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THE RESEARCH PROMOTION FOUNDATION PROGRAMMES FOR RESEARCH, TECHNOLOGICAL DEVELOPMENT, AND INNOVATION

RESTART 2016 – 2020

Green HIT

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Project Coordinator	Frederick Research Center (FRC)
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Work Package Title	Data Specifications and Requirement Analysis
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Cyprus tomorrow RECOVERY AND RESILIENCE PLAN

Republic of Cyprus

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Executive Summary

The objective of the present document is to report upon the implementation of Task 3.2 “Categorization of Sites and Pilot Studies Design”, which is part of WP3 “Data Specifications and Requirements Analysis”.

The document presents the study areas and their main concerns in regard to fire, biodiversity, and afforestation/deforestation/reforestation monitoring, as discussed with the main stakeholder, the Department of Forests. The study areas fall within the boundaries of Paphos Forest, Troodos Forest and the Akamas peninsula.

Considering the recommendations of the Department of Forests’ officers, as well as the data provided and the visibility analysis performed, the project’s pilot sites (within the study areas that will be monitored) were selected.

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1. Introduction

1.1 General

The Green-HIT project aims to develop a holistic Internet of Things (IoT) platform for forest management and monitoring using Information and Communication Technologies (ICT). The project falls under the provisions of the "CO-DEVELOP" Programme, and specifically under the Component 3.2 "Enhanced Research and Innovation" of the Policy Axis 3: "Strengthening the Resilience and Competitiveness of the Economy". The Programme's goal is to fund projects that will use the latest technologies to provide cost-effective solutions for green transition by delivering solutions for protecting the biodiversity, the wildlife and the environment. The overall goal is to reach the 2030 target for the greenhouse gas emissions as set by the European Union (EU).

The Green-HIT project will succeed its goal by:

a. Offering prevention, detection and reaction to forest fires

b. Providing afforestation and/or reforestation recommendations

c. Protecting forests from illegal logging and hunting

d. Monitoring forests and forest areas

e. Offering forest mapping and inventory by collecting, combining and analyzing field data

Further to the above, the Green-HIT project aims to enhance the effective collaboration between enterprises and the research community, in order to jointly design and implement projects for developing new cost-effective solutions to address these challenges. Green-HIT will be implemented by a consortium comprised by academic institutes and small and medium-sized enterprises (SMEs). Frederick Research Centre (FRC) will lead the project activities, along with the ERATOSTHENIS Centre of Excellence (ECoE), the Center of Excellence in Risk & Decision Sciences (CERIDES), CyRIC and I.A.CO Environmental & Water Consultants Ltd (I.A.CO).

1.2 Objectives

The Project comprises of seven Work Packages (WPs) as follows:

- WP1: Project Management
- WP2: Dissemination and Exploitation Activities
- **WP3: Data Specifications and Requirements Analysis**
- WP4: Green-HIT Hardware Components: Sensors and UAVs
- WP5: Green-HIT Software Components

- WP6: Green-HIT Intelligence Modules
- WP7: Green-HIT Platform Integration and Pilot Studies

The objective of WP3 is to perform a user-needs analysis for the determination of the requirements of the Green-HIT platform, define the pilot areas, determine the content of the database and provide the details of the specifications of the interface and the functionalities of the platform.

The objectives of WP3 are to be achieved through the implementation of the following four tasks:

1. Task 3.1: User-needs analysis
2. **Task 3.2: Categorization of Sites and Pilot Studies Design**
3. Task 3.3: Determination of Data, Data Analysis and Specifications
4. Task 3.4: UI/UX Design and Functional Requirements

The present document concerns the implementation of Task 3.2 and is comprised from the following sub-tasks:

a. Consultation with the main stakeholder, the Department of Forests (DF), focusing on identifying the most important categories of forests in order to define the forest areas in which the project's objectives can be applied, covering the whole island.

b. Identification of the main concerns of each of the selected forest area.

c. Preliminary proposition of sites from each forest area based on the recommendations of the DF and the data provided.

2. Stakeholder Consultation

2.1 Meetings

Within the context of determining the pilot sites, three meetings were held between the project partners and the main stakeholder, i.e., the Department of Forests (DF).

On the **24th of February** a first meeting of the Task was held at the DF offices in Nicosia. On behalf of the DF, Mr. Andreas Christou (Chief Conservator of Forests) was present, while Dr. Andreas Constantinides (Frederick University), Mr. Michalis Stylianou (CyRIC), Mr. Ayis Iacovides (I.A.CO) and Mr. Constantinos Constantinou (I.A.CO) were present on behalf of the project partners.

During the meeting, the objectives of the project were presented, and the main focus was discussed. The participants agreed that the project should focus on i) the forest fires monitoring and prevention, ii) the biodiversity monitoring and protection, and iii) the monitoring of afforestation/deforestation/ reforestation.

Based on the agreed goals of the project, the participants identified three different forest areas in which the project's objectives can be applied, as follows:

i. **Forest fires monitoring and prevention** → Mr. Christou suggested that the forest area of the valley of Diarizos at Agios Nikolaos area in Paphos Forest would be an ideal option. Mr. Christou mentioned the existence of some "blind spots" in the area, where the visibility from the local Forest Observatories (FOs) is limited. This fact increases the fire risk, since the delay in detecting the fire is subsequently leading to a delayed response. One of the "blind spots" is located in the area of the Arminou dam, due to the frequent presence of fisherman who often light fires for recreational purposes. It was also discussed whether smoke detection sensors could be installed in the area, as well as cameras in strategic points. Mr. Christou suggested to contact Mr. Fanos Papadiofantous who is stationed at the Fire Lookout Station at Agios Nikolaos to discuss with him further details.

ii. **Biodiversity monitoring and protection** → Mr. Christou mentioned that there is a biodiversity disturbance in nature trails by ATV's (quad bikes) and motorcycles where access by vehicles is prohibited, especially at Troodos Forest area. The monitoring of important species of flora or/and fauna within the Troodos Forest was also discussed, such as *Chionodoxa lochiae* population. Sensors could also be installed to record environmental data such as temperature, humidity, soil data etc. Mr. Christou suggested to contact Troodos District Forest Officer Mr. Loizos Loizou.

iii. **Afforestation/deforestation/reforestation monitoring** → Mr. Christou suggested that a good case study is the forest area of the Akamas peninsula where recently two wildfires occurred and some reforestation measures were implemented. The first fire began from a large private plot north of Lara region and extended up to the state forest, burning a part of the Juniper's Forest of the area.

The second fire began near Smigies area and extended at the north. Mr. Christou also added that deforestation was observed mainly around the livestock facilities, due to overgrazing. Satellite images of the areas that affected by wildfires at different time periods, should be obtained in order to assess the evolution of the flora within these areas, through remote sensing techniques. Mr. Christou suggested to contact Mr. Costas Papageorgiou, senior conservator of forests, head of fire protection and forest engineering.

On **March 15**, the second meeting of the Task was held at the Fire Lookout Station at Agios Nikolaos. On behalf of the DF, Mr. Fanos Papadiofantous was present, while Dr. Andreas Constantinides (Frederick University), Mr. Michalis Stylianou (CyRIC), Mr. Ayis Iacovides (I.A.CO) and Mr. Constantinos Constantinou (I.A.CO) were present on behalf of the project partners.

Mr. Papadiofantous informed the project partners that even though there is a Forest Observatory (FO) (Kefalos) and a Fire Lookout Station (FL Station) (Kollatzia) at their disposition, along with the Agios Ioannis FO which is located at another station's jurisdiction, there are still some "blind spots" within the area, increasing the fire risk. The Forest Station personnel was particularly concerned for one of the "blind spots", located at the base of Arminou dam in Diarizos valley and considered as quite dangerous due to the frequent visitation by amateur fishermen who often light fires illegally for recreational purposes.

During the meeting, Mr. Ayis Iacovides (I.A.CO) suggested that the DF could provide the location of the FOs so that an analysis in a Geographical Information System (GIS) environment can be performed in order to spatially identify the "blind" areas. A discussion followed on analysing the types of sensors that could be used for the improvement of the visibility from the FOs, and the possibility of using innovative systems for the fires monitoring. Mr. Michalis Stylianou (CyRIC) suggested that antennas can be installed in the FOs in order to investigate which areas are covered by the network. The participants agreed that it would be very helpful to install cameras in strategic places where the visibility is limited, for both detecting fires and preventing vandalism and theft incidents, as well as smoke detection sensors in the areas with low visibility. The use of drones was also mentioned, that could be used for sending live images from areas that smoke is detected for confirming whether there is a fire or not.

The discussion was continued at the Forest Observatory named "Kefalos" (see Figure 1).

Figure 1: View of Diarizos valley from Kefalos FO.

The third meeting was held on March 16, at the Forest Station in Platania (see Figure 2). On behalf of the DF the following were present:

- Mr. Loizos Loizou – District Forest Officer
- Mr. Minas Papadopoulos – Assistant District Forest Officer

On behalf of the project partners, the following were present:

- Dr. Andreas Constantinides (Frederick University)
- Mr. Michalis Stylianou (CyRIC)
- Mr. Ayis Iacovides (I.A.CO)
- Mr. Constantinos Constantinou (I.A.CO)

The Forest Station representatives confirmed that there is a problem with illegal entry of vehicles in the nature trails and the closed forest roads in Troodos area. The project partners suggested that this issue can be solved with the installation of acoustic sensors in selected points, thus the sound of the vehicles will be identifying and then DF personnel will be receiving a signal. The partners mentioned that will proceed on calculating the number of sensors and the antennas needed for covering the area, suggesting that could be installed in fenced and controlled by the DF areas to avoid any vandalism and theft. In addition, spatial data of the areas that

illegal logging was recorded was requested, in order to investigate the possibility to install sensors or cameras in these areas.

