ABSTRACT

Deforestation is a critical global environmental issue that poses severe threats to ecosystems and biodiversity. This research report focuses on the analysis of deforestation in Kosovo, a region experiencing significant forest loss.

A territorial analysis conducted by Sustainability Leadership Kosova (SLK) in 2021 and 2022 revealed alarming findings regarding the extent of deforestation in Kosovo.

Between 2000 and 2022, Kosovo lost a staggering ***15,980 hectares of forest***, equivalent to a minimum of **2 hectares per day,** with a maximum reaching **3.5 hectares per day.** The research highlights the urgent need to address this concerning trend and implement effective measures for forest conservation and sustainable land use.

The consequences of deforestation, including biodiversity loss, climate change, soil erosion, and disrupted water cycles, further emphasize the critical importance of preserving forests and promoting responsible forest management practices.

This report provides an overview of the causes and impacts of deforestation, the methodology employed for the analysis, and offers recommendations for policymakers and stakeholders to combat deforestation and ensure the sustainable use of forest resources.

Addressing deforestation in Kosovo requires immediate action and a collective commitment to protect and restore forests for the benefit of present and future generations.

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INTRODUCTION

1.1 Deforestation as a global environmental issue

Deforestation is a critical global environmental issue characterized by the widespread removal of forests and the transformation of forested areas into non-forest land (FAO, 2020). It is primarily driven by human activities, including agriculture, logging, urbanization, infrastructure development, and the expansion of industries (Gibbs et al., 2015).

The consequences of deforestation are far-reaching and impactful. Firstly, it leads to the loss of biodiversity as many plant and animal species rely on forests for their habitat, putting global ecosystems at risk and potentially leading to species extinction (Hansen et al., 2013).

Deforestation also contributes significantly to climate change. Forests act as carbon sinks, absorbing carbon dioxide (a greenhouse gas) from the atmosphere. When trees are cut down or burned, the stored carbon is released back into the atmosphere, exacerbating global warming (IPCC, 2014).

Furthermore, deforestation causes soil erosion, alters water cycles, and disrupts local and regional climate patterns (Mbow et al., 2019). Forests play a crucial role in regulating water systems, and their destruction can lead to decreased water quality, reduced water availability, and increased vulnerability to floods and droughts.
These environmental impacts have implications for both ecosystems and human populations. Efforts to combat deforestation include international agreements, conservation initiatives, sustainable forest management practices, and reforestation programs.

The Paris Agreement, adopted under the United Nations Framework Convention on Climate Change, aims to mitigate climate change, and encourages countries to reduce deforestation and promote sustainable land use practices (UNFCCC, 2015).

Conservation organizations, governments, and local communities are working together to protect remaining forests, promote sustainable land use, and raise awareness about the importance of preserving these valuable ecosystems (WWF, 2022).

1.2 Alarming Deforestation Trends in Kosovo: Findings from a Territorial Analysis by Sustainability Leadership Kosova (SLK)

A territorial analysis conducted by Sustainability Leadership Kosova (SLK) in 2021-2022 revealed that between 2000 and 2022, Kosovo experienced a significant loss of forests, with approximately ***15,980 hectares lost***, equivalent to over 2 hectares per day, with a maximum of 3,5 hectares per day (SLK, 2022).

This deforestation trend observed in the past two decades is highly alarming, posing a threat to ecosystems and rendering habitats unsuitable for flora and fauna.
In conclusion, deforestation is a global environmental challenge that requires a concerted effort to address. It not only contributes to the loss of biodiversity and exacerbates climate change but also disrupts water systems and local climates. Sustainable practices, policy interventions, and collaborative efforts are necessary to protect and restore forests worldwide.

1.3 Defining Deforestation

Deforestation refers to the deliberate or widespread removal, destruction, or clearance of forests or wooded areas, typically resulting in the transformation of forested land into non-forest land[1]. It involves the cutting down, clearing, or removal of trees and vegetation, often to make way for agricultural activities, urbanization, infrastructure development, logging, or

[1] Food and Agriculture Organization of the United Nations. (2010). Global Forest Resources Assessment 2010: Definitions and Concepts. Retrieved from http://www.fao.org/3/i1757e/i1757e01.pdf

mining operations[2]. Deforestation can occur on a small scale, such as clearing land for farming, or on a large scale, such as massive clear-cutting for industrial purposes.

Deforestation has significant environmental consequences. It disrupts and destroys ecosystems, leading to the loss of biodiversity and habitat for numerous plant and animal species[3]. It contributes to climate change by reducing the capacity of forests to absorb carbon dioxide (a greenhouse gas) from the atmosphere, thus exacerbating global warming[4]. Additionally, deforestation can result in soil erosion, water pollution, and disruptions to local and regional climate patterns[5].

Efforts are being made worldwide to address deforestation and promote sustainable forest management practices, including reforestation and afforestation initiatives. These aim to mitigate the negative impacts of deforestation, conserve forest ecosystems, and promote the sustainable use of forest resources[6].

[2] Meyfroidt, P., Lambin, E. F., Erb, K. H., Hertel, T. W., & Haberl, H. (2013). Globalization of land use: Distant drivers of land change and geographic displacement of land use. Current Opinion in Environmental Sustainability, 5(5), 438-444.
[3] Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., ... & Helkowski, J. H. (2005). Global consequences of land use. Science, 309(5734), 570-574
[4] Harris, N. L., Brown, S., Hagen, S. C., Saatchi, S. S., Petrova, S., Salas, W., & Hansen, M. C. (2012). Baseline map of carbon emissions from deforestation in tropical regions. Science, 336(6088), 1573-1576
[5] Bruijnzeel, L. A. (2004). Hydrological functions of tropical forests: Not seeing the soil for the trees? Agriculture, Ecosystems & Environment, 104(1), 185-228.
[6] Chazdon, R. L., Peres, C. A., Dent, D., Sheil, D., Lugo, A. E., Lamb, D., ... & Miller, S. E. (2009). The potential for species conservation in tropical secondary forests. Conservation Biology, 23(6), 1406-1417.

02

ABOUT KOSOVO

Kosovo is in a favourable position within the Balkans and covers an area of **10,908 km².**

Its geographical coordinates range from 41° 51' 21" to 43° 16' in terms of longitude and from 19° 59' to 21° 47' in terms of latitude. The population of Kosovo is 1,771,604, residing in 38 municipalities and 1469 settlements.

The country shares a border of 743.5 km with four neighbouring countries.

The terrain of Kosovo is characterized by hills and mountains, with an average elevation of 810 m above sea level.

The lowest point is at 270 m, while the highest reaches 2656 m.

Two primary climates prevail in Kosovo: a continental climate in the Kosovo Plain and an Adriatic climate in the Dukagjin Plain.

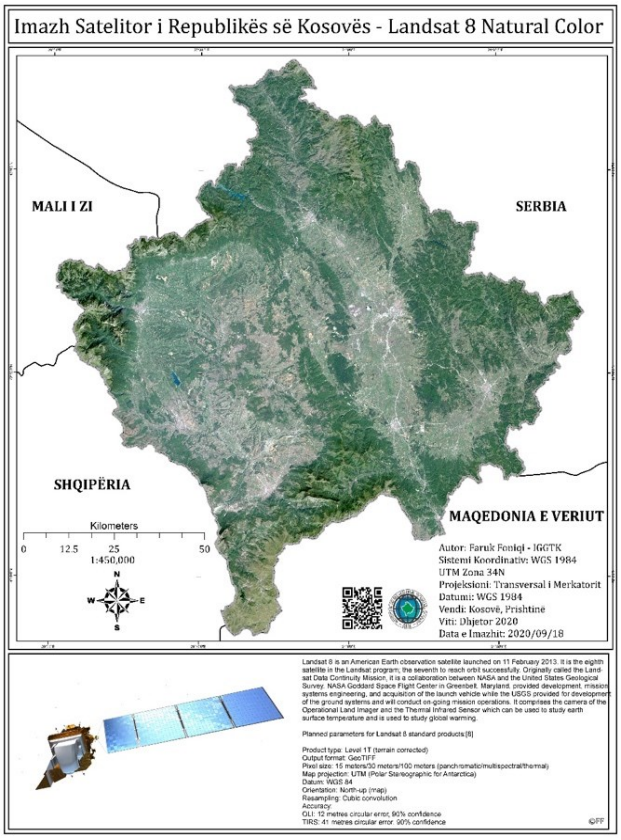


Fig.1.1 Satellite image of the Republic of Kosovo - Landsat 8

A territorial analysis conducted by Sustainability Leadership Kosova (SLK) in 2021 revealed that between 2000 and 2019, Kosovo experienced a significant loss of forests, amounting to more than **654 hectares per year**. To put it in perspective, this translates to approximately **3.5 football fields being lost each day**.

