Hungarian University of Agriculture and Life Sciences

A Comprehensive Approach for Forest Fires Restoration and its implementation in the Spatial Decision Support Systems

Ph.D. Dissertation

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I. Introduction

The total forest area covers 31% of the world's land area, just over 4 billion hectares; It is estimated that 25% of the world's land area is degraded. Over the past 30 years, forest restoration has seen significant growth globally, along with an increase in research publications since the 1980s, but a notable increase in interest in the topic after 2008 is linked to the influence of the First World Congress. For the Environmental Society(Stanturf and Mansourian, 2020).The past decade also witnessed a clear increase in the frequency of forest fires that caused great losses and the number of fires reached 2011-2018 with areas exceeding 25 hectares, and the total burned areas reached 103 thousand out of 525 thousand Hectares" according to the European Fire Center"(Alzuabi, 2020). This demonstrates that variables related to climate change and those that are exclusive to natural or human causes, or both, have caused a notable increase in forest fire events in recent decades (Alayan, 2022). Fires are a serious environmental disaster in regions of the world, resulting in significant environmental and socio-economic losses. It causes total or partial damage to large areas of these forests, and also leads to soil erosion as well as a decrease in groundwater levels (Leberger *et al.*, 2020).Therefore, forest restoration is indispensable for maintaining the ecological integrity of forests and for sustainability. The results of studies also reveal the scarcity of information in the field of forest restoration after fires in an integrated, balanced and comprehensive manner(Barros *et al.*, 2018). There was no single methodology or unified protocol that guides post-fire forest restoration and combines post-fire forest restoration projects, and most studies dealt with one aspect or criterion of restoration criteria. This means inadequacy or failure in designing strategies or forest restoration plans within an integrated framework to meet requirements or goals in the medium or long term. Forest restoration is more than just planting trees. It restores entire landscapes to meet current and future needs, provide multiple benefits and land uses over time, restore ecological functions, and enhance human well-being, especially in areas cleared or degraded by fire (Leberger et al., 2020).

As far as we are aware, this is the first study of its kind that examines post-fire forest restoration within an integrated framework. It does this by examining the most recent advancements in the field of forest restoration through a review of earlier research published over the previous 22 years, which raises awareness of resource management issues and restoration. nature, forest fires, climate change, finding gaps in scientific knowledge, and bringing these issues to the attention of the country. In order to create a generic framework that can be used to any study on forest restoration following fires, it is also critical to broaden the geographic scope of these studies and develop a comprehensive framework. No matter what kind of forest it is, where it is, why it was established, and how intense and dense the fire is that it is exposed to. Due to the necessity of updating and renewing the management techniques for strategies pertaining to forest fire restoration, planning and decision-making objectives should incorporate environmental, economic, social, cultural, scientific, political, and legal restoration criteria that can be adjusted to suit local conditions (Alayan, 2022).

Over the past ten years, the effects of wildfires on the environment, the economy, and society as a whole have gotten worse. This has resulted in a number of large, expensive fires that have a detrimental effect on wildlife habitat, recreation, tourism, water quality, supply, and values in addition to destroying forest and grassland vegetation. The entire site is designed to resemble a forest. But these effects—like the expenses of restoration, the changed habitat of species, and the expenses of tourism revenue(Kabil et al., 2022), or impacts on human health, are important components of risk assessment and management of wildfires for which direct, indirect, and long-term post-fire losses can range from 10 to 50 times (or more) the costs of suppression. Therefore, it is necessary to analyze more comprehensive economic risk and awareness of the cost of wildfires for decision makers and the public to undertake land and property management reforms (Zheng, Liwinski and Elinav, 2020).

The study of the damage caused to life due to forest fires is two-fold: theoretical and applied, and this in turn requires extensive study and careful analysis of how to calculate biodiversity values (Stanturf and Mansourian, 2020).

The forest fire is also considered one of the main factors for the ecological system that affects the biological, chemical and physical characteristics nutritional development by erosion, and the elimination of the total stability of the soil, its pollution, and the increase in the phenomenon of it With the increase in degradation and the destruction of the living niches in the soil, it also plays a decisive role in the process of feeding the nutrients, as a call to the mission, isolated the carbon, and supporting the growth of plants that is considered a natural resource that is not renewed on the human life domain of the time. Fasting it and a slow phase. It was also noted that the forest with heat lifelines of 300 degrees led to the destruction of the soil resistance, and the fires of losing in the vital lashes and organic layers, resulting in addition to adding the nourishing ash to the soil surface. This in turn increases the degree of entity and affects a large way on the chemical and biotical properties of soil as well as the destruction of the structure and the support of the spaces due to the ash and the sinks of the affected clay, to the side of the elevation of organic materials which leads to increasing the many. The phenomenon of soil likewise, in the following, the information related to changes that acquire the properties of the soil after the nurture is an open to the extension of sustainable management processing practices and a capacity to rely to restore the different environmental systems of the soil that has been subjected to persecution of understanding (Agbeshie *et al.*, 2022). After dangerous releasing, the soil is more generally to be exhausted, especially on dry recipients, as the dries that followed the freshness of the plant. The shabby can be reduced, which is provided through the dead wooden elements of the harsh conditions, and consequently reduce the hypothesis of humidity, instead of that, the environmental system can change as each, including the lower layers of the soil, through the process of burning with the effect and the impact directly and indirectly on the dust seeds, or any additional change can be necessary to renew the regeneration(Marcolin *et al.*, 2019).

Therefore, the preparedness of resettlement must be aimed at alleviating the soil on the new merits and the areas of the river, and the loss of sensitization types, and the threats related to the assets of the forests on the principles of human health, and they must aim to increase the connection between the other parts (Prescott *et al.*, 2020).

Usually after one year of the fire, the repetition of types decreases in a large way in the high and medium-risk areas, compared to the subordinate gaps, which is a common thing in the turbulent regions (Fuentes-Ramirez *et al.*, 2022)**,** Variable to a large number of time with time since Fire, with so many variants that don't show any cover in several categories. The average rate of the cover of the forests, the rocks, and the organic materials usually decreases, and this is likely to be more resistant toward severe facilities and its ability to live in the incredible regions with intensity while these disgraceful types may pre fire the successful establishment of the sequences (Budiharta *et al.*, 2016). The highest levels of competition will face the fear of the leak after Forest fires. The availability of nitrogen decreases with time due to the different operations, such as nomination and nurture. This decrease is greater in areas affected by high-severity fires. In contrast, the availability of phosphorus and potassium increases after a fire, depending on the severity of the fire. The availability of nutrients also increases after the inception in the areas affected by the risk of the food products resulting from the burning of the plants(Fuentes-Ramirez *et al.*, 2022). Also, the local climate conditions of the soil have an important relationship of the places where the primary circumstances are unacceptable to agriculture, and success can be increased through preparations, such as the expulsion of the non - intended plants. Such as gas weeds, the exploitation of the soil, or the implementation of low-cost procedures such as the manufacturing wages to prefer and access to seeds with implementation and monitoring to enhance the success of the resetting project with reducing costs through the definition of decorations, disadvantages, and the specificity of the site of the practices different, as it is possible

to be shared for more suitable and adapting projects for every context. In addition, the deterioration of the internal, environmental and social elements is also useful for the development of the prohibitions (Mesa-Sierra *et al.,* 2022).

Forests have been considered an important source of income in terms of distribution. They create opportunities that can also be created at the national level or through the primary market. Forests are considered essential to the well-being of hundreds of millions of people, especially those groups that depend on the forest as their only source of monetary income. Recently, forests have become widely recognized as homes of cultures. International interest in the appreciation of traditional cultures and their knowledge of nature has contributed to the conservation of forest systems and increased attention to the needs of forest-dwelling communities as a matter of national interest. Forests are also considered a repository of biodiversity and carbon sequestration. Due to this great complexity, policy makers face the greatest challenge of reconciling the role of forests in combining national needs with global environmental goals, as well as social and economic interests(Stanturf and Mansourian, 2020).

A forest inventory may focus on identifying vegetation, habitat types and age classes depending on management objectives. A spatial database needs to be developed and regularly updated to store and use spatial data (maps and attribute data per hectare). Management also needs to have legislative jurisdiction specially for the protected areas to keep biodiversity conservation, or some other political cases. Among the factors that encourage spatial planning of forests are regulations and voluntary guidelines for harvest units and wildlife habitat patterns. Furthermore, any biotic, social or ecological variable in forest ecosystems needs to be predicted in multi-ecosystem prediction. This is key to simulating landscape structure over time and to generating models capable of solving multi-objective management planning problems (Baskent *et al.,* 2020).

The natural resetting in large fires is also dependent on the regeneration through seeds and the remaining tree, which was exposed to a lesser harm, as well as difficulty for the purpose, if it is not impossible, predicting the effect of the releasing to renew after it. However, it is generally admitted that all forests have a capacity for the regeneration after the fire. Despite the fact that the response depends on the capacity of types of the free and its intensity, the reducing of the fuels, and how they are isolated . Forest fires can also affect the abundance of forest insects through tree-caused mortality, and the destruction of the principles, on the contrary, the trees that were wrapped or weakened due to the munitions may provide an ideal environment to spread the insects. The expense is required to be a continuous effort, including implementing of the regulations. In general, the purpose of the industrial resetting is preferred interest and use of normal resetting the intensity in the burning areas to benefit from the ability of the nature on self-restoration(Ahn *et al.*, 2014).or treating corridors and restoring access roads, removing or placing steel nets, terraces, walls that contain rocks and even dams building (Tessler *et al.*, 2019).

Also, the operations of vital processes and root processing affect the structure of the bacterial societies in the soil, including inner and external bacteria (Pizarro-Tobías *et al.*, 2015),and these treatments are based on the improvement of the soil quality criteria due the vital of the alive niches, of the original and their additional development of the vegetation. The roots are also improved by the environmental system, which speeds its natural capacity on the return to the case before the elementary quarrel as well as the ability of plants to survive of in the soil in the use of environmental systems (Pizarro-Tobías et al., 2015).

Additionally, the criteria for restoration and the establishment of a comprehensive evaluation protocol extend beyond the perspective of a single actor (e.g., individual, industry, sector, or organization). Instead, multiple stakeholders are involved in the restoration process (Cervelli *et al.*, 2022).

Moreover, utilizing spatial support systems involves integrating data layers and evaluating the impacts of different methods in ways that objectively inform decision-making. This proves highly beneficial for decision-makers and analysts who are not experts in inference systems and geographic data.

The problem of prioritizing burned forests to be restored is a critical one that depends on the goals and principles established for the restoration process, which are often multiple and different at all levels local, regional and national (Orsi, Geneletti and Newton, 2011).

Hence the role of spatial support systems that focus on the analysis of captivity and allows a multiple way to computerize data layers and comparisons of the effects and it will be of great benefit to decision-makers and analysts who are not experts in information systems.

The general goal of that comparisons is to build structural maps to depict relations between indications to increase the understanding in three areas: (1) Relationships between forest and poverty; (2) The degree to which areas are economically deprived of resources due to wildfires; And (3) Sufficiency from the available data to evaluate the progress in the community and the issues of the forests. Nevertheless, the focus stipulates the evaluation of the post -decision, the maps also aim to inform the decision-making process regarding the future location of the extent of mitigating the forests.

As the use of technologies of the basic geographical information systems for the membranes of the map and data layers helps to take the decision and evaluate after the decision through the facilitation of the comparisons of the starting, and the access to the most critical decisions, and through the formation of the effects and results of the decisions are seen suitable (McRoberts *et al.*, 2007),by modeling forms, and then the arrangement of the alternatives .Consequently, the main issues related to the MCDA curriculum that need to increase the exploration: 1) Dealing with the criteria of the place, 2) Develop alternatives with the treatment of the structures of interests that concern the character of multiple stakeholders and criteria because the owners of the interests may have different signs and analyzes, then followed by the problem of decision and the arrangement of any preferences. So, the selection will be restricted to a separate group of alternatives. Moreover, the frequency process in which the alternatives are revised according to the preferences of the interests in it, but the restrictions and resources can make this unaware. Therefore, alternatives must be established with care to rely on the arrangement of the preliminary that comes in the last step, where the selection takes place between the preferences in the form of weights of the criteria and alternatives which results from the priorities of the alternatives.

Decision makers and stakeholders must consider a wide range of often conflicting goals and determine the desired level of achievement or identify different goal preferences. The forest literature refers to several separate approaches to address multiple decision-making problems, such as: multi-criteria decision making (MCDM) and the analytical hierarchy process (AHP), where the multi-criteria spatial analysis method (AHP) is applied to integrate and prioritize restoration and forest protection functions, thus The quality of the decision depends heavily on consideration of spatial features, multiple stakeholders, inventory data, hierarchy and intentional engagement of the social system with the natural system through various stakeholders as a form of participatory decision making. (Baskent *et al.*, 2020).The importance of it should not be more 9 times the least important criterion. (Haghighi Fard and Doratli, 2022).The multi-criteria spatial analysis method using Analytical Hierarchy Process (AHP) was chosen because it was the most appropriate method for the case study as criteria for each function were defined using a participatory technique in consultation with experts (in the field) spatial planning, forestry and management by using the AHP tool available in ArcGIS.(Navalho, et al. et al., 2019).

Though it does not offer information about the level of uncertainty in the data on the input and output maps, GIS technology is widely acknowledged in some fields as a decision support system that depends on the analysis of geospatial data to facilitate reaching desired results in a shorter amount of time and at a lower cost. Consequently, the goal was defined using the Analytic Hierarchy Process (AHP) for geographical analysis and the query result. Uncertainty in AHP was successfully addressed using mean values on a scale from 1 to 9 (Russo and Camanho, 2015). The AHP approach provides an ordering of decision-making options to provide solutions to an issue. Multi-criteria taking into

account tangible and intangible criteria (Habib and Matouk, 2020). Because multi-criteria decision analysis (MCDA) may be used to assess trade-offs, such as the comparability of the consequences of different scenarios for forest restoration, it is a useful tool for decision makers and stakeholders to relate environmental policies to policy processes. In complex scenarios, the best course of action is determined by a set of assessment criteria that may be applied with varying weights since there are several participants, numerous facets, and shared interests, such as those related to the environment, society, economy, culture, ethics, law, and infrastructure. MCDA has been effectively used to forest management and planning (Sacchelli et al., 2022)where the weights and relative relevance of many aspects are estimated using multi-criteria analysis. based on the integration and restoration of the site's unique features and local circumstances. Converting various data formats into forms that may be compared with one another is crucial. To develop a suitability model inside the GIS, all of these criteria are reclassified into alternative values and transformed into a bitmap. (Habib and Matouk, 2020).

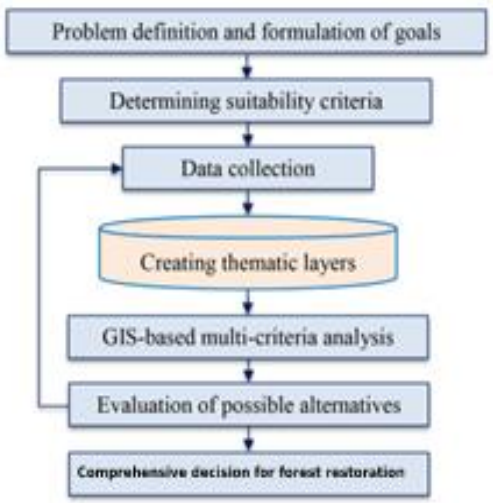


Figure 1. Flowchart methodology for the wildfire restoration decision-making process

Source: (Special editing, based on Habib and Maatouq, 2020)

In general, there is a lack of studies analyzing the extent to which spatial support systems support forest management through models, the relationship between different types of problems and how to address them. AHP-DEMATEL methods have been integrated into SDSS for problem solving (Segura, Ray and Maroto, 2014). Spatial decision support systems are integrated information systems that include modern structural functions to help pr-fire and suppress forest fires, which are represented by suitability class maps that provide important information for both decision levels. Supporting and monitoring landscape restoration allows monitoring of landscape reorganization and provides information on key restoration processes (Poccard-Chapuis *et al.*, 2021),reduces fire risk, increases resilience to climate change readaptation, strengthens local value chains, and creates a network of Local supporters for capacity building, exchanges and fundraising (Arduino, 2021).

As the integrated MCDA methods are used on the systems of geographical information to take decisions and evaluation, in addition to the process of the analytical network based on DEMATEL through the purposeful mediator, where the relevant and weighing criteria were selected and weighed and gives its priority according to the extent of influence and its impressive possibilities. The first step in this stage is the work of lines of criteria and definition of data, after identifying the criteria, they are inserted for the establishment of a map for the limitations to the use of different operations

in the environment of geographical information systems. The data is also obtained from the sources such as digital and internal maps, and the field records, work plans, and statistical reports.In the next phase, the values latter is transformed into one coordination of one by using the system of geographical information, and each of them has a way for the goal to create the final map of the necessity to unit all data layers that were produced in the previous stages, to obtain the results resulting from examining the interaction between the criteria and the sectarian criteria for making the complex decision, as these results can be used by the Regional patterns can also help the investors and planners (Asadi *et al.*, 2022).

However, the AHP method lacks the knowledge of the linear relationship between the criteria, and to solve this problem, the DEMATEL method is used. To use the exchanged relationship between the criteria contained in the problem in terms of quantity and to determine the link between the criteria through the captive and causal drawing that clarifies the economic relationships between the criteria and the assistance of the value of the idea, it helps the decision to determine the criteria which has a great impact and the elimination the one with the light effect, to improve the performance of the dispute over the time. DEMATEL can also be available in the group of reason and result, where experts are used to understand the link and the relationships between the factors in the best way and to determine which components are more important to remain on the long-term compared to the MCDM stereotypes. The higher the number of criteria and alternatives added to the implementation of a method, the more time that it uses to get the result (Abdul Rahman *et al.*, 2021).

Despite the fact that the individual or collective decision -makers can have a tendency to be dedicated, neutral, or optimistic through the decision of the decision through the generation of a group of solutions (Malczewski *et al.*, 2003).Comprehensive and consensual decision-making during the various stages of the process that allow the full participation of stakeholders and local communities. In addition, capacity making efforts should focus on promoting mutual learning and knowledge exchange between stakeholders and communities of practice at local and national levels to systematically gain and share knowledge on effective practices and innovative approaches to develop, adapt and replicate successful experiences, and avoid repeating mistakes. This will also allow for the identification of knowledge gaps, strategic research and capacity development priorities. During the planning phase of restoration projects and programs, realistic and achievable short-, medium- and long-term ecological, cultural and socio-economic goals and objectives should be established, based on a shared vision of desired outcomes which should include measurable targets and indicators. Such as increase or decrease and the size of the required change of expected results, laying the foundations for the development of the implementation plan and enabling monitoring, evaluation and adaptive management processes.

The balance between environmental, cultural, social and economic goals and objectives must be addressed and reconciled through fair and transparent negotiations, in a way that does not undermine the restoration of forests and ecosystems, with the aim of achieving the greatest possible net gains for biodiversity, including human safety and well-being. To achieve this goal, all relevant governance tools (laws, regulations, policies, strategies and plans) must be identified, adapted where necessary, and integrated into the planning and implementation of projects, programs and initiatives. In addition, strengthening and replicating successful restoration activities and approaches will facilitate and influence the formulation of laws, policies and measures at local, national and global levels, which will contribute to before fire, halting and reversing ecosystem degradation(‘Principles of Ecosystem Restoration to guide the United Nations Decade 2021-2030’, 2022).

As for the priority regions of intervention, the region was the most which is in advance in these non -profitable contexts of the forests that will not be carried out due to the low financial returns(Cervelli *et al.*, 2022).The interest owners will define their preferences individually through the analytical transmission process in the expression forms, and then to determine the arrangement of alternatives.

The ranking of alternatives has been compiled; First, for each social group using the average calculation, then the total arrangement was calculated from the grouping of the group by using the pro-calculator. Consequently, the main issues related to the MCDA curriculum, which requires more exploration, must be identified: 1) Dealing with the criteria of place, 2) Development of alternatives with the treatment of the structures of interests. The situation has the character of multiple-stakeholders and multiple-criteria(Nordström, Eriksson and Öhman, 2010).

The main research gap that this study discovered was the dearth of studies that address the area of restoration holistically, combining the many components into a single, adoptable framework. The findings of earlier research have been inconsistent in the area of regional and national planning and decision-making, and there have occasionally been more differences than commonalities. This restriction may be removed by making sure that all of the essential and basic requirements are balanced and included in order to properly recover forests following fires in a condensed manner(Sankey et al., 2021; Alayan, 2022).

Both the social and environmental problems of deforestation and forest degradation are considered by outlining the following steps: Step 1: Initiate a forest landscape restoration program to identify the problem(s) and agree on possible solutions and goals for forest restoration. Step 2: Identify restoration needs and link restoration to a broad conservation vision with focusing on the biodiversity dimension of restoration with identification of target sites for restoration within the landscape, consultation with stakeholders and comprehensive analysis of the situation, describing expected long-term outcomes. Step 3: Define restoration strategies and tactics, research different paths or scenarios to achieve specific goals, and define concepts and priorities, i.e., short to medium term goals. Step 4: Implement restoration. Step 5: Experience fully restored systems and the need for long-term monitoring and adaptive management. These steps aim to identify and prioritize opportunities and courses of action for post-fire forest landscape restoration at the national or sub-national level(Barros *et al.*, 2018).

