

NATIONAL TECHNICAL UNIVERSITY OF ATHENS
SCHOOL OF RURAL, SURVEYING AND GEOINFORMATICS
ENGINEERING

MSc Geoinformatics

**A GIS – Based Analysis on the Development of Mining Activities in
NATURA 2000 sites: Case studies in Central Greece and Eastern
Macedonia - Thrace**

George Sassanis

Mining & Metallurgical Engineer NTUA

Supervisor: K. Adam, Professor, School of Mining & Metallurgical Engineering

Athens 2023

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George Sassanis

Mining & Metallurgical Engineer NTUA

Examination committee

K. Adam, Professor, School of Mining & Metallurgical Engineering (supervisor)

M. Menegaki, Professor, School of Mining & Metallurgical Engineering

K. Modis, Professor, School of Mining and Metallurgical Engineering

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Abstract

The scope of this study is to investigate and quantify the spatial overlaps of mining areas within NATURA 2000 sites in Greece, with a focus on metallic and critical raw materials (CRMs). The study areas, selected taking into account the related Special Environmental Studies (SES 6a, 1a, 1b), are a) Evvia & part of Viotia with areas of Exclusive Mining Activity (Laterites, Magnesite) as defined by the Regional Spatial Plan of Central Greece, and b) Eastern Macedonia - Thrace (Public Mining Sites of Ayios Filippos, Aesimi, Kirki, and Thermes) based on HSGME data. Spatial analysis has been conducted so as to quantify the presence of each mining area within the sub-zones that comprise the NATURA 2000 sites (Absolute Nature Protection, Nature Protection, Habitat and Species Preservation, Sustainable Management of Natural Resources). The results showed that even though there are cases of existing mine sites within or in proximity to the protected areas (magnesite mines in northern Candili Mountain, laterite mines in Mountains of Central Evvia), extensive areas that present geological potential are excluded from further exploitation. This happens due to the fact that they are located within Nature Protection Zones, where according to the prevailing environmental legislation, mining activity is excluded (Law 4685/2020). In Evvia, 2.244 stremma of Exclusive Mining Activity areas and open pits are permitted in Habitat and Species Preservation zones, whereas there are 14.244 stremma that are excluded since they are located within Nature Protection Zones. In the Eastern Macedonia - Thrace region, particularly within the Public Mining Sites of Evros, extensive overlap between areas presenting mineral resource potential and NATURA 2000 sites has been observed, ranging from 19% (Ayios Filippos) to 81% (Kirki). It is concluded that the co-occurrence of areas with mining potential and biodiversity preservation sites may constitute a restrictive factor when assessing further exploration or the establishment of new mines. However, the issue of sustainable co-existence of extractive activities and NATURA 2000 sites needs further evaluation, given the increasing needs for raw materials that are expected to intensify the pressures to protected ecosystems. It is also important to point out that since 2010 a Guidance Document has been published in EU for the sustainable development of Non-Energy Extractive Industry in NATURA 2000 sites.

Thesis Title (in Greek): Τίτλος Μεταπτυχιακής Εργασίας

Ανάλυση σε GIS της Δυνατότητας Ανάπτυξης Μεταλλευτικής Δραστηριότητας σε Περιοχές του Δικτύου NATURA 2000: Μελέτες Περίπτωσης σε Στερεά Ελλάδα και Ανατολική Μακεδονία - Θράκη

Extended Abstract (in Greek): Εκτενής Περίληψη

Η αυξανόμενη ζήτηση σε συγκεκριμένες ορυκτές πρώτες ύλες (ΟΠΥ), ιδιαίτερα όσων απαιτούνται για την πράσινη μετάβαση, δημιουργεί κλίμα αβεβαιότητας αναφορικά με την ασφαλή τροφοδοσία της Ευρωπαϊκής Ένωσης (ΕΕ) και την εξάρτηση της από τρίτες χώρες. Βάσει της πρωτοβουλίας για ΟΠΥ (Raw Materials Initiative – RMI) που δημοσιεύτηκε το 2008, αλλά και της πρόσφατης πράξης για τις κρίσιμες ΟΠΥ (Critical Raw Materials Act, 2023), η ΕΕ αναγνώρισε και ενθάρρυνε μεταξύ άλλων, και την εγχώρια πρωτογενή παραγωγή στα Κράτη Μέλη τα οποία παρουσιάζουν δυναμικό ΟΠΥ. Το ενδεχόμενο επέκτασης της εξορυκτικής δραστηριότητας ωστόσο, αντιμετωπίζει σημαντικές προκλήσεις όπως η πρόσβαση στην γη και η κοινωνική αποδοχή.

Σε αυτό το πλαίσιο, και δεδομένου ότι σε αρκετές περιπτώσεις τα κοιτάσματα μεταλλικών ορυκτών (όπως χαλκού, ψευδαργύρου, αλουμινίου, σιδήρου και χρυσού) τείνουν να βρίσκονται σε εγγύτητα με περιοχές υψηλής περιβαλλοντικής αξίας (Murguía et al, 2016), αναδεικνύεται η σημασία διερεύνησης της συμβατότητας της ΜΕΕΒ (Μη Ενεργειακής Εξορυκτικής Βιομηχανίας) με περιοχές προστασίας της φύσης, όπως αυτές του δικτύου NATURA 2000. Το ζήτημα της βιώσιμης συνύπαρξης χρήζει περαιτέρω ανάλυσης σε χώρες όπως η Ελλάδα, όπου καλύπτεται κατά 27% από περιοχές του δικτύου NATURA 2000, και διαθέτει ορυκτό πλούτο που ενίοτε απαντάται εντός ή πλησίον των προστατευόμενων περιοχών (Τζεφέρης, 2018).

Η παρούσα εργασία εξετάζει περιπτώσεις συνύπαρξης μεταλλευτικών χώρων με περιοχές NATURA 2000 στην Ελλάδα, και εστιάζει σε περιοχές με συγκεντρώσεις μεταλλικών ορυκτών και κρίσιμων ΟΠΥ, δεδομένης της σημασίας τους στο Ευρωπαϊκό οικονομικό περιβάλλον. Όσον αφορά τον καθορισμό των προστατευόμενων περιοχών η παρούσα μελέτη βασίστηκε σε στοιχεία από τις διαθέσιμες για τις εξεταζόμενες περιοχές Ειδικές Περιβαλλοντικές Μελέτες (ΕΠΜ), οι οποίες ορίζουν τις ζώνες προστασίας εντός του δικτύου NATURA 2000 (Ζώνες Απόλυτης Προστασίας της Φύσης - ΖΑΠΦ, Ζώνες Προστασίας της Φύσης - ΖΠΦ,

Ζώνες Διατήρησης Οικοτόπων και Ειδών - ΖΔΟΕ, και Ζώνες Βιώσιμης Διαχείρισης Φυσικών Πόρων - ΖΒΔΦΠ), και τις επιτρεπόμενες δραστηριότητες εντός αυτών.

Στον Ελλαδικό χώρο, η εξόρυξη μεταλλευμάτων λαμβάνει χώρα κατά κύριο λόγο στην Στερεά Ελλάδα (Βωξίτης στην Φωκίδα, Σιδηρονικελιούχοι Λατερίτες σε κεντρική Ευβοια και Βοιωτία, Μαγνησίτες στην κεντρική Εύβοια) και την κεντρική Μακεδονία (Μαγνησίτες, Μεικτά Θειούχα στην περιοχή της Χαλκιδικής). Ωστόσο, στην περιφέρεια Ανατολικής Μακεδονίας – Θράκης έχουν επίσης διαπιστωθεί περιοχές δυνητικού μεταλλευτικού ενδιαφέροντος, εντός Δημόσιων Μεταλλευτικών Χώρων (ΔΜΧ), οι οποίοι βάσει της Ελληνικής Αρχής Γεωλογικών και Μεταλλευτικών Ερευνών (ΕΑΓΜΕ), παρουσιάζουν ενδιαφέρον για περαιτέρω έρευνα και αξιοποίηση. Παράλληλα, και δεδομένου ότι οι Ειδικές Περιβαλλοντικές Μελέτες (ΕΠΜ) για κεντρική Μακεδονία και δυτική Στερεά Ελλάδα δεν έχουν δημοσιευθεί μέχρι σήμερα, οι περιοχές μελέτης της παρούσας εργασίας επικεντρώνονται σε εκτάσεις μεταλλευτικής δραστηριότητας της Εύβοιας και μέρους της Βοιωτίας (ΕΠΜ 6α - Μεταλλεία στα όρη κεντρικής Ευβοίας, στο όρος Καντήλι και στον Άγιο Ιωάννη), στους ΔΜΧ του Αγίου Φίλιππου, Αισύμης, Κίρκης (ΕΠΜ 1α – Βόρεια της Αλεξανδρούπολης, Έβρος), και του ΔΜΧ Θερμών (ΕΠΜ 1β – Βόρεια της Ξάνθης), που χαρακτηρίζονται από μεικτά θειούχα μεταλλεύματα. Πρόκειται για ευρείες περιοχές στις οποίες το Δημόσιο διαθέτει δικαιώματα έρευνας και εκμετάλλευσης.

Πιο συγκεκριμένα, τα γεωχωρικά δεδομένα (πολύγωνα) για τις μεταλλευτικές ζώνες της Στερεάς Ελλάδας αντλήθηκαν από το Περιφερειακό Χωροταξικό Πλαίσιο και αποτελούν περιοχές Αποκλειστικής Μεταλλευτικής Δραστηριότητας, δηλαδή θεσμικά κατοχυρωμένες εκτάσεις που προορίζονται αποκλειστικά για μεταλλευτική χρήση (μεταλλειοκτησία), σύμφωνα με το άρθρο 67 του μεταλλευτικού κώδικα και τον Κανονισμό Μεταλλευτικών και Λατομικών Εργασιών. Περιέχουν ενεργά/ανενεργά μεταλλεία, ή και περιοχές που προορίζονται για αξιοποίηση αλλά δεν έχει αναπτυχθεί ακόμα κάποιο σχετικό έργο.

Οι συντεταγμένες για τους ΔΜΧ Ανατολικής Μακεδονίας – Θράκης λήφθηκαν από την σχετική χαρτογραφική εφαρμογή διαδικτύου της ΕΑΓΜΕ (οδηγός για τις ΟΠΥ), και χαρακτηρίζονται από συγκεντρώσεις σε μόλυβδο-ψευδάργυρο, χρυσό, και κρίσιμες ΟΠΥ όπως χαλκό και γραφίτη. Ως συμπληρωματική χωρική πληροφορία για

τους ΔΜΧ, χρησιμοποιήθηκαν και σημειακά δεδομένα εμφανίσεων από την βάση ProMine (EGDI, 2022).

Με χρήση εργαλείων GIS (ΓΣΠ - Γεωγραφικά Συστήματα Πληροφοριών), εξετάστηκε η επικάλυψη και χωρική συσχέτιση κάθε μεταλλευτικής περιοχής με τις υπο-ζώνες των περιοχών NATURA 2000. Επίσης, διερευνήθηκε η έκταση των μεταλλευτικών περιοχών που βρίσκονται σε απόσταση 2χλμ από τα όρια της προστατευόμενης περιοχής, καθώς η εξορυκτική δραστηριότητα στις περιοχές αυτές μπορεί να θεωρηθεί ως πιθανή πηγή για την δημιουργία κοινωνικών και περιβαλλοντικών ζητημάτων. Τα αποτελέσματα της χωρικής ανάλυσης στην Εύβοια και τμήματος της Βοιωτίας, έδειξαν ότι από την συνολική έκταση των περιοχών Αποκλειστικής Μεταλλευτικής Δραστηριότητας και Ανοικτών Εκσκαφών (130.736 στρέμματα, συνυπολογίζοντας την λατομική δραστηριότητα), η έκταση εντός δικτύου NATURA 2000 που σχετίζεται με μεταλλικά ορυκτά ανέρχεται σε 17.389,4 στρ., εκ των οποίων 3.144 στρ. (18%) βρίσκονται εντός ΖΔΟΕ και 14.245 στρ. (82%) εντός ΖΠΦ. Πιο συγκεκριμένα, υπολογίσθηκαν 11.531,7 στρ. στα όρη κεντρικής Ευβοίας (ΖΕΠ – GR2420011), και 4.957,6 στρ. στο βόρειο τμήμα του όρους Καντήλι (ΖΕΠ – GR2420010). Απο τις παραπάνω εκτάσεις, βάσει της ΕΠΜ 6α, υπολογίσθηκαν 510 στρ. για μεταλλευτική χρήση στα όρη κεντρικής Ευβοίας (λατερίτες), και 1.734 στρ. στην περιοχή εξόρυξης μαγνησίτη, στο όρος Καντήλι. Στην περίπτωση των μεταλλείων του Αγίου Ιωάννη, οι εκμεταλλεύσεις δεν εμφανίζουν ουσιαστική επικάλυψη με την προστατευόμενη περιοχή του Βοιωτικού Κηφισού – Λίμνες Υλίκη & Παραλίμνη (ΕΖΔ/ΤΚΣ – GR2410001), αλλά υπάρχουν 8.669 στρ. Αποκλειστικής Μεταλλευτικής Δραστηριότητας στην ζώνη των 2χλμ από το όριο της περιοχής NATURA 2000.

Όσον αφορά τους Δημόσιους Μεταλλευτικούς Χώρους Έβρου (Άγιος Φίλιππος, Αισύμη, Κίρκη), παρατηρήθηκαν σημαντικές επικαλύψεις με περιοχές NATURA 2000 (GR1110009, GR1110002, GR1110003, GR1110005, GR1110010, GR1130011). Αναλυτικότερα, η παρουσία των περιοχών μεταλλευτικού ενδιαφέροντος εντός της προστατευόμενης περιοχής ανέρχεται κατά προσέγγιση στο 19% για τον Άγιο Φίλιππο, 62% για την Αισύμη, και 81% για την Κίρκη, επηρεάζοντας τη δυνατότητα ανάπτυξης μεταλλευτικής δραστηριότητας. Στις Θέρμες, η επικάλυψη φαίνεται να μην επηρεάζει το ενδεχόμενο αξιοποίησης των σχετικών ΟΠΥ. Σημαντική είναι επίσης η παρατήρηση ότι σε καμία εκ των

ορισμένων ΖΔΟΕ στις ΕΠΜ 1α, 1β που παρουσιάζουν επικάλυψη με τους εξεταζόμενους ΔΜΧ, δεν προβλέπεται περαιτέρω έρευνα για αύξηση κοιτασματολογικής γνώσης ή ανάπτυξη νέων μεταλλευτικών έργων.

Συμπερασματικά, παρά την σημαντική επικάλυψη περιοχών ορυκτού πλούτου με το δίκτυο NATURA 2000 που καταγράφεται στην Ελλάδα, είναι λίγες οι περιπτώσεις όπου υφίστανται μεταλλευτικά έργα εντός αυτών. Συνεξετάζοντας τις προβλέψεις των ΕΠΜ και τις προτάσεις των Περιφερειακών Χωροταξικών Πλαισίων, διαπιστώνεται ότι στην Στερεά Ελλάδα, και ειδικότερα στο Περιφερειακό Χωροταξικό Πλαίσιο, υπάρχουν σαφείς αναφορές για βιώσιμη συνύπαρξη της μεταλλευτικής με περιοχές προστασίας της φύσης. Αντιθέτως, στην περίπτωση του Έβρου, η εκτενής επικάλυψη των ΔΜΧ με ΖΠΦ καθώς και η κατά περιπτώσεις αρνητική στάση της τοπικής κοινωνίας απέναντι σε μεταλλευτικά έργα, δύνανται να επηρεάσουν την δυναμική μελλοντικής αξιοποίησης του ορυκτού πλούτου της περιοχής.

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List of Abbreviations

Mining & Mineral Resources

PMS: Public Mining Site

L1-L14: Exclusive Mining Areas, Laterite Ore, Mountains of Central Evvia

M1-M4: Exclusive Mining Areas & Open pits, Magnesite ore, Candili Mountain

L1V-L3V: Exclusive Mining Areas, Laterite ore in Ayios Ioannis, Viotia

CRM: Critical Raw Materials

NATURA 2000 Network

SES: Special Environmental Study

SPA: Special Protection Area

SCI/SAC: Sites of Community Importance/Special Area of Conservation

NATURA 2000 Zones

ANP: Zone of Absolute Nature Protection

NP: Zone of Nature Protection

HSP: Zone of Habitat & Species Preservation

SMNR: Zone of Sustainable Management of Natural Resources

Policy

G.G: Government Gazette

P.D: Presidential Decree

EIA: Environmental Impact Assessment

AA: Appropriate Assessment

Measurement Units

Str: Stremma (1str = 1000m², Greek measurement unit of area)

1. Introduction

From the prehistoric times, to the technologically advanced society of today, mineral raw materials have been of utmost importance for the human community. The buildings where people live in, the roads, the electricity, the automobiles, and the various electronic appliances used in everyday life, are all highly dependent on the existence of mineral raw materials exploitation and supply chain. It becomes evident that the manufacturing and construction sector, and hence a major part of the economy, is based on the proper operation of the extractive industry.

Placed in the context of the 21st century, however, the mining industry needs to overcome its own challenges. Nowadays, the sector does not merely have to meet the growing demand for raw materials, but at the same time, it has to operate profitably in an environmentally and socially acceptable manner. In other words, the extractive industry needs to abide by the triple – bottom – line of sustainability (Elkington, 1998): Economic welfare, Environmental protection, and Social awareness.

While the circular economy model constitutes nowadays an indispensable part of sustainability, the supply provided by recycling is insufficient for several base metals and critical raw materials, and cannot meet their high demand. Therefore, mining activity that provides the needed quantities of primary raw materials, especially transition minerals, will still be required to a significant extent (Luckeneder, et al., 2021; BenchMark Minerals Intelligence, 2022).

The increasing need for certain mineral raw materials sparks a discourse regarding further access to land for the extractive industry. This oftentimes leads to conflicts between potential mining operations and the vulnerable ecosystems of nature protection areas. A study conducted by Duran et al. (2013) showed that a substantial percentage of metal mining regions either overlaps, or is in proximity to protected areas, while the related work of Murguia et al (2016) concluded that large-scale metal mines or deposits (Cu, Zn, Al, Fe, Au) tend to be more prevalent in areas characterized by high biodiversity. Concerns have been raised in this context, given that the mining industry can potentially adversely impact the wildlife, the water resources, the air and soil quality during its entire life-cycle (ELAW, 2010; Mononen et al., 2022). It is argued that the increased mining activity could intensify the pressures to biodiversity (Luckeneder, et al., 2021).

The value of conservation areas and biodiversity has been recognized by several countries of the world, driving them to enact legislations in the framework to safeguard threatened ecosystems. The European Union, based on the formerly adopted Birds Directive (79/409/EEC) and Habitats Directive (92/43/EEC), established the NATURA 2000 network, aiming to protect habitats of importance and preserve the related biodiversity. However, the EU has also recognized the significance of mineral raw materials of its territory. The Raw Materials Initiative (RMI), adopted in 2008, has been a cornerstone for the European Strategy towards the management of mineral resources. It consists of three pillars: (a) Access to raw materials globally on undistorted conditions (b) Fostering the sustainable supply of raw materials from European sources (c) Reducing the EU's consumption of primary raw materials. Within the context of boosting the domestic extraction of minerals, methodologies have been developed for identifying and safeguarding significant deposits in land-use planning, both by Horizon 2020 projects (MinLand, Minatura 2020 by IMA) and academic literature (Mateus, et al., 2017; Carvalho, et al., 2021). EU's mining activity, which covers less than 1% of the land, renders the EU self-sufficient in terms of industrial and construction materials (European Commission, 2010). However, only 3% of the primary metallic minerals are extracted domestically (European Commission, Raw Materials Scoreboard 2021), which indicates a strong dependency on other countries for importing metallic raw materials. More recently, the EC published the Critical Raw Materials Act (2023), which is a significant step for recognizing the necessity of mitigating the supply risk of pivotal raw materials, and supporting their domestic primary and secondary production (European Commission, 2023).

On the grounds that deposits are oftentimes found in proximity to protected areas, a discussion commenced during the last decades regarding the potential co-existence of mining industry within EU's NATURA 2000 network. For this purpose, the EU published a guidance document (2010) called "Non-energy mineral extraction and NATURA 2000", which analyzes how the Non-Energy Extractive Industry (NEEI) may affect or co-exist with NATURA 2000 sites. In 2019, a complementary booklet was published, which examines several cases of NEEI operations in NATURA 2000 sites. This document provides case studies where co-existence proved to be attainable, and investigates the good practices that led to the desirable results.

Furthermore, the issue of Mining activity in NATURA 2000 sites has been examined in a number of scientific publications. The study of Wrana et al. 2014 proposes a model for the sustainable development of NEEI within NATURA 2000 sites. It encompasses the actions that need to be carried out by each stakeholder (state, companies, research institutions), in order for the mining industry to co-exist with Nature Protection areas. The authors highlight the significance of regional policy for resource management, and point out the main barriers to NEEI development, finally concluding that embracing a collaborative mindset is crucial. The study of Kowalska & Sobczyk (2011) investigates the co-existence of mining operations (mainly aggregates, but also petroleum and natural gas) in a region of both mining and biodiversity interest, Dukla Commune (Poland). The study is mainly descriptive, and provides the deposits/operations that take place within NATURA 2000 protected areas. It is argued that the existence of deposits within protected areas should not be perceived as a reason to exclude mining activities, but as a prompt to encourage the collaboration of different sectors. Carvalho et al. (2016) presented a case study from Portugal regarding ornamental limestone extraction areas in NATURA 2000 sites. Despite their cultural and economic significance, the quarrying areas faced hurdles after the designation of the NATURA 2000 sites. After thorough studies of both biodiversity and mining aspects, and close collaboration, the stakeholders overcame more than 20 years of conflict, and decided to proceed with the operations according to the proposed plan. The NATURA 2000 sites have also been examined as a parameter of interest by some papers, while investigating the potential development of mineral resources. For instance, the study of Eerola (2022) examined the location of areas with mineral exploration permits in Finland, and showed that the overlap or proximity with the NATURA 2000 network has been a common cause for contestation.

Generally, given the EU's growing interest on its independence regarding mineral raw materials supply, and the existing robust strategies for conservation, the co-existence of mining activity and nature protection areas becomes a challenge. This can be a case to further examine in some EU countries like Greece, whose area is covered to 27% by NATURA 2000 sites that oftentimes overlap with potentially promising mining regions (Tzeferis, 2018).