Concerning the fires which are also a real threat for Troodos Forest, the DF officers mentioned that Dymes valley area is considered to be prone to fires due to human activities and the lack of monitoring. Another suggestion from DF, was the installation of cameras in DF fire trucks so that in case of fire, the DF coordination teams could have real-time images, as well as installing GPS sensors in DF personnel uniforms. This fact will improve the coordination of the fire incidents.

Lastly, the use of drones was discussed and it was concluded that they could be useful for controlling the boundaries between the state forest and the private properties coupled with the use of satellite images that can be provided by the ECoE, as well as for detecting illegal burnings of grasses during the autumn near Koutrafas community. Mr. Loizou said that the presence of drones, will discourage locals from setting illegal fires in the area and could reduce the possibility of fires caused by human activities.

Figure 2: Site visit at Platania Forest Station.

The fourth meeting was held on December 20, at the Forest Station in Platania. On behalf of the DF, Mr. Loizos Loizou (District Forest Officer) was present.

On behalf of the project partners, the following were present:

- Mr. Giorgos Tsapparellas (CyRIC)
- Mr. Christos Mourouzis (CyRIC)
- Mr. Georgios Kotsapas (CyRIC)
- Mr. Gregoris Demetriades (CyRIC)
- Mr. Michael Papacharalambous (I.A.CO)

The CyRIC representatives informed the attendees about the equipment and the possible installation locations. Mr. Loizos Loizou suggested that the acoustic sensors might be installed in the bushes while the CO_2 sensors can be installed on the side of the trees that are not facing the roads, at least 3m above the ground.

Regarding the wildfires, the partners mentioned that an area near the village of Evrychou can possibly be the first location that the equipment can be installed, while the FL Station that can be used to facilitate the sensor's needs is "Kakos anemos".

The use of drones for fire protection strategies has been proposed as a valuable tool for both preventing and detecting wildfires. UAV team highlighted that this approach allows for more efficient and proactive monitoring of fire-prone areas. In conclusion, the successful deployment of drones for fire protection depends on the understanding of the specific characteristics of each site, e.g., morphology and weather conditions.

Lastly, the attendees decided that an Official Letter addressed to the Director of the DF, will be prepared and delivered by partners, in order to serve as the official initiation of the in-situ part of the project, stating the project's goal and process and requesting authorization for the deployment of the sensors in strategic locations within the study areas.

2.2 Collection of Data

The DF provided the partners with the following spatial data:

1. **Paphos Forest – Agios Nikolaos area**
   - ≡ Agios Nikolaos monitoring area boundary
   - ≡ Location of the existing Forest Observatories and Fire Lookout Stations
   - ≡ Fire risk areas
   - ≡ Locations of proposed new Forest Observatories

2. **Troodos Forest**

   ≡ Forest Department control area

   ≡ Location of forest stations

   ≡ State forest boundaries

   ≡ Fire Lookout Stations

   ≡ Motorcycle routes

   ≡ Logging area

   ≡ Fire control area

3. **Akamas Peninsula**

   ≡ Burnt areas from 2010-2021.

3. Study areas

3.1 Introduction

In the following paragraphs the study areas in Paphos, Troodos Forest and the Akamas peninsula are presented. These areas were chosen due to their varying ecosystem and their notable heterogeneity, since different forest/vegetation categories can be found. The aim is to set the basis for the selection of the pilot sites in these study areas that will be monitored in order to achieve the project's goals.

The consultation and the recommendations of the DF officers, as well as the data provided, were taken into account.

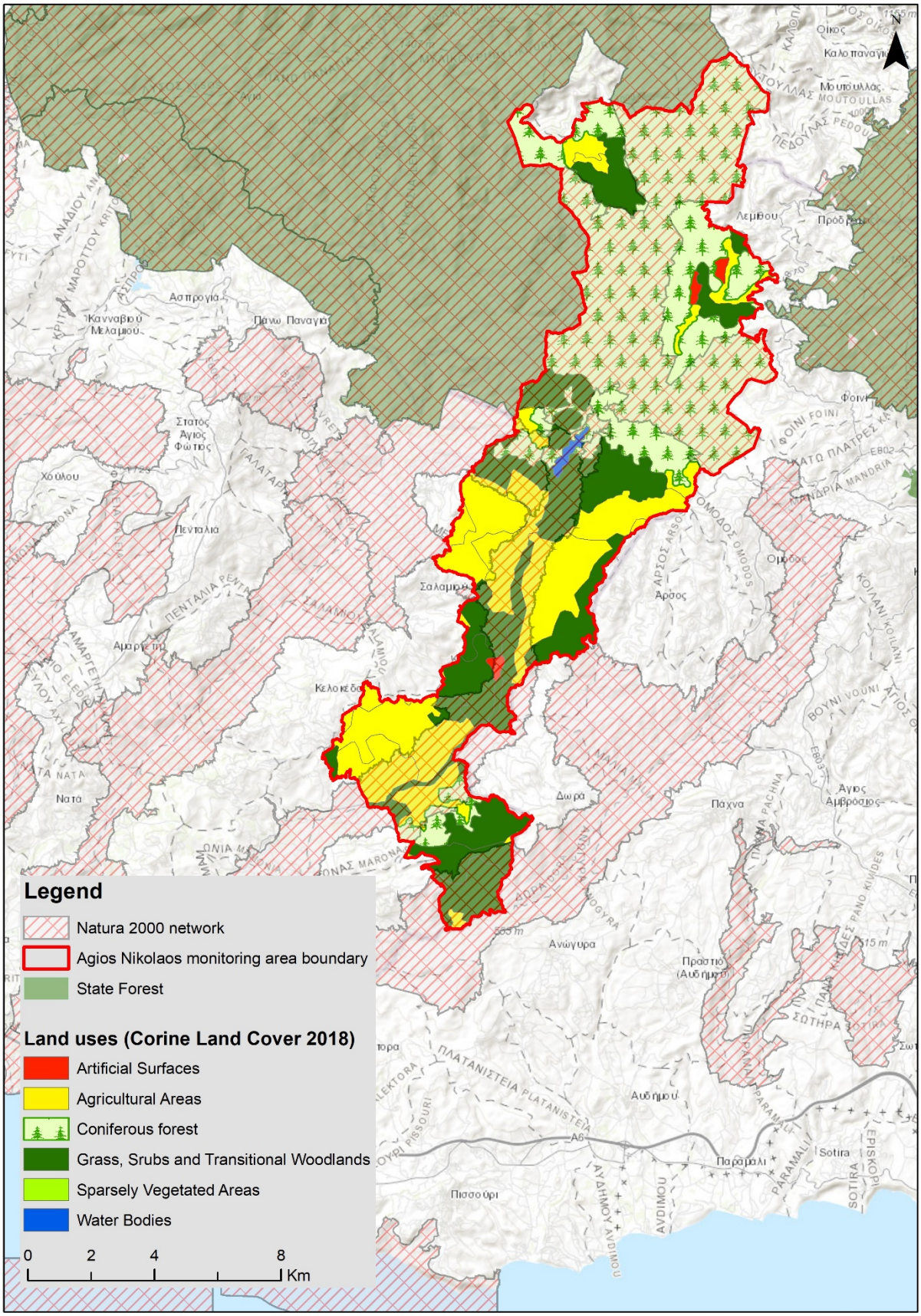
3.2 Paphos Forest

The Agios Nikolaos area which includes the Diarizos valley, it is the area that is selected to represent Paphos Forest. Diarizos valley is located in the South-eastern part of Paphos District, in the western-southwestern foothills of Troodos Mountain. It's included in the European nature protection area network "Natura 2000" as a Special Conservation Area and as a Special Protection Area Koilada Diarizou – CY4000003 and CY4000020.

Map 1 shows the land uses in the area of the Agios Nikolaos monitoring area based on the Corine Land Cover (2018). As it shown on the Table below, the biggest part of the area is covered with coniferous forest and specifically with *Pinus brutia* species, while a percentage of 26,6% is covered by grass, shrubs and transitional woodlands.

Table 1: Land uses in the Agios Nikolaos monitoring area.

Description	Area (ha)	Percentage (%)
Coniferous Forest (*Pinus brutia*)	6322,7	47,3
Grass, Shrubs and Transitional Woodlands	3559,3	26,6
Agricultural area	3362,1	25,14
Artificial Surfaces	76,8	0,57
Water body	46,7	0,35
Sparsely Vegetated Area	4,9	0,04



Map 1: Land uses in Agios Nikolaos monitoring area.