This multi-factor analysis is carried out in three broad phases: - Phase I: Preparation and Planning - The cause of the problem (loss and/or emergence of forest and the factors behind it) is determined. Phase II: Data collection and analysis by conducting a series of analyzes such as economic cost-benefit analysis associated with specific restoration interventions and recommendations for the next phase; and a diagnosis of key success factors for restoration that examines the opportunities and challenges posed by the prevailing legal, institutional, political, market, social and environmental conditions, as well as the implementation capacity, resources and level of cooperation among key actors; Analyze the financing and resources needed to implement forest restoration opportunities. Phase III: Findings and Recommendations based on the analyzes and maps produced in the previous phases, this phase provides an opportunity to formulate policies (Stanturf and Mansourian, 2020). The restoration protocol should also be based on a comprehensive understanding of the impacts of wildfires on forest ecosystems by integrating environmental, social, and economic criteria to support the restoration of burnt forests and suggest enhanced restoration strategies as well as tried-and-true adaptive value approaches in fire-prone populations (Lanta *et al.*, 2019).

It is not possible to generalize and derive a one-size-fits-all approach to restoration beyond this geographic framework, so it is important to broaden the geographic focus of post-fire forest restoration studies. It has become necessary for a new review that is more comprehensive and realistic in its findings to serve as a general framework that can be applied to any post-fire forest restoration study, regardless of forest type, location, fire intensity and area.

As well, there is a scarcity of scientific studies on forest restoration in an integrated manner, that is, in a way that combines various restoration factors, and these challenges not only face this research, but may constitute an obstacle to subsequent studies in this field unless it is an area of interest in them. Post-fire forest restoration is being expanded to draw on the experiences of others and the potential to try to harness these barriers and challenges. Fires are an achievement of multiple goals according

to the integrated fields studied in this framework, and the points extracted are: the various options and practices for forest restoration after fires according to geographical location, climatic conditions, terrain and even demographics, the extent and degree of damage and indicators associated with it, and sources of funding for restoration projects and plans, its duration and mechanism. In addition the possibility of increasing funding, such as: approved practices such as aromatic plants and the cultivation of economic species ,and local handicrafts or encouraging the practice of pastoralism and hunting to define their areas, seasons and types, traditional agriculture, management and setting of priorities and scenarios, the objective/multiple objectives, methods and tools used or available, periodic and quantitative assessment as well as challenges and selection of intervention methods and specific time period (short-medium long) and according to plans that developed with the participation of other actors stakeholders and all relevant participants as well as community owners, researchers and specialist scientists. With an emphasis on taking into account forests with sensitive ecosystems, especially if they contain endangered terrestrial habitats, allowing significant progress towards the goal of providing sufficient data to enable effective and optimal selection, achieving effective levels of application of post-fire forest restoration strategies and creating new forests with capacity highly adaptable to future changes, as these emerging forests are the foundation that will achieve sustainable and balanced development dimensions. When discussing sustainable forest restoration, criteria, targets or thresholds for assessing sustainability are often vaguely defined with defining these criteria is complicated by the diversity of forests, the diversity of goals among forest decision makers (public and private), the spatial and temporal scales, and the challenges of implementing and monitoring forest management which concerns technical and scientific aspects and provides a framework for decision-making tools. The intensity of management can vary to achieve targeted economic, environmental or social requirements, as management can be based on natural development (without human intervention) or on high-density silvicultural methods (Keenan *et al.*, 2015, Shifley *et al.*, 2017).

Considerations are also important for sustainable forest management in eco-regions by maintaining a stable forest base, emphasizing the fact that the goods and services provided by forests are indispensable, and working to maintain or increase forest biodiversity. This includes maintaining the diversity of local plant and animal populations and associated genetic diversity, especially the restoration of endangered species and habitats, and the control of invasive species. Maintaining or increasing viable yields of timber and non-timber forest products and associated economic development or increased forest employment, community stability, and improved quantitative and qualitative opportunities for people's forest recreation (Shifley *et al.*, 2017).

There is rarely an endpoint for post-fire forest restoration such that additional management intervention is not required, so the multi-stakeholder issue reveals the continuing need to adapt and redirect restoration efforts as community needs evolve and measure progress toward achieving the scenario(Lamb, Stanturf and Madsen, 2012). Specific issues that have arisen during the implementation of forest landscape restoration should also be considered to learn from setbacks faced by other restoration practitioners and to improve restoration practices or avoid common mistakes like negotiating, setting priorities, and communicating goals in a participatory process that are keys to successful restoration planning (Höhl *et al.*, 2020). Integrating adaptive management with research and experimentation will allow for a range of restoration outcomes and help make restoration efforts more successful in meeting human and ecosystem needs. There are a variety of ways in which this can be achieved, but most involve a regional planning group identifying a series of alternative restoration scenarios. Ideally, this should be institutionalized, creating a new collective decision-making body to continue managing the process over a longer period, which is usually necessary, but becomes more difficult when economic and social factors must be taken into account because environmental and economic conditions change, unexpected fires may occur or people may change

their minds (Lamb, Stanturf and Madsen, 2012).
Therefore, the most common approach to dealing with such problems is the use of a variety of strategies to restore the affected areas from the stages of decisions which are as the following:
(1) structuring the problem of decision, (2) evaluating the effects of every solution, (3) defining the preferences of decision -makers and (4) Comparing alternatives (Vacik and Lexer, 2001).
Based on this rationale, this study focused on analyzing the forest restoration after fires from a comprehensive perspective including various criteria, indicators, models/techniques. Cultural/spiritual aspects, political/legal aspects and infrastructure and services aspects, are among the varied criteria explored in this investigation (Wilson *et al.*, 2009). Addressing these diverse criteria in investigating post-fire forest restoration in this study aims not only to acknowledge their relevance in managing forests under normal conditions but also to underscore their importance in the aftermath of fires. This emphasis is particularly crucial in developing countries where forest restoration often occurs in rudimentary and marginal ways, posing challenges for effective recovery and exacerbating degradation. Additionally, this study employs mixed methods and techniques, bridging a methodological gap in prior research by integrating the Analytical Hierarchy Process (AHP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods. These two methods were incorporated into a Spatial Decision Support Systems (SDSS). Finally, fill the graphical gap, Syrian forests are considered as the primary case study in this research.
The primary objective of this study is to provide a comprehensive and current overview of the latest developments in post-fire forest restoration criteria integrated into regional decision-making processes, employing multi-criteria analysis tools such as the Analytical Hierarchy Process (AHP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL). The outcomes of these tools are visually represented in maps and tables, presenting the most restorable places followed by the least recoverable ones. This prioritization is established through a comprehensive framework that encompasses six criteria: Economic, environmental, social, infrastructural and educational, cultural and aesthetic, and managerial and legal. This holistic approach assists decision-makers in effectively and sustainably restoring forests after fires, enhancing the overall comprehensiveness, utility, and sustainability of the study outcomes. It also facilitates time and cost savings since the decision-making process is integrated into national frameworks or regional/long-term planning development tracks, based on a broad and objective scientific background.

1.1. Research problem

Lack of appropriate spatial planning for operations related to forest restoration and forest degradation due to fires, and failure to allocate spatial maps showing the best or most suitable areas for restoration. This, in turn, makes it difficult to find a methodology or protocol in integrated framework of restoration of forests after fires that included all aspects (environmental, economic, social, cultural, legal and infrastructure). As it was found from previous studies that each study was concerned with one or two aspects at most. And also because of the decisions of science around the world and because of the inadequacy of the results to be achieved when implemented on spatial decision support systems after several years of implementing effective forest restoration, which created uncertainty and doubt about the validity of the decisions to be taken like reforestation after fires for example that may had some negative consequences, such as rare large fires that decreased biodiversity and invasion of forest insects, due to the lack of integration of other aspects of forest restoration, which made post-fire management at this stage quietly complex specially in community that lives in or near forests with its effects economically and a burden on these local because the knowledge gap that requires to integrate knowledge and domains to make optimal decision when restoring forests after fires (decision quality) and to mitigate obvious potential obstacles or lack of information, reliable scientific sources, capabilities, technology and financing and uncertainty in determining the level of intervention for decision makers in the appropriate place and time.

1.2. Research gap

The first gap is that many of these studies focused on a single aspect or criterion, indicating the inadequacy or incapacity of strategies or reforestation plans designed within a coherent framework to fulfill requirements or objectives in the medium or long-term . In more detail, the majority of previous studies concentrated on measuring and assessing vegetation cover from a strictly agricultural standpoint, with few studies addressing environmental restoration and considering the social and economic elements of forest regeneration following fires. The second research gap is the lack of studies analyzing the extent to which spatial support systems support forest management through combining more than one scientific model, as well as the connections between different types of problems and how they are address. The third gap pertains to the geographic diversity of the pervious post-fire restoration studies which predominantly concentrated on specific areas and regions. Additionally, most of these earlier studies can be deemed site-specific, as the proposed findings, protocols, and frameworks for post-fire forest restoration did not prove universally applicable across different locations.

1.3.Research aims

The current study aims to provide a comprehensive framework for post-fire forest health restoration, to fill gaps, and to provide an updated and comprehensive review of the latest developments in post-fire forest restoration implemented and integrate them into spatial decision support (multi-criteria analysis tools using Analytic Hierarchy Process (AHP) and decision-making and evaluation methods (DEMATEL) and using the outputs of these tools from maps and tables to guide decision-makers in the process of making the correct and sustainable decisions by making a known number of changes in the weighting of the criteria, and so on which saves time and money, because the decision is based on a wide and scientific base without prejudice. And integrate these decisions into the regional/long-term planning development or national frameworks.

1.4.Research questions

- The primary questions addressed in this study include: Do comprehensive criteria mitigate hesitation, confusion, and bias among stakeholders and decision-makers during post-wildfire recovery efforts?
- Can the location maps of the most suitable areas for wildfire recovery indicators, as presented in this publication, be employed for long-term decision-making?

1.5. Research Hypothesis

1.Determining the methodology of spatial decision support systems integrated with decision-making and evaluation methods will lead to more effective and sustainable strategies for forest fire restoration.

2. Adopting a comprehensive framework for post-fire forest restoration will help accurately determine the most suitable places for restoration when making decisions..

3. Identifying the most suitable places for restoration will result in better-informed decisions, leading to more effective outcomes in forest fire restoration projects.

4. This method aids decision-makers in analyzing investment contracts, spending levels, and maximizing social benefits using Knapsack method.

1.6.Conceptual framework of the research

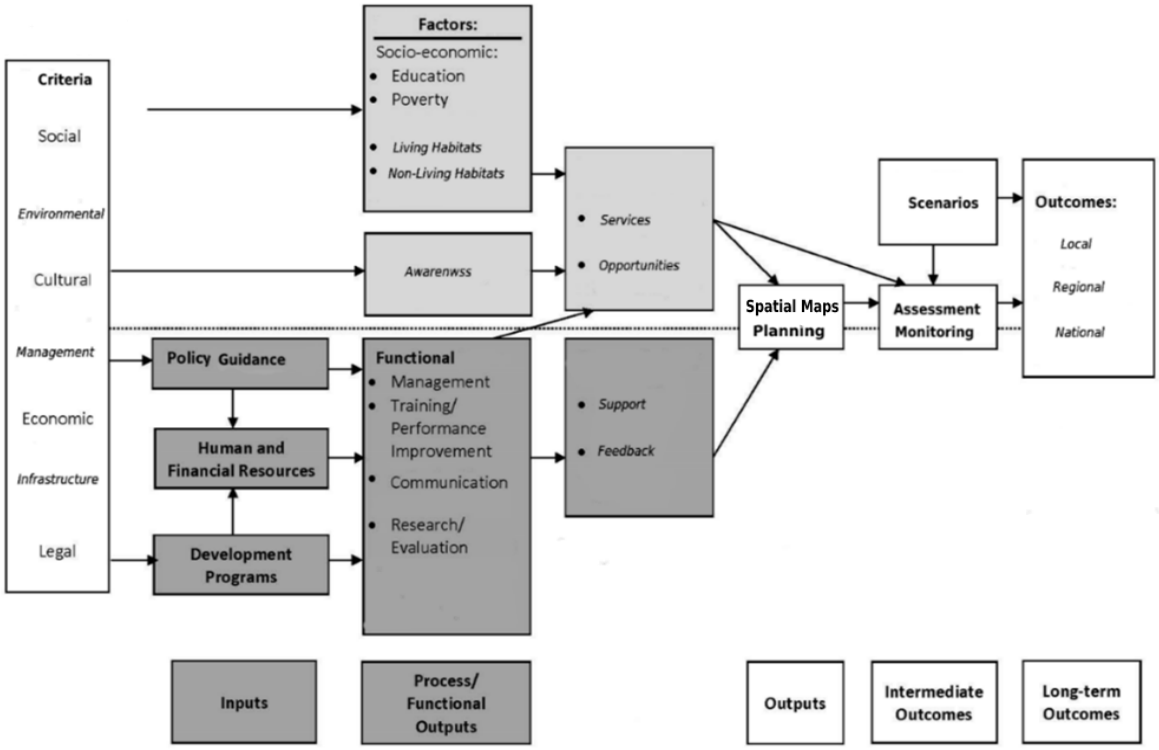


Figure 2. The conceptual framework for wildfire restoration followed in the research

Source: (Special Editing, 2022).

II. Literature review

Destructive forest fires are a symptom of disruption to natural systems exacerbated by human interventions, and these fires will be one of the most important accelerators of deforestation of forests. The available data appears as a trend of severity of the phases outside the control that affects negatives in the vital diversity, ecological services, the livelihood and the national economy. The huge forest fires are attributed to the previous and other politics, as well as to decisions taken at the level of planning and governance of the landscape view, in addition to the possibility that exceeds the ability of the domain of extinguishing. The need remains required to take immediate procedures for the phases of the hard-working gaps, so that one can be reduced the catastrophic fires of such occurrence and management for the long-term ('Challenges and opportunities for reversing deforestation', 2020). After a natural catastrophe, it is important to take effective measures to limit the losses and damages that have been inflicted on the infrastructure that relates to the specialization of the available resources to the damaged areas to deal with the catastrophe caused by the disaster and to reduce its effects (Jana et al., 2022).

The process of assisting in the restoration of an ecosystem that has been degraded or damaged by fires" is the definition of restoration. It is characterized as a conscious effort to restore a forest ecosystem to its previous level of resilience and ecological integrity(Alayan, 2022; Torres-Romero and Acosta-Prado, 2022) .

The use of the forests in general is the restoration of natural environmental processes that produce the characteristics of a dynamic environmental system appointed to the highness and the function. It was also introduced to the fact that it is the process of restoring the forest to its original state before the deterioration(FAO,2002). Often, the use is not clear and the bound consent includes a number of varied mechanisms, including aesthetic, biological variation, efficiency and economic cost. In long-term restoration management, it is difficult to measure the effects at the time of implementation. The targets and strategies of residency may be signed in a large way according to the region (Xi *et al.*, 2008).The basic represented in the effectiveness, and participation of the directing decisions directed towards the process and the evaluation of preparedness according to types. A certainty of the reservation procedures, while the other managers are used to conduct quantitative evaluations and develop the resources. Also, the open-ending in the achievement of the intended effects, which is the result of the first vision of planning, implementation, monitoring and adaptation management. Planning and prioritization activities are necessary for access to penetration and the specialization of limited financial resources to reflect long -term patterns of exhaustion and poverty and the complexity of food security with success and the productive and unmatched land management. It can be known as a means to achieve a goal in the same time, especially if or not the intervention of the user, in achieving its goals, this will be dependent in a large concept on the extent of sophisticated time and financial investments, and this place the owners in front of numerous goals with different ways. The failure in the knowledge of the owners of the interests and their shares will lead to a just way in the process of making-decision to the results of the optimal level (van Oosten *et al.*, 2014).

We live in a world in which the forests are shown, the deficiency of the offers and the services provided by the forests to the people, and the extinction of the biological diversity dependent on the forests, and the non-confirmed climatic change. This makes the decision-making bodies face in all levels, an urgent need to preserve the remaining forests, and to establish a forest covering in the forest areas, which were changed in a large way. Whereas, the size of the need and the separation of the fires of a huge difference at the national level, as the awareness of the need and the ability to restore it is the first step to stimulate the work, the obligation of my drawing to implement the intervention of the restoration and the achievement of this goal, there appeared International and global gendarmes

to encourage the assignments of the national level to conduct restoration (R.L. and M.R., 2018).
Thus, maintaining biodiversity via forest restoration is crucial to minimizing the financial losses and property damage brought on by forest fires. Thus, a two-pronged strategy must be used in response to that restoration: the first is to prevent or at least minimize deterioration, and the second is to restore systems that have been negatively impacted by the environment(Brancalion and Chazdon, 2017). Forest restoration is a challenging task, and the effects of deforestation make us pay for our errors. When restoring forests, we cannot afford to make any more errors. On the other hand, the recommended strategy—which includes the sorts of crops to be used and when to cultivate them must be followed to ensure success in the forest. This includes the requirement for a project timeline. Large-scale, successful initiatives are frequently the ones that are tiny, focused, and require a lot of maintenance (Niemspringr, Bladon and Woodsmith, 2020)with aims to restore forests, which is estimated at 150 million hectares of the world's lands that have been removed in the year 2020 and 350 million hectares in the year 2030. This challenge seeks to share the countries and other effective parties effectively, which helps the incursion of progress in commitment internationally. Until now, there are 63 countries and companies devoted more than 173 million hectares for reservation, where the restoration of the extensive forests also become an important component in the sustainable development plan for the year 2030. The most important challenges facing the Bonn Agreement to ensure that the design of programs and projects to restore forests with the national strategy approach to the analysis of natural resources and the priorities that were identified at the national level. This means that the suppression of land management and the domestication of local population with the use of planning and conflict management tools. It is difficult to overcome continuously, but direct threats may be easier in the fire, contrary to the short term, especially if the basic threats are absent, in addition to ensuring the number of the direct critical benefits . The long -term and non -critical benefits are also an important in the restoration of the forests. Also, financial benefits are short according to time through the long -term financing that is independent from the external income.
As the improved flow of services can be reinforced by the direct financial benefits of the weak societies that depend on the forests through an immediate and indirect mode, such as the availability of critical products, and especially non-physical products(Stanturf *et al.*, 2020).And the last water crisis increased the perception and there are limited possibilities to restore the forests, with the diversity of climate, formation, cultural and socio-economic between the countries and the various effects on their environmental systems. Therefore, there is no ready-made recipe, no single restoration model or technique that can be applied. The important thing is to benefit from the remaining possibilities to renew the environmental system by adapting the most suitable technologies for each case (Martins, 2018).
As the supply of the most expensive lands is available, the economic and environmental benefits are available, but a high cost of resetting, as the extensive lands provide limited possibilities to reset the expensive forests through natural regeneration or management. The greater the extent of the environmental disturbance, the greater the remediation. Therefore, it is also necessary to treat causes to determine the lands to avoid the guidance of the efforts and the recession of the future need to intervene the restoration. Economic analysis also requires the application of available information on the costs of implementation, the comprehensive costs , the capacity of the accommodated lands which can also be the economic analysis tools to direct the process decision-making(R.L. and M.R., 2018).
It is possible to submit to the provision of short -term contributions and work in favor of local societies through the long -term support services. The understanding of the effects of gaps on the local economies will assist the natural resources managers, policies and societies on the management, making decisions and policies that support local economies in a better way (Nielsen-Pincus, Ellison and Moseley, 2012).
As the biological diversity is playing an important role in increasing the environmental system by

providing a varied and adaptive characteristic, which increases the probability of the marital or resistance that some main types play, such as the seeding, and its absence may lead to reducing the successful regeneration of forests. The severe forests and the lack of biological diversity may cause the perfection of the metaphysical system that cannot be get over it, which leads to a permanent estimation of the forests or change the situation to an alternative ecosystem (Najim and Hajjar, 2022). The importance of landscape restoration is necessary to understand the environmental balance and find solutions related to natural and human resources and to preserve species of plants and animals in the ecosystem and ecological communities through the restoration of habitats .In addition to heritage, traditions and customs of the locals. Remembering the necessity of having water tanks is very important, which should be strategically placed for easy access when fighting fires(Oliveira and Panagopoulos, 2008).

In the Mediterranean sea climates, the surface soil is enrolled within 1000 years at a rate of 0.1 mm to 0.6 mm per year. Therefore, the negative effects of erosion on water and plants covering that are exacerbated by the slow rates of the soil and its restoration. In addition to the long dries that followed the shortcomings of the supply, which makes the definition of this soil erosion high. And the economic impacts that follow it later on agricultural situation like in the Syrian coast (Almohamad, 2020).