The deforestation trend observed in the past two decades is highly alarming, posing a threat to ecosystems and rendering habitats unsuitable for flora and fauna.

2.1 Geographic Overview of Kosovo: Relief, Climate, and Hydrography

Kosovo is characterized by diverse geographic features that shape its landscape and environment. This section provides an overview of the relief, climate, and hydrography of the Republic of Kosovo.

2.2 Relief

Fig.1.2 Morphological map of the Republic of Kosovo

The relief of Kosovo refers to the structure and external appearance of its landforms, including both fields and mountains. The region comprises the Kosovo Field, with elevations ranging from 510-570 meters, and the flatlands of Dukagjini, with elevations of 350-450 meters. The morphological aspect of the relief is characterized by a mosaic of different dimensions, with distinct mountainous and low-lying zones. The construction of the relief includes various geological formations, with 10% consisting of different rocks from the Paleozoic and Mesozoic eras. Additionally, the low-lying areas are dominated by sedimentary deposits from the Pliocene, including clay, sand, conglomerate, and some limestone.

The average altitude of Kosovo above sea level is 810 meters, with the lowest point at 270 meters and the highest peak being Gjeravica at 2,656 meters.

In terms of elevation distribution, surfaces below 300 meters cover only 16.4 square kilometers (0.2%), while elevations ranging from 300 to 1,000 meters span 8,754 square kilometers (80.7%).

Areas between 1,000 and 2,000 meters cover 1,872.3 square kilometers (17%), and elevations above 2,000 meters encompass 250.6 square kilometers (2.3%). The relief of Kosovo consists primarily of mountains (63%) and fields (37%).

2.3 Climate

Kosovo experiences a medium-continental climate with predominant influences from the Adriatic-Mediterranean climate in the Dukagjini Plain and the changed Adriatic-Aegean climate in the Kosovo Field. The average annual rainfall is 596 mm,

and the average annual temperature is around 10°C, with minimum temperatures reaching -27°C and maximum temperatures reaching 39°C.

The climate in Kosovo is influenced by various macrofactors, including its position relative to land masses (Eurasia and Africa), water masses (Atlantic Ocean and Mediterranean Sea), and air masses (tropical and Arctic-maritime or continental).

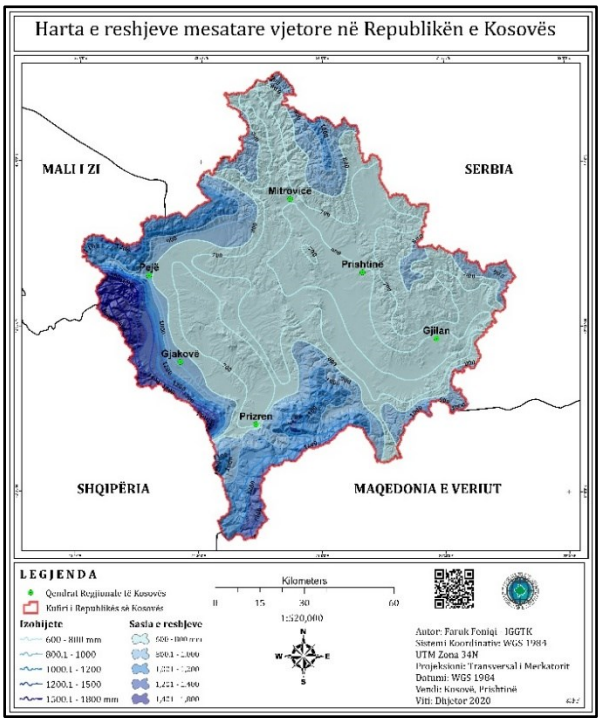


Fig.1.4 Map of average rainfall in the Republic of Kosovo

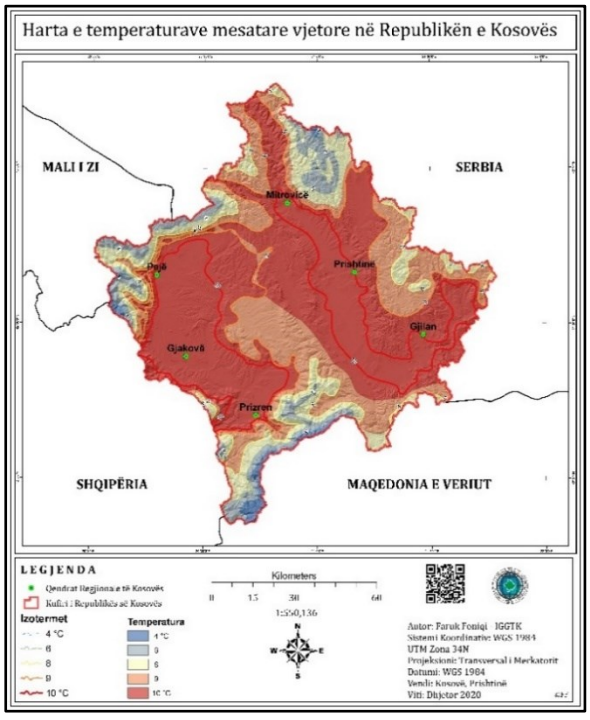


Fig.1.3 Map of average temperatures in the Republic of Kosovo

The position of baric systems, such as the maximum Azores and minimum Iceland, also affects the climate Additionally, local factors such as relief, water bodies, land cover, and vegetation play a significant role in shaping Kosovo's climate.

2.4 Hydrography

Kosovo faces challenges in terms of water resources, with limited reserves that may become a limiting factor for the country's economic and social development in the future. The estimated water availability in Kosovo is only 1600 m³ per capita. The country is divided into four river basins: the White River, Ibri, Morava of Binca, and Lepeneci.

The annual average water flow from Kosovo's territory is approximately 3.8 x 10^9 cubic meters, equivalent to 121.2 m³ per second. One of the main hydrological characteristics in Kosovo is the unequal and insufficient distribution of water resources compared to the demand. The potential for hydropower in Kosovo is limited, and its utilization has been modest thus far.

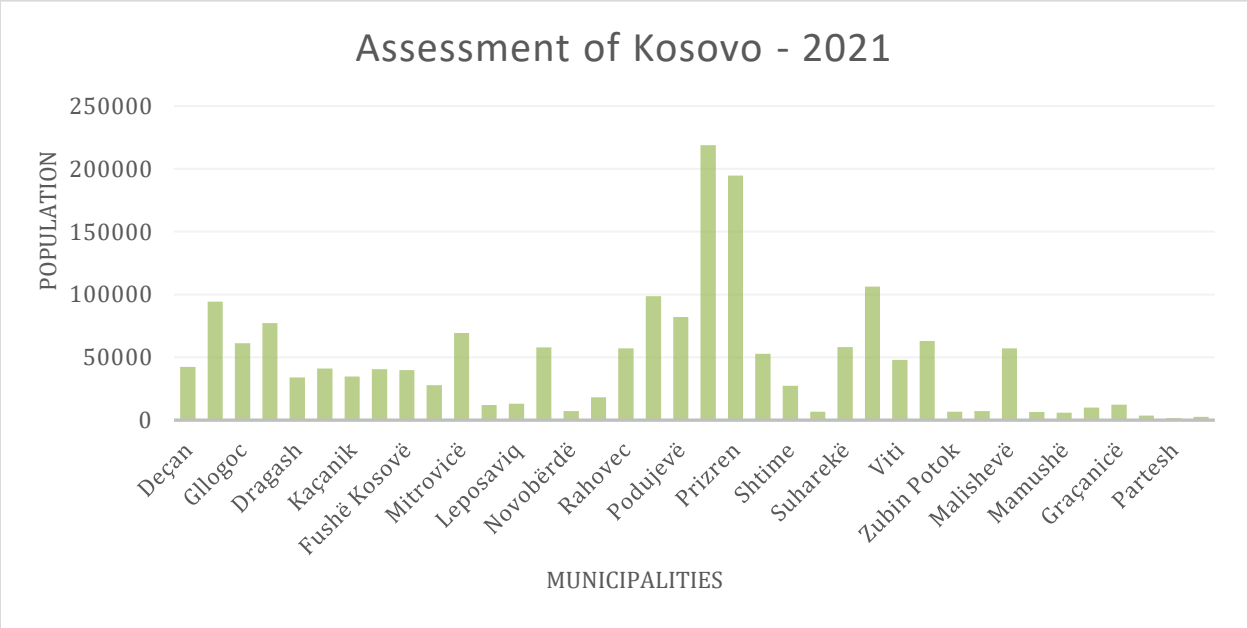
Fig.1.4 Map of average rainfall in the Republic of Kosovo

Underground water reserves are also limited, primarily concentrated in the western part of Kosovo, where they are more significant. The eastern and southeastern regions face significant water demand but have smaller reserves. Kosovo is home to several small natural lakes, including Batllava, Nsai, Radoniqi, Perlepnica, and Badovci, along with several artificial lakes used for irrigation purposes. Additionally, the thermal water sources in Kosovo hold importance for healing and recreational purposes. The preservation, defense, and sustainable development of water resources pose significant environmental challenges for Kosovo.

