

APRIL
JUNE
2026

10 Sen For Fire NEWSLETTER

SENFORFIRE. LOW-COST WIRELESS SENSOR NETWORK FOR FOREST FIRE PREVENTION AND EARLY DETECTION (S1/1.1/E0040)



Part of the SenForFire team during the international workshop on 20, 21 and 22 May in Toulouse (France).

In this issue:

INTERNATIONAL WORKSHOP IN TOULOUSE

NEW MODULES AND MICROSENSORS

WIND TUNNEL VALIDATION

EXPANSION OF THE SENSOR NETWORK

RESULTS PRESENTED AT VARIOUS CONFERENCES

International cooperation and prototype validation

The second quarter of 2026 has been characterised by intense international cooperation and further progress in sensor validation. In terms of coordination, a highlight was the organisation in Toulouse of the international workshop **Smart Sensors and Microsystems for Environment Monitoring and Fire Prevention**, which brought together 86 participants to discuss forest fire prevention. Communication efforts have been strengthened through posts on social media and the distribution of press releases.

On the technical front, we have made progress in the manufacture of new versions of electronic modules. Furthermore, the gas microsensors developed by the IMB-CNM-CSIC have been successfully integrated into Ray-Ingeniería's circuit boards. The experimental burn tests carried out in the ICIFOR-INIA-CSIC wind tunnel (Madrid), both in collaboration with the Chilean AIRIS project (Intelligent Air Quality Alert for Fires) and in subsequent validation tests, have confirmed the response of the different types of sensors to various plant species and humidity conditions.

With regard to field validation, the sensor network deployed in the pilot areas has been maintained and new locations have been added, such as the Sierra de Filabres (Almería). Progress has also been made in monitoring the moisture content of living fuel and analysing its correlation with soil moisture. Furthermore, we have presented these milestones at various national and international scientific conferences.

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Co-funded by
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SenForFire

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Social media management. Outreach activity has continued on [LinkedIn](#), [Facebook](#) and [X](#), with multilingual posts (in Spanish, English, Portuguese and French) that have highlighted the quarter's key milestones. Notable posts included the announcement of the international workshop in Toulouse, the commemoration of World Environment Day (5 June) and World Day to Combat Desertification and Drought (17 June), the release of the video on the SenForFire experimental burns, support for the project's participation in the 1st International Congress on Forest Digitalisation (CIDIFOR, Burgos) and the announcement of new project publications, such as Internal Bulletin No. 9 and Issue No. 5 of the SenForFire Journal 'Technology Against Fire'.

Online coverage and press releases for the SenForFire project. Two press releases have been published on the Interreg Sudoe programme's website. The first reports on the international workshop '**Smart Sensors and Microsystems for Environment Monitoring and Fire Prevention**', held in Toulouse from 20 to 22 May 2026, which brought together the European scientific community to discuss forest fire prevention. The second covers the scientific collaboration between SenForFire and the Chilean AIRIS project, which took place during a day of experimental burning held at ICIFOR-INIA-CSIC (Madrid) on 11 June 2026. They can be viewed on the project's website:

<https://interreg-sudoe.eu/noticia-proyecto/senforfire-reune-en-toulouse-a-la-comunidad-cientifica-europea-en-torno-a-la-prevencion-de-incendios-forestales/>

<https://interreg-sudoe.eu/noticia-proyecto/colaboracion-cientifica-senforfire-airis-entre-espana-y-chile/>

Release of the video 'Experimental Burning in Santibáñez el Alto (Cáceres)': As part of the communication activities for the Interreg Sudoe SenForFire project, a video of the technology validation workshop for the early detection of forest fires, held in March 2026 in the communal pastureland of Santibáñez el Alto (Cáceres), was shared [on the YouTube channel](#) and on social media. The workshop was attended by project partners and collaborating organisations. It can be viewed at:

https://youtu.be/lan_t-452KM?si=sYqfmMerpHCNHBp7



SenForFire | Quemadas experimentales en Santibáñez el Alto (Cáceres)

SenForFire
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Estadísticas

Editar vídeo



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Presentation by the AIRIS project (Chile). Staff from the University of Extremadura attended a presentation by Dr Fabián Guerrero, coordinator of the AIRIS project (Intelligent Air Quality Alert for Fires, Chile) at the INIA-CSIC premises. The aim was to explore ways in which the two projects could cooperate.

