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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

EDIT 23 DECEMBER 2021
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GUARDIAN Journal 3: get an update about Riba Roja de Turia's project

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In the third Journal of the Guardian project UIA expert Elsa Pastor reports on project progress during year 2021. She also analyses cross-cutting implementation challenges (identified by UIA as leadership, public procurement, organizational arrangements, co-implementation, monitoring and evaluation, communication and upscaling) that GUARDIAN consortium has faced during the last implementation phase.

Executive Summary

GUARDIAN is a pioneering model of sustainable and innovative management of the natural environment, which will ensure the safety of the citizens of Riba-Roja and contribute to the preservation of the Natural Park of Túria and La Vallesa.

The urban areas of Riba-Roja and Paterna, share the protected wildland zone "la Vallesa", which is part of the Natural Park "Parc Natural del Túria", located in a highly urbanised environment. The wildland-urban interface (WUI) between this park and these two cities is subject to the growing risk posed by forest fires, further impacted by the effects of climate change. This hazard is maximised by its progressive incorporation within the urban area and certain degradation, mainly due to agriculture abandonment and insufficient forestry management.

The project adopts a combined strategy based on the use of recycled water for fire mitigation and protection, providing preventive irrigation and extinction water spraying patterns automatically programmed. GUARDIAN will implement the hydraulic infrastructure to supply recycled water from the Waste Water Treatment Plant "Camp del Túria II" to the WUI area of "la Vallesa", and the elements (irrigation and sprinkler towers) which make up the defensive barrier. The operation of the fire prevention and suppression infrastructure will be based on sensor networks and forecast services processed by an automatic system. In order to support this hydraulic infrastructure, GUARDIAN will also make use of an existing wetland ("la Vallesa" pond) as an emergency reservoir. The required water quality for the project's goals will be ensured thanks to the implementation of an advanced modular water treatment implemented in the existing facility. Furthermore, GUARDIAN implementation actions will include vegetation treatment (i.e. reduction of tree density, pruning, shrub spacing, etc.) by which the ecologic conditions and the fire resilience of "la Vallesa" forest will be improved, and self-defense training for population in order to enhance risk perception, create awareness, communicate the basis of the project and improve self-protection through fire resilient gardening and household protection strategies.

The GUARDIAN consortium is led by the Riba-Roja City Council, acting as the main Urban Authority (UA) and has the Paterna City Council as Associated UA. Five more entities are included in the partnership: MEDI XXI, which is an environmental engineering company with expertise on fire risk mitigation and fire defence technological solutions; HIDRAQUA, the local water utility with long experience in the implementation of hydraulic infrastructures and water reuse; CETAQUA, a water technology centre providing R&D&I solutions to sustainable and efficient water cycle management; the Universitat Politècnica de Valencia (UPV) and the Universitat de València (UV), two public institutions of research and higher education in charge of designing the automated monitoring network of forest/weather conditions and validating the economic payback and efficiency of the project, respectively.

The present document is the third of a series of journals following the GUARDIAN project implementation process. It firstly presents the main achievements during the current reporting period (year 2021) and, following, it gathers a review of the potential challenges for implementation that the project is so far experiencing.

Key activities and interim achievements

During year 2021 GUARDIAN has (almost 100%!) implemented the actions regarding two of the three pillars above which the fire risk mitigation strategy is built (see web article 1 to recall the GUARDIAN overall strategy): 1) the innovative firefighting system involving a full hydraulic infrastructure to deliver recycled water to WUI areas; and 2) the forestry and environmental works to improve ecosystems' conditions and fire resilience in Riba-Roja and Paterna wildlands. Regarding the third pillar, which involves community education and awareness-raising, it has still been affected by the global COVID crisis. However, some face-to-face activities have already taken place with the presence of neighbours and first responders to increase fire risk perception and familiarity with the GUARDIAN fire-fighting system within the community.

All in all, the progress of the project has been very satisfactory according to the Consortium members. GUARDIAN implementation has generally followed the schedule set for this period with minor deviations basically due to the current pandemic situation.

