

environmental discussions, profoundly influences the aesthetic harmony and mental well-being of urban inhabitants. In this research, we present an innovative methodology to detect visual pollution using drone-captured imagery. Our distinctive dataset captures a spectrum of visual pollutants, from graffiti, faded signage, and potholes to more complex issues like cluttered sidewalks and unkempt facades. Leveraging this dataset, we fine-tuned pre-trained object detection models, specifically YOLOv6, achieving remarkable accuracy in detecting these visual pollutants from images. Central to our study is the introduction of the Visual Pollution Index (VPI), a metric formulated through the multiplicative integration of the Counting Categories Ratio (CCR) and the Severity-Weighted Score (SWS). To provide a spatial representation of visual pollution levels, we further introduce heatmap visualizations. These heatmaps, overlaid on urban maps, offer a vivid depiction of pollution hotspots, enabling city planners and stakeholders to pinpoint areas of concern. Grounded in real-world perceptions, our approach offers a comprehensive lens to assess, visualize, and address visual pollution in urban environments.

**Key words:** Visual Pollution Index, VPI, urban aesthetics, drone imagery, object detection, YOLOv6, visual pollutants, heatmap visualization, urban planning, environmental impact, Counting Categories Ratio, CCR, Severity-Weighted Score, SWS, urban well-being, geospatial analysis, automated detection, urban environmental management

## 1 INTRODUCTION

Urban environments, as the epicenters of human activity and innovation, have witnessed unprecedented growth over the past few decades. While this growth has brought about numerous advancements and opportunities, it has also introduced a myriad of challenges, one of which is visual pollution. Visual pollution, a term that encompasses unsightly and out-of-place man-made objects within public and private spaces, has become a growing concern for urban planners, environmentalists, and city dwellers alike [1].

The concept of visual pollution is not new; however, its significance has grown in tandem with rapid urbanization. Visual disturbances, ranging from graffiti, faded signage, and potholes to cluttered sidewalks and unkempt facades, can degrade the aesthetic appeal of urban areas, impacting not only the visual harmony but also the psychological well-being of residents [2]. Such disturbances can lead to decreased property values, reduced tourist interest, and even adverse health effects due to stress and mental fatigue [3].

With the advent of technology, particularly in the realms of drone imagery and machine learning, there exists an opportunity to address this issue in a more systematic and data-driven manner. Drones, with their ability to capture high-resolution images from vantage points previously inaccessible, offer a unique perspective on urban landscapes [4]. When combined with advanced object detection algorithms, such as YOLOv6, these images can be analyzed to detect and quantify visual pollutants with remarkable accuracy [5].

This paper introduces a novel approach to quantify visual pollution using the Visual Pollution Index (VPI), a metric derived from drone-captured imagery and object detection techniques.