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Exchange of Experts in Civil Protection

INFOCA - Forest fire Operational Centre

ANDALUCÍUA, Spain

Field Report

Exchange of Experts in Civil Protection

Forest Fires Operational Centre

INFOCA – ANDALUCÍUA

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Content

1. Introduction 6
2. Programme Overview 7
3. The Wildfire Prevention and Suppression Plan of Andalucia 9
   3.1. Prevention Strategies 10
   3.2. Suppression Techniques 10
   3.3. Community Awareness and Participation 11
   3.4. Lessons learned 11
4. The Wildfire Analysis Unit 12
   4.1. Lessons learned 13
5. INFOCA‘s Incident Command System 14
   5.1. Key Components of INFOCA's Incident Command Structure 15
   5.2. Adaptability and Scalability 17
   5.3. Lessons learned 17
6. Ground Operations and specialized BRICA Units 18
   6.1. Ground unit in INFOCA 18
   6.2. Role and Structure of BRICA Helitack Crews 19
   6.3. CEDEFO Crews and Their Operations 20
   6.4. Patrol and Surveillance Crews 20
   6.5. Safety in Ground Firefighting Operations 20
   6.6. Lessons learned 21
7. Personal Protective Equipment and Hand Tools 22
   7.1. Protective Clothing 22
   7.2. Helmets and Color-Coding Scheme 22
   7.3. Gloves, Shoes, and Additional Gear 23
8. Air Operations 25
   8.1. Resources for Air Operations 25
   8.2. Fixed-Wing Firefighting Planes 26
   8.3. Firefighting Helicopters 26
   8.4. Air Observer (AirOps) 27
   8.5. Integrated Operations Between Fixed-Wing and Helicopter Units 28
   8.6. Pilot Training and Safety in Air Operations 28
   8.7. Use of UAV (Drones) 29

8.8. Use of Retardants 29
8.9. Lessons Learned 29
9. Vehicle Fleet and Fire Trucks 30
9.1. Heavy Fire Engines 30
9.2. Water-Pump Support Trucks 32
9.3. 4x4 Transport Vehicles 33
9.4. Specialized and Supporting Equipment 33
9.5. Recent Modernizations and Innovations 33
9.6. Lessons learned 34
10. Personnel and Training 35
10.1. Structure and Composition of INFOCA's Workforce 35
10.2. Training Framework and Programs 35
10.3. Physical Preparedness 36
10.4. Continuous Learning and Scenario-Based Training 36
10.5. Lessons Learned 37
11. SIM Table Training 38
11.1. What is the SimTable? 38
11.2. Benefits from the use of the SimTable 39
11.3. Implementation in Training Programs 40
11.4. Lessons learned 40
12. Environmental Agents and Incident Investigation 41
12.1. Role in Fire Investigation 42
12.2. Contribution to Prevention and Policy Development 42
12.3. Fire Investigation Training 43
12.4. Lessons learned 44
13. Key Learnings and Conclusions 45
14. Acknowledgments 47

1. Introduction

This field report documents the Exchange of Experts (EoE) program focused on civil protection practices for controlling large-scale wildfires in Andalusia, Spain, hosted by INFOCA, the region's specialized forest fire management agency. Conducted from October 28th to November 1st, the program provided an in-depth exploration of Andalusia's comprehensive approach to wildfire hazard management, including prevention, preparedness, suppression, and post-event analysis. This exchange aimed to facilitate knowledge transfer among participating experts by showcasing innovative practices, operational tactics, and equipment used in managing wildfire risks within the region.

Figure 1: Map of Andalusia with an overview of available INFOCA resources

As experts taking part in this exchange, six fire officers from the Provincial Fire Service Association of the Austrian Province of Styria (Landesfeuerwehrverband Steiermark) have been selected. Styria shares a lot of similarities with Andalusia and is therefore a perfect learning ground for the Austrian experts.

Each day of the exchange was meticulously structured to balance theoretical discussions, practical demonstrations, and debriefings to ensure comprehensive learning. Key highlights included visits to regional, subregional, and local coordination centers, as well as a helitack base, where participants observed the coordination of aerial resources and physical training for firefighters. The program concluded with a consolidated debriefing session to reflect on the lessons learned and discuss potential proposals for enhancing wildfire management practices.

This report synthesizes the experiences and observations gathered during the exchange, providing valuable insights into Andalusia's multifaceted approach to wildfire control and its potential applications in other regions facing similar hazards.

2. Programme Overview

The 5-day Exchange of Experts (EoE) programme in Andalusia provided the six Austrian participants with a comprehensive insight into INFOCA's approach to wildfire management. The schedule included visits to key operational centers and field bases across Andalusia, offering a firsthand understanding of INFOCA's organizational structure and its operational strategies. The program also highlighted Andalusia's approach to wildfire behavior analysis, the Incident Command System (SMEIF), inter-administrative coordination, and the integration of advanced tools, vehicles, and aerial resources in firefighting operations. Additionally, hands-on exercises, such as sand table simulations and studies of recent wildfires, provided practical insights into strategic and tactical decision-making processes, particularly in the context of wildland-urban interface (WUI) fires.

Each day concluded with a debriefing session to reflect on key learnings and discuss their relevance to the participants' own contexts. This structured approach ensured that the exchange was not only informative but also practically applicable, fostering a deeper understanding of effective wildfire management practices.

DAY 1 - 28 October

17:30 Visit the Regional Operations Centre (Seville)

- Introduction to INFOCA: Forest fires Prevention, Preparedness and Suppression, Region of Andalucía
- Introduction to technical analysis wildfire fighting approach
- Wildfire behaviour Analysis Unit‘ Procedures

19:30 Daily sum-up and debriefing

DAY 2 - 29 October

11:30 Visit of Subregional Operations Centre (Granada)

- Inter-administrative Coordination. Incident Command System in Spain/SMEIF
- Firefighting: strategic and tactics in wildfires. Facilities, tools, vehicles, aerial resources.
- Sand table exercise
- WUI fires prevention and Suppression

16:00 Visit of Local Forest Fires Defense Centre (CEDEFO)

- Tactical fire in suppression op: study of recent wildfires
- Large Fires Suppression Techniques. Indirect attack
- Safety&Security SOPs

19:30 Daily sum-up and debriefing

DAY 3 – 30 October

08:00 Visit of INFOCA's Forest Fire Brigades Base (BRICA) (Jerez del Marquesado, Granada)

- Helitack procedures and Physical training for forest firefighters
- Aerial resources coordination

18:30 Daily sum-up and debriefing

DAY 4 – 31 October

09:30 Visit of Provincial Coordination Centre (Córdoba)

- Prescribed burnings
- WUI fires prevention and suppression

18:30 Daily sum-up and debriefing

DAY 5 - 1 November

09:00 Visit of Regional Operations Centre (Seville)

- EoE debriefing. General Conclusions & Proposals

12:00 Visit for the 112 Center (Malaga)

3. The Wildfire Prevention and Suppression Plan of Andalucia

INFOCA, short for Plan de Prevención y Extinción de Incendios Forestales en Andalucía, operates as a unified system under the authority of the Regional Ministry of the Environment. The INFOCA Plan serves as the cornerstone for wildfire prevention, suppression, and restoration efforts across the region's extensive forest lands. Since its inception in 1995, the plan has become a robust framework for addressing one of Andalusia's most pressing environmental threats, combining innovative approaches, advanced technologies, and community participation.

Figure 2: Logo of the INFOCA Plan for public awareness campaigns (Source: INFOCA)

Key features of the INFOCA Plan include:

- Centralized management for wildfire suppression through the Regional Ministry of the Environment.
- Comprehensive integration of resources from multiple institutions and organizations.
- Advanced technological applications to optimize operational efficiency.
- A professional workforce of nearly 5,000 individuals trained in wildfire management.
- A strong focus on community awareness and participation in prevention efforts.

The plan integrates prevention, suppression, and post-fire restoration activities, ensuring seamless coordination between various stakeholders.