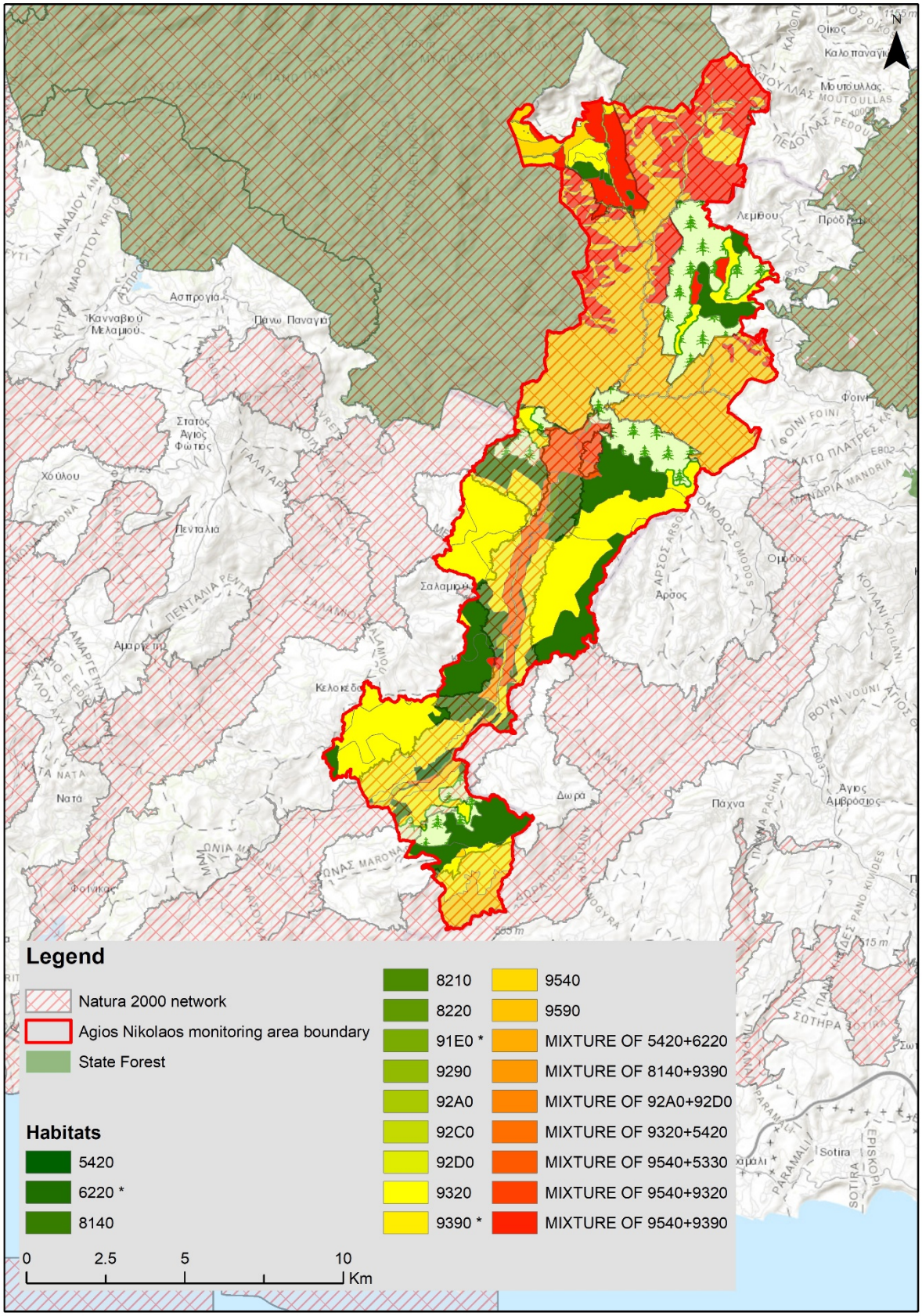
In addition to the above, Map 2 shows the distribution of habits in the study area which falls into the "Natura 2000" network. Table 2 shows the habitat types that can be found in the study area. Within the boundary of the Agios Nikolaos area, there are three designated priority habitat types, whereas two of them are endemic in Cyprus; 91E0* residual alluvial forests, 9390* Shrubs and forest stands of *Quercus alnifolia* 9590* *Cedrus brevifolia* forests.

Table 2: Habitats type in the Agios Nikolaos area[1]

Habitat Type	Priority	Endemic	Area (ha)
5420	No	No	63,9
8140	No	No	2,04
8210	No	No	36,2
8220	No	No	0,42
91E0*	Yes	No	17,2
9290	No	No	23,4
92A0	No	No	1,56
92C0	No	No	136,74
92D0	No	No	64,01
9320	No	No	354,6
9390*	Yes	Yes	241,3
9540	No	No	3302,3
9590*	Yes	Yes	0,08

[1]*Source: Department of Environment (2017)*

Furthermore, in the area of Agios Nikolaos, the landscape is enriched with the present of riparian forests, characterized by a diverse array of native trees; *Platanus orientalis* and *Alnus orientalis* lining the watercourse of the "Koilada Plati", providing vital habitat support for various aquatic and terrestrial species.



Map 2: Habitat mapping in the area of Agios Nikolaos (Source: Department of Environment 2017).

As it is mentioned by the DF officers, there are some “blind spots” where the visibility from the FOs and the FL Station is limited, thus the fire risk is increased.

In order to determine the surface locations where the visibility is limited, a GIS analysis utilizing the “Visibility tool” was performed. For this purpose, the provided data were converted into a GIS format, i.e., shapefiles. The data that were used are the following:

- Agios Nikolaos monitoring area boundary
- Location of the existing Forest Observatories named “Kefalos” and “Agios Ioannis”
- Location of the existing Fire Lookout Station named “Kollatzia”
- Proposed locations for new Forest Observatories (two new Forest Observatories)
- Fire risk areas
- Digital Elevation Model (DEM) of the area

The goal of the visibility analysis was to determine the locations that are not visible from both the existing and the proposed Forest Observatories and the Fire Lookout Station. For achieving this goal, the visibility tool was performed for the following scenarios:

1. Scenario 1: Visibility analysis for the existing Forest Observatory named “Agios Ioannis”
2. Scenario 2: Visibility analysis for the existing Forest Observatory named “Kefalos”
3. Scenario 3: Visibility analysis for the existing Fire Lookout Station named “Kollatzia”
4. Scenario 4: Visibility analysis for combining both the existing Forest Observatories and the Fire Lookout Station (“Agios Ioannis”, “Kefalos” and “Kollatzia”)
5. Scenario 5: Visibility analysis for combining both the existing Forest Observatories and the Fire Lookout Station (Scenario 4), including the proposed new Forest Observatory “1”
6. Scenario 6: Visibility analysis for combining both existing Forest Observatories and Fire Lookout Station (Scenario 4), including the proposed new Forest observatory “2”
7. Scenario 7: Visibility analysis for combining the existing Forest Observatories and Fire Lookout Station (Scenario 4), including the two proposed Forest Observatories “1” and “2”.

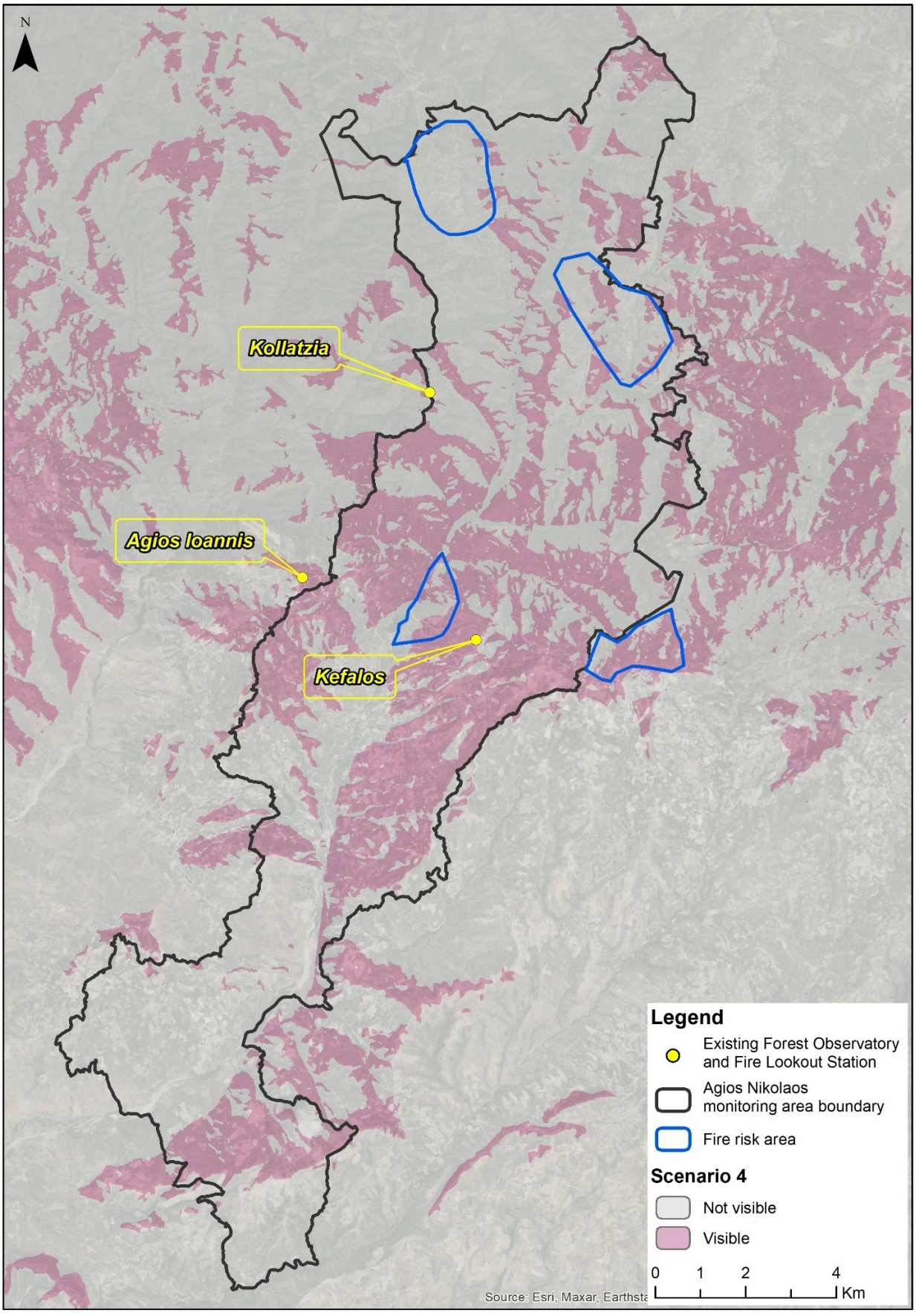
The outcome of the Visibility analysis, is the production of seven Maps showing the areas that are visible and not visible from the Forest Observatories and the Fire Lookout Station used in each Scenario.

