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THE SMART GREEN SWITCH: A DIGITAL FRAMEWORK FOR EQUITABLE URBAN GREENING IN THE EURO-MEDITERRANEAN REGION

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Summary

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The Euro-Mediterranean region faces an urban "green divide", where low-income neighbourhoods and entire cities on the southern shore bear disproportionate heat and pollution due to scarce, poorly planned green space. Current greening programmes are often inefficient, driven by land availability rather than strategic need, and fail to integrate community input, eroding public trust.

This brief proposes “The Smart Green Switch”, a three-phase digital framework that combines Artificial Intelligence (AI)-driven mapping, community validation through a digital portal, and a transparent, adjustable decision-support system to ensure every planting decision maximises cooling, air-quality, and equity outcomes. The framework uses openly-available satellite data and local community inputs to compute a transparent Suitability Score for candidate sites, which municipalities can weight according to budgetary or social priorities.

To implement this, the brief calls on the European Union (EU) to integrate digital engagement into the Green City Accord and fund an open-source toolkit. It advises municipalities to create cross-departmental "Green Equity Teams" and transparent funds, and urges Euro-Mediterranean partnerships to launch joint pilot projects and build capacity in data-scarce areas. Adopting this

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model transforms greening from a symbolic act into a targeted instrument for climate resilience and urban equity.

Introduction: the urban green divide in a heating climate

Cities across the Euro-Mediterranean are already feeling the sharp edge of climate change: more frequent and intense heatwaves, deteriorating air quality, and an increased risk of droughts and coastal flooding, as observed in many Mediterranean urban centres including Athens, Barcelona and Casablanca (Nastos & Saaroni, 2024; EEA, 2025). A clear and damaging outcome of this is the urban heat island effect, which can be defined as built surfaces like concrete, asphalt and dark roofs absorbing and re-emitting heat, leaving cities substantially hotter than surrounding rural areas (U.S. Environmental Protection Agency, 2025). These sustained high temperatures do more than make life uncomfortable; they increase heat-related illness and death, and worsen cardiovascular and respiratory conditions, with older people, young children and those with pre-existing health problems most at risk (Ebi et al., 2021). Evidence suggests that major European cities such as Athens, Brussels and Budapest experience some of the highest mortality burdens where access to green space is limited, and that expanding equitable green cover could avert many thousands of premature deaths each year (Barboza et al., 2021), and this public health crisis echoes across the Mediterranean. The broader basin faces interlinked climate and health challenges, with air pollution accounting for 12.8% of all deaths in the North Africa and the Middle East (MENA) region in 2019 (Abbasi-Kangevari et al., 2023), and high temperatures increasing mortality risk across both northern and southern shores, though further studies are especially needed in North African and Asian Mediterranean regions (Perry et al., 2023).

The burden is not shared equally. Low-income, densely populated neighbourhoods that are often dominated by impermeable surfaces and lacking tree canopy face the worst exposure while having the fewest cooling resources. This disproportionately harms the communities that typically contribute least to emissions, deepening health and socioeconomic inequities (Rocha et al., 2024). A broader "green divide" strikingly appears between the two shores of the Mediterranean. While Northern Mediterranean cities like Barcelona can undertake bold and ambitious initiatives like the "Superblocks programme" to boost citizen access to green areas and enhance urban liveability (Matilla Ayala, 2025), southern counterparts such as Tunis and Marrakesh, however, face challenges with insufficient green infrastructure development that tends to be project-based and reactive instead of systemic (Ben Salem et al., 2021). The consequences of both iterations of the divide are significant, as they reinforce prevailing socioeconomic disparities, perpetuating a cycle in which disadvantaged communities endure the impacts of environmental harm while not having the means to adjust (Brun, 2024).

