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FUNCTIONAL DESIGN OF THE WFRPM PLATFORM – FRED PLATFORM

Work package 1 – WP1

Defining and implementation tools for wild fire prevention and mitigation

Activity 1.2 – A1.2

Specification and implementation of the WFRPM platform

Deliverable 1.2.1 – D.1.2.1

Functional design of the WFRPM platform

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List of abbreviations and terms

Abbreviation	Definition
API	Application Programming Interface
CSV	Comma-separated values (text file format)
FRED	Fire Free MED
FDI	Fire Danger Index
FWI	Fire Weather Index
GEE	Google Earth Engine
GFS	Global Forecast System
GeoJSON	Format for encoding geographical data structures using JavaScript Object Notation (JSON)
ICT	Information and Communications Technology
NetCDF	NETwork Common Data Form
NBR	Normalised Burn Ratio
SITAC	Standardization of Firefighting Tactical Situation Management
SMTP	Simple Mail Transfer Protocol (Internet standard communication protocol)
UAV	Unmanned Aerial Vehicle
URL	Uniform Resource Locator (i.e. web address)
WMS	Web Map Service
WFRPM	WildFire Risk Prevention and Mitigation

Abstract

The current segment of project implementation involves development of Wildfire risk prevention and mitigation platform - the FRED Platform, which is a comprehensive ICT and remote sensing-supported software solution designed to aggregate, process and visualize georeferenced data relevant to wildfire risk management. This platform aims to support functionalities across three key areas: prevention, mitigation and communication.

Prevention – the FRED platform provides dynamic fire risk maps and fire propagation maps, supported by real-time data from UAVs (Unmanned Aerial Vehicles) and current meteorological data. This includes hotspot detection and early warning systems to identify potential fire risks before they escalate.

Mitigation – the platform assists in active firefighting operations with features such as drone-supported firefighting, real-time visual support, decision-making tools, search and rescue support and post-fire terrain surveillance. UAVs play a critical role in providing real-time data and video streams to support these activities.

Communication – the platform enables effective communication and coordination among firefighting teams and stakeholders. It includes features for sending alerts and notifications through various channels (in-app, email), managing user roles and permissions.

Key Functionalities:

- Dynamic Fire Risk Maps: Utilizes real-time meteorological sources to create accurate and up-to-date fire risk assessments
- Early Warning and Hotspot Detection: hotspot detection supported by live drone feeds
- UAV Integration: Supports UAVs for data collection, real-time video streaming, fire detection and communication
- User Management Interface: Manages user accounts, navigation, and settings through a robust and user-friendly interface
- Role-based Access Control: Differentiates access and functionalities based on user roles (Public User, Regular User, Power User, System Administrator)
- Notification System: Sends alerts and notifications based on predefined criteria, ensuring effective early warning

- Historical Data Export: Allows users to export historical meteorological and fire risk data for analysis and research
- Map Layers and Controls: Provides a multi-layered map with various data layers (roads, populated areas) and controls for enhanced situational awareness
- Fire Simulation and Spread Prediction: Simulates fire spread based on ignition points to aid in planning and training and operational capacity during potential interventions
- Surveillance and Post-fire Analysis: Offers tools for post-fire analysis and ongoing surveillance to mitigate potential risks.

The platform is designed for end beneficiaries, primarily FRED project piloting partners who will use the software in real-world scenarios. UAVs will be deployed to:

- Collect initial fuel mapping data of pilot areas for fire risk assessment
- Gather daily operational data during pilot testing, including meteorological data and thermal camera readings.

By integrating these functionalities, the Wildfire Risk Prevention and Mitigation Platform aims to enhance the effectiveness and efficiency of wildfire management efforts, providing a robust tool for prevention, active mitigation and strategic communication.

1. Part 1: System Administration

1.1. Epic: User Interface and User Account Management

This epic includes all aspects of the user interface related to user accounts and navigation within the platform. It covers the functionalities for the header, landing page, login, registration, password reset and user settings.

1.1.1. User Story: Header

As a user, I want to see the FRED project logo, the Programme logo and EU FLAG emblem, as well as the wording *Co-funded by the European Union,* when clicked once on, leads to the landing page. If I am not already logged in, the login link and the "Create new account" button should be displayed in the top right corner in the header. If I am logged in, the following is displayed:

- Current user's name
- User settings icon - opens the user settings page
- Notification bell with a badge for the number of unread notifications - clicking it opens the notifications panel with a list of the latest notifications with a clear indication of read/unread status
- Export historical data icon
- Logout link.

Acceptance criteria:

- The FRED project, the Programme logo and EU FLAG emblem, as well as the wording Co-funded by the European Union must be visible in the header
- Clicking the logo redirects the user to the landing page
- If the user is not logged in, a login link should be displayed in the top right corner of the header
- If the user is logged in, the header should display the current user's name, user settings icon, notification bell with unread notifications badge and a logout link
- The user settings icon should be visible when the user is logged in
- Clicking the user settings icon should open the user settings page
- The notification bell should be visible when the user is logged in
- The notification bell should display a badge indicating the number of unread notifications
- Clicking the notification bell should open the notifications panel

- The notifications panel should list the latest notifications with a clear indication of read/unread status
- The logout link should be visible when the user is logged in
- Clicking the logout link should log the user out and redirect them to the login page
- The "Create new account" button should be visible when the user is not logged in.

1.1.2. User Story: Landing page

As a user, when I go to the URL of FRED web application, a web page should be displayed, containing: the header, footer, sidebar and the map that covers the rest of the screen. I can choose the pilot area (depending on my user role) and once my area is selected, the map is cantered to that area and zoomed so that the whole area is clearly visible. I can show/hide the sidebar by clicking on it.

Acceptance criteria:

- The FRED web application should load correctly when the user navigates to the URL
- The landing page should display the header, footer, sidebar and a full-screen map
- The header should be visible at the top of the page
- The footer should be visible at the bottom of the page
- The sidebar should be visible and collapsible
- The map should cover the entire screen area excluding the header, footer and sidebar
- The map should allow the user to select a protected area based on their user role. The specific functionalities available based on the user role should be clearly defined and implemented;
- Once an area is selected, the map should centre on that area and adjust the zoom level to make the entire area clearly visible
- The sidebar should have a visible control for showing/hiding
- Clicking the control should show or hide the sidebar without affecting the visibility of the map or other elements.

1.1.3. User Story: User Registration

As a user, I want to register for an account using my email and password so that I can access the application. I can access the User registration form via the "Create new account" link within the Login modal or in the top right corner of the application header.

Acceptance criteria:

- Users can register for an account using an email and password
- Registration requires email verification to activate the account
- Given a user is on the registration page, when the user enters a valid email and password and submits the registration form, the system should send a verification email to the provided email address
- Given a user has received a verification email, when the user clicks the verification link, the system should activate the user's account
- Given a user has registered for an account, when the user has not verified their email, the user should not be able to log in and should see a message prompting them to verify their email
- Given a user is on the login page and wants to register, when the user clicks on the "Register" link, a new registration form should be opened
- The registration form should allow the user to enter their email and password
- The registration form should have a submit button that, when clicked, sends a verification email to the user's email address
- Users should receive a verification email containing a link to verify their email address
- Given a user has verified their email, they should be able to log in using their email and password and have access to all features assigned to their user role.

1.1.4. User Story: User Login

As a user, I want to log in by entering my email and password so that I can access all the features of the application assigned to my user role. If I enter an incorrect username/password combination, I want an error message displayed. If an incorrect password is provided three times in a row for my username, I want to be notified that my account is locked and prompted to reset my password.

Acceptance criteria:

- Users can log in using their email and password after verifying their email
- Users have access to all features assigned to their user role upon successful login
- Given a user is on the login page, when the user enters a verified email and correct password, the user should be logged in and redirected to the application with access to features assigned to their role
- If an incorrect username/password combination is entered, an error message is displayed stating "Incorrect username or password"
- If an incorrect password is entered three times in a row for their username, the account is locked and the user is notified with a message stating "Your account is locked"
- Users are prompted to reset their password if their account is locked
- Given a user's account is locked, when the user tries to log in, the system should prompt the user to reset their password
- If a user attempts to log in after their account is locked, the following steps occur:
    - The system displays a message: "Your account is locked. Please reset your password to unlock your account"
    - The user is given an option to reset their password
    - The user cannot attempt to log in again with the locked account until they have reset their password;
- Given a user is on the login page, when the user enters a verified email and correct password, the user should be logged in and redirected to the application with access to features assigned to their role
- Given a user's account is locked, when the user tries to log in, the system should prompt the user to reset their password.

1.1.5. User story: Password Reset

As a user, I want to be able to reset my password if I forget it or if my account is locked. I should be able to request a password reset by clicking the "Reset password" button and entering my email. I should then receive an email containing the password reset link and upon clicking the link, I should be prompted to enter and confirm a new password. Once I submit the new password, it should update in the system, unlock my account and allow me to log in with the new password.

Acceptance criteria:

- Users are prompted to reset their password if their account is locked
- Users can request a password reset by clicking the “Reset password” button and entering their email
- Users receive an email containing the password reset link
- Given a user’s account is locked, when the user clicks the “Reset password” button and enters their email, the system should send an email containing the password reset link to the provided email address
- Given a user has requested a password reset, when the system sends the password reset email, the email should contain a link to reset the password
- Given a user has received a password reset email, when the user clicks the reset link, the system should prompt the user to enter a new password twice and confirm it
- Given a user has entered a new password twice and both entries match and confirm it, when the user submits the new password, the system should update the user’s password and unlock the account, allowing the user to log in with the new password.

1.1.6. User story:

As a user, I want the system to generate alerts and send notifications when specific events occur, so that I can stay informed and take appropriate action promptly.

Acceptance criteria:

- The system should automatically generate alerts based on predefined criteria and events. Predefined events:
    - Active Fire Registered
    - High Fire Weather Index
    - UAV (Unmanned Aerial Vehicle) in flight
- Alerts should include relevant information such as:
    - Type of event
    - Location
    - Time of occurrence

    - Severity
- Notifications should be sent via multiple channels:
    - In-app notifications
    - Email
- Users should be able to configure their notification preferences in the user settings page
- Preferences should include:
    - Types of events for which they want to receive notifications
    - Preferred channels for notifications (in-app, email, both)
    - Option to turn off notifications for specific events or channels.

1.1.7. User Story: User Settings Page

As a user, I want to access a user settings page where I can view my email, change my password, and manage my email notification settings.

Acceptance criteria:

- The user settings page should be accessible when the user is logged in.
- The page should display the user's email address, which should be read-only.
- Given the user is logged in, when they click on the user settings icon in the header, the user settings page should be displayed.
- The page should include a section for changing the password:
    - The user must enter their current password.
    - The user must enter a new password.
    - The user must confirm the new password by entering it once more.
    - The new password should match the confirmation password for the change to be accepted
- The page should include a separate section for email notification settings
- Allowing the user to turn notifications on or off for each type of supported email notification
- Supported email notifications:

- An active fire was registered in the application within your area.
- Fire Weather Index value for your area is high.
- Fire Weather Index value for your area is extreme.
- Drone from your area is currently in flight and a video stream is available.

- Given the user is on the user settings page, the page should display options to turn on or off email notifications for each supported notification type
- When the user toggles a notification setting and saves changes, the system should update their preferences accordingly
- The user's preferences should be saved and persist across sessions.

1.1.8. User Story: User logout

As a user, I want to be able to log out of the application by clicking on a corresponding logout button within the GUI.

Acceptance criteria:

- Logout functionality is clearly accessible from anywhere in the application.
- Session is completely terminated on logout.

1.1.9. User Story: Inactivity Log out

As a user, in case that I do not log out manually, I want the application to log me out after 1h of inactivity.

Acceptance criteria:

- Session automatically expires after 60 minutes of inactivity and the user is logged out of the application.

1.2. Epic: User Roles and Permissions

This epic covers the management of user roles and permissions, allowing different types of users to manage accounts and access control based on their roles.

1.2.1. User Story: System Administrator

As a System Administrator, I want to manage all user accounts and permissions so that I can ensure proper access control across the application.

Acceptance criteria:

- Has full read-only access to all data
- Can edit all user information except the username
- Can reset user passwords
- Can delete users.

1.2.2. User Story: Power User

As a Power User, I want to manage users within my assigned area so that I can maintain control over my pilot area's access. I am able to create new user accounts and assign appropriate access rights to ensure effective management of your region's access control.

Acceptance criteria:

- Has full read and write access to all data within their designated area
- Can create new users and assign access rights for their respective pilot area
- Can reset user passwords for users from their respective areas.

1.2.3. User Story: Regular User

As a Regular User, I have read-only access to all data within my designated area. I can manage my own profile information so that I can keep my account up to date.

Acceptance criteria:

- Has full read-only access to all data within their designated area
- The system must identify the user's role as "Regular user" upon login and restrict functionalities accordingly.

1.2.4. User Story: Public User

As a Public User, I have limited read-only access to public information within the application.

Acceptance criteria:

- Has limited read-only access to public information available in the application
- The system must restrict functionalities for users that aren't logged in accordingly.

1.3. Epic: User management

This epic covers the management of user accounts and permissions, allowing system administrators and power users to manage user information, create new accounts, reset passwords and ensure proper access control based on user roles.

1.3.1. User Story: System Administrator

As a System Administrator, I want to view all users in the management table, create new users with specified information, edit user details (except usernames), reset passwords and delete users to maintain secure and updated access control across the application.

Acceptance criteria:

- Can see all users in the user management table
- Can create new users by clicking the “Create new user” button, opening a blank “Create user” form to enter the following information:
    - Email address
    - First name
    - Last name
    - Organization
    - Assigned protected area (selectable from a list or map)
    - User role (selectable from a drop-down menu)
- Can edit user information except the username
- Can reset user passwords for users.

1.3.2. User Story: Power User

As a Power user, I have control over user accounts within my designated pilot area. I am able to view users assigned to my area in the management table, create new users with specific information while having the assigned protected area pre-filled, edit user details (except usernames, user roles, or assigned areas) and reset passwords for users within your area to maintain proper access control.

Acceptance criteria:

- Can see users that are assigned to their area in the user management table

- Can create new users by clicking the “Create new user” button, opening a blank “Create user” form to enter the following information:
    - Email address
    - First name
    - Last name
    - Organization
    - User role (selectable from a drop-down menu)
- Note: The field “Assigned protected area” is pre-filled and cannot be changed
- Can edit user information except the username, user’s role or the assigned area
- Can reset user passwords for users in their assigned area.

1.3.3. User Story: Regular User

As a Regular user, I have the ability to login and manage my own profile information. I can view and edit my profile details (except for username and user role) and see my assigned protected area.

Acceptance criteria:

- Can register for an account through a public registration form
- Can log in and view their own profile information
- Can edit their own profile information except for their username and user role
- Can only view the non-public data for the assigned protected area
- Cannot see or interact with the user management table
- Cannot create, edit or delete other users.

1.3.4. User Story: Public User

As a Public user, that isn’t logged into the application, I’m able to only view the data available for the public.

Acceptance criteria:

- Can only view the publicly available data for all protected areas
- Cannot see or interact with the user management table
- Cannot create, edit or delete other users.

1.4. Epic: User Management Actions and Forms

This epic covers the various actions and forms required for user management, including creating new users, editing user information and resetting passwords. Different roles have specific permissions and capabilities.

1.4.1. User Story: Create User Form - System Administrator

As a System Administrator, I want to create new user accounts.