The visibility analysis has shown some areas within the boundaries of Agios Nikolaos area that are not visible from the existing FOs and the FL Station. Map 3 shows these areas as derived by the visibility analysis of

"Scenario 4". As it is shown, part of the Agios Nikolaos monitoring area at the North and at the South it is not covered from the existing FOs and the FL Station. It is noticeable that two of the areas that were recognised as fire risk areas at the north, are confirmed to be not visible from the FOs and the FL Station.

It is also shown that the proposed new FOs (Scenario 7) increase the visibility in the area, however some areas at the north and south are still not visible.

The Maps of the rest of the Scenarios can be found in ANNEX I.



Map 3: Visible and not visible areas from the existing Forest Observatories and the Fire Lookout Station [Scenario 4].

3.3 Troodos Forest

Troodos National Forest Park is located in the heart of Troodos mountain range and it was designated as a National Forest Park in 1992, aiming to safeguard its sustainable use and to perpetuate the values and functions of the area: ecological, scientific, recreational, hydrological and economic. The greater part of the Park has been included in the European network of protected areas "Natura 2000", named "Ethniko Dasiko Parko Troodous" as a Special Area of Conservation and a Special Protection Area (CY5000004), since 2004.

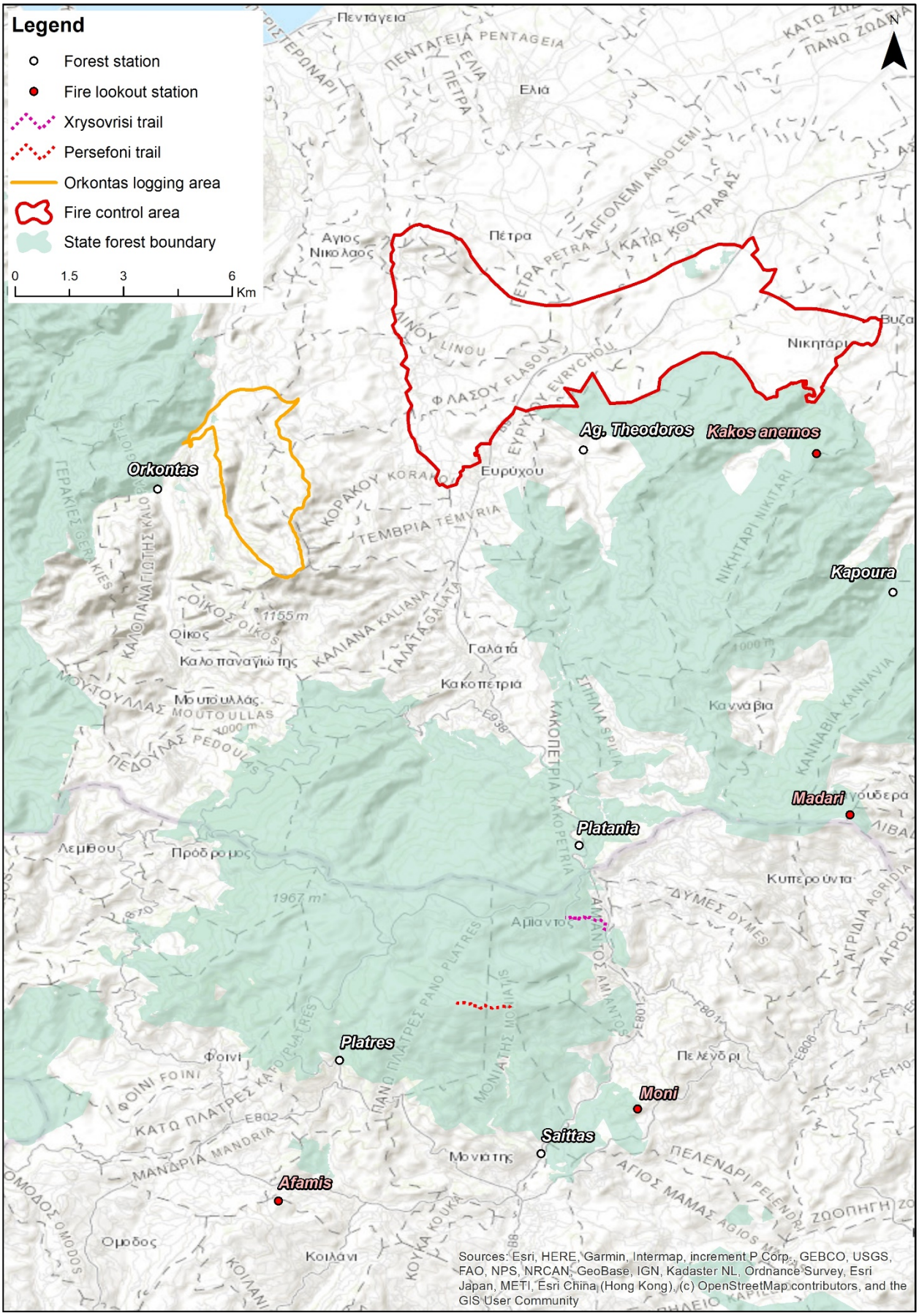
The main concern in Troodos Forest is the biodiversity disturbance due to the illegal entry of vehicles in the nature trails and the closed forest roads, as well as the fire risk mainly in the Dymes valley due to the human activity and the illegal logging in the area of Orkontas.

The overall area is characterized by the abundant presence of *Pinus brutia*, a resilient coniferous species. However, the present of coniferous forest makes the region susceptible to wildfires, since *Pinus brutia* contributes to wildfires due to its resinous nature and flammable foliage. The high resin content in the pine needles and cones can act as fuel during dry conditions, making areas with a dense population of *Pinus brutia* more susceptible to the rapid spread of wildfires.

The goal is the installation of cameras and sensors, and the usage of drones for the prevention of the illegal entry and the limitation of the illegal human activity.

The following Map 4 shows the location of two nature trails that the DF mentioned that there is illegal entry, the boundary of the area in Orkontas where illegal logging occurs as well as the fire control area. The Map also indicates the location of the existing FL Stations and the Forest Stations.

Cameras and sensors will be installed in these areas; however, the specific locations will be indicated at the next stage of the Project.

