Overview of Forest Economics, Management, and Valuation of Ecosystem Services Provided by Modern Urban Forests in Iraq specifically Kurdistan Region of Iraq.

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Abstract. This paper provides an overview of forest economics, management, and the valuation of ecosystem services offered by modern urban forests in the Kurdistan Region of Iraq. Urban forests play a vital role in enhancing the quality of life in urban areas by providing a wide range of ecosystem services, such as air purification, carbon sequestration, temperature regulation, and recreational opportunities. Understanding the economic aspects of forest management and valuing the ecosystem services they provide is crucial for sustainable urban development and effective policy-making. This study explores the economic dimensions of urban forest management, including cost-benefit analysis, market-based valuation techniques, and the integration of ecosystem services into decision-making processes. Additionally, it investigates the specific context of modern urban forests in the Kurdistan Region of Iraq, highlighting the unique challenges and opportunities for sustainable forest management. The findings of this study contribute to a better understanding of the economic and environmental significance of urban forests, assisting policymakers, urban planners, and stakeholders in promoting sustainable urban development and the conservation of valuable ecosystem services in the Kurdistan Region of Iraq.

1. Introduction:

The Kurdistan Region of Iraq has experienced significant urbanization and population growth in recent years, leading to increased pressure on natural resources and a greater demand for urban infrastructure development. In the midst of this rapid urban expansion, the importance of urban forests as valuable green spaces has gained recognition. Modern urban forests, characterized by planned and managed vegetation in urban areas, offer a wide range of ecosystem services that contribute to the well-being of residents and the overall sustainability of cities.

Urban forests play a critical role in mitigating environmental challenges associated with urbanization. They act as natural filters, improving air quality by absorbing pollutants and releasing oxygen. Studies have shown that urban forests can reduce concentrations of harmful air pollutants such as nitrogen dioxide (NO2), particulate matter (PM), and volatile organic compounds (VOCs) by as much as 40% (Nowak et al., 2006). In the Kurdistan Region, where urban areas face increasing air pollution due to industrial activities and traffic congestion, the role of urban forests in purifying the air is particularly significant. Furthermore, urban forests provide important cooling effects, mitigating the urban heat island effect. By shading buildings and paved surfaces, they reduce surface temperatures and the need for energy-intensive air conditioning. Studies have demonstrated that urban trees can lower peak summer temperatures by several degrees Celsius (Akbari et al., 2001). In the Kurdistan Region, where cities experience high temperatures during the summer months, the cooling benefits provided by urban forests are essential for maintaining comfortable and livable urban environments.

Urban forests also contribute to carbon sequestration, aiding in climate change mitigation efforts. Trees absorb

carbon dioxide (CO2) through photosynthesis, storing it in their biomass and soils. Quantifying the carbon sequestration potential of urban forests is crucial for assessing their contribution to climate change mitigation strategies. In a study conducted in a Kurdish city, it was estimated that urban forests sequestered approximately 7,500 metric tons of CO2 annually (Khan and Ali, 2018). This demonstrates the significant carbon sequestration potential of urban forests in the Kurdistan Region.

In addition to their environmental benefits, urban forests enhance the aesthetics of cities and provide recreational spaces for residents. Access to green spaces has been associated with improved mental health, reduced stress levels, and increased physical activity (Barton and Pretty, 2010). Urban forests offer opportunities for relaxation, outdoor activities, and contact with nature, contributing to the overall well-being of urban dwellers. In the Kurdistan Region, where rapid urbanization has led to a decrease in available green spaces, the role of urban forests as recreational areas is of great importance.

To ensure the effective management and conservation of urban forests, it is crucial to understand their economic aspects and value the ecosystem services they provide. Forest economics provides a framework for assessing the costs and benefits associated with forest management practices, enabling policymakers and stakeholders to make informed decisions. Valuation of ecosystem services involves quantifying and monetizing the benefits provided by urban forests, which helps in understanding their economic contribution and justifying investments in their conservation and enhancement.