Acceptance criteria:

- Given a system administrator is logged in, a “Create new user” button should be visible in the user management modal
- When the system administrator clicks the “Create new user” button, then a blank “Create user” form should open
- The form, when displayed, should include fields for: email address, first name, last name, organization, assigned protected area and user role
- When the system administrator submits the form, then the new user should be created with the entered information and appear in the user table.

1.4.2. User Story: Create User Form - Power User

As a Power User, I want to create new user accounts within my assigned area so that I can manage access to the application.

Acceptance criteria:

- Given a power user is logged in, a “Create new user” button should be visible in the user management modal dialogue
- When the power user clicks the “Create new user” button, a blank “Create user” form should open
- The form, when displayed, should include fields for: email address, first name, last name, organization and user role. The assigned protected area should be pre-filled and non-editable;
- When the power user submits the form, the new user should be created with the entered information and appear in the user table.

1.4.3. User Story: Edit User Form - System Administrator

As a System Administrator, I want to edit user information so that I can update user details and manage access effectively.

Acceptance criteria:

- Given a system administrator is logged in, an “Edit user” button should be visible in the user management modal for each user in the table
- When the system administrator clicks the “Edit user” button for a specific user, then an “Edit user” form pre-filled with the user’s existing information should open
- Given the edit user form is open, when the form is displayed, then the system administrator should be able to change all information except the username
- Given the edit user form is filled out, when the system administrator submits the form, then the user’s information should be updated in the system and reflected in the user table.

1.4.4. User Story: Edit User Form - Power User

As a Power User, I want to edit user information within my assigned area so that I can keep user details up to date.

Acceptance criteria:

- Given a power user is logged in, an “Edit user” button should be visible in the user management modal dialogue for each user in the table
- Given a power user is viewing the user management modal dialogue, when the user clicks the “Edit user” button for a specific user, then an “Edit user” form pre-filled with the user’s existing information should open
- Given the edit user form is open, when the form is displayed, then the power user should be able to change all information except the username, user’s role or the assigned area
- Given the edit user form is filled out, when the power user submits the form, then the user’s information should be updated in the system and reflected in the user table.

1.4.5. User Story: Password Reset - System Administrator

As a System Administrator, I want to reset passwords for any user so that I can assist users who have forgotten their passwords.

Acceptance criteria:

- A "Reset Password" button is available next to each user in the user management table

- Given a system administrator is logged in, when the user views the user management modal dialogue, a “Reset Password” button should be visible next to each user
- Given a system administrator clicks the “Reset Password” button for a specific user, then the system should send a password reset email to that user.

1.4.6. User Story: Password Reset - Power User

As a Power User, I want to reset passwords for users in my assigned area so that I can assist users within my region who have forgotten their passwords.

Acceptance criteria:

- A "Reset Password" button is available next to each user in the user management table within the assigned area
- Given a power user is logged in, when the user views the user management modal dialogue, a “Reset Password” button should be visible next to each user in their assigned area
- Given a power user clicks the “Reset Password” button for a specific user in their assigned area, the system should send a password reset email to that user.

1.5. Epic: Sidebar

As a user, I want a sidebar that allows me to show or hide it, displaying major alerts, indicating the availability of live streams and providing current meteorological data for the selected area. This will enable me to have a more organized, informative and user-friendly interface that meets my needs efficiently.

1.5.1. User Story: Option to Show/Hide Sidebar

As a user, I want to have the option to show or hide the sidebar, so that I can have more control over my workspace and focus on the main content when necessary.

Acceptance criteria:

- The user opens the application and the sidebar is visible by default
- The application should have a clearly visible button or icon (e.g., an arrow) to toggle the sidebar visibility
- This button should be accessible from any page where the sidebar is present
- When the sidebar is hidden, clicking the toggle button should make the sidebar visible
- The main content area should adjust accordingly, ensuring that it does not overlap with the sidebar
- When the sidebar is visible, clicking the toggle button should hide the sidebar
- The main content area should expand to fill the space previously occupied by the sidebar, providing more room for the main content.
- The application should remember the user's last choice regarding the sidebar's visibility
- Upon returning to the application or navigating between pages, the sidebar should maintain its previous state (shown or hidden).

1.5.2. User Story: Sidebar: Display alerts

As a user, I want alerts (e.g. an active fire) to be displayed prominently at the top of the sidebar, so that I can quickly be informed about critical issues and take appropriate action.

Acceptance criteria:

- Major alerts should be displayed at the top of the sidebar, ensuring they are immediately visible upon opening the application
- Alerts should include a clear and concise message, the type of alert (e.g., fire, emergency) and a timestamp
- The system should update the sidebar in real-time to reflect new alerts as they are registered
- Alerts should automatically refresh without requiring the user to manually reload the page
- Users should have the option to acknowledge and dismiss alerts once they have been noted.

1.5.3. User Story: Sidebar: Live stream available

As a user, for my designated area (depending on my role), I want an indication in the sidebar when a live stream is available, so that I can easily access and watch the live stream directly from the application. I want to be able to click and view the stream.

Acceptance criteria:

- The sidebar should display a clear and prominent indicator when a live stream is currently available
- The indicator should include a live stream icon (e.g. a red dot or a camera icon) and the text "Live Stream Available"
- The indicator should include a clickable link or button that opens the live stream
- The sidebar should automatically update to display the live stream indicator as soon as a live stream becomes available.

1.5.4. User Story: Sidebar: Display Current Meteorological Data in Sidebar

As a user, I want to see the current meteorological data for the selected area displayed in the sidebar, so that I can stay informed about the weather conditions without leaving the application. The following information is displayed: last updated date and time, air temperature, relative humidity, wind speed, wind direction and total precipitation for the past 6h.

Acceptance criteria:

- The sidebar should include a section that displays current meteorological data for the selected area
- This data should include temperature:

- Last updated date and time
- Air temperature (taken from temperature_2m_above_ground)
- Relative humidity (taken from relative_humidity_2m_above_ground)
- Wind speed (calculated from u_component_of_wind_10m_above_ground and _component_of_wind_10m_above_ground using the following formula: W=sqrt(u^2+v^2)
- Wind direction (calculated from u and v components using the following formula for the angle: θ=arctan2(−u,−v))
- Total precipitation for the past 6h (taken from total_precipitation_surface)

- The meteorological data should be obtained from Google or a reliable weather API
- The data should be updated in real-time or at regular intervals (e.g. every 15 minutes) to ensure accuracy.

2. Part 2: Map with multiple layers

2.1. Epic: Map controls and layer panel

This epic includes a map that supports multiple layers, including but not limited to geographic data, points of interest, traffic data etc. This feature will allow users to view and manage different data sets (layers) on the map, enhancing their experience and providing them with the necessary tools to effectively use the FRED platform. The map will include navigation controls for panning/zooming and complete control over the choice of layers that are visible.

2.1.1. User Story: Map controls for moving the map, zoom in/out

As a user, I want to have map controls for moving the map and zooming in and out.

Acceptance criteria:

- Controls for panning (moving) the map should be available and visible on the map interface
- Controls for zooming in and out should be available and visible on the map interface.

2.1.2. User Story: Layers icon

As a user, I want a Layers icon available on the map interface, so that I can open the Layers panel to manage the visibility of different map layers.

Acceptance criteria:

- A Layers icon should be present on the map
- When the Layers icon is clicked, a panel should open displaying a list of all available layers
- Each layer should have a toggle (on/off) switch next to its name in the panel OR colour indication (light for when layer is Off and bold for when a layer is ON
- When a layer is toggled on or off, it should be instantly shown or hidden on the map
- It is possible to have multiple layers shown on a map at the same time.

2.1.3. User Story: Roads infrastructure layer

As a user, I want a road infrastructure layer available for supported areas, so that I can have an accurate overview of available routes to assist in planning firefighting actions, evacuations, and other critical operations.

Acceptance criteria:

- The road infrastructure layer should be available and easily accessible within the Layer panel
- This layer should be placed on top of the base map to provide a clear and accurate representation of the road network
- The road infrastructure layer should include all major roads, highways, and relevant transportation routes
- All data collected from the stakeholders was compiled into shape files and GeoJSON format so it can be displayed on the map component.

2.1.4. User Story: Populated area and buildings indication

As a user, I want a populated area and buildings indication layer available for supported regions, so that I can have an accurate overview of populated areas to assist in planning firefighting actions, evacuations, and other critical operations.

Acceptance criteria:

- The populated area and buildings indication layer should be available and easily accessible within the Layer panel
- This layer should be placed on top of the base map to provide a clear and accurate representation of populated areas and buildings
- The populated area and buildings layer should include all relevant residential, commercial, and industrial buildings
- All data collected from the stakeholders was compiled into shape files and GeoJSON format so it can be displayed on the map component.

2.1.5. User Story: Manual markers

As a user power user/admin, I want to add a variety of manual markers within my designated area, so that I can provide specific information (e.g., assembly points, headquarters, fire sectors, charging points for water) that is visible to other users when they click on the marker.

Acceptance criteria

Marker addition:

- Power users should have the ability to add manual markers to the map within their designated areas

- A marker icon will be available somewhere within the map component. Clicking the icon changes the cursor to indicate that the user is selecting a place for a new marker;
- Only power users/admins can modify the markers;
- Add marker icon will be available and visible to power users/admins within the map component - clicking the icon changes the cursor so the user is aware he is picking a place for this new marker
- After picking a location for the new marker, a modal dialogue is displayed above the map with the following input fields and options:
    - Marker Type: The user must pick the type of marker by selecting an appropriate icon from a list of supported icons
    - Marker Name: Text input field for the name of the marker. This text can be displayed alongside the icon on the map if configured;
    - Description: Multiline text input where the user can provide more information about the marker
    - Geographical Coordinates: Latitude and longitude are pre-filled from the point that was clicked, however
        - the user can modify these values and manually type in the marker's location
        - a "Select Location" action is available, allowing the user to click on a new location on the map, automatically filling in the geographical coordinates
    - Save Button: Allows the user to store this marker's data in the database and displaying it on the map
    - Cancel Button: Allows the user to discard all entered data and close the modal dialogue.

Marker display:

- Existing markers are displayed on the map at the provided geographical location, shown as the selected icon with the title displayed alongside it if configured
- Clicking on the marker opens a bubble containing all relevant data associated with the marker (title, marker type, description, geographical location)

- Power users and administrators have an edit action available within this bubble, allowing them to modify an existing marker
- Power users and administrators have a delete action available within this bubble, allowing them to delete an existing marker from the map. This action requires user confirmation;
- Power users, admins and regular users can see the markers
- Public users do not see the markers
- The markers should be updated in real-time and visible to all users immediately after being added.

2.1.6. User Story: Manual arrows

As a power user/admin, I want to add a variety of vector-type symbols (arrows) within my designated area, so that I can provide specific information (e.g., wind direction and strength, main direction of fire propagation, secondary fire flank) that is visible to other users when they click on the arrow.

As a regular user, I am able to see the arrows created by power user/admin.

Acceptance Criteria:

- Power user/admin can add, modify, or delete arrows on the map
- Power users/admins and regular users can see the arrows on the map
- Public users do not see the arrows on the map
- An "Add Arrow" icon will be available and visible to power users/admins within the map component
- Clicking the icon changes the cursor to indicate that the user is selecting a place for a new arrow
- To add an arrow, the user picks a starting point location and an endpoint location for the new arrow symbol on the map
- A modal dialogue is displayed above the map with the following input fields and options:
    - Arrow Type: The user must pick the type of symbol by selecting an appropriate icon from a list of supported icons (as specified in the SITAC symbology document)
    - Arrow Name: Text input field for the name of the symbol. This text can be displayed alongside the icon on the map if configured;

- Description: Multiline text input where the user can provide more information about what the arrow represents
- Geographical Coordinates: Latitude and longitude of both the starting and end points of the vector are pre-filled from the points that were clicked.
  - The user can modify these values and provide the arrow's position, orientation, and size by manually typing in the values
  - Select Location Action: Available here, allowing the user to click new locations on the map, automatically filling in the geographical coordinates
- Save Button: Allows the user to store this arrow symbol's data in the database, displaying it on the map
- Cancel Button: Allows the user to discard all entered data and close the modal dialogue

- Existing arrows are displayed on the map at the geographical location provided during creation, shown as the symbol selected by the user with the title displayed alongside it if configured
- Clicking on the arrow opens a bubble containing all relevant data associated with it (title, symbol type, description, geographical location)
- Power users and administrators have an edit action available within this bubble, allowing them to modify an existing arrow
- Power users have a delete action available within this bubble, allowing them to delete an existing arrow from the map. This action requires user confirmation;
- The arrows should be updated in real-time and visible to all users immediately after being added.

2.1.7. User Story: Manual areas

As a power user/admin, I want to manually draw polygons in a separate layer on the map, select the background colour and opacity, and enter a title and some free text that will be displayed when the area is clicked, so that I can designate zones that need specific attention (e.g., zones that need clearing up).

Acceptance Criteria:

- Only power users/admins can add, modify, or delete areas on the map.
- Power users/admins and regular users can see the areas on the map.
- Public users do not see the areas on the map.
- An "Add Area" icon is available and visible to power users/admins within the map component.
- Clicking the icon changes the cursor to indicate that the user is specifying a polygon for the area they want to mark on the map.
- The user specifies the polygon by clicking points on the map to define the new area.
- A modal dialogue is displayed above the map with the following input fields and options:
    - Area Type: The user must pick the type of area by selecting an appropriate option from a list of supported area types (as specified in the SITAC symbology document)
    - Area Name: Text input field for the name of the area. This text can be displayed inside the area on the map if configured
    - Description: Multiline text input where the user can provide more information about what the area represents
    - Geographical Coordinates: Latitude and longitude of all points defining the polygon are pre-filled from the points that were clicked.
        - The user can modify these values and provide the area's position by manually typing in the values
        - Select Location Action: Available here, allowing the user to click on new locations on the map, automatically filling in the geographical coordinates
- Background Colour and Opacity: The user can select a custom background colour and opacity setting to provide more freedom in defining the area
- Save Button: Allows the user to store this area's data in the database, displaying it on the map
- Cancel Button: Allows the user to discard all entered data and close the modal dialogue

- Existing areas are displayed on the map at the geographical location provided during creation, shown as the polygon and background colour selected by the user, with the title displayed inside it if configure
- Clicking on the area opens a bubble containing all relevant data associated with it (title, area type, description, geographical location).
- Power users and administrators have an edit action available within this bubble, allowing them to modify an existing area
- Power users have a delete action available within this bubble, allowing them to delete an existing area from the map. This action requires user confirmation;
- The areas should be updated in real-time and visible to all users immediately after being added.

2.1.8. User Story: Fireline Management

As a user (Administrator, power user or regular user) I want a fireline management layer on the map, so that I can utilize SITAC symbols for enhanced firefighting planning and operations.

Acceptance criteria:

- The fireline management layer should be available and easily accessible within the Layer panel.
- The fireline management layer is only visible to Administrators, Regular and power users, not to public users.
- Users can turn the fireline management layer on or off from the Layer panel.
- The layer should contain SITAC symbols, as specified in the SITAC symbology document.

2.1.9. User Story: Custom Symbol Layer

As a user, I want a custom symbol layer on the map, so that I can use various symbols that don't belong in any other predefined layers for specific purposes.

Acceptance criteria:

- The custom symbol layer should be available and easily accessible within the Layer panel
- Users can turn the custom symbol layer on or off from the Layer panel

- The layer should contain various custom symbols not categorized under other layers
- Only registered users should be able to view the custom symbol layer.

