Integrated monitoring and early warning forest fire detection system implementation project

United Nations project (RFP 3100005138) for Provision of technical assistance for building up integrated monitoring and early warning forest fires detection system in the Borjomi - Kharagauli National Park by innovative remote sensing tools, in Georgia

Assignment: Output 3 (Deliverable): Develop and Test the system in the area of the Borjomi - Kharagauli National Park of Georgia (Causacus). - Activity 3. 2.2 Software solution development and Implementation Report

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1.1. Project Overview

This initiative, undertaken by the International Business and Economic Development Center (IBEDC) under a contract with the United Nations, seeks to enhance forest fire management using innovative remote sensing tools.

The objective of this project (Integrated Monitoring and Early Warning Forest Fire Detection System Implementation Project) is to implement a monitoring and early detection system for forest and landscape fires. The system enhances early detection capabilities, provides real-time monitoring, and facilitates quick response to potential fire incidents. The system will be installed on the Customer's local server and will provide secure access to authorized users through a web interface.

Project Key Objectives were:

- Develop an integrated monitoring and early warning system for forest fires.
- Utilize innovative remote sensing tools to enhance fire detection capabilities.
- Establish a standard operating procedure for the system's use.
- Train personnel on the new system for effective implementation.

Stakeholder Analysis

- **United Nations (UN)**: Client, providing oversight and ensuring project aligns with global standards and protocols;
- **International Business and Economic Development Center (IBEDC)**: Contractor responsible for project execution;
- **LEPL The Agency of Protected Areas** (http://apa.gov.ge/en) of Ministry of Environment and Natural Resources Protection of Georgia Protected Areas - **Beneficiary** of the System;
- **Local Authorities and Park Management**: Key stakeholders in the Borjomi-Kharagauli National Park who will utilize and manage the new system;
- **Local Community**: Indirect beneficiaries of enhanced fire detection and management systems.

2. Assignment Objectives

2.1. Activity 3.2.2: Assignment Objectives Development and Implementation

United Nations project (RFP 3100005138) for Provision of technical assistance for building up integrated monitoring and early warning forest fires detection system in the Borjomi - Kharagauli National Park by innovative remote sensing tools, in Georgia

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Once the technology will have been selected by the stakeholder working group, the implementer will design the full architecture of the integrated monitoring and early warning forest fires detection system to be used in Borjomi - Kharagauli National Park.

This information will be summarized first with the architecture of the system, then in a report that will provide details about the components and the specificity of the designed system.

3. Developed and Implemented system design

By following Assignment Develop and Test the system in the area of the Borjomi - Kharagauli National Park of Georgia- Activity 3. 2.2 Software solution development and Implementation following system design developed and implemented.

3.1. Summary

The Implemented software solution meet the specific needs of the integrated monitoring and early warning forest fires detection system, ensuring robust functionality, high performance, and security for the selected area. Project team excepts provide a comprehensive system design and implementation of system that supports real-time monitoring, effective user management, accurate fire localization, and reliable alarm notifications (Activity 3. 2.2 Scope).

considering the scalability, reliability, and integration capabilities of potential solutions to select the best fit for the project's objectives. Adopting industry best practices for software development, security, and user experience are critical to the designed and implemented system's success and future improvement.

3.2. *Implemented* System Design Overview

The Integrated Monitoring and Early Warning Forest Fires Detection System will consist of the following main components:

1. Data Acquisition Layer
2. Processing and Analysis Layer
3. User Interface Layer
4. Communication Layer
5. Storage Layer

Let's break down each component and discuss the processes involved

4. Data Acquisition Layer

This layer is responsible for collecting data from various sources, primarily the network of cameras installed throughout the Borjomi-Kharagauli National Park.

This layer consists of high-resolution video cameras with night vision capabilities installed at strategic locations throughout the Borjomi-Kharagauli National Park. The cameras equipped with

pan-tilt-zoom (PTZ) capabilities for wider coverage and detailed inspection. They also have thermal imaging capabilities to detect fires obscured by smoke or foliage.

Processes: a) Video Feed Collection

- High-resolution cameras continuously capture video feeds of the monitored area.
- PTZ (Pan-Tilt-Zoom)[1] functionality allows for wider coverage and detailed inspection. (For more details click Here)

b) Weather Data Collection (For more details click Here)

- Weather stations integrated with the system collect real-time meteorological data, including temperature, humidity, wind speed, and direction.

c) Satellite Data Integration

- The system integrates satellite imagery and data to provide a broader perspective on the monitored area.

4.1. Data Acquisition Layer Components

Integrated monitoring and early warning fires and smoke detection system consist from the following components:

A metal mast equipped with the following components is placed in the selected place for monitoring forest massifs with the beneficiary (Details)

1) Lightening rod;
2) Rack cabinet for equipment;
3) Independant power supply system built with solar panels;
4) Communication system;
5) Remote sensing tools – video camera set;
6) Video camera for monitoring the tower and adjacent area providing local security;

[1] A pan-tilt-zoom camera (PTZ camera) is a robotic camera capable of panning horizontally (from left to right), tilting vertically (up and down), and zooming (for magnification). PTZ cameras are often positioned at guard posts where active employees may manage them using a remote camera controller.

4.1.1. The mast location

For the purposes of analysis within the scope of the assignment, a potential location was selected with the contract beneficiary at the following coordinates in Abastuman, Zekar Pass:

- Latitude 41.8230806;
- Longitude 42.8486678;

A 6-meter mast will be installed in the selected place, and the visibility of the video camera in the monitoring area covers 3050 hectares.

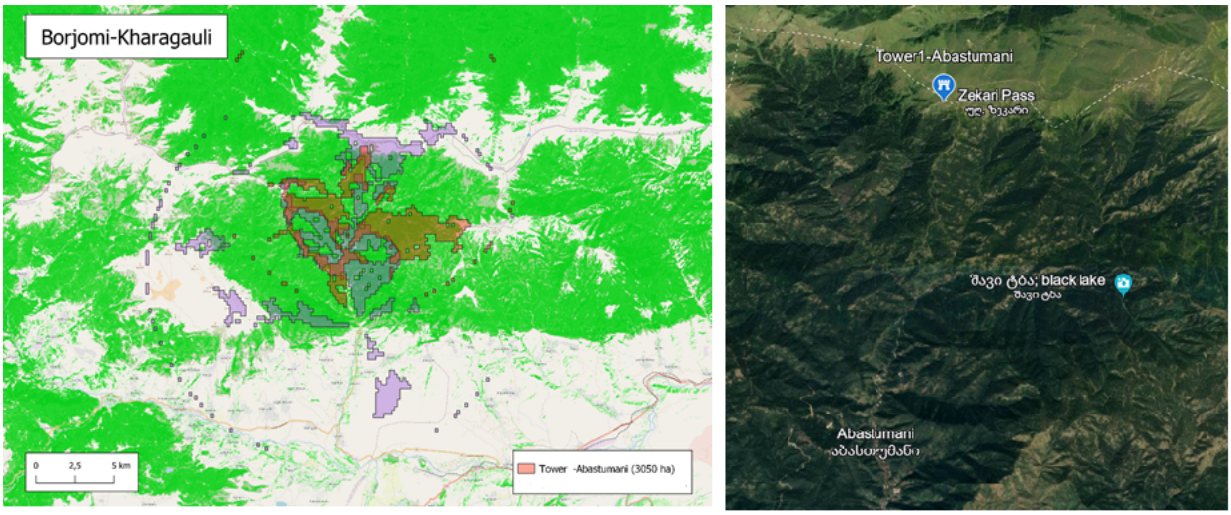


Figure 1 - Camera mast location

The following recommendations were considered for implementation:

- A robust maintenance schedule was implemented for all hardware components to ensure continuous operation.
- AI-enabled cameras with built-in processing capabilities to reduce data transmission load implemented.

5. Processing and Analysis Layer

This layer is the core of the system, responsible for analyzing the collected data and detecting potential fire incidents.

This layer is responsible for real-time video processing and fire detection. It includes AI-based algorithms for smoke detection and fire source visualization. The system is capable of issuing alarm

signals to operators upon fire detection and generating patrol routes for automatic territory inspection.

Processes: a) **Video Analysis** (For more details click Here)

- AI-powered algorithms analyze video feeds in real time to detect smoke or fire.
- The system compares current images with baseline images to identify anomalies.

c) **Smoke Detection**

- Advanced algorithms process data from smoke detector groups to identify potential fires.
- Determining the location of the fire. Location and indicating it on the map
- Ensuring the accuracy of determining coordinates with visibility from one camera with an error (with an object range of up to 10 km) of no more than 150

d) **Fire Hazard Calculation**

- The system calculates and updates fire hazard classes based on current weather conditions and historical data.

e) **False Positive Reduction**

- Machine learning (AI – Artificial Intelligence) algorithms continuously improve fire detection accuracy, according built-in AI learning process and reduce false alarms.

5.1. Central Management software for the system

The beneficiary of the system allocates the necessary information technology resources (server, data storage, internal and external communication channels[2]) resources, where the software of the central management system will take place. This program is represented by the following modules:

1) Web portal built on the GIS system;
2) Full management of video cameras;
3) Automatic detection of smoke and fire;
4) Determine the distance and mark the point on the map;
5) Incident fixation, confirmation;
6) Users rights management
7) Sharing video cameras;
8) Internal messaging;

[2] Detailed technical requirements are explained in the document below

9) Archive;
10) Statistics, reports;
11) Support to various organizations, multitenant
12) Obtaining information from third-party systems

5.1.1. Designed and Implemented Functional capabilities of system

1. Installation and Access:
    - The software is installed on a local server located at the Customer's premises.
    - System Ensures secure access to the system from any internet-connected location.
    - System Ensures Fully functional access for the Customer's specialists through a secure web interface without additional software installations.
    - User identification in the system according to established access rights and statistics collection is implemented.
2. Monitoring and Detection:
    - Video monitoring of the territory with early fire detection capabilities in both automatic and manual modes.
    - Alarm signal issuance to operators upon fire detection.
    - Generation of patrol routes for automatic territory inspection.
    - Automatic saving of video material from inspections and easy user access to the saved materials.
    - Notification mechanisms for detected potential fires.
    - Enlarged display of suspected fire sources and map marking of fire locations.
3. User Interaction and Control:
    - Detailed video camera viewing and control capabilities.
    - Full access to camera interfaces (orientation and zoom adjustments).
    - Real-time camera orientation information (azimuth) displayed numerically and on a map.
    - Formation and viewing of patrol routes with user access.
    - Time-sharing mode for multiple users on one camera.
    - Online video output to additional monitors.
4. Map and Statistical Tools:
    - Interactive map integration with real-time updates of camera locations and orientations.
    - Tools for measuring distances and areas on the map.
    - Generation of detailed statistics on communication channel operations.
    - The addition of various map types and terrain diagrams.
5. Data Handling and Reporting:
    - Real-time and archived video data access.

- False positive prevention mechanisms.
- Fire hazard class calculation and display.
- Comprehensive data recording for system changes and user actions.

5.1.2. Designed and Implemented Non-functional capabilities of system

1. **Performance:**
   - Fire detection speed within 10 seconds.
   - Error margin for fire direction determination (0.05 degrees) and object coordinates (up to 100 m for two cameras).
   - Accurate coordinate determination within a 150 m error for up to 10 km range.
2. **Scalability:**
   - Support for an unlimited number of cameras and users.
   - High scalability for future expansions.
3. **Reliability:**
   - High system availability and fault tolerance.
   - Robust data storage and retrieval mechanisms.
4. **Security:**
   - Secure access protocols.
   - User authentication and authorization mechanisms.

Detailed system capabilities described in the appendix below

Detailed technical requirements explained in the document below

6. User Interface Layer

This layer provides secure access to the system for authorized users through a web-based interface.

This layer provides a user-friendly web interface for system operators, administrators, and decision-makers. It supports secure access from any internet-connected location, user identification based on established access rights, and real-time weather condition display.

1. **User benefits**
   - User-friendly web interface.
   - Training for customer users on system operation.
   - Regular updates and maintenance support.
   - Real-time weather condition display.

Processes:

a) User Authentication and Authorization

- Secure login process with multi-factor authentication.
- Role-based access control to manage user permissions.

b) **Real-time Monitoring Dashboard** (For more details click Here)

- Display live video feeds from selected cameras.
- Show interactive map with camera locations and orientations (For more details click Here).
- Present current weather conditions and fire hazard levels. (For more details click Here)

c) **Alert Management** (For more details click Here)

- Display alerts for potential fire incidents with enlarged images and map locations.
- Provide tools for operators to verify and respond to alerts.

d) **Patrol Route Management** (For more details click Here)

- Generate and display automatic patrolling routes.
- Allow manual adjustments to routes as needed.

e) **Reporting and Analytics**

- Generate detailed statistics on system performance and incidents.
- Provide tools for custom report creation.
- Early detection system for forest fires Collects information in incident register in video format for their further review and assessment (For more details click Here)

The following recommendations were considered for system design and implementation:

- an intuitive, user-friendly interface design that minimizes training requirements.
- responsive design for access from various devices (desktops, tablets, smartphones).