Where some of the burning regions are increase of 200 % to 800 % in erosion, especially in the description of the rains, where the erosion after the it reaches its peak(Abdo and Salloum, 2017),and after forest fires, the burned area should be restored as soon as possible to prfire secondary damages such as: loss of soil, landslides, etc. Forests after fires should also be managed appropriately; otherwise, it may be a threat to the conservation of forest ecosystems with guidance on post-fire community management and post-fire restoration capacity in entire burned areas and combining field monitoring data, satellite data and fire zones simulation to discuss the vegetation dynamics of each plant in order to maintain a sustainable forest. Against fires, and to mitigate their damage as a long-term plan suitable for afforestation and soil (Nonomura, Masuda and Moriya, 2007).

Data on the ongoing and indirect effects of fires is also rarely calculated. However, these effects, such as the costs of restoring, and the change in the wild life, and the lack of tourism revenues are important components to manage forests and to evaluate the risks of the effects of short and long -standing effects, and the formulation of policies effectively, as the management of the forests adopts on the volume, social, and economic effects and a varied group of factors, and the availability of sufficient resetting. Here, we find that there is a large amount of the number of those in the same point of this information, as there is no entity that coordinates a single data aid for the effects of forests, so the information is based on the search through the Internet and the interviews of the Governmental employees' states to determine the information that is collected and reported. If the extension of the intensity of the fire is large, the forest may require the hundreds of years to return to the conditions of what is before the disturbance and even the other environmental systems, which will be recovered at a speed of less for the necessary time to restore it. The ability also affects the procedure of the development business in the sub -regions, also on the path of naturalization the period of exposure and the invasion by the gravitational herbs, as the effects depend on the condition of the environmental system surrounding the overall, such as determining the availability returning to the normal nature, the degree of the effect of the critical of the destiny, and for example, effects are approved the water community, the intensity of burning, and the necessary time to use the environmental function, as well as the economic and social impacts of the land (general or private) and the group responsible for financing the rehabilitation and residency and thus it will have direct economic effects on individuals less than the damage to the soil.

Private sector, where fewer and smaller sources of financing are generally available. The social impacts of the forests are also, including the damages that were caused by cultural or historical sites,

and the emotional pressure associated with the lack of homes. It was rarely found that social influences were calculated and the effects were found in the long run such as evacuations or road closures. Recently, the research efforts have started to include the articles of social influences, including emotional attractions arose from the loss of ownership, the lower value of the ownership, and the damages that were inflicted on the views . However, the data may be collected for a long time on the national level, a group of changes in politics instead of research, as it is still difficult to reach information from local governments in particular for the old inhabitants, due to the budget for the employees. (Douglas , Roessing,Camp, and Tyrrell, 2003).

2.1. Forest restoration framework possibilities

Integrated restoration with social cooperation with owners to reduce fire risks in the future. Analysis the regional and cultivated species lists, data, photographic records, mapping, periodic reports, and other information to help understand possible reasons for restoration success or failure, and the possibility of selecting appropriate indicators according to the objectives. This makes the need to understand the non-linear relationships between interconnected physical, biological and cultural systems to be able to effectively reduce the vulnerability of ecosystems and human communities, through improved and proactive risk management. To economically evaluate investment in a fire management program, and to help evaluate alternatives and make decisions, it must to take into account multiple conflicting management options, which are subject to several sources of uncertainty, and their economic impact on the flow of goods and services to determine the ratio between pre-fire practices and expenditures, research is required in this stage to describe the effects of alternative fires in management options on market and non-market values, and losses economic goods and services with an attempt to mitigate the consequences of fire, with an integration of suppression planning, fuel management, decision analysis, and optimization, along with qualitative methods such as expert elicitation and open-ended interviews, which can help enhance understanding of problem structures, and enable the exploration of options better alternative management.

Also, the restriction of the intense process is due to what is caused by a relative and compassionate, and it will be forced, which can also be necessary from the environmental point of view due to the lack of structural and structured costumes because of the majority of mandatory forests are renewed ultimately contribute to increasing the resilience of the environmental system exposed to fires (Stephens, Collins and Rogan, 2020).

In the fire that there are intensity, risks, or fears of a societal that require administrative procedures for determining, the preferred strategy to expedite the increase in the availability of small sites to protect the regeneration where the deadly tree can fall. This in turn will be required for future research to prove whether it was possible to obtain a higher density and better performance of natural regeneration in the medium and long-term (Marcolin *et al.*, 2019).

It is not easy for any developing state in the current global economic system of dominance over the group of external and internal obstacles without the exhausting stipulations of the world to determine the priorities and the direction of limited resources in most of the time, within the right to achieve the goals of the subordination. Development ، and that by removing or reducing internal disabilities that can be controlled at the level of the state, and from the external obstacles in which the control is difficult at that level, while the decision depends on the future (Shawabkeh, 2011).

Due to the global volume of the forest extinct their assets, and the high cost of reservation, many methods were used to determine the priorities of expenses or the resetting on the targets and different criteria to develop a system of multiple-criteria for the preparation. The priority regulations of the forests usage and the plant covering it is directly effective on the restoration success. Natural regeneration, as is the case with the existence of the fungus and animals, which are necessary for the seeds that are dispersed. Where many criteria can make the project more complicated, which makes

it difficult for decision-makers to determine the priorities of appointed fields, for this must be in line with the forest to restore the local leaderships and non -governmental organizations and governments. A solution to obtain the necessary support to preserve the long-term and confrontation.

Important challenges for implementing large-scale forest restoration; Therefore, it is necessary to the following:(1) increasing the knowledge about the processes of choosing and managing local types, (2) assess quantity and the quality of the available phases and the seeds of local types, (3) increase in the availability and promotion of the market of commercial products from the regions (4) organizes the economic carbon programs that effectively implemented, incentives for forest restoration outweigh incentives to continue deforestation activities (Cavalcante *et al.*, 2022).

The damage of the forests and the ability to estimate the regions that are completed in the field monitoring data (Nonomura, Masuda and Moriya, 2007).

Nevertheless, the sources of the information of the various fire Sciences are easily available, except that the development of these information is at the time of the appropriate in the project of the prohibition management is still limited. The development of the sciences (principles, main tools and monitoring information and management) plans by the project managers and resources in the environmental region to evaluate the goals or tools or the effectiveness of the followed approach. The definition of capacity affected the main sensitivity, and its ability to adapt. Therefore, the foundations of strategies that help to increase the adaptation impact and the reducing sensitivity, including the reservation of the forest circumstances of natural resilience. The priority of the climatic crops in the efforts of the fees; the facilitation or acceptance of shifts in the weak areas, as well as focusing the re -processes after the fires in the regions that will support the future forests (Mspringr *et al.*, 2015).

2.2. Forest restoration principles

No action with the wrong sort of restoration may be conducted because restoration forests must be founded on an accurate knowledge and integration of the environmental, economic, and social issues involved with forest ecosystems. It calls for the application of management strategies, the most successful of which are passive restoration procedures, such as planting seeds or seedlings. About the cost of repairing big regions without incurring unexpected costs in the future (Stanturf, Palik and Dumroese, 2014; Alayan, 2022). The participatory planning procedure plays an important role in determining forest restoration priorities, taking into account environmental, social and economic values, in addition to technical support, supervision and performance monitoring. The main factors for success in forest restoration work are: the availability of high-quality plant materials of the selected species and good soil preparation with a choice of period. Proper cultivation (Hani *et al.*, 2017).

The framework of resetting and the widest number in the first place also focused on the seven principles: (1) A landscape approach is necessary to restore ecological functions; (2) taking into account the local regional context of communities to understand their needs; (3) tools for planning, designing and monitoring restoration projects; (4) promoting local and national economic sustainability; (5) strengthening participatory governance that allows for the transparency and credibility of projects (6)ensuring management and establishment of knowledge of cultural and technical backgrounds; (7) presence of a criterion structure and their objectives (Mesa-Sierra *et al.*, 2022).

Each type of different types of outputs used a potential in the decision -making, but there is a need to organize it more better according to the different parts from accuracy degrees (Colavito, 2021).

As the forest is to restore the use of the environmental system services provided by the forests through the regeneration of the plants, their growth and development. Therefore, the deterioration of interaction between the plants and their environment is the basic part of any effort.

Restoring the natural environment and the human activity in the first stages of resetting which has a largest effect, with the consultation of natural geographical conditions, the requirements of the growth

as well as the basis for the principles for the ground for restoration. Where the reservation can only be done after a series of evaluations, so one of these evaluations is the land's situation and its consequences to restore forests successfully. Thus, the way to evaluate the land is to reform the original forests is an essential matter where the benefit, the foresight, the side, the depth, type of the soil and its richness, all of them effect the nominal type that covering the average plant growth. Governments in all parts of the world have made a great effort to manage these extensive environmental systems to protect and restore forests in recent years, however, most of the traditional practices to recover the forests are no longer as sufficient in terms of multiple needs of expert services. Therefore, knowing the ecological construction is more effective approach to the restoration. Likewise, it is necessary to examine the extent of the soil on regional range on the basis of the geographical conditions(Chen *et al.*, 2021).

2.3. Forest restoration types and its ways

The possibility of natural regeneration is also commonly used as an alternative to implementation costs; where the creation of the forests is a least low cost on the largest and most miraculous ranges. It is a success of the long -term restoration to ensure representation of biological, geographical and human diversity; and the environmental social benefits of local societies and the owners of other interests (R.L. and M.R., 2018) . The fires also changed some chemical properties in the soil during the burning process. Therefore, the impact of the information of the availability of soil richness, as the inception led to the increasing of the hydrological ace, electrical connection , as well as an increase in the deficiencies of the accurate elements in the soil. While the content of organic matter and the percentage of silt and clay decreased compared to non-soil soil. Fires can also cause a number of organic and inorganic changes in the soil. It is also expected that releasing will increase changes in the rain falling system, and the length of the rain season (Al-hasn and Almuhammad, 2022).

The largest forests can affect a number of economic sectors in the rural areas, resulting in positive and negative effects. Therefore, the local leaders, the agents, the practitioners and the policymakers can help and document the construction of these impacts and relationships between the forest and the local economic development to meet the needs of affected societies that live in the forests(Moseley, Jakes and Nielsen-Pincus, 2011).

Where it is also recognized on the broader way that the environmental role is a vital feature of the successful regulation of the environmental system, with the possibility of practicing the use of the contribution to achieving this goal. The extension of the elements in the disturbances that occur in a natural way is necessary for the planning and monitoring to direct the decisions, providing some clarification of the decision-making process. The sections of the restoration of the environmental system and the type of disorder are different and ranged from about 120 years, consequently, most of the studies measure the projects after one year of compensation to estimate time for the full restoration.

The amended forests were held by a maximum of 6 years after the disturbance(but the most common between a year and two years)to enable the effect and early response, to achieve or study the ecological systems with long restoration periods such as the forests, and the procedures of the measurements before the "complete" restoration of the environmental system, which is left scientists, managers, and organizations to seek the production of whether biological societies are on a path or to return to its previous state, or whether the path indicates the conversion of a different condition, or the trajectory indicates a shift towards a different state. The environmental soundness may lead to the transformation of the environmental system into a resounding state, and here it is necessary to find different productions around in the confrontation of the requirements and if they are followed for a sufficient period, to suit the case before the disturbance(Cowan et al., 2021).

The plant composition five years after the fire appears to follow the mature successional phase and exhibit values comparable to the nearest mature stands; nevertheless, the residual percentages of

dwarf shrubs and grasses at moderate and high intensity will enhance the danger of fire. Consequently, pre-fire procedures for fires should not only concentrate on reducing the hazards associated with them but also increase their frequency and intensity to levels comparable to those seen in sustainable fire systems (De Vega ,et al., 2018).

It must be clarified that all the resetting models and techniques have their environmental, social and economic importance, because it contributes to the return of the ecological systems of the forests to an unparalleled state with direct or indirect effects on the edge of the political, nutritional, biological diversity, and agricultural production, and a genius and the awareness of the population. Therefore, a there is a need to provide a set of "excessive and technologies", which must be neglected and followed throughout the country. In fact, there are possibilities and pretexts that are not limited to the restoration of the forests with climate, cultural, social and even ecological diversity, therefore, there is no mode or a single technician graph of the environmental system by adapting the technologies more suitable for each case and all of the resetting frequencies. It is important to confirm that the environmental caliphate responsible for the process of renewing the environmental systems starts to go out. The existence of the soil or from the attempts, the growth of the roots of the various forms of life (Martins, 2018).

Monitoring burned forest areas also has several goals, to determine and estimate the extent of damage to forest, and to verify the ability of the ecosystem to recover naturally after the fire to support the planning of reclamation interventions; and to evaluate the dynamics (pattern and speed) of natural restoration; knowing the outcome of any final restoration intervention to design the most appropriate post-fire management (reclamation and restoration interventions, etc.). Moreover, from the practical side, future research efforts should be directed towards effective integration of available data sources (Rojo Serrano, 2013).

Most of the burning lands were subjected to continuous monitoring of firelights and the agencies. related to the aim of pre firing their investment for different purposes and the visionary specialization In some areas, after the fire's trees were burnt, and natural regeneration in other parts that are not statistically Included ,the works that were done in the locations were exposed to fires، the afforestation was done by the absence of the possibility of the success of the seeds at the locations in which the natural regeneration is delayed in terms of the soil richness. With the living seeds and the control of the plants, where the intervention of the cultivation of planting in the locations that are delayed. including natural regeneration either due to the prohibitions of burning or due to the weakness of the soil and seeds situation, where the grass are spread because trees type are economical in terms of fruits and wood (Ashi, 2006).

There are three ways that fires affect wildlife, or had direct effects during the first period of fire occurrence, it is more than two weeks that can cause the death of the animals resulting from the smooth smoke and the transmission of oxygen, secondly, indirect effects resulting from the regeneration of vegetation cover, affected by the number and the time of fires, which leads to increased competition on food and water in the places of fires, through the future effects of the prohibitions on lives that affect the preparatory regeneration as it may be supportive of the sacrifice regeneration in the site that is converted and transformed into the environmental system that may have some damages and may lead to desertification depends on the presence of seeds in the fire funnels. The fires also affect the hydrogenated and soil through the increased running flow, resulting in the growth of the vegetarian cover and this in turn leads to an increase in the danger of the erosion, and therefore the nutrition in the soil, which causes change in the strengths and the accumulation of physical and chemical properties of soil after two weeks of fires and increased PH degree, foaming, organic stroke, and reducing the categorical capacity, moisture and the overall organic corridors .The content of this soil fires affect the quality of the water as well by changing the physical and chemical properties of the surface water. As for the chemical effects on water, the studies are combined that

the fires increase from the release of some food elements that carry to the water through the monuments such as nitrogen and the phosphorous, which increase their proportion to a specific lineage in water.

Disputes of property, farms, and lack of the various resources in wood , medical and aromatic plants makes the area not attractive to tourists (Marouf, 2011).

Based on the biomasses where changes in land-use associated with agriculture, and urban development lead to large changes in the patterns of grasses in a wide range of environmental systems. The conversion of the lands from the original plant covering also leads to the changes in the properties that may lead to an increase these gaps. The variable irrigation systems can create an inappropriate manner for the local of restoration after a huge fire specially in Mediterranean sea climate, which is the most severe prone forest with difficulties of the spread of strong winds. Surface fires burn foliage, dead grass and vegetation like grasslands and savannas where productivity is higher to play as fuel. Fires can spread vertically by igniting shrubs to become brushwood and this makes organic layers are burned under the surface of the soil. So, biomass fuels are a major factor in increasing fire intensity.

The processes of advanced countries are often confirming the exclusion of burners, as many developing countries lack the ability to manage the prohibitions, so that the response is permissible for the fires to become a direct threat to life, ownership and for the environmental systems through the periodic burials. However, some countries still follow the policies of reforestation the forests, whereby the exclusion of the anti -burners can complete (Noise, blazes and mismatches: emerging issues of environmental concern,UN, 2022).

Some survivor trees with a small economic value must be left due to the volume or the burn of the forests. It is also necessary to avoid the tree cuts in large areas, because the exposure to the solar radiation must be exposed. In the case of any excess of the soil that it increases the water evacuation, and therefore dispenses the natural regeneration, as it is recommended to increase what is more than 25 % in total after the obligatory to preserve 90 % of the types of forests and 37 % of the biological diversity. This will reduce erosion of the soil and supporting the construction of the carbon storing and food cycles (Najim and Hajjar, 2022).

The human intervention is a good matter for the restoration for the types of trees that may be slow or even disabled for different reasons such as environmental circumstances after the fires, or sedimentation. Also in many cases, the final procedure for the direct agriculture where the remaining woods are saved, such as seizing, chopping or burning. These processes are called post-fire rescue registration. Sometimes the main motivation may be the economist in some areas, as the woods continue to provide commercial benefits , however, in many cases, the wood is not a praising, or for the small size of the affected the wood, or the quality of it, or regional lack of the production industry in such cases. It is imposed that the restoration of the region through the direct agriculture will be the lowest cost and the most efficient if it is done.

Reconstruction in an open area(was rescued)including the economic balance of the tree in positive path when looking at the efforts and costs of that procedures. The process of this economic balance depends on the competencies between the various factors related to the agents. To ensure the costs of lower restoration and higher success, the necessary time must be determined to take into considerations the natural growing, such as the volume of the tree or its severity.

The strategies of post-burning management such as the cut-off are often increased the costs of restoration in future, especially if it is not accounting the basic support and organizational services.

Economic efficiency with all the management steps with total cost is essential to restore the forests as well as the re-operation settings, but modern studies appear the excess of the wood is not necessary to increase the risks of level or pests, as the fronts of the burned intercession for the damaged region. The cost of the revenue from the wood affected by social, economic and environmental stages of the influential region, which may be positive, and these types of affects must be economically

evaluated(Leverkus et al., 2012).The resources can achieve balance between direct human needs, environmental needs, and biophysics domination for the length of the ecology system of the forests. Damaged wood is considered a local resource for reconstruction and an economic asset. Given that the advance planning to determine how to use the drain resources after the disaster is rarely carried out, it does not exist as a policy or a clear list that covers this type of use after the fires according to the type of wood, the causes of the catastrophe and the air / climatic conditions that follow the fire directly. Therefore, it is preferable to accelerate the setting of a strategic plan during the three months that follow the fire to direct the restoration activities, and the aim of alleviating the long-term effects of the leaves and recovering the production of the forests, while taking into account the leadership of financial, human and material resources. Therefore, the long-term response is dependent on which affects the forests to a large limit on the economic value of the forests(Forest-related disasters – Three case studies and lessons for management of extreme fires,FAO, 2020).

Thus, many restoration projects often fail due to insufficient coordination with local governance arrangements. This is a mechanism that helps explain how organizations can achieve their goals, noting how interventions are greatly influenced by the overlapping social and political systems that affect the landscape.

The indicators can be used to reach track the trajectory of forest landscapes as interventions undertaken in either projects or programs and landscape management towards a future that includes healthier forest ecosystems, providing a range of goods and services that locals demand. There is uncertainty about whether the benefits of development will be reinvested in nature capital and enhancing environmental values associated with restoration concerns (Ferretti-Gallon et al., 2022).

It is known that fire affects the diversity of plant species exposure to ecological systems can be subjected to a decrease in proportional types by time (Hernando et al., 2019).On the original environmental system even with the cultivation of one type or a small number (McLauchlan et al., 2020) can makes the landscape flexible, as the original forests. So, it has a variety and arrangement for the types of environmental operations such as dispersion, transfers, competitiveness, and processing of foods and physical factors of rising and harms, in addition to the types of trees that constitute life forms for the other different environmental system, such as antennas, eras, branches, and their associated animals (Martins, 2018).

To ensure the success of the restoration project, it is proposed to be carried out in three stages: the first stage (0 to 3 years) priority goes to restoring the original species through proper management of the forest area. Recommending activities such as promoting seed dissemination campaigns, establishing a vegetable farm, and developing eco-tourism in this first stage, and new infrastructures must be created(old ones restored, and new ones also created if necessary). The second stage (from 4 to 10 years) in this stage, continuing to develop the work proposed in the previous stage and restoration must be made to next stage to create a mutual relationship between all elements (natural and artificial), where the landscape can grow through an ecological and well-balanced method. Phase three (>10 years) The final phase of the proposed restoration project(Oliveira and Panagopoulos, 2008).

It is necessary to plant indigenous tree species, especially if they have lost flexibility or it is very low. It is related to the planting of agricultural organs, as a precipitation. The indication is that the rehabilitation models are for the production of wooden and non-wooden products, when they are temporary, they can be converted into a seminary form, despite the fact that it is a celebration of the characteristics of the productive system for a long period of time with reasonable reduction in the costs of restoring and forming forests through the most natural and sustainable process in the long-term (Martins, 2018).