2.1.10. User Story: Fire Weather Risk Layer

As a user, I want a fire weather risk layer on the map, so that I can assess fire risk based on the Fire Weather Index (FWI) and current weather data for improved firefighting planning and operations.

Acceptance criteria:

- The fire weather risk layer should be available and easily accessible within the Layer panel.
- The layer is generated using the FWI script, which calculates the risk based on the Fire Danger Index and current weather data.
- The FWI values are calculated once per day and the layer is generated from these values for all relevant geographical coordinates.
- Clicking on the map inside the layer on a non-null value provides the user with the value of the Fire Weather Index and the corresponding Fire Danger Index value.
- The FWI value, a number between 0 and 1, will be displayed as a heatmap, providing a visual indicator of the fire risk severity in the area.
- All users should be able to view the fire weather risk layer.

2.1.11. User Story: Personnel and equipment location

As a user, I want to see a geographical layer displaying the current positions of active personnel and equipment (e.g., fire trucks, etc.) on the map. This will help in coordinating firefighting efforts and resource management effectively.

Acceptance criteria:

- A geographical layer should be available and easily accessible within the Layer panel
- The layer should display real-time locations of active personnel and equipment, including firetrucks and other firefighting resources
- Each type of personnel and equipment should be represented by distinct icons on the map

- The layer should update in real-time, reflecting the current positions of personnel and equipment
- The system should automatically refresh the data at regular intervals to ensure accuracy
- Hovering over or clicking on an icon should open an information bubble displaying details such as:
- Name or identifier of the personnel or equipment
- Current status (e.g., active, in transit, available)
- Last update time
- Only registered users should be able to view the personnel and equipment location layer
- Access to detailed information should be restricted based on user roles (e.g., system administrators and power users can see the detailed information whereas regular and public users can not)
- Users can turn the personnel and equipment location layer on or off from the Layer panel
- The layer should be visible by default for users with appropriate access rights
- The implementation of this feature depends on acquiring the connection details to an API that can provide us the required data.

3. Part 3: Fire and smoke detection, early warning, surveillance

3.1. Epic: Fire and smoke detection, early warning, surveillance

Description: As a user, I want a comprehensive system for early warning, surveillance, and detection of fire and smoke. This system should integrate UAVs to provide real-time video feeds, fire detection capabilities, and communication tools to enhance situational awareness and operational efficiency.

3.1.1. User Story: UAV Icon on Map

As a user, I want a UAV icon marked on the map so that I can know when the UAV is in the air, streaming the video feed and access detailed information about its status.

Acceptance criteria:

- A UAV icon should be visible on the map whenever a UAV is in the air and streaming video
- The icon should accurately reflect the UAV's current location and movement
- Hovering over or Clicking the UAV icon should open an information bubble displaying:
    - Current position
    - Current altitude
    - Current speed over ground
    - Drone model and identification
    - Hot spot temperature (if thermal camera is used)
    - Video stream URL
    - Copy video URL icon – clicking the icon copies the video stream URL to the clipboard.

3.1.2. User Story: Video stream and link sharing

As a user, I want to open the video stream from a UAV in a new tab, so that I can monitor the UAV's live feed separately. I also want to be able to copy the video stream link so that I can share it with others, such as firefighters who might not be directly using the app.

Acceptance criteria:

- Clicking the video stream URL should open the video stream in a new tab.
- The system should provide a copy link functionality for the video stream URL, when the user clicks the copy icon next to the video stream URL.
- Users should be able to share the copied link with others by pasting the link from clipboard.

3.1.3. User Story: Fire Spread Simulation

As a user, I want to simulate the spread of a fire based on an ignition point, allowing me to visualize the predicted spread of the fire over time on the map. This simulation will help in both real-time emergency responses and training scenarios.

Acceptance criteria:

- The user clicks the Start fire action and is prompted to select the ignition point on the map
- A clear indication is provided on the map where the ignition point has been selected
- The user can choose if the fire is real or a simulation for training/testing purposes
- If it is an actual fire, once the data is saved, a notification is displayed to users in the designated area via the sidebar, informing them of an active fire
- The notification includes details such as the location of the ignition point and the time of ignition
- The user can specify the period and temporal resolution for the fire spread simulation
- The user can initiate the calculation by pressing the appropriate action button
- Necessary data (ignition point, simulation type, period, temporal resolution) is sent in the internal API request payload to the backend
- The backend performs the calculation using the fuel map (vegetation), terrain data, and meteorological data available for the area
- The response from the backend contains the data necessary to draw the fire spread polygons over time

- The predicted spread of the fire is displayed on the map in multiple polygons, indicating how much the fire would spread in specified time intervals (e.g., one hour, two hours, three hours)
- The polygons are visually distinct and clearly show the progression of the fire over the selected period
- Users can view the simulation progress and adjust parameters as needed
- Users subscribed to the designated area receive notifications about the active fire and the ongoing simulation
- Notifications include the initiation time, current status and updates as the fire spreads.

3.1.4. User Story: Map Shortcuts to Supported Protected Areas

As a user, I want to have shortcuts on top of the map to quickly navigate to any of the supported protected areas, with the first shortcut being my designated area if I am a regular or power user. This will enable efficient access to areas of interest and streamline navigation.

Acceptance criteria:

- A shortcut bar should be present on top of the map interface, displaying quick navigation links to supported protected areas
- The shortcut bar should be visible at all times when the map is displayed
- For regular and power users, the first shortcut on the bar should be their designated area
- All supported protected areas should be listed as shortcuts on the bar
- Each shortcut should be labelled with the name of the protected area
- Clicking on a shortcut should immediately centre and zoom the map to the selected protected area
- All users can see the shortcut bar, but the specific areas listed may vary based on their user role
- Regular users see only the shortcuts to their designated area and public protected areas
- Power users and system administrators see shortcuts to all supported protected areas

- System administrators should have the ability to manage and update the list of supported protected areas.

3.1.5. User Story: Export Historical Data

As a user, I want the option to export historical data for a specified period, so that I can analyse past conditions and events.

Acceptance criteria:

- An icon to open the "Export Historical Data" modal dialogue should be available in the main menu in the header.
- Clicking the icon opens a modal dialogue for exporting historical data.
- The modal contains a select input field for the protected area, as well as the date input fields for the start and end dates of the period for which historical data should be prepared.
- The input fields should allow users to select dates from a calendar or manually enter them in a valid date format.
- The modal includes an export button to initiate the data preparation process.
- Once the user clicks the export button, the data is prepared on the backend.
- The system should provide feedback indicating that the data preparation is in progress.
- The backend processes the data for the specified date range, compiling meteorological data and Fire Weather Index values for each day within the period.
- When the data preparation is complete, the file download starts automatically.
- The downloaded file should be in CSV or Excel, to ensure compatibility with various analysis tools.
- The downloaded file contains the following data for each day in the specified date range for the selected protected area:
    - Meteorological data, including parameters such as temperature, humidity, wind speed, wind direction, and precipitation.
    - Fire Weather Index (FWI) value for each day, providing an assessment of fire risk.

4. Part 4. Technical Concept for Backend Development

The backend development of the Wildfire Risk Prevention and Mitigation Platform focuses on integrating and managing various data sources, performing critical calculations and providing necessary data to the frontend and external applications. The backend system will ensure seamless data flow, robust calculations, and efficient data storage and retrieval to support the functionalities outlined in the user stories.

4.1. Meteorological Data Retrieval from the Global Forecast System (GFS) using Google Earth Engine (GEE)

The backend will periodically retrieve meteorological data from GFS using the GEE API. The following parameters will be obtained and stored in the database, along with timestamps and geographical locations:

- Temperature at 2 meters above ground (temperature_2m_above_ground)
- Relative humidity at 2 meters above ground (relative_humidity_2m_above_ground)
- U component of wind at 10 meters above ground (u_component_of_wind_10m_above_ground)
- V component of wind at 10 meters above ground (v_component_of_wind_10m_above_ground)
- Total precipitation on the surface (total_precipitation_surface)

The backend will periodically use the GEE API to fetch GFS data. The data will be parsed and stored in a relational database, ensuring it is accessible for frontend applications and backend calculations.

Caveats: The GFS data have a spatial resolution (cell size) of 27,830 meters (about 28 km) according to their specifications[1], so the spatial extent covered by each pixel is approximately 775 km^2 wide, making them suitable for analysis at a regional scale at most. Consider, for example, that the Enna study area is only 10.64 km^2 wide, so it should only be covered by one pixel.

Therefore, for a more detailed evaluation of the fire danger forecast at the local scale, more accurate spatial weather forecast data sources will also be used (e.g., COSMO-2I and COSMO-5M). To this aim, see “D.1.1.1 Preliminary data collection and processing study”.

[1] https://developers.google.com/earth-engine/datasets/catalog/NOAA_GFS0P25#bands

4.2. DJI Cloud API Connection

The backend will integrate with the DJI Cloud API to support connections from multiple drones, accepting telemetry data and video streams. The following drone telemetry data will be stored in the database and displayed on the map:

- Drone ID
- Drone location (latitude and longitude)
- Drone altitude
- Drone speed over ground
- Maximum surface temperature (if the thermal camera is used)
- Video stream URI.

Drones and their controllers will be configured to connect to the DJI Cloud platform, ensuring all drone data is available in the app. The backend will handle data ingestion, storage and real-time updates to the frontend.

4.3. Fire Weather Index (FWI) and Dynamic Fire Danger Calculation

For the FRED purposes, a Dynamic Fire Danger map is defined as the product of the Fire Danger Index (static) and the daily Fire Weather Index (variable).

To this aim, the Fire Danger Index (FDI) and the Fire Weather Index (FWI) will be calculated and made congruent with each other (same resolution and spatial extent) in order to calculate the Dynamic Fire Danger. The process involves:

1. **Static Data Preparation**: Fire Danger Index data is pre-calculated and stored.
2. **Meteorological Data Retrieval**: Meteorological data can be retrieved from the database which is updated daily using the GEE API, as described in chapter 4.1.
3. **FWI Calculation**: A Python script runs daily to calculate new FWI values using mathematical models described in Annex 1. The script processes the daily meteorological forecast data stored in the database.
4. **Data Storage**: The calculated FWI values are prepared as georeferenced TIFF files, which are stored on the disk to be displayed as layers in the application.

4.4. Fire Propagation Calculation

Fire propagation simulation models constitute very important tools in the development of a fire management strategy because they allow managers to know the potential behaviour of a fire before it occurs or during the fire event. In the WFRPM platform the FARSITE fire behaviour simulation model will be integrated after permission that has been ensured by the United States Department of Agriculture (USDA). FARSITE is a two-dimensional model which simulates fire behaviour in both space and time under varying site and weather conditions, and is based on Rothermel's fire spread model. It further incorporates various other models from the international literature that deal with other aspects of fire behaviour such spotting, fire spread of ground and crown fires e.t.c. The great advantage of this model is that it allows the simulation of fire behaviour under real time conditions. The results of fire behaviour simulation with FARSITE are spatial and non-spatial data regarding fire intensity, spread, flame height and others.

The input data required are also spatial and non-spatial and include:

1. Fuel models of the study sites before fire. Although custom fuel models might be required for some of the study sites an effort will be made to classify the various vegetation types of each study area into the standard fuel models that can be integrated in the simulation model without additional description

2. Data on the vegetation structure before the fire including canopy cover, crown bulk density, crown base height and stand height.

3. Spatial data for the topographic conditions of the two study sites including digital elevation model, digital slope model, digital aspect model.

4. Prevailing weather conditions during the fire

5. The exact ignition point as well as the ignition time.

FARSITE is widely considered superior to simpler fire behavior simulation tools like Propagator or FireFront due to its comprehensive modeling capabilities and integration of diverse environmental and fire behavior parameters. While Propagator and FireFront focus primarily on simulating fire spread based on simplified assumptions, FARSITE incorporates spatially explicit inputs, such as topography, fuel models, canopy characteristics, and weather conditions, allowing for more nuanced and accurate predictions.

FARSITE uses a semi-empirical approach that combines physical principles with empirical data, offering detailed outputs like fire growth patterns, intensity, and perimeter evolution over time. Furthermore, its ability to model surface and crown fire interactions, ember transport, and spot fires makes it a more versatile tool for complex landscapes. These features make FARSITE particularly valuable for strategic planning, operational decision-making, and post-fire assessments in heterogeneous and fire-prone environments.

For research purposes the results obtained with Farsite will be compared with those of simpler models such as Firefront (https://github.com/forefireAPI/firefront), and Propagator models (https://github.com/CIMAFoundation/propagator_sim). The last two models can be an interesting alternative in cases where simplicity, scalability, and computational efficiency are essential. They require a much simpler description of the vegetation types and they allow for easy adaptation of the EU wide landcover types into fuel types. However, the spatial accuracy and the validity of the results obtained by Farsite are superior to the other two models. The fire behavior simulation that will be provided in the platform is expected to be of significant importance to fire managements since it will allow an increased level of preparedness as well as the development of effective fire suppression tactics during the event.

4.5. Fire Severity Estimation

The importance of estimating fire severity is enormous as it largely determines the post-fire environment and the dynamics of natural restoration of an ecosystem. A high-severity crown fire can kill all the seeds found in closed mature cones, as occurs in the thermophilic and serotinus Mediterranean pines Aleppo and Turkey. On the contrary, although a moderate-severity fire can kill an individual the seeds within the cone may survive. This is because of the low amount of thermal energy that is released during the fire which prevents the development of high temperatures within the cone and as a result it results in their survival and availability for replanting the burned area. Fire severity is equally important for shrub species, since a high-severity fire can cause the necrosis of dormant buds located in the root system (e.g. oaks) or in the lignotuber (e.g. Strawberry tree), resulting in limited post-fire overgrowth. Researchers have suggested that fire intensity is the most important factor determining plant survival after fire, as high-severity fires can destroy the meristematic tissues from which new shoots would normally arise. Higher mortality of plants with the ability to resprout in cases of high-severity fires was also reported by researchers, who also found that in such cases the plants show a time delay in resprouting. Plants that resprout after a high-severity fire have fewer overgrows, which may not be enough to provide the necessary photosynthetic surface to produce sufficient carbohydrates to satisfy the requirements of the underground part of the plant after the initial exploitation of stored carbohydrates, resulting in increased post-fire mortality.

Therefore, the assessment of the severity of the fire that has affected an area is the first and very important step in determining the measures and interventions that will ultimately be selected for the effective protection and recovery of the ecosystems of the area. The WFRPM platform will integrate a tool for estimating fire severity based on preselected thresholds of the difference between the pre- and post-fire Normalised Burn Ratio (dNBR). The NBR before the fire and after the fire will be calculated using Sentinel 2 images and the following formula:

$$NBR = \frac{\text{NIR} - \text{SWIR}}{\text{NIR} + \text{SWIR}}$$

Where: NIR= Reactance in the Near Infrared (Band 8A)

SWIR= Reactance in the Shortwave Infrared (Band 12)

4.6. Email Server Configuration

An SMTP server will be configured to send emails to registered users. The backend will support:

- Password reset links
- Email notifications for various events (e.g., fire alerts, UAV updates)

The email server configuration will ensure secure and reliable email delivery, with templates for different types of notifications.