7. Communication Layer

This layer handles all communication between system components and external stakeholders.

Processes:

a) Internal System Communication (For more details click Here)

- Manage data flow between cameras, servers, and user interfaces.
- Ensure secure, encrypted communication within the system.

b) Alert Notifications (For more details click Here)

- Send automated alerts to relevant personnel via multiple channels (e.g., in-app notifications, SMS, email).

c) External Systems Integration

- Facilitate communication with other relevant systems (e.g., local fire departments, emergency services).

The following recommendations were considered for implementation:

- Redundant communication channels implemented to ensure system reliability.
- standardized protocols implemented for easier integration with external systems.

8. Storage Layer

This layer manages the storage and retrieval of all system data.

This layer provides a user-friendly web interface for system operators, administrators, and decision-makers. It should support secure access from any internet-connected location, user identification based on established access rights, and real-time weather condition display.

Processes: a) Video Storage (For more details click Here)

- Efficiently stores and manages video feeds, allowing quick access to historical data.
- Implements data retention policies based on storage capacity and legal requirements.

b) Metadata Storage

- Stores and manages metadata related to incidents, alerts, and system operations.

c) User Activity Logging

- Records all user actions for auditing and system improvement purposes.

The following recommendations were considered for implementation:

- Imp tiered storage system implemented, with frequently accessed data on faster storage media.
- regular backups and a disaster recovery plan developed.

8.1. Developed and implemented GIS Platform, Fire Events Localization, Case Management System

Objective: To implement a Geographic Information System (GIS) platform that facilitates real-time fire event localization and case management.

Business Requirements developed and Implemented:

- GIS Platform:
  - Developed a GIS platform that integrates with the central database and displays real-time data on a map.
  - Supports layers for different types of geographical data, including terrain, vegetation, and fire risk zones.
  - Allows users to visualize camera locations, active fires, and other critical infrastructure on the map.
  - Provides tools for measuring distances, drawing boundaries, and marking points of interest.
- Fire Events Localization:
  - Implemented real-time tracking of fire events with precise location data.
  - Designed and implemented Video monitoring of the territory and early detection of fires in automatic and manual mode with the issuance of alarm signals to the operator
  - The ability to create automatic patrol routes for the territory in accordance with the characteristics of the territory, equipment and communication channels, and control filming during patrolling along the created routes
  - The ability to automatically save video material obtained during an automatic inspection of the territory, with subsequent provision of convenient access to the saved materials to the user
  - Automatic Smoke Detector Group Processing Tool
  - Allows users to set geofences and receive alerts when a fire is detected within these boundaries.
  - Checking and confirming objects detected by the System;
  - Clarification of coordinates of objects detected by the System;
  - Changes in the status of objects detected by the System (potentially dangerous object, verified potentially dangerous object, fire).
  - Select a video camera for detailed viewing and control;
  - Full access to camera interfaces: ability to change camera orientation, camera zoom;
  - User access to camera interfaces: ability to change camera orientation and zoom;

- Camera orientation control: by coordinates/azimuth, video image, saved camera positions;
- Camera control using a map of the area, indicating the orientation direction. The direction can be an arbitrary point on the map
- Presenting the user with the current orientation of the camera relative to the north (azimuth) as a number and an indication of the direction on a map of the area;
- Presentation of information about the location of video cameras and their current orientation on the map;
- Formation of patrol routes intended for viewing the territory, as well as quick user access to launching and viewing the route. A patrol route is understood as a sequential transition of the camera from one shooting orientation to another while forming video or photo materials of the observation territory at each stop point;
- Unlimited number of users working with one camera in time-sharing mode by separating control and viewing access rights;
- Simultaneous output of online video from cameras to additional monitors;
- Possibility to measure the distance between objects using an interactive map
- Online calculation of the terrain in the direction of the camera's view to accurately determine the distance to a potentially dangerous object from one camera;
- The error in determining the coordinates of an object detected from 2 (two) cameras is no more than 100 m;
- Ensuring the accuracy of determining coordinates with visibility from one camera with an error (at an object distance of up to 10 km) of no more than 150 m;
- Enable integration with satellite data for enhanced fire detection and monitoring.
- Store historical fire event data for trend analysis;

- Case Management System:
  - Developed a case management system to track and manage fire incidents from detection to resolution.
  - Allows users to log incident details, assign tasks, and monitor the progress of fire response activities.
  - Developed to be Integrated with the GIS platform to link incidents with their geographical locations.
  - View real-time video from an unlimited number of cameras simultaneously;
  - Automatic maintenance of photo and video archive on the server;
  - Availability of mechanisms to prevent false alarms;
  - Access to the archive of potentially dangerous objects found by the automatic system;
  - Possibility of creating exclusion zones (masks) on captured images to reduce false alarms during automatic fire detection

Functional Requirements:

- Real-time map visualization of fire events and system data.
- Event localization with GPS accuracy and integration with satellite data.
- Case management with task assignment, progress tracking, and reporting capabilities.

Non-Functional Requirements:

- **Scalability:** Support for increasing data volume as more geographical data and fire events is added.
- **Reliability:** Ensure that the GIS platform remains available and responsive even under heavy load.
- **Security:** Protect sensitive location data with encryption and access controls.

8.2. Developed and implemented Alarm and Notification System

Objective: To create an alarm and notification system that provides real-time alerts for fire events, integrating with external systems through APIs.

Business Requirements developed and Implemented:

- Alarm System:
  - Implemented alarm system that triggers visual and sound alerts based on predefined conditions (e.g., fire detection, camera malfunction)
  - System Allows for customizable alert thresholds and notification settings for different user roles.
  - System designed to integrated with the control and management system to display alarms on the WEB GUI.
  - System Provides redundancy to ensure alarm delivery even if the primary communication method fails.
- Notification System:
  - Developed a notification system that automatically sends alerts to users via email, SMS, or push notifications.
  - System Allow users to configure their notification preferences (e.g., type of events, delivery methods).
  - System designed for integration functions (APIs) to connect with third-party applications, such as fire dispatch systems or emergency services.
  - System Ensures that notifications are delivered promptly and reliably to the intended recipients.

Functional Requirements:

- **Real-time alarm triggering** based on system events.
- **Customizable notifications** for different user roles and events.
- **API integration** with third-party systems for extended functionality.

Non-Functional Requirements:

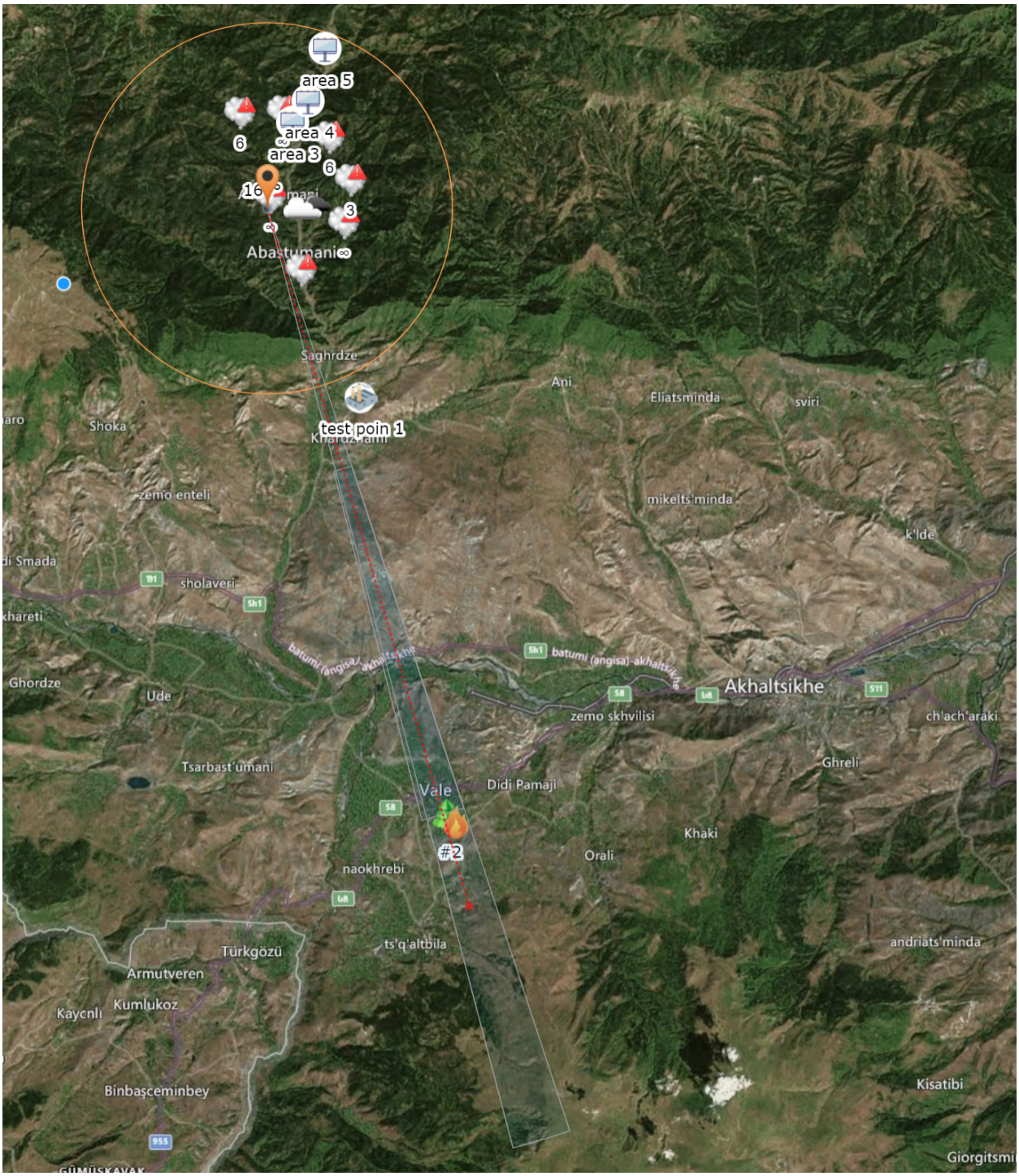
- **Performance:** Ensure alarms and notifications are delivered with minimal latency.
- **Reliability:** Implement failover mechanisms to maintain system operations during outages.
- **Security:** Secure the notification system against unauthorized access and data breaches.

9. Implemented System design and Capabilities in practice

9.1. Video Feed Collection

High-resolution cameras continuously capture video feeds of the monitored area

System Displays live video feeds from selected cameras. Show interactive map with camera locations and orientations.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zemo skhvilisi
ch'ach'araki
Ghordze
Ude
Tsarbast'umani
Didi Pamaji
Vale
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naokhrebi
ts'q'altbila
andriats'minda
Türkgözü
Armutveren
Kumlukoz
Kaycnlı
Binbaşceminbey
Kisatibi
Giorgitsmi

Figure 2 – Camera Monitoring area 1 (from 360 Degree)

Figure 3 - Camera Monitoring area 3 (from 360 Degree)

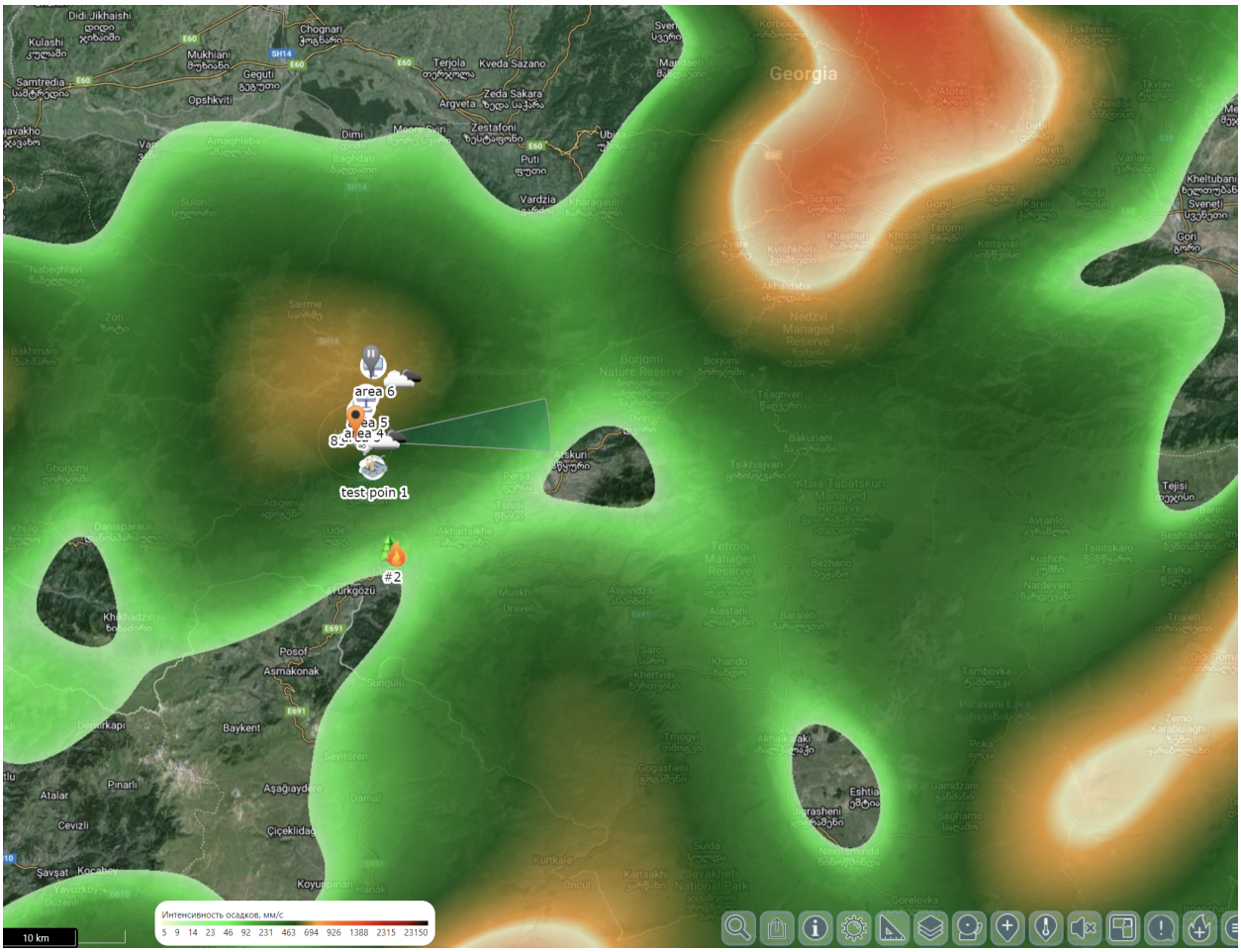
9.2. Weather Data Collection

Weather stations integrated with the system collect real-time meteorological data, including temperature, humidity, wind speed, and direction. System Present current weather conditions and fire hazard levels. Below there are following demonstrations about the Weather in the monitored area:

- Wind direction and speed
- Intensity of atmospheric precipitation
- Air humidification - rain
- Air temperature at a height of 2 meters

Figure 4 - Wind direction and speed (M/S)

Figure 5 - Intensity of atmospheric precipitation (MM/C)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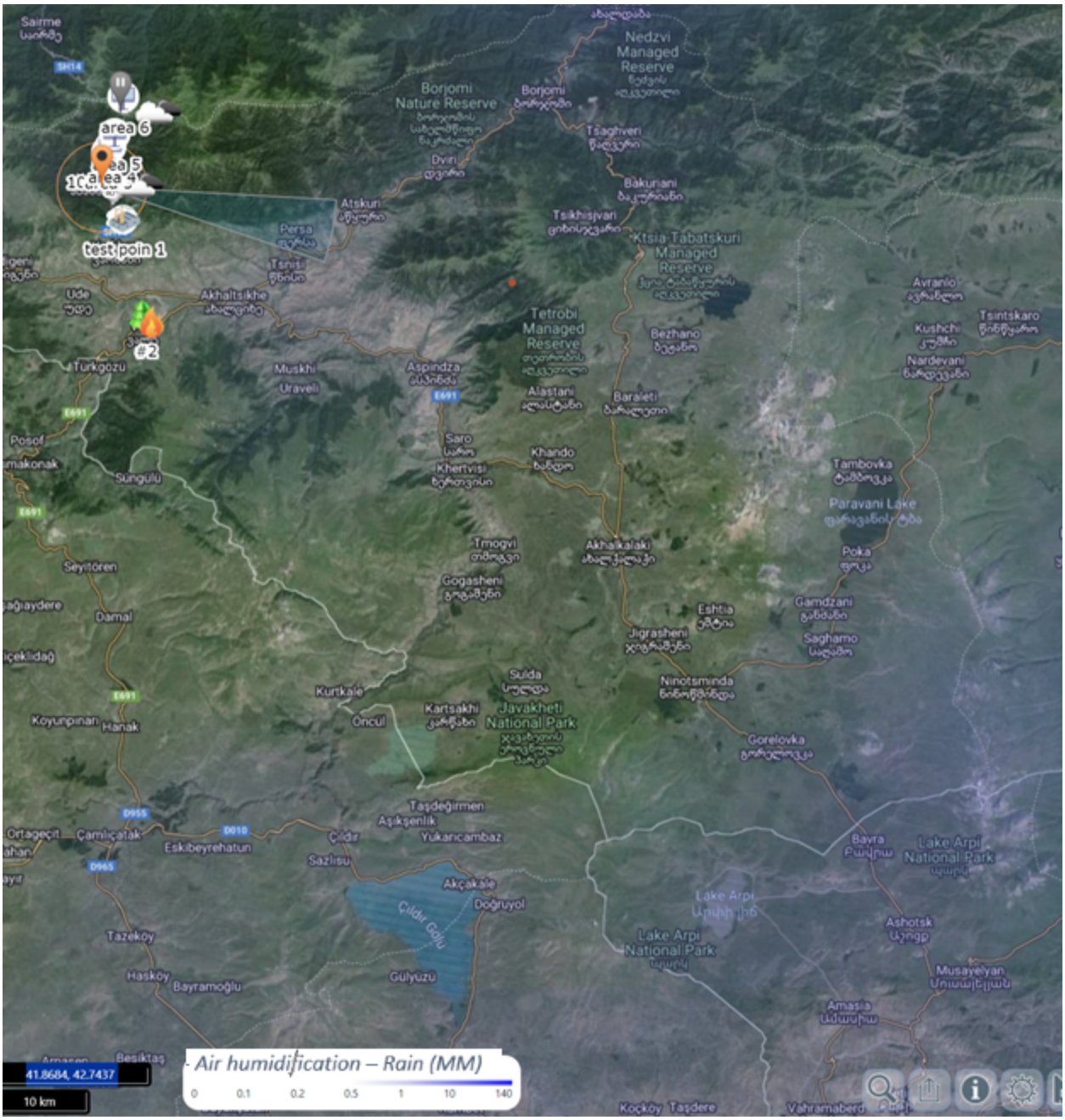


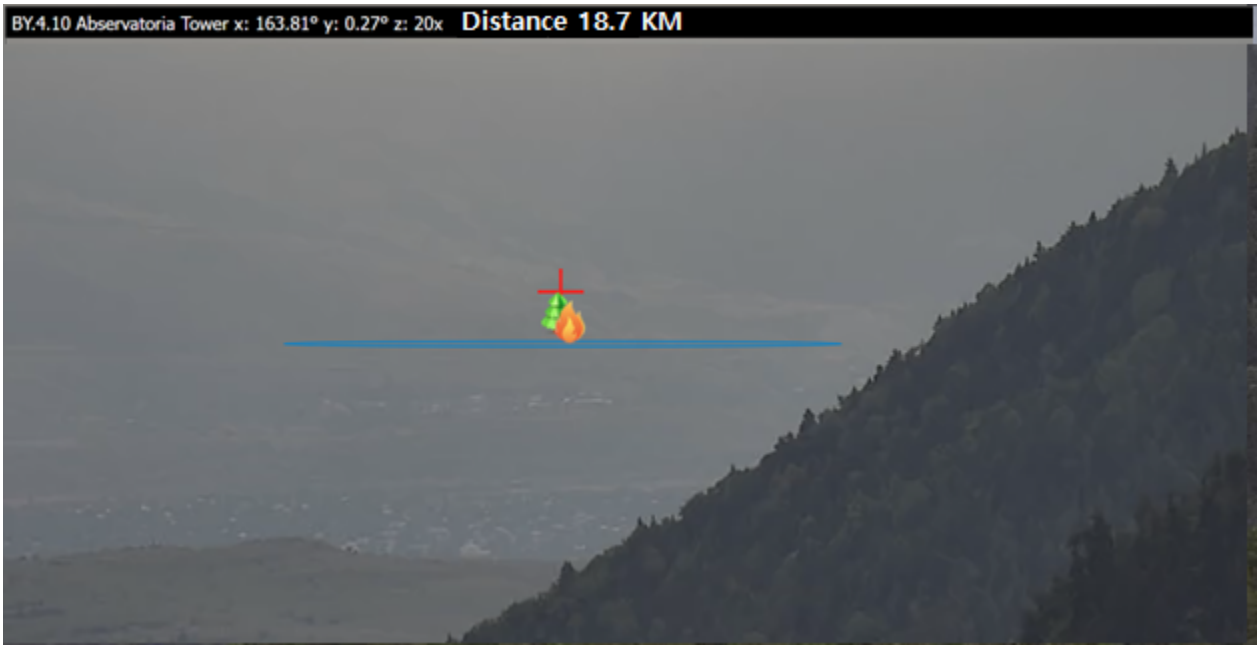
Figure 6 - Air humidification – Rain (MM)

Figure 7 - Air temperature at a height of 2 meters (Celsius)

9.3. Potentially dangerous object detection

AI-powered algorithms analyze video feeds in real-time to detect smoke or fire. The system compares current images with baseline images to identify anomalies as shown in the images below:

Figure 8 - Potentially dangerous object detected – Alert in the Map



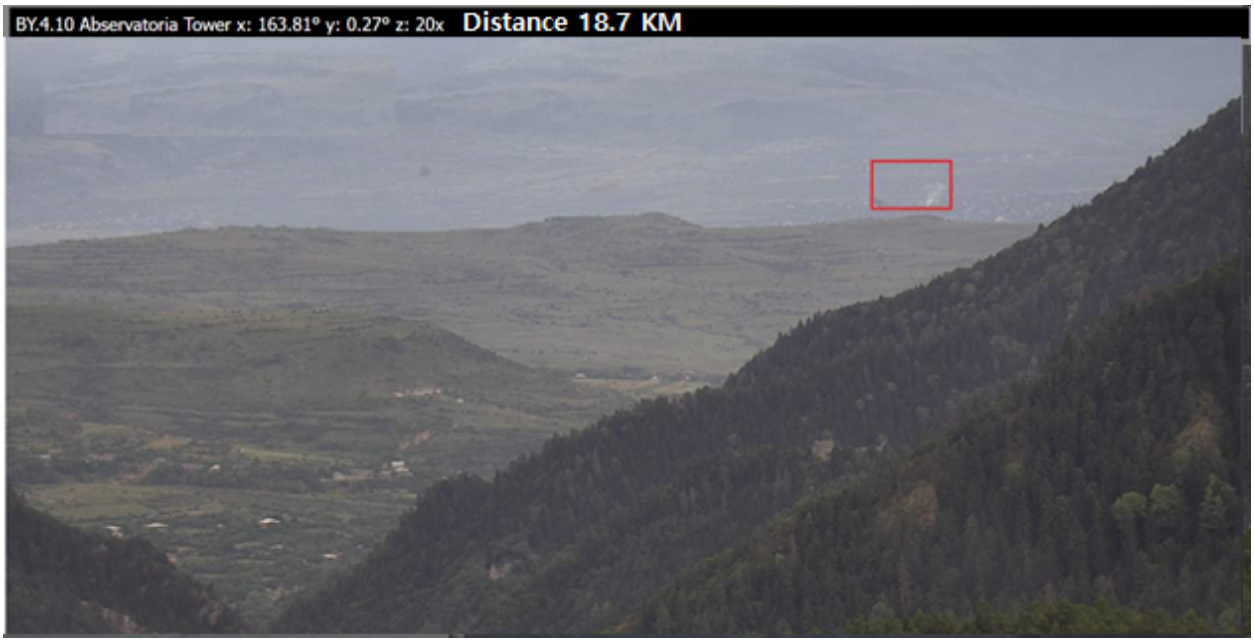


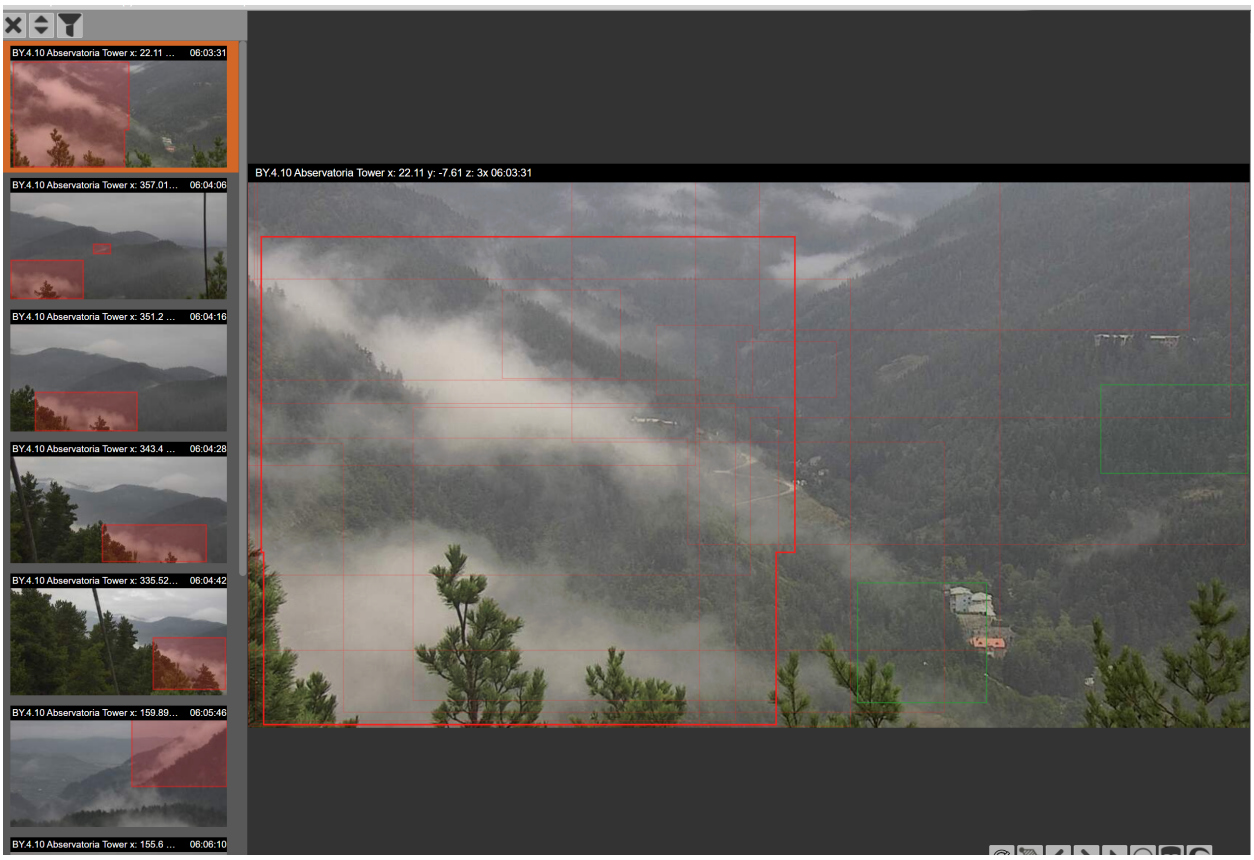
Figure 9 - Potentially dangerous object detected – Real-time View