While many municipalities and organisations in the Euro-Mediterranean region are actively planting trees, their current greening approaches typically fall short, as they are driven by the availability of land rather strategic locations (Fleischman et al., 2020). This opportunistic approach results in considerable inefficiencies, as it ties greening projects to existing development cycles instead of focusing on areas with the greater environmental and social needs. Furthermore, urban planners in

many Mediterranean cities had historically failed to consider redesigning cities with sufficient green spaces that address specific climate challenges and community requirements (Andrea et al., 2021), and they usually overlook consulting the locals resulting in wasted resources and eroded public trust. When communities are overlooked, they feel no ownership, which often leads to poor long-term maintenance and the ultimate failure of the greening initiative (Caperon et al., 2022).

A modern and more proactive approach is needed, which is why this policy brief presents an integrated, three-phase model that combines AI-driven spatial prioritisation with a digital community portal and a dynamic decision-support system. This framework is designed to optimise urban greening, ensuring that every tree is planted in the right place, maximises ecological and social benefits, and has full community support. By adopting this model, policy-makers will be able to turn urban greening from a symbolic gesture into a targeted powerful tool in the name of climate resilience and urban equity.

The limitations of current greening strategies in the Euro-Mediterranean Region

In order to better understand the need for a new approach, we should first examine the serious shortcomings in current urban greening methods as currently practised by many municipalities across the Euro-Mediterranean region. Even well-intentioned projects frequently fail to achieve their full potential due to recurring constraints, which are particularly pressing in cities grappling with the dual pressures of climate change and rapid urbanisation.

Non-strategic planting and wasted resources

Many greening initiatives are driven by convenience, such as readily available land or political pressure, rather than strategic ecological and social goals. They end up focusing on simplistic performance metrics, like the number of trees planted, instead of meaningful outcomes like reduced heat islands and improved community well-being, which results in the misallocation of already limited public funds (Fleischman et al., 2020). A city can proudly showcase the achievement of planting 10,000 trees in a single year, but the overall benefit gets diluted if only 1,000 of those trees were planted in bare, heat-vulnerable and poor areas, while the rest were in already verdant suburbs.

The data deficit in decision-making

As highlighted in recent research on Mediterranean urban development, smaller and/or underfunded municipalities usually struggle with the lack of institutional capacity to leverage modern data for planning (Soygür & Doratlı, 2025). Their decision-making process ends up being forced to rely on outdated land-use maps, low resolution satellite imagery, or subjective opinions.

This constraint is rarely caused by the lack of data, given that, with the exception of areas the MENA countries, the necessary information is readily available for much of the region, with programmes such as the EU's Copernicus offering an abundance of free, high-resolution satellite data (European Space Agency, n.d.a). However, many cities do not have the tools, the training, or the framework to turn this data into an actionable plan.

Consequently, planners in these cities cannot analyse overlapping factors like air pollution, and population density. They are also largely unable to model or predict the ecological outcomes of their different interventions, outcomes such as “How much does the temperature drop when we plant in this area?” The very existence of resources like the Joint Research Centre (JRC)'s “Handbook of tools for informing and monitoring urban greening strategies”, which lists and evaluates 59 distinct planning tools, highlights this issue facing cities. While sophisticated tools for analysing overlapping socio-ecological factors and modelling intervention outcomes do exist, their successful application is frequently restricted by the necessity for advanced technical expertise and substantial data input requirements (Remme et al., 2025).

Top-down planning and ignoring local communities

A top-down approach to urban greening often creates a disconnect with the very people it is meant to help. Plans fail to reflect local needs and daily routines when they are drafted without resident input or consultation. This results in underused or poorly located places, like a shaded plaza that is inaccessible to the elderly, or a community garden situated away from residents’ daily activity areas. This type of failure erodes public trust, as citizens see resources being spent on projects that do not serve them (Hunter et al., 2017). Conversely, inclusive planning fosters community ownership and ensures that the societal benefits of greening, from mental well-being to safer play spaces, are distributed equitably.