As in the last journal, the main project implementation milestones achieved during 2021 will be summarized following the GUARDIAN water cycle (see web article 2 to recall the smart use of water in GUARDIAN): we will start by commenting actions implemented concerning the water reclamation plant, followed by the hydraulic infrastructure works. We will then give details on the irrigation program that is being designed and on the forestry management actions.

Following, we will comment on the progress achieved on dissemination, community education and awareness-raising, which, despite the difficulties, has been worth enough to be mentioned. And last but not least, we will finish this section by reporting on the efforts made by Universitat de Valencia devoted to analyse the economic viability of GUARDIAN.

The Water Reclamation Plant set-up

The Water Reclamation Plant (WRP) was successfully installed by the end of the last reporting period (December 2020). Its mission is to remove organic micro-pollutants to guarantee the safe reuse of the reclaimed water for fire preventive uses (in Zoom-in 1 you will find all details regarding the WRP engineering solution). During 2021 operational parameters have been adjusted to maximize the efficiency of the treatment processes. Particularly, CETAQUA and HIDRAQUA have tested different operation conditions with the aim of optimizing the water reclamation process in terms of removals, energy consumption, operation cost and environmental impact. As such, ozone doses, addition of hydrogen peroxide, biofilters performance or influence of other parameters such as pH, redox or temperature have been assessed in parallel with the execution of three 1-week sampling campaigns of organic micro-pollutants in the inlet and the outlet of the WRP (Figure 1).

The performance of the WRP has now proved successful. However, there are still some open questions regarding water quality as for instance how to prevent legionella breeding downstream. Water outlet form the WRP will be bacteria-free, but the water distribution network has some low-level points where the risk of detecting legionella bacteria may have to be considered.

Figure 1. Water analysis at CETAQUA premises.

Hydraulic infrastructure building works

Civil works on the hydraulic infrastructure that has to convey water from the WRP down to the wildland-urban-interface started by October 2020 and have been finished during this reporting period. All infrastructure is already in place: 4 new water tanks -Alpha, Bravo, Delta and Echo- plus 1 renewed tank –Charlie- (Figure 2), water pumps, auxiliary energy supply units, control instrumentation, and a network of 6.5 km of pipelines to link all the elements with the water canyons deployed in the different WUI areas of Riba-Roja and Paterna: Els Pous, Masia Traver, Canyada Nord and Canyada Sud (see past Journal 2 to recall the infrastructure map and location of key points).

Figure 2. Top: Alpha water tank located in the proximity of the WRP. Water from Alpha is pumped to Bravo, Delta and Charlie tanks. Bottom: renewed Charlie tank located at "Els Pous" settlement (this is the only tank that has not been built from scratch. An existing tank at "Els Pous" has been refurbished for GUARDIAN purposes.)

Regarding the water canyons, a total of 40 have been installed in 4 different WUI areas as initially planned: 6 towers in "Cañada Norte" and "Els Pous" and 14 towers in "Cañada Sur" and "Masia Traver" settlements, respectively. This activity has successfully overcome some implementation issues. Heavy cranes have been used to transport the towers (which can be up to 26 m long) to the site through a complex landscape (i.e. WUI neighbourhoods with narrow roads close to wild areas). Moreover, requirements coming from airport regulations have had to be considered in Cañada Norte and Cañada Sur settlements, due to the proximity of Valencia airport. As such, towers have been painted with white and red strips for the sake of increasing visibility in this area, while for the rest of the towers an effective visual and landscape integration has in turn been achieved (Figure 3).

Figure 3. Left: Tower at Masia Traver site, painted in green to achieve landscape integration. Right: Tower at Cañada Sur site, painted in white and red strips in accordance to airport regulations.

After completing civil works, the overall infrastructure has been successfully tested to check pumping efficiency, flow rates and water pressure at the end of the lines so that to ensure the correct reach of the canyons (which is around 40 m) and to detect potential water losses or any other anomalies within the water network that may affect the proper functioning of the infrastructure (Figure 4).