Within the relevant literature, no studies were found to be targeted on Mining and NATURA 2000 from a detailed spatial perspective, taking into account the management plan of the protected sites and the regional spatial plan. Moreover, the vast majority of the cases refer to aggregate mining, and there is a lack of studies concerning specifically metals and CRMs.

On this basis, the objective of this study is to investigate and quantify the spatial overlaps of existing mine sites and/or areas presenting geological potential for further exploitation with NATURA 2000 sites in Greece, with a focus on metallic and critical raw materials (CRMs). This is carried out under the light of the published draft Special Environmental Studies (SES), whose role is to define the zones of protection (according to law 4685/2020) of areas presenting a particular ecological interest, and propose a management plan for each of the examined NATURA 2000 site. The aim of this study is to assess how the mining activity is managed in these protected areas, examine cases where it is permitted or prohibited, and evaluate the potential implications for the future development of metal mining activity in Greece.

2. The European Framework for Mining and NATURA 2000

2.1. Birds & Habitats Directives

The European Union, having recognized the value of preserving biodiversity, adopted the Birds Directive in 1979 (79/409/EEC). This document, amended in 2009, establishes the ground rules for protecting and managing endangered bird species within the territory of each member state. Worth mentioning is the fact that more than a third of the EU's bird species are not considered to be in good conservation status (EC, The Habitats Directive). The directive lists a range of bird species that require special protection, either due to the risk of extinction, vulnerability to changes in their habitat, small or restricted populations, or some habitat trait of particular interest. It includes the actions needed to be taken so as to preserve, maintain and re-establish biotopes and habitats, and presents cases where the potential harm on the integrity of the site can be further tolerated. The Birds Directive, given the fundamental role of the hosting habitats, introduces the Special Protection Areas (SPA), which constitute regions where the species of interest feed and breed.

In 1992, an additional measure was adopted to address the ongoing decline of vulnerable species: the Habitats Directive (92/43/EEC). This complementary directive specifically addresses issues concerning wildlife and plant life, encompassing a diverse range of over 1000 animal and plant species, as well as 200 different habitat types. It introduces the concept of conservation status and provides guidelines on how to define a state of "favorable" conservation status. The Habitats directive also acknowledges the crucial importance of habitats for species preservation, and designates a second type of protected areas: the Sites of Community Importance (SCI). These areas contain physical and biological factors pivotal for the life and reproduction of the species of interest. Articles 6.3, 6.4 are of particular interest in this directive, on the grounds that they demonstrate the required steps for authorizing a plan or project within these protected ecosystems. The stages include: 1) *Screening* (examination of the likely effects of a project on the protected site), 2) *Appropriate Assessment* (Concludes whether the project may threaten the integrity of the site, and propose potential compensation measures), 3) *Assessment of Alternative Solutions* (examines alternatives in order to avoid or mitigate the adverse impacts), and 4) *Assessment where no alternative solutions exist and where adverse effects remain* (addresses cases where harm may be justified for health & safety reasons or

imperative reasons of overriding public interest) (European Commission, 2001, Guidance on the provisions of Articles 6.3 and 6.4).

The steps for assessing whether a plan or project will be green-lighted are provided in the following flowchart (Figure 1).

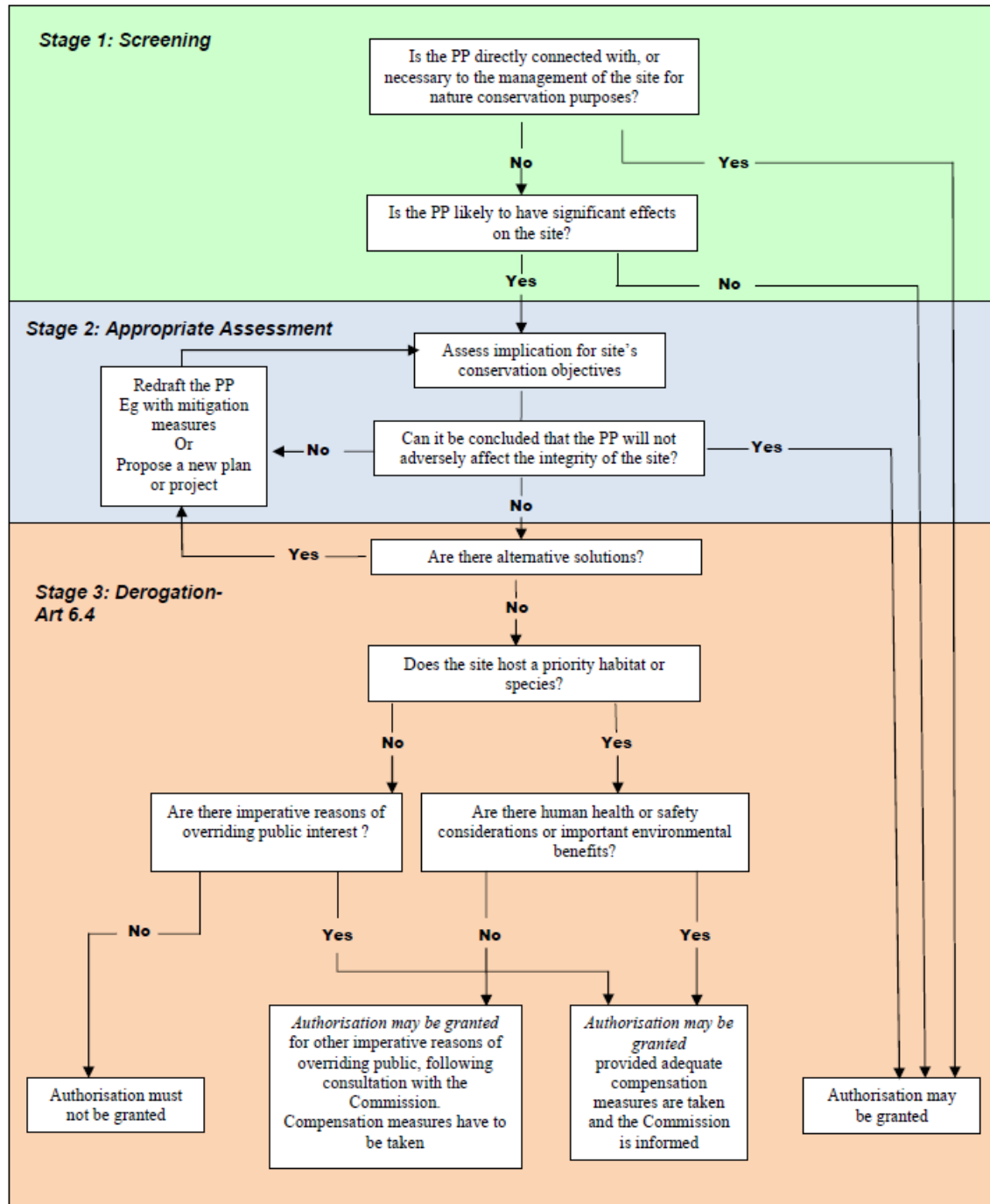
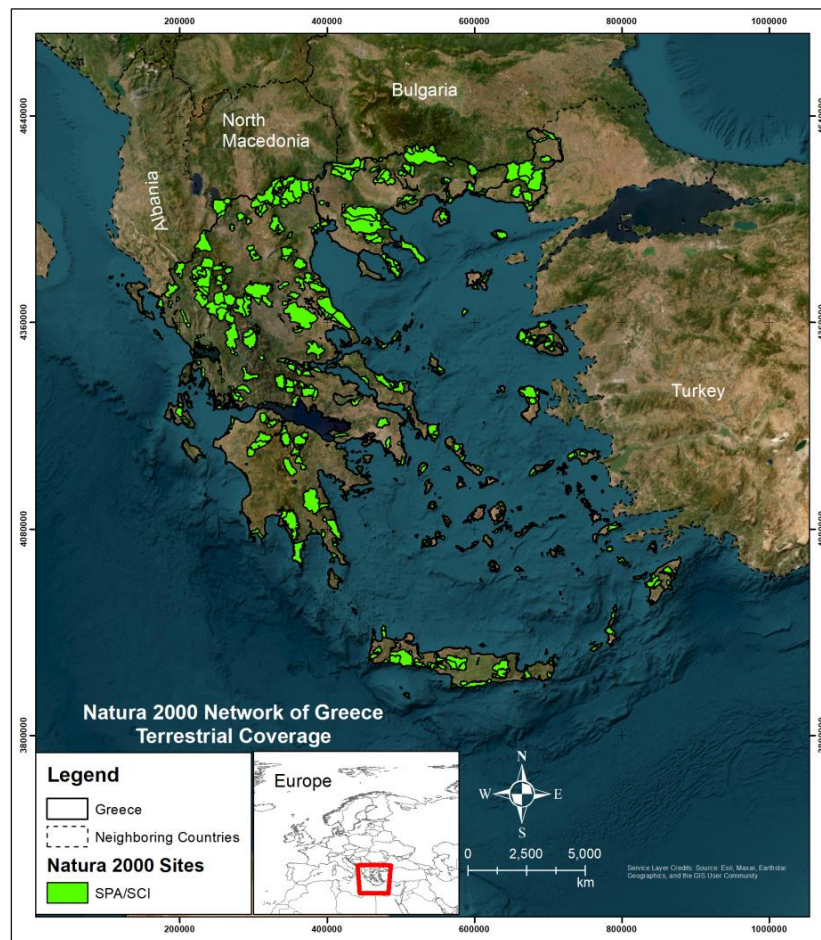


Figure 1: General flowchart showing the methodology for assessing a plan or project in a NATURA 2000 site (European Commission, 2010, Guidance Document).

2.2. The NATURA 2000 Network

The aforementioned directives serve as the foundation of the NATURA 2000 network, which covers more than 18% of the EU's land area and 8% of its territorial sea, making it the largest coordinated network of protected areas worldwide (European Commission, NATURA 2000 network, webpage). Its primary goal is to safeguard the highly endangered species and habitats within the EU. However, NATURA 2000 sites are not meant to be devoid of human or economic activities. The aim and challenge, for the member states, is to offer a sustainable management plan, both from the financial and the environmental perspective (European Commission, NATURA 2000 network, webpage).

According to the European Environment Agency (2017), the percent of terrestrial coverage for EU countries by NATURA 2000 sites ranges from approximately 5 – 35%. Greece, which is of interest in the present study, has a 27% of its land covered either by SPA and/or SCI (5th highest position in EU). The spatial coverage of NATURA 2000 sites in Greece is shown in Map 1.



Map 1: NATURA 2000 network of Greece, terrestrial coverage.

2.3. NEEI in NATURA 2000: Guidance Document (2010)

Having recognized the potential overlap between mining regions and NATURA 2000 sites, the European Commission (EC) issued a guidance document for Non-Energy Mineral Extraction and NATURA 2000 (European Commission, 2010). Its purpose is to provide guidelines, on which the mining developments can take place in non-conflicting ways in relation to the provisions of the Birds and Habitats Directives.

This guidance book presents the European Framework for Non-Energy Extractive Industry (NEEI) in NATURA 2000, including detailed documentation about the provisions of Articles 6.3 & 6.4 of the Habitats Directive (Appropriate Assessment, Alternative Solutions and reasons for overriding public interest). It also clarifies the differences between appropriate assessment, environmental impact assessment, and strategic environmental assessment.

Within the context of co-existence between NEEI and NATURA 2000, the document highlights the significance of spatial planning. The potential of the extractive industry to operate in this type of conservation areas is related to the “access to land” issue, and in general, to the second pillar of the RMI (extraction from domestic sources). From a land-use perspective, the mining industry has two distinguishing characteristics. To begin with, the location of a mine is strictly dependent on the concentration of mineral raw materials in the earth’s crust, and hence, it is not flexible. Secondly, existing mines will eventually reach the mine closure and reclamation phase, and thus new mines will be needed to meet the demand for raw materials. Therefore, it makes sense to assess the economic potential of mining regions, and integrate the ones of interest in spatial planning. These procedures can foster the participation of different stakeholders, propose an optimal land-use management plan, and minimize potential conflicts of NEEI with competing land-uses, such as conservation areas.

The European Commission acknowledges that the NEEI, more or less, does have an impact on the land. This can be due to potential land clearance, the excavation itself, spoil tips, tailing ponds, or related infrastructure (access roads, buildings). The extractive industry is intertwined with threatening factors like dust (due to loading, hauling, processing), noise (blasting, crushing), human presence and transportation, all of which can potentially be detrimental to the areas under protection. Mining

excavations may also alter the quantity and diminish the quality of water resources (dewatering, pollution). It is possible that these effects may jeopardize the successful implementation of conservation strategies, leading to unacceptable degradation of the sites.

However, the extent of the impact of each NEEI operation may vary significantly. To start with, it is prudent to mention that the visual and environmental footprint of surface mining is generally more intense in relation to underground mining. Moreover, a distinction between quarries and metal mines is reasonable. The former is characterized primarily by small-medium scales and involves mechanical processing, whereas the latter may require larger areas for excavation, chemical processing of the ore, and waste disposal. Furthermore, it is worth pointing out that the degree of impact is influenced by the sensitivity of each habitat or species to the particular characteristics of a project. The negative effects may also vary in terms of duration or timing, and can be either direct or indirect. These facts clearly suggest that the significant disturbance stemming from the NEEI is not systematic, and has to be examined on a case-by-case basis.

According to the Habitats Directive (Article 6.3), the Appropriate Assessment (AA) concludes whether the proposed operation is expected to cause significant impact on the site's integrity. If adverse effects are identified and the project plan cannot proceed, then a discussion between the stakeholders begins regarding potential solutions, in the attempt to reduce the estimated damage to the site. Prevention and mitigation measures are examined, aiming to avoid or minimize the environmental degradation. If no alternative plan is acceptable but there are reasons of overriding public interest according to Article 6.4 of Habitats Directive, then compensatory measures are considered. Compensation refers to actions, whose purpose is to counterbalance the unavoidable negative effects of the operation. For instance, it could be the further protection or enhancement of an existing habitat. Relevant to the compensation measures are the biodiversity offsets, whose aim is to prevent net loss of biodiversity, by boosting the conservation status of an area outside the affected region.

An interesting aspect of NEEI, related to its long-term environmental footprint, is rehabilitation. It constitutes an integral part of mine planning and permitting, with a

significant potential to be conducive to habitat recreation and biodiversity preservation. Rehabilitation can be considered a mitigation measure, when the coherence of the sites in question is maintained. Despite its potential to be beneficial for the ecosystem, rehabilitation is unlikely to return an equal (in terms of quality) habitat with the related species, especially in cases of significant impact on the site. It constitutes a process that may require years or even decades to yield the desired results. Generally, the best practice is for the excavation to be closely followed by the reclamation process, which will be properly planned according to the site's characteristics.

The efficiency of prevention, mitigation and compensatory measures is attained by defining and monitoring specific criteria in detail. There should be a clear understanding of the site's particularities before the commencement of the project, and the indicators monitored need to be appropriate so as to detect unexpected changes. This in turn, will initiate further conversations for corrective actions, in order not to derail from the conservation objectives. The monitoring program is integrated in Article 11 of the Habitats Directive.

The proper collaboration and open dialogue between relevant stakeholders (regional authorities, mining firms, consultants, NGOs, local community) is pivotal when discussing NEEI projects within the NATURA 2000 network. A fruitful cooperation could be the key for estimating the potential impacts, assessing the alternatives, and make a decision in the perspective of having a win-win situation.

Several cases of NEEI and NATURA 2000 co-existence are mentioned within the document, most of them referring to aggregates. However, it becomes clear that the aim for the European Commission is not to exclude any type of NEEI from NATURA 2000 sites. It is to foster communication between the interested groups, suggest solutions that abide by the Nature Directives, and eventually achieve a balance between economic growth and biodiversity preservation.

2.4. Case studies of Extractive Operations in NATURA sites, EU Booklet (2019)

This document is complementary to the guidance document, and provides a number of case studies where the balanced co-existence of NEEI and NATURA 2000 areas proved to be sustainable. The purpose of this booklet was to investigate and present the implemented good practices, related to three pivotal elements: Partnerships and Stakeholder collaboration, Impact Assessment and Mitigation, and Rehabilitation.

The cooperation between mining firms and related groups, such as environmental organizations, NGOs, local people and regional authorities, seems to be quite valuable for NEEI operation in protected areas. For instance, the collaboration of Bird life Austria and the Mineral Resources forum in Austria proved to have tangible contribution to threatened species and related habitats in NEEI sites (Mineral Resources Forum, website). In Germany, Nature and Biodiversity Conservation Union (NABU) and the Industrial Association of Stones and Soils of Baden – Wurrtemberg (ISTE) jointly foster the proper operation of NEEI and the efficient rehabilitation in areas of high ecological value. Finland has established the Network for Sustainable Mining, in order to cultivate strong relationships between the relevant groups of interest. Eleven organizations related to mining, nature conservation, regional authorities and other stakeholders, having developed a Standard for Sustainable Exploration and Mining, provide practical tools for mining firms to render their operations environmentally and socially acceptable (KAIVOSVASTUU, website). The UK, although not an EU country since 2020, has implemented the Nature After Minerals Programme according to the aims of the UK's Biodiversity Action Plan (Davies, 2006). With the support and collaboration of mineral planners, industry, statutory bodies, conservation organizations and local communities, the project's objective is to recreate priority habitats on former extractions sites.

In terms of the type of resources being extracted, the majority of the cases mentioned in the booklet pertain to aggregates, while only one case involves metal mining. One notable example is the Neves Corvo mine in Portugal, which is recognized as one of the largest underground copper mines in the European Union. Although the actual excavation activities do not take place within a NATURA 2000 site, the concessions that encompass the mine and its associated industrial site partially overlap with a Special Protection Area and a Site of Community Importance. The conducted

Environmental Impact Assessment has identified several risks associated with the NATURA 2000 site, including the potential for dam failure, soil or waste rock leaching, and water management challenges. The company Somincor, in close collaboration with Nature Conservation NGOs and the relevant authorities, identified the environmental threats stemming from the mentioned sources of potential damage. Aiming to reduce the potential threats, the mining firm established a strong monitoring program (water quality, dam condition), and revised its procedures so as to manage, reduce, or even eliminate the sources of risk. Moreover, given that a potential dam overflow or rupture would be a significant threat for the surrounding area, the company adopted further safety layers (e.g. rerouting of tailings in case of overflow) and fostered the adoption of emergency plans. Another good practice was related to water management, which aimed at substantially reducing the production of effluents. More specifically, the current operations recycle and reuse 90% of the water used in the mining and processing areas. In turn, this mitigated the amount of wastewater within the tailing dam, and therefore reduced the risks of an accidental discharge to the nearby river pertinent to NATURA 2000 site.

It is also significant to point out that the case studies mainly refer to existing mines/quarries, or former extraction sites. Only Finland is mentioned to have plans for future underground mining activity near NATURA 2000 site, in Lapland. In this case, however, concerns have been reported regarding the potential impact of mining operations on the hydrological regime of the area, affecting the NATURA 2000 sites. Moreover, even exploration activities carried out in proximity to NATURA 2000 may be regarded as threats for the protected species. Until 2018, Finland had no mines/quarries operating within NATURA 2000 sites (European Commission, 2019).

3. The Extractive Industry in Greece

3.1. Contribution to the Economy

The economic contribution of the mining industry in Greece is demonstrated in the report conducted by the Foundation for Economic & Industrial Research (IOBE) in 2018, while some recent data are obtained from the annual 2021 report of the Association of Mining Companies (SME). The Greek extractive industry contains a wide spectrum of mining products. This list includes 1) metals like Al from bauxite ores, Fe-Ni from laterite ores, concentrates (Pb-Zn) from mixed sulfide ores, and magnesite ores 2) industrial minerals such as perlite and bentonite, and 3) building materials like limestone and marble.

According to the SME report, the total sales revenue (year 2020) is 1.257.470 € thousand, from which 909.737,6 € thousand is attributed to exports, a fact that confirms the sector's high-export profile and financial sustainability. Regarding specifically the metal ores, concentrates and related products, the sales revenue is 638.091 € thousand, which constitutes 50.7% of the total. Based on the study of IOBE, the extractive industry contributes approximately 3% of the country's GDP.

The extractive sector is of significant value for Greece's economy and society. This effect may be direct (within the companies), indirect (the effects from business-to-business transactions) and induced (the wider results of increased personal income). The contribution of the extractive sector lies especially on indirect positive impacts, due to collaborations with various services, consultants, and by boosting the local income and market. The following table contains data from IOBE (2018) regarding the economic effects of extractive sector.

Table 1: Positive economic impacts from the extractive sector (IOBE, 2018).

| | Direct | Indirect | Induced | Total |
|-----------------------------|---------------|-----------------|----------------|--------------|
| GDP (B €) | 1.2 | 0.7 | 2 | 3.9 |
| Employment (K) | 14 | 19 | 48 | 82 |
| Public Revenues(B €) | 272 | 149 | 546 | 967 |

However, it needs to be acknowledged that the data analyzed from IOBE may have changed, given the destabilizing or hindering events that took place during this time, such as the Covid-19 pandemic, and the Russo-Ukrainian war that commenced in 2022. However, for the purpose of this thesis, the data are deemed adequate to support the current general picture of the extractive industry's role in the Greek national economy.

3.2. National Mineral Policy

The Greek state has recognized the economic significance of the extractive sector both at the national, and the European level. Following the RMI issued in 2008 by the European Commission (EC), the Greek Ministry of Environment, Energy and Climate Change (YPEKA) has published the Greek National Policy (NP) for the Exploitation of Mineral Resources (Tzeferis, 2012, National Policy). This constitutes the foundation for the several actions needed, in order to ensure the proper management of the country's mineral wealth. The NP provides a framework in which the state, the industry and academia, will jointly pursue the sustainable development of Greece's extractive sector, in accordance with EU's guidelines. In addition to the triple-bottom-line of sustainability, the NP introduces a fourth pillar: good governance. This could be the key to striking the right balance between economic growth and socio-environmental responsibility.

While discussing the appropriate management of the country's deposits, the first step is to invest in exploring the mineral potential. In particular, this effort is to be targeted primarily on the deposits of minerals significant for national or European level. Moreover, deposit data need to be stored in the respective European geospatial databases, in a transparent manner. The ores of national interest mentioned in NP are Laterite ores (Fe-Ni), Bauxite (Al), Mixed Sulfide Ores (Pb-Zn-Ag), Gold, Magnesite, Marble, Bentonite and Perlite. The evaluation of these resources needs to take into consideration both the domestic needs, and the international market trends.