This planning gap cannot be filled by data alone. While satellites can identify heat islands, they cannot capture the ground-truth information held by locals (Emard et al., 2024). As noted in recent green-infrastructure guidance, a proposed site for tree planting may be inappropriate if it is an informal shortcut used by many residents, suffers from frequent flooding undermining tree survival and accessibility, or is a hotspot for anti-social behaviour after dark, which diminishes site safety (Hunter et al., 2017). In addition, top-down projects do not usually account for community ownership, so locals have little to no incentive to report damage or to make sure young trees are watered every day, and the project ends up neglected due to inadequate long-term upkeep.

The integrated digital framework: a three-phase approach

Phase 1: AI-driven mapping

This brief proposes a framework that transcend traditional mapping, moving from the question “where can we plant?” to “where should we plant?”, by pinpointing sites where new green spaces can deliver the maximum ecological and social return on investment. The satellite data would be sourced from the EU's Copernicus programme, specifically Sentinel-2 imagery, because it provides freely available imagery with high spatial resolution (10-20m) that is specifically designed to monitor detailed land cover and vegetation health.

Its ability to frequently update data across the entire region makes it perfectly suited for tracking changes in urban heat and green space coverage over time, providing the consistent database needed for regional policy planning (European Space Agency, n.d.b).

We train an AI deep learning algorithm to analyse this satellite data and scan the urban landscape for specific metrics such as:

- areas devoid of vegetation cover as evident by its low Normalized Difference Vegetation Index (NDVI);
- heat island hotspots using land surface temperature data to find areas where cooling is most needed;
- air pollution hotspots to prioritise zones where trees can act as a natural air filter, mitigating public health risks;
- high population density combined with distance from existing parks to ensure equitable access to green space and direct resources to underprivileged communities.

This AI model moves beyond a static map of current problems to proactively predict the impact of greening interventions, enabling the strategic allocation of resources. The algorithm integrates established ecological relationships, such as the correlation between tree cover expansion and local temperature reduction (Li et al., 2025), to calculate site-specific estimates for cooling and air purification for each candidate site.

Phase 2: integrating community engagement

As established earlier, a top-down approach is ineffective and needs grounding, so we can understand that while the AI model identifies sites with high predicted impact, community endorsement is still irreplaceable. The algorithm can be validated with quick field visits, but more importantly with local knowledge checks, by partnering with residents using a specifically designed digital portal to ensure our sites match the reality of streets, not just satellites.

The portal needs to provide a visual map interface with tools allowing the proposal of new locations that the model might have missed, and commentary fields for open discussions, confirming or challenging the candidate sites. It is very important to ensure its accessibility for all categories of residents by making it multilingual, mobile friendly, and so on. This integrated approach will allow communities to be invested in their local urban green spaces, and therefore ensure their maintenance.

The community engagement through the portal also helps to patch data deficit wherever it exists, especially in the many areas in the MENA region where the lack of transparent data and modern environmental laws is a key barrier to effective action (Sulaiman, 2025), making the implementation of this digital framework itself a major step toward improving data transparency and accountability for local governments.

Phase 3: planting prioritisation and decision-support system

Finally, the AI-driven insights and community input merge together in a dynamic prioritisation framework based on Multi-Criteria Decision Analysis (MCDA) principles, designing this system to make tough choices clearer and more defensible (Skidmore et al., 2023). It moves beyond a simple technical ranking to balance three often competing priorities: the potential ecological benefit, the hard reality of budget constraints, and local community support.

To make this balance actionable, each potential planting site receives a transparent Suitability Score. This score is a composite index that breaks down and quantifies the performance of a site across the three core pillars: Ecological Impact, Feasibility and Cost, and Community Endorsement. This score is not a fixed number. Instead, city planners can adjust the weight given to each of the three pillars based on current policy goals. For instance, in a year focused on building public trust, the community endorsement score could be given more importance. Conversely, when facing a tight budget, the Feasibility and Cost score would have a greater influence on the final ranking. This transparency makes the rationale for every planting decision clear and defensible to the public.