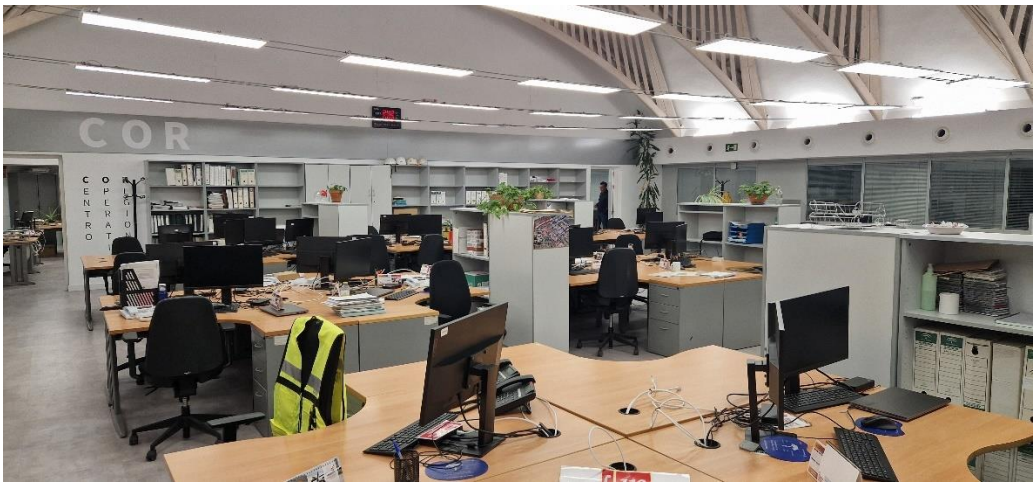

Figure 3: INFOCA Regional Operations Center (COR) in Seville

INFOCA is tailored to protect Andalusia's diverse natural landscapes, which span over 4.6 million hectares, from the destructive impacts of wildfires. It boasts a wide network of operational facilities and resources to support its activities:

- **Coordination Centers:** The Regional Operations Center (COR) in Seville and eight Provincial Operations Centers (COPs) oversee strategic and tactical decisions.
- **Local Defense Centers (CEDEFO):** These centers are distributed across forested areas to house ground and aerial firefighting resources.
- **Specialized Brigades (BRICA):** Three bases for highly trained helitack brigades focus on rapid response and aerial operations.
- **Terrestrial and Aerial Fleet:** INFOCA's resources include fire trucks, bulldozers, helicopters, and aircraft (e.g., Canadair amphibious planes). The aerial fleet, totaling around 40 units, is strategically distributed across Andalusia.

3.1. Prevention Strategies

Prevention is a core pillar of the INFOCA Plan. Its strategies include Preventive Silviculture like Reducing forest fuel loads through pruning, clearing, and controlled grazing. Firebreaks and prescribed burns are also employed to limit fire spread. Furthermore INFOCA works closely with local farmers, cattle raisers, and landowners to promote fire safety practices. Initiatives like the "Red de Áreas Pasto-Cortafuegos de Andalucía" utilize grazing as a dual-purpose tool for fire prevention and land management. The plan enforces strict rules on agricultural burn-offs and collaborates with infrastructure managers to clear vegetation near railways and power lines.

3.2. Suppression Techniques

INFOCA has established a mix of direct and indirect suppression tactics to combat wildfires:

- **Fire Behavior Analysis:** Advanced tools, including wildfire simulators like FARSITE, help predict fire dynamics and inform suppression strategies.
- **Aerial Coordination:** Helitack teams and aerial tankers play a critical role in initial attack and large-fire containment.
- **Safety Protocols:** Extensive measures ensure the safety of both personnel and affected populations, supported by advanced training and updated individual protection equipment.

INFOCA incorporates innovative technologies to enhance its capabilities. Systems like SIGYM are used for weather forecasting and SIADEX for decision-making support during suppression operations. Infrared and optical cameras on watchtowers are installed over high risk areas for early fire detection. GPS tracking allows real-time resource management to optimize deployments.

3.3. Community Awareness and Participation

Recognizing that over 95% of wildfires are human-induced, INFOCA prioritizes public education and awareness:

- Media campaigns, roadside warning panels, and fire danger maps disseminated via TV and other channels.
- School-based programs, such as "Crece con tu Árbol," involve younger generations in forest conservation and fire prevention.

The INFOCA Plan exemplifies a comprehensive and integrated approach to wildfire management. By combining state-of-the-art technology, professional expertise, and community involvement, it provides a scalable model for regions facing similar challenges. INFOCA's success not only safeguards Andalusia's natural heritage but also underscores the importance of proactive and collaborative wildfire management.

3.4. Lessons learned

The INFOCA Plan demonstrates a holistic and highly effective approach to wildfire management, combining prevention, suppression, and restoration. Key lessons learned include:

- **Centralized Management:** A unified system under the Regional Ministry of the Environment ensures seamless coordination and efficient use of resources.
- **Integrated Resources:** Collaboration among institutions, including specialized brigades like BRICA, terrestrial and aerial fleets, and advanced coordination centers, enhances response capabilities.
- **Comprehensive Prevention Strategies:** Initiatives such as controlled grazing, prescribed burns, and strict regulations on fire use reduce wildfire risks effectively.
- **Technology Integration:** Tools like wildfire simulators, GPS tracking, and real-time resource management systems optimize operational efficiency and situational awareness.
- **Community Engagement:** Public education programs and partnerships with local stakeholders, such as farmers and landowners, foster widespread involvement in fire prevention efforts.
- **Innovative Suppression Techniques:** A combination of direct and indirect tactics, supported by fire behavior analysis and aerial coordination, ensures a dynamic and adaptive response to wildfires.

INFOCA's scalable and proactive model offers valuable insights for other regions, including Austria, in developing integrated wildfire management frameworks that balance prevention, suppression, and community participation.

4. The Wildfire Analysis Unit

The Wildfire Behaviour Analysis Unit plays a critical role in INFOCA's ability to predict, manage, and suppress wildfires effectively. This specialized unit uses advanced tools and methodologies to analyze fire dynamics, ensuring that firefighting strategies are data-driven and adaptable to the complex and evolving nature of wildfires.

Figure 4: INFOCA Wildfire Analysis Unit

The primary objective of the Wildfire Behaviour Analysis Unit is to support operational decision-making by providing real-time insights into fire behavior. Its responsibilities include:

- **Fire Prediction:** Utilizing modeling tools to forecast fire progression based on environmental factors such as wind, topography, and fuel loads.
- **Operational Support:** Offering strategic advice to the Incident Command Post (ICP) on suppression tactics and resource allocation.
- **Post-Fire Analysis:** Assessing the behavior of past fires to improve future operational strategies and prevention efforts.

The unit uses a range of up to date tools and technologies to enhance its predictive capabilities. Simulation Software Tools like FARSITE and SIADEX allow for detailed modeling of fire spread under various conditions. Data from drones, satellites, and ground-based sensors provide real-time imagery of fire progression. Geographic Information Systems (GIS) enable the mapping of fire perimeters, fuel loads, and suppression resources. Weather forecasting tools, including SIGYM, integrate wind, temperature, and humidity data into fire behavior models.

The Wildfire Behaviour Analysis Unit is fully integrated into INFOCA's operational framework, working closely with Aerial and Ground Resources, providing actionable data to optimize the deployment of aerial units and ground crews. It delivers real-time updates and forecasts to inform strategic decisions during active fires in the incident command post. The Unit shares insights and data with personnel to improve the understanding of fire dynamics and enhance tactical responses during training.

4.1. Lessons learned

The Austrian experts observed several key practices that could enhance wildfire behavior analysis capabilities in Austria:

- **Use of Advanced Modeling Tools:** Adopting simulation software to predict fire behavior and inform suppression strategies.
- **Integration of Remote Sensing:** Utilizing drones and satellite imagery for real-time monitoring and data collection.
- **Collaboration with Meteorological Services:** Incorporating detailed weather data into operational planning to improve accuracy and adaptability.
- **Focus on Training and Knowledge Sharing:** Ensuring that all personnel, from analysts to field crews, have a solid understanding of fire dynamics.

5. INFOCA‘s Incident Command System

The effectiveness of INFOCA's wildfire management operations is underpinned by its robust Incident Command Structure (ICS), which was derived from the United States Federal Emergency Management Agency (FEMA) ICS. INFOCA has adapted this framework to the specific needs and challenges of Andalusia’s wildfire environment, combining the best practices from FEMA ICS with its regional expertise. This hierarchical, modular system ensures clarity, efficiency, and adaptability during wildfire suppression efforts, enabling a seamless response to incidents of varying complexity.