Besides the evaluation and exploitation framework, the axes of NP revolve around mitigating land-use conflicts, enhancing the permitting procedures, and highlighting the need for obtaining the Social License to Operate (S.L.O.). Land-use plans have to acknowledge the fact that there is no flexibility in the positioning of mining operations. Having this basis, the state needs to aim at two fronts: (a) the long term

continuation of existing operations, and (b) the preservation of identified significant deposits that are not under exploitation yet. The planning has to prevent these areas from being “sealed” by other economic activities or infrastructure.

Finally, the instrumental role of environmental permitting procedures is highlighted. The NP generally highlights the need for the modernization of legislation, the reasonable duration of the permitting procedures, the transparency, and the active involvement of the public. The potential co-existence of mining and NATURA 2000 network is also recognized, and the need for explicit defining and managing of these protected areas is underscored.

3.3. Legislative Framework & Environmental Permits

According to the Environmental Permitting law 4014/2011, projects and activities fall into two categories, A and B, based on their potential impact on the environment. Category A is further subdivided into A1 and A2, contingent upon whether the environmental footprint is deemed very significant or significant, respectively. In the specific case of mining operations, their categorization as either A1 or A2 depends on their particular characteristics, as outlined in G.G 841B/2022, Appendix 5 (Group 5: Mining and associated activities).

Table 2: Main types of mining projects, and their respective category in terms of environmental permitting. Further earth moving operations, as well as drilling for hydrocarbons or geothermal purposes, mine waste management, etc. are not presented in this table, but can be found in the official document (G.G 841B/2022).

| Type of Mining Project | Sub-category A1 | Sub-Category A2 |
|--|---|---|
| Energy Minerals Mining, Exploration Drilling for Energy Minerals | All Activities | |
| Metal Mining, Exploration Drilling for metallic ores | All Activities | |
| Industrial Minerals, Marbles, Schists | Surface mining: a) $E^1 \geq 250$ stremma b) $E \geq 150$ stremma and within NATURA 2000 sites. Underground mining within NATURA 2000 sites. | Surface mining: a) $150 < E < 250$ stremma and outside NATURA 2000. b) $E < 150$ stremma Underground mining outside NATURA 2000 sites. |
| Aggregate Mining | $E \geq 250$ stremma | $E < 250$ stremma |

¹ E = Worksite area (measured in stremma)

On the grounds that this study is focused on metal mining and exploration, the environmental legislation to analyze is related to category A, and especially A1. For the environmental permitting of all new projects within the A category, an Environmental Impact Assessment (EIA) study is required. The EIA is followed by the issuance of Decision of Approval of Environmental Terms. Prior to conducting the EIA, the project owner can receive consultation from the environmental authority, for submitting the Preliminary Definition of Environmental Requirements. In this stage, the Project developer may initiate public discussion regarding the technical aspects of the project, and the primary environmental concerns. The objective of consultation process is to define the elements of EIA. The Decision of Approval of Environmental Terms defines the limits or the required changes for conducting the activity. These terms are mainly related to preventing, mitigating and monitoring the environmental impact, and propose compensation measures. The responsible environmental authority for activities included in subcategory A1, is the Ministry of Environment, Energy, and Climate Change.

Article 10 of law 4014/2011 refers to the environmental permitting procedure for activities within NATURA 2000 network. As part of the EIA, it is required to conduct an Appropriate Assessment (AA), the aim of which is to examine whether the project has a negative impact on the preservation goals of the related sites. Alternatives are investigated, as well as mitigation measures, so as to preserve the ecological integrity of the protected site. If a significant impact is concluded, and no adequate alternatives have been proposed, then the project can only proceed for reasons of overriding public interest. In this case, compensation measures take place as well. Finally, for projects that are not located within NATURA 2000 sites but it is possible to have a negative impact on them, the provisions of Article 10 are implemented.

In Greece, the NATURA 2000 sites may consist of four (4) zones, according to the Article 44 of the law 4685/2020 (modification to the Article 14 of P.D 59/2018):

- 1) Zones of Absolute Nature Protection (ANP)

These zones are characterized by highly vulnerable habitat types or/with extremely vulnerable species, the presence of which is deemed of high importance, or it requires strict protection. In zones of Absolute Nature Protection, only a number or every activity from the ones stated in Article 14a of P.D 59/2018 is permitted, such as

scientific research, roads, common utility facilities, projects related to water resources management etc². These activities are assessed in each case, according to the related Special Environmental Study (SES).

2) Zones of Nature Protection (NP)

These zones consist of habitat types or habitats with species whose presence is of high significance or their status requires strict protection. In these areas, natural environment is protected from activities that have the potential to substantially undermine their conservation status. These activities are excluded or limited, according to the management plans, when regarded as threats to the conservation goals. In zones of Nature Protection, only a number or every activity from the ones stated in Article 14b of P.D 59/2018 is permitted, such as management for the protected area, agricultural activity, floating marine recreational facilities etc. These activities are assessed in each case, according to the related Special Environmental Study (SES).

3) Zones of Habitat and Species Preservation (HSP)

The aim in these areas is to be properly managed, in order for their habitat types or species to maintain an appropriate conservation status. Activities that may hinder the preservation of these areas, either by themselves or cumulatively with others, are excluded or limited. In zones of Habitat and Species Preservation, only a number or every activity from these stated in Article 14c of P.D 59/2018 is permitted, such as tourist accommodation, renewable energy infrastructure, mining projects etc. These activities are assessed in each case, according to the related Special Environmental Study (SES).

4) Zones of Sustainable Management of Natural Resources (SMNR)

These zones can co-exist with the relevant cultural values and/or human activities that promote Natural Resource Management and sustainable development. Human activities within this zone, when they may lead to a deterioration of the conservation status of the protected object in the protected area and, in particular, the conservation status at the national level, are subject to appropriate regulations based on the relevant

² The complete list of possible activities for each zone of protection can be found in law 4685/2020 (in Greek).

provisions of the characterization act of the protected area and the respective Management Plan.

It has to be pointed out that mining activities are excluded by definition from ANP, and NP. The development of mining projects within NATURA 2000 sites can be discussed within the context of a SES, only in the cases of HSP and SMNR.

Table 3: NATURA 2000 zones: On which can mining development be examined?

| ANP | NP | HSP | SMNR |
|-----|----|-----|------|
| X | X | ✓ | ✓ |

3.4. Special Environmental Studies

Special Environmental Study (SES) is a type of scientific study, the aim of which is the issuance of presidential decree and the management plan of protected areas. The objective of these projects is to define the zones with different levels of protection within the NATURA 2000 sites, the terms and limitations for the potential land uses, aiming to provide development opportunities that comply with the preservation goals. The proposed management plans will conclude on the human activities that may be developed or will be maintained based on the relevant legislation (law 4685/2020). The content of each SES is specified, and it is divided into 5 chapters: I) Introduction II) Description of the Protected Object III) General Assessment of NATURA 2000 Habitat IV) Defining Protection Zones V) Management of Protected Sites. The SES chapters are accompanied with land-use tables containing the types of NATURA 2000 zones, and the activities that are either allowed, under discussion, or excluded for each area of study. The parameters of spatial interest are all presented in SES webGIS platforms. To this date (September, 2023), 13 SES have been conducted and have been presented for public consultation, and for 10 of them the public consultation is completed (Table 4).

Table 4: Special Environmental Studies, to this date (September, 2023), in Greece (YPEN, 2023).

| ID | Study Areas (Regional Units) | Status |
|-----------|--|-------------------|
| SES 9b | Chania and part of Rethymno | Open Discussion |
| SES10b | Korinthia, Argolida, Arkadia, and part of Lakonia | Open Discussion |
| SES 7a | Attica Region | Open Discussion |
| SES 5a | Kerkyra, Kefalonia, Ithaka, Leykada, Zakynthos | Closed Discussion |
| SES 8a | Part of South Aegean | Closed Discussion |
| SES 11a | Thesprotia, Ioannina, Grevena, Eastern – Western Parts | Closed Discussion |
| SES 1a | Evros and part of Rodopi | Closed Discussion |
| SES 1b | Part of Rodopi, Xanthi, Kavala, Thasos, Drama | Closed Discussion |
| SES 4a | Larissa, Magnesia, Sporades | Closed Discussion |
| SES 4b | Trikala, Karditsa | Closed Discussion |
| SES 6a | Part of Viotia, Evvia | Closed Discussion |
| SES 9a | Part of Rethymno, Heracleon, Lasithi | Closed Discussion |
| SES 10a | Part of Lakonia, Messinia | Closed Discussion |

3.5. Mining and NATURA 2000 in Greece

Regarding Greece, the most relevant work regarding the overlaps of the several types of mining areas and NATURA 2000 sites has been conducted by P. Tzeferis (2018), General Director of the Raw Materials Directorate, Mineral & Aggregate Resources Division, YPEKA. In the following graph (Figure 2), the percentage of overlap between existing or potential mining areas and the NATURA 2000 network is presented, for the different types of mining activity.

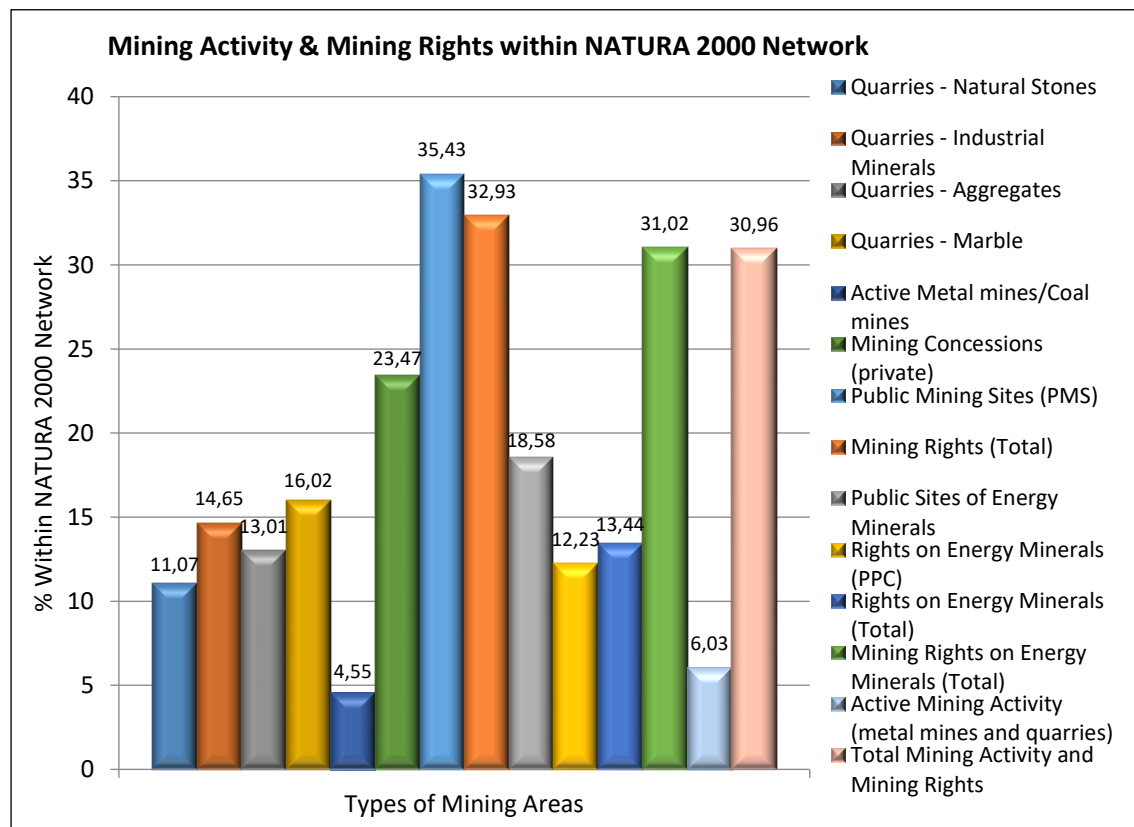


Figure 2: Types of Mining Areas in NATURA 2000 Network of Greece (Tzeferis, 2018).

It can be observed that the active mines and quarries have limited presence within the NATURA 2000 network, demonstrating a 6% overlap. However, the areas that may be of interest for mineral exploration or future mining activity show a substantial overlap, 23.5% for private concessions and 35.4% for Public Mining Sites. This fact may attract further attention to the topic of co-existence, given the EU's urge for developing mining activity.

Based on the above, in the light of the recently published SES that define the zones within NATURA 2000 sites, this study aims to provide a more targeted analysis with a spatial perspective towards metal mining areas and the related CRM.

4. Methodology – Study Areas

4.1. Methodology

This study's objective is to analyze the potential co-existence of areas with mines or mining rights in relation to the NATURA 2000 network of Greece. These areas will include Areas of Exclusive Mining Activity (EMA)³ and Public Mining Sites⁴ (PMS), according to the Spatial Regional Plan of Central Greece and the Mineral Resource Guide of Hellenic Survey of Geology & Mineral Exploration (HSGME) respectively. The analysis is targeted on areas characterized by metallic mineral resources potential and the spatially related Critical Raw Material (CRM) occurrences, given their increasing importance on European level.



Figure 3: Types of Mining Areas analyzed in this study.

In Greece, metal mining primarily takes place in Central Greece and Central Macedonia. However, according to the HSGME, the region of Eastern Macedonia–Thrace also hosts PMS that could be made available for immediate development through the initiation of public, transparent, and international invitation to tender for the leasing of the Metallic Minerals' Ownership Right.

On the grounds that the Special Environmental Studies for Fokida (Western Central Greece) and Central Macedonia (Northern Greece) have not been published to date,

³ This category contains open pits, undeveloped potential mining areas, and mining related infrastructure (e.g conveyor belt)

⁴ According to HSGME dictionary, PMS are sites in which the ownership of metallic minerals belongs to the state. The state may exercise this right either by an “in house” procedure, or through leasing. (HSGME Terminology-Glossary)

the study areas of this thesis are narrowed down to Evvia and part of Voiotia in Eastern Central Greece (SES 6a), and to Eastern Macedonia – Thrace (SES 1a, 1b). From these three special environmental studies, the mining areas that are within or in close proximity to NATURA 2000 sites are examined. For the analysis, overlaps between the mining areas and the NATURA 2000 zones are calculated with the GIS intersection tool accordingly (measurement unit: stremma⁵):

$$\text{Overlap (\%)} = \frac{\text{Intersection of EMA or PMS with NATURA 2000 zones (str)}}{\text{Total Area of the EMA or PMS (str)}} \times 100$$

Furthermore, a 2km buffer zone was created (0-1km, 1-2km) around the boundaries of the examined NATURA sites in order to quantify the mining areas that are in proximity with these sites as well. These zones aim to determine neighboring areas that may have an immediate effect on the protected sites. They do not attempt to evaluate their potential mesoscale effects, as in the study of Duran et al (2013), where the buffer extended to 10km. In any case, the radius of environmental impact of mining may vary significantly, and has to be assessed on a case by case analysis. Within the context of this thesis, the 2km buffer is considered adequate to quantify existing or potential mining areas in close proximity to NATURA 2000 sites. The areas of Exclusive Mining Activity analyzed in this study, are the ones defined as such in the Regional Spatial Plan of Central Greece that are entirely or partially located within NATURA 2000 sites and the respective buffer zones.

Furthermore, given the importance of land use planning in establishing or continuing mining operations (Panagiotopoulou, n.d., Wrana 2014) there will be an analysis regarding the current land cover in the PMS, and the intended land uses according to the Regional Spatial Plan prevailing for the area. The coverage of the various land uses in relation to the PMS will be discussed, while assessing the prospects of these potential mining areas to be developed in the future.

Regarding the main sources of geographic data, the polygons for NATURA 2000 sites of Greece were obtained from the official site of the Greek Government (Ministry of Energy and Environment, 2015), and their respective sub-zones were digitized after georeferencing the maps accompanying the SES. The Public Mining Sites have been obtained and georeferenced from the Mineral Resources Guide WebGIS platform

⁵ Stremma: Greek unit for measuring areas (1str = 1000m²).

(HSGME, 2022). Furthermore, the point data for indicating the base metal and CRM occurrences were collected from the ProMine project site (EGDI, 2022). The symbology for each Public Mining Site, was opted according to the INSPIRE directive for Mineral Resources (European Commission, 2013).

The current Land-Use-Land-Cover data have been obtained by the latest Corine Land Cover dataset (CLC, 2018), offered by Copernicus land monitoring service. The main towns and the intended land uses for each study area were digitized after georeferencing the respective maps from the Regional Spatial Plans of Central Greece and Eastern Macedonia – Thrace. The projection for all the data used was set to GGRS 1987 (Greek Geodetic Reference System 1987).

The analysis is expected to provide insights on how areas with metallic mineral resources and CRMs are managed within NATURA 2000 sites, what part of these mining areas is excluded, and investigate the cases where mining operation is accepted.

The geospatial analysis is conducted in the ArcGIS software (ESRI), under the license provided by the National Technical University of Athens.

4.2. Study Areas

4.2.1. Mining Areas in Central Greece

In the case of Central Greece, areas of Exclusive Mining Activity and open pits from the Spatial Regional Plan may correspond to laterite (Fe-Ni) mining sites, magnesite mining sites, quarries, or relevant infrastructure. For the purpose of this study, the digitized polygons depict metal mining areas, and may include developed active/inactive open pits, reclaimed sites, or undeveloped areas with mining rights.

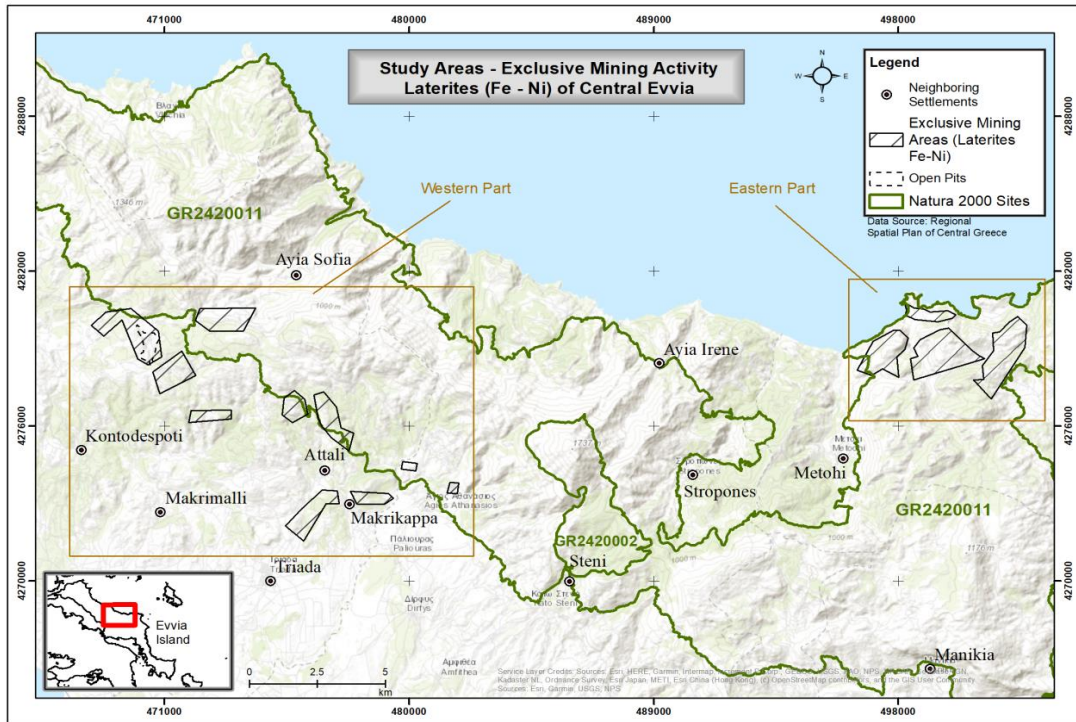
Table 5: Areas of Exclusive Mining Activity in Evvia and part of Viotia.

| Exclusive Mining Area | Location | CRM Prospects | SES | Related NATURA 2000 sites |
|---------------------------------|---------------------------------------|----------------------|------------|----------------------------------|
| Laterite Mining Areas | Evvia (Mountains of Central Evvia) | Ni ⁶ , Co | 6a | GR2420011 (Western part) |
| Laterite Mining Areas | Evvia (Mountains of Central Evvia) | Ni, Co | 6a | GR2420011 (Eastern part) |
| Magnesite Mines | Evvia (Candili Mountain) | - | 6a | GR2420010 |
| Laterite Mines of Ayios Ioannis | Viotia | Ni, Co | 6a | GR2410001 (NE part) |

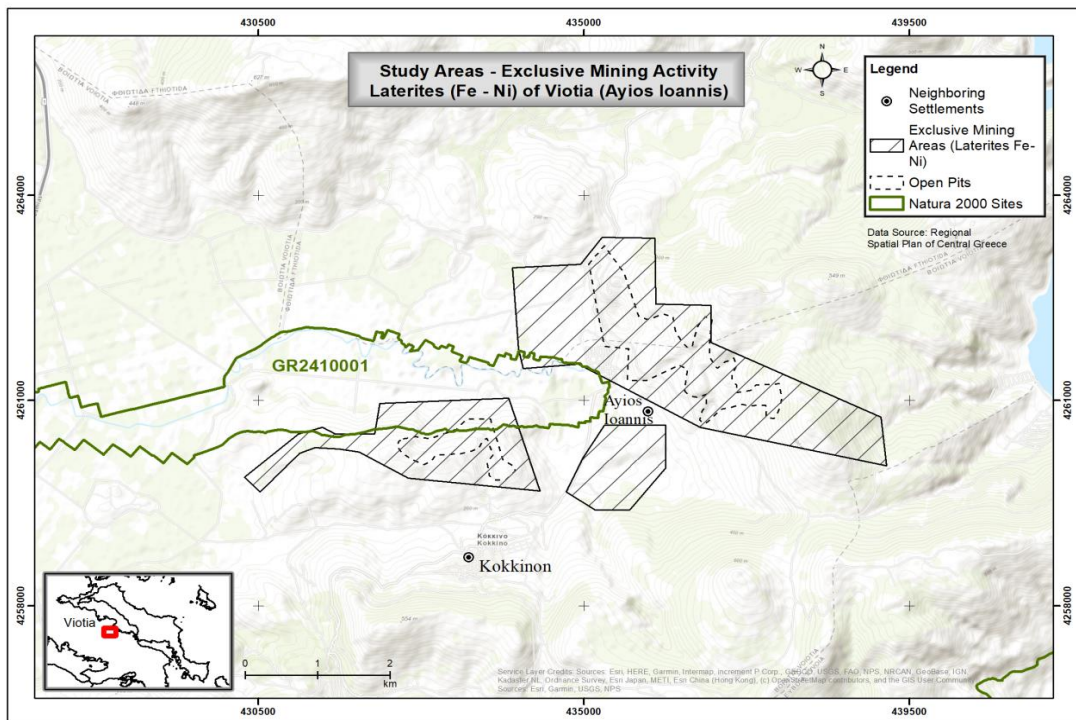
Laterite Mining and Fe-Ni production in Evvia & Viotia has been conducted by LARCO (General Mining & Metallurgical Company SA). The company's operations were taking place for 50-60 years, until the cease of its operations in 2019. Currently, processes for privatizing the facilities of the company are underway. The deposits of Evvia and Viotia are laterites, and the final Fe-Ni product is produced through pyrometallurgical process in the company's plant in Larymna, exported to be used in steel industry. However, the potential of the company to employ hydrometallurgical methods aiming to extract the nickel and cobalt contained in the deposit is also being assessed (Agatzini-Leonardou, et al., 2021). In this perspective, the deposits of LARCO could potentially provide valuable EV metals required for the green transition.