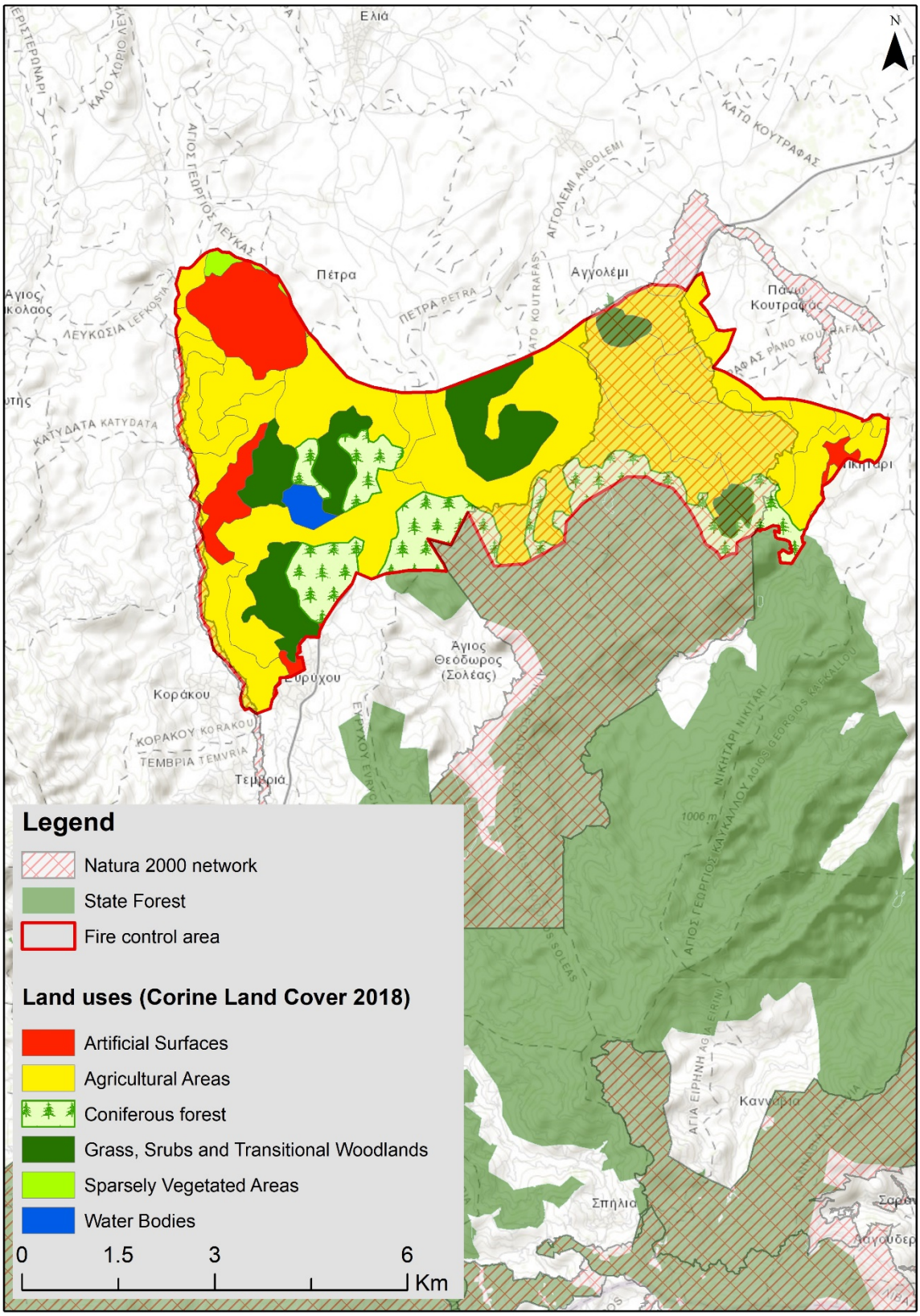


Map 4: Places of interest in the area of Troodos Forest.

The following Table 3 and Map 5 show the various land use types within the fire control area of Troodos, along with their respective areas (ha), based on the Corine Land Cover (2018). The biggest part of the area is covered by agriculture land, where a percentage of 14,4% is covered by *Pinus brutia* species.

Table 3: Land uses within the Troodos fire risk area.

Description	Area (ha)	Percentage (%)
Agricultural area	2178,5	61,0
Coniferous Forest (*Pinus brutia*)	514,2	14,4
Grass, Shrubs and Transitional Woodlands	504,3	14,1
Artificial Surfaces	320,4	8,97
Water body	35,9	1,01
Sparsely Vegetated Area	19,2	0,54



Map 5: Land uses within the Troodos fire risk area.

3.4 Akamas Peninsula

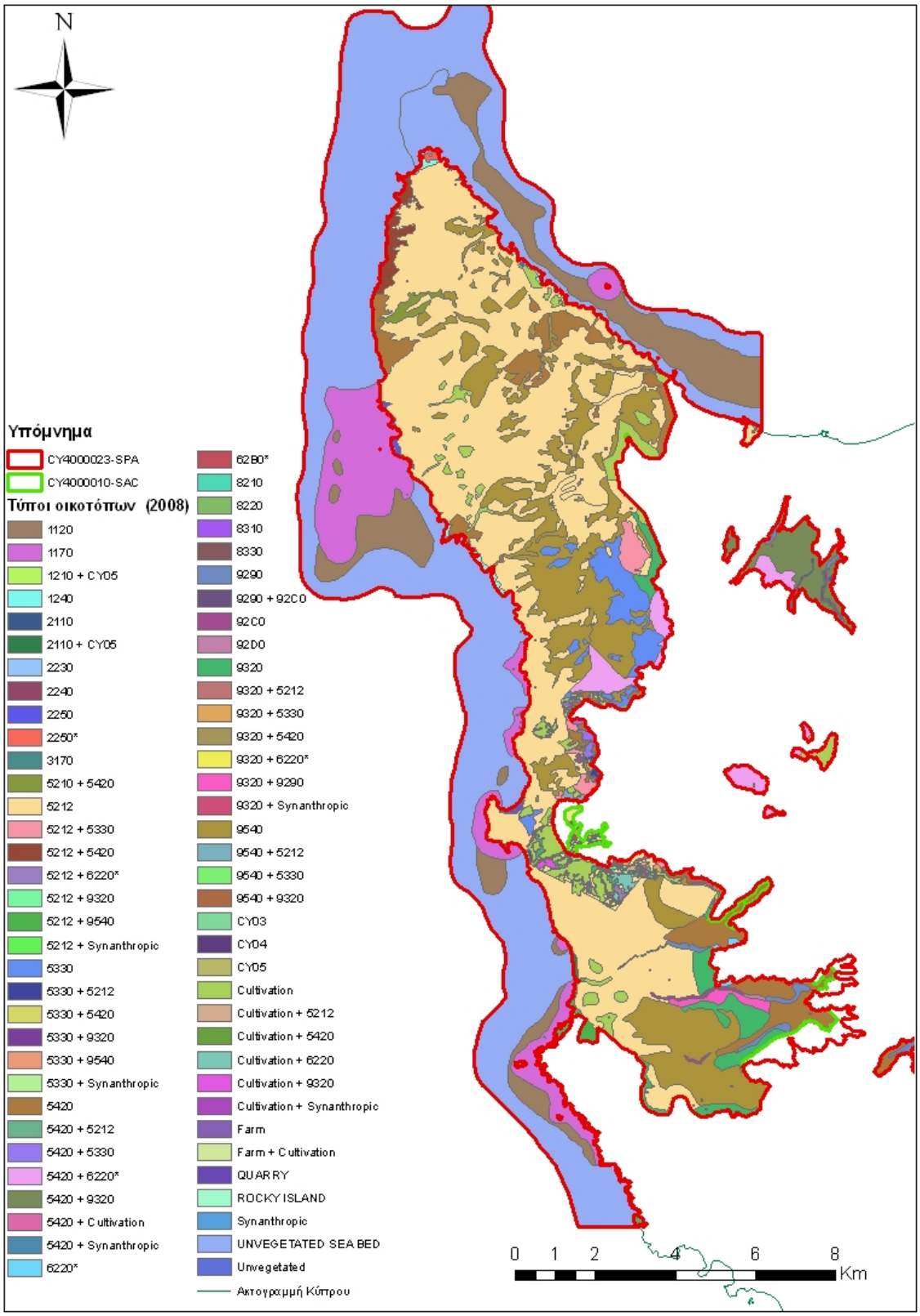
The Akamas peninsula which included the Akamas National Forest Park (NFP) is selected as the ideal case study for the monitoring of the afforestation, deforestation and reforestation.

The Akamas peninsula occupies the westernmost tip of Cyprus, covering an area of ~17.000 hectares. It's included in the European nature protection area network "Natura 2000" as a Special Conservation Area and a Special Protection Area (CY4000010 and CY4000023).