Natural restoration produces a healthy environment with little disturbance to the ecosystem and speeds up the process of restoring plants. Complementary agriculture and natural regeneration are

typically combined in natural restoration strategies. Artificial restoration, on the other hand, asserts that natural restoration ignores topsoil losses, other possible calamities, and the entire spectrum of environmental, social, and economic goals in favor of concentrating just on growing organism populations. In order to take use of nature's capacity for self-repair, artificial/secondary restoration which is preferred over passive natural restoration techniques also aims to manage the ecosystem in order to assure the return of high density in burnt regions. Neither locals and forest scientists analyze it (Ahn *et al.*, 2014). Therefore, the use of many forest restoration strategies and approaches depends on multiple aspects of restoration. In active, passive, and mixed restoration, the adoption depends on the degree of risk and damage, the availability of resources, and the goal of restoration. In less severely degraded lands, natural regeneration is the most appropriate and cost-effective to improve and maintain biodiversity, while restoration processes can take years to produce adequately to recover more intensive resources. Active restoration assisting natural regeneration is to accelerate the restoration of ecosystem functions and produce a variety of beneficial economic and social impacts, while artificial restoration is in cases where the goal of post-fire restoration is to produce timber. As for passive restoration in the form of natural regeneration, it can be used if the focus of restoration was on species richness and canopy density (Uprety *et al.*, 2012; de Jong, Liu and Long, 2021).

One of the ways to restore forests after fires are: traditional tree: It is possible to conduct a rebuilding with a lower traditional type. To do so, it is necessary to innovate and create new images of the arrangements of agriculture in this field, meaning tolerance to intensify the agriculture of the runners in the regions or farms that really need this type of intervention with the places of the seedlings(with a distance of 3 x 3 m)for restoring Frequently, the region is required to be agitated first. Often this regulation which leads to the elimination of many of the factors that started in the succession process, to give a place to the tremendous etiquette. It requires a lot of time and labor, and there is no process to treat the large areas of the land, and this depends on a large number of the fires area. Without the use of origin and annual grains in the most evident is a great way. Using the seed mixture to reflect the limited use of the high costs and the number of performances sufficient that eliminate these factors, in addition to the lack of research on the effectiveness of the manufactured types and their effects on the local societies that association with the opinions of regional specialists over the long-term and continuous monitoring of 5 to 10 years.

There is an agreement between the administrators of the lands and modern scientific references that there is no sufficient studies on the effectiveness of the seed processing in the long-term and the number of those who are effective in terms of its effectiveness in alleviating the invading of non - localized types, and the necessity of financing the quantity to explore the long -term effectiveness after-fire effects (Peppin, Mottek-Lucas and Fulé, 2014).

The regeneration of the types of the intensity of the methods was identified, and this is attributed to the distances between the source of the seeds, the water amounts or the length of the rains, the benefits, and the plant competition. It is also recommended to implant tree in the burning areas to increase the remaining tree to be a source of seeds in the natural regeneration, especially if the minimal survivors with unless the samples are taken from the large territories to characterize the spatial variation of the effects of fire and tree regeneration (Stevens-Rumann and Morgan, 2019).

One of the first oppositions to make restoration is more ecological in a region whose survey is a few times, then it must be preserved and changed the restoration to the forest agriculture. As a general, in the area of the forests, the normal regeneration is more abundant, and it starts from the remains; in these cases, the phases are planted in wider distances, such as 4 x 4 to 6 x 6 m and in the parts that contain the regeneration seedlings, or even the number of seeds if the regeneration is actual.

Another important aspect that must be taken into account in the restoration process in the total area is the unified shape, which is represented by an increase in the seedlings. Whereas, the raising types are slowly growing, and thus in the first years of agriculture, the region becomes a short to be ranked.

There is another way to make the re-processes the lowest traditional and more ecological through the accreditation of the agriculture or the etiquette, which makes the forest the most similar to the original forest. When the segmentation of the phases becomes more, it is possible to increase the operators in the areas of the scratching, covered or intended soil, and increasing the distance between them.

i. Natural regeneration

It is the process which the Ecosystem has affected fully the biodiversity or partiality and its function with natural or human perseverance, through the upcoming severity of time. Without doubt it is the cheapest way to restore forests. The use of the forests on a wide range that cannot be followed by a single model by looking at the economic element which is different in a large number of a region ,at another through the natural regeneration costs are largely reduced to the third or even zero, and the establishment of a critical separation in the regions that are subject to regeneration where the forest can be founded in its natural way, and in the following natural regeneration cannot be referred as exclusive regeneration, but rather according to cases of environmental deterioration. The regeneration depends on three basic environmental mechanisms: seeds and the soil seeds bank, the restoration of the roots, and the existence of remains and this process may happen or be slow for the purpose.

Before recommending the natural regeneration as a limited technology for a specific region, it is necessary to make a diagnosis for the ability to renew. The diagnosis must be taken into account the normal productivity in which a specific region is entered to be resisted, and the distance of the remaining forests parts in the normal regulations, and the existence of the new materials with a generation. The forests technologies of interventions depend on the management goals that informed by the assessment and interpretation of site conditions while incorporating silvicultural knowledge and skills. The administration's goals are served more preferred by controlling and formation the types of forests.

ii. Nucleation techniques

For the cases where the natural regeneration process does not perform, or to accelerate the process by applying alternative technologies, such as the intensity as a pretext to improve in terms of reducing the costs and the restoration of ecological systems that are restored on the widest and more. The experimental tests for the applicable intelligence indicate that the severity and diversity of the invading species are higher in the extracted nuclear in the areas in which the agriculture is not done and that these studies indicate that the strategy of the submitted intensity has the ability to reset cultivated projects (Martins, 2018) .It represents the forest management, due to the invasion of the absence of recurrent burns (Arnberger et al., 2022).The species chosen for restoration efforts can easily be grown in large quantities in nurseries, can shade out weeds or other undesired plant species in the early stages of succession, are able to endure severe trimming or soiling, and are resistant to fire, pests, and diseases(Uprety *et al.*, 2012).

Plant residues and soil transport in the regions that suffer from the maturity and erosions of soil, the segmentation of soil may not be sufficient to provide the resetting of the forests. In these cases, the balanced connections may advance well, especially if the nutrition, organic materials and soil, that can be stated because the root system is running out resources of the soil and makes environmental small isolated trees, with small amount of soil.

It is clear that the plant covering with these characteristics is funded to enhance the use of forests in these severity environments, so the soil erosion is an environmental and low-cost alternative. However, when the soil of the plants is rich of organic materials, or roots in the deteriorated areas this method is recommended to stimulate natural regeneration.

This technology can be applied of forests in the regional preserved areas, through a project that analyzes by the suitable environmental situation, where cultivated plants are used in the compact of the forests in the expensive soil. And that is necessary to enhance the chemical and physical properties of the soil to increase biological diversity and stimulate environmental processes, as well as to be

able to reduce a bigger number of planted seedlings.

iii. Direct seeding

One of the main factors that pre-fire of the natural regeneration process is the lack of human activity of the seed ,with a variety of types. Where some common types can reach in some cases to large distances and use a specific region that continue the basic chains, because other types do not achieve the same success. Pointing to the regeneration process does not advance in these areas due to the distance between seed sources and / or the lack of density, the productivity becomes through the direct seed in terms of the cost of trees planting, the input can be included the types that have a regional finding , but it cannot be accessed by confusion (Martins, 2018).

iv. Thinning

Mitigation impacts depend on carbon storage and provision of habitats and livelihoods. In general, it does not affect the total of a carbon in the environmental system on the long-term, where the remaining tree grows in the largest differential competition which has a small economic value, while the lowering of increasing some large areas that can provide a greater economic value, but it also has negative immediate and long-term impacts on carbon storage. Thinning also reduces the water competition and increases the health ,the resistance and remaining tree, especially in the severe years of dries, with a lineage impact on the success of some types (Torras et al. *et al.*, 2008).

There is a few information or not found about genetic disadvantages of the prohibitions and identification of the genetic effects of natural forests that the management practices regarding the genetic diversity and the state-made processes that affect the genetic diversity are being defined by the comparison of the genetic diversity after harvest, and the alternative of re-processes. From several years prior to the seeds, which provides a geographically diverse group of seeds. Nevertheless, the local seeds must be used as a large number that are made for the fire of preserving their genetic diversification, will also be the control for new farmers in a periodic manner to ensure that they are kept that diversity in their rule. The regeneration of cultivation must take this genetic characteristic in the consideration, for the regional and private genetic diversity (Rajora and Pluhar, 2003).

When carries are equal in length and ages, the harvest becomes a matter that is not reluctant, but it is necessary to follow the systems that can be preserved in a sustainable manner without reducing other management goals. It must also be excluded in the effect in Syria from the harvest completely, as well as any type that may be subjected to a loss of the widest range in accordance with the climate changes, such as Turkish oak to increase the production and economic values (Salmon *et al.*, 2015).

Terrace walls are constructed in belt-shaped configurations in large areas of pine trees and to improve fire adaptation traits in fire-prone environments resulting in rapid stabilization of soil erosion and landslides in burned areas, restoration operations based on traditional row planting in burned areas have also been evaluated favorably by forest scientists and local people and highlighted the future needs regarding the production of high-quality, harvestable, fire-adapted timber through mass planting (Ryu, et al. *et al.*, 2017).

The effects of alleviating treatment cannot be seized on this restoration if the plant covering is not included and the other locations in the surveillance protocol after two or three years of a burning outbreak, and here the targets of work on the soil turn to sub -productive regions will decide for a long -term production and environmental restoration (Robichaud *et al.*, 2009).

The light can also work to accelerate the solution of organic materials and the launch of the nutrients, and consequently improve the productivity of the forests(Ahn *et al.*, 2014). Interest, as the green cover can create a normal protection. However, the fragments created can be efficient during the restoration operations, so there is a need to influence administration. Therefore, this practicing should not be seen as the only intervention that is internationally applied in any environment after the fire(Marcolin et al., 2019).

2.4. Effects of post-fire on environment

However, these human activities (Fire suppression and reforestation), may contribute to some negative results, such as changes in biological diversity and dispersal of the forests, will this be the only case, or is there other scenarios for the user to use the forests more preferred? These are questions that should be discussed in the future(Wang, He and Li, 2007).

As for polluting estimates: forests produce smoke that contains air pollution, such as physicals and organic organisms, the Hydro carbonate and carbon monoxide (CO) nitrogen oxides (NOx).

It is likely that the functions of the forest in the natural regeneration that the human being part of it and its consequences by three basic types of "inputs" that caused by a human intervention. First, human beings are affected by the quantity and distributing of the fences through the nature by changing the vital blocks and mixing the types of the formation through the changes in the use of the lands such as the construction of rating and agricultural activities and development . Secondly, human change the distribution of radiation exports of forests and a varied group including the purpose of description, intentional burning ,and unintended reasons, and railways (Mercer et al, 2000).

Smoke and flames also directly affect animals and its ability to escape from fires which this can have a strong impact on the probability of survival or have local shelters, such as burrows or rock crevices, are able to escape or avoid the fire and take shelter until it ends. ; These movement-related behavioral responses not only affect animal survival but also allow species to recolonize the burned areas. This may cause accelerated loss of topsoil after fire, with rates of 0.1-41 Mg ha / year after moderate to severe fires compared to 0.003-0.1 Mg ha / year in unburned landscapes (*Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires*, UNEP, 2022).

2.5. Implantations of comprehensive forest restoration

Prioritizing problem-solving activities and emphasizing the environmental, social, and economic benefits is a good way to implement continuous practices. However, raising awareness alone won't change behavior; other strategies, like social marketing which is grounded in society and transitional stimulus with an enhancement goal may be more effective at strengthening the desired changes. local marketplaces, as well as assisting in reducing the length of the food production and consumption cycles(Maioli *et al.*, 2021).

Therefore, information should be obtained from the various owners of the cultural heritage and environmental services in the region (Velázquez-Rosas *et al.*, 2018).

It can also support the efforts of the biological turn and the support of economic growth through the agriculture of a varied group of high value local types to establish nurseries to give more benefits to forests. Enhanced biological diversity within the forest can increase the rates and length of longevity of carbon sequestration and reduces exposure to disturbance again. It also works to increase the diversity of species ecologically. And forest structures are also affected by enhancing ecosystem resilience to climate change. The cultivation of types that supports non-wooden forest products (NWFP), such as honey, mushrooms, medicinal plants, cork and firewood. When the soil is contaminated with the toxic materials, the soil processing methods that used on the intensity of the absence of covering. In addition, the rest of the traditional processing methods such as the treatment, it can be supported in non-policing regions.For example, pine forests in Syria often have high natural success rates. Nevertheless, the organized fires may only find local support in the regions that have not been transformed into agriculture, but this leaves large areas that are affected(Prescott *et al.*, 2020).

The size of the fire can suspend the natural regeneration of plant covering, especially in these environmental systems, which is not dependent on the internal processes, and consequently on the

seeds in the irreversible regions.
The time features include the releasing time are considered to be important factors for the structure and the formation of the ecological systems, as well as its ability, so the releasing is the number of drivers in a certain period that can be reinforced by the ability to restoration. In the studies, the ability to recover after fires is that different scenarios for the irrigation systems. The size of the severity in the forests, and the period like the short term (and 5 years) and the medium term. Where the intensity of the burning in the largest forests showed a counter -relationship with the use of the clean covering of the plants in the short and medium term.
Nevertheless, Normalized Difference Vegetation Index (NDVI) changes values for each of categories intense are higher than those of non-sudden condition. Time features include also the frequency and the restoration time ,and the intensity of the burning. For the green covering on the short term (two years after a fire).When the reinforcement of the beneficial is short, long way or medium which is the most suitable scenarios for restoring(Fernández-García *et al.*, 2018).
It is not only the necessity of the forests, but the failure to restore the forests after the fires is also one of the main threats to preserve the environmental systems . Therefore, it is necessary to appreciate the ability to recover damage in forests directly by the administration community.
As a result, resistance against forest fires and regeneration capacity were high in the areas of the previously accustomed plant covering, while (NDVI) is also different according to the type of vegetation in the destroyed forests.
Despite the availability of sufficient data that available to determine the sub-region except the industrial destinations and the field monitoring data which are useful in verifying the area, so the results calculated spatially and temporally (one year before the fire, one month after the fire, and one year after its occurrence). Therefore, the forest must be correctly managed or eliminate the region from this necessity, then to assess the resistance and the ability to recover from the damage of the burned forests (Nonomura, Masuda and Moriya, 2007).
In most Mediterranean countries, reforestation through seeding is the most widespread restoration practice as it aims to reduce the effects of fire by restoring forests, preparing the site as well as improving seedling production and strategies, and preliminary overview of the best treatment to achieve large-scale restoration of burned forests (Habrouk, 2002).
The types of related intervention are the activity management that is used to preserve the biological diversity or restore it in the lands designated for the forests (Bernes *et al.*, 2015). Facilitation is the most appropriate indication of use when planning intervenes by focusing on locals instead of the fields that can be achieved with the benefits of multiple residence at the lowest cost, such as the reservation. For example, it is likely that the natural regeneration in the areas with a low-ranging of the forests, which leads to less costs than the planting trees in the areas with an rich soil that distant from the location of the forests (R.L. and M.R., 2018) .It is possible that the natural regeneration occurs because of the irregular seeds, or seed that may fall after fires. Therefore, direct seeding by hand or by helicopter was common in the sixties, but it turned out to be ineffective due to animal predation and lack of control over storage. Immediate implantation can be intended for increasing the tree numbers, and in terms of cost, as soon as the other area is left for several years. Treatment options are difficult to be chosen because the costs become higher.
After 10 years, it is clear that this area will quickly be dominated by shrubs and conifers that will be suppressed or die. The shrub has a much higher ability to keep soil ,water, and a higher rate of leaf and root production. Therefore, conifers should be planted immediately after burning before any shrubs become dominated.
The multiplicity of specializations in evaluating environmental and societal costs and the rate of achievement for applying each treatment according to forest types, severity, integrity, impacts and possibilities that can be positive and negative. And identifying the future outstanding position for

each chosen area. It is necessary to focus at this stage on the characteristics of the natural dispenser, the ownership , the goals, and some of the affected trees that must be left for continuing the wild life cycle. Setting the chosen site is designed to provide the cover with the advantage and to increase the possibilities of its entity. It is designed to give preferences to the proportions intended for a limited resource, where it is necessary to focus on the technology that has a minimum effect on the site with the provision of preferred circumstances to mix the required plant cover. In all cases, it is necessary to keep the soil in place and not reduce its productivity. After returning vegetation to the burned sites, Subsequent treatments depend on the needs to secure the conditions of the particular situation and plant mixture. Since the small gaps are treated to age groups that can be achieved and the variety of the mixture is provided even small materials can be transformed into cash value products.

The milestones are usually starting to be simple and relative, but the simple structures can be kept or made contracting by openings to the invading of diverse plants. The chances of success of the treatment depend on in general on obtain a value from selling small materials or products , as well as the costs and the supply of financing to formulate the treatment plan type in the production sites (Helms, 2007) .The methods of exposing the plant cover and by infidelity the soil in terms of their economic cost, effects on the survival of the sects and their growth, and even strengthening the environmental effects.

However, the relation between the cost and the economic effect reduced the environmental influence that make the control more difficult to prepare the soil and the need of knowledge of how to allocate this limited financing to achieve the maximum effect(Espelta, Retana and Habrouk, 2003) by comparing the negative use of treatment, like active treatments that had a few of the median processes of activities with a vegetarian limit that was constantly reduced. The processes of the activities also included the costs of buying trees and employment costs to prepare the sites. Therefore, the decision must be adopting the goals of the connections, project features, and the characteristics of the sites ,as well as the historical use of the lands and the outbreak period of time of the fire(Morrison and Lindell, 2011) .

2.6. What is concerned when forest restoration takes place

It is difficult to determine the effects of the forests separately from the sources of other pollution. The industry and the non-treated water ,health and the surface flow that is contributed to the water before the fire. The damages that were caused by the water processes, the agricultural expansion, and the absence of industrial organization.

As it leads post-fire management in the long term, changes in density. The plants, in turn, may have negative impacts on the properties of the soil on the long term, and the best time to implement the post fire administration, when the direct and indirect effects of the forests are not hidden, the procedures for the removal of the post-resolving administration are not involved to protect the seed bank, but it is better to implement it on the medium -sized period to the long one by reducing the strategic effects. It is also a risk of harm by reducing the disrupting of the leaders, with the total costs of forest management at the same time. The ecological systems of the medium period in the rushing growth of the plants are distinguished after forest fires, these areas must be managed to mitigate the risk of fires due to the lack of accumulation of forest fuels and the low density of the cover, and reducing root competition for water and nutrients (Francos, Úbeda and Pereira, 2020).

That succession may be used for a long time due to the shortage of seed or multiplication, and this may make the incurred system of a great danger from the environmental dust in the speedy restoration of the plant covering and contributes to preserving the soil and water in the region that it already suffered from severe burns through the restoration of the destroyed ground cover. It was found that the forests were recovered more than that in the stage of the early regrowth after the investment (Li *et al.*, 2010).

Building community awareness also creates a sense of belonging to the forest. The long -term action also helps to protect the resetting site. It is also important to monitor the locations of the forests regaining including the growth of the treasures, the highness of the plants and trees covers, and the effect of the types, by monitoring the wildlife (Fawzi *et al.*, 2020).

Grazing animals help lower the risk of fire and fuel load. But herbivorous animals can potentially put a limit on the restoration of flora. Consequently, local threats and wild herbivore products like wool, milk, cheese, and meat should not be protected or restored(Vallejo, Arianoutsou and Moreira, 2012; Moreira et al., 2020). Tourism can also be a good option for the region - hunting, with the boundaries of hunting areas with consideration to hunting seasons, and type of species that can be hunted (Oliveira and Panagopoulos, 2008).Previous studies indicate a limited impact on bird communities and insect species, including Red List species in forests. In practical biodiversity management such as cutting gaps can be used to benefit specific groups of organisms, while avoiding negative impacts on ancient species associated with growth. It is also important to evaluate appropriately for different ecological restoration methods, including different organisms and groups with a long-term perspective when evaluating the effects of restoration. Thus, focusing on only one organism group can lead to misunderstanding of the true impact of restoration on an ecosystem (Brockerhoff at al. *et al.*, 2017).

Measuring the success of landscape restoration is a complex issue that requires an attempt to evaluate social impacts and environmental indicators at different levels in across different scales, spatially and temporally, while identifying patterns and long-term treatments to better guide recovery strategies. This requires the need to integrate spatial planning into the preparation of a restoration program on a national scale that manages limited funding or resources and sets priorities that must be consistent with multiple restoration objectives in a balanced and optimal manner with the demands of the future, while considering the characteristics of the place and the forest to make the comparison between the desired results, and to find more effective restoration paths. Therefore, there is no doubt the need for a monitoring system to evaluate the micro and macro results at each stage of forest restoration, which enhances access to adaptive management and resilience in the long term. There is also a need to account for the complexity and changing nature of ecosystems, site conditions, and diverse social and political systems while providing aesthetics and amenities or other activities with social impacts, such as strengthening the community through participation in restoration projects with continued economic enhancement of infrastructure site development (Gómez *et al.*, 2019; Oh *et al.*, 2020; Iniguez *et al.*, 2022).