4.6.1. Token Generation for Password Reset Links and User Registration Confirmation

When a user requests a password reset or creates a new user account, the backend will generate a secure token to be included in the reset/user confirmation link. This token is generated as follows:

1. **Token Generation**: A cryptographically secure random URL-safe string token is generated.
2. **Token Storage**: The generated token is stored in the database along with the user's ID and an expiration timestamp. This ensures that the token is valid only for a limited time (e.g., 1 hour).

4.6.2. Password Reset Link/User Registration Confirmation Generation

The generated token is included in the password reset/user account confirmation link. The link is formatted to include the token as a query parameter, allowing the system to identify the user and validate the token when the link is accessed.

4.6.3. Sending the Email

The backend uses the configured SMTP server to send the email. The email content, including the password reset/user confirmation link, is prepared using a predefined template. The email is then sent to the user's registered email address.

4.7. Database Design

The backend database will be designed to store various types of data, including:

- User accounts and roles
- Manual markers
- Manual areas
- Manual arrows
- Meteorological data with timestamps and geographical locations
- UAV telemetry data
- User notification preferences and email logs.

4.8. Security and Authentication

The backend will implement robust security measures, including:

- Secure API endpoints with authentication and authorization
- Data encryption at rest and in transit
- Regular security audits and updates.

4.9. Conclusion

The backend development of the FRED Platform will ensure efficient data management, robust calculations and seamless integration with external systems. By leveraging the outlined technical concepts, the platform will support critical functionalities for wildfire risk prevention, mitigation and communication, enhancing the overall effectiveness of wildfire management efforts.

Annex 1 – Fire Weather Index

Main concept

To calculate FWI, some other indices must be calculated first. The calculation takes in a lot of conditions. For example:

$$S = \begin{cases} e^{2.72 \cdot (0.434 \cdot \ln B)^{0.647}}, & \text{for } B > 1 \\ B, & \text{for } B \leqslant 1 \end{cases}$$

These conditions are increasing complexity, but the main factor that complicates the FWI calculation, is that the indices it needs rely on their previous values.

For example, the Drought Code index (DC) is calculated using its previous value, and its previous value is calculated using an even earlier value and so on. The earliest value possible is at the starting date of the year, where DC takes the value 15. The DC calculation starts, in regions normally covered by snow in winter, on the third day after snow has essentially left the area. In regions where snow cover is not a significant feature, the calculation starts on the third successive day with noon temperature greater than 12 °C (Lawson and Armitage 2008). The starting value of the index has to be set to 15. This is the case for some of the other indices as well.

Simplified/Pseudo code

Disclaimer: This is pseudo code meant to give the main idea of the code structure while keeping it as simple as possible. This will not run with a Python interpreter. There are some helper functions that were not included here (for example: `roi = ee.Geometry.Polygon(coords)`)

```
def find_first_day_above_12C(roi, date_today):
# Gets all Modis images this year and finds what is the
# first date that the temperature was > 12C for 3 days in a row
# If there no date where the above condition is true, it returns None

    date = ee.ImageCollection("MODIS/061/MOD11A1")
    …

    return date
```

```
def get_temperature(roi, starting_date):
    temp = ee.ImageColletion(("NOAA/GFS0P25")
           …
    return temp
```

```
def get_rainfall(roi, starting_date):
    rainfall = ee.ImageColletion("JAXA/GPM_L3/GSMaP/v6/operational")
           …
    return rainfall
```

```
def get_humidity(roi, starting_date):
    rhum = ee.ImageCollection(f'NOAA/GFS0P25')
    …
    return rhum
```

```
def get_wind(roi, starting_date):
    gfs = ee.ImageCollection('NOAA/GFS0P25')
    …
    return wind
```

```
def get_lcmask(roi, starting_date):
    lc_mask = ee.ImageCollection("GOOGLE/DYNAMICWORLD/V1")
    …
    return lc_mask
```

```
def calc_DC(starting_date, date_today):
    # We need the factors that define the length of the day for each
month. This information was provided in the link.
    day_length = [-1.6, -1.6, -1.6, 0.9, 3.8, 5.8, 6.4, 5.0, 2.4, 0.4, -
1.6, -1.6]
    dc_name = f’dc_{date_today}’
    asset_id = f’projects/…/assets/{dc_name}’
    # Now we will use recursion to go back in time until we reach the
#starting date. Note that recursion is a costly process. In the AWS EC2
# instance I was using, it was able to only calculate a month at a time.
# The good thing is that when you calculate one date, you don’t have to
# do it again.
    if date_today <= starting_date:
        return ee.Image(15.0)
```

```
    else:
        if file_exists(asset_id):
            dc_prev = ee.Image(asset_id)
        else:
            dc_prev = calc_DC(roi, starting_date,
                              date_today - timedelta(days=1))
            export_asset(dc_fname, asset_id, dc_prev, roi)
        # Here we are out of the recursion loop
        temp = get_temperature(roi, startting_date).max(ee.Image(-2.8))
        rainfall = get_rainfall(roi, startting_date)
        rain_mask = rainfall.gt(2.8)
        Pd = rainfall* 0.83 - 1.27
        Q_prev = 800 * (-dc_prev) / (400.exp())
        Q = Q_prev + Pd * 3.937
        dc_new = 400*((800/Q).log()).max(ee.Image(0.0))
            .updateMask(rain_mask)

        dc_new_unmasked = ee.ImageCollection([dc_new, dc_prev])
                          .mosaic()
        v = (0.36 * temp + 2.8) + day_length[month - 1])
           .max(ee.Image(0.0))

        dc = (dc_new_unmasked + 0.5) * v

        return dc
```

```
def calc_DMC(roi, starting_date, date_today):
    ef_day_length = [6.5, 7.5, 9.0, 12.8, 13.9, 13.9,
                     12.4, 10.9, 9.4, 8.0, 7.0, 6.0]
    dmc_name = f'dmc_{date_today}'
    asset_id = f'projects/…/assets/{dmc_name}'
    if date_today <= starting_date:
        return ee.Image(6.0)
    else:
        if file_exists(asset_id):
            dmc_prev = ee.Image(asset_id)

        else:
            dmc_prev = calc_DMC(roi,
                                starting_date,
                                date_today - timedelta(days=1))

            export_asset(dmc_fname, asset_id, dmc_prev, roi)
        rainfall = get_rainfall(roi, starting_date).toFloat()
```

```
        rain_mask = rainfall.gt(1.5)

        Pe = rainfall * 0.92 - 1.27
        M_prev = 20.0 + ((5.6348 - dmc_prev/43.43).exp())

        # Piecewise equation
        pw_1 = dmc_prev.lte(33.0)
        pw_2 = dmc_prev.lte(65.0).multiply(dmc_prev.gt(33.0))
        pw_3 = dmc_prev.gt(65.0)
        b_1 = pw_1 * (100.0 / (0.5 + 0.3 * dmc_prev))
        b_2 = pw_2 * (14.0 - 1.3 * dmc_prev.log())
        b_3 = pw_3 * (6.2 * dmc_prev.log() - 17.2)
        b = b_1 + b_2 + b_3

        M = M_prev + ((Pe * 1000.0) / (48.77 + b * Pe))

        dmc_new = 244.72 - 43.43 * (M - 20.0).log()
                 .max(ee.Image(0.0)).updateMask(rain_mask)
        dmc_new_unmasked = ee.ImageCollection(
                       [dmc_new, dmc_prev]).mosaic()

        temp = get_temperature(roi, starting_date).max(ee.Image(-1.1))
        rhum = get_humidity(roi, starting_date)
        K = 1.894 * (temp + 1.1) * (100.0 - rhum) * ef_day_length[month
- 1] * 0.000001

        dmc = dmc_new_unmasked + K * 100.0

        return dmc
```

```
def calc_BUI(roi, starting_date, date_today):
    # BUI depends on 2 other indices DC and DMC
    dc = calc_DC(roi, starting_date, date_today)
    dmc = calc_DMC(roi, starting_date, date_today)
    cond = dmc.lte(ee.Image(0.4).multiply(dc))
    not_cond = cond.Not()
    B_1 = 0.8 * (dmc * dc) / (dmc + 0.4 * dc)
           .updateMask(cond).rename('buildup_index')
    B_2 = dmc - (1.0 - ((0.8 * dc) / (dmc + 0.4 * dc))) * ( 0.92 +
(0.0114 * dmc).pow(1.7))
            .updateMask(not_cond).rename('buildup_index')

    bui = ee.ImageCollection([B_1, B_2]).max()

    return bui
```

```
def calc_FFMC(roi, starting_date, date_today):
    ffmc_name = f'ffmc_{date_today}'
    asset_id = f'projects/…/assets/{ffmc_name}'
    if date_today <= starting_date:
        return ee.Image(85.0)
    else:
        if file_exists(asset_id):
            ffmc_prev = ee.Image(asset_id)
        else:
            ffmc_prev = calc_FFMC(roi,
                                  starting_date,
                                  date_today - timedelta(days=1))

        m_prev =  147.2 * (101.0 - ffmc_prev) / (59.5 + ffmc_prev)

        rainfall = get_rainfall(roi, starting_date)
        rain_mask = rainfall.gt(0.5)

        m_prev_mask1 = m_prev.lte(150.0)
        m_prev_mask2 = m_prev.gt(150.0)

        Pf = rainfall - 0.5 * rain_mask
        m1 = (m_prev + 42.5 * Pf * (-100.0 / ((251.0 - m_prev).exp()) *
(1.0 - (-6.93 / Pf).exp() * m_prev_mask1

        m2 = (m_prev + (42.5 * Pf * (-100.0 /(251.0 - m_prev).exp()) *
(1.0 - (-6.93 / Pf).exp()) + (0.0015 * (m_prev - 150.0).pow(2) *
Pf.pow(0.5))) * m_prev_mask2)

        m_new = (m1 + m2).min(250.0).updateMask(rain_mask)
        mr = ee.ImageCollection([m_new, m_prev]).mosaic()

        rhum = get_humidity(roi, starting_date)
        temp = get_temperature(roi, starting_date)
        wind = get_wind(roi, starting_date)

        Ed = 0.942 * rhum.pow(0.679)) + ( 11.0 * ( ((rhum - 100.0) /
10.0)).exp()) + 0.18 * (21.1 - temp) * (1.0 - (rhum * -0.115).exp())

        Ew = 0.618 * rhum.pow(0.753) + 10.0 * ((rhum - 100.0) /
10.0).exp()) + 0.18 * (21.1 - temp) * (1.0 - (rhum * -0.115).exp())
        k_1 = 0.424 * (1.0 - ((100.0 - rhum) / (100.0)).pow(1.7))) +
0.0694 * wind.pow(0.5) * (1.0 - ((100.0 - rhum) / 100.0).pow(8))
```

```
        k_0 = 0.424 * (1.0 - (rhum / 100.0).pow(1.7)) + 0.0694 *
wind.pow(0.5) * (1.0 - (rhum / 100.0).pow(8))

        k_d = k_0 * 0.581 * (0.0365 * temp).exp()
        k_w = k_1 * 0.581 * (0.0365 * temp).exp()

        # Wetting and drying conditions
        drying = mr.gt(Ed)
        wetting = mr.lt(Ew)
        no_change = (drying + wetting).Not()

        # Moisture content after drying
        m_drying = drying * (Ed + ((mr - Ed) / (10.0).pow(k_d)))
        m_wetting = wetting * (Ew - (Ew - mr) / (10.0).pow(k_w)))
        m_no_change = no_change * mr
        m = m_drying + m_wetting + m_no_change

        # Calculate today's Fine Fuel Moisture Code
        ffmc = (59.5 * (250.0 -m) / (147.2 + m)) \
                .min(ee.Image(101.0)).rename('fine_fuel_moisture_code')

        return ffmc
```

```
def calc_ISI(roi, starting_date, date_today):
    wind = get_wind(roi, starting_date)
    fu = (0.05039 * wind).exp()
    ffmc = calc_FFMC(roi, starting_date, date_today)

    m = 147.2 * (101.0 - ffmc) / (59.5 + ffmc)

    ff = (91.9 * (-0.1386 * m).exp()) * (1.0 + (m.pow(5.31)) / (4.93 *
10000000)))

    isi = 0.208 * ff * fu

    return isi
```

```
def calc_FWI(coords, date_today):
    roi = ee.Geometry.Polygon(coords)
    starting_date = find_first_day_above_12C(roi, date_today)
    if starting_date is None:
```

```
        fwi = ee.Image(1) # If there is no starting date, FWI is 1
    else:
        # Since we have a starting date, it is time to start calculating
the individual indices that are required by FWI. First is BUI
        bui = calc_BUI(roi, starting_date, date_today)

        isi  = calc_ISI(roi, starting_date, date_today)

        heat_transfer = bui.gt(80.0)
        normal = heat_transfer.Not()

        fD_n = 0.626 * (bui.pow(0.809)) + 2.0.rename('fD')

        fD_h = 1000.0 / (25.0 + 108.64 * (-0.023 * bui).exp())) \
            .updateMask(heat_transfer).rename('fD')

        fD = ee.ImageCollection([fD_n, fD_h]).max()

        B = 0.1 * isi * fD

        S_scale = B.gt(1.0)
        B_scale = S_scale.Not()

        fwi_s = (2.72 * (0.434 * (B.log()).pow(0.647)).exp() \
            .updateMask(S_scale).rename('fire_weather_index')
        fwi_b = B.updateMask(B_scale).rename('fire_weather_index')
        fwi = ee.ImageCollection([fwi_b, fwi_s]).max()

        lc_mask = get_lcmask(roi, starting_date)
        masked_fwi = fwi.updateMask(lc_mask)

        fwi_fname = f'fwi_{date_today.strftime("%Y-%m-%d")}'
        asset_id = f'projects/…/assets/{fwi_fname}'

        export_asset(fwi_fname, asset_id, masked_fwi, roi, scale=100)
```

Annex 2 – SITAC symbology

CEN

WORKSHOP

AGREEMENT

CWA 18017

July 2023

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English version

Management of forest fire incidents - SITAC-based symbology

This CEN Workshop Agreement has been drafted and approved by a Workshop of representatives of interested parties, the constitution of which is indicated in the foreword of this Workshop Agreement.

The formal process followed by the Workshop in the development of this Workshop Agreement has been endorsed by the National Members of CEN but neither the National Members of CEN nor the CEN-CENELEC Management Centre can be held accountable for the technical content of this CEN Workshop Agreement or possible conflicts with standards or legislation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This CEN Workshop Agreement (CWA 18017:2023) has been developed in accordance with CEN-CENELEC Guide 29 "CEN/CENELEC Workshop Agreements – A rapid prototyping to standardization" and with the relevant provision of CEN/CENELEC Internal Regulations – Part 2. It was approved by a Workshop of representatives of interested parties on 2023-06-23, the constitution of which was supported by CEN following the public call for participation made on 2021-12-17. However, this CEN Workshop Agreement does not necessarily reflect the views of all stakeholders that might have an interest in its subject matter.

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The following organizations and individuals developed and approved this CEN Workshop Agreement.