Alarm initial Report:

- Condition: Potentially dangerous object detected, Confirmed as a fire
- Type of Alarm: Bonfire
- Source: Tower camera 01
- Area Detection time: 2024-07-03 18:06:10
- Confirmation time: 2024-07-03 18:24:18
- Longitude: 42.8812362909
- Latitude: 41.606795036288
- Nearest cameras: Camera 01
- Distance: 18.7 KM
- Information: Nearest urban district and national park

9.4. Event Center

Early detection system for forest fires Collects information in incident register in text and video format for their further review and assessment


BY.4.10 Abservatoria Tower x: 22.11 ... 06:03:31
BY.4.10 Abservatoria Tower x: 357.01... 06:04:06
BY.4.10 Abservatoria Tower x: 351.2 ... 06:04:16
BY.4.10 Abservatoria Tower x: 343.4 ... 06:04:28
BY.4.10 Abservatoria Tower x: 335.52... 06:04:42
BY.4.10 Abservatoria Tower x: 159.89... 06:05:46
BY.4.10 Abservatoria Tower x: 155.6 ... 06:06:10
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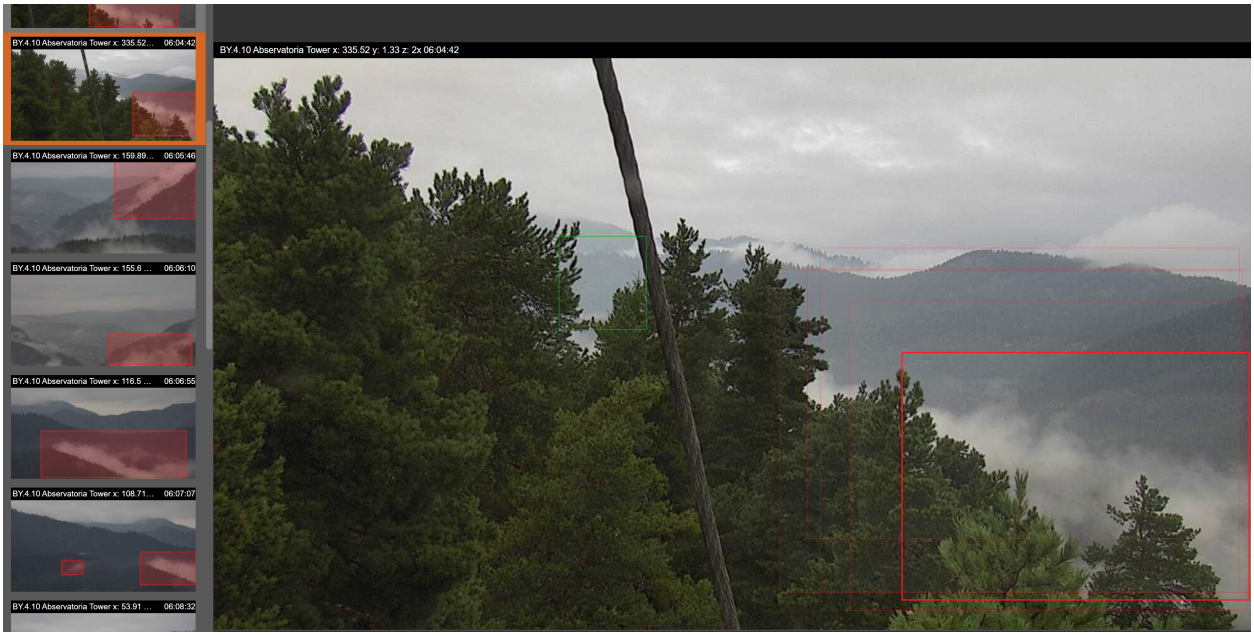
BY.4.10 Abservatoria Tower x: 335.52... 06:04:42
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BY.4.10 Abservatoria Tower x: 116.5 ... 06:06:55
BY.4.10 Abservatoria Tower x: 108.71... 06:07:07
BY.4.10 Abservatoria Tower x: 53.91 ... 06:08:32
BY.4.10 Abservatoria Tower x: 335.52 y: 1.33 z: 2x 06:04:42

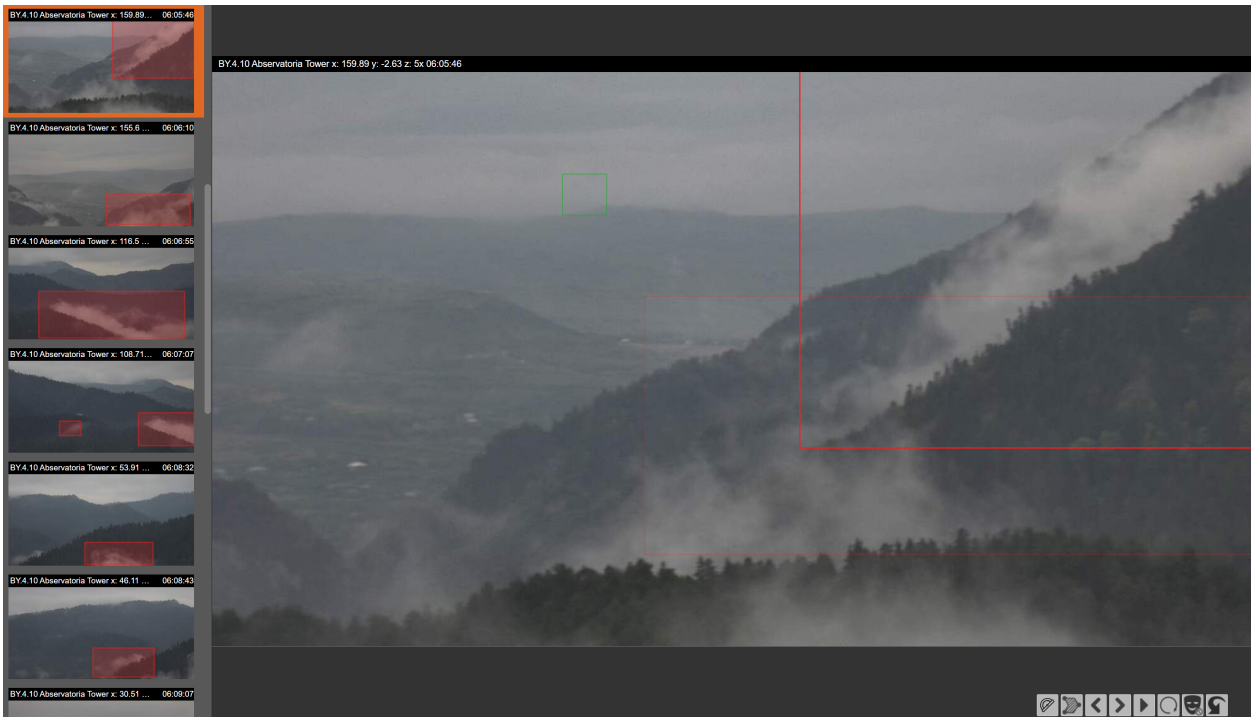


Figure 10 – Alerts Archive – Video Format

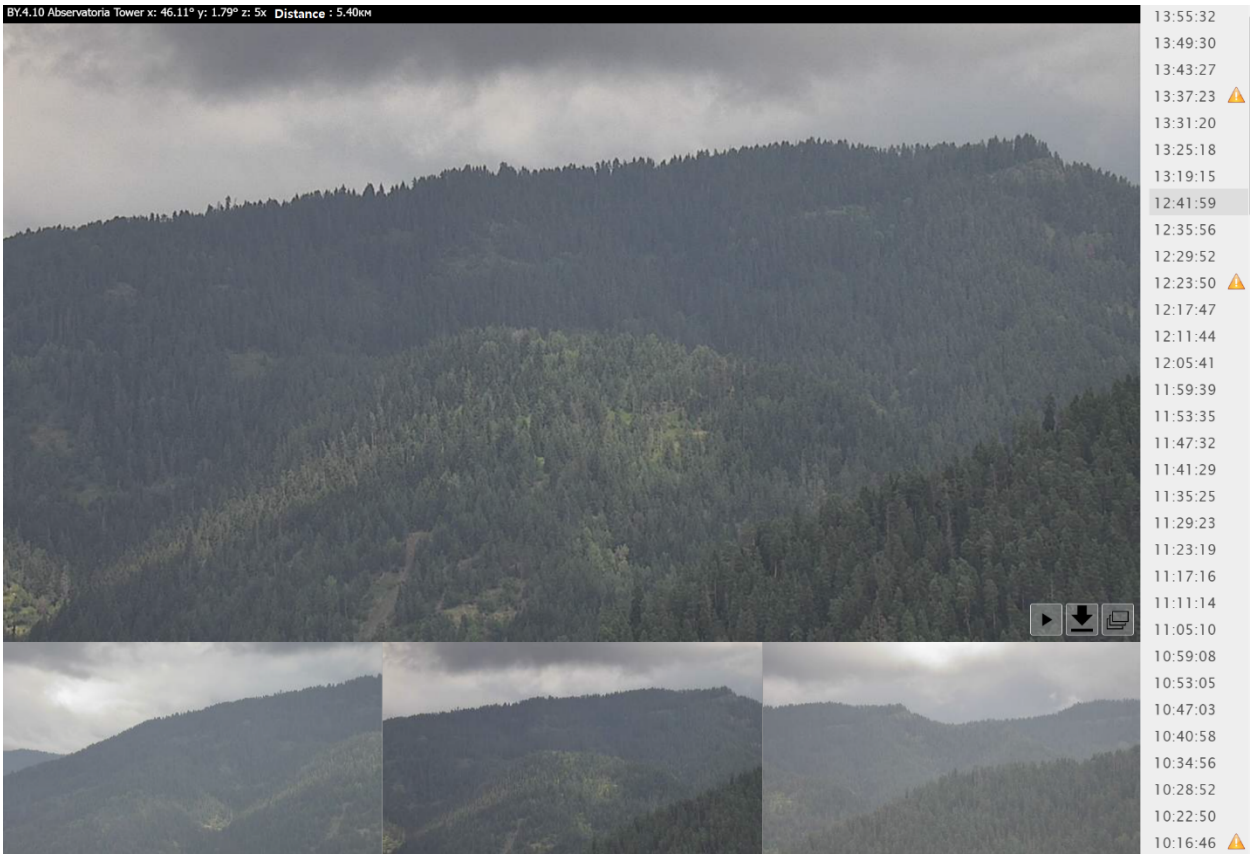


Figure 11 – Alerts Archive by time periods and Distance to the Object – Image Format

9.5. Internal System Communication

System Manages data flow between cameras, servers, and user interfaces. Ensure secure, encrypted communication within the system. Send automated alerts to relevant personnel via multiple channels (e.g., in-app notifications, SMS, email).