⁶ According to the European Commission's list of Critical Raw Materials (2023), only battery-grade Nickel (Class 1, with purity standard at least 99.8%) is deemed CRM.

In Map 2 & 3, the Exclusive Mining Areas (laterites) of Evvia and Viotia that demonstrate overlap with NATURA sites or the respective buffer zones are presented.

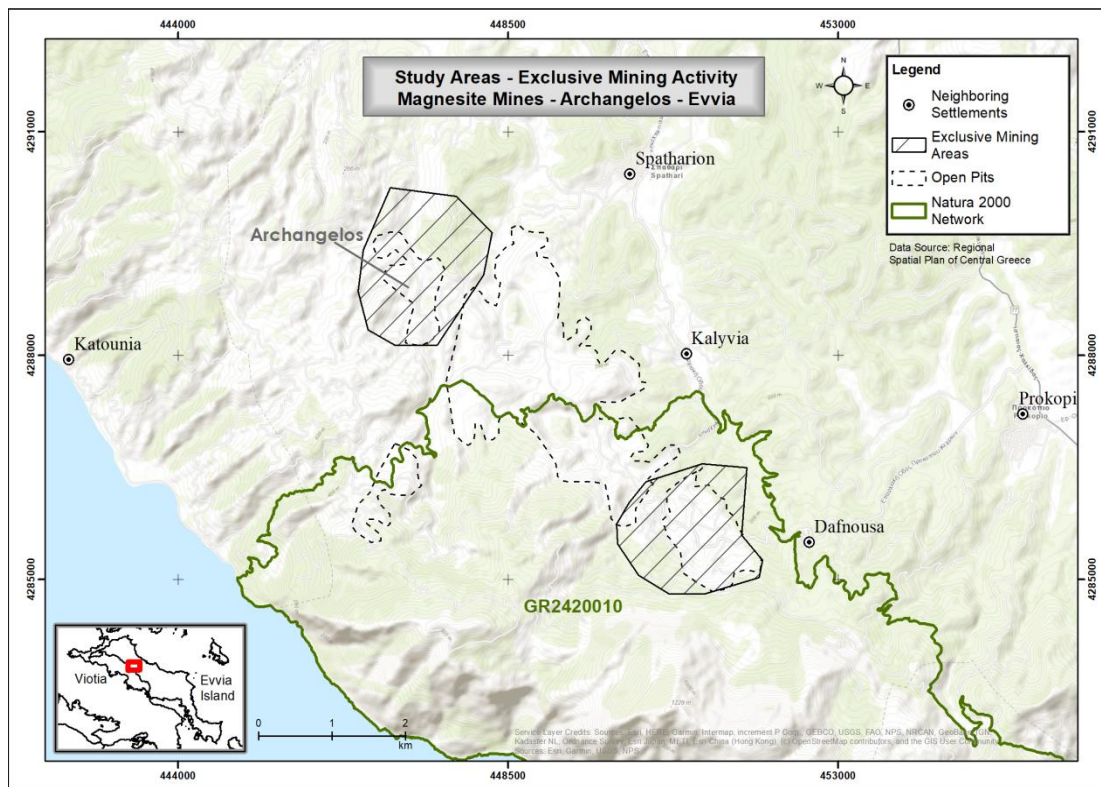


Map 2: Study Areas of Central Evvia (laterites). Exclusive Mining Areas (developed or undeveloped) within or in proximity to NATURA 2000 sites, according to the Regional Spatial Plan of Central Greece.



Map 3: Study Areas of Viotia (laterites). Exclusive Mining Areas (Ayios Ioannis mines) within or in proximity to NATURA 2000 sites, according to the Regional Spatial Plan of Central Greece.

In north Candili Mountain (Evvia), TERNA MAG Company (GEK TERNA GROUP), owns mining rights to the Exclusive Mining areas shown in Map 4. According to the company’s website, there are five (5) reported locations with magnesite reserves (Terna Mag, website). Despite not having conclusive data available regarding whether operations currently take place in these areas, it can be assumed within the context of this thesis, that there is ongoing mine development/exploitation in Archangelos - Bobakas and Kakavos 5, based on some studies conducted by collaborating firms (OmikronKappa Consulting, n.d; GeoTest, Consutling Engineers S.A, 2021). Finally, given that no information has been found regarding the polygons located entirely within the protected site, the areas are deemed inactive/reclaimed.



Map 4: Study Areas - Magnesite Mines (TERNA), Central - North Evvia, according to the Regional Spatial Plan of Central Greece.

4.2.2. Mining Areas in Eastern Macedonia - Thrace

The Public Mining Sites studied are the ones from Eastern Macedonia – Thrace that present potential for further exploration or development, whereas on the same time partially overlap with NATURA 2000 sites. According to the PMS reports of Mineral Resource Guide of HSGME these potential mining areas are described as follows:

- Ayios Filippos

Ayios Filippos area: 1.220.000 tons of mixed sulphides (Pb 3,40 – 6,1%, Zn 3-7,4%) of which 365.000 tons with 4% Cu content. King Arthur area: 200.000 tons (Pb +Zn 1% average content) 30.000 tons of which have 5% Pb +Zn average content. There are no available data on the resource potential for the other sub areas of the Public Mining Site. Exploration research conducted so far, demonstrated prospects for gold and possible development of a porphyry system in depth.

- Aesimi

The metal contents are as follows: 300.000 tons with 7,46 % Zn (Eastern and South zone), 13.000 tons with 5,57 % Zn (Western zone), 300.000 tons with 7,47 % Zn and 0,4 % Pb in Miloi. The reporting of resources/reserves estimation and classification is not compliant with international standard or code. The specific Public Mining Site presents significant prospects, according to the respective HSGME report.

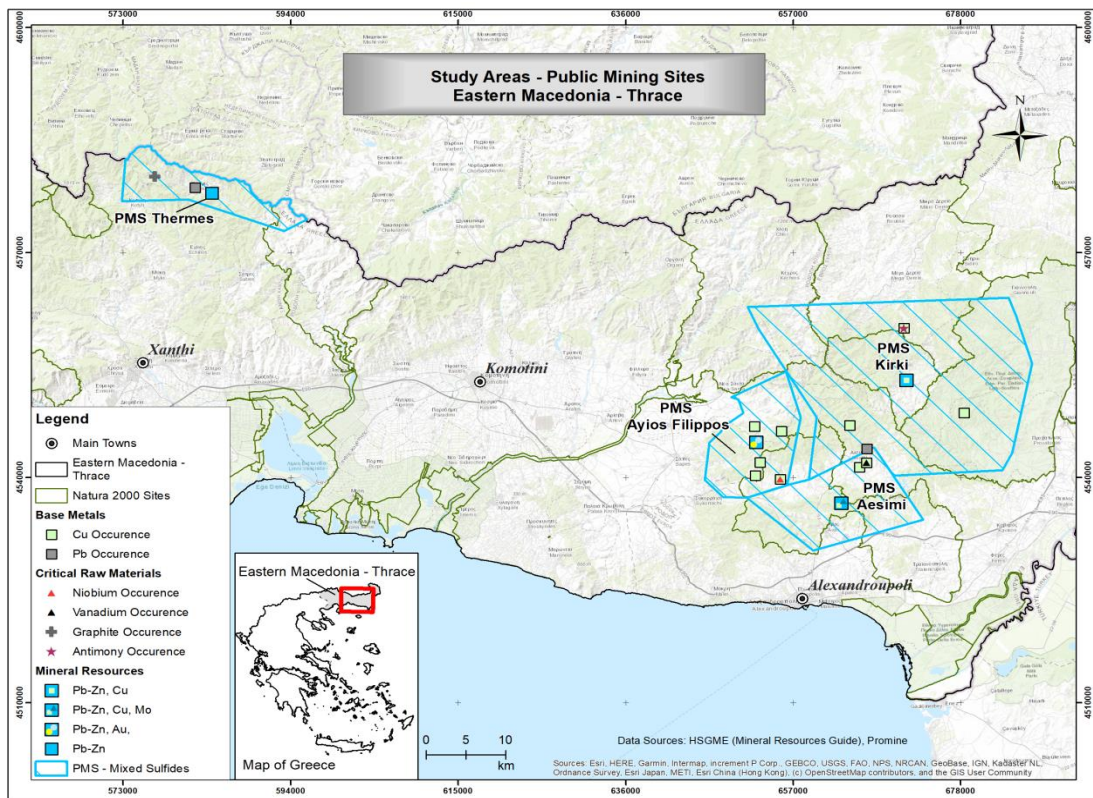
- Kirki

Resource Potential is 25.000 tons, probable reserves. The reserves' figure concerns the Location Treis Bryses – Bougate (average contents of 3,18 % Pb and 5,22% Zn). The reporting of resources/reserves estimation and classification is not compliant with any international standard or code. The southern part of the site is the most promising.

- Thermes

Resource Potential 7.750.000 tons, proved reserves. The metal contents are as follows: 5.100.000 tons with 6,88 % Pb+Zn and 28,13 ppm Ag, 2.250.000 tons with 10 % Pb+Zn and 40 ppm Ag, Graphite reserves: 400.000 tons with 6% C.

These four Public Mining Sites are depicted in Map 5, along with the reported base metal and CRM occurrences.



Map 5: Study Areas in Eastern Macedonia - Thrace. Public Mining Sites of Thermes, Ayios Filippos, Aesimi, and Kirki, with the spatially related base metal and CRM occurrences according to ProMine data.

Given that base metal and CRM occurrences are integrated in the study, they are used as a supplementary guide to the resources location, besides the available description by HSGME. The mineral concentrations of interest and the code of the spatially related NATURA 2000 sites are provided below (Table 6).

Table 6: Public Mining Sites, Location of Reserves & Occurrences, and related NATURA 2000 sites.

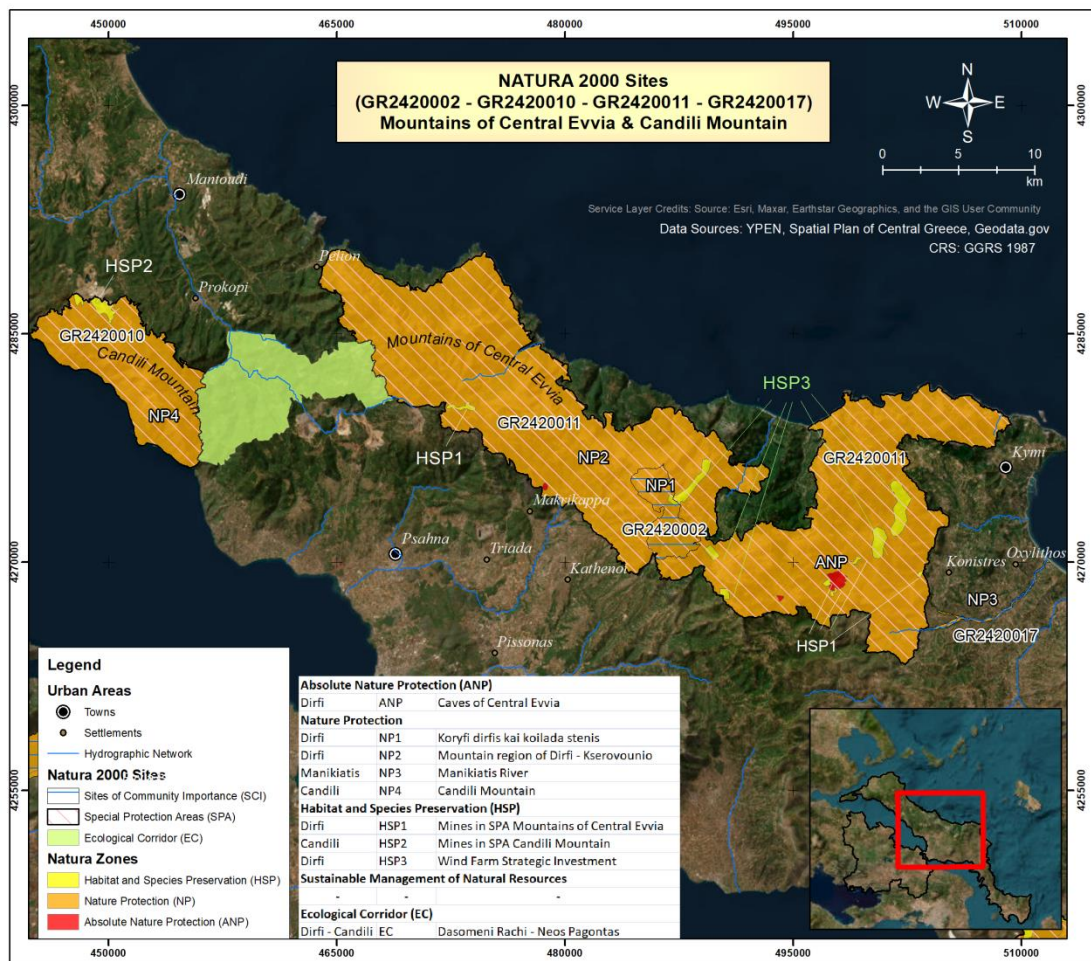
| Public Mining Site | Reserves Location | Base Metal & CRM Prospects | Special Environmental Study | Related NATURA 2000 Sites |
|--------------------|--|----------------------------|-----------------------------|--|
| Ayios Filippos | Ayios Filippos Area, King Arthur Area | Pb-Zn, Cu, Nb | 1a | GR1110009 |
| Aesimi | Mainly in southern zone, eastern zone, and in Miloi | Pb-Zn, Cu, V | 1a | GR1110009 |
| Kirki | Treis Bryses – Bougate. The southern part of the site is the most promising. | Pb-Zn, Cu, Sb | 1a | GR1110003 GR1110005 GR1110010 GR1130011 |
| Thermes | No location mentioned | Pb-Zn, Ag, C | 1b | GR1130012 |

4.3. NATURA 2000 Sites

4.3.1. NATURA 2000 Sites of Evvia & Viotia

4.3.1.1. NATURA 2000 Sites of Central Evvia

The Mountains of Central Evvia and Mt. Candili are regions of both mining and environmental interest. Due to geographic proximity and similar ecological traits, there are four (4) areas managed as one entity: Dirfi – Forest of Steni (GR2420002), Mountains of Central Evvia (GR2420011), Manikiatis River (GR2420017), Candili Mountain (GR2420010). The protected site of Mountains of Central Evvia is spatially connected to the SPA - Candili mountain through the ecological corridor of Dasomeni Rachi – Neos Pagontas (Map 6).



Map 6: Mountains of Central Evvia and Mt. Candili. NATURA 2000 sites and zones, according to the Special Environmental Study 6a (Arapis, et al., 2022, GEOANALYSIS S.A).

Table 7: Surface Area of the NATURA 2000 sites related to the examined mining areas.

| Site | Name | Surface Area (km ²) |
|-------------------------------|----------------------------|---------------------------------|
| GR2420002 | Dirfi – Forest of Steni | 13.6 |
| GR2420011 | Mountains of Central Evvia | 391.8 |
| GR2420017 | Manikiatis River | 1.6 |
| GR2420010 | Candili Mountain | 61.8 |
| Total Area (without overlaps) | | 455.1 |

The ANP zone includes three (3) caves, and constitutes a significant habitat type that hosts priority bat species. The NP-1 sub-zone defines the area of site GR2420002 (SCI - Dirfi summit and upper part of Steni basin). It includes slopes with low vegetation and sparse trees or thorny shrubs (Dirfi slopes) and mixed/pure stands of chestnut and fir trees. This zone is significant for habitats with low vegetation and cliffs, but mainly for some fauna and flora priority species (e.g *Emperiza caesia*, *Falco biarmicus*, *Nepeta argolica* subsp. *dirphyia*). Sub-zone NP-2 refers to the area of SPA GR2420011 (Dirfi and Xerovouni mountain ranges, excluding the aforementioned SCI). It includes slopes with low vegetation and sparse trees or thorny shrubs, Greek fir forests, shrublands of sclerophyllous vegetation, rock formations, and gorges (Manikiatis River, Meg. Souda River, and Fteri/Kastania River). It is significant for habitats with low vegetation and cliffs, as well as river habitats, but mainly for some fauna and flora priority species (e.g *Emperiza caesia*, *Falco Biarmicus*, *Nepeta argolica* subsp. *Dirphyia*). The sub-zone NP-3 defines the river and riparian zone of the Manikiatis River in its plain section (SCI - GR2420017). Finally, sub-zone NP-4 defines the entire SPA GR2420010, with the exception of the mines in its northern part. The eastern and northern slopes of Mt. Candili include slopes of moderate incline with pine forests, while the western slope consists of steep slopes with rock formations (including caves) and scattered shrubs/trees. It is significant for the site's characteristic (*Emberiza caesia*) and high priority bird species (*Aquila fasciata*).

The sub-zone HSP-1 is devoted to laterite mines of Central Evvia. It is significant for forest habitats, and habitats with low vegetation and cliffs. The HSP-2 zone includes the northern part of Candili Mountain, where magnesite mining activity presently takes place. This area is of interest for important bird species (*Circaetus gallicus*, *Pernis apivorus*, possibly *Falco peregrinus*). Finally, the HSP-3 refers to areas intended for wind farm development. The project is considered as a strategic investment, and has acquired the decision of approval for its environmental terms. These areas are significant for habitats with low vegetation and rocky areas, but are primarily important for fauna and flora priority species.

Table 8: Mining Intended HSP zones in Central Evvia. The polygons correspond to Map 6.

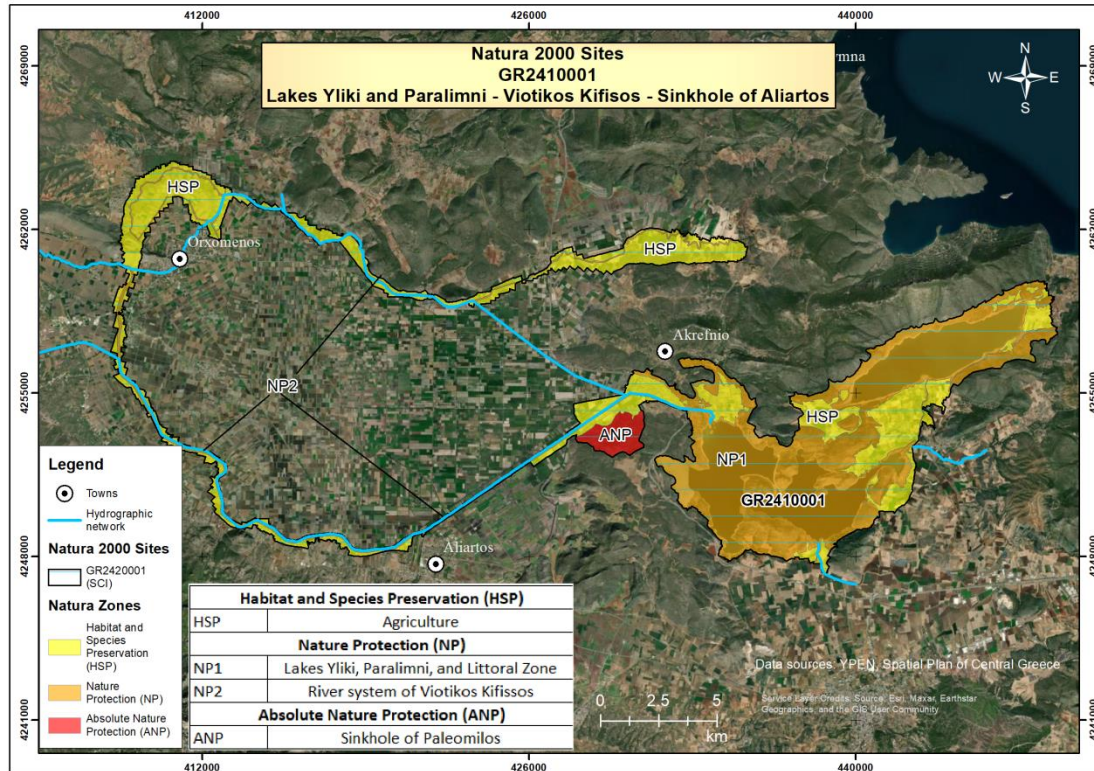
| Mining Intended HSP zones of Central Evvia | Site | Location | Area (str) |
|---|-------------|----------------------------|-------------------|
| HSP-1 | GR2420011 | Northern part of GR2420011 | 512.7 |
| HSP-1 | GR2420011 | Southern part of GR2420011 | 158.7 |
| HSP-1 | GR2420011 | Southern part of GR2420011 | 118.5 |
| HSP-1 | GR2420011 | Southern part of GR2420011 | 157.8 |
| HSP-1 | GR2420011 | Southern part of GR2420011 | 97.2 |
| HSP-2 | GR2420010 | Northern part of GR2420010 | 338.1 |
| HSP-2 | GR2420010 | Northern part of GR2420010 | 1344.7 |

Site GR2420011 contains ten (10) reported potential Fe-Ni deposits, one of which has received permits in the area of Katavolos, near Metohi Settlement (Arapis, et al., 2022 – GEOANALYSIS S.A, SES 6a).

