Press release

Red fades, black resists: the secrets of colors in urban murals revealed

A collaborative study by the University of Pisa, the National Research Council (CNR), and the University of Perugia, focusing on the mural Musica Popolare (2017) by the Orticanoodles collective in Milan, highlights how drones and advanced technologies can significantly enhance the efficiency and sustainability of street art conservation. The findings are published in the journal Proceedings of the National Academy of Sciences (PNAS)

New opportunities are emerging for the preservation of street art, a form of expression now widely acknowledged as part of our contemporary cultural heritage but highly vulnerable to environmental degradation. Not all pigments used in these works age equally well, affecting the overall integrity of the artwork. A recent study, conducted by the University of Pisa, the National Research Council (CNR) and the University of Perugia and published in the *Proceedings of the National Academy of Sciences (PNAS)*, investigates the causes and mechanisms behind this degradation.

The research is part of *SuPerStAr* (Sustainable Preservation Strategies for Street Art), a project led by Professor Francesca Modugno from the University of Pisa and funded by the Italian Ministry of University and Research under the PRIN program.

The case study focused on *Musica Popolare* (2017), a large-scale mural by the Orticanoodles collective located in Milan's Ortica district. Spanning nearly 400 square meters on a railway overpass, the mural depicts key figures from Milanese music and culture—including Dario Fo, Ornella Vanoni, Enzo Jannacci, and Giorgio Gaber—and has become a symbol of local identity.

To examine the artwork, researchers developed an innovative methodology that integrates portable spectroscopic analysis, hyperspectral imaging, and multispectral drone surveys, supported by laboratory-based chemical analyses of micro-samples. This interdisciplinary approach enables the creation of comprehensive chemical maps of even very large murals and allows for long-term monitoring of their condition—offering significant reductions in cost and time compared to traditional conservation techniques.

The study found that red tones—particularly those using the pigment PR112—are among the most susceptible to fading and chemical degradation. In contrast, purple and yellow hues showed greater stability, while black and gray tones retained their color intensity over time. The binder composition also plays a critical role: acrylic and styrene-based resins tend to lose their gloss and become powdery, especially in the presence of titanium dioxide, which accelerates the degradation process.

The on-site analysis campaign was coordinated by the Institute of Chemical Sciences and Technologies "Giulio Natta" (CNR-SCITEC) in collaboration with the Institute of Heritage Science (CNR-ISPC), the Institute of Chemistry of Organometallic Compounds (CNR-ICCOM), and the Center of Excellence SMAArt of the University of Perugia.

"We analyzed the *Musica Popolare* mural using an innovative method that combines laboratory-based chemical analyses with non-invasive field surveys, including drones equipped with multispectral cameras," explains Ilaria Degano of the Department of Chemistry and Industrial Chemistry at the University of Pisa.

"This approach makes monitoring more sustainable for local administrations and simultaneously more effective, as it allows us to build a detailed timeline of the mural's conservation status," emphasizes Laura Cartechini of CNR-SCITEC.

"This study represents the first proof of concept for a scalable model dedicated to the analysis and conservation of street art. The hyperspectral drone data, which have already been acquired and are currently being processed, will enable an even more precise evaluation—delivering high-quality insights while keeping costs low and response times short," adds Nicola Masini of CNR-ISPC.

"In this specific case, the hyperspectral imaging equipment of the Center —operating in the visible and near-infrared spectral range—was used, with data collected via mobile platforms, to calibrate the response of multispectral instruments developed by CNR-ISPC and mounted on drones," concludes Aldo Romani, Director of the SMAArt Center at the University of Perugia. "The results are extremely promising, offering a highly effective approach for monitoring the condition of large-scale polychrome artworks, such as those found in Street Art."

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