2.5 Population dynamics

According to the "Population Estimate for 2020," Kosovo had an estimated resident population of 1,798,186 at the end of 2020, which serves as the basis for estimating the population for 2021. In 2021, there were a total of 29,236 live births among residents of Kosovo, while the number of deaths reported was 14,845. It should be noted that births and deaths within the Serb community are not fully registered, particularly in municipalities in northern Kosovo, leading to under-registration. This report does not assess the extent of unreported cases. Additionally, a significant number of birth and death cases occurring outside Kosovo are registered as residents of Kosovo based on the current legislation, although they may not have been actual residents. The review of birth and death cases will be conducted after the Census.

Natural population growth resulted in an increase of 14,391 inhabitants in Kosovo's population in 2021.



According to data from the Ministry of Internal Affairs (MOI), municipalities, the United Nations High Commissioner for Refugees (UNHCR), the International Organization for Migration (IOM), and Eurostat database, the number of immigrants in Kosovo during 2021 was 4,122. This figure includes returnees/repatriates, asylum seekers who acquired citizenship, and individuals with residence permits lasting more than one year in Kosovo (including workers and students).

International migration, including legal and illegal immigrants, is estimated to have resulted in a total of 42,728 Kosovar immigrants in 2021. Most immigrants were legal immigrants, driven by factors such as family reunification, marriages, job opportunities, permanent relocation (primarily to neighbouring countries), and long-term studies with employment. Apart from EU and EFTA countries, a significant number of Kosovars have emigrated to other countries, particularly the US, Turkey, Canada, and various other destinations.

The international migration trend in 2021 was also influenced by the return of many migrants who had initially returned due to the COVID-19 pandemic in 2020, primarily from Croatia, Slovenia, Montenegro, Turkey, and other EU countries, followed by their subsequent emigration in 2021. The net international migration balance for Kosovo in 2021 was -38,606 inhabitants.

Furthermore, national migration within Kosovo occurred as a significant number of residents relocated from rural to urban and suburban settlements or due to marriages. It is estimated that 7,353 individuals changed their municipality of residence within Kosovo in 2021. Overall, while there was a natural population increase of 14,391 inhabitants.

03

DEFORESTATION IN KOSOVO

CAUSES, IMPACTS, AND CONSERVATION STRATEGIES

In the context of Kosovo, deforestation has emerged as a significant concern due to the rapid rate of forest loss observed in recent years. This literature review aims to provide an overview of existing research and studies related to deforestation in Kosovo, focusing on the causes, impacts, and potential conservation strategies.

3.1 Causes of Deforestation

Several factors contribute to deforestation in Kosovo. Studies have identified the expansion of agricultural land as a primary driver, with commercial and subsistence farming practices encroaching upon forested areas (Avdibegović et al., 2017).

Additionally, illegal logging, often driven by economic motives, has been identified as a significant cause of deforestation (Bytyqi et al., 2019).

Other factors include infrastructure development, urbanization, and the collection of firewood for energy purposes (Krasniqi et al., 2020).

Research indicates that socio-economic factors such as poverty, lack of alternative livelihood options, and weak governance also contribute to deforestation in Kosovo (Republic of Kosovo, 2019).

3.2 Impacts of Deforestation

The impacts of deforestation in Kosovo are wide-ranging and affect both the environment and human populations. Studies have shown that deforestation leads to loss of biodiversity, degradation of ecosystems, and increased vulnerability to climate change (Republic of Kosovo, 2019). Forests play a crucial role in carbon sequestration, and their destruction contributes to

greenhouse gas emissions (Ministry of Environment and Spatial Planning of Kosovo, 2018). The loss of forest cover also results in reduced water retention capacity, increased soil erosion, and altered microclimates (Avdibegović et al., 2017). Moreover, deforestation negatively impacts local communities by disrupting traditional livelihoods, reducing access to forest resources, and affecting cultural heritage (UNDP, 2019).

3.3 Conservation Strategies

Researchers and policymakers have proposed various conservation strategies to address deforestation in Kosovo. One approach is the strengthening of forest governance through the development and enforcement of regulations, improved monitoring systems, and increased penalties for illegal logging (Bytyqi et al., 2019). Creating protected areas and establishing community-based management systems have shown promise in preserving forests and involving local communities in conservation efforts (Ministry of Environment and Spatial Planning of Kosovo, 2018). Sustainable land use practices, such as agroforestry and reforestation programs, offer alternatives to destructive agricultural practices and help restore degraded lands (Avdibegović et al., 2017). Public awareness campaigns, education programs, and capacity building initiatives are also essential in promoting sustainable forest management practices and fostering a sense of environmental responsibility among the population (Republic of Kosovo, 2019).

International cooperation and collaboration with regional and global initiatives can provide additional support, resources, and funding opportunities for conservation efforts in Kosovo (UNDP, 2019).

04

RESEARCH METHODOLOGY

The analysis of deforestation in the Kosovo region incorporates various advanced technologies and field work activities to provide a comprehensive understanding of the phenomenon:

4.1 Remote Sensing

This technology plays a crucial role in this research, utilizing satellite and radar imagery from platforms such as Landsat 8[7], Landsat 9[8], Sentinel 2[9], and Sentinel 3[10]. These technologies are complemented by the integration of DJI Air 2S[11] drone technology for validation purposes.

Landsat 9, with its advanced features, significantly enhances the quality of field data by providing high-resolution radar images. This enables more accurate identification of areas experiencing changes in natural cover compared to conventional bands/layers. Additionally, the imagery from Sentinel 2 and Sentinel 3 satellites enhances the analysis by capturing comprehensive images of specific surfaces, particularly in the Anamorava region.
The utilization of specific bands/layers commonly employed in Remote Sensing science[12], such as categories 5, 7, and 8, further contributes to monitoring vegetative cover in space.

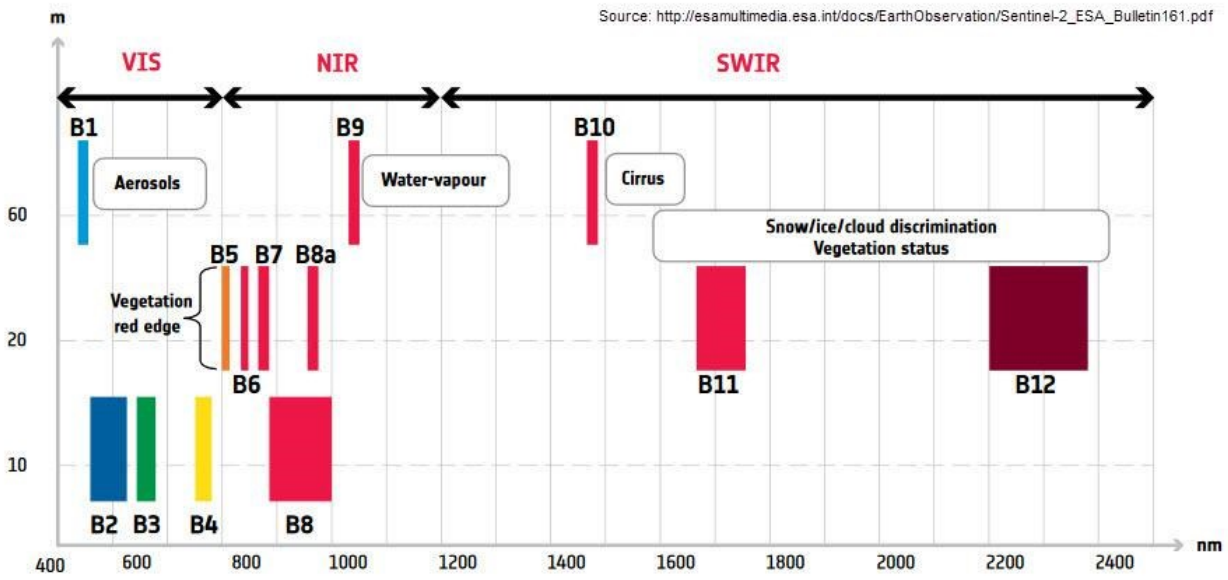
[7] Landsat 8 Official Website: https://landsat.gsfc.nasa.gov/landsat-8/
[8] Landsat 9 Official Website: https://landsat.gsfc.nasa.gov/landsat-9/
[9] European Space Agency (ESA) Sentinel-2 Mission Page: https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-2
[10] European Space Agency (ESA) Sentinel-3 Mission Page: https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-3
[11] DJI Air 2S The DJI Air 2S is a drone manufactured by DJI designed for aerial photography and videography, offering high-resolution imaging capabilities and advanced flight features. https://www.dji.com/air-2s
[12] Jensen, J. R. (2007). Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education, Inc.