Figure 5: Coordination meeting with ground crews at an Incident Command Post (Source: INFOCA)

The FEMA ICS, originally developed to address large-scale emergencies in the United States, provides a standardized approach to command, control, and coordination. It is based on principles of flexibility, scalability, and unified command, making it suitable for a wide range of incidents. INFOCA adopted and tailored these principles to create a wildfire-specific ICS that meets the unique demands of Andalusia's extensive and diverse natural landscapes. INFOCA has successfully localized these principles to address its priorities, such as wildfire prevention, suppression, and community engagement, while maintaining the core features of FEMA ICS. Key similarities between FEMA ICS and INFOCA ICS include:

- **Unified Command:** A centralized authority overseeing all aspects of the operation to ensure clear decision-making.
- **Modular Structure:** The system expands or contracts based on the incident’s complexity, allowing for the efficient allocation of resources.
- **Defined Roles and Responsibilities:** Clear delineation of tasks within sections ensures accountability and coordination.
- **Interoperability:** The structure facilitates collaboration between multiple agencies and organizations involved in emergency response.

5.1. Key Components of INFOCA's Incident Command Structure

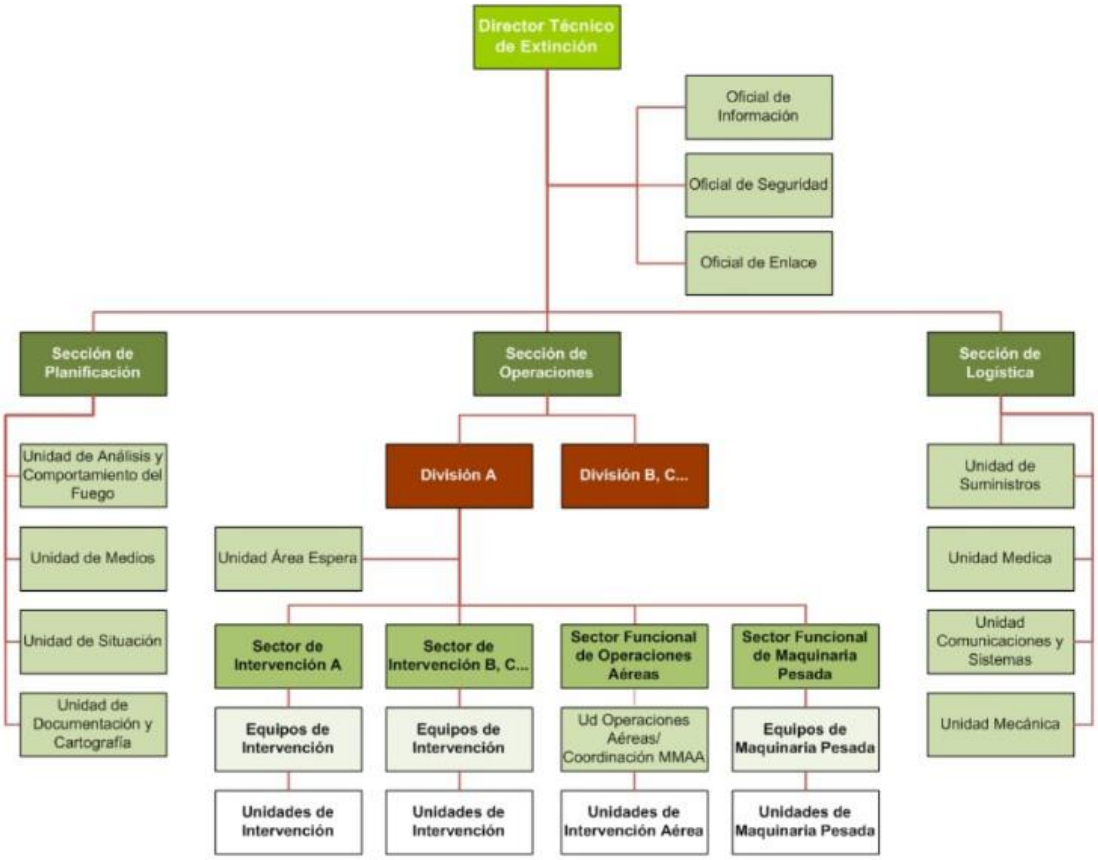

Figure 6: Diagram of the Deployment of the Command and Coordination Structure of the SEIF (Forest Fire Extinction Service) at Maximum Deployment Level

INFOCA's ICS is divided into four main sections: Command, Planning, Operations, and Logistics, each playing a critical role in the response effort.

Command Section

At the top of the structure is the Director Técnico de Extinción (Technical Director of Extinction), who serves as the unified command authority. This position mirrors FEMA ICS's Incident Commander, responsible for overall management and coordination. The director is supported by:

- **Information Officer:** Handles public and media communications.
- **Safety Officer:** Ensures compliance with safety protocols for personnel and affected communities.
- **Liaison Officer:** Coordinates with external agencies and stakeholders to ensure unified efforts.

This centralized command ensures that all operational activities align with the overall strategy.

Planning Section

Derived from FEMA ICS, the Planning Section in INFOCA is responsible for information gathering, analysis, and documentation. Key units include:

- **Fire Behavior Analysis Unit:** Predicts fire spread and intensity using advanced modeling tools.
- **Resources Unit:** Monitors the allocation and status of resources.
- **Situation Unit:** Tracks the progress of the incident and environmental conditions.
- **Documentation and Cartography Unit:** Maintains operational records and produces maps for field use.

This section ensures that strategic decisions are based on real-time data and accurate analysis.

Operations Section

The Operations Section oversees the execution of firefighting strategies. It is divided into functional and geographic subdivisions, similar to FEMA ICS, to maintain clarity and manageability:

- **Division A, B, C...**: Each division is responsible for specific operational zones.
- **Sector Intervention Units**: Implement suppression tactics, such as firebreak construction and direct attack.
- **Functional Sectors**:
    - Aerial Operations: Manages helicopters and fixed-wing aircraft for suppression and reconnaissance.
    - Heavy Machinery Operations: Deploys bulldozers and other equipment to create containment lines.

This section mirrors FEMA ICS's focus on direct action, ensuring that resources are effectively deployed in the field.

Logistics Section

The Logistics Section supports all operational activities by ensuring the availability of resources and infrastructure. It includes:

- **Supply Unit**: Manages essential resources, including food, water, and fuel.
- **Medical Unit**: Provides healthcare support to personnel during operations.
- **Communications and Systems Unit**: Maintains communication networks, including radios and mobile command centers.
- **Mechanical Unit**: Handles maintenance and repair of vehicles and equipment.

FEMA ICS's emphasis on logistical efficiency is evident in this section, which ensures the smooth functioning of all operational aspects.

5.2. Adaptability and Scalability

INFOCA's ICS, like FEMA ICS, is designed to scale up or down based on the complexity and size of the wildfire. This modular structure ensures efficient resource utilization and the ability to manage multiple incidents simultaneously. The system can seamlessly integrate additional divisions or sectors as the situation demands, making it highly flexible and responsive.

INFOCA's adaptation of the FEMA ICS serves as a model for efficient and effective wildfire management. By combining the best practices of FEMA's scalable and unified framework with region-specific innovations, INFOCA has developed an incident command structure that is both robust and adaptable. This ICS not only supports Andalusia's firefighting efforts but also provides valuable lessons for Austria and other regions seeking to enhance their wildfire management systems.

5.3. Lessons learned

- Unified Command and Communication: Ensures consistent decision-making across all sections, a critical feature for large-scale incidents.
- Scalable and Flexible Design: Allows for quick adaptation to incidents of varying size and complexity.
- Specialized Units: The division of labor into specific functional areas improves operational efficiency and safety.
- Advanced Predictive Tools: The emphasis on fire behavior analysis and real-time data management enhances situational awareness and tactical planning.

6. Ground Operations and specialized BRICA Units

INFOCA's ground firefighting operations are a cornerstone of Andalusia's wildfire suppression strategy. The system relies on a network of specialized ground units, including the BRICA helitack crews and other dedicated firefighting teams. These units work in coordination with aerial resources to implement strategic and tactical operations that address the region's diverse wildfire challenges. INFOCA's ground units operate under a unified command structure, ensuring seamless integration across all resources and prioritizing safety in every phase of their operations.