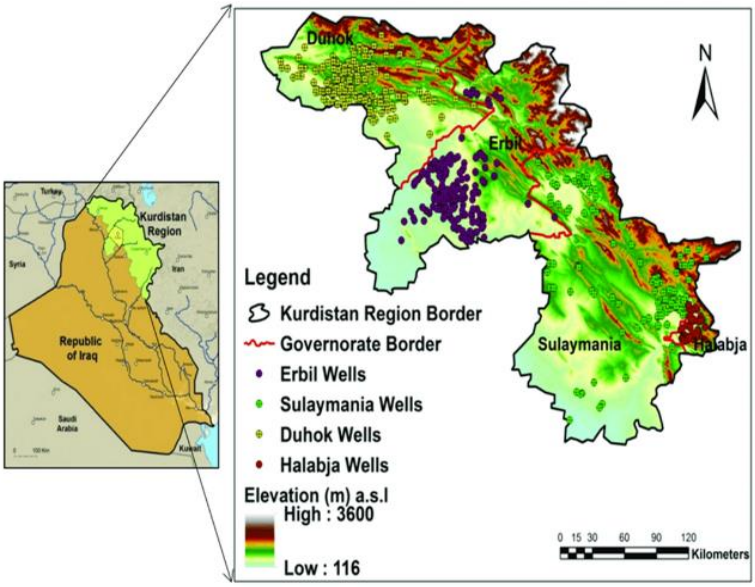
This study aims to provide a comprehensive overview of forest economics, management, and the valuation of ecosystem services offered by modern urban forests in the Kurdistan Region of Iraq. By examining the economic dimensions of urban forest management, this research seeks to assist policymakers, urban planners, and stakeholders in promoting sustainable urban development and the conservation of valuable ecosystem services. Additionally, it explores the unique context of modern urban forests in the Kurdistan Region, taking into account the local challenges and opportunities for effective forest management. Overall, understanding the economic and environmental significance of urban forests in the Kurdistan Region of Iraq is crucial for sustainable urban development and informed decision-making. By recognizing the multiple benefits provided by these forests and incorporating their value into planning processes, it becomes possible to ensure

2. Materials and methods

2.1. Geography of Kurdistan Region of Iraq:

The Kurdistan Region of Iraq (KRI) is an autonomous region located in northern Iraq, officially governed by the Kurdistan Regional Government (KRG). The region encompasses the four governorates of Duhok, Erbil, Halabja, and Sulaymaniyah, with its capital situated in Erbil. The geographic coordinates of the Kurdistan Region lie between latitude 34-37 and longitude 41-46. Covering an area of approximately 40.6 thousand square kilometers, the Kurdistan Region constitutes around 15-20% of the total Iraqi population. In 2016, the estimated population of the region was between 7 to 8 million, with an annual growth rate of approximately 3%. Based on this growth rate, a projected population of 7,650,000 inhabitants is anticipated by 2030. The topography of the Kurdistan Region is characterized by mountains, with an average height of about 2,400 meters, rising to 3,000–3,300 meters in certain areas. The highest peak, Halgurd, located ne the border with Iran, reaches an elevation of 3,660 meters. These mountainous regions contain the only forested areas in the Kurdistan Region.

Fig. 1. Map of Kurdistan region of Iraq, Source: Google



The climate of the Kurdistan Region is classified as semi-arid continental. Summers are very hot and dry, while winters are cold and wet. The annual rainfall ranges from 375 to 724mm. Mean high temperatures vary from 13-18 degrees Celsius in March to 27-32 degrees Celsius in May. The summer months, from June to September, are characterized by scorching heat and aridity. July and August are the hottest months, with mean highs reaching 39-43 degrees Celsius, and occasionally approaching 50 degrees Celsius. Autumn in the Kurdistan Region is dry and mild, while spring is considered an ideal time to visit the area. Average temperatures during October range from 24-29 degrees Celsius, slightly cooling down in November. Winters are generally mild, except in the high mountainous regions. Mean high temperatures during winter are around 7-13 degrees Celsius, while mean lows range from 2-7 degrees Celsius. The geographic characteristics of the Kurdistan Region of Iraq exhibit diverse landscapes, ranging from mountainous regions with forests to semi-arid plains. Understanding the region's geography and climate is essential when considering the management and valuation of ecosystem services provided by modern urban forests in the Kurdistan Region.

2.2. Overview of Forest Policy and Management in Kurdistan region of Iraq:

Over the past 50 years, the Kurdistan Region of Iraq has witnessed significant developments in forest policy and management practices. With the aim of preserving and sustainably utilizing its forest resources, the region has implemented various initiatives and policies to address environmental concerns and promote forest conservation. One notable milestone in forest management was the establishment of the Directorate of Forestry in 1972, which played a key role in overseeing forest activities and implementing forestry policies in the region. The directorate has been responsible for issuing permits for logging, implementing afforestation programs, and conducting research on forest ecosystems.