Figure 4. Top: Water test at "Els Pous" site

HIDRAQUA engineers are already working on the exploitation dynamics definition (e.g. water flow balances, design of operations of consumables usage such as diesel or chlorine, etc.) while co-designing together with MEDIXXI and UPV the remote control of the infrastructure.

Unsupervised irrigation module: design and operational tests of the NETSense platform

As mentioned in past web article 3, unsupervised irrigation is the most innovative aspect of the GUARDIAN project, as it clearly represents a step forward on implementing front-line research on ecohidrology-oriented silviculture. During this reporting period, scientists from the Universitat Politècnica de València (UPV) have been processing the huge amount of data on atmosphere-plant-soil water dynamics coming from their field work to design the irrigation algorithm that has to be programmed for a fully unsupervised operation of the GUARDIAN system. To this end, UPV scientists together with MEDIXXI engineers (Figure 5), are now designing a new version of the widely used Fire Weather Index to account for complex water dynamics and interaction in wild vegetation. With this algorithm, water needs for preventive irrigation and pre-suppression wetting (see web article 2 to recall

the different water uses of GUARDIAN) will be precisely determined according to the fire weather and the vegetation state.

Figure 5. Technical meeting of UPV and MEDIXXI teams for the design of the unsupervised irrigation module.

The unsupervised irrigation module will be responsible of calculating the irrigation pattern consistent with daily conditions and has been designed to be fed with data coming from a wireless sensory network, the so-called SIDEINFO NETSense. NETSense has been already implemented to monitor meteorological and biomass variables (e.g. temperature, relative humidity, wind speed and direction, fuel and soil moisture, etc.) together with eventual fire ignitions in real time. For that purpose, 3 weather and air quality monitoring stations, 4 biomass monitoring stations and 40 fire detectors have been installed within the Túria Natural Park and initial tests of the system have been recently performed (Figure 6).