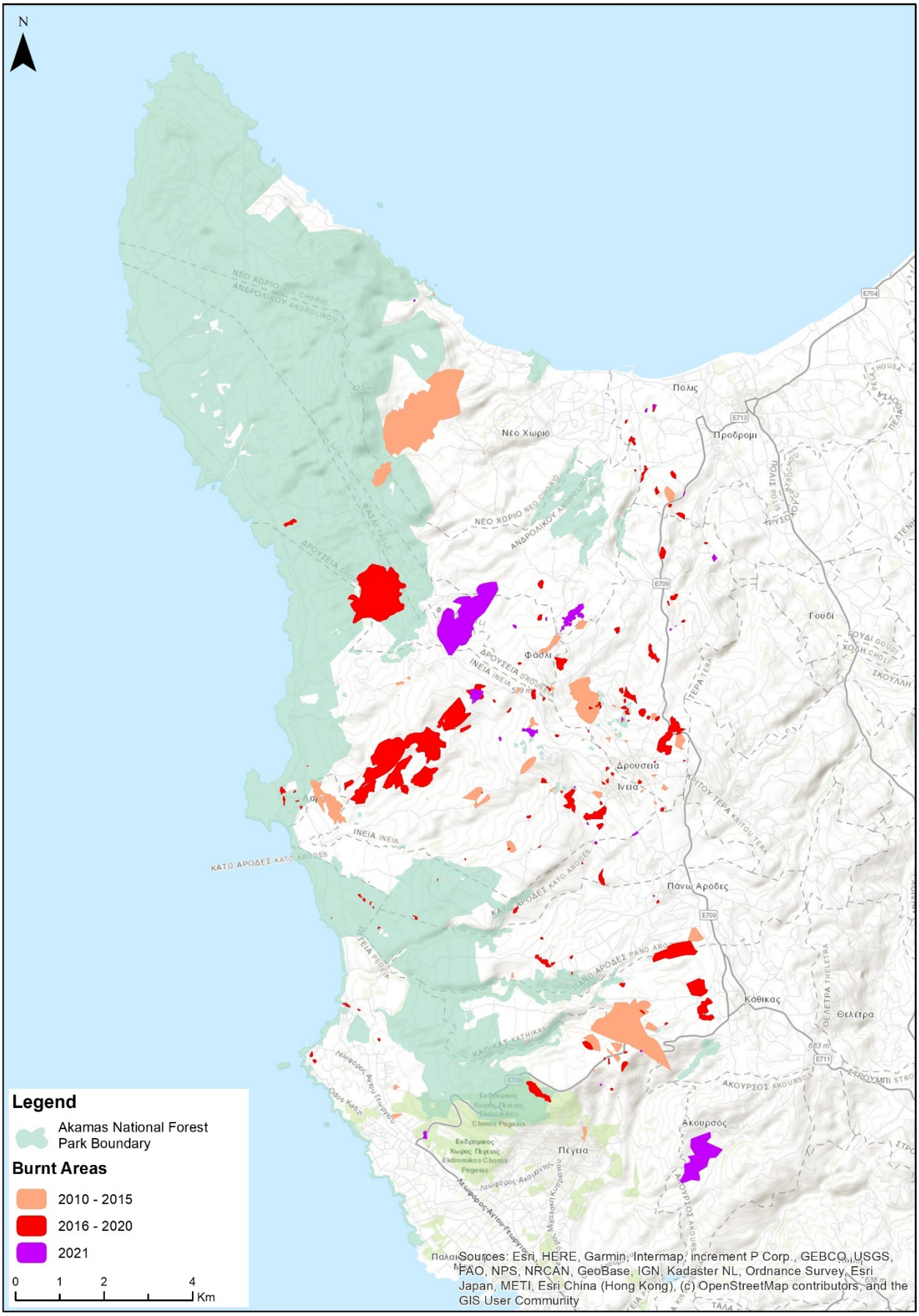
The Peninsula hosts a wide variety of vegetation, as the area encompasses 24 out of the 43 terrestrial habitats of Cyprus, included in Annex I of the Habitats Directive. The geological diversity, combined with the wide variety of habitats, favors the presence of a rich flora. The Peninsula is home to approximately 650 indigenous species and subspecies of plants, accounting for 40% of the total indigenous flora of Cyprus[1]. Coniferous forest (*Pinus brutia),* bushes (*Juniperus phoenicea*) and riparian forest are present in the area. Map 6 shows the distribution of habitats in the area of Akamas as prepared by the DF (2008).

The following Map 7 shows the fires that occurred in the area (within and outside the boundaries of the NFP) from 2010 to 2021. In total 234 fires were recorded in this time period, of which 44 occurred in 2019, 42 in 2018 and 38 in 2020. It is noted that the burnt area within the boundaries of the NFP is estimated at ~1,4km^2.

[1] Management Plan for the Natura 2000 area "Chersonisos Akama", ENVECO A.E., I.A.CO Ltd (2016)



Map 6: Habitat distribution in the Natura 2000 area “Chersonisos Akama” [CY4000010] (Source: Habitat Mapping of Akamas by the Department of Forests (2008).



Map 7: Fires recorded in Akamas area from 2010 to 2021.

4. Conclusions

The objective of the present document was to report upon the implementation of Task 3.2 “Categorization of Sites and Pilot Studies Design”, which is part of the Work Package 3 “Data Specifications and Requirements Analysis”.

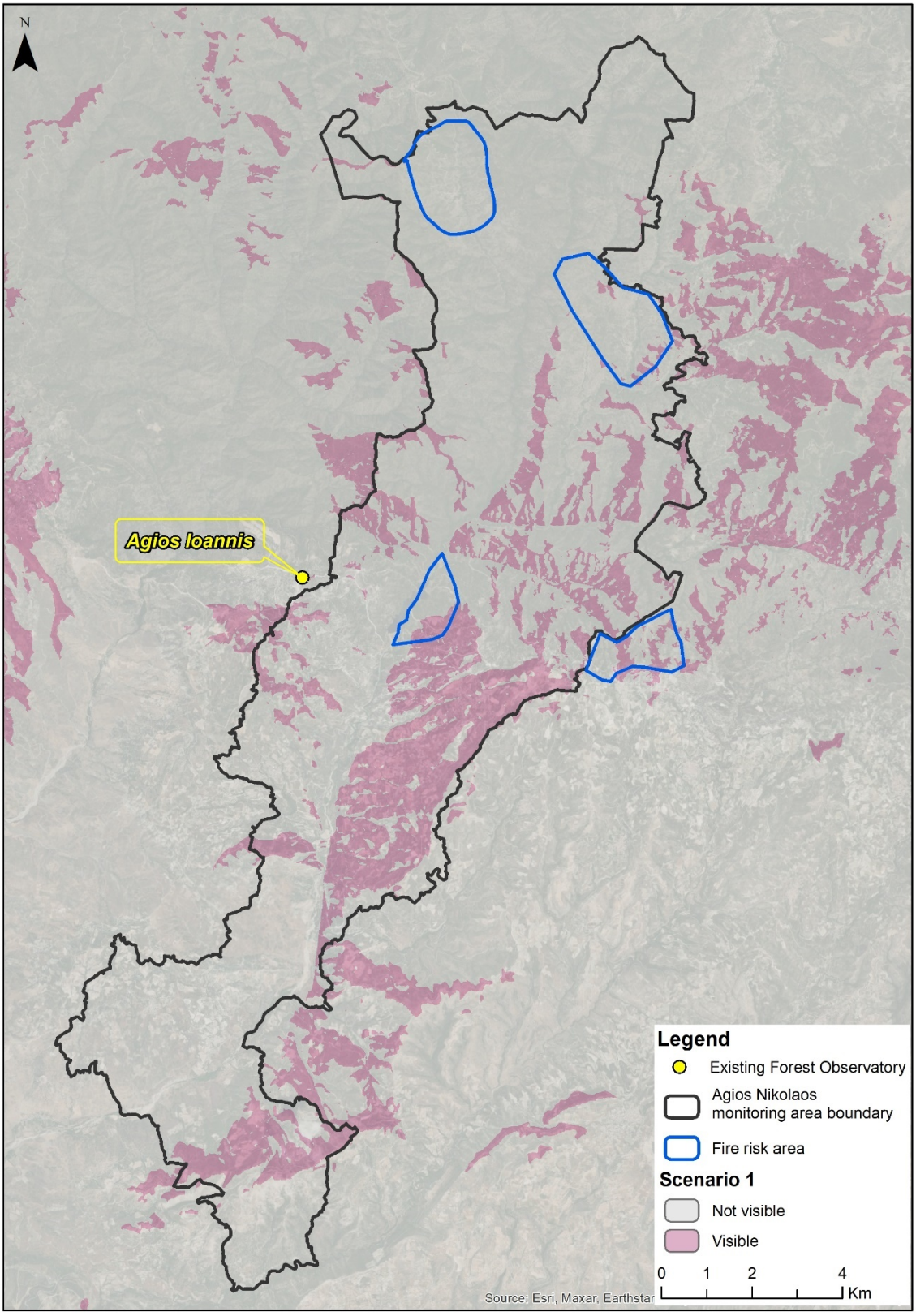
For implementing Task 3.2, a series of consultation meetings between the project partners and the Department of Forests were held. The participants agreed that the project should focus on i) the forest fires monitoring and prevention, ii) the biodiversity monitoring and protection and iii) the monitoring of the afforestation/deforestation/reforestation. Agios Nikolaos area within the boundaries of Paphos Forest was selected for the forest fires monitoring and prevention, Troodos Forest area was selected for the biodiversity monitoring and protection, and Akamas peninsula was selected for the monitoring of the afforestation, deforestation and reforestation.

Taking into account the recommendations of the DF officers, as well as the data provided and the visibility analysis performed, the basis for the selection of the pilot sites within the study areas that will be monitored in order to achieve the project’s goals was set.

The next step of the project, is to specify the pilot sites in each of the study area, in which the sensors, cameras, monitoring programmes etc will be implemented.