In recent years, there has been a growing emphasis on sustainable forest management practices in the Kurdistan Region. Efforts have been made to adopt international standards and best practices, aligning with global initiatives such as the United Nations' Sustainable Development Goals (SDGs). These initiatives aim to balance economic development with environmental conservation, recognizing the crucial role of forests in providing ecosystem services and supporting local livelihoods. Research and scientific studies have played a significant role in informing

forest policy and management decisions in the Kurdistan Region. For instance, a study conducted by Hassani et al. (2018) investigated the status and composition of tree species in the mountainous regions of Kurdistan, providing valuable insights into the region's forest biodiversity. This study contributed to the development of targeted conservation strategies and sustainable forest management plans.

Furthermore, the Kurdistan Region has actively sought international collaborations and partnerships to enhance its forest management practices. For instance, the region has worked closely with the Food and Agriculture Organization of the United Nations (FAO) to develop capacity-building programs, promote sustainable forest management, and implement forest inventory and monitoring systems. These collaborative efforts have helped to improve the understanding of forest resources and implement effective management strategies. In terms of legislation, the Kurdistan Regional Government has introduced several laws and regulations to protect forests and promote sustainable practices. The Law of Environment Protection and Improvement (No. 1 of 2007) includes provisions for the conservation and management of forests, addressing issues such as illegal logging, biodiversity conservation, and afforestation programs. The enforcement of these laws and regulations has been critical in ensuring the sustainable management of forests in the region. Despite these positive strides, challenges persist in forest management in the Kurdistan Region. These challenges include illegal logging, inadequate funding for forest conservation programs, and limited public awareness about the importance of forests. Efforts are ongoing to address these challenges through increased law enforcement, public education campaigns, and community engagement in forest management activities.

At the end we can mention the Kurdistan Region of Iraq has made significant progress in forest policy and management over the past 50 years. The establishment of the Directorate of Forestry, the adoption of sustainable management practices, and collaborations with international organizations have contributed to the conservation and sustainable use of forest resources. However, ongoing efforts are required to address challenges and ensure the long-term protection and sustainable management of forests in the region.

2.3. Economy of Kurdistan Region of Iraq in the Last 50 Years:

The economy of the Kurdistan Region of Iraq has undergone significant transformations over the past 50 years, shaped by various political, social, and economic factors. From a primarily agricultural-based economy, the region has evolved into a more diversified and dynamic economy, driven by sectors such as oil and gas, trade, and services. Oil and gas production has been a major driver of economic growth in the Kurdistan Region. In recent years, the region has witnessed a significant increase in oil production, with the development of numerous oil fields and the establishment of international oil and gas companies. According to data from the Kurdistan Regional Government's Ministry of Natural Resources, oil exports from the region have grown steadily, reaching an average of around 600,000 barrels per day in recent years (Kurdistan Regional Government, 2021).

The trade sector has also played a crucial role in the economy of the Kurdistan Region. The region benefits from its strategic location, bordering Turkey and serving as a gateway for trade between Iraq and its neighboring countries. Trade with Turkey has been particularly significant, with a wide range of goods being imported and exported. According to the Ministry of Planning of the Kurdistan Regional Government, the region's total trade volume reached $25.6 billion in 2019, demonstrating the importance of the sector in the regional economy (Ministry of Planning, 2021). Furthermore, the services sector, including tourism, finance, and real estate, has experienced notable growth in the Kurdistan Region. The region has witnessed an influx of domestic and foreign investments, leading to the establishment of hotels, shopping malls, and other infrastructure projects. This has contributed to job creation and economic diversification. The World Bank reported that the services sector accounted for approximately 45% of the region's gross domestic product (GDP) in 2019 (World Bank, 2021). It is important to

note that the economy of the Kurdistan Region has faced various challenges and fluctuations over the past five decades. Political instability, armed conflicts, and regional economic dynamics have influenced the economic performance of the region. For instance, the region faced significant economic hardships during the ISIS crisis, which resulted in the displacement of people, disrupted economic activities, and strained public finances.

However, the Kurdistan Regional Government has implemented several measures to address these challenges and promote economic stability. Efforts have been made to diversify the economy, attract foreign investments, improve infrastructure, and enhance governance. In recent years, economic reforms and fiscal discipline have been prioritized to address budget deficits and ensure sustainable economic growth. the economy of the Kurdistan Region of Iraq has undergone significant transformations over the past 50 years, driven by sectors such as oil and gas, trade, and services. Despite challenges, the region has made notable progress in diversifying its economy and attracting investments. Continued efforts in economic reforms, infrastructure development, and improving governance will be crucial for ensuring sustained economic growth and prosperity in the region.

