern Anatolia and the Black Sea region. The study provides a data-driven framework for prioritising surveillance deficit zones and recommends evaluating complementary detection technologies such as unmanned aerial vehicles and automated camera systems for areas where conventional tower infrastructure is insufficient.