There is no systematic compilation of forest restoration projects (globally), and the Bonn Challenge does not even have a mechanism to detail what is proposed on the field. The Bonn Challenge scale is a limited attempt (20 countries as of 2020) to summarize efforts but only presents results at the country level. Therefore, its findings are limited and not comprehensive, and rely on compilations and case studies, while restoration is difficult to implement due to environmental, social and economic complexities and the time required for change to become necessary in the long-term-restoration is likely to be short-lived, especially if the main benefits are in the short term (Stanturf , et al. *et al.*, 2020). It is not suitable for time the economic resources when the requirements of the statements are not enough and when the lack of information and quantity is not available, where it is possible to provide the data of the statements and the ground covered with a clear perception of formulating , in the following place and day the restoration projects will be directed to choose the appropriate sites to restore them. Likewise, there may be some of the mistakes in the dates of the used data that may lead to wrong calculations and identification, as the speed of the occurrence of environmental residence on the initial plans and the activities of the restoration is not provided, but it is also provided as far as they organized (Hof, Zachrisson and Polvi, 2021). It is also noted that there is also a noticeable spatial bias in the distribution of restoration studies due to influence by economic prosperity, political

stability, scientific and technical progress. Forests face a numerous challenge, such as deforestation due to land use and land cover changes, disturbances that caused by fires, diseases, insect pests, and extreme weather conditions due to climate change. Forest fires also affect the ability to regenerate and biogeochemical cycles, in addition to large economic losses due to the huge number of resources used in fire suppression. Forest fires also greatly affect the carbon balance, as estimates indicate that they contribute about 5%-10% of the total global warming from greenhouse gas emissions. Scientific evidence also shows that more than 90% of all existing forest fires are directly or indirectly linked to human activities, which amounts to 53% of the total hectares burned globally , such as arson, lightning, pasture maintenance and open fire incidents. Forest fires depend on land cover dynamics and current local conditions such as fuel type and loading, humidity, wind, temperature and terrain. Thus, forest loss due to fire amounts to about 15% of global forest losses, with an average of 68.2 million hectares of forest area burned annually from 2006 to 2015 (Fischer, 2021; Hoover and Hanson, 2023).

Forest ownership has the potential to have a strong impact on post-fire restoration response and management. In general, the ownership of the forests may not respond to the speed required due to the administrative, organizational, or budget-related restrictions. The differences in the use of the forests appeared by the owned forests of the public sector and the special segment, this can be made clear partly by showing the intervention levels in the plant covering process for each of the lands owned by the public and private sector are use of a similar management method in attempting restoration regions that have been affected by the two perinates and these methods harvesting deadly trees or that were severely damaged , planting trees and seedlings ,controlling plant cover and competition with planted seedlings ,or relying on natural regeneration. The difference between the properties was the extent to which these activities were applied and the intensity with which they were implemented. The treatments in public lands were the least and continuous of the largest and more powerful(Stephens, Collins and Rogan, 2020).

Reducing integrated fire risks is essential to adapt current changes, and estimating the negative impacts that is a critical requirement to clarify the importance of investing in effective pre-fire practices and mitigation measures as well as the necessary and appropriate response for restoration. Wildfire risk management also requires an integrated, region-specific approach, which in turn influences population awareness and preparedness, for potential prediction of fire spread, monitoring and early warning systems, adaptive fire suppression strategies, restoration and management of fire systems, landscape-scale fuel management, and changes in forest fire practices. Land use, and thus on the active restoration. Furthermore, to enable effective planning and decision-making, priority areas must be identified to which resources should be allocated to fire mitigation or suppression, all of which require technical information, such as potential fire behavior and impact, uncertainty about fire risks, distances, and accessibility to spread situations. In most cases, this information is often unavailable or unorganized. In addition to practical technological limitations, large-scale structural methods can mitigate and reduce risks in the short term, but increase them in the long term. They only serve to effectively postpone the risk because it the process that creates a natural hazard can rarely be eliminated. Conversely, a fire may occur less frequently, but when it will overwhelm the structural repair and often results in severe damage. In this regard, we have a lot to learn from many indigenous peoples who have historically coexisted effectively with fire-prone ecosystems and often used fire as a tool for sustainable land management(Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires, UNEP, 2022).

However, most countries lack the necessary infrastructure to establish regeneration and restoration systems, and there is still little understanding of how to use the ideas and management framework. Achieving long-term restoration goals therefore requires a good scientific and technological

background, with adequate legislation and financing. With the involvement of the local community in decision-making processes, taking care to support multi-level cooperation while maintaining national or regional cooperative capacity after determining priorities and the need to allocate resources to successfully restore forests. Not forgetting the important role that traditional knowledge plays in the environmental restoration of forests affected by fires, as most forest communities possess rich traditional knowledge that can be linked in an integrated manner to preserve biodiversity and sustainable management of natural resources. Also, traditional knowledge and science complement each other and therefore should be used at the same time in restoration projects, taking into account the following factors while establishing restoration goals in general, and which are identifying current and expected environmental goals such as climate change projections, improving environmental knowledge, modeling, social improvements, and applying environmental monitoring. Long-term results, taking into account the spatial and temporal conditions of the distribution and characteristics of the burned forest, will help in risk reduction efforts and guide the formulation of integrated fire management with monitoring and evaluation to redirect adaptive management actions for restoration (Clavet,et al. *et al.*, 2021; Noulèkoun *et al.*, 2021).

Restoration is an interdisciplinary field of science that requires practice including diverse perspectives that is important for ensuring effective environmental monitoring and restoration on a large scale. Therefore, it is essential to provide a protocol for stakeholders involved in post-fire forest restoration. This protocol aims to generate an extensive data to determine regional references values and improve restoration efforts ,outputs and associated benefits(Barros *et al.*, 2018). The duration and mechanism of post-fire forest restoration may vary between previous studies due to the location of the studied area and its environmental and climatic characteristics, the varying economic growth of each region or country, and the competitive market structure.

Scientific and cognitive progress are essential in forest restoration, other factors include the severity, scale and frequency of burns as well as the balance of social goals and priorities of local management policies and practices, which are important to ensure effective ecological monitoring and large-scale restoration and the extent of regional cooperation to engage in post-fire forest restoration(Viani *et al.*, 2017). Many communities want to apply traditional knowledge to post-fire forest restoration and resource management. This includes strategies to reduce hazardous fuels and re-introduce fire within the context of community values, cultural revitalization that takes time, dedication and trying to understand challenges from different perspectives, and collaborative landscape restoration efforts i.e., coordinating and communicating with local people on planning and implementing projects and outreach to cooperate and build relationships and trust for success. Addressing fire management challenges (Lake *et al.*, 2017).

Whereas, the tools for estimating the costs of restoring and the effectiveness of the costs of the maintenance interventions of the planning and the definition of priority. In the current models, it is often used to sell the lands, the cost of renting, or the total economic wages of the agricultural cultivation as a substitute for the costs of the alternative chances. In view of the resource limited, the best of investment are the processes between feasibility and the use of practical and capable procedures with high levels of multiple benefits. Different types of spatial data sets can provide indicators or proxies of regain (R.L. and M.R., 2018).

The size of the large forests fires may make the complete benefit from the local capacity really difficult. Nevertheless, the local companies may be available, and desire to provide services, but they may not be able to provide the necessary services, the economic implications on nearby communities varies according to the spending on the repression that is registered in a local. Even when the societies are able to respond to the largest forests through the availability of suppression services through decades with the service of the forests, local spending stimulates the employment during the forests, and helps the communities to seize the problem. The most markets that might be created by forests

when local communities are not in a good position to allowed cancellation the contracts, this will lead to some short-term employment possibilities that do not achieve a potential economic association. When large forests are caused, its first priority is to spend with the specialization of additional money to the sub-regions after the forests. The researcher also indicates that in the following year of the pillar in which the income spending on the services of reform and rehabilitation of the damaged areas in the large forests that is made because it is reconstructed each of the infrastructure and the natural systems, and the restoration business. It is used to the affected societies after the fire that the forests services are often associated with the efforts of the local group to combat the management of the forests with the possibility of companies in the advanced installation of the previous compressions such as the work of the previous business of the local capacity that leads to the most benefits which affected by wildfires and reduces net spending (Ellison, Moseley, Nielsen-Pincus, et al., 2012). Therefore, in order to successfully minimize the vulnerability of ecosystems and communities through enhanced and proactive risk management, it is necessary to comprehend the non-linear interactions between physical, biological, and cultural systems(Sample *et al.*, 2022).

2.7. Dimensions of forest restoration

Employment rates and the average wages have increased the short term in a huge fire in a region, as the local economic impacts of the large forests are positive, as the labor and wages are to grow as soon as possible from the expected to see the trends. It was found also that the regions in which the fires of the frequencies were brought up in the passage of time, the increase in labor and its drifters were an example of the general average of each of the urban and cultural, with the existence of a statistically significant difference, and in return there were additional increases In the rate of employment and wages in the regions that were economically dependent on governmental sectors or delegation, while added labor and all jobs and wages may decrease during the largest forests or may be paid in a different way, in the government areas the added workers are the highest to include the additional work and risk, when no similar pay scales exist for work in other sectors. Also, the increase in the total costs of the forests level had a significant effect on local employment and wages, as there was an increase in local spending on the suppression, which had a clear effect on local employment and wages, as there was an increase in local spending on the suppression, which greatly affected the labor and wages, and this indicates that the total cost of the leaves had a clear effect on the local economies, while the total amount spent in the region had a significant impact in reducing the average level. Therefore, the distribution of suppression costs can play an important role in the effects of wildfires on local economies(Nielsen-Pincus, Ellison and Moseley, 2012).

Where it happens forest fires affects economic growth and converting it, as it leads to the inconsistency of the weakening points exactly through the amplification of the current seamless labor and the trends of the wages. In general, it is possible that the employment grows and increases the average local investment more than that can be expected when the large forests occur, but the total employment may decline in the result of trade and business activities, and the loss of tourism, or evacuation works. But the greatest effect was due to the growth of the average wages in government employment. The investment in the local resources involved in the forests and the return of the hidden efforts can help in increasing the local level, and more importantly, it is to determine the policy and the local societal factors that tell the local investment of the movement of impressive societies The tremendous incense is towards an economic future, with the possibility of developing strategies focuses on the improvement of the local capacity on the partnership in the efforts of the repression and the restoration or the lightness and even the adaptation to build the environmental system and the local economy that is sufficient with the fires (Nielsen-Pincus, Moseley and Gebert, 2013).

The amount of money that is agreed upon is affected by the economic impact of the largest forests in the neighboring societies. Also, increasing the local spending leads to an increase in the employment during the largest forests, as the value of the spending on the practices of the repressive managing in

a large way. However it is not recognized by a little by the effect of the suppression that is registered with a solution (Nielsen-Pincus *et al.*, 2012) .There is generally no assessment of the annual economic burden from fires in most countries, with more than half of wildfire-related expenditures allocated to response, while only 0.2 percent of the total budget allocated to wildfires is typically allocated to planning. However, to reduce the huge costs of damage and loss which far exceeds all expenditure on bushfire management. So, more work is needed to determine the optimal allocation for each country. As a starting point, countries may consider re-balancing investments by up to 1 percent for planning, 32 percent for pre-fire practices, 13 percent for preparedness, 34 percent for response, etc. and up to 20 percent restoration. Therefore, understanding fire severity and the factors that influence is a critical requirement in post-fire assessment and ecosystem management. However, the methods used to classify fire severity are highly variable and are often developed for specific purposes in specific ecosystems. The lack of specific criteria in many methods limits their application and thus paralyzes the ability to infer the behavior of a fire after it occurs (*Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires*, UNEP, 2022) .

Consequently, the economic analysis can be supplied to supply the services of the ecological system and the biological diversity. Because these methods are limited and specialized for each case, there is a need to develop tools and entrepreneurial databases to apply economic evaluation methods and assisting practitioners of resetting on the development of economic set for regions or from us a natural views to direct the decision -making process and predicting financing needs (R.L. and M.R., 2018).

2.8. Decision making process according to forest fire restoration

Decision making is an essential aspect of the forest management planning process, which includes many ecosystem services, the environmental, economic and social complexity of managing forest systems and planning methods and tools, as well as the vision, intuition and wisdom of planners. The need to develop a framework to integrate the different dimensions of the planning process and the balance between use and conservation, taking into account natural disturbances such as forest fires and climate changes including spatial scale, compositional context and temporal, and therefore quality, decision-making depends largely on consideration of spatial attributes, multiple stakeholders, inventory data, hierarchy and intentional engagement of the social system with the natural system through various stakeholders as a form of participatory decision-making (Baskent, Borges and Kaspar, 2020). When it comes the role of the decision to support the decision -making tools that have been developed to inform how to provide the largest intervention of the largest effect of the lowest cost. The settings of information supply these local or universal data on the ground covering, and the lands, climate, distribution of types and procedures, and demographic surveys, or groups of social or physical data. Once these layers are collected, they can be used as input to analyzes serving priority is the same as the analysis of the alternative scenarios for reservation, to evaluate the emergency services of the different environmental system, the biological types and the costs to processing settling goals.

Management options include conserving species, reducing forest risks, and addressing climate impacts where the judiciary can lead to the coverage of the plants, which competes with the tree to improve the strength of the tree. This will be more important to the climate temperature raising, because the lowering soil and other pressure, including the wild forests, so may allow the tree by staying for a period of time, in addition to increasing quality and perhaps productivity, leading to improved social and environmental value of long-term treatments of forest resources (Vose et al., 2021).

The scenarios included three levels 3, 10 and 30 years old, a period of time for 3 years is an ideal for preserving the health and diversity of natural cleansers and reducing the risks of the forests while 30 years are harmful to the environmental function and increases the risk of forests. To evaluate the relative acceptability of restoration treatments, the resulting factors are subjected to for a hierarchical

analysis in large areas were divided in which most of the trees where cut with an area of 16-40 ha. as for the intermediaries, where most of the tester is cut off, an area of 8 in addition to the selective pieces of the tree as well as the small spaces where the segment of the most preparedness are made. A tree with an area of less than 4 years uses the mechanical means of preserving the open lower conditions, such as the planned fires and their control, such as if the burden of intensity is made for every 10 years. As for every 3 years, the types of intended plants with the dead tree in the microorganism. Naturalization as well as the use of herbicides to remove invasive species (Arnberger *et al.*, 2022) .

In the field of planning and making decisions, the concept of making the Multicriteria Decision Making in order to actively play the rationalization of the administrative and planning decisions, that is, it should be taken in view of the consultation of these criteria when making the decision instead of a criterion or one goal (Nizar et al. *et al.*, 2022).

The groups of criteria and biological importance are then weighted. The priorities for the preservation of biological diversity and the types of primary plant covering and the presence of a secondary plantation, and the use of a way to produce different scenarios so that one of the priority is selected by the compatibility, to produce a map of highly and medium priority regions for restoration (Naidoo and Ricketts, 2006; Naidoo *et al.*, 2006).

Also, studying the land map is better to understand the characteristics of the natural cleanser, and how it can be a tool to support the decision to resume the natural personnel through the aggravation of the use of the updated lands that suit the possible rights of two goals preserving normal resources and producing goods.

It is also worth noting that small possession holders are less successful the duties of the forests, especially if the presence in the promoted sandy soil and in the survived sites, and close to the paved road because it is possible that the farmers are the continuous use of the cuts and burning, which is the main option of the owners of small possession. There are two other important issues related to the spatial system of the forest, which is direct association with the services of the equal system and the lack of economic motivations to enhance the restoration of the forests, it is the process, it may not be done. Outputs of maps and tools by farmers or interest owners, and this affects the calculation of the land, where the weight of each criterion can be required for the local circumstances, which affects the results and the possibility of application. Consequently, it is not possible to reach a map that is appropriate to support the real fact which is to help the decision -makers to achieve the balance between the preferences to restore the forests (Poccard-Chapuis *et al.*, 2021) .

When the main goal of restoration is quick restoration the following points become a need (1) the agriculture of the removable seeds that were collected in close places or unnoticed (2) taking any procedure, a sufficient number of seedlings are naturally prepared after the fire, allowing the natural succession of tree lands that are highly adapted to fires (Taboada *et al.*, 2021).

Some of the forms of residency may still include many traditional residency goals, but the potential results mean that there can be differences in the number of used types, and relative proportion . Restoring biological diversity in degraded landscapes on a wide range that requires technology support and return. This is what is difficult in terms of financial and practical practice, it may be the best approach to do this in a way that is in progress and the highest stages, while taking into consideration that it is always a possibility that the current and domicile approach will be changed for better. The new ecological systems may represent the best that can be achieved by looking at environmental, social and economic changes and the volume of deterioration that occur the environmental supervision and biological protection because it may not be possible to overcome many negative impacts to environmental degradation (Perring, Audet and Lamb, 2014).

The fires shed light on the development of the strategy, which is based on five pillars within the “Risk Management Framework,” which include:

A) Research, information and analysis to create a common database on fires.
B) Displacement by enhance the pre-fire practices to reduce risks through continuous composition of forests and increase awareness by local societies.
C)Readiness by increasing the ability to combat the burners through the appropriate equipment at the time of early intervention and improve the infrastructure.
D)Responding to the forest fires, Including coordinated interventions between all parties;
e) Restoration and reforestation after fires (Harati, 2011).
Where strategies can be divided into two categories compatible with two of the vigorous motivations to renew the forest,: (1) how to adopt agricultural strategies and climate change (2), how to reduce the large main sites to notice the success of their regeneration at the present time and in the future climate, which is not expected to find without the administration's intervention.
Also, literature shows, there are many sites that are potential in which the regeneration of the trees, such as the small spots inside regions that are very dangerous or within 50 to 100 of the surviving trees. Therefore, these areas may not need to be replanted. On the contrary, agriculture may be necessary to prepare planned fires in a large area with long distances between the remaining trees that are considered as source of seeds. The distance between remaining trees is an important indicator of the density of tree seedlings after the fire to understands the shape and size of the severity of the burning stains, the most important thing is to understand the possibility of renewing the trees as well, and the administration interferes ,it must be focused on the agriculture efforts on that largest partner in the large areas that are inside the spot more than 100 to 400 , depending on the region and type.
The soil in the new reinforcements may not promote the regeneration process that needs a deep and rich soil, as there were multiple studies that the local site conditions must always be tasked and must be taken before agriculture. It defines whether the plant is profited from natural regeneration or competes with removable phases with the determination of the temporal agriculture.
The promotion of the cultivation may be directly after the fires in the largest growth regions, which allows the years to monitor the nature where the databases and depths of the soil affects the parts or the types, and a large group of small sites such as the sickness resilience, and accordingly requires the estimation of the administration, returning on local experience. Also, the number of trees 'cultivation is sufficient to avoid the regions potential loss, and to reduce the probability of the extreme fires. The increase in the processes can also lead to the including the mitigation, the treatment of the fences, and the desired prohibitions, to the restoration of the region that is burning in the decisive conditions, and consequently increasing the probability of the survival of the tree seeds that can be provided for regeneration. Currently, many researchers and managers suggest that future planning developing a proactive strategic plan to manage forest fires, and even the method of not taking any action, will have consequences that can be evaluated to form final management decisions. In some cases it may be recommended by enhancing Non-forest ecosystem, even if the site is climatically suitable, because there is an urgent need for effective management by assessing the vulnerability of forests (Stevens-Rumann and Morgan, 2019) .
Key decision factors such as complexity, alternatives, consequences and uncertainty, in fire management. The relative between these factors varies with the connections between the socio-ecological in fire management decisions that are made such as the productivity and effectiveness of suppression actions the integration of ecosystem modeling with economic principles, and the stronger adoption of risk and decision analysis in fire management decision-making. Complexity and uncertainty of fire response, decision support systems are likely to be essential to help fire managers identify effective solutions and demonstrate that combined with counterfactual scenarios they can be reliably modeled. The inherent variability of the natural world, the limited control over human interventions in natural systems, and the knowledge gaps in modeling system evolution in response to environmental change, human intervention, and opportunities to enhance and expand knowledge

exchange within the global fire community are some of the well-defined uncertainties that impact decision-making processes like these. Though creating tools and solutions that are applicable to everyone is challenging (Thompson *et al.*, 2017).

2.9. Decision making tools to support forest fire restoration

Results from the composition factors through (GIS, a multi -criterion analysis) is a map that can be as a tool to set the risks of fires and any decision -support systems that are integrated with information systems as well to help fires prediction in forests and suppression (Sakellariou *et al.*, 2017).

Some strategies achieve flexibility on the preservation of the historical circumstances or re -establishing them, and on the improvement of a long -term response to the system through focusing on features or the development of the principles of the administration that usually balances between the procedures that can increase the normal resilience of the forests and between multiple goals which are often competitive.

AHP analyzes a problem, question or decision into variables into a system of criteria and sub-criteria, makes pairwise comparisons between them and then converts these comparisons into numerical values that can be processed and compared with the full scope of the problem. The weighting of each of the variables allows each of them to be evaluated within the specified hierarchy. To identify the specific geographical location of management interventions, which enables planners and practitioners to make the best judgments to make appropriate decisions.