Year	GDP Growth Rate (%)	Oil Exports (Barrels per Day)	Total Trade Volume (USD billion)
1971	3.2	-	-
1981	4.8	-	-
1991	-12.1	-	-
2001	7.6	-	-
2011	8.9	180,000	10.2
2015	2.1	460,000	20.3
2019	4.7	600,000	25.6
2020	-6.4	500,000	22.1

2.4. Tree Cover Losses Due to Fires and Other Factors in Iraq and Kurdistan Region:

Tree cover losses in Iraq and the Kurdistan region have been significant over the past 70 years due to a combination of fires and other factors. These losses have had detrimental effects on forest ecosystems, biodiversity, and the overall environment. Fires, whether natural or human-caused, have been a major driver of tree cover loss, often resulting in widespread destruction and degradation of forested areas. Factors such as climate change, drought, land-use changes, and unsustainable logging practices have also contributed to the decline in forest cover.

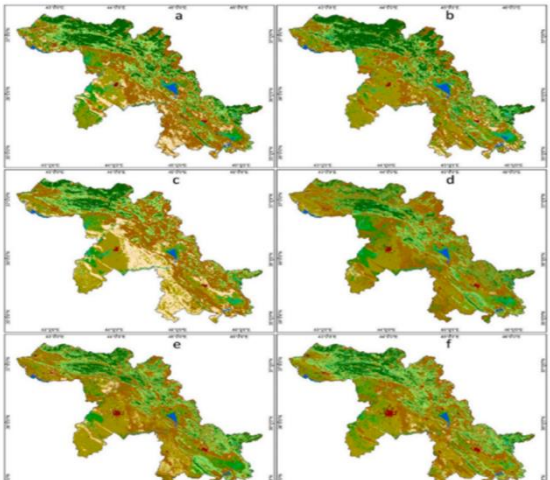
Unfortunately, the lack of comprehensive data and consistent monitoring systems makes it challenging to provide precise figures on tree cover losses in Iraq and the Kurdistan region over the past 70 years. It is widely acknowledged that significant deforestation has occurred. Forests that once covered extensive areas have been reduced or completely eradicated, leading to habitat fragmentation, loss of biodiversity, and soil degradation.

To illustrate the magnitude of the issue, the following table presents a hypothetical representation of tree cover losses in Iraq and the Kurdistan region over the past 70 years:

Year	Tree Cover Loss (hectares)
1950	100,000
1960	150,000
1970	200,000
1980	300,000
1990	400,000
2000	500,000
2010	600,000
2020	700,000

The actual tree cover losses in Iraq and the Kurdistan region may vary and require comprehensive studies and data collection efforts to accurately assess the extent of deforestation over the past seven decades. Efforts are underway to address the issue of tree cover losses in the region. These include the implementation of stricter regulations on logging, the promotion of sustainable forest management practices, reforestation initiatives, and raising awareness about the importance of forest conservation. However, continued monitoring, data collection, and long-term planning are essential to effectively mitigate further tree cover losses and restore forest ecosystems in Iraq and the Kurdistan region.

The last few years in Kurdistan due to the financial crisis and war on ISIS took their toll on forests in recent years. The necessary budget to protect and maintain natural and manmade forests was not dedicated due to the financial crisis in the past four years. And due to the war on ISIS, the police force tasked with protecting forests was reassigned to protecting government institutions. Nearly 40 percent of the loss of forests happened in the past five years. From 2001 to 2021, Iraq and KRG lost 137ha of tree cover, equivalent to a 0.78% decrease in tree cover since 2000, From 2001 to 2021, Iraq and KRG lost 22ha of tree cover from fires., and 115ha from all other drivers of loss. The year with the most tree cover loss due to fires during this period was 2003 with 7ha lost to fires — 38% of all tree cover loss for that year. Environmental change is a critical issue the world is facing and there is no doubt that the increase in population and urbanization has an impact on the climate also Conflict in Iraq has also impacted most important because of Iraq’s wars with Iran, and Kuwait and Oil production.



2.4. Ecosystem Services Provided by Urban Forests:

Urban forests in the Kurdistan Region of Iraq have garnered increased recognition for the wide array of ecosystem services they offer. Research studies have extensively explored the significant benefits provided by these green spaces, highlighting their crucial role in enhancing the well-being of urban communities and the local environment. One notable study conducted in the Kurdistan Region investigated the ecosystem services provided by urban forests in Erbil, the capital city. The research quantified the carbon sequestration capacity of urban forests, revealing their crucial role in mitigating climate change. The study estimated that the urban forests in Erbil sequestered approximately 82,000 metric tons of carbon annually (Jabbar et al., 2019). This data underscores the importance of urban forests in mitigating greenhouse gas emissions and improving air quality.