4.3.1.2. NATURA 2000 sites of Viotia

The laterite mines of Ayios Ioannis are located near the borders of the northeastern part of the NATURA 2000 site GR2410001 (SCI). The Habitat & Species Preservation zone is devoted to existing agricultural land, and the Nature Protection zones encompass the lakes Yliki & Paralimni in the southeastern part of the site, and

the river system of Boeotian Cephissus (Viotikos Kifissos), stretching from the southern section to the northeastern region where mining activity used to take place. The total area of the site is 126.7km² (Map 7).



Map 7: Site GR2410001, part of SES 6a. Its NE part is spatially related with the open pits of Ayios Ioannis (Arapis, et al., 2022 – GEOANALYSIS S.A, SES 6a).

The site GR2410001 is notable for its riparian zones, caves, and areas with low vegetation. It is important for wetland systems, and shrublands. It is highly significant for areas characterized by low vegetation that are used as grazing habitats. The ANP zone includes the sinkhole of Paleomylos, which is a refuge for priority bat species, and constitutes a habitat for cave-dwelling invertebrates. The NP-1 zone covers the lakes Yliki and Paralimni, as well as the seasonally flooded areas, and the uncultivated hilly section that lies between them. The NP-2 zone defines the river system of Viotikos Kifissos. It includes the main course of Boeotian River and the related channels and tributaries, along with their riparian and adjacent zones. This is significant for river and riparian habitats, fish species, mammals associated with riparian zones, and slopes with shrubby vegetation used as grazing habitats. The HSP zone is dedicated to agricultural land. According to the SES 6a webGIS data, the SE

part constitutes habitat of very important fauna species (Rhinolophus hipposideros, Myotis myotis, Elaphe situla) (Arapis, et al., 2022 – GEOANALYSIS S.A., SES 6a).

4.3.2. NATURA 2000 Sites of Eastern Macedonia – Thrace

4.3.2.1. NATURA 2000 Sites in Evros

The Public Mining Sites examined in Evros (Ayios Filippos, Aesimi, Kirki), are spatially related to six (6) NATURA 2000 sites. These sites are grouped as 1) GR1110009 (South Forest Complex of Evros), 2) GR1110002 - GR1110003 GR1110005 - GR1110010 - GR1130011 (National Forest Park of Dadia-Lefkimi-Soufli, Mountainous Evros, and the Valleys of Dereio and Filiouri).

The NATURA 2000 sites of the National Forest Park of Dadia-Lefkimi-Soufli, Mountainous Evros, and the Valleys of Dereio and Filiouri have a total area of 1284km² (without the overlapping parts). They contain extensive areas designated as Nature Protection zones, which primarily include forests. The HSP zones mainly refer to agricultural land, and existing technical infrastructure. The SMNR zones include settlements, technical infrastructure, and agricultural land (OMIKRON SA, 2021 – SES1a).

Table 9: Area of the NATURA 2000 sites related to the Public Mining Sites of Evros.

| Site | Area (km ²) |
|-------------------------------|-------------------------|
| GR1110002 | 423.4 |
| GR1110003 | 99.7 |
| GR1110005 | 423.4 |
| GR1110010 | 389.5 |
| GR1130011 | 372.3 |
| Total Area (without overlaps) | 1284.8 |

GR1110002 (SPA – Forest of Dadia-Soufli)

The area has significant ecological value due to the large number of bird species, 84 found there, many of which are rare in Europe. The area serves as an important habitat for many birds due to its location, acting as a crossroad for bird migration and

nesting and is mainly inhabited by raptor species, with notable ones being the Black Vulture, Golden Eagle, Short-toed Snake Eagle, Bonelli's Eagle, Goshawk, and Egyptian Vulture.

GR1110010 (SPA – Mountainous Evros, Valley of Dereio)

The protected area includes 70 bird species. The area is a significant habitat, primarily for the bird species of prey found here. It is vital for the feeding of the protected species of the Black Vulture, which nests in the neighboring forest of Dadia. Other important bird species of prey found here include the Golden Eagle, the Eastern Imperial Eagle, the Short-toed Snake Eagle, the Bonelli's Eagle, the Lesser Spotted Eagle, the Peregrine Falcon, and the Egyptian Vulture.

GR1110003 (SCI – Treis Vryses)

The site presents particular ecological interest due to the mixed forests of beech and oak, characterized by rich flora and fauna, which render it as the most valuable forest production area in Evros. The traditional agroforestry landscape is also of special interest. Within the protected area, three habitat types of Annex I of Directive 92/43/EEC, one plant species, and nine animal species are reported. These include four mammal species, one fish species, two amphibian species, two reptile species, and one invertebrate species. However, there are no highly significant plant species in the area, and none of the recorded animal species are priority species.

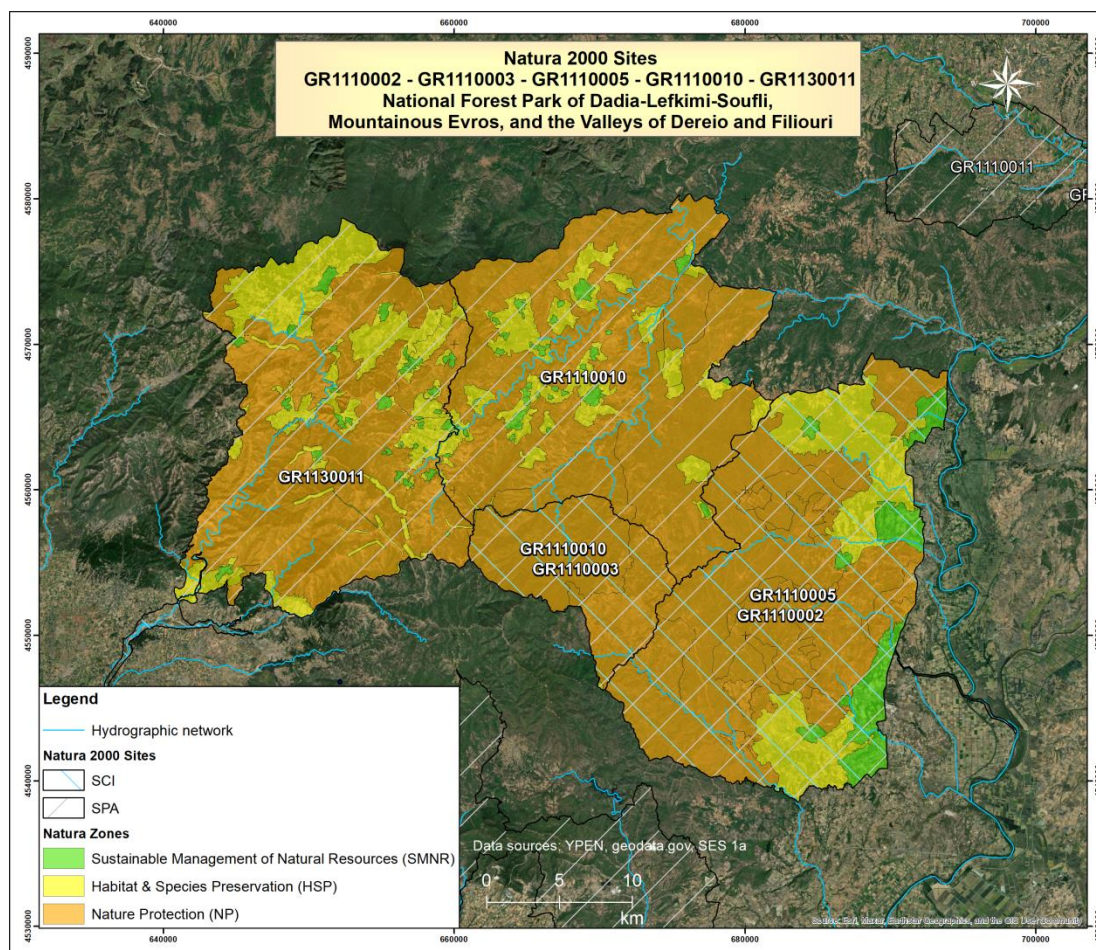
GR1110005 (SCI – Mountains of Evros – Lyras river – Caves of Didimotiho and Kefalovouno)

This site demonstrates extensive overlap with the SPA GR1110002. The area has significant ecological value due to the large number of bird species found there, many of which are rare in Europe. It serves as an important habitat for numerous reptiles and birds, thanks to its location, which acts as a crossroad for bird migration and nesting. The area is part of the forest complex of Dadia-Lefkimi-Soufli and includes grazing areas within forested areas.

GR1130011 (SPA – Valley of Filiouri)

46 bird species are reported for this site. The area is nationally significant, especially for the raptor species that live, breed, and nest during the winter in it, as well as for species associated with forests and shrubs. The main raptor species found in the area are the Black Vulture, the Golden Eagle, the Eurasian Griffon Vulture, the Short-toed Snake Eagle, and the Egyptian Vulture.

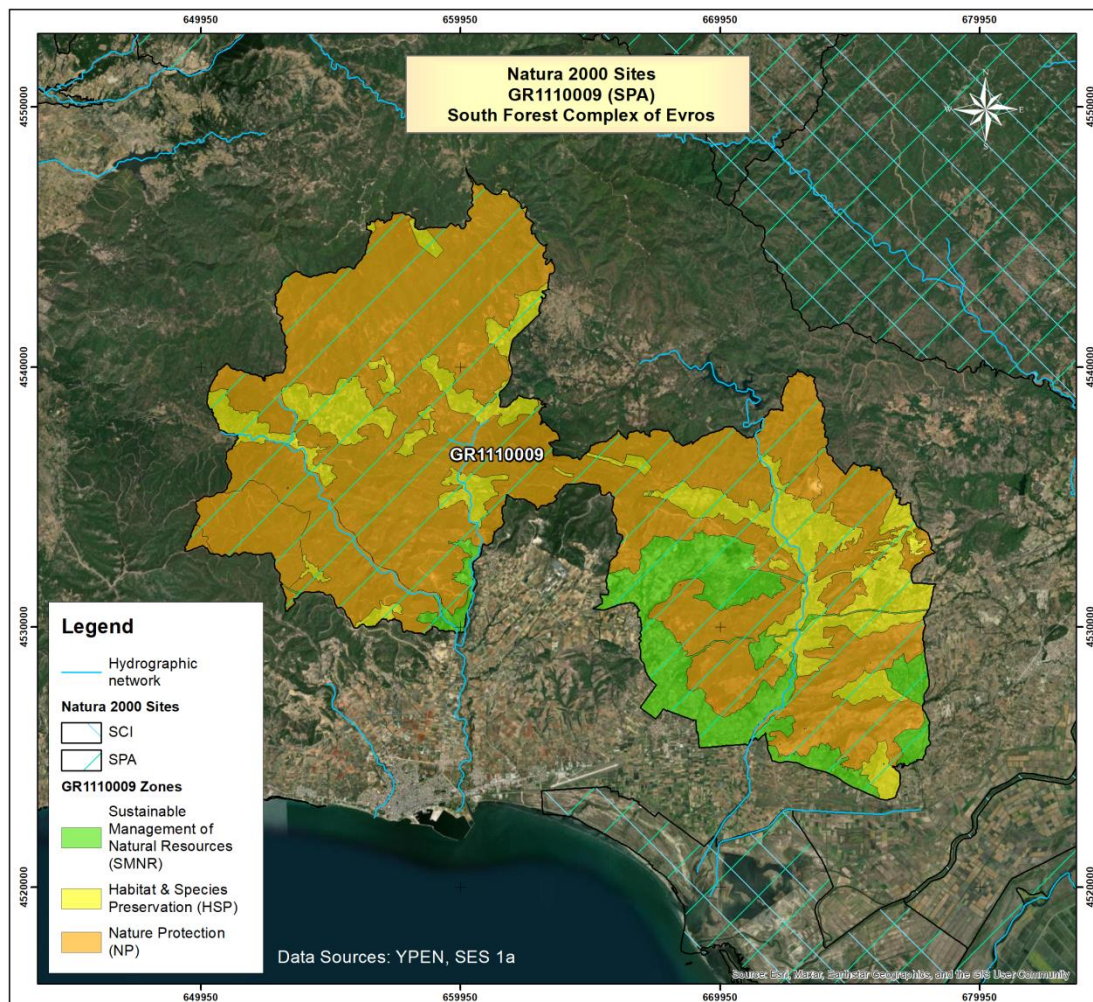
All the aforementioned sites comprising the National Forest Park of Dadia-Lefkimi-Soufli, Mountainous Evros, and the Valleys of Dereio and Filiouri, are shown in Map 8 with their respective protection zones (NP, HSP, SMNR).



Map 8: Zones of NATURA 2000 sites related to PMS of Evros (OMIKRON SA, 2021 – SES1a).

GR1110009 (SPA – South Forest Complex of Evros)

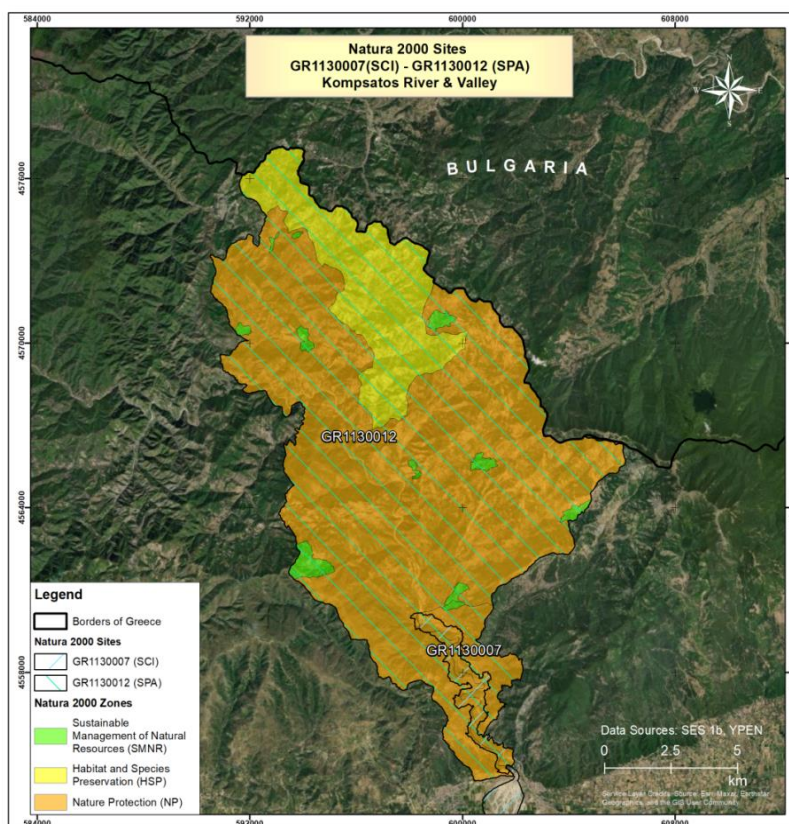
This protected site covers an area of 297.9km², and includes 70 bird species. The region is significant for the reproduction and habitation of raptors and other bird species found with forests. The birds breeding here include some of the species in Europe that are restricted to Mediterranean ecosystems during their reproductive cycles. The main raptor species found in this area are the Black Vulture, the Short-toed Eagle, the Golden Eagle, the Peregrine Falcon, the White-tailed Eagle, and the Egyptian Vulture. The zones within the site GR1110009 are presented in Map 9 (OMIKRON SA, 2021 – SES1a).



Map 9: Zones of NATURA 2000 site GR1110009, related to the PMS of Evros (OMIKRON SA, 2021 – SES1a).

4.3.2.2. NATURA 2000 sites in Thermes

The Public Mining Site of Thermes overlaps with the northern part of the site GR1130012 (SPA), Kompsatos Valley. Together with the site GR1130007 (SCI), they constitute an integrated area for biodiversity protection, covering 164.9km². The combined area GR1130007-GR1130012 is a deep valley surrounded by hills covered with deciduous forests, shrubs, and meadows. It is a very significant area for breeding raptors and forest species, as well as for migratory raptors. Specifically, in terms of raptor presence, it is considered one of the most important sites at the national level (Map 10).



Map 10: Zones of NATURA 2000 sites GR1130012 – 1130007 (OMIKRON SA, 2022 – SES 1b). Its northern part is related to the PMS of Thermes.

Zones NP-1 and NP-2 include the Kompsatos River, including its adjacent areas, and the majority of the river valley. NP-2 encompasses a section that belongs to the Kechros-Kerasia Community Wildlife Refuge. Zone HSP-1 comprises primarily mountainous forested areas in the northern part of the Kompsatos River valley. Finally, the site includes eleven (11) SMNR zones. The majority of them include agricultural areas mainly surrounding settlements with existing infrastructure (OMIKRON SA, 2022 – SES 1b).

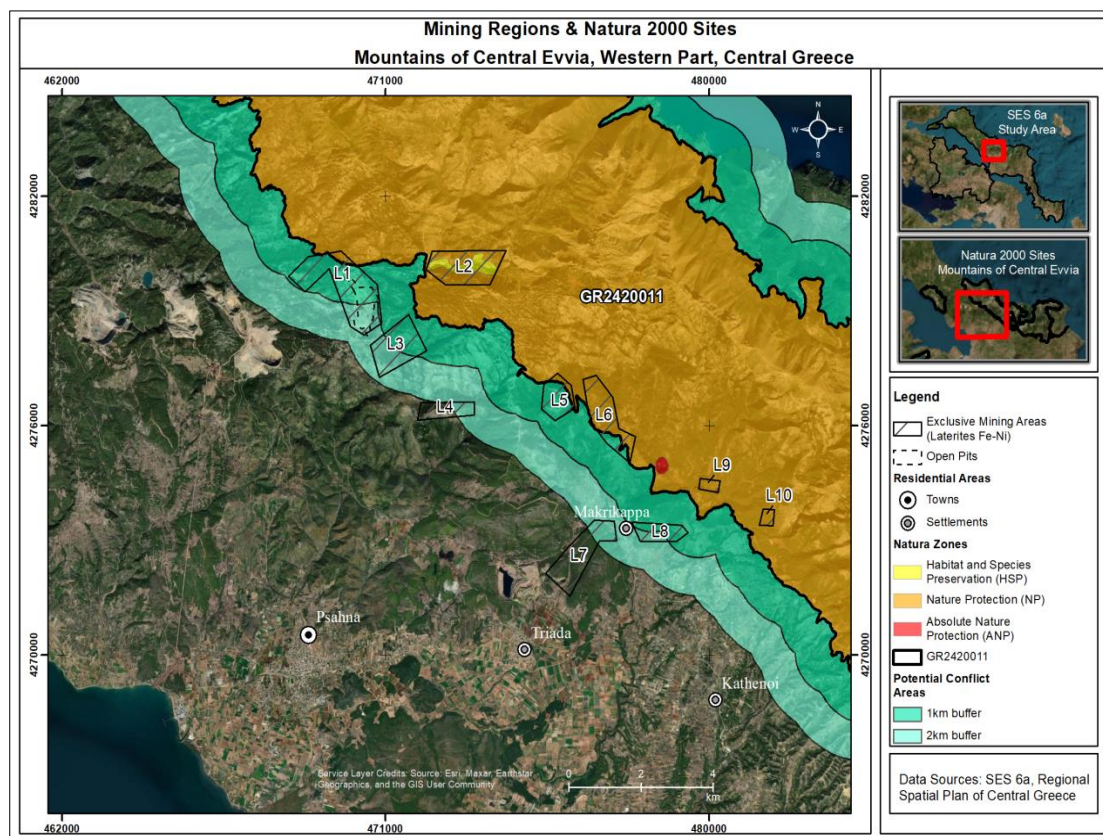
5. Results

5.1. Spatial Coincidence of Mining Areas & NATURA 2000 sites

5.1.1. Central Greece (SES 6a)

The island of Evvia hosts several mining areas, either active or inactive, and the majority is devoted to metallic mineral extraction (laterites, magnesite). For Central Evvia, the coordinates of the areas of Exclusive Mining Activity (and the related open pits) have been obtained by the Regional Spatial Plan of Central Greece, on the grounds that they constitute specific areas intended for mining activity or related infrastructure. In the spatial analysis aiming to assess the potential overlapping of mining areas with NATURA 2000 sites, only the areas of Exclusive Mining Activity that demonstrate overlap with the protected site or at least one buffer zone were examined. To enhance the spatial visualization, the areas of Exclusive Mining Activity in Evvia are presented in three (3) different maps (11 – 13):

I) Laterites – Western part of GR2420011 – Mountains of Central Evvia



Map 11: Areas of Exclusive Mining Activity & NATURA 2000 Sites. Mountains of Central Evvia, western part.