Figure 7: INFOCA ground crews during firefighting operations (Source: INFOCA)

6.1. Ground unit in INFOCA

INFOCA deploys multiple types of ground units to address the varying demands of wildfire suppression. Each unit has specialized roles and responsibilities:

- **BRICA:** These helitack crews are trained to operate with helicopters, enabling rapid deployment to hard-to-reach areas. They excel in establishing firelines, coordinating aerial operations, and tackling fires in steep or rugged terrains.
- **CEDEFO Crews** (Forest Defense Centers): These are stationed across Andalusia and provide the first line of defense during fire outbreaks. They are equipped with fire trucks, bulldozers, and hand tools for constructing firelines and protecting assets.
- **Patrol and Surveillance Crews:** These teams monitor forested areas during high-risk periods to detect and report fires early, reducing response times.
- **Heavy Machinery Operators:** Bulldozer crews and other operators are responsible for creating firebreaks, clearing vegetation, and supporting fire suppression in difficult terrain.

Together, these units form a cohesive system capable of addressing both small incidents and large-scale wildfire emergencies.

6.2. Role and Structure of BRICA Helitack Crews

BRICA helitack crews are among the most versatile and critical components of INFOCA's ground operations. Their primary focus is rapid deployment to wildfire hotspots, often in coordination with helicopters for transport and aerial suppression support. Each unit comprises a **pilot crew**, a **technician**, and a **ground-based firefighting team** of 20 members.

Figure 8: BRICA Team ready to board

The roles and responsibilities of BRICA are:

- Direct Suppression: BRICA teams specialize in extinguishing fires directly at their source, using hand tools, hoses, and water pumps.
- Coordination with Aerial Resources: These teams work closely with pilots to guide water drops and ensure precision in targeting firelines.
- Accessibility to Remote Areas: Helicopters enable BRICA crews to reach steep, inaccessible terrain, where they establish containment lines and suppress fires effectively.

BRICA crews undergo intensive physical and tactical training to handle the demanding conditions of wildfire suppression. They are trained in helitack operations, advanced fire behavior analysis, and the use of specialized equipment like 3000 l Bambi Buckets for combined Air Operations.

Figure 9: BRICA Team storing a 3000 l Bambi Bucket and getting ready for take off

6.3. CEDEFO Crews and Their Operations

The CEDEFO (Centros de Defensa Forestal) crews form the backbone of INFOCA's firefighting operations. Stationed at strategic locations, these teams are responsible for managing and implementing most ground-based suppression efforts. The key responsibilities are:

- **Fireline Construction:** CEDEFO crews create firebreaks using hand tools, bulldozers, and other machinery to halt fire progression.
- **Asset Protection:** These crews prioritize defending critical infrastructure, homes, and natural resources from approaching wildfires.
- **Support for Long Campaigns:** In prolonged fire suppression efforts, CEDEFO crews provide logistical and operational support to sustain firefighting activities.

CEDEFO units work in tandem with aerial resources and bulldozer operators, ensuring that all efforts are aligned for maximum impact. Their coordinated actions improve response times and operational efficiency.

6.4. Patrol and Surveillance Crews

Patrol and surveillance crews play a crucial preventive role in INFOCA's operations. During the high-risk fire season, these teams monitor forested areas for early detection and rapid response to fire outbreaks. The key responsibilities of these crews are:

- **Early Detection:** By identifying fires at their incipient stages, these crews allow INFOCA to mobilize resources before fires escalate.
- **Community Engagement:** Surveillance crews also interact with local communities to raise awareness about fire prevention and safety measures.

Their vigilance ensures that INFOCA maintains a proactive approach to wildfire management, minimizing the likelihood of large-scale incidents.

6.5. Safety in Ground Firefighting Operations

Safety is a core tenet of INFOCA's approach to wildfire suppression. All ground units adhere to comprehensive safety protocols designed to minimize risks and protect personnel.

INFOCA employs the LACES protocol—a safety framework emphasizing Lookout, Attention/Awareness, Communication, Escape Routes, and Safe Places. This proactive system ensures that all team members are continuously aware of their safety status and prepared to adjust as needed. LACES was adopted from US Forst Service Protocols and safety procedures and is one of the cornerstones of Safe operations within INFOCA. In contrary to other approaches within the LACES rule "A" was integrated as "Attention/Awarenes", in other interpretations of the LACES Rule "A" might also stand for "Anchorpoint".

The LACES Rule as it is implementes within INFOCA is structured as follows:

- **Lookout:** Continuous monitoring of fire behavior and environmental conditions to identify potential risks.
- **Attention/Awareness:** Teams maintain situational awareness to anticipate changes in fire dynamics and adjust strategies accordingly.
- **Communication:** Reliable channels ensure that all units remain informed and coordinated during operations.
- **Escape Routes:** Multiple escape routes are identified and defined
- **Safety Zones:** Safe zones are established to provide refuge in emergencies.

INFOCA firefighters are trained to recognize 18 critical danger scenarios and adhere to the 10 Standard Firefighting Orders to mitigate risks. These guidelines ensure that safety remains the top priority, even in high-pressure situations.

6.6. Lessons learned

Several aspects of INFOCA's ground operations can be adapted or fostered in Austria especially in the following areas:

- **Diverse Ground Units:** The combination of specialized teams like BRICA, CEDEFO crews, and surveillance units creates a layered approach to wildfire suppression.
- **Safety Culture:** INFOCA's emphasis on safety protocols, particularly the LACES framework, demonstrates the importance of a proactive approach to risk management.
- **Integrated Operations:** The seamless coordination between ground units, aerial resources, and heavy machinery offers a model for improving multi-resource firefighting efforts.

7. Personal Protective Equipment and Hand Tools

INFOCA teams are equipped with specialized Personal Protective Equipment (PPE) and tools designed to provide maximum safety, functionality, and efficiency during wildland firefighting operations. Additionally, the use of standardized equipment ensures consistency and effectiveness across all units.

Figure 10: INFOCA BRICA Crew with PPE and Handtools

7.1. Protective Clothing

INFOCA firefighters wear protective clothing that follows european standards and PPE for wildland firefighting. It is composed of 64% viscose for breathability, 35% aramid for heat resistance and 1% antistatic fibers, ensuring balance between protection and wearability. The fabric has a density of 265 g/m^2, balancing durability and breathability. Shirts are colored bright yellow for high visibility and green for the pants, symbolizing their forest firefighting role. The colours are based on the colour scheme also used by the US Forest Service. Reflective Stripes on pants and shirts for enhanced visibility during low-light conditions or in smoke-heavy environments. The gear is suited for heat exposure up to 20 kW/m^2 with proper body coverage but not designed for confined spaces or areas with extreme radiant heat.

7.2. Helmets and Color-Coding Scheme

Helmets play a dual role of providing physical protection and facilitating team identification through a color-coded scheme. This system ensures clear communication and coordination under challenging conditions. The colour Scheme is also used for Identification in the field and is structured as follows:

- **White Helmets:** Worn by team leaders for easy recognition during operations.
- **Green Helmets:** Firefighters from BRICA helitack crews
- **Yellow Helmets:** Assigned to general firefighters of ground crews
- **Blue Helmets:** Designated for drivers, helping differentiate roles within a team.

7.3. Gloves, Shoes, and Additional Gear

INFOCA firefighters are equipped with heat-resistant lightweight leather gloves that protect against burns and abrasions while enhancing grip on tools and equipment. They use heavy-duty boots specialised for firefighting in different terrains. Additionally, each firefighter carries a personal pack containing essential items, such as hydration systems, energy supplies, first aid kits, and supplementary protective gear, ensuring they are prepared for extended missions in remote and challenging environments.

Figure 11: INFOCA BRICA Firefighter with PPE, Personal Pack and Helmet

4. Hand Tools

INFOCA teams rely heavily on hand tools for ground operations, particularly in remote or rugged areas where machinery cannot operate. The primary tool is a basic firefighter hoe that is fitting for the most soil types that can be found in Andalusia.

Figure 12: Firefighting hoe

Additional Tools like chainsaws, axes or portable water pumps are also part of the standard toolkit. The tools are lightweight and ergonomically designed to minimize fatigue while maximizing efficiency.