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4th follow-up meeting in Toulouse. The 4th follow-up meeting for the project took place in Toulouse on 18 and 19 May. The beneficiary organisations from the French CNRS (LAAS and CIRIMAT) organised and hosted the meeting, which was attended – either in person and/or remotely – by representatives from all the project's beneficiary organisations.

The meeting reviewed the progress and current status of the activities of the specific task forces and discussed how these would develop over the coming period.

The operation and maintenance of the sensor network (RIS) deployed in the summer of 2025 and the deployment of new sensors in the pilot areas identified in the first quarter of 2026 were the issues that received the most attention.

Part of the SenForFire team during the 4th project follow-up meeting, held in May in Toulouse (France).



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Progress was also made in evaluating the performance of the latest prototypes for early fire detection, including systems based on advanced gas microsenors from the IMB-CNM-CSIC, integrated into modules developed by Ray-Ingeniería, as well as modules developed by the University of Extremadura (UEX) based on commercial sensors for gases, volatile organic compounds (VOCs) and particulate matter (PM). Furthermore, it was agreed to carry out further tests with these prototypes during experimental vegetation burns at the ICIFOR-INIA-CSIC pilot facility (Madrid) and during prescribed burns, to be conducted during the medium-to-low fire risk period in Santibáñez el Alto (Cáceres), Fundão and a new pilot area in the south of France.

Final dissemination event in Valladolid. The representative of the Regional Government of Castile and León (JCyL) announced that the project's final dissemination event will form part of the **AR-PA Cultural Tourism** international conference, to be held in Valladolid in November, on a date yet to be confirmed.

Submission of the project's third expenditure report. The project beneficiaries have submitted the third annual expenditure report, covering the period from June 2025 to May 2026.

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International collaboration with the AIRIS project (Chile). To mark the experimental burns carried out in the ICIFOR-INIA-CSIC wind tunnel, an international collaboration workshop was held at the ICIFOR-INIA-CSIC facilities in Madrid, with the participation of Fabián Guerrero, coordinator of the AIRIS (Intelligent Air Quality Alert for Fires) at the Federico Santa María Technical University (Valparaíso, Chile). This collaboration strengthens scientific cooperation between Spain and Chile in the field of forest fires.

The meeting, organised by the SenForFire team, aimed to share progress, methodologies and technologies between the two projects, which share a common approach: the use of low-cost wireless sensor networks for environmental monitoring and early fire detection.



The AIRIS project, funded by the Regional Government of Valparaíso, will deploy a network of air quality monitoring devices in an urban-rural interface area in Chile, aimed at both detecting fires and monitoring air quality before, during and after them.

Representatives from SenForFire and AIRIS, alongside other project partners, during the event held at ICIFOR-INIA-CSIC.

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There have been no new developments in this working group's activities this term.

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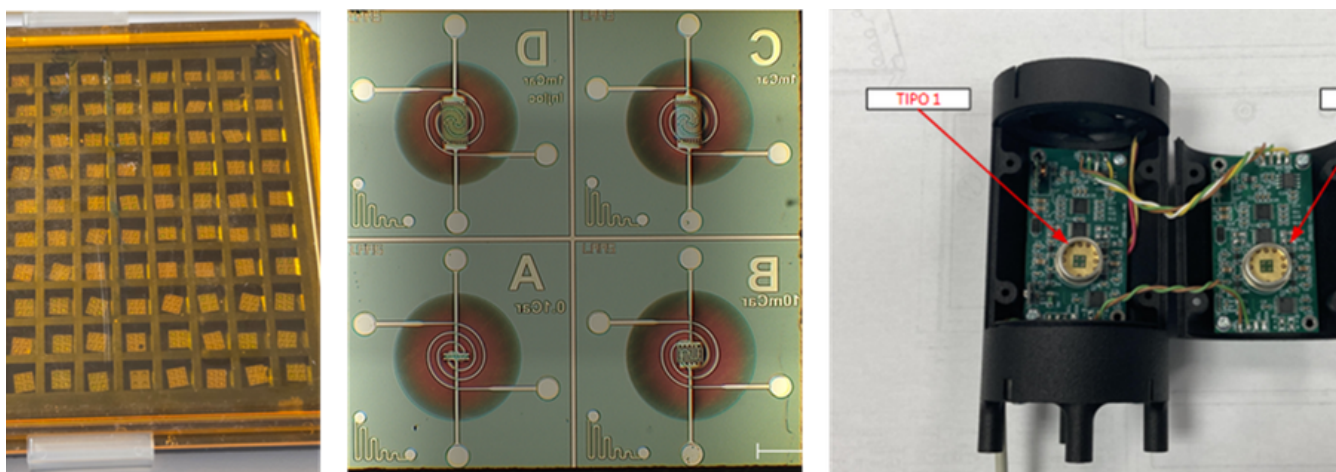
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Integration of gas microsensors into electronic modules. The gas microsensors developed by CIRIMAT and LAAS (CNRS) have been integrated with the electronic modules designed by Ray-Ingeniería. During this process, a number of discrepancies were identified between the schematics of the two components, as well as certain specific requirements relating to the microheaters. All these issues have been successfully resolved.