The DJI Air 2S drone technology is utilized in conjunction with satellite and radar data analysis to precisely identify and test selected samples within the region. This multi-faceted approach, combining various technologies, ensures a comprehensive and robust analysis of deforestation in the Kosovo region.

4.2 Normalized Difference Vegetation Index (NDVI)[13],

This is a well-established index in scientific research, we employed it to identify areas of healthy vegetation in Kosovo.

The creation of a combined map displaying both NDVI[14] and deforestation data supports the analysis, revealing the expansion of deforestation hotspots towards regions characterized by good vegetative health.



↑ Spatial resolution versus wavelength: Sentinel-2's span of 13 spectral bands, from the visible and the near-infrared to the shortwave infrared at different spatial resolutions ranging from 10 to 60 m on the ground, takes land monitoring to an unprecedented level

[13] Tucker, C. J. (1979). Red and photographic infrared linear combinations for monitoring vegetation. Remote Sensing of Environment, 8(2), 127-150.

[14] Dr. Robert Rouse developed the NDVI formula, (NIR - Red) / (NIR + Red), which measures vegetation health by comparing near-infrared and red-light reflectance. The formula is widely used in remote sensing and provides valuable insights into vegetation density and health.

The calculation of NDVI involves utilizing specific bands from Landsat 8 imagery, namely band 4 (Near Infrared - NIR) and band 5 (Red). The index is determined using the formula: NDVI = (NIR - Red) / (NIR + Red).

This formula calculates the NDVI value by subtracting the Red value from the NIR value and dividing it by the sum of the NIR and Red values. Higher NDVI values typically indicate healthier vegetation, providing insights into the density and health of vegetation in the analyzed area.

4.3 Fieldwork

This work was crucial to validate and complement data obtained from remote sensing technologies and satellite imagery. It provided firsthand information, verified assumptions, identified challenges, and generated a more comprehensive dataset. Field work also allowed for a deeper understanding of the local context, socio-economic factors, and ecological dynamics influencing deforestation processes and their impacts. We have included tasks such as:

Site visits: Researchers have visited specific locations to observe and document the physical characteristics of the area, such as tree density, species composition, and evidence of deforestation.

Data collection: Field researchers have collect various types of data, such as measurements of affected areas and visual evidence.

Remote sensing: In the research we have used instruments like drones, satellite imagery, or other remote sensing technologies to capture images or data from above-ground, providing a broader perspective on deforestation patterns and changes over time.

Panel Discussions: During the phase 2 of *#MoseMerrMalin* campaign we have engaged in local dialogues and discussion with representatives of the public sector, civil society organisation and activists to understand insights, and information about local practices, policies, or drivers of deforestation.

Documentation and photography: We have documented these findings through photographs, videos, field notes, and other records to create a comprehensive record of the fieldwork and support further analysis and reporting.

4.4 Data Validation and Accuracy

To ensure he quality and reliability of the data, Sustainability Leadership Kosova (SLK) collaborated with CorrelAid Netherlands[15], a reputable organization specializing in data analysis and validation. The collaboration aimed to validate the extracted data obtained from the analysis conducted by SLK.

Once the initial analysis was completed, the data underwent a rigorous validation process. CorrelAid Netherlands provided a team of data scientists, environmental scientists, and artificial intelligence.

They reviewed the analysis results and assessed the accuracy and reliability of the data. Their expert team conducted an in-depth evaluation to verify the methodology, data sources, and analytical techniques employed by SLK.

Following the validation process, CorrelAid Netherlands confirmed that the analysis results had an impressive accuracy rate of over 95%. This validation provided reassurance regarding the credibility and accuracy of the data generated by SLK's analysis.

With the validation and confirmation from CorrelAid Netherlands, the data was deemed reliable and trustworthy. Subsequently, it was approved for publication on the widely recognized and respected portal #mosemerrmalin. The publication on this platform ensured that the findings and insights derived from SLK's analysis would reach a broader audience, including experts, policymakers, researchers, and the public.

It is important to note that the information provided in this section serves as a concise summary of the findings from SLK's analysis. It highlights the meticulous data collection process, the utilization of various techniques, and the validation procedures undertaken in collaboration with CorrelAid Nederland. This summary provides transparency and emphasizes the rigor applied in obtaining reliable and accurate data for the research.

[15] Correlaid Netherlands is a non-profit organization that applies data science for social good. They bridge the gap between data science expertise and organizations working towards social impact, empowering non-profits and public institutions with data-driven solutions.

05

KEY INFLUENCES ON DEFORESTATION IN KOSOVO

The analysis of deforestation in Kosovo between 2000 and 2022 reveals a concerning loss of forest cover.

The country has experienced a total deforestation of **15, 980 hectares** during this period, equivalent to a minimum of over **2 hectares per day,** with a maximum reaching **3.5 hectares**. The deforestation trend indicates a significant threat to the country's ecosystems and biodiversity.

The research findings highlight several key factors contributing to deforestation in Kosovo. These include:

Agricultural Expansion: The conversion of forested areas into agricultural land, particularly for crop cultivation and livestock grazing, is a major driver of deforestation. Increased demand for food production and economic activities related to agriculture have led to the clearing of forests.

Logging and Wood Extraction: Unregulated logging practices for timber and firewood extraction have contributed to deforestation. Illegal logging activities, driven by the demand for wood products, have had a detrimental impact on forest ecosystems.

Infrastructure Development: The expansion of infrastructure, including road construction, mining activities, and urbanization, has resulted in the clearance of forests. The need for improved transportation networks and urban areas has led to the loss of forested land.

Forest Fires: Forest fires, both natural and human-caused, have been responsible for significant forest loss in Kosovo. Factors such as climate change, drought conditions, and agricultural practices have increased the risk of forest fires.

Lack of Forest Management: Inadequate Forest management practices, including the absence of sustainable forestry plans, monitoring, and enforcement of regulations, have contributed to deforestation. The lack of effective governance and limited resources for forest protection have exacerbated the problem.

5.1 FAR-REACHING EFFECTS OF FOREST DEGRADATION IN KOSOVO

The consequences of deforestation in Kosovo are far-reaching and have significant environmental, social, and economic implications.
Some of the key impacts include:

Biodiversity Loss: Deforestation disrupts ecosystems and leads to the loss of habitat for numerous plant and animal species. The destruction of forests reduces biodiversity and can result in the extinction of vulnerable and endemic species.

Climate Change: Forests act as carbon sinks, absorbing and storing significant amounts of carbon dioxide. Deforestation releases stored carbon into the atmosphere, contributing to greenhouse gas emissions and exacerbating climate change.

Soil Erosion and Degradation: The removal of trees and vegetation destabilizes the soil, making it more susceptible to erosion. Deforested areas are prone to soil deg
radation, reduced fertility, and increased vulnerability to landslides.

Disruption of Water Cycles: Forests play a crucial role in regulating water cycles. Deforestation disrupts this natural process, leading to decreased water quality, reduced water availability, and increased risks of floods and droughts

Socio-economic Impacts: Deforestation can have adverse socio-economic effects, particularly on local communities dependent on forests for their livelihoods. Forest loss can result in the loss of traditional practices, food sources, and income-generating opportunities.

06

RESEARCH FINDINGS

6.1 Land Surface Coverage

Understanding the Land Surface Coverage[16] is important for a wide range of applications, including environmental monitoring, resource management, urban planning, climate modelling, and ecosystem assessments. It provides valuable information about the extent, distribution, and dynamics of different land cover types, which helps in assessing the impacts of human activities and natural processes on the environment (FAO, 2012).

Land surface coverage can be analysed and mapped using remote sensing techniques, satellite imagery, aerial photography, and ground-based surveys.
These methods provide data on the spatial extent, characteristics, and changes of land cover types, enabling comprehensive assessments of land use and land cover dynamics (Goward et al., 2018).