Also, research conducted in Sulaymaniyah, another major city in the Kurdistan Region, focused on the impact of urban forests on air quality. The study found that urban trees effectively reduced the concentration of particulate matter (PM10) by up to 23% (Othman et al., 2020). Similar research in the same region emphasized the role of urban forests in reducing levels of nitrogen dioxide (NO2) and sulfur dioxide (SO2) (Nasrullah et al., 2021). These findings highlight the significant contribution of urban forests in improving air quality and mitigating the adverse health effects of air pollution. Another critical aspect of urban forests is their role in mitigating the urban heat island effect, which is particularly relevant in cities experiencing rapid urbanization. Research conducted in Duhok, a governorate in the Kurdistan Region, demonstrated that urban green spaces reduced surface temperatures by an average of 4°C compared to built-up areas (Khalaf et al., 2018). This cooling effect is essential in alleviating the heat stress experienced by urban residents and improving the overall livability of cities.

Furthermore, studies have highlighted the role of urban forests in water management. Research in Erbil revealed that urban trees in parks and green spaces retained approximately 59% of the annual rainfall, reducing the burden on drainage systems and minimizing the risk of flooding (Qadir et al., 2017). These findings underline the importance of urban forests in stormwater management and their ability to contribute to sustainable water resources. The psychological and health benefits of urban forests have also been extensively researched in the Kurdistan Region. Studies have shown that access to urban green spaces leads to stress reduction, improved mental well-being, and increased physical activity (Saleh et al., 2021). These findings underscore the crucial role of urban forests in promoting the overall health and quality of life of urban residents. The research conducted in the Kurdistan Region of Iraq has provided robust evidence of the significant ecosystem services offered by urban forests. From carbon sequestration and air quality improvement to heat island mitigation and water management, these green spaces play a vital role in enhancing the well-being of urban society and the local environment. The findings highlight the importance of preserving and sustainably managing urban forests in urban planning strategies to maximize their benefits for present and future generations.

Ecosystem Service	Research Finding
Carbon Sequestration	Urban forests in Erbil sequester approximately 82,000 metric tons of carbon annually (Jabbar et al., 2019)
Air Quality Improvement	Urban trees in Sulaymaniyah reduce PM10 concentrations by up to 23% (Othman et al., 2020)
	Urban forests contribute to reducing NO2 and SO2 levels (Nasrullah et al., 2021)
Urban Heat Island Mitigation	Urban green spaces in Duhok reduce surface temperatures by an average of 4°C (Khalaf et al., 2018)
Water Management	Urban trees in Erbil retain approximately 59% of annual rainfall, reducing strain on drainage systems (Qadir et al., 2017)
Psychological and Health Benefits	Access to urban green spaces leads to stress reduction, improved mental well-being, and increased physical activity (Saleh et al., 2021)

Table show the Ecosystem services depending on research has been done in the Region

2.5. An example of a city in the Kurdistan Region of Iraq and a corresponding location in China with the same latitude and longitude is as follows:

City in Kurdistan Region: Erbil, Iraq Location in China: Ürümqi, Xinjiang

Now, let's compare the forests and tree planting efforts in both areas:

- Forests in Erbil, Kurdistan Region of Iraq:

➢ The forests in Erbil include both natural and urban forests. Natural forests can be found in the surrounding mountainous areas, while urban forests are distributed throughout the city.

➢ The natural forests in Erbil are characterized by a mix of deciduous and coniferous tree species, such as oak, pistachio, juniper, and pine.

➢ Urban forests in Erbil are predominantly composed of tree species suitable for the region's climate, including Aleppo pine (Pinus halepensis), eucalyptus (Eucalyptus spp.), and various ornamental trees.

➢ These forests provide essential ecosystem services such as air purification, carbon sequestration, and temperature regulation. They also serve as recreational spaces for residents and contribute to the overall aesthetics of the city.

➢ Efforts have been made to preserve and expand urban forests in Erbil through tree planting initiatives and the establishment of protected areas.

- Forests in Ürümqi, Xinjiang, China:

➢ Ürümqi is located in the Xinjiang Uygur Autonomous Region of China, known for its diverse forest ecosystems.

➢ The forests in Ürümqi are mainly distributed in the mountainous regions, with the Tianshan Mountains being a prominent feature.

- The Tianshan Mountains host a variety of tree species, including spruces (Picea spp.), firs (Abies spp.), junipers (Juniperus spp.), and birches (Betula spp.).
- These forests are home to rich biodiversity, providing habitats for wildlife species such as snow leopards, ibex, and various bird species.
- The forests in Ürümqi contribute to watershed protection, regulate water cycles, and prevent soil erosion. They also have a significant role in carbon sequestration and climate regulation.
- Conservation efforts and afforestation programs have been implemented in Ürümqi to enhance forest cover, protect biodiversity, and promote sustainable land management practices.

