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JOURNAL

PROJECT

GUARDIAN - Green Urban Actions for Resilient fire Defence of the Interface Area

Riba-roja de Túria, Spain

TOPIC

Climate adaptation

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The GUARDIAN Project - Journal nº4

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In this fourth Journal, the project UIA expert Elsa Pastor reports on GUARDIAN progress after the project implementation period (which was officially ended by April 30th 2022). After more than one year with GUARDIAN solution being implemented, involving two entire wildfire seasons, the overall evaluation of the system performance is positive. This paper concludes a series on the GUARDIAN project's implementation, covering progress, sustainability measures, and knowledge generated. It emphasizes lessons learned, offers recommendations for similar projects, and concludes with reflections on GUARDIAN's legacy and impact.

Executive summary

GUARDIAN, a ground-breaking initiative for sustainable environmental management, enhances wildfire safety in Riba-Roja and Paterna while preserving the Natural Park of Túria. Both cities share the protected wildland zone of "la Vallesa" exposed to increasing forest fire risks, which are exacerbated by climate change. The project deploys recycled water for fire mitigation, incorporating irrigation and automatic suppression systems. It establishes hydraulic infrastructure, sensor networks, and a cutting-edge forecast and control system. Vegetation treatment and community training are also key activities to improve the fire resilience of all wildland-urban interface (WUI) in the area. The consortium, led by Riba-Roja City Council, includes Paterna City Council, MEDI XXI (an environmental engineering company), HIDRAQUA (local water utility), CETAQUA (water technology centre), UPV (Technical University of Valencia), and UV (University of Valencia), collaborating for holistic wildfire resilience. This last paper marks the conclusion of a series detailing the GUARDIAN project's implementation journey. To begin with, it presents the progress made since the last journal, encompassing the final implementation phase and approximately one year of testing after the project end. Detailed insights into actions taken to ensure the project's sustainability, scalability, and transferability are then presented. Subsequently, the last part summarizes the knowledge generated during the project, focusing at first on lessons learned from overcoming implementation challenges and providing then valuable recommendations for other urban authorities interested in similar innovative solutions addressing wildfire risk mitigation. Reflections and evaluations of the overall project are concluding the Journal, emphasizing GUARDIAN's legacy and the impact it has created.

Project's progress

Project update from last journal

During the period covered by this journal, the implementation of GUARDIAN was completed (January–April 2022), and regular operations commenced in May 2022 and are still ongoing. Regarding the final tasks of the implementation phase, several key activities deserve special attention:

- Development and testing of the GUARDIAN management system: NetSense is the system through which GUARDIAN infrastructure is monitored, controlled and operated. GUARDIAN uses various information technologies to offer a fully digital and interconnected service. This has been made possible by deploying hundreds of sensors at the interface between the wildland and urban areas of Riba-roja and Paterna. The system has been developed involving control and simulation algorithms which continuously provide information 24/7 to update fire risk managers and first responders from both municipalities with real-time status of wildfire danger and dependable forecasts in case of an emergency. Moreover, NetSense is linked to the water canyon triggering system that allows the different types of irrigation patterns to be activated.
- Green firebreak species plantation: As detailed in a previous web article, the GUARDIAN firebreaks consist of multi-layered, biodiverse structures incorporating various species of trees, shrubs, and herbaceous plants. With their specific configuration and features—being fire-resistant, discontinuous, hollow, and kept moist through artificial irrigation—they create a unique microclimate. This microclimate is characterized by substantial shading, a notable reduction in wind speed, and effective control over relative humidity and temperature. This combination acts as a formidable barrier, effectively impeding the spread of fire. In the last part of implementation phase, the planting of the final fire-resistant species (e.g., *Fraxinus ornus, Celtis australis, Sorbus domestica*) required to complete the green firebreaks has been successfully carried out.
- Prescribed burning: As part of the comprehensive fire management plan costumized for Riba-roja and Paterna, a prescribed fire was planned in an abandoned cropland. The objectives of this activity were threefold: to reduce the wildfire risk in the WUI area of the Mas d'Escoto neighbourhood, to provide a training scenario for first responders in case of a fire emergency, and to conduct research experiments on the effects of prescribed irrigation on safety zones. Unfortunately, due to abnormal weather conditions (high temperatures and winds typical of summer in February), the burn had to be called off. It might be rescheduled soon, but, once again, it will always depend on weather conditions.
- Education and awareness raising activities: In the last months of implementation, various activities have unfolded in this domain. These include training sessions for fire risk managers on the NetSense platform and the utilization of portable irrigation units for fire protection. Additionally, activities targeting residents have been conducted, such as creative workshops focused on risk awareness and education, along with home assessments through door-to-door visits.
- GUARDIAN official inauguration: Preceded by an on-the-spot official audit in March 2022 (Figure 1), on April 7th, GUARDIAN was officially unveiled in the presence of local authorities, stakeholders, residents, and the media at Trenor Country House. The GUARDIAN leader and partners, along with the mayors of Riba-roja and Paterna and the regional secretary of Safety and Emergencies, participated in the event. Following the speeches, attendees visited the GUARDIAN infrastructure at the Cañada Sur site to witness the water cannons in action.
- Dissemination activities: During this final phase, GUARDIAN's media presence has been robust, with coverage in local, national, and even international newspapers. Additionally, the scientific aspects of GUARDIAN have been shared at various research conferences and events. It is also noteworthy that GUARDIAN representatives participated in the Just Transitions and Climate Adaptation UIA workshop held in Seville at the end of April 2022 (Figure 2).