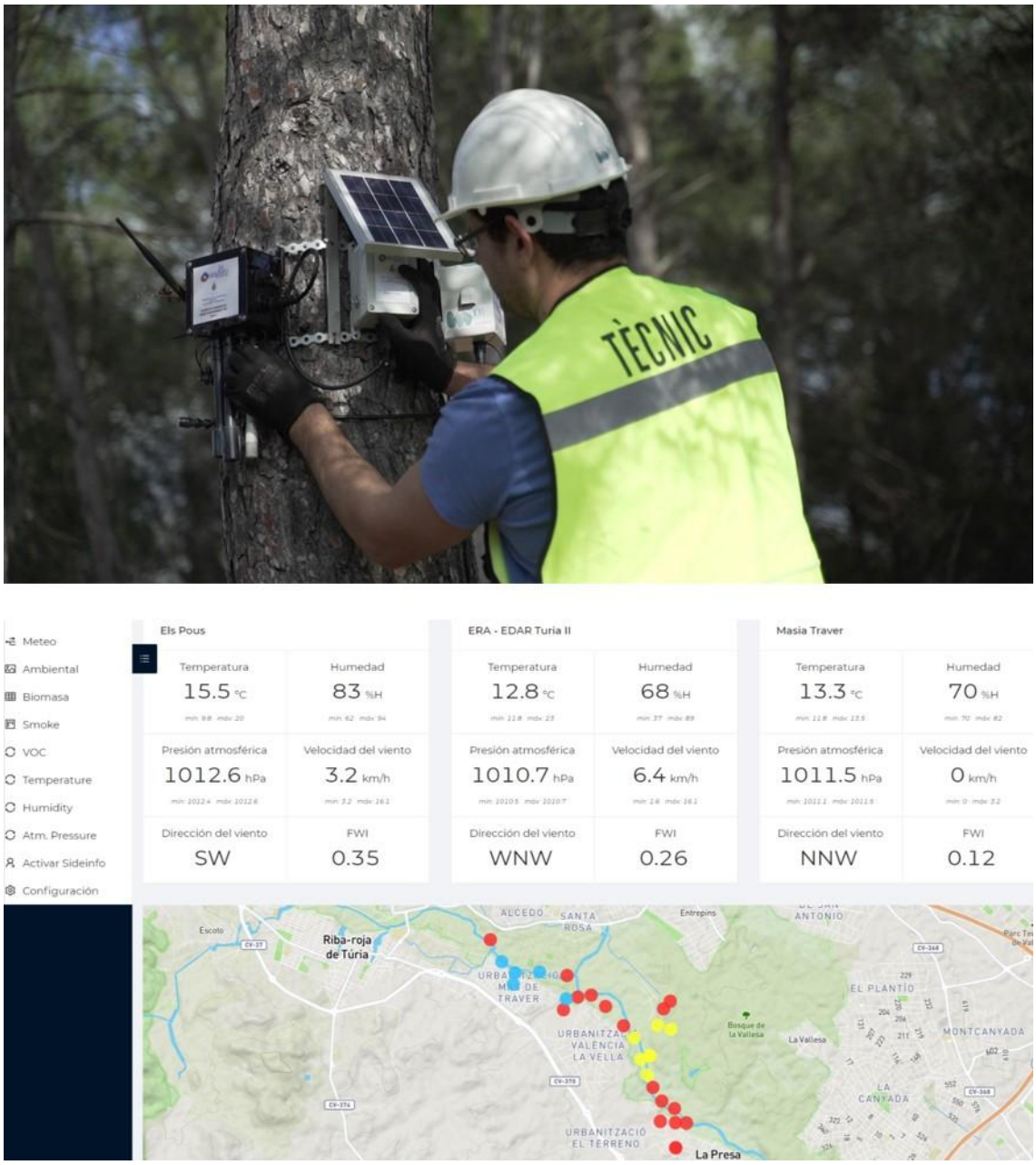

Figure 6. Top: Biomass sensors installed in La Vallesa Forest (photo source "El Temps"). Bottom: Graphical interface of the NETSense system showing sensed data from the overall monitoring network.

NETSense has been designed as a unit of an overall remote control system that has to supervise the operation of both the hydraulic infrastructure installed by HIDRAQUA (tank levels, pumping, water regeneration station, etc.), and the prevention and defence infrastructures (sensor signals, activation of water towers, etc.). During the last months of this reporting period all technical partners are working together to ensure the efficient operation of GUARDIAN system during the next fire season, paying particular attention that the balance between available water and needed water is smoothly satisfied at all times.

Forest management related works

Fuel treatments have continued over 2021, being particularly focused on the construction of green fire breaks. In parallel with the execution of classic fuel management jobs (i.e. thinning and clearing), MEDIXXI brigades are implementing an innovative eco-hydrological forestry solution in which fuel treatments are combined with artificial water inputs delivered through prescribed irrigation. GUARDIAN green fire breaks consist on a multi-layered biodiverse multi-specie structure that thanks to their shape and features will be able to create a particular microclimate on site leading to a scenario with less wind, high relative humidity and larger shaded areas with lower temperatures (find more information about green firebreaks on web article 5). Areas in which these fire protection infrastructure have to be implemented have been prepared during this reporting period. In figure 7, an area ready to host a green fire break is shown. The zone will be enriched with the introduction of native fire-resistant vegetation and the introduction of a shrub windbreak barrier made of low fire vulnerability species at the windward edge of the firebreak.

Figure 7. Area prepared to be enriched as a green firebreak.

Together with the previously mentioned treatments, MEDIXXI brigades have also finished the works devoted to eliminate cane fields. As mentioned in past Journal 2, cane is a high flammable fuel that may escalate fire spread if ignited. As such, several cane fields located in Túria NP have been eliminated and treated with fully opaque geotextile covers to avoid emerging buds (Figure 8).

Figure 8. Works performed in a cane field. Opaque fabrics to avoid new buds have been placed in all treated cane fields.