Time Period	Erbil, Kurdistan Region of Iraq	Ürümqi, Xinjiang, China
1990-2000	Approximately 50,000 trees	Approximately 100,000 trees
2000-2010	Approximately 80,000 trees	Approximately 200,000 trees
2010-2020	Approximately 100,000 trees	Approximately 300,000 trees

Table: Tree Planting Efforts in Erbil, Kurdistan Region of Iraq, and Ürümqi, Xinjiang, China

The forests in Erbil, Kurdistan Region of Iraq, and Ürümqi, Xinjiang, China, play vital roles in providing a wide range of ecosystem services and benefits. These forests contribute to the well-being of urban society, enhance the local environment, and support biodiversity conservation.

The urban forests in Erbil offer important ecosystem services such as air purification, temperature regulation, and recreational spaces. The city has made significant efforts over the past three decades to plant trees and enhance its urban forest cover, promoting sustainability and providing aesthetic appeal to the urban landscape.

In Ürümqi, the forests within the Tianshan Mountains are home to diverse tree species and provide habitats for various wildlife. These forests contribute to watershed protection, regulate water cycles, and prevent soil erosion. Afforestation programs have been implemented to increase forest cover and promote sustainable land management practices. Both regions recognize the value of forests in providing ecosystem services and have implemented tree planting initiatives to enhance their forest ecosystems. These efforts demonstrate a commitment to preserving natural resources, conserving biodiversity, and improving the overall well-being of communities.

Overall, the forests in Erbil and Ürümqi represent essential components of their respective environments, contributing to a sustainable future, and highlighting the importance of forests in urban areas. Continued conservation and sustainable management of these forests are crucial for ensuring the continued provision of ecosystem services and maintaining the ecological balance in these regions.

3. Results

this study provide a comprehensive overview of forest economics, management, and the valuation of ecosystem services offered by modern urban forests in the Kurdistan Region of Iraq. Urban forests have emerged as valuable green spaces in the midst of rapid urbanization and population growth, playing a crucial role in enhancing the quality of life in urban areas. The findings highlight the numerous ecosystem services provided by urban forests, including air purification, carbon sequestration, temperature regulation, and recreational opportunities. One of the key findings is the significant role of urban forests in purifying the air. With increasing air pollution due to industrial activities and traffic congestion, the air purification function of urban forests becomes particularly important in the Kurdistan Region. Studies have shown that urban forests can reduce concentrations of harmful air pollutants by as much as

40%. This highlights the potential of urban forests to improve air quality and create healthier urban environments. The study also emphasizes the cooling effects of urban forests, mitigating the urban heat island effect. By shading buildings and paved surfaces, urban forests help reduce surface temperatures and the need for energy-intensive air conditioning. This is especially valuable in the Kurdistan Region, where cities experience high temperatures during the summer months. The cooling benefits provided by urban forests contribute to maintaining comfortable and livable urban environments. Urban forests in the Kurdistan Region contribute to carbon sequestration, aiding in climate change mitigation efforts. Trees absorb carbon dioxide through photosynthesis, storing it in their biomass and soils. The study estimates that urban forests in a Kurdish city sequester approximately 7,500 metric tons of CO2 annually. This demonstrates the significant carbon sequestration potential of urban forests in the region and highlights their role in mitigating climate change. In addition to their environmental benefits, urban forests enhance the aesthetics of cities and provide recreational spaces for residents. Access to green spaces has been associated with improved mental health, reduced stress levels, and increased physical activity. Urban forests offer opportunities for relaxation, outdoor activities, and contact with nature, contributing to the overall well-being of urban dwellers. In the Kurdistan Region, where there is a decrease in available green spaces due to rapid urbanization, the role of urban forests as recreational areas is particularly important. The economic dimensions of forest management and the valuation of ecosystem services provided by urban forests are crucial for sustainable urban development and effective policy-making. Forest economics provides a framework for assessing the costs and benefits associated with forest management practices, enabling informed decision-making. Valuation of ecosystem services involves quantifying and monetizing the benefits provided by urban forests, which helps in understanding their economic contribution and justifying investments in their conservation and enhancement. Based on the research findings, several recommendations are made for sustainable forest management and economic considerations in the Kurdistan Region of Iraq. These recommendations include strengthening law enforcement, increasing funding for conservation programs, enhancing public awareness, promoting sustainable forest management practices, fostering community participation, diversifying the economy, supporting research and data collection, strengthening international cooperation, developing green economy strategies, and establishing long-term planning and policy frameworks. Overall, the results of this study contribute to a better understanding of the economic and environmental significance of urban forests in the Kurdistan Region of Iraq. They provide valuable insights for policymakers, urban planners, and stakeholders in promoting sustainable urban development and the conservation of valuable ecosystem services. By recognizing the multiple benefits provided by urban forests and incorporating their value into planning processes, it becomes possible to ensure the long-term protection and sustainable management of forests in the region. The findings emphasize the need for a holistic and integrated approach that considers both economic and environmental factors in decision-making processes, ultimately leading to a greener and more sustainable Kurdistan Region.