- Chairperson: Mr. Ilias Gkotsis, Greece;
- Secretariat: Mrs. Diana Iorga, ASRO (Romanian Standards Association);
- Satways Ltd. (Leonidas Perlepes, Ioannis Chasiotis, Dimitris Diagourtas, Antonis Kostaridis, Giorgios Eftychidis, Alexios Pagkozidis, Aikaterini Poustourli, Katerina Valouma), Greece;
- Unidade Militar Laboratorial de Defesa Biológica e Química / Centro de Investigação da Academia Militar (UMLDBQ/CINAMIL) (Wilson Antunes, Luís Carvalho), Portugal;
- Corpo Nazionale dei Vigili del Fuoco (Gianfilippo Micillo, Giovanni Fresu), Italy;
- Fraunhofer INT (Sascha Duerkop, Juliane Schlierkamp, Claudia Berchtold), Germany;
- German Fire Brigade Association (Ulrich Cimolino), Germany;
- Fire Fighting Station Gumpoldskirchen (Richard Feischl), Austria;
- Kobra GmbH (Andreas Rehbein), Germany;
- ENB -National Fire Service School (Vitor Figueiredo dos Reis), Portugal;
- ENTENTE (EPLFM) ECASC (Philippe Meresse), France;
- International Disaster Response Germany (Christian Beninde), Germany;
- INLECOM (Loredana Mancini), Ireland;
- UK Health Security Agency (Louise Davidson), UK;
- Direction generale de la securite civile et de la gestion des crises (DGSCGC) (Francois Gros, Djamel Ferrand), France;

- Ministry of Interior General Secretary DPSIS/Standardization Division (Bernard Rajau), France;
- GAP ANALYSIS S.A. (Evita Agrafioti), Greece;
- Kentro Meleton Asfaleias (KEMEA) (Varela Vassiliki, Danai Kazantzidou-Firtinidou), Greece;
- CERTH (Spyridon Kintzios, Panagiota Masa), Greece;
- Autoridade Nacional de Emergencia e Protecao Civil (Joao Carlos Nunes), Portugal;
- Disaster Competence Network Austria (Laura Essl), Austria;
- General Inspectorate for Emergency Situations -IGSU (Catalin Vasile Samsodan), Romania;
- French National Fire Officers Academy (Antoine Izac, Raphael Supplisson), France;
- The Firefighting Association of Slovenia (Neza Strmole, Tadej Marusc), Slovenia;
- Hellenic Fire Service (Vasileios Karydas, Georgios Karditsas), Greece;
- Hellenic Fire Brigade (Kiriakos Tsakiridis), Greece;
- EPAYPS (Dimitrios Menemenlis), Greece;
- AFNOR (Yohann Pressard), France.

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Introduction

Crises and emergencies usually result from unpredictable events or unforeseeable consequences of various events, such as natural disasters, man-made threats and technological accidents. Considering those events can adversely affect human life, property and the environment, the swift response to them and their efficient handling is deemed instrumental. Therefore, the development and application of strategies that inform the sound response mechanisms to deal with sudden and adverse events are among the core challenges of crisis management.

Effective crisis management highly depends on accurate communication and information sharing among the different stakeholders involved in operations. Efficient collaboration requires a common situational understanding, especially in complex situations involving multiple actors, mandates and disciplines from various jurisdictions and nations. In that direction, cartography is essential in conveying reliable and readily interpreted operational information through digital or paper-based maps. Maps summarize and describe a situation visually, providing the involved actors with a common operating picture for supporting coordination during emergencies and crises. The cartographic symbols used on those maps depict, among others, information related to the event, the characteristics of the affected area and the preparedness and response actions that need to be taken. Unfortunately, although several cartographic symbols and symbol schemes for crisis management have been developed and published in different countries, few standardized sets exist worldwide. A typical example is the ANSI 415-2006 INCITS[1] Homeland Security Map Symbol Standard which the US Department of Homeland Security designed to standardize point symbols for emergency management mapping.

Wildfire incident management requires effective and coordinated management and multi-agent collaboration through common situational interpretation. Unfortunately, there are still no standardized approaches to forest fire management symbology. National organizations typically use informal cartographic symbols to share wildfire incident-related information in the field and operational centres. For example, in the US, the National Wildfire Coordinating Group (NWCG)[2] has developed a set of standard symbols for wildland fires to facilitate the fast and consistent interpretation of map-depicted information. Among the relevant symbol sets used in a non-systematic way in the EU, SITAC (abbreviation of "SITuation TACtique")[3], initially developed by the French Fire Service (Sapeur Pompiers), then revisited and enriched with new symbols and operationally adopted then by the "Corpo Nazionale dei Vigili del Fuoco (CNVVF)" in Italy, is currently under consideration by several fire services in other EU Member States. Representatives from these practitioners, relevant stakeholders from the R&D community and the industry have been engaged in developing the current document. The aim is to consider all aspects involved in the standardization process to evaluate the potential of using SITAC as a European operational standard in firefighting operations. The proposed symbology was initially made compatible with that already used in France, Portugal and Italy thanks to the kind cooperation of the ECASC in Valabre, and has been enriched with new symbols that further enhance the descriptive capabilities of the system. Within the CWA and in cooperation with its members, further enhancements have been achieved.

Formalizing information and establishing a standardized symbology set is a crucial challenge for supporting effective wildfire management practices and coordination requirements during the response. The lack of a standardized approach for visually communicating operational messages, using a commonly agreed and understood symbology among the actors involved in forest fire fighting, renders the effectiveness of coordinating the field operations even more troublesome. As previously mentioned, each

[1] ANSI INCITS 415-2006. Homeland Security Mapping Standard - Point Symbology for Emergency Management. https://webstore.ansi.org/standards/incits/ansiincits4152006
[2] National Wildfire Coordinating Group (NWCS). https://www.nwcg.gov/publications/pms936/symbology
[3] SITAC – Standardization of Firefighting Tactical Situation Management. https://www.in-prep.eu/wp-content/uploads/2018/05/Symbology-SITAC.pdf

EU member state has its processes, procedures and symbols for communicating situational information during large fire incidents and crisis management operations. In cross-border crises, such peculiarities and differences may confuse first responders and civil protection bodies or waste assistance between the Member States. More specifically, regarding large-scale forest fires in a cross-border context where multiple authorities and modules from foreign countries are usually involved, sharing operational information and a common understanding of the situation becomes even more crucial to an effective coordinated response. In this regard, establishing a standardized symbology that can be used by the forest fire management services and public safety agencies across the EU, is essential for combating/ mitigating the onset of wildfire-related disasters and facilitating cross-border collaboration in a coordinated manner.

This CEN Workshop Agreement (CWA) has been elaborated as part of the EU-funded research project STRATEGY (https://strategy-project.eu/), which received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement (GA) N° 883520. More specifically, upon investigation of the standardisation universe across its thematic streams of research and prioritisation of the identified gaps against the operational perspective of end-users, STRATEGY underlined the need and supported the drafting of this CWA.

1 Scope

This document proposes a set of standardized symbols to be agreed upon and adopted by the responsible public safety agencies and more specifically by the organizations involved in wildfire management in an optimally coordinated approach (particularly when considering a cross border context). Such symbology will enable the visual communication of the operational and field information that fire commanders exchange during firefighting operations, displayed on a geographical background, to effectively support the coordination and planning of the response activities. Hence, adopting such symbology will expectedly improve the understanding of the situation by the involved agencies, based on a common visualization approach concerning the information sharing among field actors from different countries, jointly operating in the theatre.

The set of symbols encompassed the characteristics of the area of operations, the propagation of the fire front, the intervention measures/available equipment and the actions that need to be taken.

The symbology proposed in this document is based on SITAC, a set of symbols developed by the French Fire Service (Sapeur Pompiers), which is currently operationally adopted by the "Corpo Nazionale dei Vigili del Fuoco (CNVVF)" in Italy and a number of other fire services in EU Member States.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp/

— IEC Electropedia: available at http://www.electropedia.org/

3.1
anchor point
an advantageous location, usually a barrier to fire spread, from which to start building a fire break or line

3.2
briefing map
map drawn and displayed in the briefing area and used during operational briefings. It is a simplified, large-format map of the incident area that is used to discuss work assignments and other details. The briefing map can be hand-drawn, printed or displayed digitally using a projector

Note 1 to entry: Sometimes in the US operational references, this map is referred to as a Briefing Area Map (BAM).

3.3
Command Post, CP
Incident Command Post, ICP
location at which the commander of a unit or an incident in the field receives orders, takes decisions and controls, and organizes the forces. The CP or ICP may be collocated with the incident base or other incident facilities

3.4
crown fire
type of fire that moves above the surface i.e. from top to top of trees or tall shrubs, its advancement being eventually independent of the propagation of the fire at the surface. Crown fires are sometimes classified as running or dependent to distinguish the degree of independence from the surface fire

3.5
EU Module
a combination of team and equipment of the EUCPM, which include forest Firefighting (ground or aerial) Modules, using concrete capacities defined by the EUCPM provisions

3.6
escape route
pre-planned and understood route firefighters take to move to a safety zone or other low-risk area. When escape routes deviate from a defined physical path, they should be marked (flagged)

3.7
evacuation
act of moving people or animals from a dangerous place to somewhere safe, reducing the possibility of injury or casualty

3.8
extreme fire
fire with unpredictable and erratic behaviour due to its potential associated with an unexpected rate of spread and/flame length/intensity

3.9
Fire (Incident) Commander
the highest-ranking member on the scene of a fire, rescue, incident, or emergency, responsible for the management of all incident operations at the incident site

3.10
fire flank
parts of a fire's perimeter that are roughly parallel to the main direction of the spread

3.11
fire front
part of a fire within which continuous flaming combustion is taking place. Unless otherwise specified, the fire front is assumed to be the leading edge of the fire perimeter

3.12
fire outline
boundaries of the current area burning

3.13
fire start
precise location where a competent ignition source came into contact with the material first ignited and sustained combustion occurred

3.14
fire team
Fire (Incident) Commander and appropriate Command and General Staff assigned to an incident

3.15
first responders
Emergency Services' professionals (from Fire/Wildfire, Police/Law-Enforcement, Emergency-Medical-Services, Rescue Agencies) and professionally trained-and certified volunteers (from local communities and/or citizen groups and/or civic society at large) who are immediately responding to scenes of emergency, disaster and/or crisis, with the pertinent and necessary culture/behaviour, training, skills, procedures and equipment to tackle the said emergency, disaster and/or crisis

3.16
ground fire
type of fire that spreads on the ground and consumes the organic material beneath the surface of litter, such as a peat fire

3.17
health care or healthcare
improvement of health via the prevention, diagnosis, treatment, amelioration or cure of disease, illness, injury, and other physical and mental impairments in people

3.18
helibase
main location for parking, fuelling, maintenance, and loading of helicopters operating in support of an incident, usually located at or near the incident base

3.19
helispot
natural or improved take-off and landing area intended for temporary or occasional helicopter use

3.20
hot spot
particularly active part of a fire

3.21
Law Enforcement Agency (LEA)
any government agency responsible for the enforcement of the law

3.22
line ignition
technique used in wildfire management to create a controlled burn along a predetermined line or boundary to create a barrier that will slow or stop the spread of a wildfire. This technique is known as "firing out" or "burning out”

3.23
recon
reconnaissance
examine a fire area to obtain information about current and probable fire behaviour and other related fire suppression information

3.24
rescue
help someone or something get out of a dangerous, harmful, or unpleasant situation

3.25
retardant
substance or chemical agent (e.g. foam, class A, gel) which reduces the flammability of combustibles

3.26
retardant drop
dropping of fire retardants from aerial means (air tankers or specially designed buckets slung below a helicopter)

3.27
retardant line
applying fire retardants from ground crews to slow down the fire, protecting infrastructures, preventing further ignitions, etc.

3.28
safety line
designated area around the perimeter of a wildfire where firefighters and other emergency personnel can work safely without being immediately threatened by the flames

3.29
safe zone
safety zone
area cleared of flammable material, used for escape in the event the line is outflanked or in case a spot fire causes fuels outside the control line to render the line unsafe. In firing operations, crews progress to maintain a safety zone close at hand, allowing the fuels inside the control line to be consumed before going ahead. Safety zones may also be constructed as integral parts of fuel breaks; they are greatly enlarged areas that can be used with relative safety by firefighters and their equipment in the event of a blow-up in the vicinity

3.30
spot ignition
spot fire
fire ignition that occurs from sparks or embers carried by the wind and which start new fires (spot fires) beyond the zone of direct ignition by the main fire. A cascade of spot fires can cause a blow-up

3.31
surface fire
type of fire that moves near the surface, burning surface fuels comprising dead branches, leaves, and low vegetation

3.32
staging area
location set up at an incident where resources can be placed while awaiting a tactical assignment

Note 1 to entry: Staging areas are managed by the Operations Section.

3.33
transit point
temporary location established by fire managers and incident commanders as part of the overall firefighting strategy aims to support the operations by providing a central location for personnel, equipment, and supplies and a staging area for firefighting resources

3.34
volunteers' team
team of volunteers
fire fighter's department of volunteers who perform fire suppression and other related emergency services for a local jurisdiction

3.35
water point
indicate water supply points

4 Forest fire incidents and the use of symbology

4.1 General

First responders routinely use location-based information (maps) to dispatch resources, analyze spatial risk, coordinate field activity, be aware of dangerous spots and perform several other mission-critical tasks. In large fires, paper maps (hand drawn, printed or digital) are used in the form of wall maps, field drawings or digital maps in responders' vehicles. In the headquarters or operational centers, a growing number use high-quality computer-based maps utilizing Command and Control (C2) software, based on Geographic Information Systems (GIS) capabilities and technology.

There are multiple examples of map symbol standards, currently in use, designed to support emergency management. These include symbol standards for humanitarian demining efforts (GICHD 2005), military operations (NATO 2005), and emergency response and recovery (ANSI 2006; Martin and Black 2007). Most of these standards specify designs for point symbol markers, though some also suggest standards for symbolizing area features by defining styles for boundary lines (Kostelnick et al. 2008).

A primary challenge with any map is to create a consistent look so that information can be conveyed across all operational levels (tactical, operational and strategic) and different agencies, disciplines and jurisdictions. Information consistently presented in such maps is commonly referred to as Common Operating Picture (COP).

4.2 Types of maps used in managing forest fire incidents

In wildfire management, maps are used to plan and coordinate activities, and develop a common operational picture between responders and involved actors. Several maps may support communication and information sharing during firefighting operations related to a specific wildfire incident. This is the case in modern fire management operations applied by the leading countries in fire management technology.

Such maps, endorsed by the National Wildfire Coordination Group (NWCG), established in the USA in 1976, are presented here next regarding the exchanging information, which may be considered potential elements of the SITAC standardization process.

Incident Action Plan Map

The Incident Action Plan (IAP) map is the primary map used by field operations personnel and it is an essential tool for firefighter safety. The IAP map effectively communicates incident management objectives in addition to geographic and incident features.

Briefing map

The Briefing Map is displayed in the briefing area and used during operational briefings. It is a simplified, large-format map of the incident area that is used to discuss work assignments and other details. The briefing map can be printed or displayed digitally using a projector. Sometimes this map is referred to as a Briefing Area Map (BAM).

Situation Unit Map

The Situation Unit Map is a large-format map with an accurate, current, and detailed record of the incident information, displayed in or near the Situation Unit area. The Situation Unit Map should be limited to the

extent of the incident rather than showing the surrounding area. Its purpose is to show the current incident information and provide a place for marking map edits.

Transportation map

The Transportation Map shows the access routes to the incident and is included in the Incident Action Plan (IAP). It provides an overview of the transportation network in the incident vicinity to support safe transportation. This map is used to facilitate land-based delivery of equipment, supplies, and personnel to and from the incident location.

Progression map

The Progression Map shows the areas affected by the incident over time. A copy of the map is required to be included in the incident documentation package.