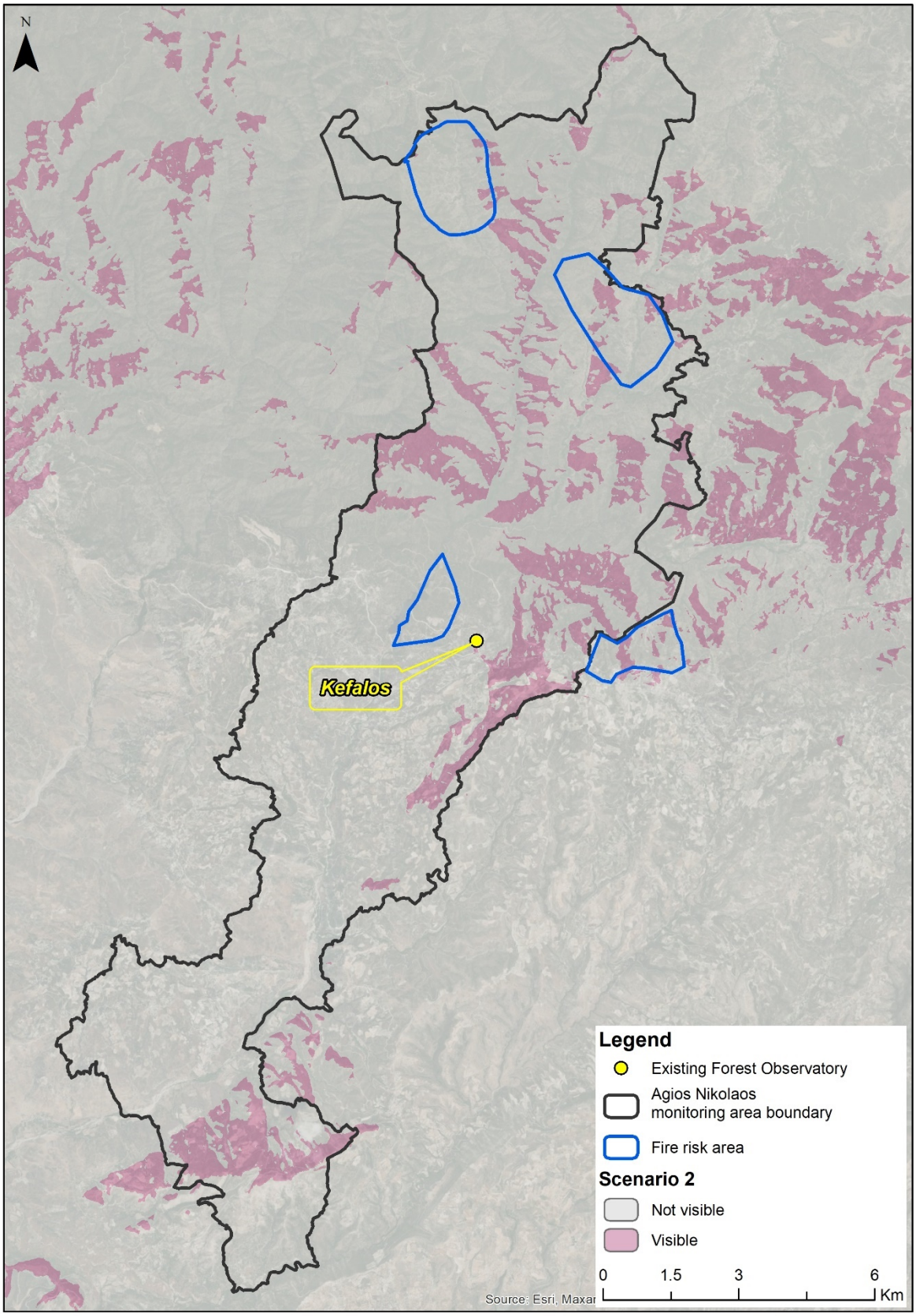
ANNEX I

Scenario 1



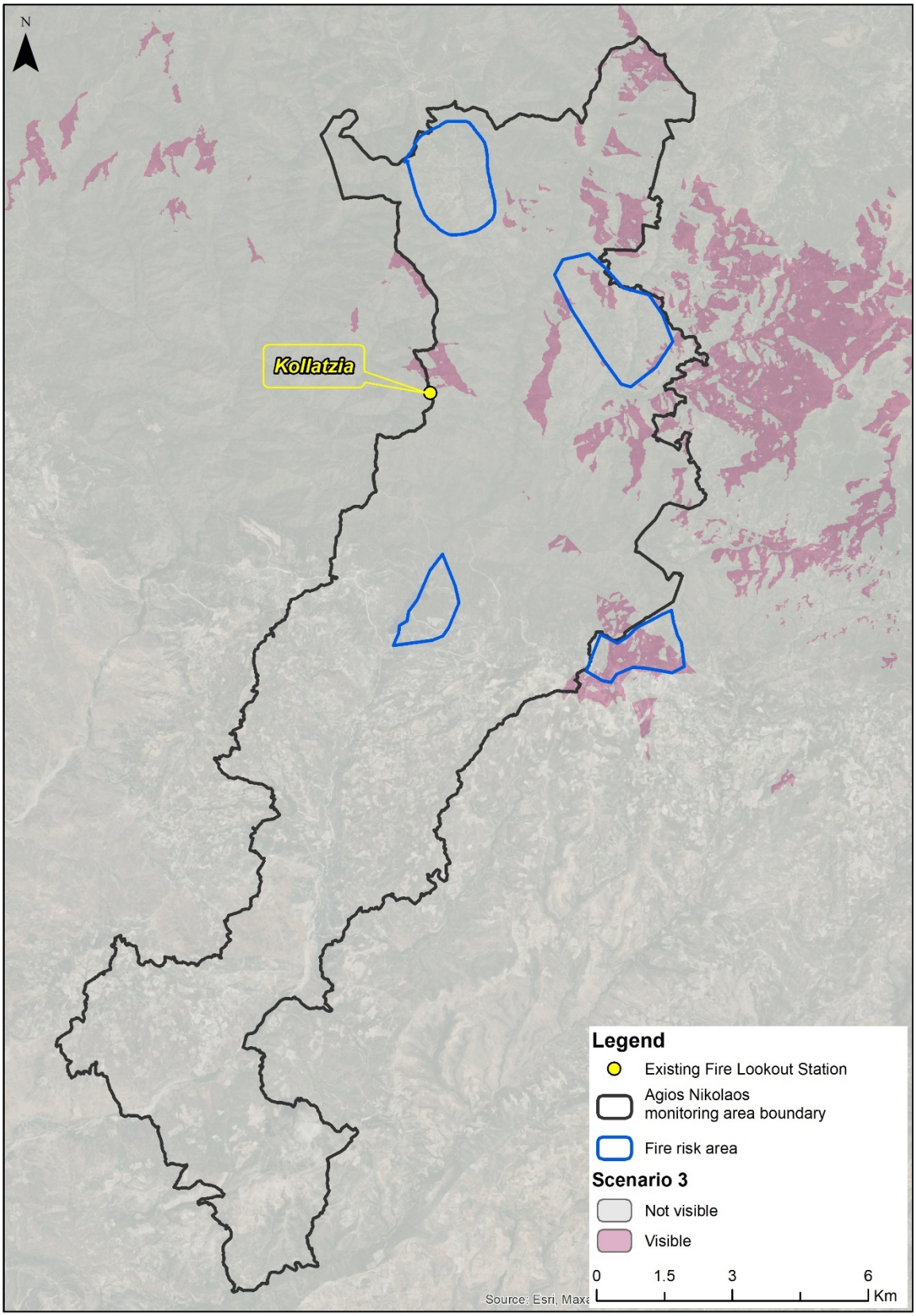
Map 8: Visible and not visible areas from Agios Ioannis FO [Scenario 1].

Scenario 2



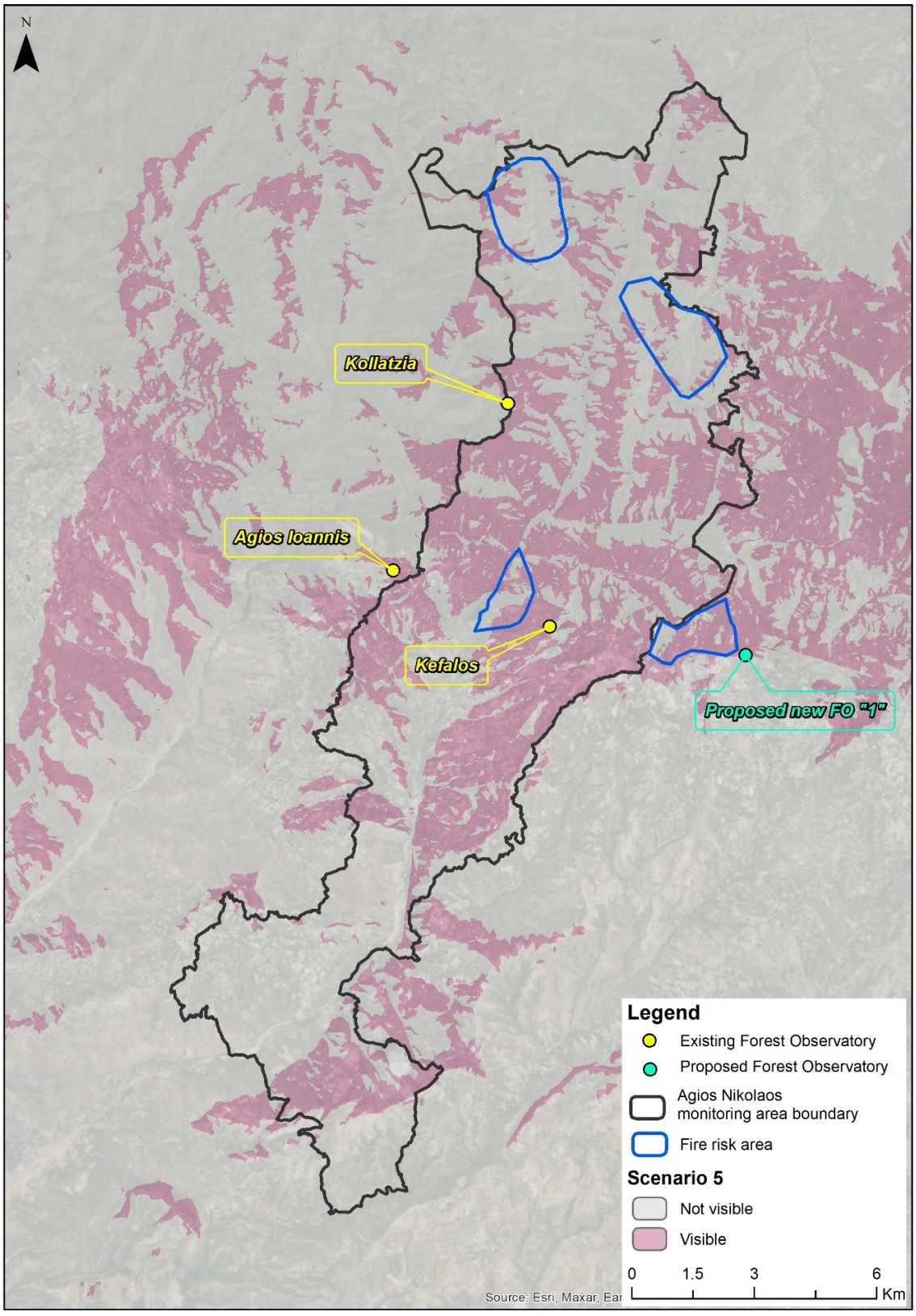
Map 9: Visible and not visible areas from Kefalos FO [Scenario 2].