Dissemination, community education and awareness-raising

As previously mentioned, activities involving interaction with main stakeholders (i.e neighbours, first responders and local agents) have been fully affected by the current COVID19 crisis. However, huge efforts have been devoted to organize safe face-to-face activities to show GUARDIAN infrastructure functioning to Cañada Norte, Cañada Sur, Els Pous and Masia Traver communities. With the aim of increasing feedback and interaction between all key agents, it has to be highlighted the organization of a community participation day (past November 6th) linked to the FIRECONGRESS scientific dissemination effort. Apart from local communities, GUARDIAN received visitors coming from divers countries (e.g. China, Czech Republic, United Kingdom, Greece, Italy, Germany) with which stimulating discussions on fire prevention and risk perception took place (Figure 9).

Figure 9. Community Participation Day (November 6th2021)

It is also worth mentioning that over these last months the project has aroused the interest of local politicians who wanted to know and see GUARDIAN infrastructure first-hand. Among others, GUARDIAN has received the regional minister for ecological transition and the regional minister for innovation, universities, science and digital society (revisit web article 4 to find one of our reports on dissemination).

Economic viability analysis

During this reporting period scientists from Universitat de València (UV) have deeply studied the economic viability, replicability and scalability of GUARDIAN. It is already acknowledged that GUARDIAN will promote several ecosystem services in La Vallesa Natural area involving multiple social and environmental benefits. These benefits will be considered in the overall economic final balance by applying complex techniques that account for those concepts not having a direct monetary impact. UV team has been exploring different techniques (see web article 6 for a synthetic description of these) to perform a thorough Cost-Benefit Analysis by which it should be proved that GUARDIAN is sustainable, reproducible and economically viable at the end of the implementation phase.

Review of current implementation challenges

As mentioned in past Journals, UIA has identified seven cross-cutting challenges that might be relevant when implementing innovative projects like those from UIA. These are mainly related to leadership, public procurement, organizational arrangements, co-implementation, monitoring and evaluation, communication and upscaling. These challenges may have different intensities depending on the type of the project and on the implementation phase the project is experiencing.

In this section we review the challenges that GUARDIAN has faced during 2021, the third year of implementation

of the project in which the project has experienced an amazing progress despite the still present COVID19 crisis. The overall survey tells us that, despite all adversities, the efforts made by the consortium have been effective to overcome main implementation challenges.

In Table 1 a summarized analysis of how the consortium is facing the seven implementation challenges is provided. Inspired by a classic SWOT (strengths, weaknesses, opportunities and threats) analysis, we have concisely highlighted pros and cons that are helping or hampering the GUARDIAN implementation. Through a classic traffic-light system, we assess the level of risk against each challenge, where red is high, orange is medium and green is low.

Challenge	Level	Observations	
Leadership	M	Strengths & opportunities	► Political leadership from Urban Authorities has been strong when dealing with authorities and media. ► Project leader has lead GUARDIAN efficiently keeping the consortium working as a unit.
		Weaknesses & threats	► Political leadership from Urban Authorities has been weak when dealing with communities.
Admin. Procedures: permits & tendering	H	Strengths & opportunities	► Smooth cooperation between public and private companies to transfer budget. ► Opportunity detected to improve regulations to simplify contracting procedures.
		Weaknesses & threats	► Hiring process are long in Riba-roja and Paterna which jeopardize meeting project deadlines. ► Difficulties on public procurement have a negative impact on private companies' finances.
Cross-department working	L	Strengths & opportunities	► High level of mutual trust across and between partners. ► Links have been strengthened through team building activities.
		Weaknesses & threats	► Difficulties on engaging particular profiles with occasional involvement.

Challenge	Level	Observations	
Participative approach	H	Strengths & opportunities	► Key associations and persons are already on board. ► Fostering co-implementation has agreed to be high priority for the next months.
		Weaknesses & threats	► Face-to-face participatory initiatives are difficult due to the current COVID19 crisis.
Monitoring & evaluation	L	Strengths & opportunities	► Consistent internal monitoring of the project implementation plan. ► Indicators-based system is being used to gather meaningful data.
		Weaknesses & threats	► Monitoring and evaluation activities have already pointed at important challenges regarding maintenance of the GUARDIAN infrastructure.
Communic. with beneficiaries	M	Strengths & opportunities	► Benefit from online tools to reach technical and scientific audience. ► High-impact activities already programmed for next reporting period.
		Weaknesses & threats	► Difficulties on reaching communities due to COVID19 crisis.
Upscaling	L	Strengths & opportunities	► Nearby municipalities already interested in GUARDIAN.
		Weaknesses & threats	► Ecosystem services difficult to be qualified in monetary terms.