Figure 1. On-the-spot official audit of GUARDIAN infrastructures

After completing the overall implementation of GUARDIAN (April 2022), the operational phase served at the beginning as a testing period, particularly during weeks characterized by high fire risk. Preventive irrigations would be activated based on information collected by the sensors deployed in the field during days with rainfall deficits and low vegetation moisture content. Additionally, they would be triggered in the event of a nearby wildfire, as occurred on June 22nd, 2022. At the afternoon on that day, a wildfire was reported in the "Pedrera" canyon, between the Traver and València la Vella communities (just a few kilometres away from the GUARDIAN sites). Given the fire weather conditions (34ºC, relative humidity of 20%, and west-southwesterly winds exceeding 20 km/h), it was recommended to activate the water cannons in "Masia Traver" and "Els Pous" sectors, and so it was promptly executed. Fortunately, the fire was quickly brought under control with minimal consequences and a very limited area burned. It proved to be a valuable test for the system, showcasing its prompt response to an emergency situation.
In the final months of the implementation phase, the predominant challenges have been technical in nature. GUARDIAN has developed and fine-tuned water irrigation algorithms and IT solutions, navigating through hard deadlines and the technical complexities inherent in dynamic systems like daily wildfire danger forecasts, vegetation and weather variable statuses, etc.

Figure 2. Mr. Robert Raga, Riba-roja mayor on stage at the "Just transitions and urban adjustments" event in Seville (April 27th 2022). Source: InfoTúria

Sustainability, scalability and transferability of the project

In addition to ensuring the proper functioning of the GUARDIAN system in the event of a high risk of fire or emergency, the consortium has been diligently working on guaranteeing the project's sustainability, scalability, and transferability after the completion of the implementation phase.

Sustainability

With the GUARDIAN project, numerous infrastructures have been established that require ongoing maintenance and proper operation. In this regard, the overall system can be classified into three sections: one directly supervised by Riba-roja, another managed by Paterna, and a third designated as general facilities for shared use. In both the cases of Paterna and Riba-roja, facilities have been incorporated into the comprehensive water cycle inventory. This integration allows the expenses to be covered by drinking water rates, and the operating company of the service extends its responsibilities to these new facilities. As for the general facilities, a collaboration agreement has been established, assigning maintenance responsibilities to Riba-roja while Paterna covers the associated costs.
Significantly, most project partners remain actively involved. Riba-roja and Paterna, being beneficiaries of the

system, have dedicated personnel for its operation. Hidraqua is responsible for system maintenance (hired by both Paterna and Riba-roja), while Cetaqua oversees the control of the regenerated water system on behalf of Hidraqua. Medi XXI is engaged by Hidraqua to manage various sensors, and UPV scientists persist in optimizing the overall system, investing substantial effort in data collection, including weather and vegetation data. They correlate this information with water irrigation parameters to ensure efficient system operation.
As for forestry works, ensuring the sustainability of fuel-reduced areas involves maintaining both the fuel load and structural integrity. The total treated area spans 37 hectares, all of which require ongoing maintenance. The municipalities will be responsible for maintaining the areas within their jurisdiction, while the park management entity associated with the Vallesa Natural Park will assume responsibility for the corresponding areas. As for the river area, maintenance duties will be overseen by the Spanish Ministry of Ecological Transition.
Sustainability challenges primarily revolve around political support, which may be influenced by changes in government. While a shift in priorities could potentially relegate GUARDIAN to a secondary position, it is essential to acknowledge that GUARDIAN infrastructure is integral to a wildfire safety system. Despite changes in municipal government, the citizens' commitment will ensure the continuous operational effectiveness of this infrastructure. Political support remains a crucial aspect, and it is unlikely that any municipality would withhold support for GUARDIAN, given its significance as a vital topic.