The western part of Mountains of Central Evvia contains ten (10) Exclusive Mining Areas related to Laterites (hence the abbreviation L1-L10) that overlap either with the NATURA 2000 site (GR2420011), or with the 2km buffer around its defined borders. As seen in the satellite basemap, there are open pits in the wider region, which were not included in this analysis due to their distance from the protected site boundaries. The percentage of overlap between L1-L10 and the NATURA 2000 zones is calculated and presented in Table 10:

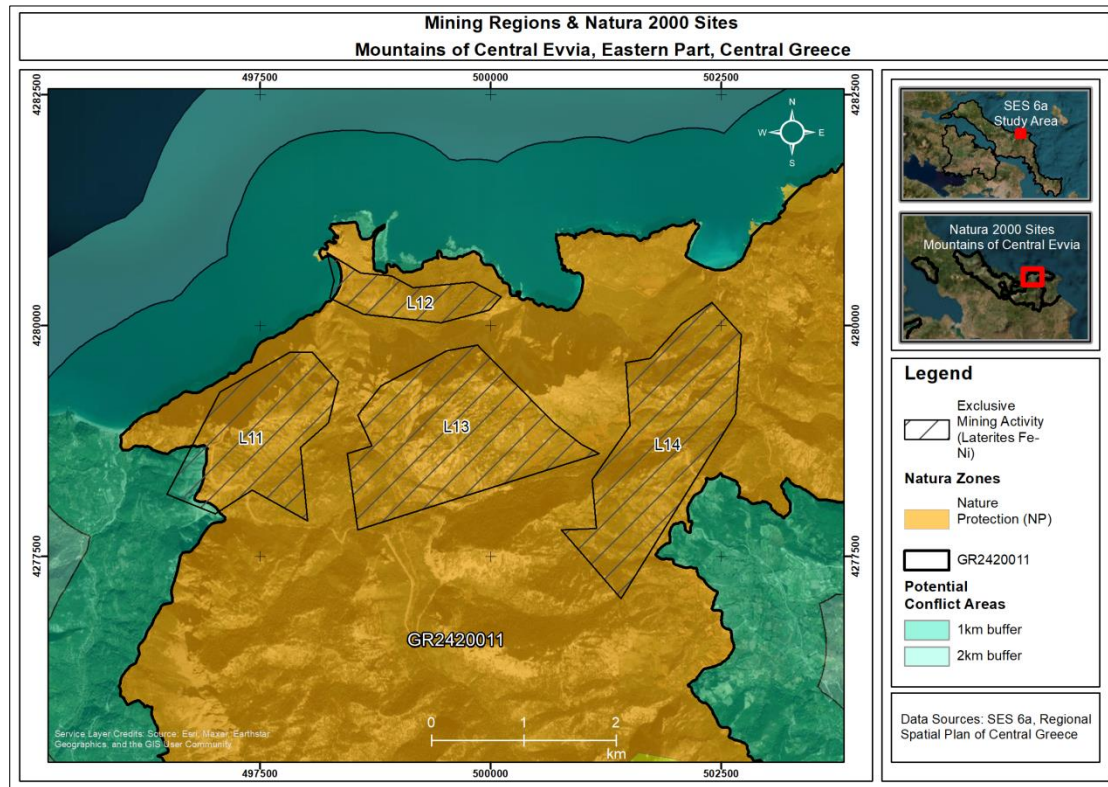
Table 10: Areas of Exclusive Mining Activity (EMA) & NATURA 2000 zones, western part, GR2420011. Mountains of Central Evvia. All area units are measured in stremma (str).

| EMA | Area (str) | Status | Overlap with NP (str) | Overlap with NP (%) | Overlap with HSP (str) | Overlap with HSP (%) | Overlap with 1km buffer (str) | Overlap with 1km buffer (%) | Overlap with 2km buffer (str) | Overlap with 2km buffer (%) |
|-----|------------|----------------------|-----------------------|---------------------|------------------------|----------------------|-------------------------------|-----------------------------|-------------------------------|-----------------------------|
| L1 | 2527.1 | Developed - Inactive | 122.8 | 4.9 | 0.0 | 0.0 | 1773.3 | 70.2 | 631.0 | 25.0 |
| L2 | 1610.5 | Developed - Inactive | 1100.5 | 68.3 | 510.0 | 31.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| L3 | 1355.2 | Undeveloped | 0.0 | 0.0 | 0.0 | 0.0 | 708.2 | 52.3 | 647.1 | 47.7 |
| L4 | 613.5 | Undeveloped | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 220.1 | 35.9 |
| L5 | 788.1 | Undeveloped | 143.7 | 18.2 | 0.0 | 0.0 | 644.3 | 81.8 | 0.0 | 0.0 |
| L6 | 1413.9 | Undeveloped | 1166.0 | 82.5 | 0.0 | 0.0 | 247.9 | 17.5 | 0.0 | 0.0 |
| L7 | 1502.2 | Developed - Inactive | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 361.3 | 24.0 |
| L8 | 592.3 | Undeveloped | 0.0 | 0.0 | 0.0 | 0.0 | 382.4 | 64.6 | 209.9 | 35.4 |
| L9 | 161.6 | Undeveloped | 161.6 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| L10 | 146.5 | Undeveloped | 146.5 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

It is seen that in Central Evvia, 6 of the 10 examined Exclusive Mining Areas are either partially or entirely within the NATURA 2000 network. L2, covering an area around 1600 str., is the only polygon of this area that overlaps with HSP zone, and according to the SES 6a, it is intended for mining activity. Furthermore, the majority of L6 area is within NP zone, and thus only a quite limited part of the polygon could be further examined as a potential mining project (around 250 str. within the 1km buffer zone). The L9, L10 polygons are small areas within the NP zone of GR2420011, and hence based on the current environmental legislation they are excluded from any potential mining activity. Areas L1 and L5 show a slight overlap

with NP zone, and are practically on the borders of the site, within the 2km buffer. Polygons L3, L4, L7, and L8 constitute areas of Exclusive Mining Activity outside the borders of the GR2420011 site, but within their vicinity.

II) Laterites – Eastern part of GR2420011 – Mountains of Central Evvia



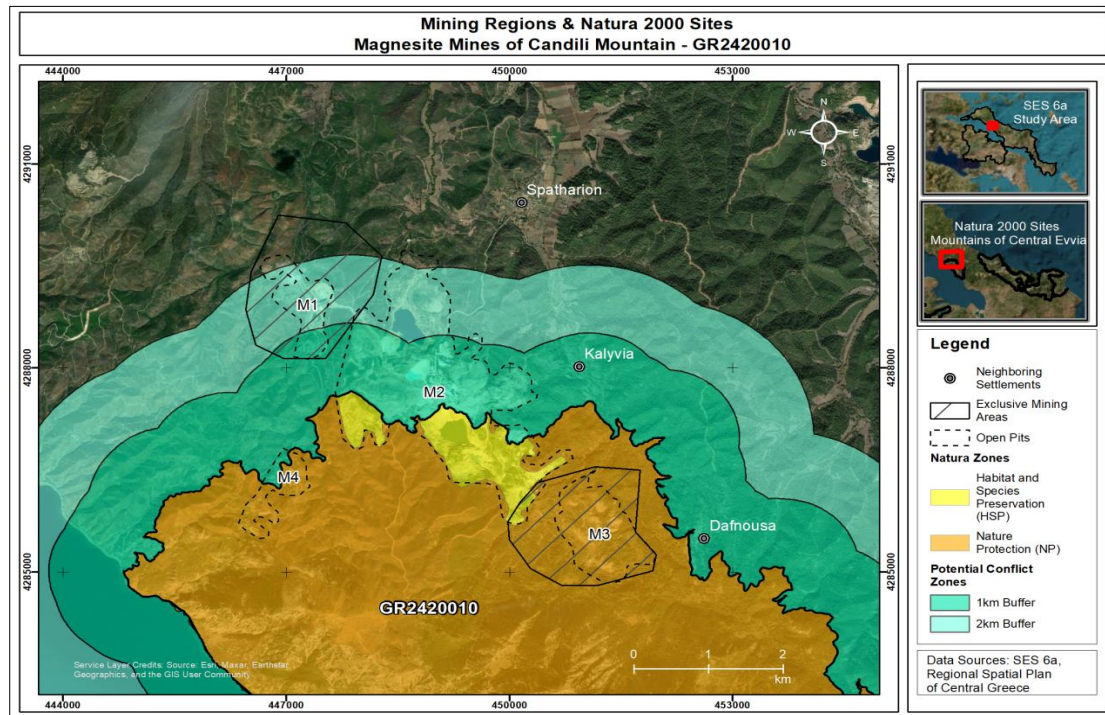
Map 12: Areas of Exclusive Mining Activity & NATURA 2000 Sites. Mountains of Central Evvia, Eastern part.

Table 11: Areas of Exclusive Mining Activity (EMA) & NATURA 2000 Zones, eastern part, GR2420011. Mountains of Central Evvia. All area units are measured in stremma (str).

| EMA | Area (str) | Status | Overlap with NP (str) | Overlap with NP (%) | Overlap with HSP (str) | Overlap with HSP (%) | Overlap with 1km buffer (str) | Overlap with 1km buffer (%) | Overlap with 2km buffer (str) | Overlap with 2km buffer (%) |
|-----|------------|-------------|-----------------------|---------------------|------------------------|----------------------|-------------------------------|-----------------------------|-------------------------------|-----------------------------|
| L11 | 1950.1 | Undeveloped | 1776.1 | 91.1 | 0.0 | 0.0 | 174.0 | 8.9 | 0.0 | 0.0 |
| L12 | 694.4 | Undeveloped | 658.3 | 94.8 | 0.0 | 0.0 | 36.5 | 5.3 | 0.0 | 0.0 |
| L13 | 2978.8 | Undeveloped | 2978.8 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| L14 | 2766.6 | Undeveloped | 2766.6 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

It becomes evident that in the eastern part of GR2420011, the mining intended areas with a total area of 8179 str., are practically excluded based on the provisions of the prevailing environmental legislation where extraction activities are not allowed in NP zones. Only L11 has a limited part outside NATURA 2000 site (174 str.), which is approximately 9% of the respective polygon.

III) Magnesite – Northern part of GR2420010 – Candili Mountain



Map 13: Areas of Exclusive Mining Activity & NATURA 2000 Sites: Magnesite mines in Candili Mountain, GR2420010.

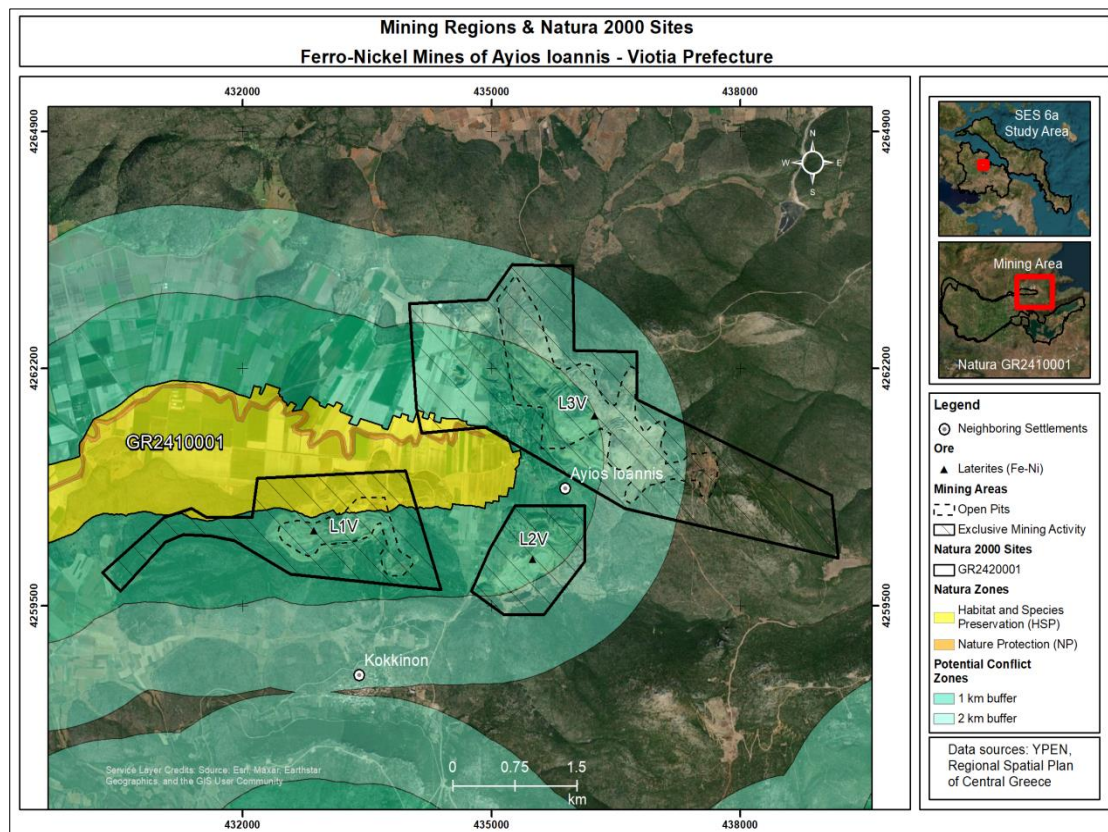
Table 12: Areas of Exclusive Mining Activity (EMA) & NATURA 2000 Zones, GR2420010, northern Candili Mountain, Evvia. All area units are measured in stremma (str).

| EMA | Area (str) | Status | Overlap with NP (str) | Overlap with NP (%) | Overlap with HSP (str) | Overlap with HSP (%) | Overlap with 1km buffer (str) | Overlap with 1km buffer (%) | Overlap with 2km buffer (str) | Overlap with 2km buffer (%) |
|----------------|------------|---------------------|-----------------------|---------------------|------------------------|----------------------|-------------------------------|-----------------------------|-------------------------------|-----------------------------|
| M1 (Exclusive) | 2860.5 | Developed - Active | 0.0 | 0.0 | 0.0 | 0.0 | 318.7 | 11.1 | 1708.0 | 60.0 |
| M2 (Open Pit) | 5505.2 | Developed - Active | 286.3 | 5.2 | 1665.1 | 30.2 | 2579.2 | 46.9 | 881.3 | 16.0 |
| M3 (Exclusive) | 2591.7 | Inactive - Restored | 2522.5 | 97.3 | 69.2 | 2.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| M4 (Open Pit) | 501.9 | Inactive - Restored | 414.5 | 82.6 | 0.0 | 0.0 | 87.5 | 17.4 | 0.0 | 0.0 |

In this case, the magnesite mines of northern Mt. Candili area examined. Open pit M2 has an overlap of 30% with the NATURA 2000 site, with the respective HSP zone designated as mining intended by the SES 6a. The remaining part of M2, as well as the Exclusive Mining Area and open pit M1 lie primarily within the 0-2km buffer zone. Finally, the areas M3 & M4, are mainly within designated NP zones.

IV) Laterites in Ayios Ioannis, Viotia Prefecture – GR2410001

The study area of SES 6a covers the NATURA 2000 site of Lake Yliki – Paralimni, and Viotikos Kifissos (in Viotia), where laterite mining activity used to take place, near Ayios Ioannis. The geographic presence of these mining areas in relation to the NATURA 2000 site is presented in Map 14.



Map 14: Areas of Exclusive Mining Activity & NATURA 2000 Zones. Ayios Ioannis Mines in relation to GR2410001 (Lake Yliki Paralimni – Viotikos Kifissos). Zone data were obtained from SES 6a.

In this case, the only region with substantial overlap is L1V, which accounts for 28% of the area. However, it can be seen that the related open pit is present to a very limited degree within the HSP zone, which according to the SES 6a is devoted to agriculture. L3V shows a very slight overlap with HSP and NP at the border of the

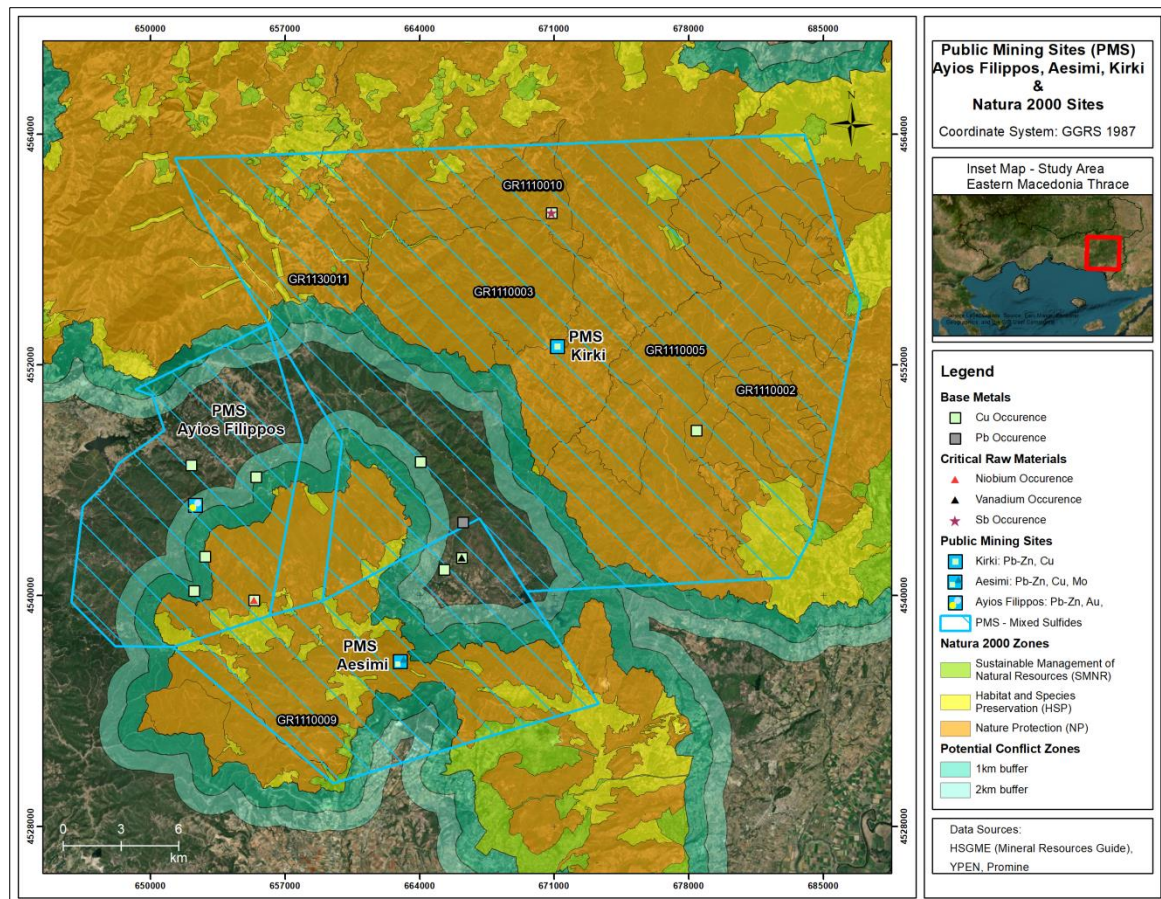
site, but the western part of the mining area has been covered by agricultural land. The areas for Exclusive Mining Activity, however, are largely present in proximity to the site. A total of 8669 str. intended for mining activity are within the 2km buffer, where 2595 str. of open pits are located.

Table 13: Areas of Exclusive Mining Activity & NATURA 2000 sites: Laterite Mines of Ayios Ioannis, Viotia Prefecture.

| EMA | Area (str) | Status | Overlap with NP (str) | Overlap with NP (%) | Overlap with HSP (str) | Overlap with HSP (%) | Overlap with 1km buffer (str) | Overlap with 1km buffer (%) | Overlap with 2km buffer (str) | Overlap with 2km buffer (%) |
|-----|------------|----------------------|-----------------------|---------------------|------------------------|----------------------|-------------------------------|-----------------------------|-------------------------------|-----------------------------|
| L1V | 2912.8 | Developed - Inactive | 0.0 | 0.0 | 815.3 | 28.0 | 2097.5 | 72 | 0.0 | 0.0 |
| L2V | 1258.2 | Developed - Inactive | 0.0 | 0.0 | 0.0 | 0.0 | 896.1 | 71.2 | 362.0 | 28.8 |
| L3V | 7075.9 | Developed - Inactive | 10.8 | 0.2 | 84.8 | 1.2 | 2440.3 | 34.5 | 2873.0 | 40.6 |

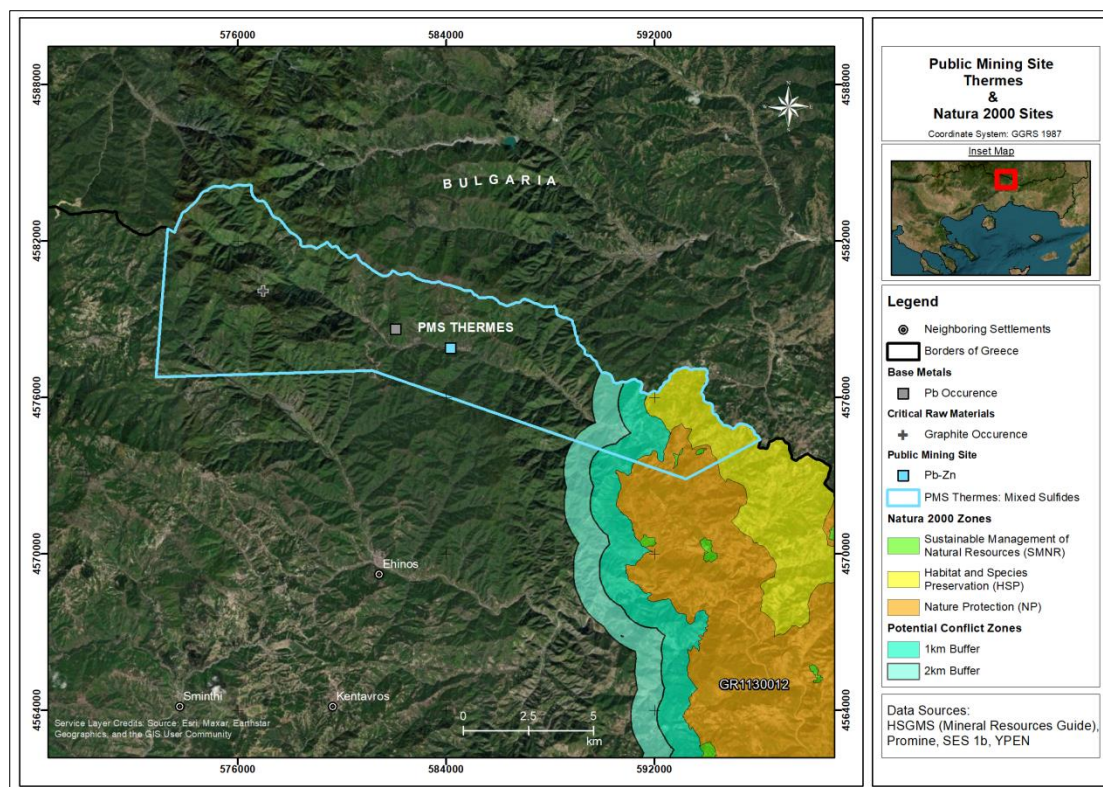
5.1.2. Eastern Macedonia – Thrace (SES 1a, 1b)

In Eastern Macedonia – Thrace, the study areas are three (3) PMS located in the region of Evros and one (1) PMS located in Thermes. Due to geographic proximity, PMS of Evros (Ayios Filippos, Aesimi, and Kirki) are grouped into one map, Map 15, and PMS of Thermes is presented separately in Map 16.



Map 15: Public Mining Sites of Evros (Aesimi, Ayios Filippos, Kirki) in relation to NATURA 2000 zones.

PMS Thermes and the spatially related NATURA 2000 site GR1130012 are shown in Map 16. The overlap analysis of the four (4) PMS of Eastern Macedonia – Thrace with the protected areas and their respective buffer zones is presented on Tables 13 & 14.



Map 16: Public Mining Site of Thermes & NATURA 2000 zones (GR1130012).