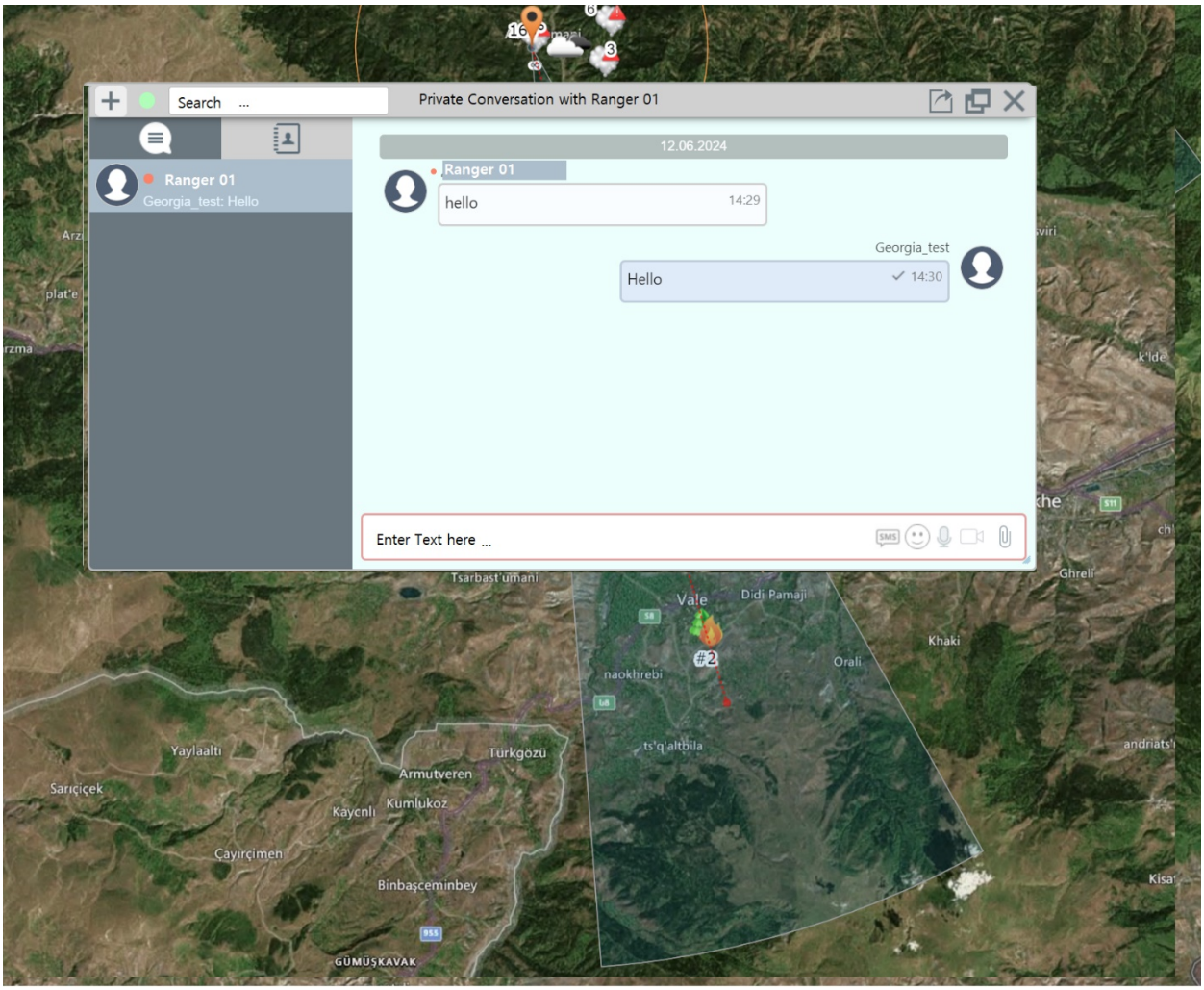


Figure 12 – Real Time Conversation between Operators

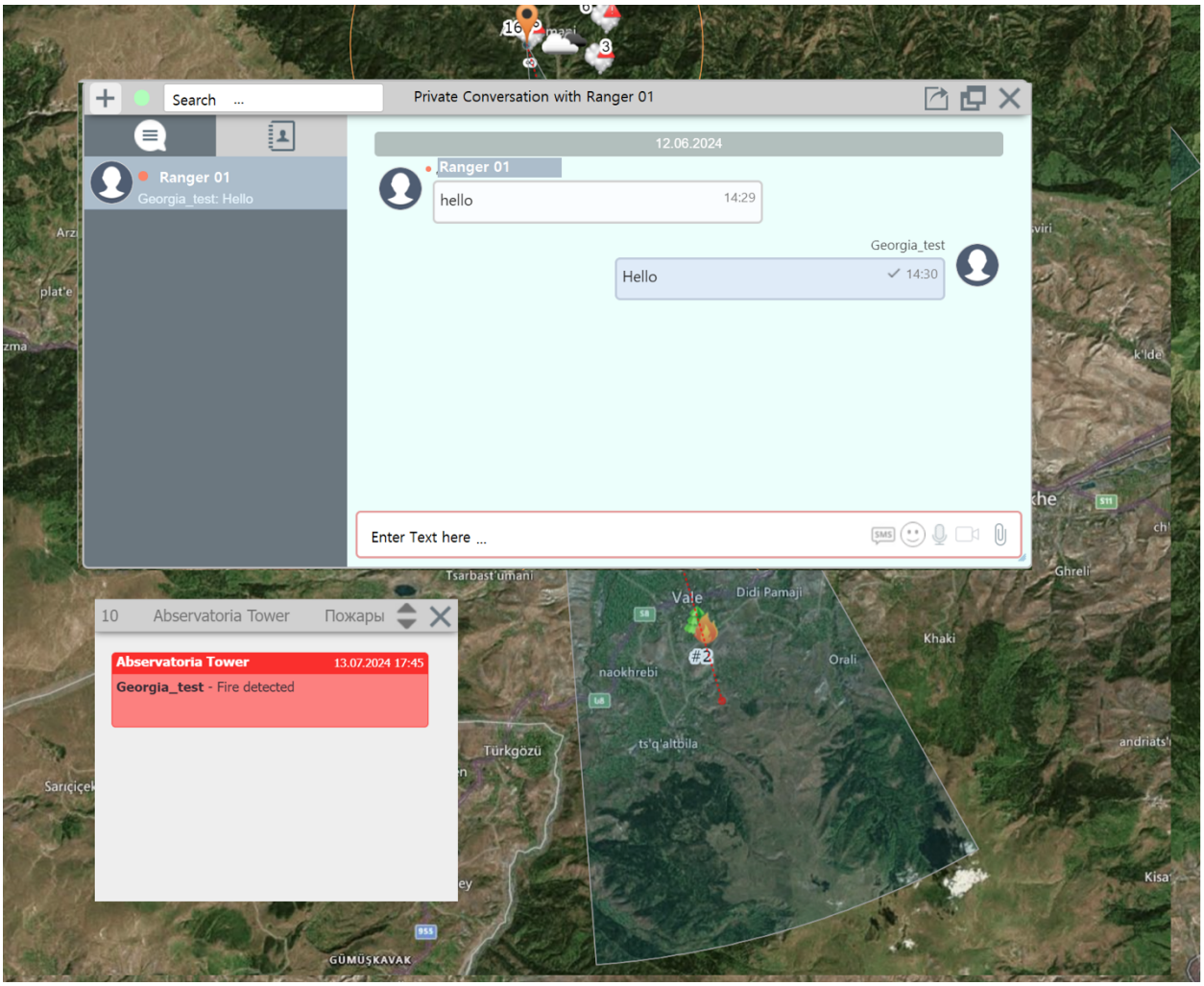


Figure 13 - Figure 14 – Real Time Conversation between Operators and System – Fire Detected Alert

9.6. Video Patrolling Representation Formats

Video patrolling displayed in the integrated Different Geoformation systems:

1. Free Map
2. Open Street Map
3. Open Topo Map
4. Bing Ortho photo
5. Base map – Yandel
6. ESRI Map Box Ortho Photo
7. Google Ortho Photo
8. Google Height Map