Scalability

Riba-roja and Paterna are actively participating in GUARDIAN infrastructure expansion projects, collaboratively ensuring the continued functionality and growth of the overall system. This collective initiative enhances fire resilience for both residents and the park. GUARDIAN's priority areas were identified through wildfire risk assessments, and these expansion projects aim to cover initially excluded areas due to budget constraints. Complementary projects are currently in preparation and will soon be submitted to natural park administrations for approval. Specifically, for Riba-roja, there is consideration to cover the risk area known as "Valencia la Vella," with an anticipated investment of approximately €400,000, relying on municipal financing (potential collaboration and subsidies are being explored). Concurrently, Paterna is examining the protection of the portion of the "la Cañada" settlement not covered by Guardian due to financial limitations.
It is noteworthy that, within the GUARDIAN project, portable water cannons (Figure 3) were designed and provided to the municipalities. These are currently being used for various municipal purposes, such as enhancing safety at pyrotechnic events. Thanks to GUARDIAN dissemination efforts and the positive connections between nearby towns, the municipality of Eliana (in the vicinity of GUARDIAN sites) has already acquired portable cannons similar to those developed in GUARDIAN. Other municipalities have also expressed interest.

Figure 3. Portable water canyon designed in GUARDIAN

Transferability

In the context of climate change and the elevated fire risk in numerous residential areas, the implementation of defence systems aligned with the GUARDIAN project becomes increasingly crucial. The latter is indeed transferable, and several municipalities have already expressed interest. For instance, on a national scale, the Natural Park of "El Saler" near Valencia is currently adopting a system like the one developed in GUARDIAN. Beyond Spain, there is notable interest from other regions, such as the municipality of Athens, which faces a metropolitan wildland-urban interface with a high fire hazard, and has sought information about the project. To ensure transferability, numerous knowledge transfer activities have been conducted throughout the GUARDIAN implementation phase and beyond. Conferences, seminars, scientific forums, television, local and international press media, scientific papers, and more have all been dedicated to disseminating GUARDIAN methods and results for transferability purposes. A few examples of this collective effort are highlighted below:

- URBACT Conference (September 2021, Madrid, Spain). The 'Urban Transfers' Conference organized by the URBACT Spain National Point and the City Council of Madrid, saw the participation of over 60 Spanish cities, with 150 in-person attendees and more than 600 virtual participants through streaming broadcasts. Under the theme "Sharing Knowledge to Improve Cities," GUARDIAN representatives actively engaged in dedicated workshops to present the GUARDIAN solution to representatives from other municipalities.
- CONAMA Conference (November 2022, Madrid, Spain). With the aim of an effective ecological transition, the 16th National Conference on Environment advocated for a unified urban agenda, with climate ambition and a just transition, to accelerate real transformation in the face of sustainable development and climate change challenges. Mr. V. Adobes, the GUARDIAN project manager, delivered a presentation during one of the sessions dedicated to municipalities planning for climate change adaptation.
- Contribution at the International Fire and Safety Journal (December 2022). Through an interview of F. Dalmau (Medi XXI CEO), the prestigious journal on fire safety dedicated an article describing the GUARDIAN methods and results as the "Europe's biggest suppression system" (Figure 4).

Figure 4. Front page of the article included at International Fire and Safety Journal

Generated knowledge

Lessons learnt

The GUARDIAN project represents a collaborative endeavour aiming at implementing an innovative solution for wildfire resilience in Riba-roja and Paterna municipalities. Throughout the project, specific challenges were encountered (involving, among others, public procurement, administrative procedures, organizational arrangements, and communication with target beneficiaries), and the process of resolving them has yielded valuable lessons, which are summarized as follows:

- Public Procurement: The procedures outlined in the public administration contract law pose a significant challenge in aligning project deadlines with those specified in the grant contract. This challenge has proven to be especially daunting. Over the course of the project's evolution, the GUARDIAN consortium has gained insights into the importance of **proactively anticipating procedures and maintaining consistency and realism with deadlines**. Additionally, they have come to appreciate the significance of having a well-thought-out monitoring plan, evolving it into a dynamic and functional document. This, coupled with effective control over project indicators and clearly defined roles for each participating member, has been identified as crucial for project success.