New modules featuring microsensors from LAAS and CIRIMAT. Thanks to these developments, new modules are now available that incorporate the gas microsensors developed by LAAS and CIRIMAT (CNRS). These are in addition to the modules previously fitted with gas microsensors from the IMB-CNM-CSIC, which were successfully tested during the controlled burns carried out at Santibáñez el Alto in March 2026.

Fabrication of new wafers with interdigitated electrodes. LAAS (CNRS) has fabricated new wafers incorporating various platforms with improved interdigitated electrode designs. These improvements will extend the measurement range, enabling the characterisation of materials with both high and low resistivities. Meanwhile, CIRIMAT (CNRS) has coated twenty-four of these new platforms with the aim of having several microsensors available for future measurement campaigns.



Photographs of the LAAS/CIRIMAT (CNRS) platforms and microsensors, and their integration into the electronic module developed by Ray-Ingeniería.

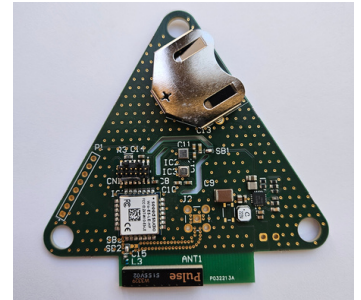
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A 2.2

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Manufacture of the second version of the ULP_EC module. The second version of the ULP_EC module has been commissioned for manufacture; this time, it features a temperature and humidity sensor to calibrate the response of the electrochemical sensors. A total of ten of these modules have been ordered.

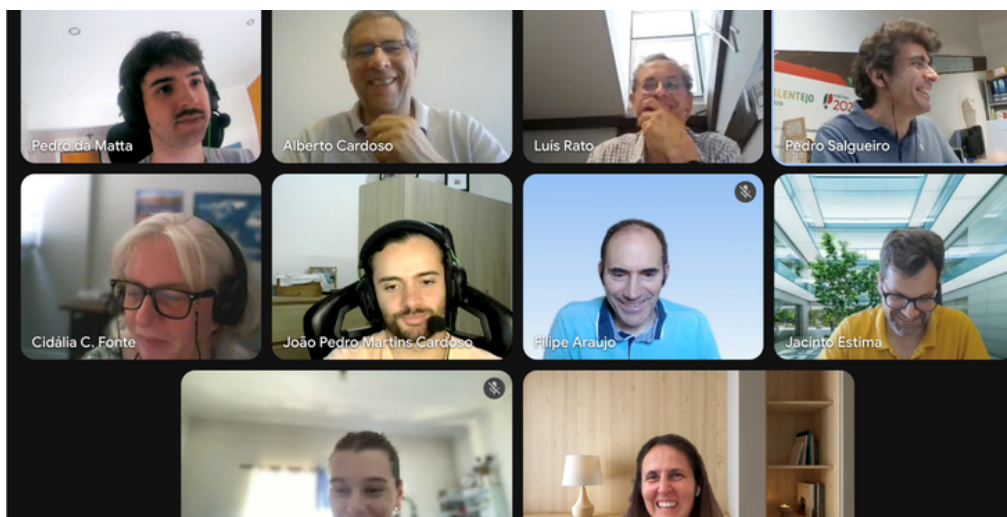
Manufacture of additional ULP_MOX modules. Following successful testing of the solar radiation shield nodes, a total of twenty additional ULP_MOX modules have been commissioned to cover new areas.