Based on the above-gathered main points, a more detailed discussion of the seven implementation challenges is provided down below:

- **Leadership**: During 2021 the role of the project leader has again been crucial to keep the consortium working cohesively and efficiently despite all the difficulties that the current COVID19 crisis imposes. The project leader has succeed in identifying everyone's capacities and allocating responsibilities to take the most of all partners for the sake of GUARDIAN progress. Regarding the leadership provided by city authorities, it has to be highlighted that it has been fruitful while dealing with dissemination activities with local authorities and media. However, it has not reached expectations regarding local communities. The lack of a clear and bidirectional dialogue with the neighbourhood associations has limited the impact of the actions aimed at educating and briefing Riba-Roja and Paterna citizens. Two main reasons may be responsible of this issue: in one hand, the current COVID19 crisis is indeed hampering fluid and smooth communication and, in the other hand, there may be underlying (unresolved) local conflicts intermingling with GUARDIAN management. During the following months, activities devoted to community education and awareness-raising will have to be strongly promoted and implemented, as citizens will play a key role during the exploitation phase of GUARDIAN. To this end, local authorities will have to pick up the reins on this matter.

- **Administrative procedures**: During 2021 administrative procedures have still been challenging as in past reporting periods. It has been acknowledged by local authorities that public procurement processes are in themselves a strenuous job. Public procurement processes are long, bureaucratic, with deadlines that can compromise project schedule. According to Riba-roja and Paterna realities, any hiring process usually takes more than 7 months, even giving it the highest priority. In this sense, GUARDIAN consortium has experienced the challenge to plan contracting times according to the project times, jeopardizing deadlines for work execution. To solve major problems, GUARDIAN consortium has derived the procurement of the services and infrastructures initially planned to be made by municipalities to private companies (HIDRAQUA and MEDIXXI). This has involved transferring budgets to these partners with all the difficulties that go with it: companies have ended up contributing more (20% unsubsidized) than what was initially planned and with greater financial burden (anticipated income has arrived late with respect to contracting expenses and payments to suppliers). In GUARDIAN the importance of public-private smooth collaboration has been demonstrated, without which the project could by no means have been carried out. Despite not being public companies, HIDRAQUA and MEDIXXI have tried to carry out contracting processes following the transparency, concurrence and competition criteria that rule public procurement at European level. GUARDIAN consortium agrees that it would be interesting to explore/develop specific regulations to simplify contracting procedures when the project has been validated by a higher administrative entity.

- **Organizational arrangements**: During this 3d year of implementation a high level of mutual trust has been reached by all partners' key-figures which has helped to speed-up implementation progress. Moreover, several activities have been organized aimed at team building to create stronger links between different members of the consortium. This has been key for organization purposes at consortium level, bearing in mind that the GUARDIAN consortium has a very heterogeneous nature in terms of type of entities involved (municipalities, universities, big companies, SMEs). At partner level, some particular challenges have been experienced: municipalities have struggled trying to involve those profiles

whose participation in GUARDIAN is occasionally required (e.g. legal profiles, operational profiles, etc.). These have revealed to be essential to undertake tasks in certain phases of the project although not being continuously required. Universities have also experienced some internal difficulties as the hiring of personnel under the GUARDIAN project umbrella has been an organizational challenge in their teams' dynamics.

- **Participative approach for co-implementation**: With the COVID19 crisis still impacting day-to-day lives, fostering co-implementation with relevant actors (e.g. neighbourhood associations, environmentalist entities, WUI communities, emergency responders, etc.) has become extremely difficult. Although key associations and persons are already on board, they have not had the opportunity of being fully involved in the GUARDIAN implementation phase yet. The Consortium is totally aware of this issue and has already designed and prioritized the implementation of activities devoted to foster co-design of the operational phase as soon as the global crisis allows more fluid face-to-face communication. Regardless of these difficulties, GUARDIAN has taken advantages of some opportunities risen during periods of lower COVID19 risk as the Community Participation Day, co-organized with the local wildfire research scientific community.