- Administration procedures – permits: The GUARDIAN project executed most of its work within a natural park under special environmental protection, necessitating external permits from other administrations. This consistently posed a significant organizational challenge. A substantial coordination effort among partners was essential to ensure timely and accurate permit requests. Following this, **ongoing communication and follow-up with external administrations were crucial** to expedite procedures. This experience underscored the significance of effective internal management and a robust monitoring system.
- Organizational arrangements within the urban authority (cross-department working): The GUARDIAN project, executed through collaboration with seven partners, has necessitated meticulous management to ensure clarity in task distribution, responsibilities, and interrelations among various functions. Additionally, the involvement of a municipal security authority in the project has required thorough discussion of all agreements, adding complexity to procedures. The consortium has acquired essential lessons about **the importance of clarifying each member's competencies, maintaining well-defined communication channels, and staying vigilant about deviations**, particularly those that may impact multiple partners. Furthermore, the importance of having a prepared contingency plan has been underscored. The consortium has come to appreciate the significance of well-organized teamwork, emphasizing the importance of soft skills in collaborative efforts. GUARDIAN members have recognized the value of effective leadership and a comprehensive understanding of the project from a management and monitoring perspective.
- Communication with target beneficiaries and users: Maintaining consistent and informative communication with involved groups such as environmental protection, neighbours, and first responders has been crucial. Initial stages of the project posed challenges in this regard. The solution was **to establish a dedicated team focused on communicating and engaging with these sensitive groups**. This team ensured that progress was communicated in the most effective manner possible. The GUARDIAN consortium has realized the paramount importance of incorporating the concerns of affected groups into project development, recognizing that the ultimate success of the project hinges on this aspect.

Recommendations to other urban authorities

Several messages from the GUARDIAN consortium can be delivered to urban authorities who want to implement innovative solutions as GUARDIAN to mitigate wildfire risk in their wildland-urban interfaces. Those are gathered as follows:

- Collaborative partnerships: cultivate strong collaborations with pertinent stakeholders, such as local communities, environmental agencies, firefighting services, and research institutions. The engagement of diverse perspectives and expertise is imperative for comprehensive wildfire risk reduction.
- Holistic approach: design the project implementation to encompass not only fire protection infrastructure (e.g., water infrastructure, fuel breaks, strategic defence points, control systems, etc.) but also elements like risk awareness campaigns, education, and training. Achieving wildfire resilience requires understanding and preparedness across all agents, actors, and population.
- Community engagement: involve the local community in the project's planning and implementation right from the outset. Encourage active participation and be mindful of the diverse needs of different target groups, including children, the elderly, and disabled individuals.
- Adaptability and flexibility: develop the project with adaptability in mind, recognizing the evolving nature of wildfire risks and climate conditions. Flexibility in implementation allows for adjustments based on emerging challenges and opportunities.
- Risk assessment: conduct a thorough, scientifically-based risk assessment to comprehend specific wildfire vulnerabilities in the municipality. This analysis should guide the development of targeted and effective solutions for the most vulnerable points.
- Innovative technologies: explore and leverage cutting-edge technologies to enhance early detection, monitoring, and response capabilities. Tailor strategies to fit your municipality, accounting for the fire regime and fire history in the area.
- Regulatory compliance: ensure strict adherence to environmental regulations and proactively devise a strategy for obtaining necessary permits for project activities. This compliance is crucial, particularly when operating in protected areas or regions with specific ecological considerations.
- Communication strategy: develop a comprehensive communication strategy to keep stakeholders, residents, and the public well-informed about the project's goals, progress, and outcomes. Clear communication fosters support and understanding.
- Monitoring and evaluation: establish robust monitoring and evaluation mechanisms to assess the project's effectiveness over time. Regularly review and adapt strategies based on outcomes and lessons learned.
- Knowledge transfer: document and disseminate project experiences, successes, and challenges to a wide audience through various channels. This knowledge transfer ensures that insights gained from the implementation can benefit other municipalities in implementing similar projects, contributing to the advancement in this field.

And, not least importantly, the concluding message from the GUARDIAN consortium to other urban authorities is that the project has delivered numerous benefits to the city authority. These include the ability to foresee and navigate forthcoming challenges, formalize an innovation strategy and goals, enhance the utilization of data and capacity in policy design and implementation, streamline internal government operations, foster novel ways of engaging residents, and generate additional resources for the city. Successfully navigating the complexities of a project like GUARDIAN has emboldened the municipalities of Riba-roja and Paterna to approach future endeavours with a more adventurous mind-set, embracing risks that could yield even more ambitious outcomes. Currently, both municipalities are involved in other innovative projects, with a focus on digital tourism in Riba-roja, incorporating cutting-edge solutions.