Sustainable forest management requires multiple criteria based on geographic information systems (GIS) as an approach to aid decision-making, criteria and indicators that are intended to serve as alternatives for more detailed data to facilitate evaluation and enable applicability at a specific spatial scale (Pasqualini et al. *et al.*, 2011) which allowed the production of support maps for decision-making in an integrated manner for landscape planning, nature and forest management both within the scope of regional forest planning and within the scope of forest plans (Baskent *et al.*, 2020).The spatial and quantitative description allows fire risks forests by identifying and activating treatment methods in targeted landscape areas, as this information may be useful for preparing fire management plans (Marcolin *et al.*, 2019),responding to fire objectives and results of periodic forest fire risk assessments that give a quick overview of current landscape conditions and future risks and enable monitoring of risk approaches and potentially evaluate their mitigation (Scott, Thompson and Calkin, 2013).

These tools are valuable when making decisions related to forest management and allow forest managers to determine the impact of different disturbances on forests. To determine the best strategies for managing key landscapes that may be significantly affected by multiple, interacting threats(Xi *et al.*, 2008).

Decision support tools and important information are used to balance the allocation of multiple resources at the regional and national levels, as well as to find out the necessary results and supporting models, given the large costs associated.

Pre-replanning can help overcome problems that may occur and will be more representative of the decision-making process. However, decision makers must be more transparent in the decision-making process to support research due to the lack of information about the response alternatives that have been developed. Analyzing them allows researchers to focus on identifying gaps in decision-making processes and the questions managers must ask as they meet the environmental, economic and social needs to expand them to ecological expansion of the right kind in the right place and time, while still protecting valuable resources and assets, largely dependent on changing business strategies using the best available data and analytics (Dunn et al. *et al.*, 2017).

Spatial decision support systems are also effective to help evaluate alternatives and make decisions, and the multiple conflicts of management options must be taken into considerations, which are subject to several sources of uncertainty. The outputs of these systems work to determine the ratio between

pre-fire practices and expenses and describe the effects of alternative fires in management options, on the market and non-market values as well as economic losses in goods and services resulting from the consequences along with qualitative methods such as expert elicitation, open-ended interviews, which help enhance understanding of problem structures, and better enable exploration of alternative management options. However, the performance of spatial decision support systems is limited by the quality of the input data (Pacheco et al., 2015). Decision support systems use not only geographic information systems, but also satellite technology to quickly measure and survey vegetation characteristics and to help with faster and more effective management of vegetation planning in Post-fire restoration.

Spatial decision support systems can contribute to estimating and facilitating dealing with critical situations in a timely manner. The main positive points of spatial decision support systems are the possibility of grouping them with infrastructure and natural resources such as human settlements, transportation, energy, oil and communications infrastructure, housing with endangered species, and historical monuments. The strategy and tactics can be modified according to the current conditions in any given area. Management expertise can mitigate the effects of forest fires on the natural and cultural environment. Most decision support systems are created in order to gain a complete understanding through data analysis and then make the best management decisions within a narrow time frame. This also represents a challenge in natural disaster management as reducing environmental, social and economic impacts is the overall (Sakellariou *et al.*, 2017).

Spatial information is represented on maps and digital data layers, and GIS tools are used to analyze it, information is of great value for decision-making and post-decision evaluations and facilitating comparisons of alternatives, by depicting the effects and results of decisions. Unfortunately, decision makers and analysts do not often do this because they do not have access to experience of the crisis in geographic information systems, and the interpretation of relevant data layers (McRoberts *et al.*, 2007).Nevertheless, the focus is on the evaluation of the post-decision, the maps also aim to the media manufacturing process, regarding the future site to mitigate the forests (McRoberts *et al.*, 2007) . It is also possible to evaluate the deterioration resulting from fires by using several satellite images of the start of fires and after their end, because it is important and decisive in managing fires and to combat them before the fire spread to prepare a fire risk assessment system that also helps to find the variables and factors that contribute to severe fires and determine the appropriate methods for introducing the variables to the problem (Marouf, 2011).

Measuring vegetation regeneration of different species was linked to fire severity levels and to verify that the less damage is caused to vegetation cover in the short term, the greater the regeneration, and this is closely linked to the environmental characteristics of the regeneration of each species (Tonbul ,et al. *et al.*, 2016) . Where the use of plant covers of the forests is dependent on four entrances to the initial data: (1) a classification map for the physical settings, (2) the reference conditions for the natural regeneration rate of each biophysical preparation, (3) assets landscapes for each biophysical site (4) a map of the structure of the vegetation cover of the forests in the present time (Haugo *et al.*, 2015).

The decision is determined by the MCDA technique used and the following three general procedures for achieving the collective decision are: 1) The participant, as the group can work as one decision-making manufacturer and agrees to prefer one subscriber. 2) Assembly, as interest owners can determine their individual and an involved preference that is made through voting or calculation; 3) comparison the owners of the interests are determined by their individual and being used in the negotiation process through discussions where the goal is to find a compatibility solution (Nordström, Eriksson and Öhman, 2010).

Spatial support systems also allow multiple ways to combine layers of data and compare the effects of different methods, which can contribute objectively to decision making and be a great benefit to

decision makers and analysts who are not experts in systems thinking. Although the focus is on post-decision evaluation, the maps are also intended to inform decision-making regarding the future location of wildfire mitigation resources, while using basic GIS techniques to integrate maps and data layers aids decision making and post-decision evaluations by facilitating comparisons of alternatives, and visualizing the effects and consequences of decisions (McRoberts *et al.*, 2007).

As for the evaluation of the criteria to integrate it with the current administrative methods while achieving the requirements of sustainable restoration in the capacity of the place the complement of a local and diverse charity and the consequence local, population, natural, social, and economic problems- integration of restoration investments with decision-makers ,and the possibility of achieving the treatments that needed to restore within the current available capabilities and the extent of decision makers to develop them and to achieve social justice, balance and build a strong connections between the residents and the available resources (Matouk, 2009),in comprehensive framework by taking the decisions multiple-criteria ,and conducted the number of studies to treat the issue of preferred one by choosing between a group of initiatives. This theory that aids the decision-making was developed by the professor Saati in 1926, and since that time this theory has become the most common way in the world in the analysis and decision-making process with multiple-criteria. And that is for the number of reasons for the existence of a computing program that can be applied to the theory and the construction of the hierarchy forms،and the work of sensitivity and the use of results in a simplicity and effective, which had defined it Saati in 1980. It is a "framework that combines the subjects and the non -subjective and the vulnerable comparisons based on the basis of a relative measurement of building indicators by using comparisons that depend on the opinions of the experts and decision-makers. A minor, as the existence of a high-level is required in the case of the difficulty of comparisons is due to the large discrepancy between the criteria in the degree of importance. It was found also that when comparing, a matrix must be designed according to the following conditions:

1. Its diameter must be one because it represents a comparison of the criterion with itself.
2. The values above the diagonal are the inverse of the values.
3. Judgments/Assessments must be free of contradiction (consistency).

As for calculating priorities, there are two methods for calculating them, the approximate method.

The priority calculation of the approximation by collecting the values in each column, then dividing each value in the column on the total number of the columns itself; we obtain the matrix, which allows the comparisons of the meaning between the elements ، and the average calculation of the ranks by gathering values in each description of the criterion where the correct and priorities are used by raising the provisions .This process is given what is satisfied ، and the result of this process is the value of the main agent (λmax), which is used and the calculation of proven in the provisions. Thus, we get (N) from the numbers ، then we will hit each of them with priority that is given in the results with the accuracy of the dispensed arrangement in the provisions for an acceptable level of contradiction. We need measuring stability (lack of contradiction) Consistency Verification when the description is fixed, the all-standing group of each description is informed of the amount of all the elements by calculating the number of elements in each column and multiply every value of the criterion value of the ranks. Then the results are collected for all columns (λmax) will be greater than (N) and the equity of difference is a measure for the contradiction. The difference between this value and the (N) is divided with the opposite of the corresponding to the provisions that must be less or equal (10%) Consistency Index (CI) must be compared to the value of the Random Index (RI) for the recognition of the ratio of CR while the provisions are described by the stability and the acceptable limits for the proportion. Therefore, the decision that was taken must be reviewed by using the hierarchical analysis method can be summarized as follows:

1. A practical way to deal quantitatively with different types of functional relationships in a complex

network.
2. A powerful tool for integrating expected planning and required planning in a dynamic way that reflects the judgments of all management personnel.
3. A new way to:
• Integrating clear data with objective judgments about intangible factors.
• Mixing the rulings of several individuals and resolving differences between them.
• Low-cost sensitivity analysis tool.
• Strengthening management's capabilities to make concessions clearly(Priorities).
4. One alternative for predicting the future and protecting against risk in the fire of failure.
5. A tool for monitoring and guiding organizational achievement towards a set of vital goals.
6. It is related to personal decisions ، but personal preferences are transformed into a position when making more depth decisions through the participation of a group of experts and specialists in decision-making(Nizar et al. *et al.*, 2022).Consequently, all the criteria are composed with some of them in the GIS program for the potential regions, the (AHP) has been applied, and criteria were transferred to the databases in the ArcGIS program to determine the location to the set by increasing the degree every pixel to achieve the goal (Halder *et al.*, 2022).
Allocating resources in restoration projects often requires consideration of multiple landscape characteristics especially those that affect achieving the goals of the restoration effort.
Spatial decision support aims to improve the effectiveness of decision making by translating human knowledge (data) into structured computer processes. GIS has been used to address many of the complexities of decision problems through the integration of MCDA methods GIS-based multi-criteria decision analysis (GIS-MCDA) is a procedure that combines geographic data and decision maker preferences into spatial maps ,in addition to traditional MCDA methods used in restore forests(Noth, Rinner, and Department of Geography and Environmental Studies, Ryerson University, Toronto, ON, Canada, 2021) Sustainable forest management requires multiple-criteria based on GIS as a decision-making approach. It has been driven by multiple criteria and indicators regarding values (particularly environmental, social and economic benefits) and risks related to forests. The situation is exacerbated by the general lack of spatial data on values and risks (Lamb, Stanturf and Madsen, 2012). For the site Criteria and indicators are intended to serve as alternatives to more detailed data and offer the advantages of being easy to evaluate and applicable to a given spatial scale. The maps created provide local officials with information thus saving time and money, and weights and other maps can be obtained and produced of management priorities in different locations.
AHP can be used in the study to evaluate stratified data, rather than indicators that are weighted by the actors involved in the process (Pasqualini et al. *et al.*, 2011), to stabilize and diversify local livelihoods and employment opportunities, improve the quality of ecosystem functions and services, and improve social equity, well-being, and habitats and to promote biodiversity conservation, and generate a range of ecosystem goods and services that benefit multiple stakeholder groups in the medium and long term, taking into account institutional, financing, and technology challenges. Interventions are then evaluated to align with national-level priorities. A set of principles through a framework of criteria and indicators to meet political, economic, social, environmental, political, cultural and aesthetic needs. Within different regions and time scales driven by different priorities tracked through outcomes and application of adaptive management (Robin L Chazdon *et al.*, 2020).
The maps created give priority to local officials. However, this methodology may be limited by the lack of detailed spatial information on environmental or economic criteria and indicators such as biodiversity and soil quality (Pasqualini. et al., 2011).where geographical information systems are used to treat many of the problems of the decision held by developing the methods of analyzing decision -making with the number of information (GIS-MCDA) where the geographic data is combined and preferred decision is made in creating maps, and the weight of the criterion is applied;

A value is assigned to each criterion that indicates its importance relative to other criteria. In many cases, AHP, which includes the resolution of the criterion, is valid, which includes the agricultural comparison of the criteria, which requires decision -makers and identify individual preferences.
To determine the criterion weights used to carry out through consulting fifteen experts in the environment, irrigation, management and restoration of forests.
The implementation of different groups of requests will lead to the establishment of different compound maps, so it is improved to consider strategies to take multiple-decisions to examine the variable levels of the state.
This results in a composite map that is affected only by the importance weight of each criterion. Applying demand weights in conjunction with the most common importance weights also led to four scenarios: each of them is focused on different patterns for the performance of the criterion, where local expertise must be consulted to determine the relevant criteria and the weights of the importance to determine the priorities of the lands to restore the forest leaves (Hakeem et al. *et al.*, 2022 ,Chandio *et al.*, 2013).
It should also be noted that group decision making should be further developed in spatial decision support systems (DSS). To make a stronger contribution to stakeholders in decision making and to inform the future development of forest management by focusing on economic models that integrate the value of environmental services and collaborative decision making of multiple decision-makers and stakeholders (Segura, Ray and Maroto, 2014). Multi-Criteria Management Decision Analysis (MCDA) is a useful tool to determine the optimal outcome/solution in complex scenarios and for support in decision-making processes, where there are many actors involved, with multiple aspects, for example, environmental, social, economic, technical and ethical of historical and spiritual value. aesthetics and interests. Recently, MCDA has become a decision support tool for decision-makers and stakeholders to link environmental policies processes, due to its ability to evaluate trade-offs, and allows comparison of decision alternatives based on a set of evaluation criteria that may use different weights.
Many have successfully applied MCDA to forest management and planning, GIS-based MDCA has the advantage of allowing the user to deal with multiple criteria, it can include conflicting opinions that describe the decision problem from different angles.
Different viewpoints are combined to automatically obtain agreed upon results that are feasible to implement. It is important to note that the final map is not intended to be the optimal solution, but only the most appropriate solution according to the value judgments of the makers (Uribe *et al.*, 2014).
Post-fire forest restoration management relies on key indicators to ensure viability and usability. Key indicators include LU/LC, NDVI, and NBR, which are used separately according to each criterion. Economic indicators include village and road cost-effectiveness, social factors like distance from institutions, managerial viability, institutional capability, technical know-how, logistical limitations, environmental services, biodiversity changes, and habitat suitability. Evaluating restoration sites' ecological appropriateness is crucial for fostering ecosystem resilience, biodiversity, and habitat quality. Cultural and aesthetic factors like distance from institutions, hiking trails, shrines, ecotourism, traditional knowledge, and infrastructure and educational factors are also important. The number of indicators depends on the complexity of the decision problem, available resources, and decision-makers' ability to understand and analyze information. To maintain usability and efficacy, it is recommended to keep the number of indicators to three to five important criteria. Focusing on relevant and actionable indicators is crucial for streamlining spatial decision support systems and thorough forest fire restoration.
A common gap for MCDA applications is that there is little attention to how to provide information about the performance of each alternative converted to a measure without mentioning the dimensions of preference and how different weights affect the importance of decision criteria, combining weights

and scores into overall values for each alternative to increase confidence and validity of the conclusion (2) Choosing the best multi-criteria decision support method also depends on the quality of information available in preferences from the information available to evaluate decision alternatives criteria (Kangas,and Pykäläinen, 2001).

Wide attention should be paid to others, indicators such that short-term gains are not offset by macro-level economic, political or environmental forces affecting broader forest landscapes to specify what must happen for the restore to be performed. Furthermore, entities involved in forest restoration should apply the criteria and indicator framework to forest management measurement (Sacchelli *et al.*, 2022,Cinelli *et al.*, 2022). Some of the challenges arising from forest management planning are obtaining a forest with high-resolution inventory data, effective delivery of a large spatial database, quantifying all factors, risks and uncertainties, conducting conflict resolution exercises with multiple stakeholders, and integrating the management of different land uses. In the concept of comprehensive management, and the use of fast computing opportunities(Baskent, Borges and Kaspar, 2020). In addition, there is no systematic projects of multi-functional and multi-benefit forest landscape restoration globally. Therefore, the need to address the drivers of forest loss and degradation remains a challenge in most cases, especially when the main direct drivers such as those related to agricultural progress, infrastructure development, and urbanization, security of tenure, or marginalization of already vulnerable groups that are similar and may ultimately have important implications for the success of forest restoration themselves (Stanturf *et al.*, 2020), and the performance of even the most accurate decision support systems is limited by the quality of the input data (Pacheco et al., 2015).

In any planning process, it is also useful to perform as comprehensive a decision analysis as the data allows. Thus, there is a need for decision support methods that can take advantage of ordinal information. These ordinal preferences can be considered implicitly uncertain, as it is often the case with preferences expressed in actual decision-making processes. Simulated results can then be used with other information sources, such as analytics. GIS, expert judgements, personal preferences and metadata (Kangas and Pykäläinen, 2001).Researches are also needed to describe the effects of fires on management choices on market and non-market values that are at risk, and economic losses of goods and services resulting from the consequences of fires, which can help advance understanding of problem structures better to enable exploration of alternative management options, as well as carefully manage challenges. It aims to develop a framework that organizes knowledge about implementation, and how to manage it efficiently, to better prioritize future efforts to mitigate associated risks. This requires further regional and social science research with a spatial-temporal perspective to facilitate and improve the quality of decisions under uncertainties, and to enable coherent fire management in an uncertain environment. It also points out the importance of understanding the institutional constraints of management programs through which wildfires can be mitigated (Pacheco et al., 2015).

The compensation mechanism also provides an incentive to restore forests along with triggering rural development where the associations of the users are compensated to be interviewed in the areas designated for proceeding and reform.

Compensation funds generate direct income for those who work as guardians of the protected forests; The money is generated indirectly when it is in the community's concerns, as public funds are to the number of the main source of financing for all practitioners starting from the regional and national administrations to joint cooperation such as cooperation with the French accompaniment to the world commission (International Communities) of the European Community through the LIFE program or IFAD Development Supplies (Fund) also comes from private institutions and local communities or owners of local interests to produce and evaluate it through groups in a short and medium term after the project end (Arduino, 2021).

The restoration of areas with high capabilities of the natural regeneration of the forests can also lead

to an effective increase in the cost of forest restoring in a large way and to increase the priority fields of the speedy restoration such as the previous forests covered by the trees and otherwise it is useful for the existing critical diseases, and it is expected to have sufficient bodies of seeds of the types of local trees, as it results from high benefits from the carbon store, the quality of the water and the biological variety.

Without planning and information can lead to the selection of the types of trees to restore the processes monitoring lands, forest protection, or agricultural obstacles, to high rates of burned trees or other problems, such as poor economic returns or adverse environmental consequences.

In the worst cases, it ends with the process of restoring to increase levels of drain, instead of reducing and reflecting the effects of desired connection, the costs can also be high, and there may be a loss of trust and cooperation with local communities. Consequently, the participation of local interests is the matter of importance because the types of survived trees are imposed on the livelihood of local living, food products, and the management. It is necessary to consider these steps in restoration (R.L. and M.R., 2018).

In the context of the use of forests, the decisions are taken to the extension of the lands for the restoration projects. This is because the preparation of the use often is working in a limited resource, as the priority in the most important thing to ensure the project's sustainability and success at the long-term period. The necessity of supporting decision in this context is increased, as the climate change led to an increase in the intensity and re-integration of the forests, and here the local experts must be consulted to determine the relevant criteria and the weights of importance. In addition, the future status studies of the GIS-MCDA are to determine the priorities. It must be established and improved by this method and may help the development of groups in criteria, weights of importance and strategies of decision-makers for practical applications by using geographical information systems (GIS) and taking decisions with multiple criteria (MCDM). In parallel, an in-depth literature review was conducted in order to determine suitability criteria for restoration as well as evaluation. The analytical hierarchy process (AHP) is used to assign weights to the criteria studied; to create maps that using the Weighted Overlay tool within ArcGIS 10.8. to obtain the level results(Noth, Rinner, 2021), the evaluation works, which is integrated with the geographical information and co - technologies for planning and chanting priorities to improve to conduct a long -term evaluation to influence the burnings to confirm the actual losses in the environmental and societal flow for the harvesting and the production of the source of animals because this evaluation is useful for the expectation the period in which the activities can be accompanied by the collection of the local products, while monitoring the changes of the regeneration covering by time to understand the fundamental mechanisms that lead to change in the environmental services. The great defect also represents the evaluation of the environmental and social aspects that extends for limited data of the formal information of the study of the categorical studies followed and different spatial (Taboada *et al.*, 2021) .

The use of MCDA is highlighted because it allows the processing of environmental, social and economic dimensions in the forests, as it is the most common way to the problems of the forests at the region. The strategic and intelligence is the short -running time. While the most deep analysis will be, through a target survey on the definition, useful for understanding the best for when and why is it used as different technologies (Nobre, Eriksson and Trubins, 2016).

Geographic information (GIS) is a type of decision support system, which is used to collect, process, analyze and visualize geospatial data and information. It is a powerful tool based on multi-criteria decision analysis (MCDA) by comparing alternatives within a given criteria framework(Habib and Matouk, 2020). Because it can address multi-criteria that simulate geographically opposing stakeholder desires, and produce tangible outcome maps, multi-criteria decision analysis within a GIS framework is a helpful tool in restoration planning. Even if the suggested method can account for the

opinions of each participant, subsequent applications might enhance the value function survey structure, further lowering uncertainty. The final point to make is that the map is a useful tool for ongoing negotiations between actors and is subject to modifications that can improve the viability of the practical restoration process and guarantee the greatest benefits for local communities. It is not intended to be the optimal solution, but rather the most appropriate solution based on participants' opinions on values. Further research and practical applications could point to the implementation of MCDA techniques to manage adaptive policies for restoration at regional and local scale (Uribe *et al.*, 2014). As generalization is not possible, so each study must be planned to adapt to changes by creating thematic maps from data stored in digital layers that facilitate identification of the location and affected area. Analysis of problems through maps and diagrams facilitates discussion of the topic under study, especially in forest planning processes that are developed over long periods, sometimes lasting for several years. However, there are cases where decision-making cannot wait and rely on quick decisions, such as in large-scale forest fires as well as weighting criteria by the people involved, the results will be discussed later (Acosta-Berrocal, Bedoya-Roqueme and Quirós-Rodríguez, 2022). MCDS methods have been applied to address this, so there are many challenges to better manage forests and these challenges include providing decision support for multi-purpose forestry and participatory planning (Thrippleton *et al.*, 2023). This calls for treating DSSs as computer-based digital systems that represent and process data in ways that allow the user to make decisions.