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Meetings to integrate the intelligent models into the platform. The University of Coimbra and the University of Évora held several working meetings to finalise the configuration for integrating the intelligent models developed as part of the project into the SenForFire technology platform.



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Experimental burns in a wind tunnel (ICIFOR-INIA-CSIC). In June, ICIFOR-INIA-CSIC carried out a series of six experimental vegetation burns in a wind tunnel using various species of Mediterranean vegetation representative of the Iberian forest environment: strawberry tree (*Arbutus unedo*), Pyrenean oak (*Quercus pyrenaica*), stone pine (*Pinus pinea*), maritime pine (*Pinus pinaster*), holm oak (*Quercus ilex*) and cork oak (*Quercus suber*).

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Burning trials were carried out using recently collected vegetation with high moisture content, with an epiradiator used as the ignition source; in these trials, combustion took place with high gas emissions and minimal flame.

Furthermore, trials were conducted using vegetation that had been collected previously and conditioned to ensure a low moisture content; in these trials, combustion produced flames that were taller and lasted longer.



Photographs of the two types of experimental burning carried out in the ICIFOR-INIA (CSIC) wind tunnel.
Left: *Arbutus unedo* (strawberry tree), freshly collected vegetation. High humidity with smoke predominating over flame. Right: *Pinus pinea* (stone pine), vegetation collected previously and prepared. Low humidity, with high flames predominating.

As part of these burn-offs, further tests were carried out using the Ray-Ingeniería modules fitted with gas microsensors from the IMB-CNM (CSIC). The results obtained, both in these tests and in those previously carried out in Santibáñez el Alto, demonstrated the functionality and robustness of the modules developed. In general, the gas microsensors showed clear and reproducible responses to pulsed burning, with a certain degree of tolerance to variations in wind direction. In this regard, significant sensor responses were observed, even when wind conditions were not entirely favourable.



Electronic modules fitted with microsensors from the IMB-CNM (CSIC) installed at INIA (CSIC) to monitor the burning tests carried out in the wind tunnel.

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Performance of UEx's commercial sensors. During the burn tests at INIA-CSIC, the fire detection performance of modules using commercial sensors for gases (CO₂), volatile organic compounds (VOCs) and particulate matter (PM) was also assessed. These included the latest generation of low-cost, ultra-low-power modules developed by UEx, in which the protective housing for the electronics and sensors has been replaced by a solar radiation shield, similar to that used in meteorological modules, in order to prevent overheating that distorts measurements of ambient temperature and humidity.

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Presentation of the project at the Central Region DIH roadshow. The SenForFire project was presented during the **Central Region Digital Innovation Hub (DIH)** roadshow, held in Guarda, with the aim of showcasing its progress and promoting the exchange of experiences in the field of technological innovation.

14H30 | Receção dos participantes

14H45 | Abertura

Joaquim Manuel Fernandes Brigas (IPG)

14H50 | Apresentação do Projeto PTCentroDIH

André Garcia Vieira de Sá (IPG)

15H00 | Exercício de Avaliação da Maturidade Digital

Rui Soares (CENTIMFE)

15H10 | Capacitação Tecnológica

(Pitches de apresentação de diversas tecnologias pelos parceiros participantes)

1. "Aplicação prática de tecnologias emergentes ao serviço da proteção de pessoas, bens e património", André Garcia Vieira de Sá (IPG);
2. "RePo-SUDOE: Uma Rede Transnacional para o Reposicionamento de Fármacos no Espaço SUDOE", Hugo Filipe (IPG);
3. "Inteligência Artificial Responsável", Catarina Silva (UC);
4. "Análise inteligente de dados de sensores: caso de estudo SenForFire", Alberto Cardoso e Catarina Silva (UC);



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Presentation of the project at the Central Region DIH roadshow. The SenForFire project was presented during the Central Region **Digital Innovation Hub (DIH)** roadshow, held in Coimbra, with the aim of showcasing its progress and promoting the exchange of experiences in the field of technological innovation.