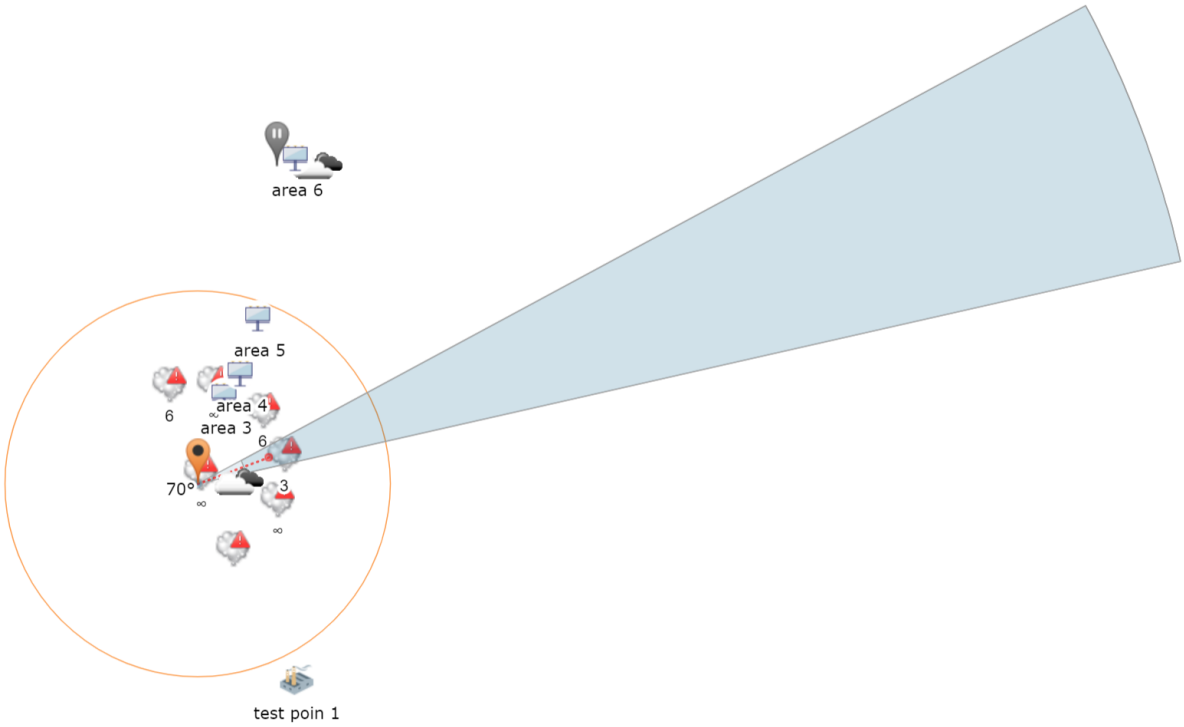


Figure 15 – Free Map

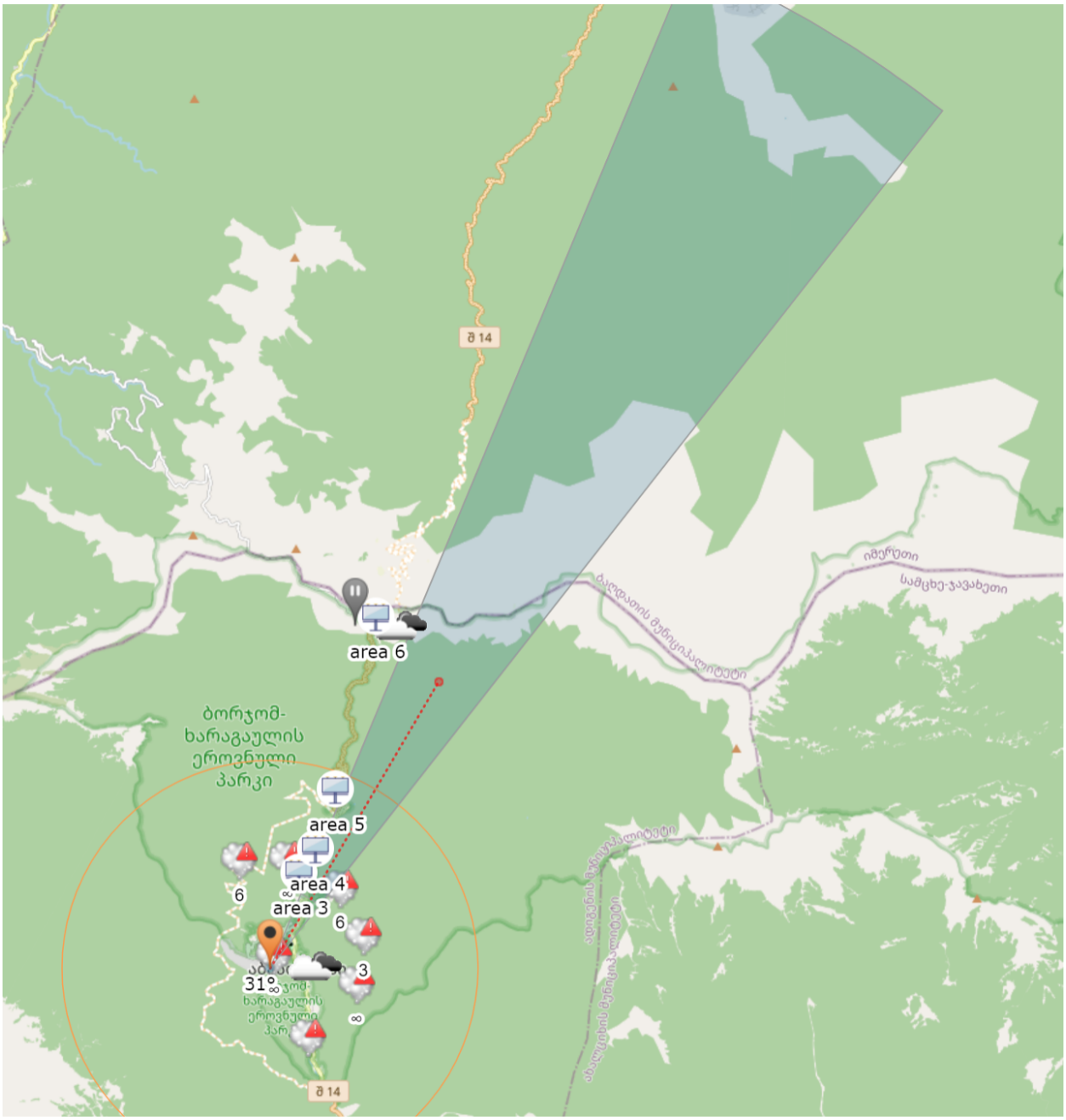


Figure 16 – OpenStreet Map

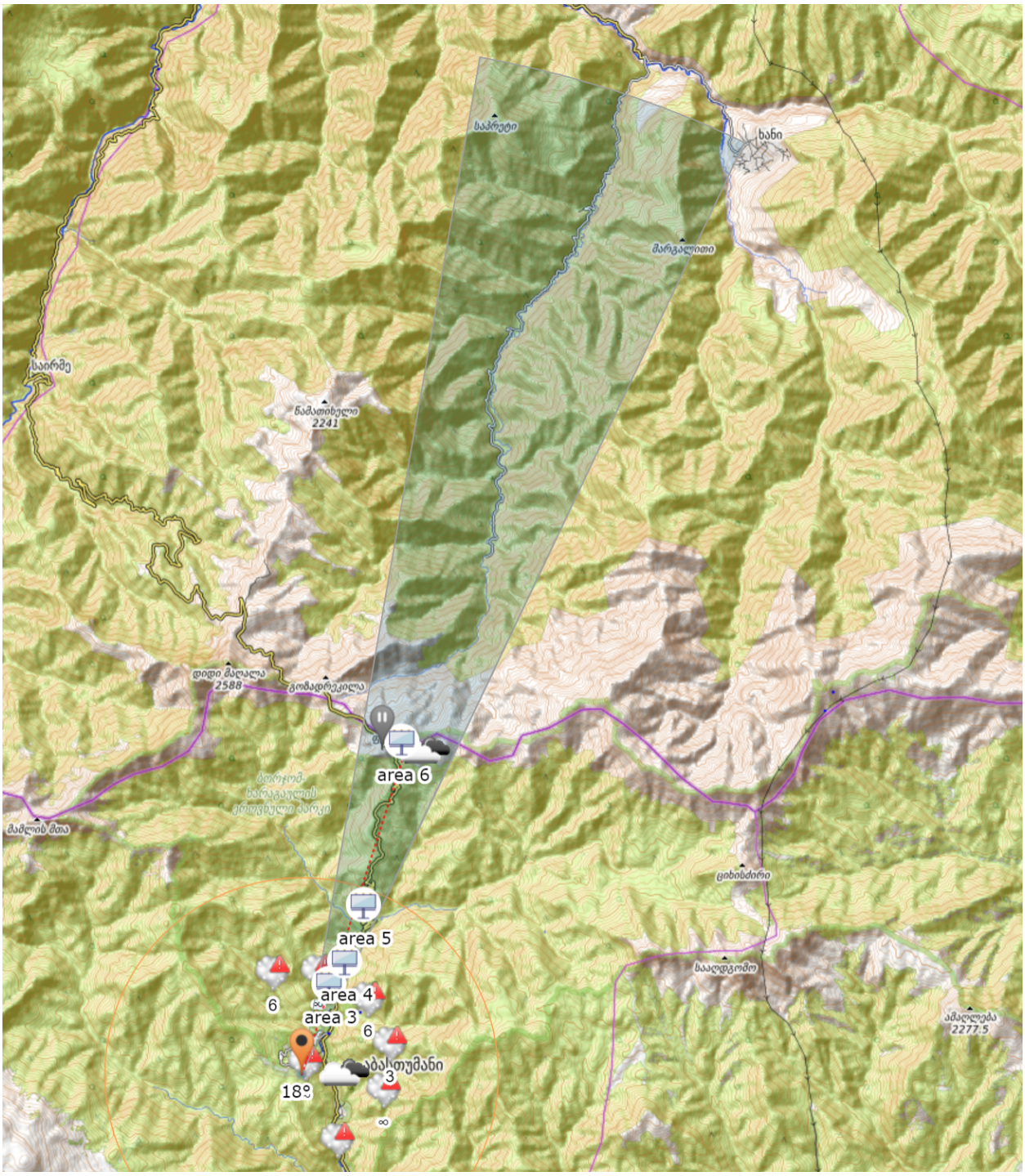


Figure 17 – Open TopoMap

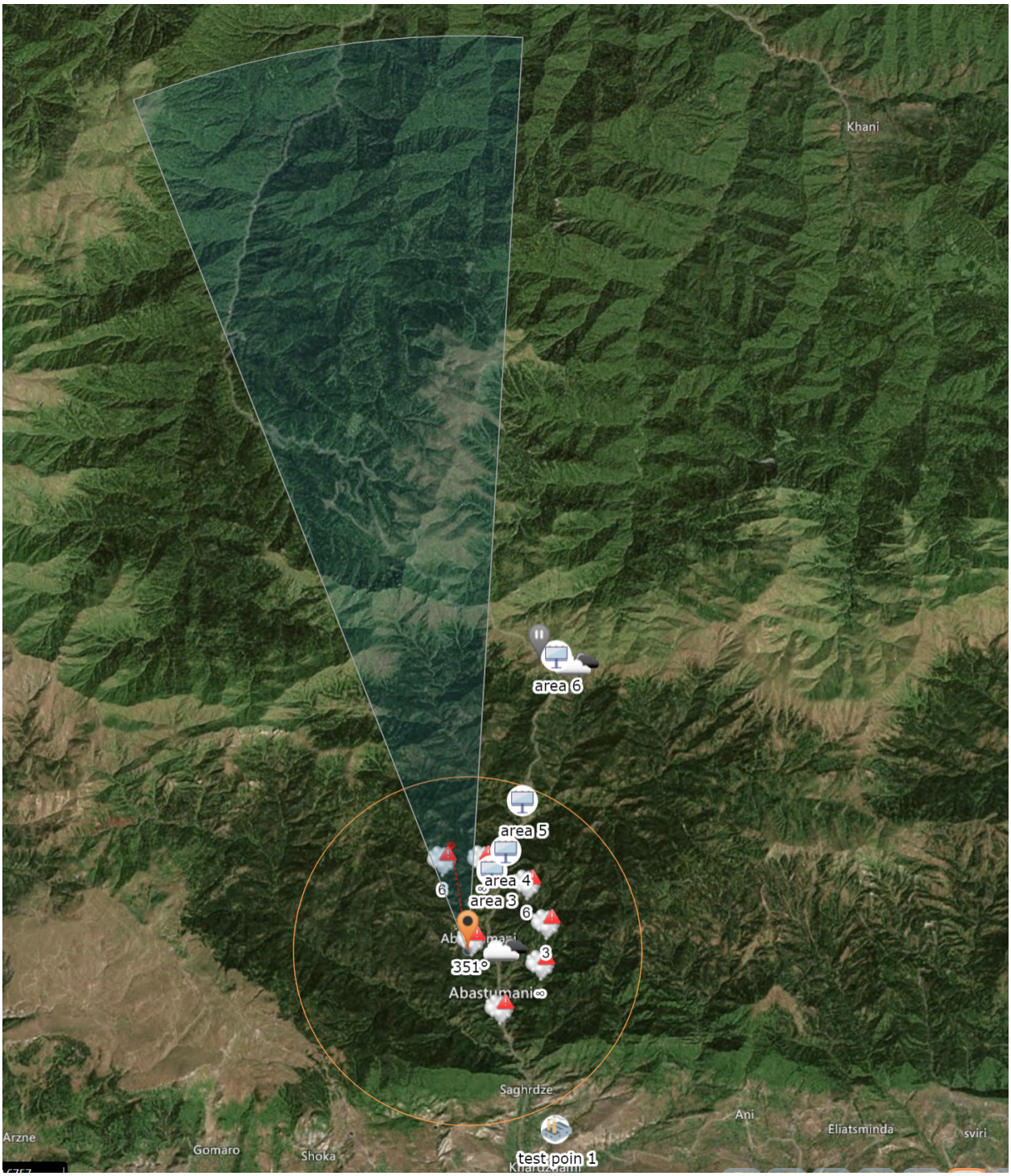


Figure 18 – Bing OrthoPhoto

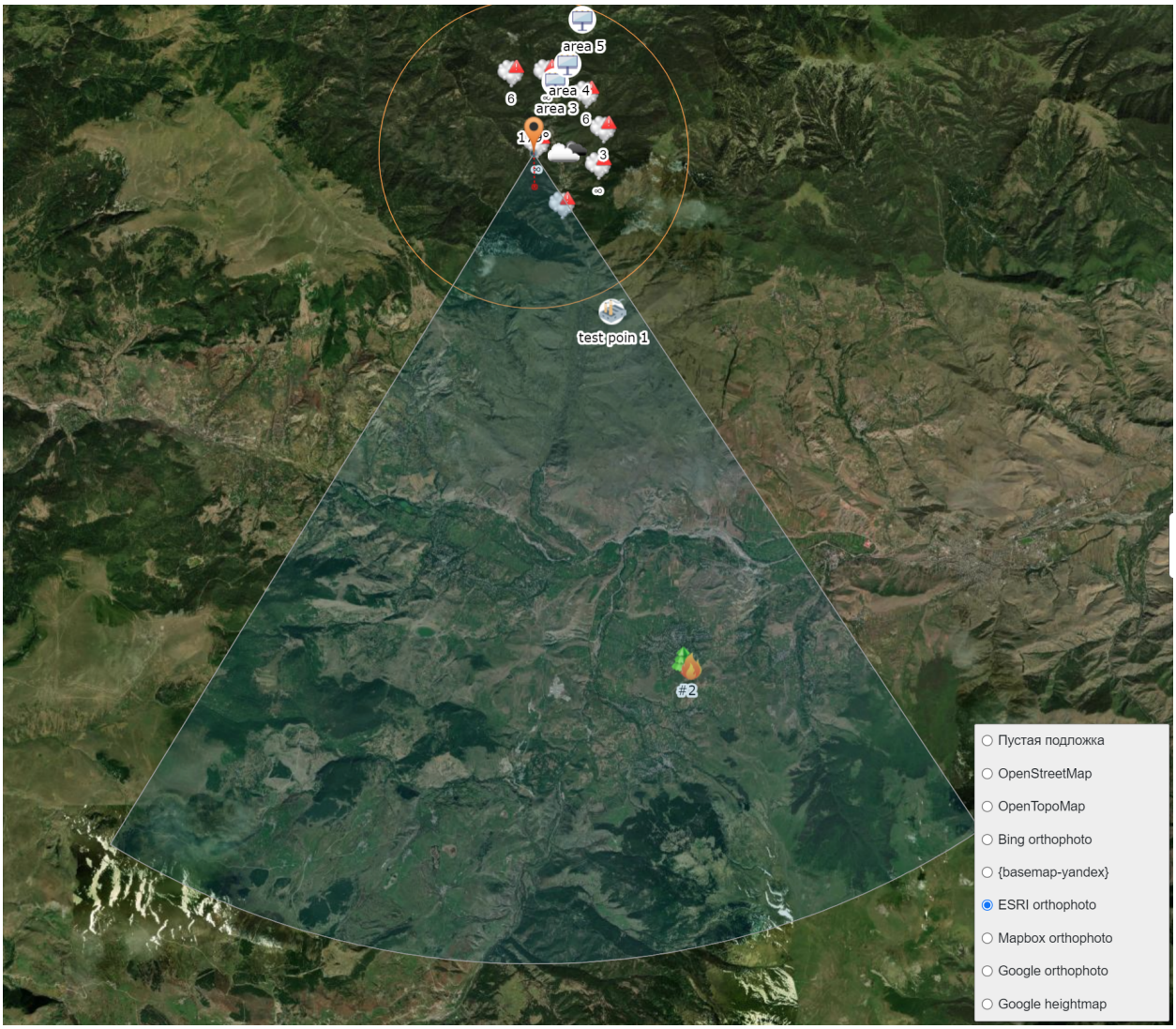


Figure 19 – ESRI OrthoPhoto

Figure 20 – Google Ortho photo

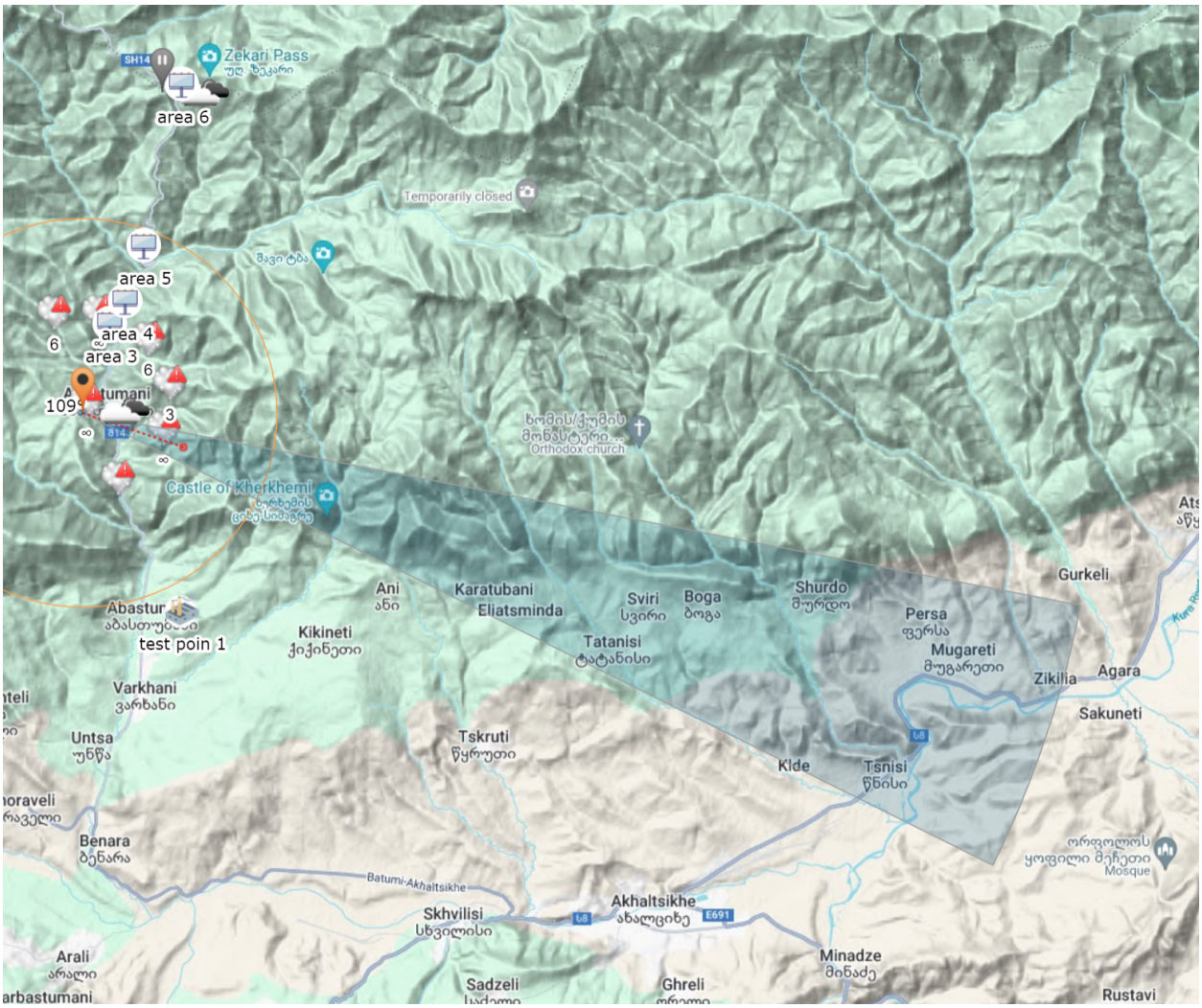


Figure 21 – Google Height Map

9.7. Real Time Measurement

The system can measure the following parameters in real time:

- Measure Distance
- Measure Area
- Measure Coordinates
- Vector of Direction

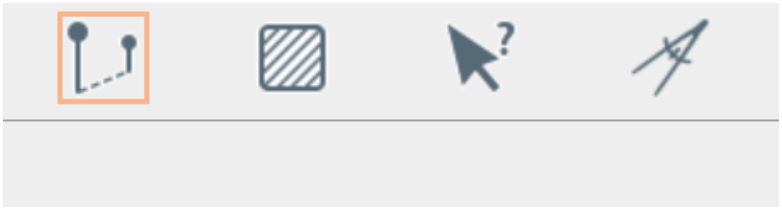


Figure 22 – Types of measurement in the system

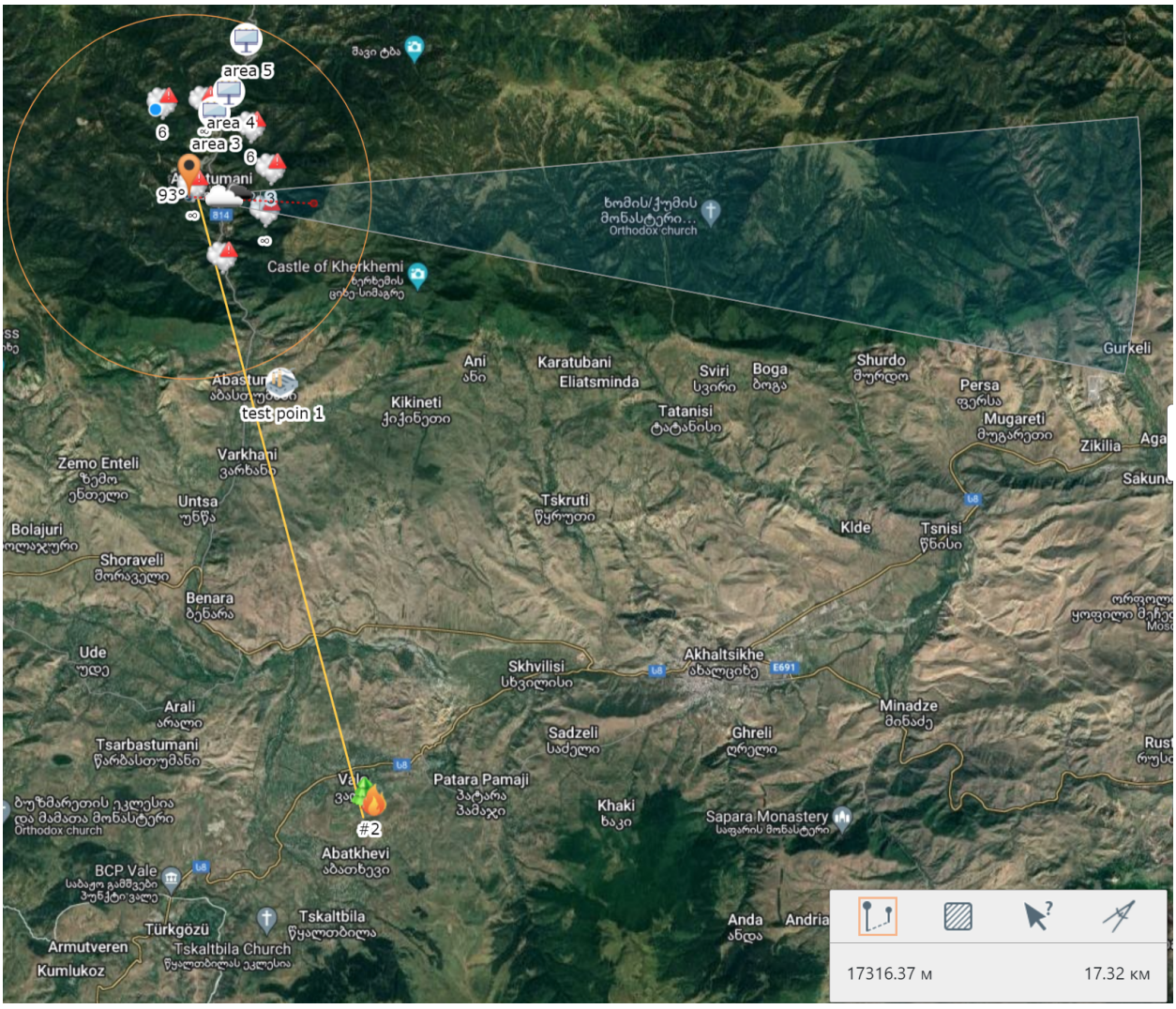


Figure 23 - Measure Distance to the potential fire Alert

Figure 24 - Measure Area under the risk from the potential fire Alert

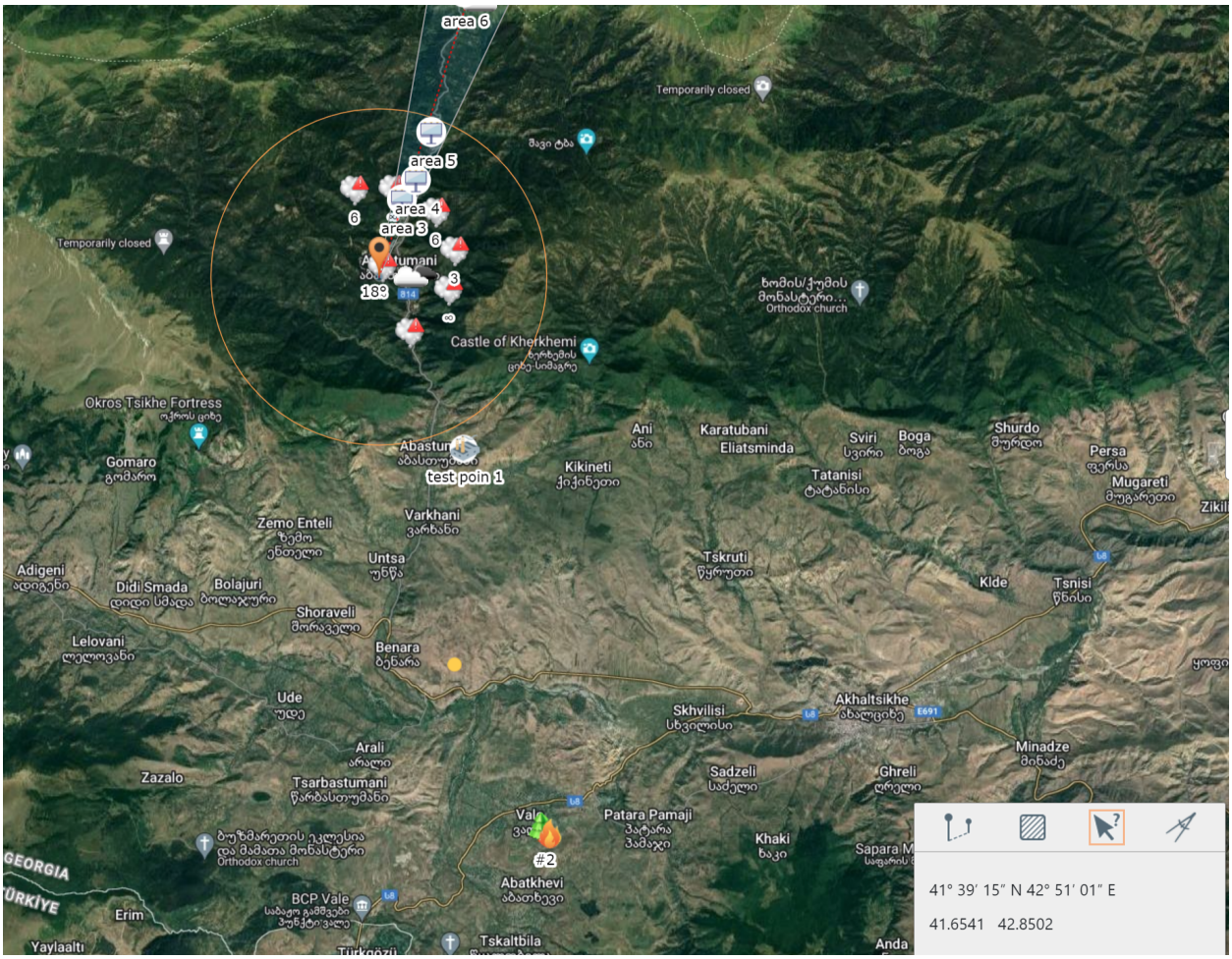


Figure 25 - Measure Coordinates of the potential fire Alert

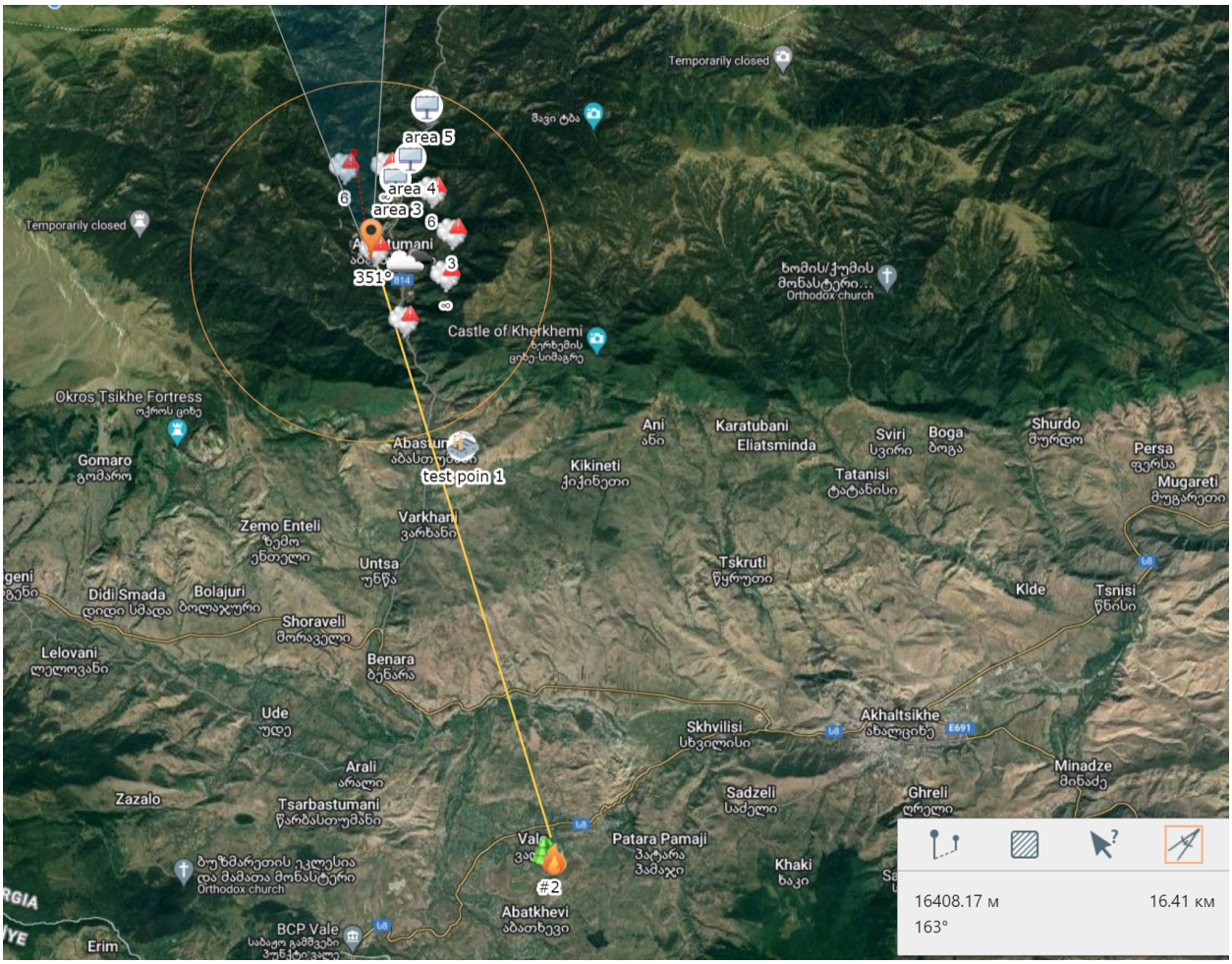


Figure 26 - Vector of Direction to the potential fire Alert

10. Technical Requirements

Installation Requirements for Cameras

1. **Camera Specifications:**
   - High-resolution video cameras with night vision capabilities.
   - Weather-resistant and durable for outdoor conditions.
   - **Pan-Tilt-Zoom (PTZ) capabilities[3]:** For wider coverage and detailed inspection.
2. **Camera Mounting Mast:**
   - Sturdy masts with the ability to withstand high winds and harsh weather.

[3] A pan-tilt-zoom camera (PTZ camera) is a robotic camera capable of panning horizontally (from left to right), tilting vertically (up and down), and zooming (for magnification). PTZ cameras are often positioned at guard posts where active employees may manage them using a remote camera controller.

- Proper grounding and lightning protection.
- Adjustable mounts for optimal camera positioning.

3. Installation Guidelines:
   - Strategic placement to cover maximum area.
   - Height considerations to avoid obstructions and enhance visibility.
   - Secure mounting to prevent vandalism and damage.
   - Sturdy camera mounting masts with appropriate height and adjustability should be installed at designated locations. Consider wind resistance and potential wildlife interference.
   - Power and Communication: Reliable power supply (solar or grid) and a stable communication network (wired or wireless) are essential.
4. Server Hardware Requirements
   - Processor: High-performance multi-core CPU.
   - Memory: Minimum 32GB RAM.
   - Storage: SSDs with a minimum of 2 TB storage, expandable as needed.
   - Network: High-speed Ethernet interfaces with redundancy.
   - Operating System: OpenSource (GNU, BSD, MIT licenses) or Windows operating system.
5. Software Requirements
   - Operating System: Compatible with Linux distributions or Windows Server.
   - Database: Robust and scalable database system (e.g., PostgreSQL, MySQL).
   - Web Server: Apache or Nginx.
   - Application Server: Suitable for running web applications (e.g., Tomcat, Node.js).
   - Security: SSL/TLS for secure communications.
6. Communication Requirements
   - Network Infrastructure:
     - Reliable internet connection for remote access.
     - Internal network setup for secure data transmission.
     - Redundant connections to ensure uninterrupted service.
   - Protocols:
     - Secure communication protocols (HTTPS, SSH).
     - Real-time data streaming protocols (RTSP, WebRTC).

10.1. Camera for Video Feed Collection

Camera installation Advantages for installation in the integrated monitoring and early warning forest fires detection system:

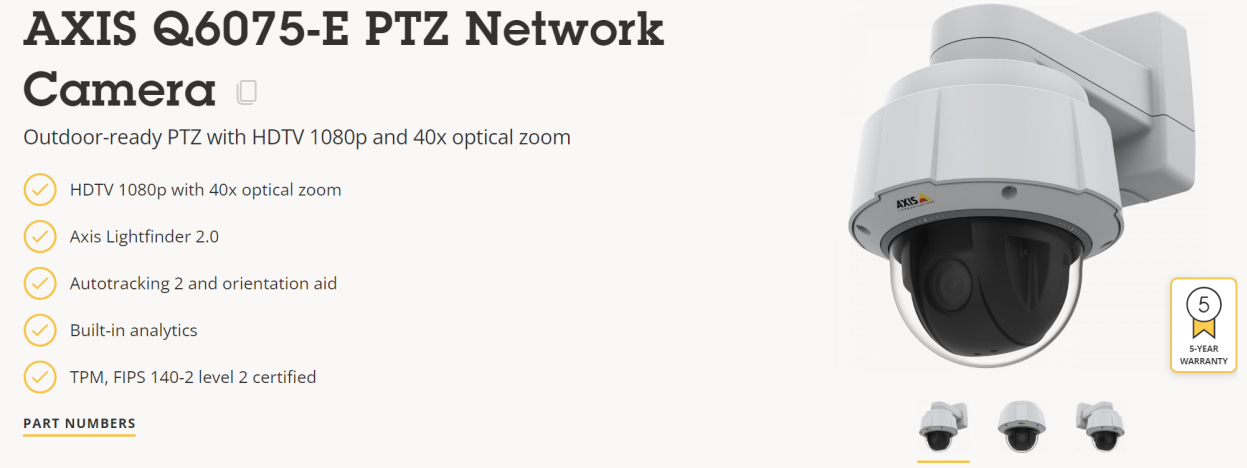
- less depends on climatic conditions;
- Detection and management are performed in real time;
- It is possible to produce a video/photo history of the forest;
- The technology is well known; the hardware complex is widespread

- It is possible to use appliances from different manufacturers
- It is easy to service the system
- The system is easily expandable

In the proposed system design The following cameras are used for video feed collection:

- AXIS Q6075-E PTZ Network Camera
- Uniview IPC6622SR-X33-VF, 2MP 33x Light Hunter Network PTZ Dome Camera

10.2. AXIS Q6075-E PTZ Network Camera



AXIS Q6075-E delivers superior video quality in HDTV 1080p and 40x optical zoom for excellent details. It features Axis Lightfinder 2.0 which captures low-light images with more saturated colors and sharper images of moving objects. And, Zipstream with support for H.264 and H.265 preserves all the important forensic detail you need, while significantly lowering bandwidth and storage requirements.

This high-performance outdoor PTZ camera with IP66/67, NEMA 4X, and IK10-ratings is protected from dust, rain, snow and impacts. Arctic temperature control ensures startup from a deeply frozen state and operation in temperatures ranging from -40 °C to 50 °C (-40 °F to 122 °F). Autotracking 2 with click and track functionality and an orientation aid allows for active object tracking and quick orientation. AXIS Q6075-E comes with AXIS Guard Suite analytics for detecting motion, intrusion and loitering. Furthermore, where privacy must be kept, privacy masking with mosaic lets you pixelate whole areas such as a neighboring property.

- For More Details Click Here

10.3. Uniview IPC6622SR-X33-VF, 2MP 33x Lighthunter Network PTZ Dome Camera

The Uniview IPC6622SR-X33-VF is a 33x optical zoom PTZ Dome IP camera that offers 2 megapixel resolution, 33x optical zoom andPTZ Dome IP cam with smart IR and up to 150m (492 ft) IR distance. The camera also has an alarm feature with 2 in/1 out and audio input, as well as a privacy masking function. Additionally, the camera can be attached to a pendant or wall mount.