Air operations map

The Air Operations Map provides air operations with enough detail to aid in locating key features on an incident. A secondary Air Operations map, the Pilot Map, may be created for pilots.

Operations map

The Operations Map effectively displays geographic and incident features for use by operations personnel (Operations Section Chief, Operations Branch Directors, Division/Group Supervisors) either in the Incident Command Post or out in the field. Sample legends of Operation maps are shown next.

Other maps

Fire personnel frequently request special maps. These maps may refer to:

a) Areas of Special Concern (ASC), used to identify sensitive areas, such as endangered species habitats or locations, cultural resources, and other areas at risk;

b) Facilities Map showing the layout of the incident facilities at the Incident Command Post (ICP) or Incident Base/Camp;

c) Fuels Map showing the fuels in the fire perimeter;

d) Ownership–Land Status Map showing the ownership or land status for the areas impacted by the incident. It graphically depicts the land ownership or fire protection responsibility around the incident;

e) Structure Protection Map showing structures and resources that could be impacted by the incident etc.

4.3 Specific requirements for forest fires incidents symbology

Standardized symbols in mapping wildland fires facilitate fast and consistent interpretation of mapping products and help prevent ambiguous map interpretation, which can become a safety issue during an incident.

Moreover, the transmission of the field operations map across the chain of command, allows a more informed assessment to higher decision-making levels that need to take broader initiative. The use of operational mapping, updated regularly during the phases of the intervention, also allows for a kind of operations logbook, a concise logbook easily interpreted by all the present actors. It is important to keep the number of symbols small, and categorized by topic, so as to make sketching easy and the cartography not too redundant and therefore unreadable. Likewise, it is important to identify symbols in such a way that they are always clearly distinguishable (even in small size), even in the case of a black-and-white representation. Further, common map conventions (e.g., blue for hydrologic features) should be observed, if possible, to ensure clear communication.

For forest fires incidents symbology, the following requirements apply:

- In practice, symbols will need to be drawn on a map during an incident, but the user should choose such symbols and/or clues that are easy, simple and understandable to everyone who receives these notes/remarks. A necessary condition of understanding rather than confusion, which can easily be caused, especially during the management of large forest incidents (megafires), should take into consideration to inform and/or agree in advance on the imprinting of these symbols. If properly and timely communed, it can work in practice.
- Means/resources symbols contained on a map are quite generic, avoiding including for example basic information about a fire truck, such as the amount of water, installations, special tools for forestry operations (shovels, ferns, hoes, overseers, chainsaws, etc.), and even all the personnel on board. The only information it provides has to do for example with the operating point of the fire truck, information that should be updated very often, especially in the development of the forest incident. So, combinations of such symbols with containers (e.g., a specific text code or acronym that depicts all the above information) that each Agency and/or country further defines or standardizes is needed, so that all involved stakeholders understand the map in the same way.
- A wide range of symbols, covering every case and providing in depth details on the operations would be more confusing than helping. Introducing a number of standard symbols that can be further adapted or enhanced (if needed) nationally or within an agency (e.g., by using more containers in symbols) is the key point.
- The ambiguous interpretation of maps or misunderstanding should be avoided as it will raise safety issues for both personnel and equipment in the development of a forest incident.

5 SITAC-based methodological framework and symbol system definition, for forest fire incident management

5.1 SITAC-based methodological approach

The creation of a standardized methodology of graphical representation of the various concepts and elements describing the tactical situation on a fire incident, allows having a common communication language that can be used:

— at the national level, where Forest Fire Fighting systems have a complex organization with multiple actors involved, and/or

— at the European and international level, to facilitate missions and interventions linked to bilateral agreements or the EU Civil Protection Mechanism.

In this sense, SITAC, is the common "language" designed to facilitate the collection, processing, transmission, and understanding of operational information at different levels of command and execution.

SITAC is also a method of analysis that, combined with a specific graphical symbology, makes it possible to represent the picture of the ongoing situation of complex fires and to plan operations in a standardized and understandable way for all involved. Furthermore, with modern data transmission systems, sharing the plan with operations rooms and different decision-making levels becomes extremely easy.

SITAC also constitutes a kind of "campaign notebook" in which updates on the evolution of the fire and the actions taken to deal with it can be recorded, and shared. As the duration of operations continues, it also constitutes a handy tool for the handover of handovers in changes between Directors of Operations.

All graphic symbols adopted are designed to be unambiguously understandable even in the case of black-and-white representation and easily reproduced by hand on a field map.

The symbols of operational means and teams and the actions performed by them, are indicated differently if provided and/or implemented.

The symbols of actions and of teams and means must be congruent with each other: an action in place presupposes an operational team in place, but on the other hand, actions in progress with teams not yet arrived are not possible.

5.2 Classification structure

Four steps must be included in the creation of a complete operational mapping:

- Analysis of the area of operation (topography, fuel, sensitive points, roads, power lines, etc.);
- Assessment of the most likely fire behaviour depending on the area of origin, topography and weather conditions, distribution of fuels;
- Identification of actions to be taken: indirect attack, containment on flanks, localized attacks, etc.
- Operational organization at the scene of the event (actions and means).

All the above info must be represented, associating a symbol, having a precise meaning, with a geographical location on the map. The SITAC set of symbols includes fire management concepts and formalized relevant shapes as depicted in the next figure, presenting the following ten main categories:

1. Description of the intervention area

The perception and analysis of the characteristics of the area in which the firefighting system has to extinguish the fire (morphology, fuels, railroad network, water resources, flight obstacles, power lines, etc.) is the first step to preparing the action plan; this means to identify the more relevant elements that condition the fire spread, the endangered areas, the infrastructures available to fight the fire; the size of the area to be analysed are such as to allow for the forecast of negative evolutions of the fire as well.

2. Source of danger

Source of danger are places (points, lines, areas) where the existence of e.g. an asset, an infrastructure, an element, a substance, etc. can lead to causing the ignition of a fire or expanding the fire propagation For example assets, infrastructures, elements, substances, such as a pilar of power distribution network that could cause fire ignition.

3. Sensitive points

Sensitive points are places (points, lines, areas) where is possible a change of fire behaviour due to a change of morphology, fuels, exposure, or to the presence of a road and so on. These situations could represent a chance to stop easier the fire or places where a negative evolution of the incident is likely. WUI Sensitive points represent areas with houses, factories, railroads and main roads that could be endangered by the fire. Other sensitive points are for example assets or infrastructures that their service can be impacted/disrupted due to the fire propagation in the area.

4. Infrastructure for resources

The evaluation of infrastructures that are useful for the Forest Fire Fighting System present on site is one of the main elements to be considered; the characteristics of the road network, the presence of fuel-break and the availability of water points for ground and air means in the endangered area, are very important

to plan and to run the attack to the fire; they condition the possibility of approaching the fires with the engine crews and to fill them, the rotation time for the drops of Forest Fire Fighting aircrafts.

5. Fire evolution and weather situation

Fire evolution is strictly linked to fuels, morphology and weather conditions, particularly with wind and humidity.

6. Fire front

The fire front is one of the most important parameters to evaluate the difficulties to extinguish the fire; the length is important but also if the front is continuous or broken in different parts.

7. Type of fire

Crown fires, surface fires, and ground fires, request different approaches and techniques; ground fires in particular need good handover procedures for mop-up and surveillance

8. Wind direction and intensity

Wind direction and intensity shape the main spread direction and speed of the fire; firefighters use the relationship between the wind speed and rate of spread to plan the operations.

9. Means

The availability of ground and air means is important to make a realistic plan of operation; the Incident Commander must evaluate the number and the type of resources really usable according to the road network and availability of water, and the weather conditions for the air means.

10. Actions

Actions depend on the availability of means and crew, their skills and capability, the morphology, the road network, the weather condition and so on. The plan of actions must be realistic and flexible.

11. Evacuation

Evacuation requests to be planned in time; it is necessary to identify the safety zone and the safe way to reach it, and the evaluation of the needed time to run this operation.

5.3 Design of symbols

The following Tables 1, 2 and 3 provide the basic rules for designing the proposed symbols, with regards to their shape, colour, line and filling (with information/text) which, when followed by all organizations or countries involved in the fire incident management, will lead to easily understanding of the shared information.

Table 1 — Basic shapes

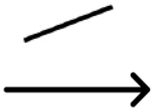
Shape type	Description	Shape image
	Means/resources	
Triangle top	Warning or danger	
Triangle bottom	Sensitive points	
Polygon	Area	
Circle	Place or point	
Star	Incident or part of incident	
Line (or arrow)	Limit, action, motion, direction	
Rectangular with a line on top	Infrastructure	
Flag	Command post	

Table 2 — Design colours

Black	Green	Blue	Red	Orange
Generic	Rescue	Water	Fire	CBRNe

Table 3 — Shape drawing line

Solid line	Dashed line
Running action (examples)	Planned action (examples)
	

5.4 Combined map symbols

The approach for drawing each shape/icon in a consistent and formalized way is described together with the main description of each symbol.

5.4.1 Description of the operating area

5.4.1.1 Sectors of operations

The delimitation of sectors is used to define the areas of operation, supporting the coordination of teams and the management of the incident. Graphically it is represented by a dashed-dot line.

5.4.1.2 Roads

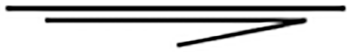
5.4.1.3 Road with normal access

A road with normal access is a rural/forest road with width that allows access to all types of vehicles. It is depicted with two bold parallel continuous lines. In case that the road is unpaved or its conditions indicates that only vehicles with off-rad capabilities are appropriate to access, then next to the symbol it should be indicated the text (4x4).

5.4.1.4 Road with limited access

A road with limited access is a road with limited width allowing access only to small/light vehicles. It is represented with a straight line on top and a parallel dashed line at the bottom. In case that the road is unpaved or its conditions indicates that only vehicles with off-rad capabilities are appropriate to access, then next to the symbol it should be indicated the text (4x4).

5.4.1.4.1 One-way route



One-way route symbol is depicted with a straight line (road) and a parallel line ending with an arrow showing the valid direction.

5.4.1.4.2 Road closed

A blocked or closed road (with no access to fire vehicles) is represented by an X sign, crossing the straight line of the road that is closed.

5.4.1.5 Trail

A trail is usually a forest narrow road which may be used by persons or crews. It is represented with a straight line on top and a parallel line of dots at the bottom.

5.4.1.6 Slope

5.4.1.6.1 Slight slope

An area with slight slope (0-10%) is marked with a downward arrow with 1 perpendicular dash at its tail

5.4.1.6.2 Moderate slope

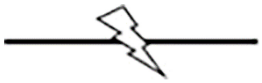
An area with moderate slope (11-30%) is marked with a downward arrow with 2 perpendicular dashes at its tail

5.4.1.6.3 Steep slope

An area with steep slope (>30%) is marked with a downward arrow with 3 perpendicular dashes at its tail.

5.4.1.7 Power lines

5.4.1.7.1 Active power line



An active (charged) power line is marked by placing a blitz sign on the drawn lines depicting the electricity network.

5.4.1.7.2 Power line off

A deactivated power line is depicted with a crossed blitz symbol placed on a mapped/drawn electricity line.

5.4.2 Water points

5.4.2.1 Water point for ground vehicles

The point where ground vehicles could pump water and use it for ground firefighting actions. It is depicted as a blue solid circle. Within the circle the capacity of water could be added in case it indicates a water tank, otherwise no text is included.

5.4.2.2 Water point for helicopters

A point where helicopters could pump water and use it for aerial firefighting actions. It is depicted as a circle divided into quarters, with the two verticals colored white and the two vertical colored blue.

5.4.2.3 Water point for airplanes

A point where airplanes could pump water and use it for aerial firefighting actions. It is depicted as a circle with blue color and a white rectangle in the middle (horizontal axis).

5.4.3 Helicopter pad

A natural or improved take-off and landing area intended for temporary or occasional helicopter use. It is depicted by a circle with black outline and white filling, containing letter H.

5.4.3.1 Obstacles

5.4.3.1.1 Cable car, overhead wires etc.

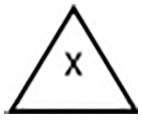
Cable car, overhead wires, and related hanging elements above the ground (horizontal or oblique flight obstacles in general) in the area of operations are depicted with a black rectangle from an oblique line.

5.4.3.1.2 Repeaters, antennas, wind turbines, etc.

Repeaters, antennas, wind generators and other point elements representing high linear structures (poles) are depicted by an open isosceles triangle with a bold dot at the bottom.

5.4.3.2 Source of danger

5.4.3.2.1 Generic source of danger



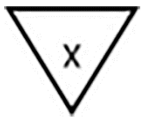
A source of danger, depicted as a black triangle with the apex down which can be combined with a container/filling (in the place indicated with an X in the graphic) in order to depict any generic information on the map. Indicative containers are: UXO (for unexploded ordnance – explosives), G (for Gas) and E (for Electric).

5.4.3.2.2 CBRN related source of danger

A source of danger, depicted as an orange triangle with the apex down which can be combined with a container/filling (in the place indicated with an X in the graphic) in order to depict any CBRN related information on the map. Indicative containers are: C (for Chemical), B (for Biological), R (for Radiological), N (for Nuclear).

5.4.3.3 Sensitive points

5.4.3.3.1 Generic sensitive point



A sensitive point, depicted as a black triangle with the apex down which can be combined with a container/filling (in the place indicated with an X in the graphic) in order to depict any generic information on the map. Indicative containers are: UXO (for unexploded ordnance – explosives), G (for Gas) and E (for Electric).

5.4.3.3.2 CBRN related sensitive point

A sensitive point, depicted as an orange triangle with the apex down which can be combined with a container/filling (in the place indicated with an X in the graphic) in order to depict any CBRN related information on the map. Indicative containers are: C (for Chemical), B (for Biological), R (for Radiological), N (for Nuclear).

5.4.3.3.3 Fire related sensitive point

A sensitive point related to fire is depicted as a red (solid fill) triangle with the apex down.

5.4.3.3.4 Human related sensitive point

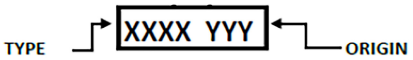
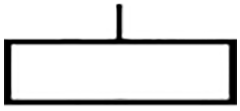
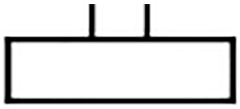
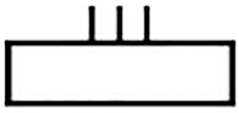
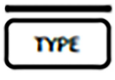
A sensitive point related to humans/lives, especially in a wildland-urban interface or rural-urban interface. It is depicted as a triangle with the apex down with a pattern fill with diagonal green and white stripes.

5.4.4 Resources and means

5.4.4.1 Additional design principles for resources and means symbols

Symbols related to resources and means that are operating in the area or planned to operate, use a rectangle as the basic shape (see Table 1), in different colours when needed to depict the organization/authority they belong. Moreover, further adjusted graphics are used in order to specify the type of resources, usually combined with text (container) in order to specify further the type or even the origin of the resources. The colour filling is also used to specify if the specific resource is planned to operate or if it is active. All these are presented as design principles in the following Table 4.