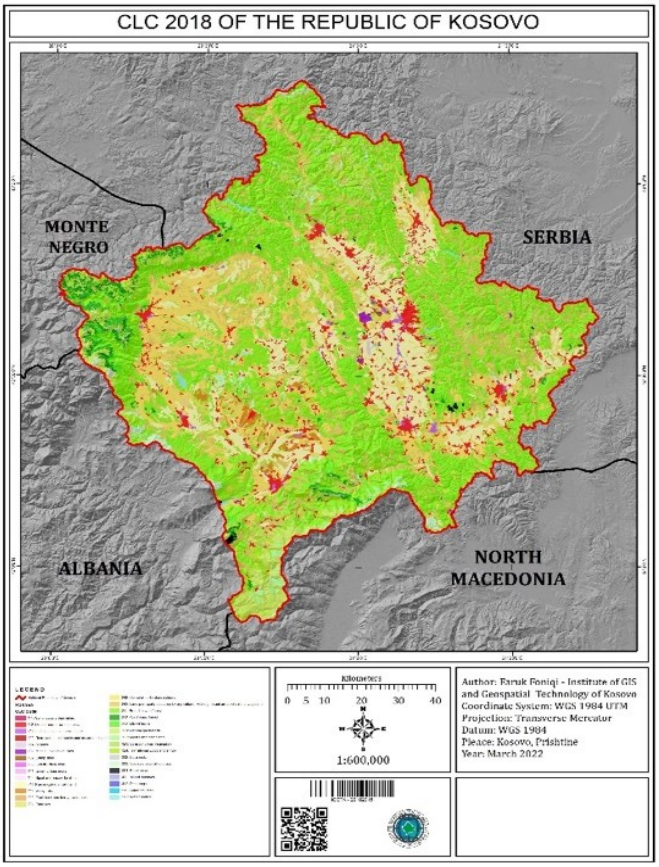


Fig. 2.1 Corine Land Cover Map

Mapping CLC changes is done by applying the *'firstmap change'* approach, meaning that changes are interpreted live, based on reference image comparison (2012 and 2018).
Visual comparison of satellite images (with vector data CLC2012 covered for spatial reference), is followed by direct determination of the changing polygons.

[16] Earth surface coverage refers to the composition and distribution of various features and land cover types on the Earth's surface. It encompasses the different land cover classes such as forests, croplands, grasslands, wetlands, urban areas, water bodies, and other natural and artificial land cover types.

Practically, if a change occurs in a CLC2012 polygon, it should be transferred to the CLC change database, where the altered part will be delined and kept as polygons.

Code_12	Land Cover	ha_18	Polygons	%
111	Urban structures	80.59	1	0.01
112	Non-continuous urban structure	42630.08	474	3.91
121	Industrial and commercial	4538.08	52	0.42
122	Road and rail network	536.29	13	0.05
124	Airports	458.04	2	0.04
131	Mineral Extraction Zone	1818.07	20	0.17
132	Waste Cluster Area	744.5	14	0.07
133	Construction sites	105.11	3	0.01
141	Green urban areas	39.11	1	0.00
142	Sports and recreational spaces	107.65	3	0.01
211	Arable land without water system	128932.57	203	11.82
221	Vineyards	6533.18	32	0.60
222	Fruit trees and shrubs	1177.88	15	0.11
231	Pastures	16669.88	206	1.53
242	Complex structures for cultivation	145875.04	423	13.38
243	Combined agricultural land and natural vegetation	116979.67	878	10.73
311	Deciduous Forest	400955.11	510	36.77
312	Coniferous Forest	20941.71	113	1.92
313	Mixed forests	11540.57	119	1.06
321	Natural meadowland	70527.44	376	6.47
322	Bushes and steppes	5167.38	17	0.47
323	Bare rock surfaces	3.61	6	0.00
324	Transitional area of forests and shrubs	91765.85	942	8.41
332	Bare rock surface	714.18	9	0.07
333	Vegetation-based fields	17567.09	138	1.61
334	Burned areas	1636.85	15	0.15
411	Swamps	95.22	2	0.01
412	Wetland (wet decomposed land)	36.13	1	0.00
511	Water flows	188.55	2	0.02
512	Water Bodies	2152.3	11	0.20
L	All	1090517.7	4601	100.00

7.2 Forest Loss Data and Analysis

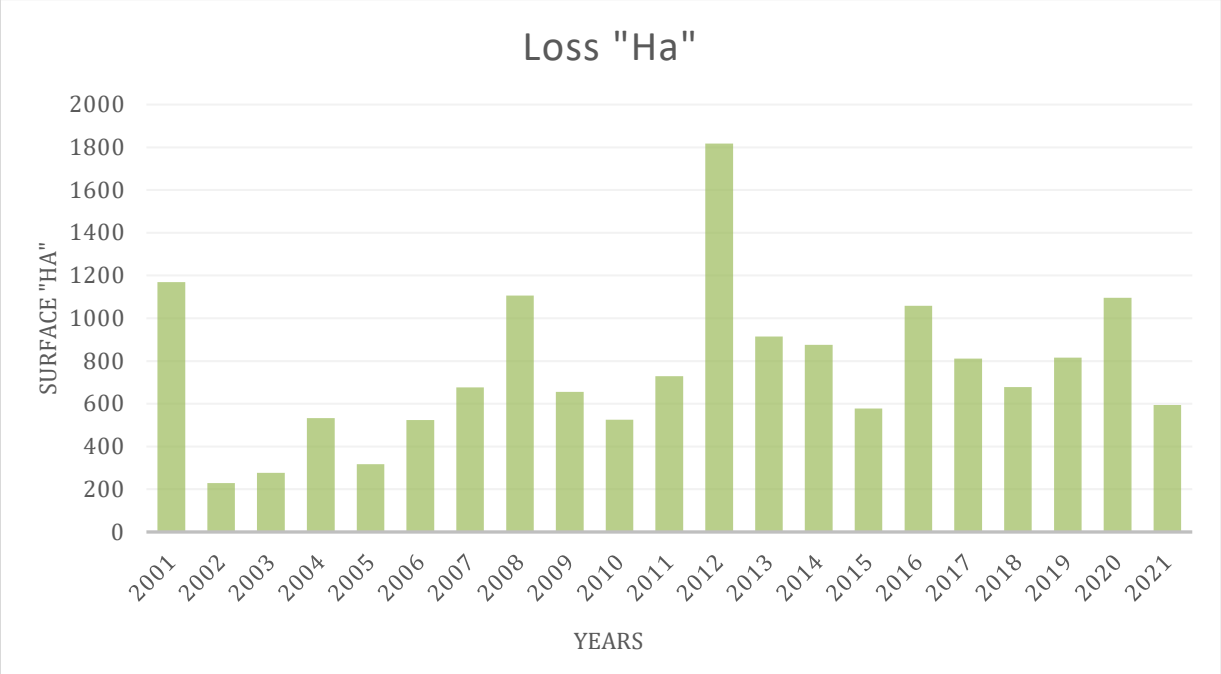
The analysis of forest loss data reveals significant patterns and trends over the studied period. The data provides insights into the extent of deforestation in terms of hectares (Ha) and the corresponding percentages relative to the total forest area.

Between 2001 and 2006, the forest loss remained relatively moderate, with annual figures ranging from 228.7 Ha to 524.28 Ha, accounting for 1.43% to 3.28% of the total forest area. However, a notable increase in deforestation occurred in 2007, with 675.97 Ha lost, representing 4.23% of the total forest area. This upward trend continued, reaching its peak in 2012, when an alarming 1817.74 Ha of forest was lost, constituting 11.38% of the total forest area. This particular year stands out as the most critical period of deforestation within the analysed timeframe.

The situation in 2012 was particularly concerning due to the combination of high deforestation levels and widespread forest fires. These fires exacerbated the extent of forest damage, intensifying the already distressing state of deforestation. The combined impact of deforestation and fires in 2012 had severe consequences for the region's ecosystems and biodiversity.

Subsequent years showed a noticeable decline in forest loss; however, the levels remained relatively high compared to earlier years. Between 2013 and 2021, the forest loss percentages ranged from 3.62% to 6.92%, with corresponding hectare values ranging from 578.2 Ha to 1106.32 Ha. Of note are the years 2008 and 2012, which stand out as having the highest rates of deforestation.

The data emphasizes the urgent need for comprehensive measures to mitigate deforestation and promote sustainable forest management practices. It highlights the importance of raising awareness about the significance of forests, implementing stricter regulations to combat illegal logging activities, and fostering initiatives that prioritize reforestation and ecosystem restoration. By adopting a proactive and holistic approach, it is possible to reverse the trend of forest loss and safeguard these critical ecosystems for the well-being of future generations.


Loss "Ha"
SURFACE "HA"
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
YEARS


Loss "%"
%
12
10
8
6
4
2
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
YEARS

7.3 Findings from Normalized Difference Vegetation Index (NDVI) for Kosovo

The presented map highlights different vegetation levels across the analyzed areas. Values ranging from < 0.015 to 0.18 indicate non-vegetated areas, including urban and rural regions, construction sites, wastelands, and road infrastructure. On the other hand, areas with values above 0.18 signify the presence of vegetation, such as shrubs and grasslands.