Features

- High quality image with 2MP, 1/2.8'' CMOS sensor
- 1920*1080@60fps in the main stream
- Ultra 265, H.265, H.264, MJPEG
- Triple streams
- 33X Optical Zoom
- Lighthunter technology ensures ultra-high image quality in low illumination environment
- Smart IR, up to 150m (492 ft) IR distance
- AC 24V±25%, DC 24V±25% or PoE power supply
- Alarm 2 in and 1 out, Audio 1 in and 1 out
- IP66 ingress protection
- For More Details Click Here

11. System implementation Action Plan

In order to develop and implement an integrated forest fire detection monitoring and early warning system, the following activities will be implemented:

1. Installation of towers on selected location;
2. Install a lighting conductor on the tower;
3. For the physical safety of the mast and the equipment placed on it, a fence will be built around mast;
4. A rack cabinet for instruments will be installed next to the tower;
5. Will install a power supply system built with solar panels;
6. Remote sensing tools will be installed on the tower - a video camera set;
7. A video camera will be installed on the mast to observe the adjacent territory, providing local security;
8. A network equipment will be install on the mast and in the rack cabinet to provide reliable, high-speed and security connection with Agency datacenter, where will be locate servers infrastructure with control and management software. For reliable connection will be implemented two communication channels:
   8.1. Primary channel – Internet connection will be implemented by an Internet Service Provider company: Silknet (https://silknet.com) or Magticom (https://www.magticom.ge);
   8.2. Backup channel - 3G mobile internet connection;
9. For management and control of the integrated monitoring and early warning forest fires detection system will be develop and implement software system – Cental Managemet System

12. Assignment Summary

This section presents a brief summary of the Integrated Monitoring and Early Warning Forest Fires Detection System Implementation Project Design for the Borjomi-Kharagauli National Park.

Project Summary:

Title: Integrated Monitoring and Early Warning Forest Fires Detection System (System) Design for Borjomi-Kharagauli National Park

Objective: To enhance forest fire management in the Borjomi-Kharagauli National Park through the implementation of an advanced, technology-driven early detection and warning system.

Key Components:

1. Advanced Remote Sensing: Utilization of high-resolution cameras and thermal imaging technology for comprehensive coverage of the park area.

2. AI-Powered Detection: Implementation of artificial intelligence algorithms to analyze visual and thermal data for early fire detection.
3. Real-Time Monitoring: Development of a system that provides continuous, real-time monitoring of the park area.
4. Rapid Alert System: Creation of an efficient alert mechanism to notify relevant authorities immediately upon fire detection.
5. User-Friendly Interface: Design of a web-based interface for easy access and operation by authorized personnel.
6. Data Management: Implementation of robust data storage and retrieval systems for historical analysis and reporting.
7. Integration with Existing Systems: Ensuring seamless integration with current park management and emergency response systems.

Critical Aspects:

1. Spatial Analysis: Careful consideration of the park's topography and vegetation to optimize camera placement and coverage.
2. Environmental Sensitivity: Designing the system to have minimal impact on the park's ecosystem during installation and operation.
3. Scalability: Ensuring the system can be expanded or adapted for future needs or technological advancements.
4. Training and Capacity Building: Comprehensive training program for park staff and relevant authorities to effectively use and maintain the system.
5. Sustainability: Implementing energy-efficient solutions and considering renewable energy sources where possible.

Expected Outcomes:

1. Significantly reduced response time to potential fire incidents.
2. Increased accuracy in fire detection, minimizing false alarms.
3. Enhanced protection of the park's biodiversity and natural resources.
4. Improved data collection for long-term forest management and fire prevention strategies.
5. Potential for the system to serve as a model for other protected areas in Georgia and beyond.

Challenges and Considerations:

1. Ensuring system reliability in various weather conditions and seasons.
2. Managing potential technical difficulties in remote areas of the park.
3. Balancing comprehensive coverage with cost-effectiveness.

4. Addressing any concerns from local communities or environmental groups.

This System Design project represents a significant step forward in forest fire management for the Borjomi-Kharagauli National Park. By leveraging cutting-edge technology and a comprehensive approach to implementation, this system has the potential to greatly enhance the protection of this valuable natural resource while providing a template for similar initiatives in other protected areas.