Figure 13: Equipment and Material of a CEDEFO Unit in the Back of a Pickup Truck

6. Lessons for Austrian Experts

The Austrian delegation observed several key takeaways from INFOCA's approach to PPE and tools:

- **Focus on Protection and Functionality:** Lightweight protective gear and ergonomic tools reduce risks and improve firefighter efficiency.
- **Adequate Hand Tools:** The standard tools used by INFOCA firefighters are basic but fit for the purpose. Hand Tool selection has to fit the requirements of the ground and soil type especially regarding fireline construction.
- **Role-Specific Helmets:** The color-coded helmet system is a simple yet effective way to improve coordination in dynamic and high-pressure situations.

8. Air Operations

Air operations are a critical element of INFOCA's wildfire management strategy, providing essential support for ground teams and enhancing the overall effectiveness of suppression efforts. The 2024 wildfire season will see INFOCA utilizing a robust fleet of **44 aircraft**, including both helicopters and fixed-wing planes, tailored to meet the specific challenges of Andalusia's diverse terrain.

Figure 14: Super Puma Helicopter within a BRICA Unit

INFOCA's air operations are organized to maximize efficiency and effectiveness in wildfire suppression, leveraging both fixed-wing aircraft and helicopters in a carefully coordinated framework. This structure is supported by specialized personnel, advanced technology, and robust integration between air and ground teams. The clear distribution of roles and responsibilities ensures that every aspect of aerial operations contributes to the overall success of wildfire management efforts.

8.1. Resources for Air Operations

INFOCA's air operations rely on a diverse and well-equipped fleet, complemented by advanced planning tools and specialized personnel. INFOCA's fleet for the 2024 wildfire season consists of **44 aircraft** of varying types. The selection of aircraft prioritizes agility and efficiency, particularly for operations in Andalusia's mountainous regions:

- **Smaller Helicopters and Fixed-Wing Aircraft:** These aircraft are preferred due to their maneuverability, making them particularly effective in rugged and forested terrain.
- **Larger Aircraft:** Amphibious planes such as Canadair are deployed for high-volume water drops in accessible areas.
- **Unmanned Aerial Vehicles (UAVs):** Drones are increasingly used for real-time reconnaissance, fire behavior analysis, and situational awareness.

8.2. Fixed-Wing Firefighting Planes

Fixed-wing aircraft play a critical role in INFOCA's air operations, providing high-volume water drops, reconnaissance, and aerial coordination capabilities. INFOCA's fleet includes a variety of fixed-wing aircraft, tailored to meet different operational needs:

- **Canadair CL-215/415 Amphibious Planes:** These aircraft are the backbone of large-scale suppression efforts, capable of scooping water from nearby bodies of water and dropping it over active fire zones. Their high payload capacity and rapid turnaround make them ideal for combating extensive wildfires.
- **Partenavia P68 Observers:** These lightweight planes are equipped with advanced sensors and cameras for reconnaissance and are used to transport the **Air Observer (AirOps)** to the fire zone.

Fixed-wing planes are particularly effective in accessible areas where their speed, range, and payload can be fully utilized. Their roles and responsibilities are:

- **High-Volume Suppression:** Amphibious planes deliver significant quantities of water or retardants to firelines, slowing the spread of large wildfires.
- **Reconnaissance and Coordination:** Observers in fixed-wing aircraft provide real-time intelligence on fire behavior, terrain, and resource deployment, enabling precise coordination of aerial and ground operations.

8.3. Firefighting Helicopters

Helicopters are indispensable in INFOCA's air operations, offering unparalleled agility and precision, especially in rugged and mountainous terrain. INFOCA operates a diverse fleet of helicopters, each suited to specific tasks:

- **Light Helicopters:** Used primarily for reconnaissance, transport, and small-scale suppression. Their agility makes them ideal for navigating narrow valleys and steep inclines.
- **Medium Helicopters:** Equipped with external buckets or tanks, these helicopters are used for water drops and crew transport.
- **Heavy Helicopters:** With higher payload capacities, these helicopters are deployed for large-scale suppression efforts and to support BRICA teams with equipment transport.

The agility and versatility of helicopters make them a vital asset in INFOCA's operations, particularly in areas where fixed-wing aircraft are less effective. Roles of firefighting helicopters within the INFOCA system are:

- **Helitack Operations:** Helicopters transport BRICA teams to remote locations, enabling rapid deployment to areas inaccessible by ground vehicles.
- **Precision Water Drops:** External buckets, such as the **Bambi Bucket**, allow helicopters to deliver water to specific fire hotspots, complementing ground suppression efforts.

- **Logistical Support:** Helicopters are also used to transport equipment, supplies, and personnel between staging areas and fire zones.

Figure 15: INFOCA Helicopter with 3000 l Bambi Bucket

8.4. Air Observer (AirOps)

A key component of INFOCA's air operation strategy is the **Air Observer (AirOps)**, a specialized role that ensures the coordination and safety of aerial firefighting efforts. This role is critical for maintaining the safety and efficiency of air operations, particularly during complex incidents involving multiple aircraft.

Figure 16: Partenavia P68 Air Observer Plane (Source: INFOCA)

The Air Observer operates from a fixed-wing aircraft, overseeing the movement of helicopters and planes to ensure they are deployed effectively and do not interfere with one another. The Observer is equipped with advanced communication tools, the Air Observer relays critical information between the Incident Command Post (ICP) and aerial units, aligning tactical aerial operations with overall suppression strategies. Observers assess fire progression, wind patterns, and terrain conditions, providing actionable insights to the Incident Command Post.

8.5. Integrated Operations Between Fixed-Wing and Helicopter Units

INFOCA's air operations rely on the seamless integration of fixed-wing planes and helicopters to achieve tactical and strategic objectives:

- **Complementary Roles:** Fixed-wing aircraft focus on large-scale suppression and reconnaissance, while helicopters provide precision and agility for localized operations.
- **Coordinated Tactics:** The Air Observer ensures that planes and helicopters operate harmoniously, avoiding conflicts and maximizing resource utilization.
- **Combined Impact:** The integration of these two aerial platforms allows INFOCA to tackle wildfires of varying sizes and complexities, adapting to the unique demands of each scenario.

This integrated approach ensures that aerial resources are used efficiently and effectively, minimizing response times and maximizing the impact of suppression efforts. INFOCA utilizes different tools for planning, execution, and monitoring of air operations:

- **Resource Planning Tools:** INFOCA employs systems to track the availability and readiness of all aircraft, centralizing data for efficient management.
- **Flight Planning Tools:** Specialized software records flight routes and water drop zones electronically, ensuring precision in operations and enabling real-time adjustments.

During the visit, INFOCA presented multiple tactical scenarios, demonstrating how these tools are applied in real operations and how they enhance coordination and safety.

8.6. Pilot Training and Safety in Air Operations

INFOCA places a strong emphasis on training and safety in all aspects of air operations.

- **Pilot Training:** Helicopter and fixed wing pilots involved in aerial firefighting operations have to undergo a specialised training programme to ensure safe and efficient air operations.
- **Tactical and Foundational Training:** INFOCA personnel participate in extensive training programs that cover both tactical and planning aspects, ensuring high levels of proficiency and preparedness.
- **Safety Protocols:** Important safety measures, including the use of standardized aeronautical language and proactive risk assessment, are integral to INFOCA's operations. Clear communication, precise coordination, and structured decision-making are emphasized during all missions.

In Andalusia, helicopter pilots involved in aerial firefighting operations must meet stringent training and experience requirements. In addition to holding the necessary legal flight certifications, pilots are required to demonstrate extensive experience in external load operations and complete an internal operator-specific training program for wildfire suppression, comprising approximately 20 hours of specialized instruction. This structured approach ensures that pilots are not only technically proficient but also tactically prepared for the unique challenges of aerial firefighting.

8.7. Use of UAV (Drones)

INFOCA has incorporated various types of drones into its firefighting operations:

- **Reconnaissance Drones:** Provide real-time imagery of fire progression and environmental conditions.
- **Operational Support:** Drones are used for mapping fire perimeters, identifying hotspots, and assisting in situational awareness.

These UAVs complement traditional aircraft by providing detailed and localized data, enhancing overall situational awareness and tactical planning.