Within the range of 0.27 to 0.36, the map indicates rare vegetation with poor health. These areas are particularly vulnerable and exhibit the greatest impacts of deforestation, as observed from the analysis. It is alarming to note that even in the category above 0.36, where dense vegetation exists with normal vegetative health, these areas are constantly at risk of being cut down or deforested.

These analyses are presented to emphasize the significance of areas with healthy vegetation. Such areas play a crucial role in carbon sequestration, helping to mitigate climate change. Conversely, deforestation hotspots not only lose the ability to sequester carbon but also experience negative environmental consequences, including soil erosion, increased risk of forest fires due to the collection of wood materials, and the spread of diseases within forest ecosystems

Year	Forest loss "Ha"	Forrest loss "%"
2001	1169.40	**7.32**
2002	228.7	1.43
2003	276.55	1.73
2004	532.12	3.33
2005	317.8	1.99
2006	524.28	3.28
2007	675.97	4.23
2008	1106.32	6.92
2009	655.67	4.10
2010	525.59	3.29
2011	728.66	4.56
2012	1817.74	11.38
2013	914.49	5.72
2014	876.16	5.48
2015	578.2	3.62
2016	1058.63	6.62
2017	810.66	5.07
2018	678.06	4.24
2019	816.17	5.11
2020	1095.07	6.85
2021	593.81	3.72
Totali	**15980.05 ha**	**100.00**

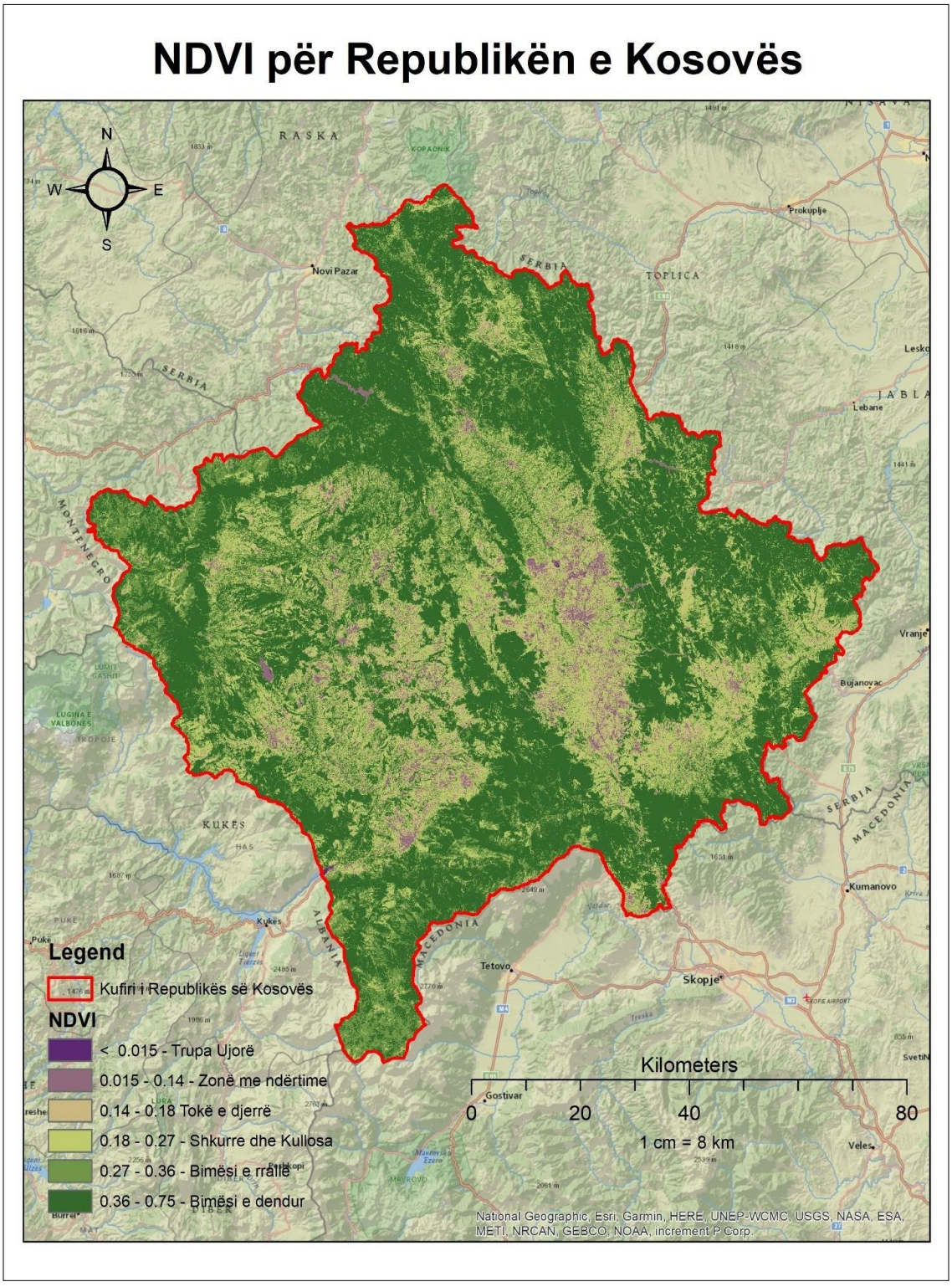


Fig. 2.2 Normalized Difference Vegetation Index - NDVI for the Republic of Kosovo

NDVI për Anamoravë

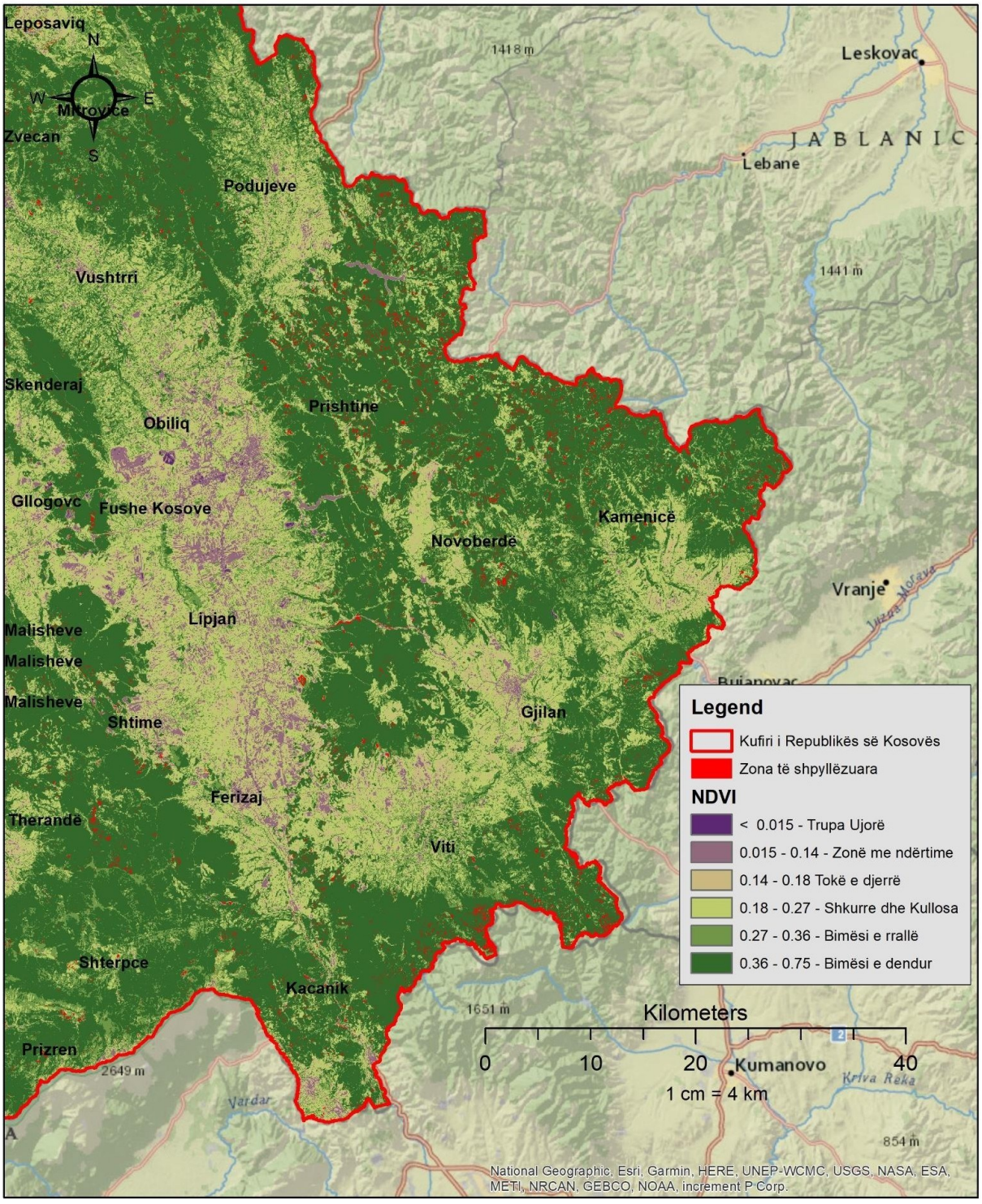


Fig. 2.3 Normalized Difference Vegetation Index - NDVI for the region of Anamorava