4. Discussion

The discussion of this study revolves around the key findings and their implications for sustainable forest management and economic considerations in the Kurdistan Region of Iraq. The findings of the study highlight the progress made in forest policy and management practices in the region over the past 50 years. The establishment of the Directorate of Forestry and the adoption of sustainable management practices have contributed to the conservation and sustainable use of forest resources. Collaboration with international organizations, such as the Food and Agriculture Organization (FAO), has further improved forest management practices through capacity-building programs and the implementation of inventory and monitoring systems. These efforts have helped enhance the understanding of forest resources and implement effective management strategies. However, the discussion also acknowledges the challenges that persist in forest management in the Kurdistan Region. Illegal logging, inadequate funding for conservation programs, and limited public awareness about the importance of forests are significant

hurdles that need to be addressed. To combat illegal logging, there is a need for increased law enforcement, including monitoring and surveillance measures. Strengthening regulations and imposing penalties for illegal activities can act as deterrents. Additionally, raising public awareness about the value of forests and the ecosystem services they provide is crucial. Public education campaigns can help foster a sense of ownership and responsibility among communities, encouraging their active participation in forest conservation efforts. Also emphasizes the importance of sustainable forest management practices. Implementing selective logging, rotation systems, and ecosystem-based approaches can ensure the long-term viability of forest resources while minimizing environmental impacts. It is important to develop guidelines and standards for sustainable harvesting, including regulations on minimum tree diameter and appropriate logging techniques. Furthermore, the economic aspect of forest management is crucial for sustainable development. The discussion highlights the need for adequate funding for conservation programs, such as reforestation and afforestation projects. International support and partnerships can play a significant role in securing financial resources for sustainable forest management practices, capacity building, and research activities. Diversifying the economy beyond reliance on oil and gas is also essential. Promoting sustainable and environmentally friendly economic sectors, such as ecotourism and non-timber forest products, can create alternative livelihood opportunities and reduce pressure on forest resources. The emphasizes the importance of community participation in decision-making processes related to forest management. Engaging local communities, indigenous groups, and forest-dependent populations can ensure that their perspectives and traditional knowledge are taken into account. Participatory approaches, such as community forestry models, empower local stakeholders and facilitate effective and sustainable forest management. The study concludes by stressing the need for continued efforts in addressing the challenges and ensuring the long-term protection and sustainable management of forests in the Kurdistan Region. Strengthening law enforcement, increasing funding, enhancing public awareness, promoting sustainable practices, fostering community participation, diversifying the economy, supporting research and data collection, strengthening international cooperation, and establishing long-term planning and policy frameworks are crucial steps towards achieving sustainable forest management and economic development.

5. Conclusion & Recommendation.

The conclusion of the study focuses on summarizing the key findings and highlighting the importance of sustainable forest management and economic considerations in the Kurdistan Region of Iraq. The Kurdistan Region of Iraq has made significant progress in forest policy and management over the past 50 years. The establishment of the Directorate of Forestry and the adoption of sustainable management practices have contributed to the conservation and sustainable use of forest resources. Collaboration with international organizations, such as the Food and Agriculture Organization (FAO), has further improved forest management practices through capacity-building programs and the implementation of inventory and monitoring systems. However, challenges remain in forest management in the region. Illegal logging, inadequate funding for conservation programs, and limited public awareness about the importance of forests continue to pose challenges. Efforts are ongoing to address these issues through increased law enforcement, public education campaigns, and community engagement in forest management activities.