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20-22

International workshop in Toulouse. CNRS-LAAS and CNRS-CIRIMAT organised an international workshop entitled '**Smart Sensors and Microsystems for Environment Monitoring and Fire Prevention**'. It was held at the IRT premises at the University of Toulouse and proved to be a great success, with 86 registered participants.

This European meeting brought together representatives from academia and industry to advance environmental monitoring systems using sensor networks and artificial intelligence. The event highlighted the latest developments in miniaturised sensors, multi-sensor devices and intelligent data processing, paving the way for more effective environmental monitoring and early fire detection.

The partners involved in Work Package 2.1 delivered two presentations related to the project: 'Gas Sensing Nanostructures for Environmental Applications' and 'Experimental Validation and Machine Learning Enhancement of MOX Sensors for Early Wildfire Detection'.

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Participants at the international workshop held in Toulouse on 20, 21 and 22 May.

For its part, the University of Extremadura presented two posters entitled ‘Low-Power Particle Sensor Node for Wildfire Aerosol Monitoring’ and ‘Smart MOX Microsystem for Early Smoke Detection in Fire Prevention Applications’. It also delivered a presentation entitled ‘Electrochemical CO Sensor Node for Fire Prevention and Environmental Monitoring’.

Both the presentation and the posters showcased the three latest modules developed by the University of Extremadura for the early detection of wildfires.



From left to right: Photographs of the presentations ‘Gas Sensing Nanostructures for Environmental Applications’; ‘Experimental Validation and Machine Learning Enhancement of MOX Sensors for Early Wildfire Detection’; and ‘Electrochemical CO Sensor Node for Fire Prevention and Environmental Monitoring’.

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Dissemination at international forums. A range of activities have been carried out to disseminate the results obtained with the gas microsensors developed by the IMB-CNM-CSIC at leading international forums.

These included the [29th World MicroMachine Summit](#) (MMS 2026), where the paper ‘Microsensors for Wildfire-Early Warning Networks’ was presented; the European Association on Smart Systems Integration ([EPoSS](#)), [Annual Forum](#), featuring the poster ‘Environmental Gas and VOC Sensing Systems for Wildfire Risk Management’; and the [Forum on New Materials](#), at which an invited talk entitled ‘Vapour-Deposited Heterostructured Nanomaterials for Environmental Gas Sensing’ was delivered.

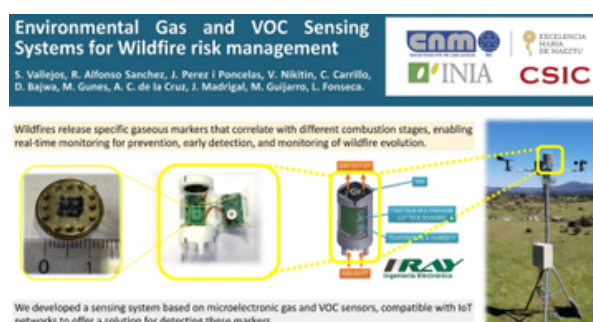
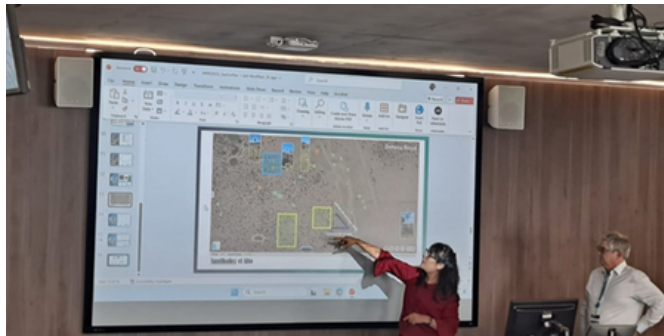


Image of the poster presented at the EPoSS Annual Forum 2026.

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Left: Presentation given at MMS 2026, as part of the Iberian delegation's report on the work carried out in this region in the field of intelligent systems, microsystems and sensors.

Right: Presentation of the project at the 4th Forestbites Seminar.



Presentation at the ForestBites seminar. ICIFOR-INIA-CSIC gave a presentation on SenForFire at the **4th ForestBites Seminar** organised by ICIFOR's Department of Forest Dynamics and Management.