7.4 Deforestation Hotspots in Kosovo: Identifying Areas of Concern

Analysis of the data has revealed significant deforestation hotspots in Kosovo, particularly in the border areas of the Eastern Region. These hotspots encompass various regions, including the Karadaku Mountains in Viti, the Eastern Mountains of Kosovo in Kamenica and Pristina, and the Mountains of Gjakova and Junik, among others. These areas exhibit alarmingly high levels of deforestation, making them focal points for conservation and intervention efforts.

The accompanying map provides a visual representation of these deforestation hotspots, highlighting the areas that require immediate attention. By identifying and understanding these hotspots, stakeholders can focus their resources and initiatives on the regions most impacted by deforestation.

Efforts to address deforestation in these hotspots should include measures such as stricter regulations, increased enforcement against illegal logging activities, and the promotion of sustainable forestry practices.

Additionally, community engagement and awareness campaigns can play a crucial role in preserving these vulnerable ecosystems and protecting the biodiversity they harbour.

By targeting these hotspots and implementing targeted conservation strategies, it is possible to mitigate the detrimental effects of deforestation and work towards the restoration and sustainable management of Kosovo's forests.

Understanding these dynamics is essential for informed decision-making and effective conservation efforts.

By addressing deforestation hotspots, implementing sustainable forestry practices, and promoting the preservation of areas with healthy vegetation, it is possible to mitigate the adverse environmental impacts and foster a more sustainable future for the region.

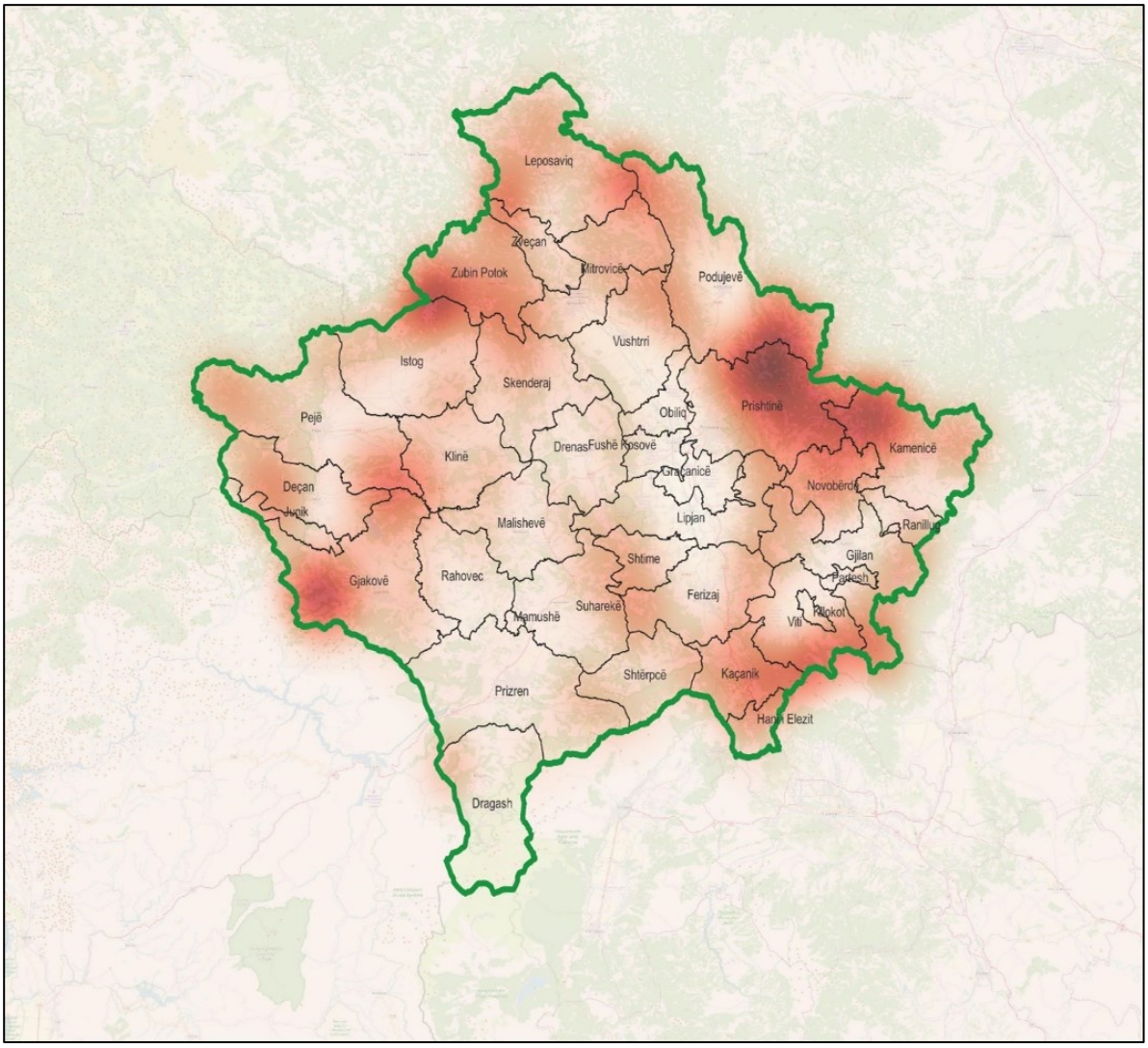


Fig. 3.1 Hotspot area of deforestation in Kosovo

7.5 Conclusive findings on deforestation in Kosovo

The comprehensive analysis conducted on deforestation in Kosovo has yielded alarming results, emphasizing the urgent need for action to protect and preserve the country's valuable forest resources.

The findings shed light on the gravity of the situation and provide a compelling case for immediate intervention:

Disturbing Trend: The data reveals a disturbing trend of increasing deforestation rates over the analyzed period. The cumulative total of deforested area during the period of **2000-2022** amounts to a staggering **159.8 square kilometers** (15,980 hectares). This relentless destruction of forests poses a significant threat to Kosovo's ecosystems, biodiversity, and the overall well-being of its people.

Critical Hotspots: Identifying the hotspots with high levels of deforestation is paramount to effective intervention. The analysis highlights the **Eastern Region** as a major concern, particularly the border areas encompassing the **Karadaku Mountains in Viti**, the **Eastern Mountains of Kosovo in Kamenica and Pristina**, and the **Mountains of Gjakova and Junik**. These regions demand immediate attention and targeted conservation efforts to curb further deforestation.

Environmental Consequences: The consequences of deforestation extend far beyond the loss of trees. It leads to biodiversity loss, disrupted water cycles, soil erosion, and increased vulnerability to climate change. The **implications for Kosovo's** environment are dire, impacting not only the natural habitats but also **exacerbating socio-economic challenges** faced by local communities dependent on forests

Call to Action: These conclusive findings serve as a resounding call to action. **Urgent measures** must be taken to **combat deforestation** and promote **sustainable forest** management practices. This requires the implementation of stricter regulations to curb

illegal logging, community engagement and awareness campaigns, and the allocation of adequate resources for forest protection and restoration.

Building a Sustainable Future: Preserving Kosovo's forests is crucial for long-term environmental sustainability and the well-being of future generations. By adopting a **proactive and holistic approach**, involving government agencies, local communities, and international partners, we can reverse the destructive trajectory and pave the way for a greener and more resilient future.

09

CONCLUSIONS

In conclusion, deforestation in Kosovo poses a critical environmental challenge that demands immediate action and collaborative efforts from all stakeholders.

The alarming loss of forest cover, averaging over 2 hectares per day between 2000 and 2022, has detrimental impacts on ecosystems, biodiversity, and the overall well-being of the country.

However, there is hope for combating deforestation and ensuring the preservation of Kosovo's natural resources.