Table 4 — Design principles for resources

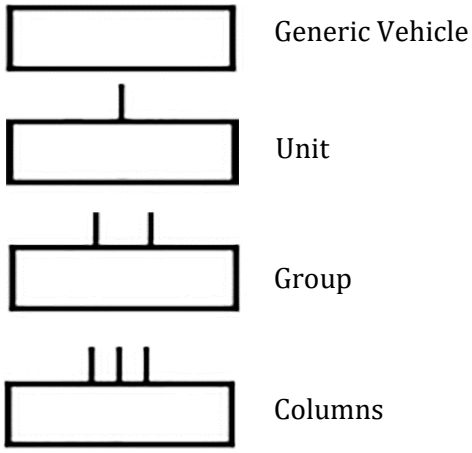
Textual	Graphic (examples)	Mixed (example)
	 Generic vehicle  Fire fighter vehicle (unit)  Group of vehicles  Columns (set of groups)  Aerial means  Infrastructures	 Example of ground forces  Example for Canadair 
Can specify type and origin of the means	Can specify type of the means	Can specify type, origin and status of the resources

5.4.4.2 Symbols related to resources and means

Based on the general principles presented in 5.3 and those presented in the Table 4, the combinations of symbols and containers for resources and means are presented below.

5.4.4.2.1 Ground forces

In order to depict the ground forces the following symbols are used: a rectangle with no or up to three vertical lines to the top side.



The approach followed by this CWA regarding the above symbols is the following:

- A Unit is typically the smallest organizational element, e.g. in fire management operations, consisting of firefighters working together on a specific task or objective. Units can vary in size depending on the specific operation, but they generally consist of three to seven firefighters.

- A Group is a larger organizational element (in fire management operations), typically consisting of two or more units. Squads are often responsible for a specific area or firefighting task, and may be assigned to work on different parts of the firefront (head, flanks, or rear).

- A Column is the largest organizational element in fire management operations, typically consisting of several squads. Columns are often used for more complex firefighting operations, such as large wildfires, and are responsible for coordinating and executing multiple tasks across a large area.

The above depends on each country/organizational structure and norms, and they may be followed as a pattern/methodology to depict the respective categories for resources.

In order to specify the status of each resource, a solid outline is used for ongoing activities or dashed for planned. Below is an example of a group of fire vehicles (red indicates fire related info).

The above symbols are used in combination with a container in order to specify the type and/or name of resources, as indicated in the example below depicting a unit of volunteers.

Indicative containers are:

- IC- Incident Commander
- FB - fire brigade
- FS - forest service
- VOL - volunteers
- DOZ – dozers
- EU – EU Module

Additional containers may be used upon adoption of the CWA by each country/organization.

5.4.4.2.2 Command post

The command post is depicted by a flag symbol (solid line for ongoing activities or dashed for planned) containing the letters CP within, in red colour as it is linked to fire (wildfire management).

5.4.4.2.3 Law Enforcement Authorities

Resources from Law Enforcement Agencies, such as police, are depicted by a black rectangle in two versions indicating the status (solid line for ongoing activities or dashed for planned) as described further above. The “Pol” is used as a container.

5.4.4.2.4 Emergency Management Services

Resources related to health care and rescue (e.g., ambulance service) are depicted by a green rectangle in two versions indicating the status (solid line for ongoing activities or dashed for planned) as described further above. The “HEALTH” is used as a container, also in green. This symbol may also be combined with vertical lines on top, following the approach described in 5.4.4.2.1.

5.4.4.2.5 Aerial means

Aerial forces are depicted by a rectangle containing two triangles horizontally connected with their apexes, combined with a text at the bottom to indicate the type of resources.

In order to specify the status of each resource, a solid outline for ongoing activities or dashed for planned, is used . Below is an example of a group of fire vehicles (red indicates fire related info).

The above symbols are used in combination with a container in order to specify the type and/or name of resources, as indicated in the example below depicting a Canadair airplane.

Indicative containers are:

Airplanes

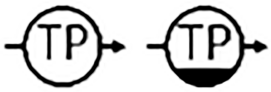
- Plane- airplanes in general
- CAN- Canadair
- BOSS- Fireboss
- PZL- PZL (Mielec) M-18B
- BE- Beriev

Helicopters

- HELI- Helicopters in general
- S64 - Erickson S-64
- COU - Cougar helicopter
- BELL - Bell 412
- CH - CHINOOK
- SP - SUPER PUMA
- KA - KAMOV

Additional containers may be used upon adoption of the CWA by each country/organization.

5.4.4.2.6 Transit Point



A transit point is depicted by a circle with a black outline, containing the letters "TP" within, and an arrow horizontally. Moreover, if the bottom part is coloured black, it indicates that it is active and running, otherwise, it is planned.

5.4.4.2.7 Infrastructure

In order to depict infrastructures in the field, a rectangle with a container (text) within it is used, combined with a solid line on the top side. Depending on the container and the type of information that is depicted, the symbol may be combined with colour (e.g. green for hospital).

Indicative containers are:

- MMP (means meeting point)
- VMP (Victims meeting point)
- MH (Mobile hospital)
- HSP (Hospital)
- MOR (Morgue)
- VET (Veterinary)
- REST (Restaurant)
- P (Parking)
- MEC (Mechanic support)
- OIL (OIL refueling point)
- ELEC (Electricity support point)
- FOAM (Foam reserve)
- RET (Retardant reserve)

Additional containers may be used upon adoption of the CWA by each country/organization.

5.4.5 Fire evolution and weather situation

The following symbols are used in order to depict on a map the current situation of the fire and the weather that prevails in the area. Sets of these symbols, which through their combination provide a more complete situational picture are presented in Annex B.

5.4.5.1 Fire outline

The fire outline depicts the outer boundaries of the current area burning. It is depicted by a red polygon which may also be filled with a light red colour.

5.4.5.2 Primary and secondary axes

5.4.5.2.1 Main development axis

The main development axis indicates the main direction of the fire propagation, which is placed where the head of the fire is drawn. It is depicted with a red big arrow.

5.4.5.2.2 Secondary flank (fast)

The secondary flank is part of the fire perimeter, which when evolving fast is depicted with an arrow with a red outline and a red/white pattern filling (lines in an angle of 45^{o}).

5.4.5.2.3 Secondary flank (slow)

The secondary flank is part of the fire perimeter, which when evolving slow it is depicted with an arrow with red outline and white filling.

5.4.5.3 Point of origin or ignition point

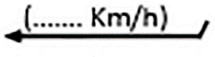
The point of origin indicates a point/area where the fire initially started and then evolved. It is depicted with a red (solid filling) star.

5.4.5.4 Fire front

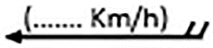
Fire front is any part of the fire perimeter that is located in the wind direction and displays continuous flaming combustion. It is depicted with red color as a polygon with a pattern of red parallel lines (or even solid red), drawn at the part of the fire outline where the above circumstances apply.

5.4.5.5 Wind direction and intensity

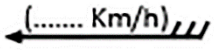
Wind direction and intensity are depicted by combining an arrow that indicates the direction of the wind, a number of short lines at its tail in order to indicate the wind intensity, and texture on top of the arrow indicating the wind speed (km/h) when known.



Wind direction with weak intensity (<19km/h)



Wind direction with moderate intensity (20-38km/h)



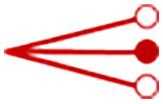
Wind direction with strong intensity (39-61km/h)

5.4.6 Type of fire

5.4.6.1 Ground fire

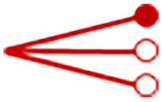
The ground fire symbol indicates a fire burning below the surface fuel layer. It is depicted with three lines starting from the same point, creating an angle of approximately 15º on top and beneath the middle one (which is parallel to the horizontal axis). At the end of each line a small circle with a red outline is placed and a white or red solid filling. For ground fire the only bottom circle is red.

5.4.6.2 Surface fire



The surface fire symbol indicates a fire that burns within the fuel layer above the ground (surface). It is drawn with the same principles as above, but with the middle circle coloured red.

5.4.6.3 Crown fire



The crown fire symbol indicates a fire that advances from top to top of trees or shrubs more or less independent of a surface fire. It is drawn with the same principles as above, but with the top circle coloured red.

5.4.7 Firefighting actions

5.4.7.1 Aerial means

5.4.7.1.1 Water drop of helicopter

The area where helicopters operate dropping water is indicated using a circle with a blue outline (solid line for ongoing activities or dashed for planned). If the area of droping is wide or linear, then several overlapping symbols may be used.

5.4.7.1.2 Retardant drop of helicopter

The area where helicopters operate dropping retardant is indicated using a circle with a red outline (solid line for ongoing activities or dashed for planned) and pattern filling of diagonal red parallel lines. If the area of droping is wide or linear, then several overlapping symbols may be used.

5.4.7.1.3 Water drop of airplane

The area where airplanes operate dropping water is indicated using an eclipse with a blue outline (solid line for ongoing activities or dashed for planned). If the area of droping is wide or linear, then several overlapping symbols may be used.

5.4.7.1.4 Retardant drop of airplane

The area where airplanes operate dropping retardant is indicated using an eclipse with a red outline (solid line for ongoing activities or dashed for planned) and pattern filling of diagonal red parallel lines. If the area of droping is wide or linear, then several overlapping symbols may be used.

5.4.7.2 Ground teams

5.4.7.2.1 Recon

A reconnaissance activity by the ground teams to obtain information is depected by a red double elbow arrow (solid line for ongoing activities or dashed for planned).

5.4.7.2.2 Line defence

Defencive actions that occur in a line by ground means in order to suppress fire or protect e.g. infrastructures, is depected by continious triangles in a row, with red outline, and no fill for planned actions or red solid fill for ongoing ones.

5.4.7.2.3 Perimeter defence

Defencive actions that occur around the fire (in the perimeter) by ground means in order to suppress fire or protect e.g. infrastructures, are depected by continious triangles creating a circle, with red outline, and no fill for planned actions or red solid fill for ongoing ones.

5.4.7.2.4 Containment attack

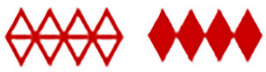
Offensive actions that usually occur at the fire flanks as mutual attacks by ground means in order to suppress fire, are depected by three elbow arrows beginning from the same point, in red colour(dashed line for planned action or solid line for ongoing).

5.4.7.2.5 Hot spot attack

Offensive action by ground forces specifically for hot spots, is depected by a red arrow (dashed line for planned action or solid line for ongoing).

5.4.7.3 Counter fire and tactical fire

5.4.7.3.1 Anchor point



Establishment of the safety line is depected continious double (united at their bottom sides, creating a diamond) triangles in a row, with a red outline, and no fill for planned actions or red solid fill for ongoing ones.

5.4.7.3.2 Spot ignitions

Spot ignitions that are used for controlled burn backfire, are depicted as red outlined circle with a red vertical arrow at the bottom, and no fill for planned actions or red solid fill for ongoing ones.

5.4.7.3.3 Line ignitions

Line ignitions that are used for controlled burn backfire, are depicted as red outlined block elbow arrow, and no fill for planned actions or red solid fill for ongoing ones.

5.4.7.4 Evacuation

5.4.7.4.1 Area to be evacuated

An area that needs to be/is evacuated is depicted by a circle with a green outline, containing the letters "EV". Moreover, if the bottom part is coloured green, it indicates that it is active and running, otherwise it is planned.

5.4.7.4.2 Escape route

The route that is used for the evacuation of people or animals (from EV to SZ) is depicted by a green arrow indicating the direction. With single arrowed head and tail, planned actions are depicted, while with double-arrowed edges active actions are depicted.

5.4.7.4.3 Safe zone

An area where the evacuated people or animals are escorted is depicted by a circle with a green outline, containing the letters "SZ" within. Moreover, if the bottom part is coloured green, it indicates that it is active and running, otherwise, it is planned.

5.5 Matching of map symbols with message structure for exchange of information

The use of formalized graphical symbols to depict the actual situation, in addition to allowing the planning of field activities, supports efficient information sharing at the advanced command post via hand-drawn maps between the personnel on the fire front. These maps can be scanned and transformed into a meaningful digital layer to be shared via smartphone and tablet, so that all the involved actors can be aware of the ongoing operations.

The proposed SITAC-based symbols are not meant to substitute other groups of symbols currently used by operational Control Centres (C2s) for the same purpose. Their role is to act as a reference to properly express concepts and meanings, so as to facilitate the implementation of sound interoperability services between C2s.

For example, as illustrated by Figure 1**– Example of implementation of symbol exchange between Control Centres**, whereas one C2 (say, C2_A) intend to communicate to a second C2 (say, C2_B) the location where a HELI WATER DROP is planned,

- the C2_A operator would still visualise such location through the correspondent symbol offered by his/her C2 system,
- the interoperability service of C2_A would automatically generate a properly formatted message containing the reference code (say, 1234) to the SITAC symbol "HELI WATER DROP", (previously selected as the best match to the C2_A symbol),
- the interoperability service of C2_B would receive such a message, and visualise for the operator either the corresponding C2_B symbol (previously selected as the best match to the SITAC symbol with reference code 1234) or the SITAC symbol "HELI WATER DROP" itself (depending from the settings).

As a result, C2_A and C2_B operators would be able to observe either on the same symbol proposed by this CWA or look to their respective symbol. Thus, each of them would see the symbol they are accustomed to, and they perfectly know the meaning of, so that avoiding unnecessary additional effort, while ensuring the inherent coherence and efficacy of the operational communication exchanged.

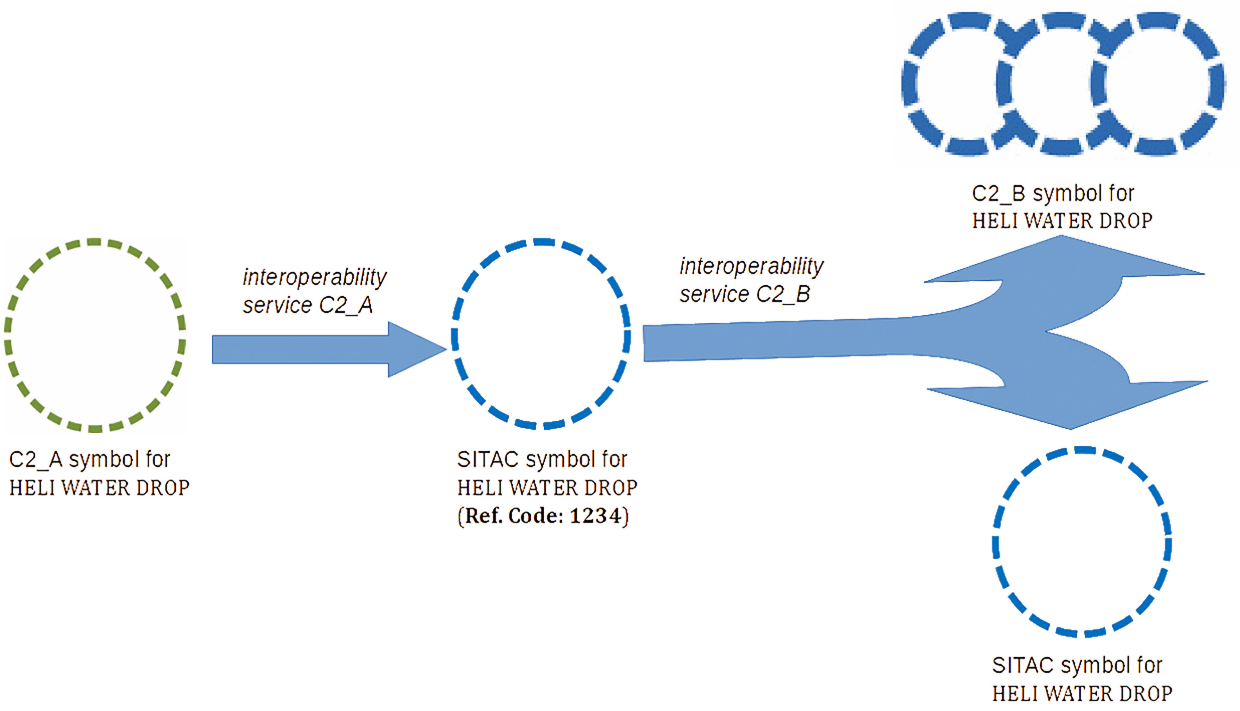
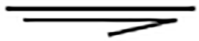


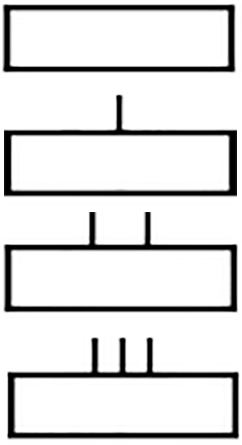
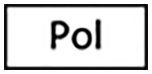
Figure 1– Example of implementation of symbol exchange between Control Centres

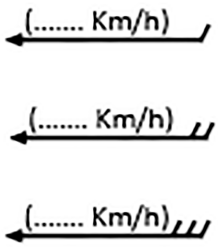
The above "translation" could be achieved either by agreeing on a specific reference code for each proposed symbol of this CWA, among the C2 operators or by using the following indicative matching of symbols with the elements and codes (see Table 5), included in other standards related to message structure for the exchange of information.