It is noted that in the case of Evros, there is a strong presence of Public Mining Sites within the NATURA 2000 network. However, the case of Thermes appears to be different, given that the overlap is noticeably less significant.

Table 14: Study areas (PMS) of Eastern Macedonia - Thrace and their overlap with NATURA 2000 and the respective buffer zones.

| Public Mining Site | Area (km ²) | Overlap with SMNR (km ²) | Overlap with SMNR (%) | Overlap with HSP (km ²) | Overlap with HSP (%) | Overlap with NP (km ²) | Overlap with NP (%) | Overlap with 2km Buffer (km ²) | Overlap with 2km buffer (%) |
|--------------------|-------------------------|--------------------------------------|-----------------------|-------------------------------------|----------------------|------------------------------------|---------------------|--|-----------------------------|
| Ayios Filippos | 135,0 | 0,0 | 0,0 | 4,4 | 3,3 | 21,8 | 16,1 | 43,6 | 32,3 |
| Aesimi | 156,9 | 3,2 | 2,0 | 19,8 | 12,6 | 74,5 | 47,5 | 43,5 | 27,7 |
| Kirki | 641,6 | 3,2 | 0,5 | 34,2 | 5,3 | 481,8 | 75,1 | 74,7 | 11,6 |
| Thermes | 100,0 | 0,1 | 0,1 | 6,8 | 6,8 | 2,8 | 2,8 | 7,4 | 7,4 |

Table 15: Study Areas in Eastern Macedonia - Thrace. Total area within and outside NATURA 2000 network.

| Public Mining Site | Area (km ²) | Total Within NATURA (km ²) | Total Within NATURA (%) | Total Outside NATURA (km ²) | Total Outside NATURA (%) |
|--------------------|-------------------------|--|-------------------------|---|--------------------------|
| Ayios Filippos | 135,0 | 26,2 | 19,4 | 108,8 | 80,6 |
| Aesimi | 156,9 | 97,4 | 62,1 | 59,5 | 37,9 |
| Kirki | 641,6 | 519,2 | 80,9 | 122,4 | 19,1 |
| Thermes | 100,0 | 9,7 | 9,7 | 90,3 | 90,3 |

More specifically, the total area of PMS *Ayios Filippos* within NATURA 2000 site (i.e. GR1110009, South Forest Complex of Evros) is approximately 19%. This percentage comprises of 16% NP zones (resulting in 22 km² excluded from mining activity as provisioned in the prevailing environmental legislation L. 4685/2020), and 3% HSP zones, which however are not intended for mining, according to the SES 1a (OMIKRON SA, 2021). Furthermore, it is worth noticing that the 2 km buffer covers 32% of the PMS. Despite not being excluded, mining activity could be a potential source of impact in this protected area.

The PMS of *Aesimi* does also have a substantial overlap with the NATURA 2000 network, site GR1110009, with 62% of the land with mining rights located within the preservation area. Similar to *Ayios Filippos*, a quite large part of the overlap is designated as NP zone (47.5%, 74.5 km²), in which any type of activity from the extractive industry is excluded by law. However, in this case the HSP zones are a bit more prevalent, covering 12.6% of the PMS. According to the SES 1a, none of the HSP zones is intended for the metallic mineral exploration and exploitation.

The PMS of *Kirki* is the largest of the investigated areas. Moreover, it shows the greatest overlap with NATURA 2000 sites (GR1110002, GR1110003, GR1110005, GR1110009, GR11100010, GR1130011), with 81% of its area covered. Similar to the other cases, the NP zones are prevalent, and 75% of the site is excluded from mining activity. The overlapping part of PMS and NATURA 2000 network does contain

further activities in HSP zones, which according to SES 1a are not targeted for projects pertinent to the metal mining industry.

Regarding the base metal and CRM occurrences, PMS of *Ayios Filippos* contains five (5) locations with metallic mineral concentrations within or in proximity to the South Forest Complex of Evros (GR1110009). One Cu along with Nb occurrence lies within the NP zone at the southern part of the PMS. Three (3) copper occurrences are located within the 0-2km buffer zone, one of which corresponds to the old mine of Ayios Filippos. The northern Cu occurrence is spatially related to the King Arthur area, and lies outside NATURA 2000 network and the 2km buffer zone.

PMS of Aesimi contains two occurrences of Cu, one of which is accompanied with V occurrence. However, these are reported in the northern part, outside the site GR1110009 and its 2km buffer zone.

Kirki deposit contains base metal and CRM occurrences as well. Cu and Sb are reported in the northern part within NP zones, and a southeastern Cu occurrence lies within NP zone as well. In the southwestern part of the Public Mining Site, one Cu occurrence lies within the 1-2km buffer zone of GR1110009, and the Pb concentration is found outside the buffers, near the borders with PMS Aesimi.

Finally, PMS of *Thermes* shows the least overlap with NATURA 2000 sites in relation to the former cases. Its intersect with the NATURA 2000 network (GR1130012, Kompsatos Valley) covers 10% of the site (eastern part), containing NP zone, and HSP not intended for mining (OMIKRON SA, 2022, SES 1b). The buffer zones also cover a noteworthy part of the site, 7.4%. However, the occurrences have been reported in central (Pb) and western part of the site (C), not relevant to the protected area GR1130012.

Table 16: Base metal and CRM occurrences (count) located in PMS, within or in proximity to the NATURA 2000 network.

| PMS | Base Metal | Base Metal in 2km buffer | CRM | CRM in 2km buffer |
|----------------|---------------------|--------------------------|-----------------|-------------------|
| | In NATURA sites | | In NATURA sites | |
| Ayios Filippos | 1 - Cu ⁷ | 3 - Cu | 1 - Nb | None |
| Aesimi | None | None | None | None |
| Kirki | 2 - Cu | 1 – Cu | 1 – Sb | None |
| Thermes | None | None | None | None |

Table 17: Base metal and CRM occurrences (count) in PMS, outside NATURA 2000 network.

| PMS | Base Metal Outside | CRM Outside |
|----------------|--------------------|------------------|
| | the NATURA sites | the NATURA sites |
| Ayios Filippos | 4 – Cu | None |
| Aesimi | 2 – Cu | 1 - V |
| Kirki | 1 - Pb | None |
| Thermes | 1 – Pb | 1 - C |

5.2. Current & Intended Land Uses of Public Mining Sites

In this part, a comparison between the current and the intended land uses of the PMS of Eastern Macedonia – Thrace will be presented. Data has been gathered from Corine Land Cover 2018 and the Spatial Regional Plan of Eastern Macedonia – Thrace respectively.

Map 17 depicts the PMS of Evros, with the CLC 2018 data. The area of the *PMS Ayios Filippos* contains mainly forests, shrubs and herbaceous vegetation. However, it

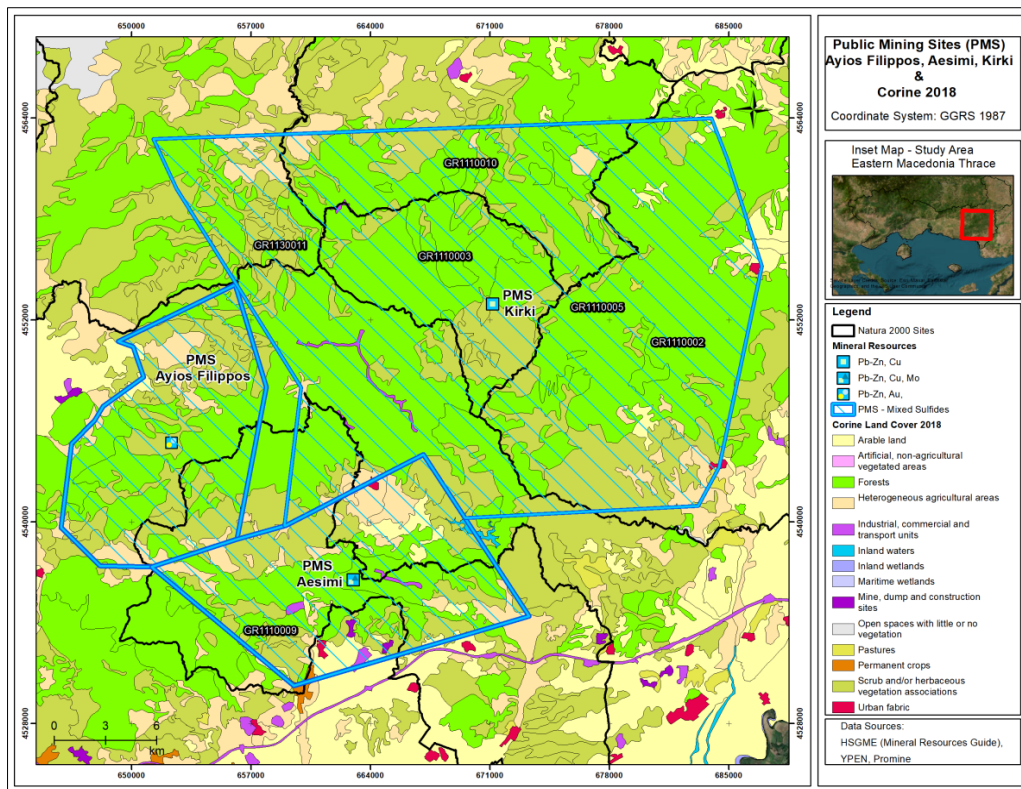
⁷ Cu is categorized as base metal in ProMine’s database. However, according to CRM list of 2023, Cu is considered critical.

also contains substantial agricultural activity present mainly in the northern, but in the southern part as well. According to the Spatial Regional Plan of Eastern Macedonia - Thrace, the area of Ayios Filippos is generally characterized by intense agricultural activity (Map 18). Moreover, there are forestry intended areas at the eastern part of PMS, as well as livestock intended land which overlaps with part of the agricultural areas.

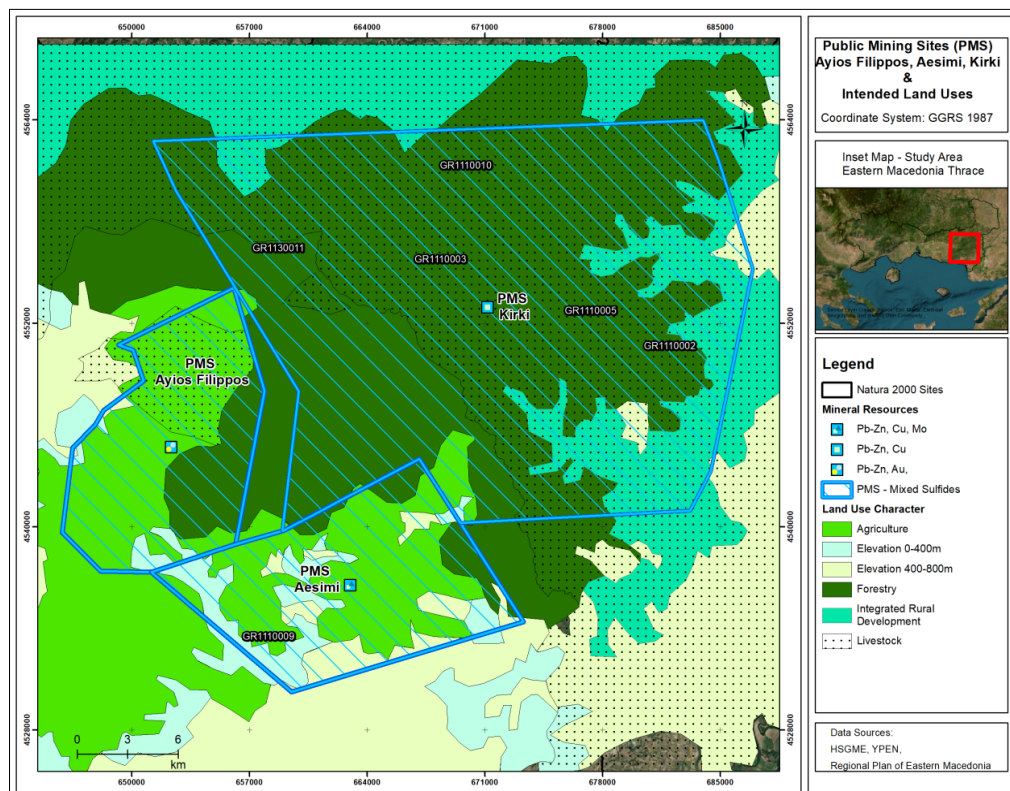
As for *Aesimi*, the area of PMS is largely covered by vegetation (forests, shrubs, herbaceous vegetation). There are also noticeable parts with heterogeneous agricultural areas and arable land, and a minor part (1%) is devoted to industrial or commercial units. As for the overlapping area of PMS and NATURA 2000 site GR1110009, the land use pattern remains similar. As observed in Map 18, the main intended activity that characterizes the area is intense agriculture.

The area of PMS *Kirki* is predominantly characterized by forests, shrubs or herbaceous vegetation (Map 17). Human activity is evident to a limited degree, with agricultural areas in the northwestern, northeastern, and southeastern part of PMS. According to the intended land uses in the PMS Kirki (Map 18), it can be seen that the area is largely covered by forestry, livestock, integrated rural development (eastern part), and few areas of intense agricultural development.

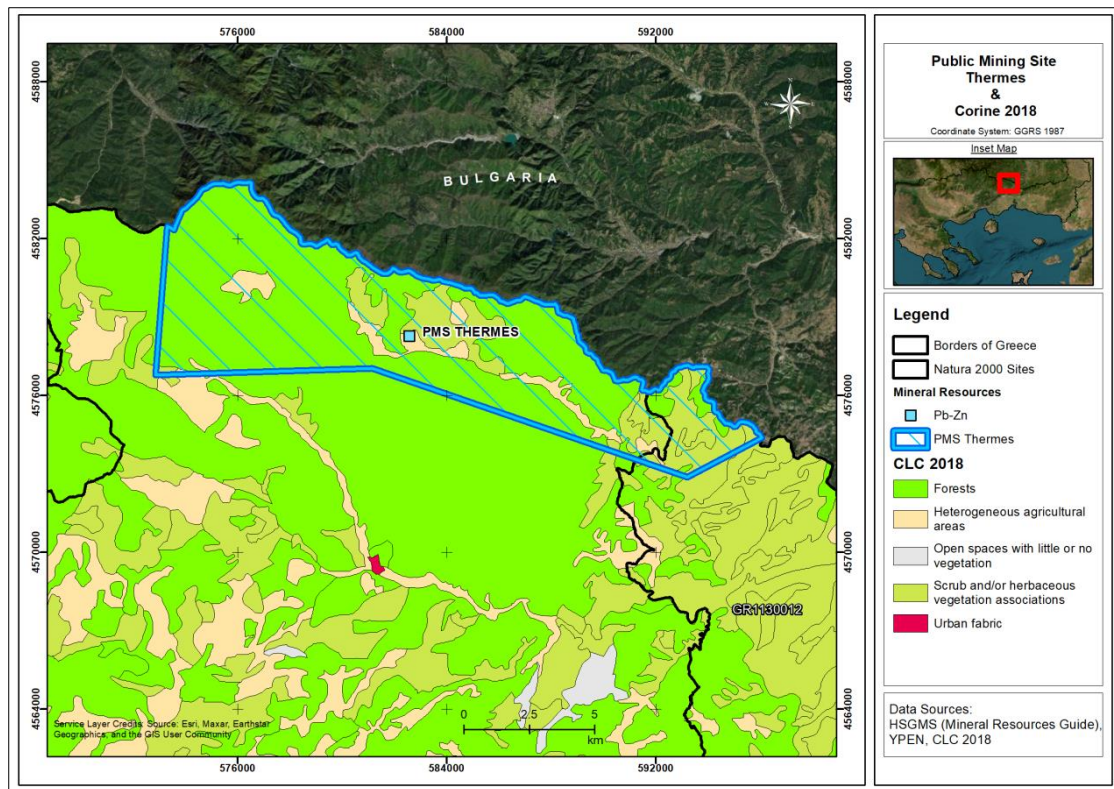
Finally, Map 19 demonstrates the current land uses of the PMS Thermes and the wider area. This PMS is largely covered by forests, shrubs and herbaceous vegetation. Regarding human activity, it contains agricultural land stretching from the western to the eastern part of the PMS. Regarding the overlapping part with site GR1130012 (eastern side), the shrubs and herbaceous vegetation are prevalent, with some forests, and quite limited human activity. Besides the current land uses, the intended land-use character of the wider area covered by PMS is integrated rural development with livestock (Map 20).



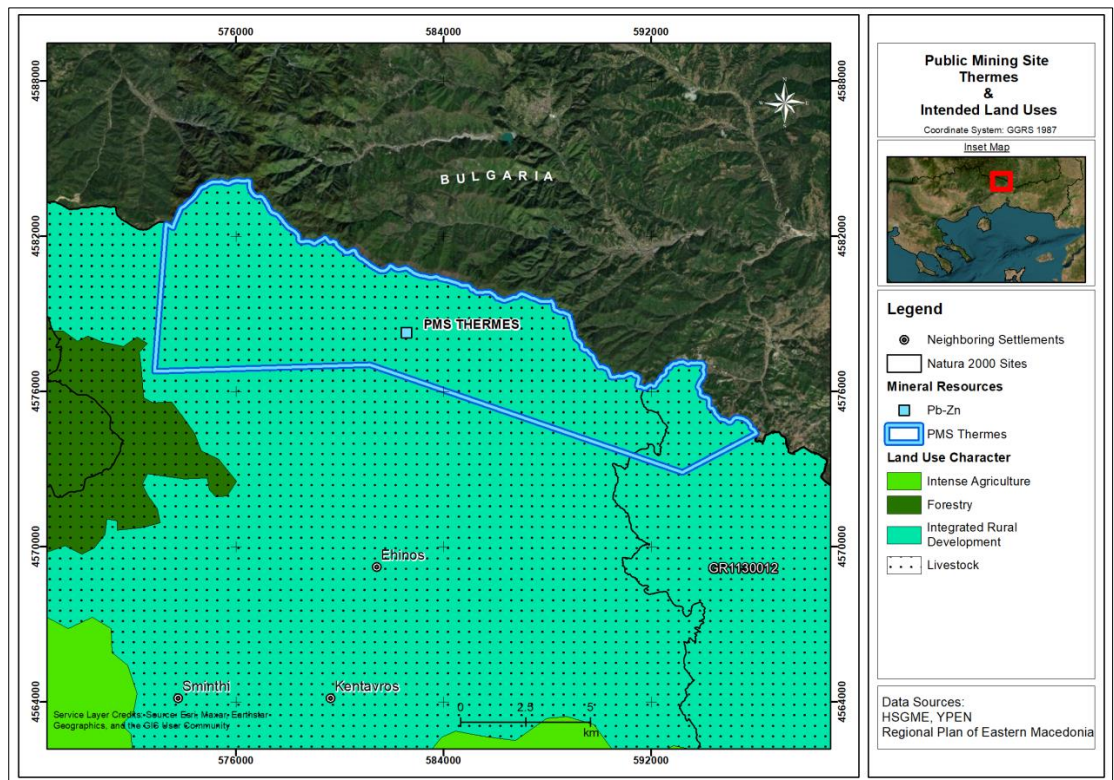
Map 17: Public Mining Sites of Evros, NATURA 2000 sites, and CLC 2018 data.



Map 18: Public Mining Sites of Evros, in relation to the land use character of the wider areas, according to the Regional Spatial Plan of Eastern Macedonia - Thrace.



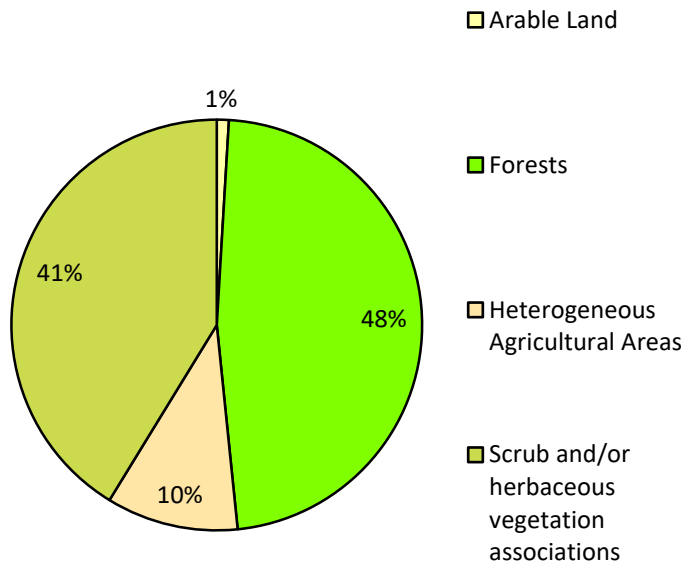
Map 19: Public Mining Site of Thermes, NATURA 2000 sites, and CLC 2018 data.



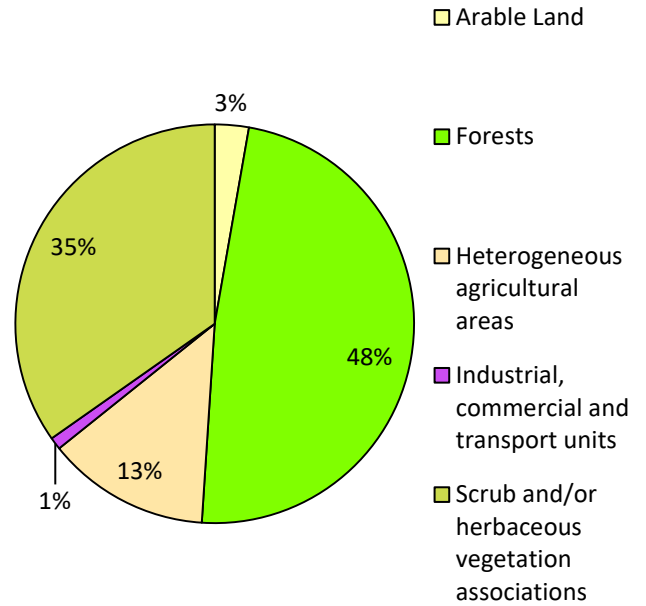
Map 20: PMS Thermes, NATURA 2000 sites, and intended land use character of the wider area according to the Regional Spatial Plan of Eastern Macedonia - Thrace.

The land use coverage of the overlapping part of PMS and the related NATURA 2000 sites is shown in the following graphs (Figure 4).