8.8. Use of Retardants

Retardants are a crucial component in wildfire suppression efforts by INFOCA, enhancing the effectiveness of water in combating fires. Retardants are classified into three categories based on their properties and duration of effect: foam agents, thickeners, and long-term retardants. Foam agents create a protective layer over vegetation, isolating it from heat and air while enhancing water penetration into plant tissues. Thickeners, on the other hand, increase water viscosity, ensuring better adherence to surfaces and extending its cooling and smothering effects. Long-term retardants, made from ammonium salts, leave behind residues after water evaporation that inhibit fire spread. INFOCA uses retardants both in direct and indirect fire attacks, using aerial means such as helicopters equipped with helibuckets and fixed-wing aircraft, as well as ground vehicles with dosing systems.

8.9. Lessons Learned

INFOCA's approach to air operations offers valuable insights for Austrian firefighting organizations:

1. **Centralized Resource Management:** Austria, particularly Styria, could benefit from adopting a centralized system for tracking and managing the availability of aerial resources.
2. **Enhanced Coordination Through Air Observers:** Deploying dedicated Air Observers to coordinate aerial operations from the field could significantly improve tactical efficiency.
3. **Special Pilot Training for Aerial Firefighting:** The implementation of a standardized training framework in Austria, specifically for pilots from BMI, the Austrian Armed Forces (ÖBH) or private operators is seen necessary. Currently, in Austria, there is no unified tactical guideline provided by fire services, and each helicopter operator follows their own protocols. Adopting a standardized tactical training model could significantly enhance coordination and effectiveness in aerial wildfire suppression operations.
4. **Unified Training Programs:** A standardized training regime for both ground and aerial personnel would enhance coordination and operational effectiveness.
5. **Automated Alert Systems:** Implementing a normed and automated alert system would streamline resource mobilization and improve response times.

9. Vehicle Fleet and Fire Trucks

INFOCA's fleet of firefighting trucks is a cornerstone of its wildfire management operations, designed to address the unique challenges posed by Andalusia's diverse terrain. This state-of-the-art fleet includes a range of vehicles, each tailored to specific roles in wildfire suppression, prevention, and logistics. Continuous modernization and integration of advanced technologies ensure that INFOCA remains at the forefront of firefighting capabilities.

Figure 17: Standard Heavy Firetruck used by INFOCA

By combining heavy-duty engines, modular light trucks, and specialized support vehicles, INFOCA ensures a versatile and efficient response to Andalusia's wildfire risks.

9.1. Heavy Fire Engines

INFOCA operates **101 heavy fire engines**, forming the backbone of its ground firefighting capabilities. These vehicles are specifically designed for wildland firefighting and are equipped to handle the rugged and varied landscapes of Andalusia. The heavy trucks feature the following characteristics:

- **High Water Capacity:** Tanks capable of holding between 3,000 and 5,000 liters of water.
- **Terrain Adaptability:** High ground clearance and robust undercarriage systems for navigating off-road conditions.
- **High-Pressure Pumps:** Systems capable of delivering powerful water streams, sometimes mixed with fire retardants, even on steep inclines.
- **Crew Safey:** Heat-resistant materials and cab deluge systems to protect crews during close-proximity firefighting.

These engines are critical for delivering large volumes of water directly to firelines and are often the first line of defense during large-scale suppression efforts. Heavy trucks are available in two generations but show similar characteristics like a short wheelbase and a low center of gravity.

Figure 18: New generation (left) and an old generation (right) heavy fire truck used by INFOCA

The fix installed pump in the back of the trucks is easily accessible for operations and maintenance. Hose reels with collapsible and non collapsible hose are installed in the back of the trucks.

Figure 19: Pump assembly at a new generation (left) and an old generation (right) heavy firefighting truck

For safety purposes the heavy trucks are equipped with a 500 liter water reserve that can not be used for direct firefighting purposes. The reserve is used for self defense of the truck. The self defense system is operated by an electrical pump.

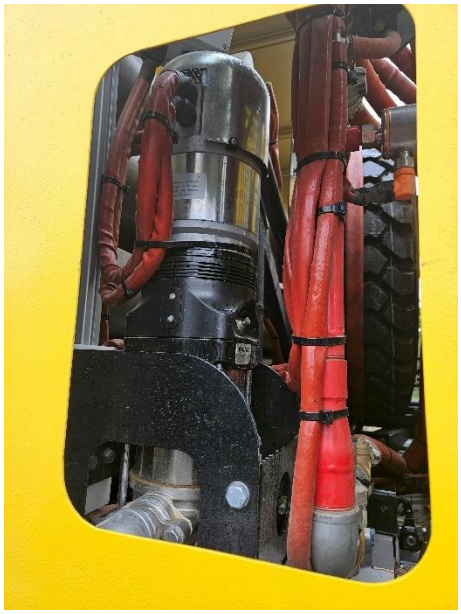

Figure 20: Electrical pump for the trucks self defense system, located in the back of the cabin

Equipment is sorted in special side compartments of the trucks, in the older trucks there is also some equipment stored at the roof section of the truck.

Figure 21: Equipment compartments at a new generation (left) and an old generation (right) heavy firefighting truck

9.2. Water-Pump Support Trucks

INFOCA operates 16 water-pump support trucks, which play a vital role in extended firefighting operations. They act as mobile water sources and are equipped to transport over 10,000 liters of water. These vehicles ensure a consistent water supply in remote locations. Allow for quick water transfers to primary fire engines or directly to firelines by high capacity pumps. The trucks can also draw water from natural sources such as rivers or reservoirs, further extending their utility These vehicles ensure that operations in water-scarce areas remain sustainable and uninterrupted.

9.3. 4x4 Transport Vehicles

INFOCA's fleet includes 1,260 4x4 transport vehicles, primarily used for moving personnel and light equipment across Andalusia's rugged terrain. The key features are:

- **Rapid Response Capability:** These vehicles enable firefighters to quickly reach remote fire zones.
- **Off-Road Adaptability:** Reinforced undercarriages and high-clearance designs allow access to challenging landscapes.
- **Basic Firefighting Equipment:** Many are equipped with portable pumps and hand tools for initial fire attacks.

These vehicles are crucial for ensuring personnel mobility and swift response times.

Figure 22: 4x4 Quick attack unit with 400 l of water capacity used to tackle spot fires

9.4. Specialized and Supporting Equipment

INFOCA's fleet also includes several specialized vehicles and tools that enhance its operational capabilities:

- **Mobile Meteorology and Transmissions Units:** Provide on-site weather data and communication support.
- **Mobile Analysis and Planning Units:** Aid in tactical planning and resource coordination.
- **Earth Movers:** Used to create firebreaks and clear vegetation in rugged terrain.

9.5. Recent Modernizations and Innovations

INFOCA has made significant investments to modernize its fleet and incorporate advanced technologies- The recent acquisitions include new heavy-duty trucks with foam injection systems, GPS tracking, and advanced safety features. Land drones for creating firebreaks and clearing paths for ground teams. Nd Mobile command units equipped with satellite communication and GIS mapping tools for real-time decision-making have been taken up into the fleet. These innovations enhance INFOCA's ability to tackle increasingly complex wildfire scenarios.

9.6. Lessons learned

The Austrian delegation identified several key takeaways from INFOCA's approach to its firefighting fleet:

- **Focus on Terrain Adaptability:** Vehicles designed for rugged, off-road conditions are essential for effective wildfire suppression in challenging landscapes.
- **Diverse Fleet Composition:** Combining heavy-duty trucks, light tactical vehicles, and support units creates a flexible and comprehensive response system.
- **Integration of Technology:** GPS systems, mobile command units, and drones significantly enhance operational efficiency and safety.
- **Continuous Modernization:** Regular investments in upgrading and diversifying fleet capabilities ensure preparedness for evolving wildfire challenges.

10. Personnel and Training

INFOCA's wildfire management success is rooted in its comprehensive training programs, which ensure that personnel are well-prepared to handle the diverse challenges of wildfire suppression. With nearly 5,000 personnel employed across various roles, INFOCA maintains a rigorous training regimen that encompasses technical, physical, and safety-focused aspects, tailored to meet the demands of Andalusia's wildfire landscape.

10.1. Structure and Composition of INFOCA's Workforce

INFOCA's personnel are drawn from the **Regional Ministry of the Environment** and the **Public Environmental and Water Agency**, comprising a mix of year-round employees and seasonal staff.