Conclusion

GUARDIAN has proven to be a successful project, implementing a comprehensive toolkit of complementary solutions for wildfire resilience. These include watering infrastructure, green firebreak constructions through forest works, and education and training activities for residents and stakeholders in Riba-roja and Paterna. The success of this project can be attributed to various factors that must be considered collectively:

- The consortium setup and expertise: The consortium's strength has been grounded in partners' dedicated focus on their expertise, ensuring total commitment. Although this approach demands extra effort to maintain a holistic view of the consortium's goal, effective management and communication have made it possible. Consequently, after years of collaboration, the GUARDIAN team has become a close-knit family, with members finding their roles and understanding each other's contributions throughout the project's development.
- Public-private sector effective cooperation: The project's outcomes have highlighted the benefits of public-private collaboration for the consortium. Viewing public administration from an external perspective can lead to the temptation of criticizing municipal activities. However, over these years, the various partners have observed that municipal public workers exert maximum effort to fulfil their duties with utmost professionalism and strict adherence to current legislation.
- Stakeholders on board: The consortium has found the collaboration with all key agencies (e.g., natural park administrations, fire agencies, civil protection agencies, etc.) to be immensely valuable. Ensuring that their technical expertise contributes to the final result has been essential for the project's success, fostering a sense of shared ownership. This has not only enhanced the technical aspects of the project but has also strengthened the overall sense of fellowship and shared commitment among all stakeholders involved in GUARDIAN.
- Community engagement and trust: Residents in Riba-roja and Paterna have been part of the co-creation process from the very beginning of GUARDIAN. It has been crucial to articulate to the neighbours and environmental groups the technical rationale behind GUARDIAN approach to the work. While their opinions have undeniably played a role in the decision-making process, they have consistently been evaluated against objective technical criteria. The project has demonstrated that public investments in natural spaces not only enhance fire safety of individuals and property but also contribute significantly to their overall quality of life. This initiative has shifted the perception of citizens regarding the positive outcomes associated with investing in environmental actions.
- The GUARDIAN mind-set: The GUARDIAN consortium's success is a tribute to their fearless determination and resilience. They embodied the mantra "because they didn't know it was impossible, they did it" turning challenges into triumphs and showcasing the power of unwavering spirit.

The primary legacy of the project lies in the innovative technical solution for wildfire protection that has been successfully implemented. The collaboration of a diverse engineering team with varied expertise enabled the establishment of green firebreaks irrigated with regenerated water from a wastewater treatment plant. By utilizing regenerated water, GUARDIAN is mitigating the polluting impact of the wastewater treatment plant and furthermore, enhancing the quality of a wetland. Additionally, the implementation of an advanced control and intelligence system to oversee GUARDIAN water infrastructure represents a state-of-the-art solution, incorporating an extensive network of sensors providing continuous wildfire danger monitoring. The significant progress made in this regard is unmistakable.
GUARDIAN has been also proved to be economically feasible, by applying innovative methods for ecosystem services' valuation that it promotes. These include air quality regulation, biodiversity conservation, carbon absorption and storage, recreational and tourism activities, sense of belonging, among others.
And last but certainly not least, it is noteworthy to highlight the impact that GUARDIAN has had on policy-making. Within the project's lifecycle, it successfully influenced a modification of legislation related to territorial planning, urbanism, and landscape by the Valencian Government. Specifically, thanks to the technological solution developed in GUARDIAN, the chapter "Legislative Modifications in Matters Competent to the Department of Territorial Policy, Public Works, and Mobility" mentions, as alternatives to fire protection based on water:

> 'the creation of networks of sprinkler elements, installation of outlets in pools and ponds [...] installation of water curtains in homes, creation of **water reserves from reclaimed water** or rainwater, etc.

This marks the first instance, both nationally and at the European level, where the utilization of regenerated water is acknowledged in regulations pertaining to forest fire defence. Undoubtedly, this achievement is a direct outcome of the GUARDIAN project. Additionally, in terms of policy impact, it is noteworthy that at the national level, the Spanish National Strategy for combating desertification explicitly references the GUARDIAN solution. In this context, GUARDIAN is cited as an exemplar of good and innovative practices for Integrated Fire Management in communities situated at the wildland-urban interface.

Climate adaptation

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