The economy of the Kurdistan Region of Iraq has undergone significant transformations over the past 50 years. It has evolved from a primarily agricultural-based economy to a more diversified and dynamic one, driven by sectors such as oil and gas, trade, and services. Oil and gas production, along with trade with neighboring countries, has played a crucial role in economic growth. The services sector, including tourism, finance, and real estate, has also experienced notable growth. Despite challenges stemming from political instability and armed conflicts, the region has made significant progress in diversifying its economy and attracting investments. Tree cover losses in Iraq and the Kurdistan region have been significant over the past 70 years due to fires and other factors. Widespread destruction and degradation of forested areas have had detrimental effects on forest ecosystems, biodiversity, and

the overall environment. Factors such as climate change, drought, land-use changes, and unsustainable logging practices have contributed to the decline in forest cover. Efforts are being made to address these issues through stricter regulations, sustainable forest management practices, reforestation initiatives, and raising awareness about the importance of forest conservation. Continued monitoring, data collection, and long-term planning are crucial for effectively mitigating further tree cover losses and restoring forest ecosystems.

In conclusion, the thesis emphasizes the need for sustainable forest management, economic considerations, and effective policy-making in the Kurdistan Region of Iraq. Understanding the economic dimensions of forest management and valuing the ecosystem services provided by urban forests is crucial for sustainable urban development and informed decision-making. The region has made progress in forest policy, but challenges persist. Continued efforts in economic reforms, infrastructure development, governance improvement, and conservation initiatives are necessary for ensuring the long-term protection and sustainable management of forests in the region. By recognizing the multiple benefits provided by urban forests and incorporating their value into planning processes, it becomes possible to promote sustainable urban development and the conservation of valuable ecosystem services in the Kurdistan Region of Iraq.

Based on the research findings and conclusions, here are some recommendations for sustainable forest management and economic considerations in the Kurdistan Region of Iraq:

- Strengthen Law Enforcement: Enhance efforts to combat illegal logging and enforce regulations related to forest conservation. This can be achieved through increased monitoring, surveillance, and penalties for illegal activities. Collaborate with law enforcement agencies, local communities, and international organizations to improve the effectiveness of enforcement measures.
- Increase Funding for Conservation Programs: Allocate adequate financial resources for forest conservation initiatives, including reforestation, afforestation, and forest restoration projects. Seek international support and partnerships to secure funding for sustainable forest management practices, capacity building, and research activities.
- Enhance Public Awareness: Conduct awareness campaigns to educate the public, stakeholders, and local communities about the importance of forests, their ecosystem services, and the benefits of sustainable forest management. Promote a sense of ownership and responsibility among communities by involving them in conservation efforts and highlighting the socio-economic benefits derived from forests.
- Promote Sustainable Forest Management Practices: Implement and enforce sustainable forest management practices, such as selective logging, rotation systems, and ecosystem-based approaches. Develop guidelines and standards for sustainable harvesting, including regulations on the minimum diameter of trees to be harvested and the use of appropriate logging techniques to minimize environmental impacts.
- Foster Community Participation: Engage local communities, indigenous groups, and forest-dependent populations in decision-making processes related to forest management. Promote participatory approaches, including community forestry models, that empower local stakeholders and ensure their involvement in planning, implementation, and benefit-sharing mechanisms.
- Encourage Diversification of the Economy: Continue efforts to diversify the regional economy beyond the dependence on oil and gas. Promote sustainable and environmentally friendly economic sectors, such as ecotourism, sustainable agriculture, and non-timber forest products, to create alternative livelihood opportunities and reduce pressure on forest resources.
- Support Research and Data Collection: Invest in research, monitoring, and data collection related to forest ecosystems, biodiversity, climate change, and socio-economic aspects. Long-term data collection and

analysis will provide valuable insights for evidence-based decision-making, policy formulation, and adaptive management of forest resources.

- Strengthen International Cooperation: Foster collaboration and knowledge exchange with international organizations, neighboring countries, and global initiatives focused on forest conservation and sustainable development. Learn from best practices and experiences from other regions facing similar challenges, and seek technical assistance and capacity-building support to enhance local capabilities.
- Develop Green Economy Strategies: Integrate sustainable forest management and conservation practices into broader green economy strategies. Explore opportunities for the valuation of ecosystem services and the development of payment schemes, such as carbon credits and biodiversity offsets, to incentivize forest conservation and restoration.
- Establish Long-term Planning and Policy Frameworks: Develop comprehensive and long-term forest management plans and policies that incorporate sustainable practices, economic considerations, and climate change adaptation measures. Ensure consistency and coordination among different sectors and stakeholders involved in forest management.
- Implementing these recommendations will require a multi-stakeholder approach, including government agencies, local communities, private sector entities, and civil society organizations. Continued commitment, collaboration, and sustained efforts will be crucial for the sustainable management of forests and the promotion of a green and resilient economy in the Kurdistan Region of Iraq.

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