- **Year-Round Staff:** Responsible for activities beyond fire suppression, including prevention, planning, and equipment maintenance.
- **Seasonal Staff:** Focused on active firefighting during the wildfire season, which spans from **mid-May to mid-October**.

INFOCA prioritizes recruiting individuals with forestry backgrounds or prior experience in related fields, ensuring a foundational understanding of the terrain and fire behavior.

10.2. Training Framework and Programs

INFOCA's training is designed to prepare personnel for all aspects of wildfire management, from prevention to suppression and recovery. New employees undergo internal training programs covering:

- **Tactics and Procedures:** Instruction on wildfire suppression techniques, such as direct and indirect attack methods, fireline construction, and use of equipment.
- **Safety Protocols:** Comprehensive education on the **LACES protocol** (Lookout, Attention/Awareness, Communication, Escape Routes, and Safe Places) and adherence to the **10 Standard Firefighting Orders**.
- **Operational Integration:** Training in the coordination of aerial and ground resources and the use of INFOCA's Incident Command System (ICS).

Certain positions require additional specialized training, such as:

- **Helitack Operations:** For BRICA crew members working closely with helicopters.
- **Air Observers (AirOps):** Training in aerial coordination and situational awareness for personnel tasked with directing operations from fixed-wing aircraft.
- **Heavy Machinery Operators:** Focused on bulldozer operations and creating firebreaks in rugged terrain.

10.3. Physical Preparedness

Given the physically demanding nature of wildfire suppression, INFOCA emphasizes physical fitness among its personnel.

- **Fitness Programs:** On-site fitness routines, conducted with or without trainers, ensure that personnel maintain peak physical condition.
- **Station-Based Training:** Exercises conducted at INFOCA stations simulate real-world challenges, such as carrying heavy equipment, scaling uneven terrain, and operating under high-pressure conditions.

These programs are tailored to ensure firefighters can endure the extreme conditions they face during operations.

Figure 23: Physical training of a BRICA unit

10.4. Continuous Learning and Scenario-Based Training

INFOCA prioritizes ongoing education and scenario-based exercises to keep personnel updated on the latest techniques and strategies.

- **Simulation Exercises:** Tools like the **SimTable** are used to recreate fire scenarios, allowing teams to practice tactical decision-making and coordination in a controlled environment.
- **Incident-Specific Drills:** Teams participate in live drills based on past wildfire incidents, refining their response tactics and addressing potential weaknesses.
- **Workshops and Refresher Courses:** Regular workshops provide updates on evolving tactics, new equipment, and lessons learned from previous wildfire seasons.

10.5. Lessons Learned

INFOCA's approach to workforce development and training offers practical insights for improving wildfire management. Key lessons include:

- **Comprehensive Training:** Basic and specialized training programs, such as for helitack operations or air observers, enhance preparedness and role-specific expertise.
- **Physical Fitness Emphasis:** Tailored fitness routines and station-based exercises prepare personnel for the physical demands of wildfire suppression.
- **Scenario-Based Training:** Tools like SimTable and incident-specific drills improve decision-making and adaptability during dynamic fire situations.
- **Safety Protocols:** Embedding practices like LACES and the 10 Standard Firefighting Orders ensures safety remains a top priority.

These strategies, when adapted to local contexts, could significantly enhance wildfire preparedness and response capabilities in Austria and beyond.

11. SIM Table Training

One of INFOCA's standout tools for firefighter training is the **SimTable**, an advanced, interactive simulation system that uses augmented reality to model wildfire scenarios. This tool plays a crucial role in preparing personnel for the complexities of wildfire suppression, allowing them to engage in hands-on, scenario-based learning.

Figure 24: Explanation of the SimTable Training during the Exchange

11.1. What is the SimTable?

The SimTable is a cutting-edge training and planning tool that uses sand tables, projection technology, and computer simulations to create dynamic, realistic wildfire scenarios.

- **Interactive Terrain Modeling:** Sand is shaped to mimic the terrain of a specific area, and a digital projection overlays the landscape with wildfire progression, weather patterns, and resource deployment.
- **Customizable Scenarios:** Trainers can program scenarios based on actual fire incidents or hypothetical situations, adjusting variables such as wind speed, fuel types, and fire behavior to reflect real-world conditions.

This innovative tool offers a realistic, flexible way to visualize and rehearse wildfire management strategies, making it an indispensable part of INFOCA's training arsenal.

By the use of the SimTable, Firefighters also gain a deeper understanding of how environmental factors influence fire dynamics.

Figure 25: SimTable setup within the INFOCA Command Center

11.2. Benefits from the use of the SimTable

There are several educational benefits from the use of The SimTable, that can directly enhance several aspects of the overall understanding and analysis of fire incidents. Examples for such learing improvements are are:

- **Enhancing Situational Awareness:** SimTable training enhances firefighters' ability to assess and respond to evolving situations. By visualizing the fire's progression and the effectiveness of various tactics, teams build a stronger situational understanding.
- **Post-Incident Analysis:** SimTable can replicate past wildfire incidents for post-event analysis, allowing teams to review their performance, identify areas for improvement, and implement lessons learned in future operations.
- **Planning and Preparedness:** Beyond training, the SimTable is used for pre-season planning. By simulating high-risk scenarios, INFOCA can test and refine its operational plans, ensuring readiness for the wildfire season.

Besides the educational benefits, the SimTable allows firefighters to practice critical decision-making in a controlled environment. It can be used to enhance the following aspects in firefighting operations:

- **Real-Time Strategy Planning:** Teams can experiment with various suppression tactics, such as direct or indirect attack, and observe their outcomes.
- **Multi-Unit Coordination:** Ground crews, aerial resources, and machinery operators can practice integrated responses, refining communication and collaboration under simulated pressure.
- **Resource Allocation:** Commanders practice deploying teams and assets efficiently based on fire behavior predictions.
- **Incident Communication:** The tool facilitates training in maintaining clear, consistent communication between units and command centers.

11.3. Implementation in Training Programs

SimTable sessions are integrated into INFOCA's regular training schedule and are used in combination with live drills and classroom instruction.

- **Scenario Customization:** Trainers tailor simulations to the specific regions where teams operate, preparing them for local challenges.
- **Team-Based Exercises:** Crews participate in group simulations, emphasizing teamwork and decision-making under realistic conditions.
- **Feedback and Evaluation:** Each session concludes with a debrief, where trainers provide feedback and discuss strategies for improvement.

11.4. Lessons learned

INFOCA's use of SimTable provides a model for incorporating advanced simulation tools into Austria's training programs. Key takeaways include:

- **Dynamic Learning:** SimTable's interactive format makes training engaging and practical, helping personnel retain complex information.
- **Integration with Other Methods:** Combining SimTable simulations with live drills and classroom sessions creates a comprehensive training experience.
- **Scenario Customization:** Adapting the tool to reflect Austria's terrain and fire risks would provide relevant, actionable insights for local firefighting teams.

The SimTable represents a powerful addition to INFOCA's training arsenal, offering firefighters an immersive, hands-on way to prepare for wildfire incidents. By combining innovative technology with practical training scenarios, INFOCA ensures that its personnel are well-equipped to handle the complexities of wildfire suppression. This approach provides a benchmark for other regions, including Austria, to enhance their training programs and overall wildfire readiness.

12. Environmental Agents and Incident Investigation

The Agentes de Medio Ambiente (Environmental Agents) play a pivotal role in Andalusia's wildfire management framework, particularly in fire prevention, suppression, and post-fire investigation. These professionals are integral to INFOCA's operations, serving as both field operators during wildfires and investigators tasked with uncovering the causes of fire incidents. Their work ensures accountability, contributes to the development of preventative measures, and fosters a deeper understanding of fire behavior and risks.

Figure 26: Fire development in a full scale model used for explanatory purposes during fire investigation Training

Agentes de Medio Ambiente are specialized personnel employed by the Andalusian Regional Ministry of Environment. Their diverse responsibilities span across environmental management, regulatory enforcement, and wildfire-related activities. In the context of wildfires, their primary roles include:

- **Prevention:** Educating the public, monitoring fire-prone areas, and enforcing regulations to reduce fire risks.
- **Response:** Supporting firefighting operations by coordinating with INFOCA units and providing local expertise.
- **Investigation:** Leading post-fire investigations to determine the cause, assess damages, and identify preventative strategies.