To effectively address deforestation, a comprehensive approach is necessary. This approach should encompass a range of strategies:

- Strengthening forest governance, promoting sustainable agriculture and agroforestry, implementing reforestation and afforestation initiatives, raising public awareness, and fostering international cooperation. By implementing these measures, Kosovo can make significant strides in mitigating deforestation and protecting its forests for future generations.

- It is vital to develop and enforce policies and regulations that support sustainable forestry practices and combat illegal logging. This includes the establishment of protected areas and the implementation of monitoring mechanisms to ensure compliance. Additionally, promoting agroforestry and sustainable agricultural techniques can reduce the pressure on forests for agricultural expansion, offering alternative livelihood options while preserving forested areas

  .

- Reforestation and afforestation programs are essential to restore degraded forests and establish new ones. These initiatives should focus on planting native tree species, ensuring proper maintenance, and long-term protection. By restoring and expanding

forested areas, Kosovo can enhance ecosystem resilience, carbon sequestration, and biodiversity conservation.

- Public awareness and education play a crucial role in fostering a sense of environmental responsibility. By informing the general public, local communities, and stakeholders about the importance of forests and the consequences of deforestation, Kosovo can encourage sustainable practices and gain support for conservation efforts.

- International cooperation is also key to addressing deforestation. Collaborating with international organizations, neighbouring countries, and global initiatives focused on forest conservation can provide valuable resources, expertise, and funding opportunities. By sharing best practices, participating in regional efforts, and accessing international support, Kosovo can amplify its conservation efforts and make a more significant impact on deforestation.

10

RECOMMENDATIONS

1. ***Strengthen Monitoring and Enforcement*:** Enhance the monitoring mechanisms and enforcement of forestry regulations in the Anamorava region. This includes increasing the presence of forest guards, implementing surveillance technologies, and establishing stricter penalties for illegal logging activities.
2. ***Collaborative Approach*:** Foster cooperation between local institutions, central authorities, and relevant stakeholders to address deforestation effectively. Establish partnerships with environmental organizations, community groups, and law enforcement agencies to promote shared responsibility and collective action in combating illegal logging.
3. ***Reforestation and Sustainable Forest Management:*** Implement comprehensive reforestation programs and sustainable forest management practices in the affected areas. This involves replanting trees, promoting natural regeneration, and ensuring the long-term viability of forest ecosystems. Encourage community participation and raise awareness about the importance of sustainable forestry practices.
4. ***Capacity Building and Training:*** Provide training programs and capacity-building initiatives for forest managers, local communities, and relevant authorities. This will enhance their knowledge and skills in sustainable forest management, monitoring techniques, and the identification of illegal logging activities.
5. ***Strengthen Cross-Border Cooperation:*** Collaborate with neighbouring countries, particularly Serbia, to address the issue of illegal logging in border areas. Enhance information sharing, joint patrols, and coordinated efforts to prevent illegal timber trade and ensure the protection of forests across borders.
6. ***Public Awareness and Education:*** Conduct extensive public awareness campaigns to educate the local communities, stakeholders, and the general public about the

negative impacts of deforestation. Promote the value of forests, biodiversity conservation, and sustainable livelihoods linked to forest resources.

7. ***Policy Review and Development:*** Review existing forestry policies and regulations, ensuring they are comprehensive, enforceable, and in line with sustainable forest management principles. Develop robust legislation and regulations that address illegal logging, land use planning, and sustainable resource extraction.
8. ***Financial Incentives:*** Explore the possibility of providing financial incentives, subsidies, or grants to promote sustainable forest management practices, reforestation efforts, and the development of alternative livelihoods that do not rely on illegal logging.

In conclusion, while deforestation in Kosovo presents significant challenges, it also offers an opportunity for positive change. Through a multi-faceted approach that involves strong governance, sustainable land use practices, community engagement, and global cooperation, Kosovo can reverse the current trend of deforestation and ensure the protection and sustainability of its forests for generations to come. By preserving its natural resources, Kosovo can safeguard its ecosystems, mitigate climate change, protect biodiversity, and improve the well-being of its people.

SPECIAL GRATITUDE

On behalf of Sustainability Leadership Kosova (SLK), I would like to express our deepest gratitude and appreciation to **CreAct Participant** - for your invaluable contributions to the #MoseMerrMalin movement. Your dedication, expertise, and unwavering support have played a pivotal role in the successful execution of this impactful campaign.

To the **Community Development Fund and Human Rightivism Project**, we extend our sincere thanks for your commitment to tackling deforestation and for generously providing the much-needed financial support to the #MoseMerrMalin movement. Your contribution has been instrumental in driving our mission forward.

We would also like to express our gratitude to **Amazon LLC** for their generous donations. Your support has made it possible for us to acquire the necessary technology for efficient data processing, which has significantly contributed to our ability to manage and analyze data effectively.

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Lastly, a special note of appreciation goes to **Faruk Foniqi**. Your passion for research and dedication to making a meaningful impact in Kosovo have been truly inspiring. Your unwavering commitment and willingness to go above and beyond have been integral to the success of this research project.

To **the SLK team**, I want to express my heartfelt gratitude. Your collective contributions have been invaluable, and it has been an honor to work alongside such a talented and dedicated group of individuals. It is through your remarkable efforts and support that we have been able to make a significant difference in the fight against deforestation.

With heartfelt gratitude,

Indira Kartallozi

Executive Director

Sustainability Leadership Kosova

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APPENDIX

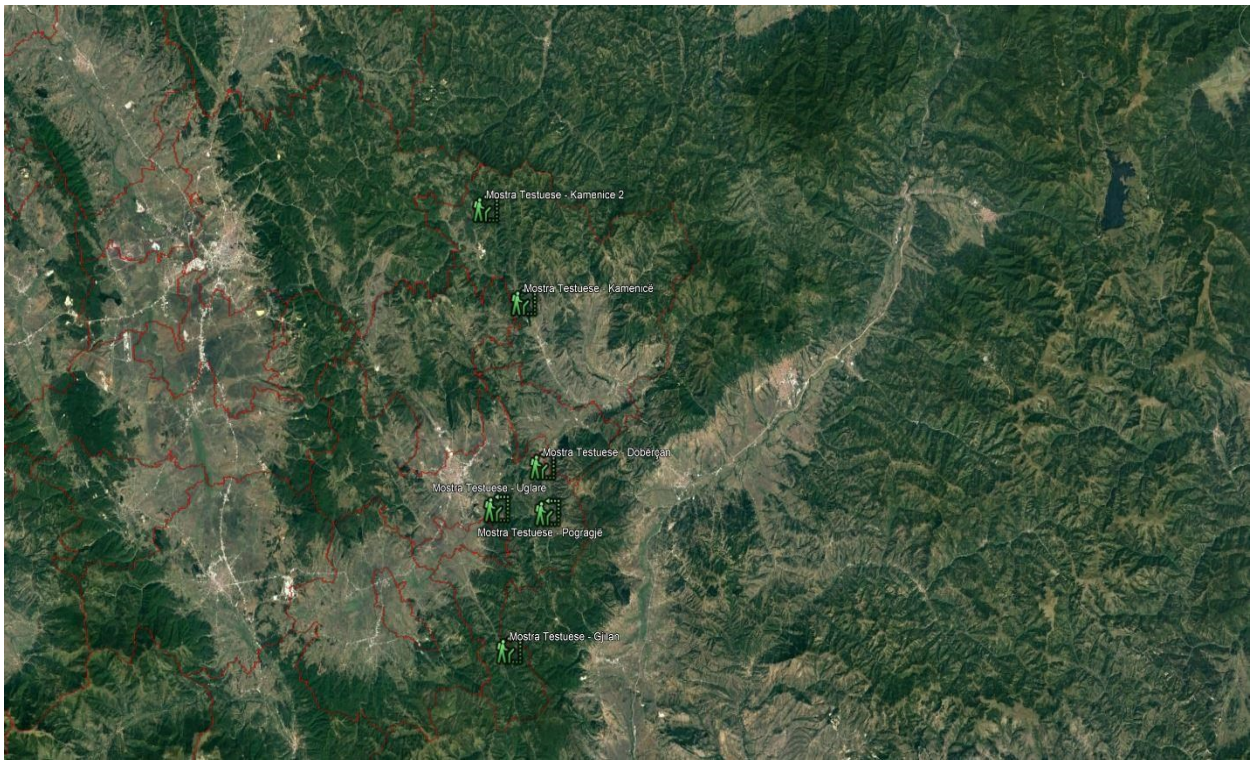

Photo 1

Photo 2

Photo 3

Photo 5

Verification of test samples (Karadak Mountains and Eastern Kosovo Mountains)

Photos from field work with drone on the test sample sites in Uglarë and Pogragja