Science communication in Barcelona. In the field of science communication, during the month of June the IMB-CNM-CSIC also took part in the round-table discussion **'It all starts with a chip: Everyday technology in small doses'**, held at the Guinardó Civic Centre in Barcelona.

It also collaborated on the **'CientífiKs en Joc'** initiative, organised by the Government of Catalonia through its Research and Universities department, aimed at primary school pupils. This activity promoted the learning of concepts related to science and sensors through the design and creation of educational video games, bringing research and technology closer to young people.



SenForFire in 'It All Starts with a Chip'.



SenForFire during CientífiKs at Joc.

Three scientific papers accepted for the 10th International Conference on Forest Fire Research (Coimbra). Three papers have been accepted for presentation at the 10th International Conference on Forest Fire Research (ICFFR), to be held in Coimbra (Portugal). The selected papers are: 'Multimodal Dataset Generation and Machine Learning Approaches for Wildfire Occurrence Prediction in Portugal', 'Impact of Data Source Variability on Wildfire Susceptibility Modelling' and 'A Platform for Wildfire Risk Monitoring and Early Warning Using Wireless Sensor Networks and Environmental Data Integration'.



Carlos G. Russo	and mass loss rate of forest fuel beds
Catarina Silva	Multimodal Dataset Generation and Machine Learning Approaches for Wildfire Occurrence Prediction in Portugal
	Trends and Applications in Wildland Fire Behaviour Modelling and Simulation

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Completion of the SenForFire MOOC design. In the second quarter of 2026, work was completed on the syllabus for the Massive Open Online Course (MOOC) on *Technological Innovation for Forest Fire Prevention: Smart Wireless Sensor Networks, aimed at the general public*. The University of Extremadura (UEX) is leading and coordinating the MOOC, in which all the project beneficiaries and AEMET are participating.

Recording of the MOOC videos. The recording of the videos has also been completed: a total of 28 videos, each lasting between 10 and 15 minutes, divided into four thematic modules.

Recording of Module 1. ICIFOR-INIA-CSIC has recorded the videos for Module 1, 'Forest fires: current challenges and new technologies for integrated management', for which it is the coordinator.

Filming of modules 3.7 and 4.7. During the first week of June, in Coimbra, the videos for modules 3.7, 'Data-driven predictive analysis of forest fire risk', and 4.7, 'Artificial intelligence, machine learning and open data for forest fire risk prediction', were filmed.



Recording of Module 1, 'Forest fires: current challenges and new technologies for integrated management', with researcher Javier Madrigal.

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A 3.2

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Monitoring and maintenance of the sensor network. During the second quarter of 2026, work continued on the monitoring and maintenance of the network of meteorological, soil and atmospheric (gases and VOCs) sensors, which was deployed in the summer of 2025 in the pilot areas of Fundão, Madrid, Cáceres and Andorra.

During this period, several low-cost soil temperature and humidity sensors have been found to be malfunctioning due to damage to the electronics caused by inadequate protection against soil moisture provided by the outer casing or housing when buried in soil with a high water content. Furthermore, housings containing the electronics that were exposed to the open air have been damaged by animals living or grazing in the pilot areas, which have chewed through the cables connecting the circuit board to the sensors buried in the ground and/or to the wireless communication antenna. The damaged nodes have been replaced with new nodes offering improved protection against the external factors described above.

Furthermore, on 10 April, meteorological and soil nodes were installed for the first time in the town of Legarda, in response to a request from the mayor of this Navarran municipality.

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A 3.2

Deployment of modules in the INIA-CSIC wind tunnel. Staff from the UEx travelled once again to the INIA-CSIC facilities, alongside several project partners, to deploy more than fifty modules for testing fire detection using a wind tunnel.

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Deployment of sensors in Coria and Cañaveral. Staff from the UEx travelled to the areas surrounding the towns of Coria and Cañaveral in Cáceres, where new sensors using three different technologies were deployed: MOX sensors, particle sensors and electrochemical sensors.