These agents act as the link between the firefighting units, governmental authorities, and the public, ensuring a comprehensive approach to wildfire management.

12.1. Role in Fire Investigation

The Agentes de Medio Ambiente are at the forefront of wildfire investigations, employing a systematic approach to uncover the origins and causes of fires. Agents are trained to identify signs of fire ignition and behavior. They use evidence-based methodologies to ascertain whether a fire was caused by:

- **Natural Factors:** Such as lightning or extreme weather conditions.
- **Accidental Causes:** Including negligence during agricultural activities or equipment use.
- **Intentional Acts:** Arson investigations often require close collaboration with law enforcement agencies.

To ensure accurate findings, agents collect physical evidence from the fire scene, such as burn patterns and ignition sources. They use specialized tools to map fire progression and pinpoint the ignition point and ocument findings with photographs, sketches, and detailed reports. Agents often work closely with:

- **Law Enforcement:** To handle criminal investigations related to arson.
- **Scientific Experts:** To analyze environmental factors and fire dynamics.
- **Judicial Authorities:** Providing expert testimony in cases of legal proceedings.

This collaborative approach ensures that investigations are thorough and lead to actionable conclusions.

12.2. Contribution to Prevention and Policy Development

Beyond determining the cause of fires, the findings of the Agentes de Medio Ambiente have significant implications for wildfire prevention and policy development:

- **Data Collection:** Their investigations contribute to a database of fire causes, which is analyzed to identify trends and high-risk behaviors.
- **Policy Recommendations:** Insights gained from investigations inform regulations, such as restrictions on agricultural burnings and the implementation of safety measures in fire-prone areas.
- **Public Awareness Campaigns:** Agents use their findings to educate communities about fire risks and promote preventative behaviors.

This feedback loop ensures that lessons learned from past incidents shape future strategies for reducing wildfire occurrences. Agentes de Medio Ambiente work in close collaboration with INFOCA's operational framework. During active fire suppression, agents provide valuable insights into terrain, vegetation, and potential fire behaviors. In post-fire scenarios, they coordinate with INFOCA's analysis units to assess the effectiveness of suppression tactics and recommend improvements. Their integration into both operational and investigative roles strengthens Andalusia's ability to respond to and learn from wildfire incidents.

12.3. Fire Investigation Training

During the exchange a lesson for fire investigation training was prepared by representatives of Agentes de Medio Ambiente. A full scale model of typical forest soil was prepared on a table, to explain fire development and the formation on significant points of material combustion, that can later be used for detailed fire investigation.

Figure 27: Full scale model of a section of forest soil for demonstration purposes

During the visit the general procedure of fire investigation and the interpretation of hints and combution marks have been explained in detail.

Figure 28: Indicators of fire spread around a solid object (yellow arrow marks the direction of the fireline propagation)

12.4. Lessons learned

The Austrian delegation identified key practices from the Agentes de Medio Ambiente that could be applied in Austria:

- **Dedicated Fire Investigation Units:** Establishing similar roles focused on wildfire investigation could enhance accountability and preventative efforts.
- **Integration with Firefighting Teams:** Embedding investigation personnel into operational frameworks ensures continuity between response and analysis.
- **Use of Advanced Tools:** Investing in technologies like GIS mapping and thermal imaging can improve fire investigation capabilities.

13. Key Learnings and Conclusions

The Exchange of Experts (EoE) program in Andalusia provided invaluable insights into INFOCA's comprehensive and innovative wildfire management strategies. The structured visits, hands-on exercises, and in-depth discussions highlighted several critical learnings and best practices that can significantly enhance wildfire management systems in Austria and beyond. The following learning areas have identified by the experts that took part in the exchange:

1. **The Critical Role of Ground Crews**: Ground firefighting teams remain the backbone of wildfire suppression, playing an essential role in direct and indirect fireline operations. The emphasis on highly trained and equipped ground crews highlights the importance of their coordination with aerial resources to achieve effective suppression outcomes.

2. **Integrated Firefighting Approach**: INFOCA's operations emphasize the necessity of an integrated approach, where ground, aerial, and technological resources work seamlessly together. This ensures efficient use of resources and a cohesive strategy during complex incidents.

3. **Advanced Aerial Coordination**: INFOCA's aerial operations exemplify state-of-the-art coordination between helicopters, fixed-wing aircraft, and ground teams. The role of Air Observers (AirOps) is particularly noteworthy, ensuring precise and safe aerial operations that complement ground efforts.

4. **Special Pilot Training for Aerial Firefighting:** The implementation of a standardized training framework in Austria, specifically for pilots from BMI, the Austrian Armed Forces (ÖBH) or private operators is seen necessary. Currently, in Austria, there is no unified tactical guideline provided by fire services, and each helicopter operator follows their own protocols. Adopting a standardized tactical training model could significantly enhance coordination and effectiveness in aerial wildfire suppression operations.

5. **Purpose-Built Specialized Trucks**: INFOCA's fleet of heavy-duty and specialized vehicles, including fire trucks and tactical modules, is designed to meet the specific demands of wildland firefighting. Their adaptability and targeted functionality ensure that firefighters have the right tools for the job in diverse and challenging terrains.

6. **Adaptability and Scalability:** The modular structure of INFOCA's Incident Command System (ICS), derived from FEMA ICS, allows for scalable responses to wildfires of varying complexity. This adaptability ensures resource efficiency and effective decision-making.

7. **Adequate Practical and Theoretical Training**: INFOCA's training framework blends rigorous practical exercises, scenario-based simulations, and theoretical instruction. This ensures that personnel are equipped not only with physical readiness but also with tactical knowledge and safety awareness, critical for handling the complexities of wildfires.

8. **Emphasis on Safety and Training:** INFOCA's rigorous training programs, including scenario-based exercises and physical preparedness, ensure that personnel are equipped to handle the physical and tactical demands of wildfire suppression. The LACES protocol and adherence to safety standards further demonstrate the agency's commitment to protecting its workforce.

9. **Advanced Technological Integration:** Tools like wildfire simulators, GPS tracking systems, and UAVs (drones) play a crucial role in enhancing situational awareness, operational efficiency, and strategic planning. INFOCA's use of the SimTable as both a training and planning tool stands out as an exemplary practice.
10. **Integration of Science and Experts**: The incorporation of scientists and forestry specialists into operational planning and fire behavior analysis enhances the precision and effectiveness of suppression tactics. INFOCA's reliance on data-driven decision-making, such as fire simulations and GIS tools, demonstrates the value of integrating science into firefighting.
11. **Fire Investigation and Data Utilization:** The role of Agentes de Medio Ambiente in fire investigation and their systematic approach to identifying fire causes underscore the importance of post-incident analysis in shaping preventive strategies and policies.
12. **Learning from International Expertise**: INFOCA has effectively incorporated lessons from the United States and Canada, particularly regarding training and tactics for ground crews. This exchange of expertise underscores the importance of international collaboration and adaptation of best practices to local contexts.

INFOCA's comprehensive and integrated approach serves as a model for wildfire management. The most critical takeaways include the importance of a strong and well-coordinated ground force, advances aerial coordination, the value of specialized equipment and vehicles, and the need for continuous training supported by science and technology. By adopting these findings, the Fire Service of the Austrian Province of Styria can enhance its capabilities in wildland firefighting, ensuring both preparedness and resilience in the face of increasing wildfire risks.

14. Acknowledgments

The Austrian delegation extends its deepest gratitude to INFOCA and the Regional Government of Andalusia for their hospitality, generosity, and openness during the Exchange of Experts program. The detailed presentations, practical demonstrations, and thoughtful discussions provided an unparalleled opportunity for learning and collaboration.

We thank the dedicated INFOCA personnel for sharing their expertise, showcasing their innovative practices, and inspiring new approaches to wildfire management. The exchange has not only deepened professional knowledge but also strengthened international bonds in the shared mission of protecting natural landscapes and communities from wildfire risks.

Figure 29: Participating Experts from Austria (from left to right): Dieter Pilat, Thomas Fessl, Bernd Fladischer, Harald Schaden, Christian Hermann, Hannes Kern

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