The output is not a static report that sits on a shelf, but an interactive public map that serves as the central tool for the planting programme. This transparent map represents a key innovation of the proposed framework. While digital city dashboards and planting maps exist, this tool synthesises the AI-driven analysis and community input into a single, publicly accessible interface, as every site on the map has a public score breakdown. A citizen can click on a proposed location and see the exact rationale for its priority; for example, a label might read: “High Priority: 95/100. Breakdown: High community demand (450 votes, near a school) + cooling potential (Projected -2.5°C reduction) + Medium-cost site.”

This level of transparency achieves two key goals. First, it builds public trust by demystifying the decision-making process. If a resident's favoured site is not first on the list, they can see the objective reasons, such as higher projected ecological benefits elsewhere or lower maintenance costs. Second, it provides a clear, accountable planting schedule for the municipality. The map becomes a public commitment, showing the planned timeline for the upcoming years, which can be updated as new funding is secured or new community needs emerge.

Policy considerations and recommendations

For the European Union institutions

- Incentivise the adoption of digital community engagement by incorporating it as a best-practice criterion within the monitoring strategy of instruments like the EU Green City Accord, encouraging its use by cities both within and outside the EU.
- Prioritise Horizon Europe and Life programme funding for the co-development and deployment of this framework in regional partnership, specifically with Southern Mediterranean cities and research institutions. The goal should be to create an open-source toolkit and build local capacity in the regions most affected by the urban green divide.
- Promote the adoption of this framework through existing EU-Southern Mediterranean partnership programmes (e.g., Union for the Mediterranean [UfM]) as a practical tool for addressing urban inequality in climate adaptation planning.

For municipal authorities

- Establish cross-departmental “Green Equity Teams” combining expertise from environment, planning, finance, and digital communication to oversee the framework's implementation. Promote the linkage of those teams through a twinning system between Northern and

Southern Mediterranean municipalities, facilitating direct knowledge transfer and sharing technical capacity.

- Create transparent Green Equity Funds with clear spending rules. Management should involve joint citizen-municipal committees to ensure transparency and build trust.

For Euro-Mediterranean and EU-MENA partnerships

- Channel EU external climate finance (e.g., through the Neighbourhood, Development and International Cooperation Instrument [NDICI-Global Europe]) to establish a dedicated support programme. This programme should focus on closing the data and capacity gap by funding ground-sensor networks in data-scarce MENA cities and providing training for local authorities and tech hubs on using the open-source toolkit.
- Transition from theoretical research to practical implementation by launching collaborative EU-MENA pilot initiatives in 3-4 selected cities. These "living labs" would act as practical showcases of the framework, offering essential data on its execution in various settings and establishing a strong evidence foundation for broader regional deployment. The UfM might act as a venue to support and advocate for these pilot projects.
- Embed the framework in high-level policy by making it a defined action within the EU's bilateral partnership agreements with Southern Mediterranean nations. By framing it explicitly as a tool for delivering "urban climate justice", it ensures that climate adaptation efforts are targeted at the most vulnerable populations.

Conclusion: growing a greener, fairer future together

The urban green divide, the stark inequality in access to cooling green space both within cities and between the northern and southern shores of the Mediterranean, will not be solved by shunning new tools, but by directing them with clear purpose. AI, despite its own environmental footprint, is becoming an inevitable force in our economies and societies. Given this reality, we have a responsibility, at the very least, to harness its power where it can be used to actively heal the environment it often strains.

The framework in this brief offers a tangible path forward. By weaving AI's precision with community wisdom, we can ensure every tree is a strategic step toward a cooler, healthier, and more equitable city. This is not just about planting more trees, but about planting the right trees in the right places, for the right reasons.

For policy-makers, the path is clear. The EU must direct funding and update standards to deploy this framework, prioritising co-development to build local capacity with Southern Mediterranean partners. Municipalities should establish cross-departmental “Green Equity Teams” and transparent funds managed with citizens. Euro-Mediterranean partnerships must bridge the data gap and launch joint pilot projects to turn this model into tangible action for urban climate justice across the region.

This is our opportunity to create a new narrative. We can turn urban heat pockets into shaded community spaces by intentionally employing AI not for profit, but for planetary and societal welfare.

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