Above: Preparation of the tests and real-time monitoring of the data recorded by the modules during the experimental fires carried out in the INIA-CSIC wind tunnel

Left: Different stages of deploying the monitoring nodes in the field; installation on trees, mounting on protective supports and a close-up of an installed sensor

A 3.3

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Monitoring of soil water properties. During the period under review, the pilot activities involved monitoring soil water properties (temperature, volumetric water content and water potential), as well as meteorological parameters and the concentration of VOCs in the air. Furthermore, in collaboration with the national (MITECO) and regional (Community of Madrid) forestry services, ICIFOR-INIA-CSIC and the Andorran Agency for Research and Innovation (AR+I) have continued to collect vegetation samples (herbaceous, shrubby and tree species) and to determine vegetation moisture content (herbaceous, shrubby and tree species) at points within the pilot areas where soil sensors have been installed.

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A 3.3

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Sensor validation in the Sierra de Filabres (Almería). Validation of low-cost environmental sensors for the prevention and early detection of forest fires in the Sierra de Filabres (Almería). From 27 to 29 April, the ITEFI-CSIC and ICIFOR-INIA-CSIC teams collaborated with the teams involved in the Interreg Sudoe EUBURN-RISK project, as part of their spring 'Flamex' prescribed burning campaign, providing support and collecting data to validate low-cost sensors during experimental burns in the Sierra de Filabres (Almería).



Installation of the Milesight EM500 sensor. The Milesight EM500 sensor (which collects data on CO₂, temperature and relative humidity) was installed on Monday 27 April in a pine forest area at the top of the hillside, adjacent to the experimental burn plot, and was removed on Wednesday 29 April.



The prescribed burn was carried out on 28 April by technical staff from the Andalusian Agency for Safety and Comprehensive Emergency Management. The experimental plot consisted mainly of *Macrochloa tenacissima* (esparto grass), with some *Genista umbellata* and *Artemisia barrelieri* also present.

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Analysis and calibration of detection modules. The fire detection modules are currently being monitored and analysed. The recorded data is being compared with public databases such as Copernicus and AEMET, in order to calibrate the various sensors deployed.

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Monitoring of living fuel moisture (HCV). Weekly monitoring of HCV continues at the INIA-CSIC farm (Madrid). Furthermore, thanks to the collaboration of a student from the Polytechnic University of Madrid (UPM), who is undertaking their final-year project within ICIFOR's Forest Fires group, soil moisture data (gravimetric and TDR) have been collected at various depths in the two INIA-CSIC sampling areas.



Monitoring of forest moisture in Guadarrama and Cáceres. ICIFOR-INIA-CSIC has continued to monitor forest fuel moisture in Guadarrama, in collaboration with the Forest Fire Unit of the Madrid Regional Fire Service, and in Cáceres, with the support of the Forest Fire Planning and Analysis Team (EPAIF).

A 3.4

Analysis of soil sensor data. Analysis of data from the soil sensor network in the pilot areas has continued, comparing it with open-access reference sources. The data (15-minute resolution) have been aggregated and cross-checked against hourly values for temperature and volumetric water content (VWC) at different depths, sourced from ERA5-Land (Copernicus, EU).

Correlation between soil moisture and vegetation moisture. A study has been launched to investigate the correlation between soil moisture (VWC and soil water potential, SWP) measured by the sensors, and vegetation moisture, as determined by the forestry services (Cáceres, Madrid and Andorra) and by ICIFOR-INIA-CSIC using a gravimetric method. The results have been discussed in remote meetings with technical staff and forest firefighters from MITECO (BRIF and EPAIF), the Regional Government of Extremadura (INFOEX) and Andorra (AR+I).

Adoption of evapotranspiration and soil hydrology models. Work has begun on the adoption of evapotranspiration and soil hydrology models (BROOK90), which use sensor data to identify the characteristics of the soil and local vegetation. This enables quantitative models to be developed to predict soil water dynamics in response to atmospheric variables, and helps to understand the dynamic processes of vegetation cover throughout the seasons.

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Participation in ISOEN 2026 (Chongqing, China). Jesús Lozano Rogado attended the 21st International Symposium on Olfaction and Electronic Nose (ISOEN 2026) in Chongqing (China), where he gave a talk entitled 'Network of electronic noses for early detection of forest fires', explaining the LoRaWAN node network that has been set up and the data collected to date.