Table 5 — Matching of symbols with the elements and codes

SYMBOL[4]	Description	Message code (Definition)[4]
	Road with normal access for all types of vehicles	/ROAD (Road Infrastructure)
	Road with limited access for smaller/lighter vehicles	/ROAD/TRK (Trackway)
	One way road	/ROAD/1RD (One-way road)
	Water point for ground vehicles	/FAC/WATFIR (Water and foam Supplies) /FAC/OTH/ RES (Reservoir) /FAC/OTH/WATSPL (Water supply)

[4] For symbols that have both planned and ongoing version, the Emergency Management Shared Information (EMSI) code can be applied to both, but only one of the two symbols is included in the table.
[4] The message codes can be further enhanced, adapted, combined by adding a in the end a slash and an acronym (e.g. a /VEH/EMG/FIRFS would be a firefighting vehicle, or /VEH/AIR/CAN would be a Canadair)

SYMBOL[4]	Description	Message code (Definition)[4]
	Water point for helicopters	/FAC/WATFIR (Water and foam Supplies)
	Water point for airplanes	/FAC/WATFIR (Water and foam Supplies)
	Sensitive point for C – Chemical B – Biological R -Radiological N – Nuclear	/DGR/CHM (Chemically contaminated area) /DGR/RAD (Radioactive area) /DGR/BIO (Biologically contaminated area) /DGR/ NUKCNL (Nuclear dose rate contour line)
	Helispot	/GEN/LA (landing area)
	Horizontal or oblique flight obstacles (ropeway, cableway, etc.)	/DGR/ OBSGEN (Obstacle, general)
	Vertical flight obstacles (poles, towers, antennas, cranes wind turbines, etc.)	/DGR/ OBSGEN (Obstacle, general)
	Ground forces Generic Vehicle Unit Group Columns	<u>Generic categories</u> VEH (Vehicles) /VEH/EMG (Vehicle — Emergency) /HUM/UNIT (Unit) <u>Organizations</u> /ORG/FIRFS (Fire services) /ORG/ CIVP (Civil Protection) /ORG /POLICE (Police)
	Command post	/FAC/OPR/MOBLCP (Command post, Mobile)
	Law Enforcement Authorities	/HUM/UNIT/POL (Police Units) /HUM/UNIT LAWENF (Law Enforcement)
	Emergency Management Services	/VEH/EMG (Vehicle — Emergency) /HUM/UNIT/MEDCL (Medical) /ORG/AMBUL (Ambulances)
	Aerial forces (airplanes, helicopters)	/VEH/AIR (Aerial vehicle) /VEH/AIR/HEL (Helicopters)

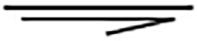
SYMBOL[4]	Description	Message code (Definition)[4]
	Transit Point	/GEN/TRSTRT (Transit route)
	Fire outline	/FLAME (Area in combustion)
	Wind direction and strength	Wddsss (Wind direction and speed)
	Recon	/INT/RECCE (Reconnaissance)
	Evacuation	/RSC/MEDEVC (Medical Evacuation) /POL/EVAC (Evacuation)
	Escape route	/GEN/SAFERT (Safe route)
	Safe zone	/GEN/SAFZ (Safety zone)

Annex A
(normative)

SITAC based proposed symbol set

The following tables summarize the symbol set to be used during the managing of forest fire incidents, categorized in symbol groups and functionalities, as described in clause 5.

Table A.1 — Symbol set for the operating area

SYMBOL	Description
	Delimitation of operational sectors
	Road with normal access for all types of vehicles [combined with a textual indication of (4x4) in case it is unpaved]
	Road with limited access for smaller/lighter vehicles [combined with a textual indication of (4x4) in case it is unpaved]
	One way road
	Road closed
	Trail
	Slight slope
	Moderate slope
	Steep slope
	Power line on
	Power line off
	Water point for ground vehicles
	Water point for helicopters
	water point for airplanes

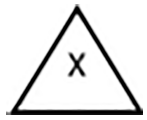
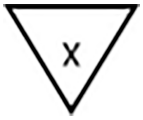
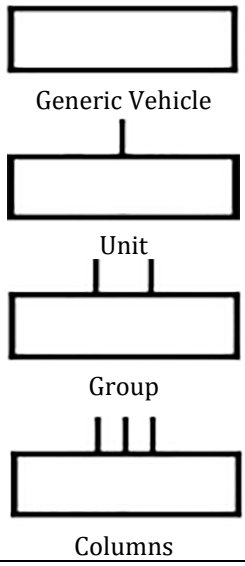
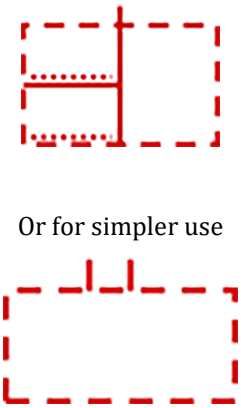
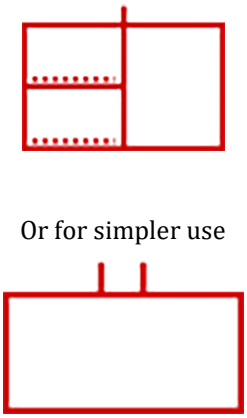
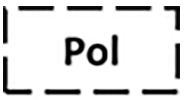
SYMBOL	Description
	Generic symbol for source of danger such as UXO- unexploded ordnance/explosives G- Gas E- Electric
	Source of danger from N – Nuclear R -Radiological B – Biological C – Chemical
	Sensitive point for UXO- unexploded ordnance/explosives G- Gas E- Electric
	Sensitive point for N – Nuclear R -Radiological B – Biological C – Chemical
	Sensitive target location related to fire
	Sensitive target location related to humans especially for WUI
	Helispot
	Horizontal or oblique flight obstacles (ropeway, cableway, etc.)
	Vertical flight obstacles (poles, towers, antennas, cranes wind turbines, etc.)

Table A.2 — Symbol set for resources and means

Means	Symbols to be combined with colours and containers	Planned	Active	Containers
Ground forces				IC- Incident Commander FB- fire brigade FS -forest service VOL- volunteers DOZ dozers EU EU-Module
Command post				
Law Enforcement Authorities				Police
Emergency Management Services				Health care/rescue
Aerial forces (airplanes)				**Plane- airplanes in general** CAN- Canadair BOSS- Fireboss PZL- PZL (Mielec) M-18B BE- Beriev
Aerial forces (helicopters)				**HELI- Helicopters in general** S64 - Erickson S-64 COU - Cougar helicopter BELL - Bell 412 CH - CHINOOK SP - SUPER PUMA KA - KAMOV

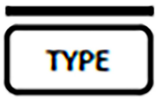
Means	Symbols to be combined with colours and containers	Planned	Active	Containers
Transit Point				
Infrastructure				MMP (means meeting point) VMP (Victims meeting point) MH (Mobile hospital) HSP (Hospital) MOR (Morgue) VET (Veterinary) REST (Restaurant) P (Parking) MEC (Mechanic support) OIL (OIL refuelling point) ELEC (Electricity support point) FOAM (Foam reserve) RET (Retardant reserve)

Table A.3 — Symbol set for fire evolution and weather situation

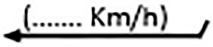
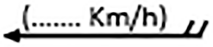
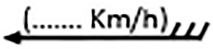
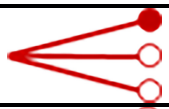
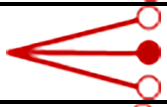
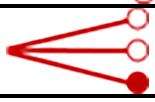
SYMBOL	Description
	Fire outline
	Main direction of fire propagation/ head of the fire
	Secondary fire flank (fast)
	Secondary fire flank (slow)
	Ignition point
	Fire front
	Wind direction weak
	Wind direction moderate strength
	Wind direction strong
	Crown fire
	Surface fire
	Ground fire

Table A.4 — Symbol set for firefighting actions

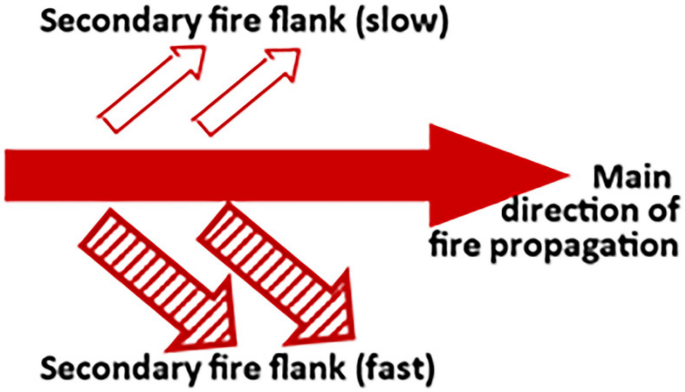
ACTION	PLANNED	ONGOING	ENGLISH TERM
AIREAL MEANS			Long Term Fire retardant drop (airplanes)
			Water drop (airplanes)
			Long Term Retardant drop (helicopters)
			Water drop (helicopters)
GROUND MEANS			Reconnaissance
			Fire defence in line
			Perimeter fire defence
			Containment-mutual attack/flank attack
			Hot spotting/offensive action
CONTROLLED BURN BACKFIRE			Establishment of safety line (Anchor point)
			Spot ignitions
			Line ignitions
EVACUATION			Evacuation
			Escape route
			Safe zone

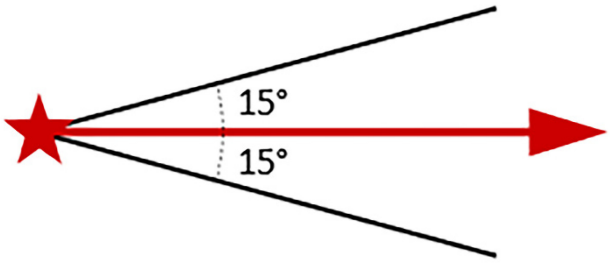
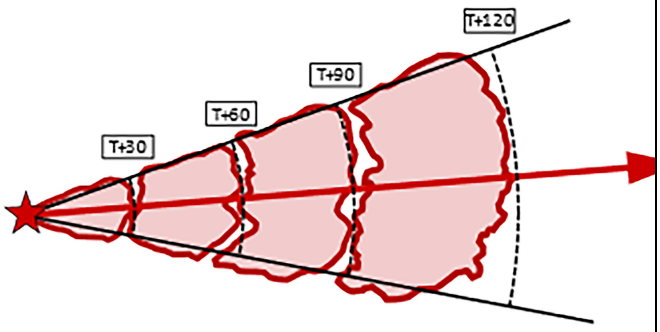
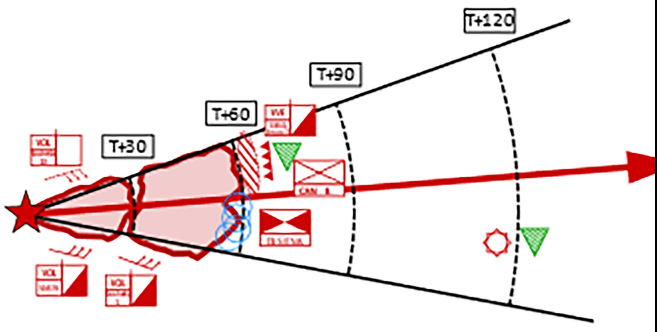
Annex B
(informative)

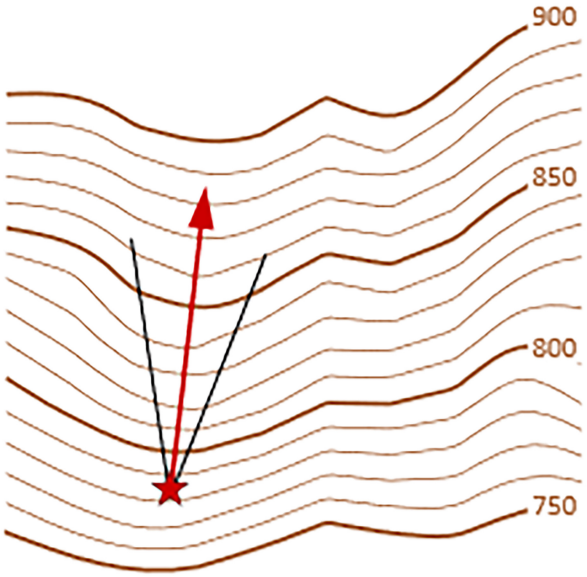
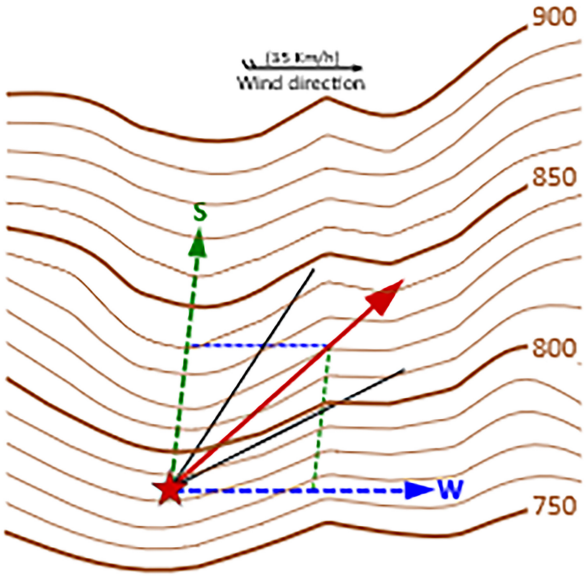
Example of symbology application during a forest fire incident

The following Table B.1 contain a description of the symbol set application (combination of symbols included in clause 5) during a hypothetical scenario of a forest fire incident, providing indicative maps with symbols per phase/step of the scenario.

Table B.1 - Example of symbology application

DESCRPTION	Symbol combination
Fire propagation directions	
Fire parts	

DESCRPTION	Symbol combination
Fire propagation hypothetic cone (degrees can be adjusted depending on the circumstances)	
Fire propagation	
Time-based response planning	

DESCRPTION	Symbol combination
Fire propagation influenced by slope only	
Fire propagation influenced by slope and wind	

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