Decision support systems are integrated information systems that include modern structural functions of assistance in suppressing forests. Decision support systems as an analytical tool contribute to alleviating specific types of certainty that are involved in the phenomenon of forest as well (Sakellariou *et al.*, 2017).

Spatial support systems can be classified into two distinguished categories: 1) Fixed and historical data that does not change during the development of the fire, for example, the transportation network, and the planning of the accompanying, 2) Dynamic data that may change the passage of time, for example, the characteristics of the fire, the environmental conditions, the location of the response units, and the automatic data ,where the spatial support systems implement all the legitimate tasks related to the modification of this tool, an example the roads are the situations of the emergency, and so on (Keramitsoglou *et al.*, 2004)

Providing the map of the suitable for the assertion of valuable information for each of the levels of decision, to support, where the map of the land can be linked with the land covers and land use because it enables it to describe the real appearances which was not in other places, such as the continuation of the stitches and burning studies in the agricultural reform survey, or attracting automatic agriculture to the best types of soil, even if it is covered with the remaining forests, as well as this spatial tool, monitoring the reports of the natural, which is suitable for the most preferable to the agricultural transformation, the progress of partnerships are information from main operations such as resetting agricultural conversion to the range, the drawing of the land is useful to determine the allocation opportunities as a strategic tool to improve the reservation ,and landscape restoration (Poccard-Chapuis *et al.*, 2021). The most productive and innovative approaches to solving decision problems are tools that take into account many environmental, economic, administrative, legal and social aspects of forest management, while the most appropriate methods for solving a given situation usually depend on the characteristics of the decision problem and the nature of the problem related to the time scale, spatial context, number of objectives, decision makers or stakeholders, goods and services that are involved, and decision support systems(DSS).Therefore, they are essential tools for practitioners in complex decision-making problems, such as those that arise in forest management and forest planning(J. S. Kleinman *et al.*, 2019).

In general, there is a lack of studies analyzing the spatial support systems in forest management through models, the relationship between different types of problems, and the methods. The

Analytical Hierarchy Process (AHP) is integrated into DSS for problem solving (Segura, Ray and Maroto, 2014). Spatial support systems can also contribute by limiting the position and strengthening creative thinking by supporting the development of scenarios that are extracted from traditional imprecisions to manage the forests and from the help of the assistance in making the connection between the different values. If the advantages of spatial decision support systems are as allowing the insertion of values multiple ways through the decision-making process. Spatial support systems do not take "effectiveness in terms of cost", but it may help in order to improve the process without making it more costly(Segura, Ray and Maroto, 2014).

2.10. Forest fire restoration aims

With support for practices local products like aromatic plants, honey, wax and pollen -traditional farming in areas (less than 300 m) using traditional techniques such as growing potatoes, grain ,grapes and olives. With the establishment of conditional rules to avoid reforestation with exotic species that grow very quickly allowing the presence of open spaces in the forest is necessary for the development of biodiversity, because there are some species of plants and animals that depend on it to complete their life cycle. Taking into account the presence of shelter, structural elements in agricultural landscapes that made up of dense trees and species that protect cultures and encourage the practice of grazing in protected landscapes by giving financial support to producers (Oliveira and Panagopoulos, 2008),more economic assessments and ecosystem services are needed for restoration (Poccard-Chapuis *et al.*, 2021).

The interventions of the restoration of forests aim to restore environmental, social and economic functions by multiple landscape, establishing a group of the authorities and services of the environmental system that provide the groups of the owners of the users, also benefits interventions in the consequences. According to the interests of the various active authorities, including the needs of preserving the biological diversity. Understanding the reason and what the result of the contradictions, and the discussion of the positive and negative impacts associated with each of the needs and development to set the goals and results that are generally different levels and the availability of a natural reinforcement between local, regional and global periods.

It is possible to develop a priority forest restoration strategy depending on the types of land uses in restoration interventions to:(1)Forest lands (2)Shrubs(3) Pastures (4) Agricultural lands (5) Fresh water areas (6) Arid lands. Then the division of these types according to the types of land covering depending on the types of the role of the administration that comes according to the condition of the forest, the different techniques of agriculture that can be vary by using seeds, and the compensation measures in the regions that are accessible .

The forest restoration department includes the involvement of the owners of interest at different levels, including weak categories, in planning and decision -making, and at this stage it is necessary to know the effect of the interest of each group of interests and their goals, then the role of the monitoring comes to measure the remedies of the time in the passage of time and to determine whether the procedures have been caused by changes or it was expected or unexpected, such as achieving the restoration of the intended future environmental state and knowing whether it has helped in achieving its social and economic goals or calculated all the obligatory conditions to restore.

In the process of setting the implementation of the deforestation targets that monitored, several indicators are chosen to measure the change in goals with focusing on the adaptation of administration experiences with the experts of the program, and the proof of the necessary themes to achieve the balance between the management technologies that support the cultural practices with the preservation of the environmental system services and its improvement and the combination of many environmental and social indicators different leading, simple and effective communication with the manufacturers of policy and donors, and the general public to put the proper reactions that take into account Social, economic and environmental values of traditional landscapes(Regato et al., 2020) .

The social and economic outcomes of restoration interventions, such as livelihoods and food security. They are through the available decision-making tools, as these tools that can be approached to recover the elaboration of the possibilities in using the lands. It evaluates the contradictions between benefits and evaluate the needs of the consistent interest owners that are prepared on a wide range to determine the priority fields of resetting using a varied group of programs and map tools to provide information about the types of tree that have proven to be useful for agricultural and allowed users to determine the types of trees that are possible to well develop in the significant sites based on their expected ability on the survival under the current and future climate conditions (R.L. and M.R., 2018).

Despite the presence of the greatest amount of social feasibility and the lowest cost of the alternative's opportunities, The restoration of agricultural forestry plants will be legally prohibited and in some areas not provide sustainable solutions. Often the political context is neglected with the development of the legal framework in the review studies, which may lead to the change of priority areas for reservation. There may be a need for learning processes during the workshops to define the owners of the interests with the framework of work. Restoration needs to reach to the proper decisions that are the acceptance of everyone, however, the experimental testing is in a case study systems required to ensure the extensive implement (Budiharta et al., 2016). Therefore, a large variety of strategies ranging from unassisted restoration to removing barriers for regeneration (fire, competition, erosion) and the introduction and composition of plant species or appropriate selection of agroforestry systems(Scheper, et al *et al.*, 2021).

2.11. Managing the restored forests

The restoration plan should take into account several aspects such as topography, disturbance frequency and severity, local restoration, possible obstacles, and resource limitations such as funding, technical ability, expertise, and project goals. Restoring the structure, function, and species composition of pre-existing forests is one of the many restorations aims. Other objectives include recovering desirable ecological services, such increasing biodiversity or carbon sequestration, and developing forest landscapes that fulfill extra social and economic functions(Scheper, et al *et al.*, 2021).Governments are playing a central role in restoring forests as financial policies use public revenues to provide investors or land directors to carry out the processes of restoring and direct management and direct inputs to the administrators practices and adopts new technologies or even imposing the prohibitions to be protected more from the draining of the gaps or bad management activities . Therefore, many mechanisms are available to fund the process of restoring forests like financial mechanisms, market mechanisms that are funded in an individual manner, and differ on a construction on the stage of restoration of forests, the needs of restoration and the nature of the informed investment. The completion of other options, in return, the national authorities may be required to change financial policies to the local authorities, or financial facilitate transfers where the local authorities can target public investment in the restoration of forests in terms of political courses can also be affected by the implementation of financial policies and public programs through government changes, and the change in public policy goals and diverse. In many times, the financing of public programs is focused on sectors that are separated, instead of focusing on the scene of its entirety.

This leads to the allocation of funds and resources without taking into account the potential conflict between sectoral objectives and activities may be produced.

The results of the restoration of forests and the different services of the ecological system, which can be sold through the different markets, can increase the investment and process the "market failures", such as the absence of markets or inflations. The benefits or costs that have not been taken into account in which one is supposed to be informed by providing the restoration of forests that include investments in the participation of interests and legal frameworks, organizational frameworks, ability to plan and manage the normal regulations, and the development financial mechanisms that include

loans, shares, insurance products and mechanisms funded in individual manner, and the personalized personal labor before the administrators of the lands or business owners, and social mobilization such as competing or voluntary work that benefits the community to provide funds for forest restoration activities during the different stages and covering the costs of transactions to establish initial assessment activities, (the company's ranges expand for restoring activities to become a sustainable). However, it can also create different management scenarios to get a more comprehensive view of the organization. Where MCDA is used on a wide range to assistant the alternative decision in the restoration management, and because of the emergence of different criteria, the model can be more effective, because the decision-makers are able to participate in the process and recognition the various criteria, as many of the different decision-making can be chosen to evaluate the administration's alternatives. Therefore, choosing the appropriate method depends on the views and goals of the decision maker. However, environmental and social balance and economic interests are important to meet the future and current requirements(Uhde *et al.*, 2015).

The current studies have indicated the review and development of the concepts of forests management and how they can solve the problems of the forests , including the description and completion of the multiple-ecological systems services, and the spatial aspects of planning since it is limited in the end of the quality of thoughts and visualizing the planning experts in cooperation with the owners which works to play appropriate roles and share rights and responsibilities for the successful integration of the framework components(Baskent *et al.*, 2020).

Defining monitoring indicators and metrics requires clear goals and objectives, the scale of the project, and a careful assessment of the environment and social landscape contexts. At the same time, the monitoring framework should not be flexible over time (Rietbergen-McCracken and Narayan-Parker, 1998). Prioritization requires establishing appropriate criteria and indicators by eliciting expert opinion, and its implementation usually uses a geographic information system. For the final "prioritization" map (Orsi, Geneletti and Newton, 2011).The AHP multi-criteria spatial analysis method is applied to integrate and prioritize forest production and protection functions and to determine the mapping as well as the criteria for the topographic, biological, climatic and sub-criteria (Baskent, Borges and Kaspar, 2020).Hence, spatial decision support systems (DSS) consider different dimensions or features of forest management problems. The dimensions and categories are:

1. Time scale: long-term (strategic), medium-term (tactical), short-term (practical).
2. Spatial context: non-spatial and spatial context (with and without neighborhood relationships).
3. Spatial scale: permanent level, forest/landscape level, and regional/national level.
4. Number of decision makers: one decision-maker or more than one decision -maker/stakeholder.
5. Number of targets: single target and multiple targets.
6. Goods and services: marketing of non-wood products, marketed wood products, and non-market services (Segura, Ray and Maroto, 2014).

The restoration of forests also works to use the grants to support a wide range of activities, such as early construction for sustainable agricultural systems, and long -term residence activities, provide the technical support of the administrators to create the markets supporting restoration.

These mechanisms are often used during the implementation and sustainable financing stages of the process of restoring forests, therefore the different mechanisms will be appropriate for specific conditions and will also be funded by different mechanisms and exports, according to available level of risks that the investors can manage, and the output results. The investment can also be coordinated and benefit from sufficient financing that is increasing the practices that generate a greater impact of a lot of resource, and works to increase financial returns and reduce costs, risk and investors that are involved, where the financing projects can be funded to fulfill their own investment criteria. The success of these projects must be treated for short and medium-sized changes effectively, and the role of the owners of interest in the mechanism that integrates solutions and evaluation by setting the

goals after collect information, and determine investment priorities projects that are taken into account in the time restoration of forests.

It is important to determine the analysis of the cost and the return of the activities of restoring the forests and account of the required compensation, as well. At the level of the individual or the community, where the mechanism can be a clear judgment supported by the policies that are the development of a long -term financing for the defenses of the environmental services, with great possibility in the cost of the other organizational methods (*Local financing mechanisms for forest and landscape restoration*, FAO, 2021).

Restoring forests is challenging due to social and cognitive constraints, including landowners' unwillingness to contribute, ignorance, disputes, and socioeconomic hurdles. The world's rapidly expanding population, extreme weather, and changing land use patterns contribute to these issues. Agroforestry activities are often overlooked in forest restoration plans. To improve health, drought resilience, and future wildfire likelihood, studies recommend adjusting management practices, spatial planning, and monitoring systems.

Mechanisms are being identified to facilitate access to financial resources that motivate the countries of non- financing, so that it can implement its national activities. In terms of specialization, the applicants will seek to implement the work plan and benefit from public financing and wide range through the strategic mobilization of international environmental fund ,and the priorities of the financing mechanisms may include the global and local effects in the plans of motivation, and the partnerships between the two sectors and private investors, as well as supporting business plans and bankable value chains that facilitate the restoration of investments(‘Action Plan for the Decade on Ecosystem Restoration in Latin America and the Caribbean’, UNEP, 2021).

Also, it is possible to reach more innovative mechanisms, and the incentive loans in a suitable manner and its development in this stage to support the implementation of the limited and planning of the forests during the stage of the empowerment of investment. One of the main challenges facing the payment plan is to meet the environmental services in the presence of a clear understanding of the program including a broader mixture of policies that affect the enforcement, where the drains can be appropriate for the supplies of the vulnerabilities.

It is important to understand its effectiveness in achieving its environmental goals, so it is likely that the use of the most preferred indicators for the services of the ecological system to costliest monitor. It is beneficial lessons that are constantly in alternative economic activities, investments in the restoration of forests come from a varied group of private, public and civil sources, and with varied forms, investors from the companies that have social responsibility for the assembly include Carbon compensation plans or for example, such crowdsourcing, banks and investment funds. The investors may include the local or national government that funds the restoration of forests through the budgets of the state, programs, or institutions, and the civil society investigates are, they are dictations or companies and environmental system services of the economic benefit of the activities that disenabling the forests or the natural regulations by making it more profitable on the long-term. It can also be paid by public users, both local, national to preserve the biological diversity, where the land guards' salaries are paid to protect the biodiversity (Liagre, 2015).

Also, the appropriate investment, the ability to meet the investment criteria, the technical efficiency, the bound access to the markets and skills, the sufficient support of the owners of small possessions to implement the reservation, level of risk and the expected return rate and transaction costs to the investor. Among the investors of the private sector, the non -governmental organizations and the multiple financial institutions and multiple frameworks to focus on the long-term sustainability, instead of the short -term and for the fire aims to link the sustainable environmental studies that include environmental agricultural tourism, which provides the agricultural stations to preserve natural areas with the administration of agricultural lands on the level of sustainability as well as

tourism standing on nature / land life, which can be practiced in public or private forests, and provides incentives for societies to memorize the communication of the principles and natural areas of the basis those who are searching for land life or natural regions, as well as social tourism, which provide assemblies to preserve the natural areas with the land administration of where the non -market benefits can increase value subject to the natural resources, and the cultural empowering local people, expanding their skills and expertise, and protecting ecosystems. It is possible that the projects that take place for one time are stimulating, which are only focused on agriculture, especially without a possible management. Projects should be successful forest restoration more than once. Planting trees that including taking care after planting and maintenance. As the rate of non -legal forests is the best option to preserve the remaining wizard. After that, the following step is the improvement of the management of the forests that treat social and economic factors and include the planned fires to increase the wild cover, so the reservation of the forests does not only relate to the agriculture, but it also includes a group of procedures, including the protection to increase the community concern and challenges. Consequently, identifying the fundamental conditions that need to be addressed and modifying the strategies to extract land life as well as social and economic elements are necessary for the effective resetting of the woods. Knowing the restoration plan also makes it possible to determine whether species are suitable for cultivation. And how should they be planted? As a result, developing a strategy is crucial to the planning process for forest restoration, as most unsuccessful restoration projects are the result of insufficient planning and management (Fawzi *et al.*, 2020).Therefore, specific plant production protocols must be developed to ensure the production of seedlings high quality and strong, which were the main factors for success.

The main points in the project's forest restoration work are: (1) the availability of high-quality plant materials of the selected types.(2) The good preparation of the soil and the accurate chart to facilitate the growth of the roots, and storage of water in the soil.(3) Choose the appropriate planting period, and ensure that the soil is sufficiently moist.

The main limit for the forests is the preservation of the water balance or the ability to carry soil the water that helps the methods of using the needed amount of water, this reduces soil water recharge.

In order to effectively implement field restoration techniques and monitor the performance and effect of all interventions taking into account the environmental conditions of the site by selecting reproductive materials, various factors like the following: (1) the origin region of the material; (2) Full ripeness of fruits in the field; (3) The good management of materials from the seeds grouping, as well as the use of the largest number and selection of the valid seeds, verifying the quality of the seeds; (5) Develop short- and long-term service procedures. (6) Development of measures before the processing to secure the plan, as the need. (7) The possibility of improving the rules for the forests without providing the additional fields for each of the seeds and phases, which represents a great success towards the reduction of the costs of contribution to the guidelines improvement of the of forests management(Hani *et al.*, 2017) .

Users 'opinions may differ significantly among individuals, depending on their level of technical experience and their need to know the different aspects for the database. However, it is important for users to have an organized view of data entities and the relationships needed for their analyzes(Armstrong and Densham, 1990). To arrange a complete group of plans that represent the different decision-makers by choosing the compatible plans with actual requests and available resources, and evaluation a group of environmental indicators which merged with other different sectors like economic and social criteria that were identified and associated with experts and specialists from different background include forestry, agriculture, hydrology and social economics to determine the best report of reservations that make satisfaction with the process of analyzing the cost and revenue in the future (Li *et al.*, 2020).

The state must also give priority to the preparation of the national levels to gain the benefits.

It is at this early stage of the restoration planning process that decision-makers are concerned with restoration activities; The focus is on the economic evaluation of it, and analysts may start a national measure to determine the priorities of resettlement at the regional level and transition to the analysis of the accurate quantity for the restoration place. Also, the resolution decisions may be confronted by the decision -making manufacturers based on the countries of the countries that committed the lands to enhance the ability to determine the benefits of restoration activities scenarios at different levels of details and costs through different geographical locations, criteria, and decision -making which allows the analysts and other decision -makers to update the properties with the change of time (Christin, Bagstad and Verdone, 2016) than this definition helps planners, and policy makers in making-decisions with regard to the development of forests restoration after fires. As for future research, it is recommended to study the possibility of incorporating administrative reforms to strengthen restoration studies and implementation. As these studies can be based on some administrative reform practices including improving governance, unifying and enhancing the efficiency of government agencies. The local authorities responsible for urban development, the more scientific capabilities to increase accountability. Moreover, It is possible updating the current master plan land use and dividing the areas according to the land suitability map to provide further guidance towards sustainable development (Al-Ghorayeb *et al.*, 2023).

Strategic plans are usually prepared to cover fairly large areas, from the forest level to the regional level. The plan is updated whenever the planning environment or needs of the decision maker(s) change, and with it, planning situations and needs vary greatly on a case-by-case basis. decision making for decision makers compared to ecosystem management planning; or when using quantitative criteria compared to qualitative criteria, each method can be used in forest planning for the tasks for which it is particularly suitable, choosing the best method to support the decision, knowing several methods, and considering the requirements specific to each case (Kaloudis *et al.*, 2005).Also, the activities of the joint supervision with the identification of the joint priorities between the necessary agencies to determine the set that meet the special interests of many lands and the owners of the interest (Ager *et al.*, 2021).Choosing the best multi-criteria decision support method (MCDS) depends on the quality of information available in preferences from the information available to evaluate decision alternatives with respect to the decision criteria and uses ordinal information for the criteria. It is one of the easy and simple methods, and has the potential for wide application in the management of forests and other natural resources, and the potential for its applications will likely increase in the future (Kaloudis *et al.*, 2005).

Post-fire management should be based on three main pillars: ecological, economic, and social. The social aspects will facilitate the identification of relevant stakeholder groups, their needs, preferences, traditions, and potential conflicts, and the economics will help in assessing the efficiency and distributional impacts (equity) of possible management alternatives.

Post-fire management affects the restoration process and depends on the type and timing of actions implemented and the development of different alternatives on how to treat the forest after fire. From an economic perspective, post-fire management alternatives are evaluated according to economic efficiency ,distributional impacts of post-fire management alternatives and costs affect the restoration pattern and period for each of the affected goods and services, as estimating the restoration period to restore the flow of forest goods and services represents another challenge in the process of economic evaluation of post-fire management measures. There is still a lack of knowledge regarding post-fire management and restoration measures. Such as removing burned trees or not, what logging techniques should be used. The type of logging waste management and the effects of the interaction between fire severity and harvesting to complete the required information to evaluate the efficiency of alternatives. Post-fire management and evaluate which ones will have the highest positive impact on social well-being and thus will be the most efficient from a social perspective.