Scenario 3



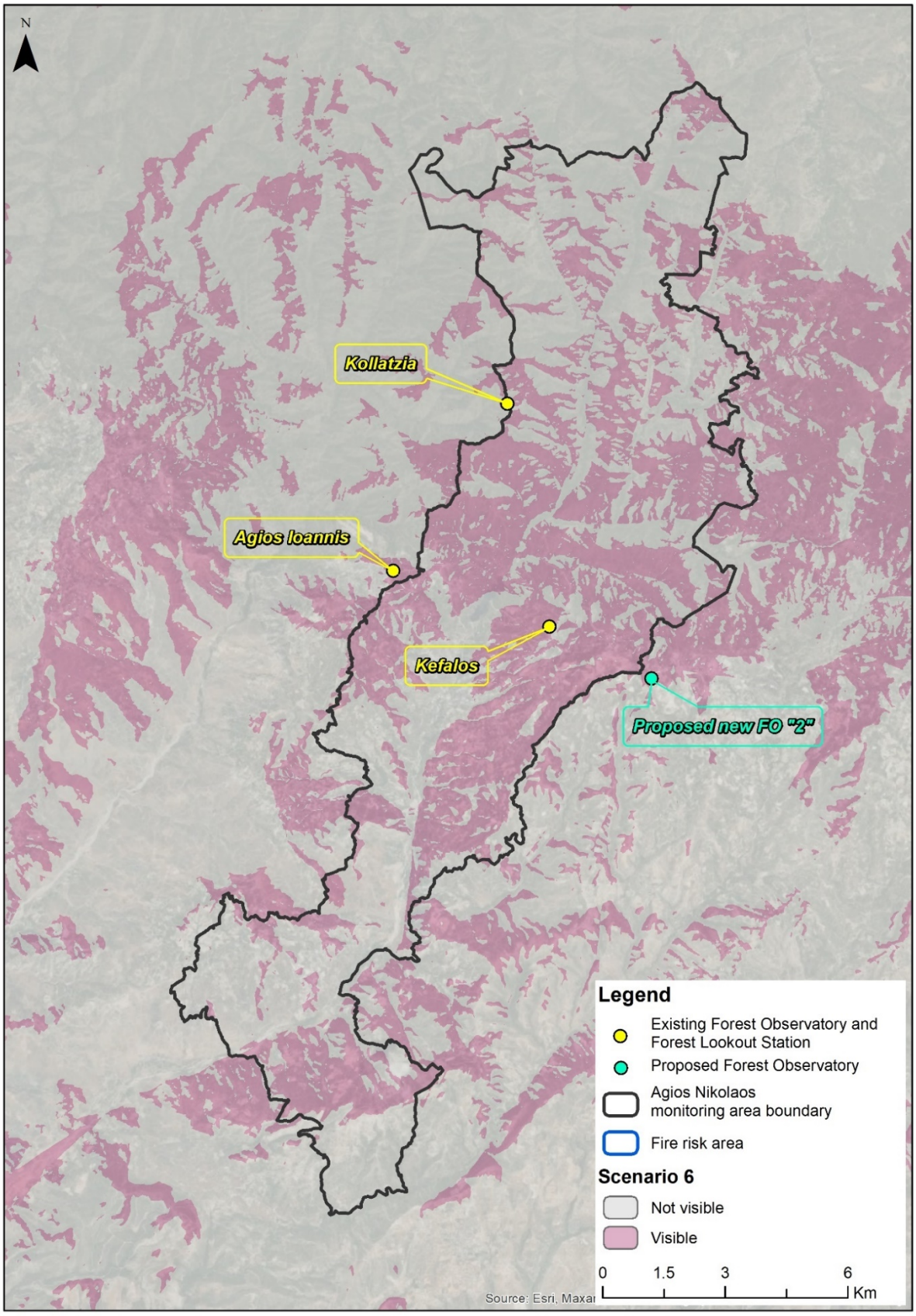
Map 10: Visible and not visible areas from Kollatzia FL Station [Scenario 3].

Scenario 5



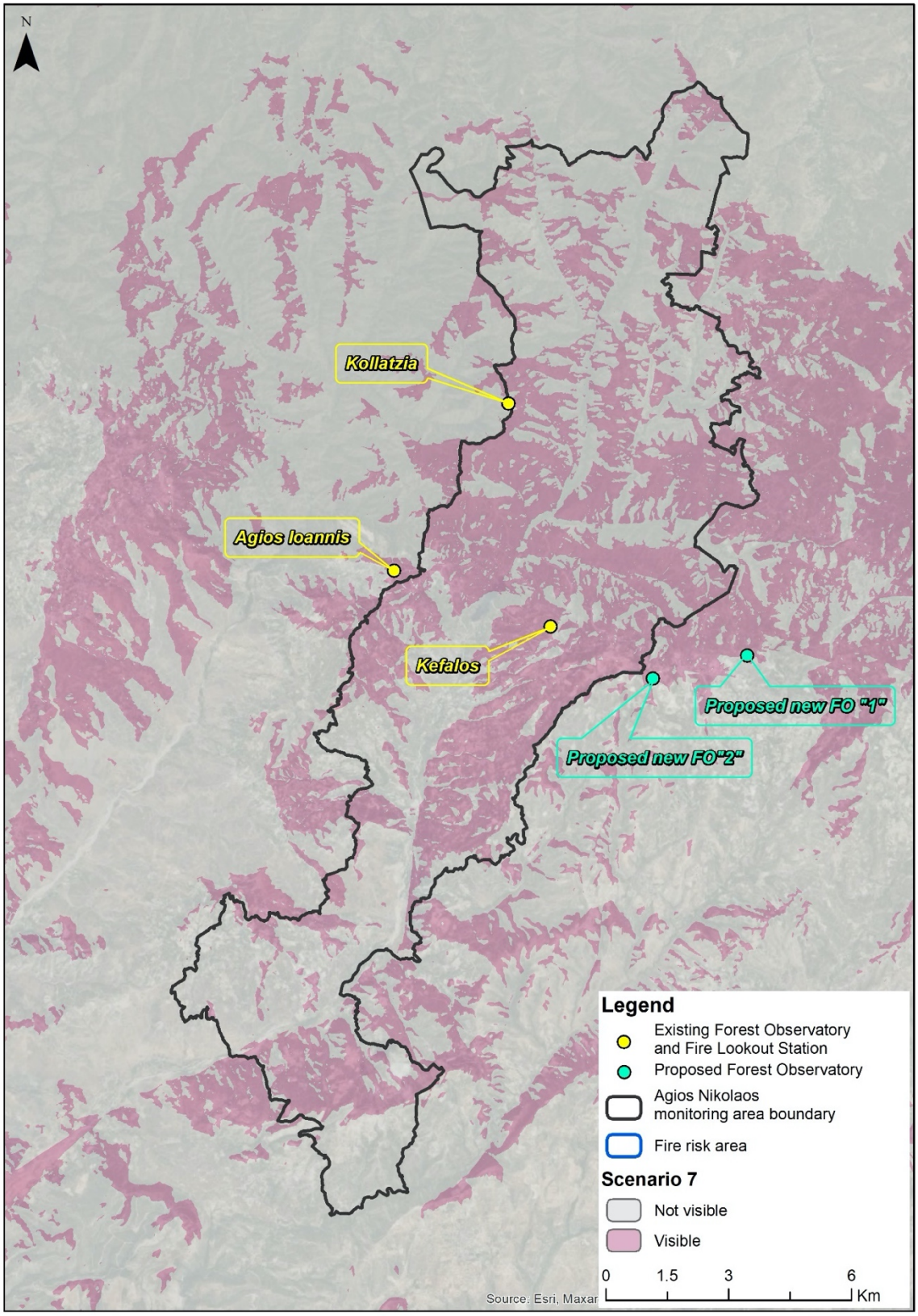
Map 11: Visible and not visible areas from the existing FOs and FL Station along with the proposed FO "1" [Scenario 5].

Scenario 6



Map 12: Visible and not visible areas from the existing FOs and FL Station along with the proposed FO "2" [Scenario 6].

Scenario 7



Map 13: Visible and not visible areas from the existing FOs and FL Station along with the proposed FOs [Scenario 7].