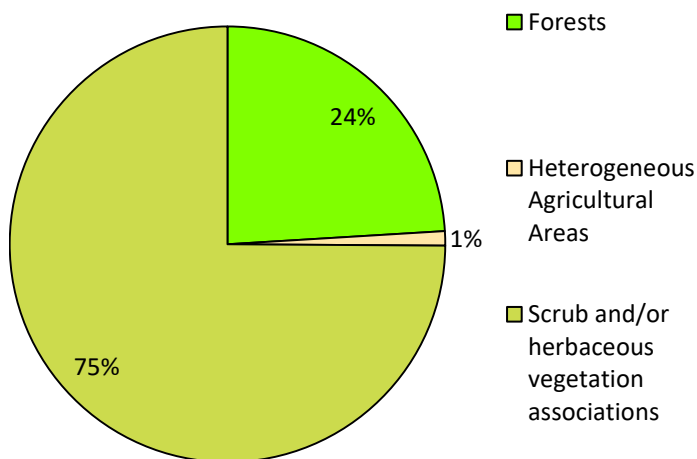
PMS Ayios Filippou - GR1110009



PMS Aesimi - GR1110009



PMS Thermes - GR1130012



PMS Kirki - NATURA 2000 Sites

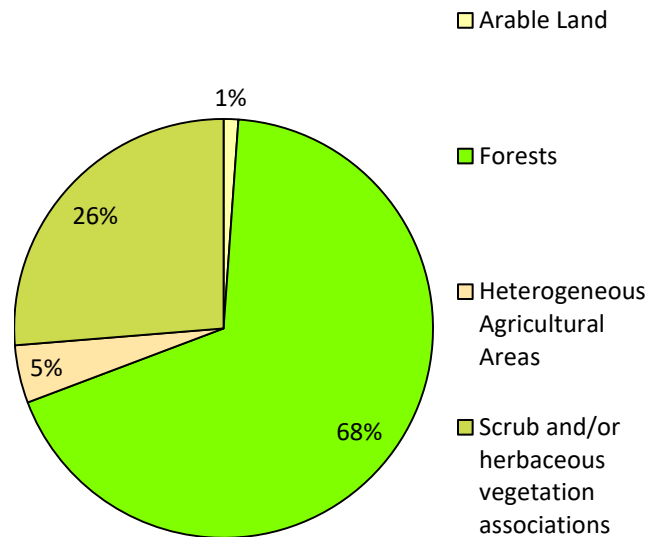


Figure 4: Land cover of the overlapping parts of Public Mining Sites and NATURA 2000 sites.

6. Discussion

The present study examined the geographic presence of mining areas in NATURA 2000 network of Greece. The analysis included specific areas targeted for mining activity, such as the case of Evvia & part of Viotia, and Public Mining Sites of Eastern Macedonia - Thrace where the state has mining rights, and can be considered areas for further exploration or development, according to the HSGME.

Regarding the areas defined by the Regional Spatial Plan of Central Greece as areas of Exclusive Mining Activity of Evvia and part of Viotia, there are two (2) cases of mining sites that are permitted within the designated Habitat and Species Preservation (HSP) zones. The first one is L2, a laterite mine in the western part of Mountains of Central Evvia (GR2420011) located entirely within the protected site. The second case is M2, part of the open magnesite pit in the HSP zone of northern Candili Mountain (GR2420010). The laterite mines of Ayios Ioannis (Viotia prefecture) could be regarded as a third case, although they lie slightly within the site (GR2410001), and mainly within the 2km buffer zone.

The western part of GR2420011 site contains a total of 3.351 str. targeted for laterite mining activity according to the Regional Spatial Plan, and 5.825 str. within the 2km buffer zone. From these within the site, only 510 str. are designated as HSP zone (part of L2), which corresponds to existing mine site (inactive). According to the SES 6a (Arapis, et al., 2022, GEOANALYSIS S.A), mining activity constitutes one of the main pressures/threats for the site.

The eastern part of GR2420011 contains a total of 8390 str. targeted for Exclusive Mining Activity (Fe-Ni laterite concessions) as presented in the Regional Spatial Plan, where mining operations have not been developed yet (Katavolos, near Metohi settlement). However, the SES 6a has designated the wider area as Nature Protection zone, excluding the potential for mining development, since 97,5% of the eastern mining areas are located in NP zones. It is argued that establishing mining operations can lead to landscape degradation, threatening the species and the protected habitat types. The extent of this impact is expected to be quite wide, due to the mining-related infrastructure and activity (roads, aerial cabling, accompanied with vehicle movement, noise and dust). It is interesting to notice that the SES 6a examines alternative scenarios where NP-2 (Mountainous area of Dirfi – Kserovounio) is

designated as HSP zone. In this case, potential extension of mining activity is expected to result in significant dust emissions, noise and light pollution in the case that appropriate environmental protection measures are not applied.

The areas of Exclusive Mining Activity and open magnesite mines in Northern Candili Mountain are in proximity and within NATURA 2000 site (GR2420010). More specifically, a total of 4.958 str. are within the site (1.734 in HSP and 3223 in NP), and 5.575 str. within the 2km buffer zone. The SES 6a encourages the reclamation of old mining sites according to the biodiversity aspects of the area, and fosters geo-tourism in the mine sites as a developmental prospect. According to the SES 6a, mining activity is deemed a long-term pressure/threat of high importance. Finally, the areas of Exclusive Mining Activity in Viotia (Ayios Ioannis, NE part of GR2410001) cover 8.669 str. in the 2km buffer zone. According to the SES 6a, mining activity is regarded one of the primary threats to the protected site. The overlaps of Exclusive Mining areas and the NATURA 2000 sites or the respective buffer zones in the cases of Evvia and part of Viotia are illustrated in Figure 5.

According to the Regional Spatial Plan of Central Greece (G.G, 2018), the areas of Exclusive Mining Activity have to be safeguarded. Having a fundamental contribution to the region, the extractive industry is supported, while competing land-uses are avoided within mining intended areas. Regarding NATURA 2000 sites, it is suggested that the management plan be carried out. Aiming to preserve the biodiversity of the area, the spatial plan suggests the avoidance, if possible, of the development of potentially threatening activities. However, mineral resources, along with water resources, are mentioned as particular cases that need to co-exist with nature protection, due to their importance for the area. Finally, underground mining is fostered, along with good practices of environmental reclamation.

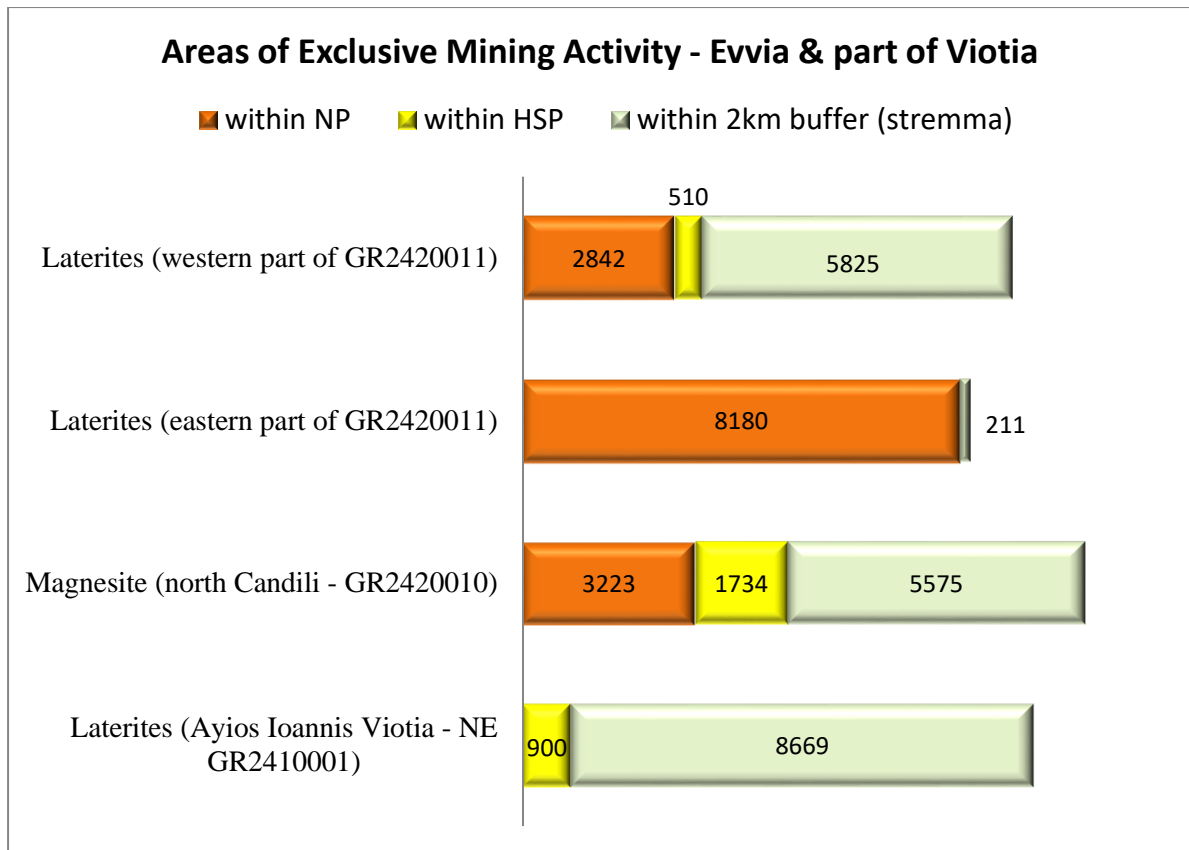


Figure 5: Areas of Exclusive Mining Activity in Evvia and Viotia. Presence of Mining intended areas within NP zones, HSP, or 2km buffer.

As for the Public Mining Sites in Eastern Macedonia – Thrace, a noteworthy overlap between NATURA 2000 zones and areas for potential mining development is observed. It is significant to mention that both in the three cases of Evros, and in the case of Thermes, the Special Environmental Studies (1a, 1b) green-light only existing legal mining operations, with improvement and modernization of the related facilities, and the consent of N.E.C.C.A (Natural Environment & Climate Change Agency). On the grounds that no metal mining projects are underway in these areas, it can be concluded that these HSP and SMNR zones do not provide any opportunity for further exploration or development. Given this fact, the following graph depicts the total percentage of each PMS that is excluded, due to its presence in NATURA 2000 network. Additionally, it displays the percentage of the potential mining areas that is in close proximity to the borders of the sites (therefore, high potential for conflict) within the 2km buffer zone.

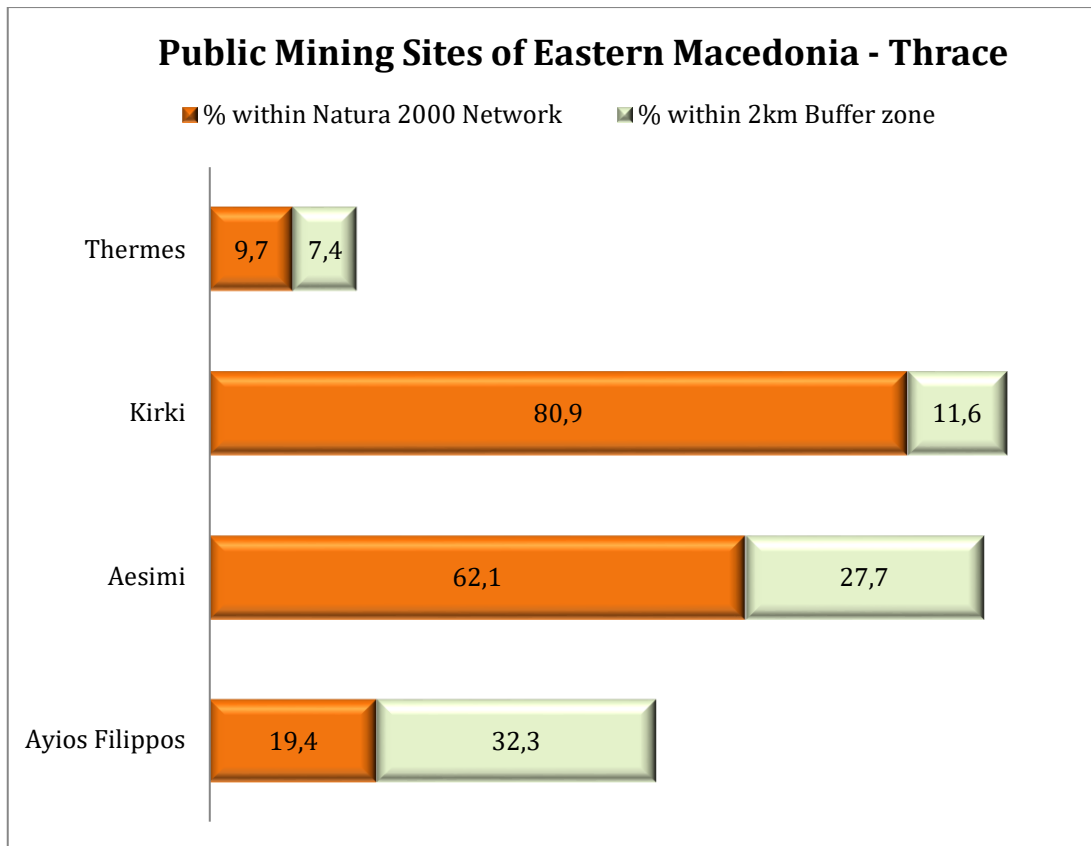


Figure 6: Public Mining Sites in Eastern Macedonia - Thrace. Percentage of overlap with NATURA 2000 network and the 2km buffer.

The reported location of mineral resources in PMS Ayios Filippos are the areas of Ayios Filippos and King Arthur. In the first case, the occurrence data are closely related to the site GR1110009 (South Forest Complex of Evros), with base metal (Cu) and CRM occurrences (Nb) within Nature Protection zones in the southern part. The old mine of Ayios Filippos, along with two more Cu occurrences lie within the 2km buffer, rendering the potential exploration or mining activity in the wider area prone to socio-environmental conflicts. The northern Cu occurrence corresponds to King Arthur, whose location appears to be more distanced from the NATURA 2000 network.

The metallic minerals of interest in Aesimi lie in several areas of the PMS, with the majority of the reported concentrations in southeastern part of the site, and in Miloi. The western part contains fewer concentrations, and is heavily covered by the site GR1110009 (South Forest Complex of Evros). Hence, it can be argued that potential exploration or mining activity in this part is not likely to be developed. The NATURA 2000 network also overlaps with the southeastern part of the site, and along with the

2km buffer zones, can restrict the establishment of mining activity. Only the north-eastern part of the site appears to have an increased distance to the protected area, and the respective occurrences of Cu and V are located outside the 2km buffer zone. Generally, PMS of Aesimi presents significant prospects according to the HSGME, but its extensive overlap with the GR1110009 may limit the potential for exploration and development to the northeastern (near Aesimi settlement) and central-southern part (near Avas settlement).

The reported mineral resource concentrations of Kirki are located in “Treis Vryses” (central part of the PMS) and in the southern part of the PMS. It is observed that the area surrounding Treis Vryses is covered by Nature Protection zone, which means that mining activity in this region is excluded according to the prevailing environmental legislation (L. 4685/2020). PMS of Kirki is largely covered by the NATURA 2000 network (81%), leaving only its southwestern part open to discussion for potential mining development. Given that the southern part of the site is the most promising (according to the HSGME report), it seems that the extensive coverage by the protected sites can significantly restrict the available area for further exploration.

Finally, the PMS Thermes demonstrates the lowest overlap with NATURA 2000 network (GR1130012 - Northern part of Kompsatos valley). Moreover, the reported concentrations of interest (Pb, C) are located on the central-western part of the PMS, whereas the protected site covers the eastern side of the PMS. Therefore, the excluded areas and the potential conflict zones do not appear as hindering factors for further exploration or development in the area.

The areas of overlap between PMS and NATURA 2000 sites are mainly Nature Protection zones, with limited parts intended for human activity (agriculture, wind farms, settlements). The land uses (Corine data) in the overlapping areas follow a similar pattern, where the forests and semi-natural areas are prevalent, with sparse areas of human activity. Moreover, in the majority of the cases, the HSP zones correspond to already existing activities. An exception is the HSP zone that overlaps with the eastern part of PMS Thermes, which has no evident existing activity. Another case is the HSP-3 zones in central Evvia, where the strategic wind farm project is to be developed in the future.

However, when discussing the potential development of mining operations, we need to factor in two significant parameters as well: Regional Spatial Plans, and SLO issues. Generally, the Spatial Plan of Eastern Macedonia –Thrace (G.G, 2018) supports the mining projects when their positive contribution in economic growth, raw material supply and the development of working positions outweighs their potential socio-environmental impact. However, if a mining project does not align with the region's development goals and poses risks to environmental protection, it should be excluded. It is significant to point out that according to the spatial plan, mining activity is not mentioned as a part of the developmental profile of the spatially related urban districts of Eastern Macedonia - Thrace.

Table 18: Developmental character of the municipalities that are spatially related to the PMS of Eastern Macedonia – Thrace.

| Municipality | Centre | Developmental Profile |
|---------------------|------------------------------|--|
| Alexandroupoli | Alexandroupoli | Integrated urban development. Includes touristic areas, coastal rural development, intense agriculture, livestock and manufacturing activities. |
| Sapes - Ariana | Sapes | Varying developmental profile. Contains integrated rural development, forestry, renewable-energy development, intense agriculture and manufacturing activity. |
| Soufli | Soufli | Varying developmental character, with limited urban areas and prevalence of natural environment. Contains areas of intense agricultural activity, integrated rural development, forestry and renewable-energy development. |
| Mikis | Ehinos – Kentavros - Sminthi | Settlements in mountainous area, cultural heritage, natural and human environment. Constitutes an area for livestock and integrated rural development. |

Furthermore, the attitude of the local population in Eastern Macedonia – Thrace does not appear to show agreement or encouragement towards metal mining activities. Recently, local residents expressed their opposition to the development plans of gold mining project in Perama Hill (by the company Eldorado Gold), an area adjacent to the PMS Ayios Filippos (Mahera, 2023). Given this perception of the local community towards the potential exploitation of an epithermal Au-Ag deposit, and taking into account the pollution-related old mine of Kirki (Triantafyllidis, 2006), it could be argued that discussing exploration or new mining projects in our study areas (PMS of Evros – Ayios Filippos, Aesimi, Kirki) may also give rise to public unrest.

Hence, given the directions from the Regional Spatial Plan of Eastern Macedonia - Thrace and the existing SLO issues in the wider region, along with the extensive overlaps with NATURA 2000 sites, the development potential in the examined PMS of Evros is significantly limited.

Lastly, it is important to notice the limitations of this study. Given that the publicly available data for mineral resources location is not precise, this study was based on generic descriptions from HSGME reports and ProMine occurrence data. However, occurrences may on one hand encourage further exploration, but on the other hand they can indicate non-promising areas. In the second case, the overlaps of NATURA 2000 sites with base metal or CRM concentrations do not constitute a restrictive factor to economic growth.

Whether a mining operation is permitted within the NATURA 2000 network can be dependent on the value returned by the project, to the public (see imperative reasons of overriding public interest, Article 6.4, Habitats directive). However, in order to assess whether there is a valuable deposit that needs to be safeguarded, extensive exploration activities need to be carried out. The issue with exploration is that its environmental impact is documented (noise, forest clearance, drilling) (ICMM, 2006), but these projects more often than not, do not result in the establishment of a new mine (Caron, et al., 2016).

The hindering factors for the development of NEEI activity within NATURA 2000 sites that are identified in the current study, broadly align with some of the issues raised by the study of Wrana et al. 2014. These barriers may refer to inadequate geological knowledge, inclusion or exclusion of mining activity in the Regional

Spatial Plans, and the perception of the general public regarding the potential co-existence of the extractive industry with biodiversity preservation sites.

Within the European Union, the guidelines for mining activity in NATURA 2000 sites are based on proper assessment of the environmental impacts, which is also targeted to the specific preservation goals of the protected sites (EIA and AA). In Greece, according to the law 4685/2020 the sites are divided into four (4) sub-zones, two of which exclude mining activity (ANP, NP). Moreover, according to the analysis conducted in this study, the NP zones are quite prevalent in the examined cases. Nevertheless, a similarity with European cases is observed, regarding the fact that most of the mentioned cases of mining within or in proximity to NATURA 2000 sites are already existing activities, as it was seen in the case-study booklet (2019). This has also been the case in our analysis. It is worth pointing out that limited discussion has taken place regarding further mineral exploration or the development of new metal mines.

Overall, this study focused on areas with existing metal mining sites or metallic mineral resources potential, given their increasing importance at the European level. Further study areas could include Public Mining Sites in Central Macedonia (wider area of Kilkis), and in Central Greece, the western part (Fokida) which contains extensive underground bauxite mining areas that demonstrate overlap with NATURA 2000 sites. This can be a quite interesting case, given that this activity has been included in Minland project, and is regarded as an operation that embraced several good practices, and has to be safeguarded. Both in Central Macedonia and Western Central Greece, the analysis will be feasible by the time the respective Special Environmental Studies are made publicly available. Finally, the concept of mining in NATURA 2000 could also be expanded to other types of mining activity, such as marble quarrying, which has a noteworthy presence in Eastern Macedonia - Thrace and other parts of Greece.

7. Conclusion

This study examined cases of existing mines or areas of potential mining interest that demonstrate overlap with the NATURA 2000 network of Greece, with a focus on metallic minerals and CRMs. In Central Greece, existing laterite and magnesite mining sites are permitted in Habitat & Species Preservation zones of Evvia, but significant areas of Exclusive Mining Activity (as defined in the Regional Spatial Plan of Central Greece) are excluded by law (4685/2020), due to the designation of Nature Protection zones. In Eastern Macedonia – Thrace, the Public Mining Sites of Evros (Ayios Filippos, Aesimi, Kirki) are characterized by extensive overlap with the NATURA 2000 sites, rendering the evaluation for further mineral exploration or new mining activity more challenging.

Conclusively, within the context of an increasing need for certain base metals and CRMs, the potential impact of the mining industry is expected to further jeopardize the integrity of biodiversity and threatened ecosystems. Therefore, attempts need to be made from all stakeholders (firms conducting the SES, mining companies, policy makers, and local communities) towards the sustainable integration of mining activity in regional plans, the implementation of environmentally friendly practices, and the engagement of the public. This approach will help provide further supply of significant raw materials, and boost the primary domestic extraction of the European Union in a sustainable manner.

8. References

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