- **Monitoring and evaluation**: Internal monitoring of the project implementation plan has been performed efficiently by the GUARDIAN steering committee during the whole duration of the project. By making use of dedicated project documents, partners are reporting in a quarterly basis to the project leader so that budget expenditure, tasks completion and time consumption can be regularly checked. All deviations can have a minor or major impact to the project progress and at some point adjustments may have to be made. During this reporting period, several adjustments have been applied. These have not implied a reduction in the scope of the project nor have they been significant in the budget or overall project timeline. Regarding the assessment of the final impact of the project, this is now work-in-progress. It has to be highlighted that monitoring and evaluation of a pioneering fire prevention model with great social and environmental impact is challenging by nature. During the last reporting period an indicators-based system was designed to capture the achievement of results and now, with some data and information already gathered, some challenges have already arisen. In particular challenges regarding maintenance responsibility of all equipment and infrastructure have already been detected, as there are different administrations concurring in the same territory: some of them are national agencies (e.g. Jucar Basin District Authority, the Space Agency for Air Safety), some others are local departments of the Comunitat Valenciana government (departments of natural environment, forestry, health, water services, etc.) and others belong to the municipalities of Riba-roja and Paterna. The challenge here is to establish collaboration protocols between entities that will not compromise subsequent monitoring and follow-up.

- **Communication with target beneficiaries**: As mentioned before, the global health emergency has been hampering communication as it entails clear limitations in terms of fostering personal attention with beneficiaries. This is an important shortcoming as a constant, meaningful and wise communication strategy would have to be applied to compensate the low level of fire risk perception and awareness of urban communities. Moreover, the unknowns regarding the overall duration of the crisis is adding even more difficulties. The consortium is waiting for the situation to improve to perform already planned (and postponed) events. However, the uncertainty is still large and there is no clue to figure out whether all programmed activities to communicate project results will finally take place. Nevertheless, the consortium has made a great effort organizing some face-to-face safe events with authorities, media and citizens and also participating in virtual technical forums and virtual scientific conferences. The consortium will work hard to compensate this issue in the final phase of the project with high-impact activities to guarantee stake holders engagement during GUARDIAN operation phase.

- **Upscaling**: With all the infrastructure built and after the pilot tests carried out during this reporting period, several nearby municipalities have shown interest on the GUARDIAN fire prevention and protection solution. In parallel, Universitat de Valencia is parametrizing environmental and social benefits that GUARDIAN entails to provide scientific evidence of the project economic viability, scalability and sustainability. This is a very challenging task as ecosystem services promoted by GUARDIAN (e.g. biodiversity conservation, water availability, recreational services and natural disaster risk reduction, etc.) are perfectly acknowledged by everyone but are difficult to be qualified in monetary terms and hence being considered in GUARDIAN economic balances.

Concluding remarks

The implementation of GUARDIAN infrastructure has almost finished during this reporting period despite the global COVID19 crisis.
Major advances include:

- WRP tests undertaken to optimize operation conditions.
- Completion of the hydraulic infrastructure building works and pilot tests.
- Unsupervised irrigation module coupled to sensory platform designed and under testing.
- Novel fire/forest management practice (green firebreaks) designed and being implemented at timely manner.
- Successful dissemination activities with authorities and media interests.

As for the UIA implementation challenges, the GUARDIAN consortium has faced them trying hard to overcome expected and unexpected difficulties. Thanks to an efficient project leader and to mutual trust and understanding between all partners (particularly between public institutions and private companies) adjustments have been

made to get over the always complex administrative procedures for public procurement. Co-implementation and communication with local communities have been hampered due to i) the current health crisis, ii) lacking of political leadership, iii) low perception of fire risk by urban communities.
This has already been recognised as high-priority issue for 2022, together with coming up with an efficient operational and upscaling program.

Climate adaptation

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