The legislation also appears to be useful as a framework that enables forest owners and responsible authorities to identify the necessary actions to be taken in fire-affected areas explicitly taking into account public perceptions, both aesthetically and ecologically, to launch restoration treatments, as well as involving the community in post-fire planning. On the other hand, appropriate forest treatments can only be determined in light of the management objectives for that particular area of forest, and these objectives are partly determined by the needs, desires and aesthetic preferences of the local community but the difficulty here lies in what might be considered the distributional effects of restoration so that the community as a whole benefit from the direct benefits, and indirect to implement restoration (Mavsar *et al.*, 2012).

The evaluation is also carried out in three stages which are: (1) drawing forest maps, using Aerial photographs and classification of areas.(2) Ground field evaluation of management units; (3) Developing management strategies.

The framework of the normalization ranges of this is a better, and it can be used by different types of lands and across a wide range of ecological systems of the forests. Economic interests are also studied, improved for livelihoods, intervention costs, and benefits arranged on the flow of the electoral system services, and in accordance with the existing policies and laws. With the selection of criteria and the identification of opportunities, it is possible to specialize in their appointment to them according to their adherence to processing a set of social and environmental needs. All basic activities that include collection and analysis of different forms of data, as they disperse experiences and data available on the largest pillars, therefore the types of analyzes will also be different.

There is consensus on the goal, which is to use the best information available to identify areas with the highest potential for restoration to determine the most appropriate restoration interventions for these areas, in order to evaluate the costs and benefits of these activities, the analysis process must take into account the needs of key end-users and the need to involve expertise ,and points of view from various sectors so that these analyzes can be a basis for improving restoration planning (Pistorius, Carodenuto and Wathum, 2017). Natural resources must be protected, restored, and preserved in order to obtain correct data, develop an appropriate plan for development and develop them, as well as come up with a realistic land use plan balanced, which is the final result of a regional plan in which we explain the concept and importance of land use based primarily on natural resources, the types of plans and criteria used in the land use plan, and the importance of land management in the success and comprehensiveness of the regional plan to manage growth and address the cumulative effects of the development process on the environment and resources in particular(Reed *et al.*, 2009).

In the selection of agricultural orientation areas with the annual or permanent solutions and productivity of the forests. The map of the repercussion also provides vision for the future, and thus reflects a group between the owners of the multiple interests on the relevant criteria that are considered task in this choice. Therefore, it is important to re -consider these maps and re-evaluate the priorities of the recipients periodically, with more information available and with priority and local and national opportunities. With the comparison of these assumptions and the set of the uninterrupted reservation to highlight the services of ecosystem and economic benefits arising from restoration interventions. After that, the costs and benefits of the use are estimated by using the progressive and non-market evaluation analysts, as well as the direct costs. In addition to the costs of the expense alternative to the previous agricultural use of the land.

After these procedures comes the role of economic analysis such as the revenue, the analysis of the effectiveness of cost, the analysis of the improvement of the reservation, and the analysis of the economy. The results of these analyzes will help determine investment priorities. The owners of the interest and the preservation of their participants may be in all stages of the restoration process, difficult and separated a long time, and therefore the owners of the interests can be classified into three different groups: (1) the owners of the interests.(2) The main ones (direct),and secondary

stakeholders those who live or work in the landscape (Indirect), such as government agencies and decision-makers, who are responsible for managing resources and land use; (3) Interest groups, such as national experts or non-governmental or international organizations, those who have an interest in restoration activities and their results, when stakeholders participate in decision-making, landscape management changes. There is no unambiguous framework in terms of guiding the decision-making process to the best implement restoration, also, the consequences of regional and national assessments of the recruitment and financing opportunities create an environment for planning multiple sectors and the participation of the main interests of the owners' Financial supplies (R.L. and M.R., 2018). Restoration should take place in the landscape, the size of the restoration area, vegetation design specifications and management of these forest areas. Achieving restoration success requires integrating the natural and social sciences in a way that produces effective landscape management plans and encourages their implementation. The restored ecosystem acts as natural capital for the accumulation of these goods and services, another goal of a restored ecosystem may be to provide habitat for rare species or to house a diverse pool of selected species to protect and restore natural and cultural values while promoting sustainable economic development through the adaptive reuse of site-built infrastructure.

Multi-criteria analysis is a mathematical tool for evaluating alternatives that allows different scenarios to be compared based on criteria to support decision makers in making wise choices over time (Navalho, et al., 2019). A number of temporal and spatial factors, including economic and social ones, must also be considered. Stakeholders meet the strategic goals and expectations of planning and decision-making through increased public involvement in natural resource management decisions, especially at the local level. This has led to calls for new methods of understanding environmental and natural resource issues, developing and accessing alternative solutions, and maintaining adaptive management for a cycle of four activities: planning, implementation, monitoring, and evaluation. While implementation is about choosing how to accomplish something and then executing it, planning is more concerned with decision-making and what has to be done. Monitoring and evaluation are activities to analyze whether the state of the managed system is close to achieving the goal or not. Tactical and strategic decisions must be made at different levels, from regional to national (Lexer *et al.*, 2005). Decision makers should be more transparent in the decision-making process to support research on the response alternatives analyzed and allow researchers to focus on identifying gaps. In decision-making processes and the questions that managers must ask to meet environmental, economic and social requirements. It needs to expand the circle of making the right decision in space and time and this has led to an increased demand for taking into account environmental, social and economic factors with multiple temporal and spatial scales (Dunn et al. *et al.*, 2017).The perspective of the stakeholders who achieve the strategic objectives of a broader destination view in sustainability science, in particular at the local level that have emerged for new ways to help understand natural resource and environmental issues, and to develop alternatives, their evaluation, and adaptive management.

Environments typically require specific decision processes such as a DSS that may be tailored to a specific problem, support a specific decision process, or just a decision making phase, or may be generic and adaptable to suit a range of decision problems and processes (Vacik and Lexer, 2001). Greater emphasis also on integrating environmental science, technology and current knowledge to expand basic and applied research, especially conducting more systematic reviews to achieve research growth that serves as a reference for all studies related to post-fire forest restoration.

Measuring success in restoring forest landscapes is also complex, and although some monitoring frameworks have been proposed, much remains to be done, trying to assess social and environmental impacts requires indicators at different levels and across different spatial and temporal scales.

In 2018 principles for forest restoration were proposed as the following 1. Focus on the landscape. 2.

Engage stakeholders and support participatory governance. 3. Restore multiple functions for multiple benefits. 4. Maintain and enhance natural ecosystems within landscapes. 5. Integrate the landscape into the local context using a variety of methods. 6. Adaptive management for long-term resilience (Robin L. Chazdon *et al.*, 2020).

The need to treat the drivers of forest loss and degradation remains a challenge in most cases, with the main direct drivers such as those related to agricultural progress, infrastructure development, mining and urbanization, tenure security or marginalization of already vulnerable groups may ultimately have significant impacts. In successful restoration studies, restoration is likely to be short-lived benefits and disappear once donor support is removed. Despite these challenges, initial results have been achieved as global restoration initiatives but their effectiveness has increased through the implementation of improved undertaking criteria and a more comprehensive and specific monitoring system. Integrating adaptive management with research and experimentation will allow a range of restoration outcomes and help make restoration efforts more successful in meeting human and ecosystem needs (the most common approaches to dealing with such problems). However, the performance of even the most accurate decision support systems is limited by the quality of the input data, and carefully managing the challenges aims to develop a framework that organizes knowledge about implementation, and how to manage it efficiently, to better define priorities for the future. Efforts to mitigate associated risks (Pacheco et al., 2015, Stanturf, Lamb and Madsen, 2012),while comprehensive landscape management, i.e. equitable participation of stakeholders in post-fire forest restoration, multi-functionality, transparent communication between policies and actual actors, consideration of future funding and adequate budget for restoration, identification of effective resistance systems through feedback, current monitoring, and evaluation of protocols used in forest restoration taking serious responsibilities and using spatial tools to identify trade-offs and priorities for forest restoration, encouraging multi-functional investments of both natural, human, social and financial capital, studying the analysis of restoration costs (labor - financial - agricultural practices - production) and the benefits of using them in decision-making, identifying the amount of funding and partnerships, the size and quantity of resources invested, the number of parties involved in restoration activities, the modification of forest restoration laws and legislation, and most importantly that restoration must be sustainable in the long-term and a resilient system with minimal appropriate human intervention (assisted - natural) with support knowledge and technology forest management, and encourage planning, monitoring and financing (adaptive management) that help overcome obstacles.

There are not yet general and effective solutions to meet the needs of everyone, and preserving nature and human needs, the main reason is that the competitive requests on the field of the cover and development are resulted in reserve implications, and there is still a difference of the best way to direct the decision -making process and implement the restoration of the forests.

The use of the natural landscape of forests of the pioneering planning process is by building the idea that international and national targets are "naturally" through the decline planning systems of countries. However, it is increasingly recognized that politically oriented planning mechanisms and administrative. It is not always compatible with the social and environmental identity of the landscape that faces in parallel the judgment and the number of their relative capacity to control the reservation, and the process become more complicated when the natural bodies extend through the political and administrative limitations, and cover more than one of the result of an administrative planning resulting, so it is permissible for those who are recognized, requires participation of the owners of multiple people working in sectors and at several levels (Rochimi, Waring and Sánchez Meador, 2021).

2.12. Obstacles and risks of forests fire restoration

The largest limitations of social operations and those that share the owners of small possession is

also the infrastructure of tourism and management skills. The environmental tourism also leads to reducing the available resources of local societies (Kabil *et al.*, 2022). Investment exports can be used to finance the needs of the restoration of different forests and the needs of the owners of interest, in different stages of the process of resetting, according to the level of the risk that the investors are intended to accept it and the rate of the signature return (Local financing mechanisms for forest and landscape restoration, FAO, 2021). Therefore, it is possible that as well as the complex planning of the financial parties in determining the priority of the investment flows and strategies of the restoration of forests in the target of the restoration of forests and the deterioration of the addition funding to support the executive with the expectation of risks with the different financing needs in all stages of implementation of forests and their adherence to the appropriate financing mechanisms with sustainable market mechanisms, to make restoration valuable in the long-term at the local level. It is also important to understand the institutions are available to guarantee the support , and increase the ability to expand the forest restoration(*Local financing mechanisms for forest and landscape restoration*, FAO, 2021).

The most prominent challenges of restoration were the lack of stable or adequate financing and the allocation of specific funds at the national or regional level. This challenge can be overcome through spatial planning by developing a national restoration plan that manages limited funding or resources while setting priorities according to the current status of methods for treating and managing damaged forests, identifying trends within and between countries, with consistent and complete documentation of these fires, with the need for coordination and defining its mechanism among all Stakeholders. Another challenge to forest restoration is the lack of a accurate strategy that defines restoration priorities, as well as limitations related to restoration operations. In addition to the social and mental constraints in forest restoration, which negatively affects the implementation of optimal forest restoration, and while the main challenge in fire management is coordination between managers and landowners with different ownerships, so reducing the scope and number of high-risk forest fire is needed. There are limits to cooperation among managers and landowners. Social constraints can exist, including unwillingness of landowners to allocate land for restoration, lack of public awareness, increased conflict, biophysical, governance, and socioeconomic barriers. There are also the complexities of integrating multiple interests and concerns often competing in scale and priorities, to balance biodiversity, ecology and livelihoods. These challenges are exacerbated by rapid growth, frequent extreme climate conditions and permanent changes in land use, which in turn increase the importance of rethinking how to restore degraded ecosystems. Livestock grazing in damaged forests delays natural regeneration, and political and legal restrictions may hinder the success of forests. Implementing effective forest restoration through social, environmental and power imbalance dimensions (J. Boone Kauffman, 2004; Schultz, Jedd and Beam, 2012; Guariguata and Brancalion, 2014; Spies *et al.*, 2017).

To raise public awareness of the value of forests to local economies and the environment, a multipronged strategy is needed. This includes education and outreach programs, partnerships, demonstration projects, economic incentives, empowerment of local people, training, capacity building, policy advocacy, collaboration with Non-Governmental Organizations (NGOs)and international organizations, curriculum integration, media campaigns, incentive programs, and integration of culture and religion. Educational initiatives should focus on the ecological, social, and economic advantages of forests and the significance of sustainable forest management techniques. Partnerships with regional organizations, governmental bodies, non-profits, educational institutions, and industry players can maximize resources and expertise in promoting environmental awareness. Demonstrations should highlight effective instances of sustainable forest management techniques and their advantages for regional economies and ecosystems. Economic incentives and benefits should be emphasized, such as financial value on ecological services like carbon sequestration, water

management, and biodiversity preservation. Empowering and involving local people in decision-making processes about forest management and restoration can promote a sense of ownership and stewardship, leading to more sustainable outcomes. Policy advocacy should promote robust national, regional, and local environmental policies, urging legislators to prioritize pollution control, support sustainable development principles, and protect the environment. Curriculum integration can instill sustainability and stewardship as lifetime values. Long-term strategies for environmental sustainability should be flexible, inclusive, and sensitive to changing environmental conditions.

Without additional funding, institutional operations will continue to work with a weakness of clarification, especially with regard to the division of roles and responses between the related parties such as response to the emergency and the management of the forests, and the food products of the regions that localization, there will be no methods for the management and the cooperation between the provisions of the answer to the limits in confronting the rising of the phases. It is also necessary to plan in the forests area, to take into account the effects the intended activities of multiple activities and developments (even if it is not a reward from the same project), for example, a new way works through the lands to the occurrence of direct social effects, such as tree cuts, business works, and the restoration of the potential, and in conjunction with the indirect or secondary effects such as ease of transgression are taken into consideration by the non-legislators or the establishment of a non-planned trade development. ('Increased climate resilience of South Caucasus mountain communities and ecosystems through wildfire risk reduction', 2019) .The inception of investment is due to its negligence in the sectarian planning of other economic interests in the environmental planning, and what it can be made to specialize in the small feature of the biological diversity. The fact that the shortage of investment in the use of the environmental system is a result of several factors, the first is awareness that the long -term solutions are provided by the use of the environmental system. Many societal challenges are treated with a more democratic method because it helps the countries of the natural capital and increase the competitiveness, and reduce exposure to climate change and other threats. The second factor is lack incentives to develop an ecosystem restoration economy, including the new investment strategies that benefit from the existing and non-traditional funding sources.

The third factor is the disagreement in the time breakthroughs between the investment, financing, and balanced sessions and political sessions (1-6 years) and the processes of renewing the environmental system that more than two or three contracts and arranged to develop the automatic arrangement corporation and political, which must include social and economic aspects. The environment is completed with tools to ensure the implementation and improve it, and this requires planning for a minute for the management of the complexity of a multi-specialized project and then the need for a decoration of the needs of information by the basis of policies and decisions with scientific research as a college for the direct and effective flow of information with the global strategy of the United Nations contract to restore the ecosystem. This action plan is based on three paths for change that are: (1) Establishing a regional movement society is involved in the recruitment of the ecological system. (2) Enhance political and decision-making be which is often supportive, and (3) stimulating research and development in which there is a technology capacity to restore the environmental system includes providing decision-making with the information and tools that are required to facilitate the development of the use of the ecological system in public and private policies with strengthening regional dialogues across the sectors, inside government and the private sector, regarding the requirements of the necessary interventions and enhance the reservation of the ecosystem within each country, setting and implementing a regional strategy for the innovative financing of the residency reports .

The ability to plan the recruitment of the ecological system that improves needs and opportunities,

environmental , socio-economic information and the case of exhaustion, the possession of the lands, and its use of the existing and expected infrastructure. In addition to the technical capacity required to design the implementation methods through the long-term monitoring which allows the development of the environmental system at the regional and national levels of tolerance for countries to follow the progress it is directed at the level of fundamental information and improving more effective technologies and capacity equipment of the neutral ecological systems through the development of environmental systems in policies and plans to face priority , national and regional development challenges to facilitate the comprehensive view of the achievement of international assignments and national priorities ('Action Plan for the Decade on Ecosystem Restoration in Latin America and the Caribbean', UNEP, 2021). In fact, the lack of rules and their implementation may lead to unsustainable management of forest resources on the one hand; In other part, a number of rules and requirements may lead to more effort and intelligence, as there are many rules and bureaucratism who accommodate innovation and adaptation management. The importance of governance challenges in landscape restoration is often underestimated the practitioners of the user in the forests or environmentalists, such as removing exotic species, and protecting sites for natural regeneration and replanting of indigenous trees.

In the fire, there are many technical challenges, and the viewpoint of the technical aspects of the naturalized repair of the forests and knowledge gaps.

More than that, when dealing with great requirements, the additional challenges that are improved under the ruling of judgment such as possession and political measures and institutions have a great effect on the restoration, and the necessity of reconciling between the parties and different opinions and agreements that depend on political and social facts for countries or specific regions (Mansourian, 2017).

There are four facts that likely contribute to the lack of a large-scale focus of fire research. First, the spatial research may not be implementable because of the same practical considerations facing practitioners. Second, demand and response, as the volume of burning depends on the response of individual types, targeted groups or interactions with important environmental, such as seeds, and the pollination that decreases in strength with the distance from the edge of the burn and there may be a lack of funding. Third, replicated experiments are difficult to design and implement. Fourth, other factors that influence or are related to by the action, for example, the intensity of the investigator and the confirmation of the influence of societies in it, which makes the isolation of the implications, large burn block, the invasion of non-native species or protect the species from grass. Seed predators are reinforced by some types by taking advantage of reducing the descending or competitive pressure within the internal part of the burning forests. However, the short period of time to return the burnings may restrict some lives from the use of internal areas of the largest burdens, especially if the population exposed. Homogeneity in fire behavior also affects plant communities over longer periods which leads to conditions that make the movement of animals more difficult. That why the spatial scope is more influential towards fragile species that are found after fire, and the non -sudden spot may be a resort to animals that reach it (Mason and Lashley, 2021).

Although forest fires are thought to be a natural occurrence, bad weather and poor forest management are to blame for the severity of the issue. From a practical standpoint, it is difficult to predict the arrival time and legal position of future woods, as well as the conduct of dangerous entities. But, within a certain time frame, the anticipated risk of the anticipated procedure in a given area can be evaluated and resolved in a different way, with the least amount of adverse environmental effects, the lowest risk of premium lives, the lowest possible cost, and the least amount of deals that negatively affect the environment and economic activity. The training of executive directors and the strengths of the forests and the organization of special media programs also plays for the development of interacting with the various social groups (Kaloudis et al., 2005).

Many ecologists argue that managers must maintain ecological resilience and spatial and temporal scales of management importance while recognizing that biodiversity is important for long-term ecosystem persistence, and disturbances play a critical role as a generator of structural and compositional variation at multiple scales, and management tends to produce forests for unexpected catastrophic change by restricting the diversity of ecological processes.

In practice, whether enhanced association due to management activity is beneficial or detrimental depends on the exchange process, the types of stresses or disturbances, the desired conditions, and the goals of the management involved. In the context of forestry, resilience-based management refers to a set of planning and silviculture practices to build an ecosystem's capacity to persist in a desired state and to reorganize the severe disturbances (Drever, et al., 2006).

In doing so the management domain must be contextualized within a hierarchy of relevant scales and understand how disturbances maintain habitat heterogeneity across temporal and spatial scales(Cowan et al., 2021).Processing of the forests management is attributed to a number of factors and the most important factor is the amount of intervention, including the current circumstances or the level of the danger associated with the treatment in the environmental resilience, taking into account the relationship between the intensity of management to achieve a broader scope of forest treatments related to professional differences (Arnberger et al., 2022).

2.13. Ways of funding forest fire restoration

It is possible that financing may be through interests provided by governments, state budgets and resources, international cooperation, technical assistance, grants (special contribution, collective financing) for tourism returns, wooden products and direct costs like implementation, production, materials, the inputs material and the direct costs such as legal frameworks, development of capabilities, cost of the alternative and environmental, social costs, as well as the case in non - traditional financing sources like the environmental funds and collective financing from budget and output development funding institutions by the road of financial institutions, multiple parties with many banks in developing countries, multiple parties, in terms of their ownership of a membership or a clear property and focus on private activities like The European Investment Bank(EIB)the international development funds and the United Nations Development Program(UNDP) (Liagre, 2015).

Payments for environmental services can boost the regional economy. And has a potential negative impact on jobs if forest protection leads to abandoning agricultural land that could have created job opportunities. Also, the markets are also made of sustainable agriculture, the critical production, and the non-wooden products(NWFPS), environmental tourism and services ,all these can start to fund the activities of direct return, from what make it profitable and rich in the long term, for example, the development of the livelihood and the foundation value for natural product and services, including defenses for environmental services, reliance plans, environmental tourism and wooden products. Three Public Database of the Environmental System Services, and each of them is a distinction like government subscribers, as they seek the agents of the public sector to ensure public commission. In these cases, they will be a national or a regional or local development, or international donors, commercial subscribers, and the companies that involve these plans as diverse due to a direct link between the long-term profit and the reservation of the environmental system services through the producers. The improved and the sustainable that reduces the need to the entrances or the risks of environmental or environmental disturbance or social for its operations, while others are involved in the definitions for environmental services due to organizational obligations to compensate the environmental impacts a part of social responsibility programs for companies to improve their listening in local or international societies. As well as charitable buyers those who include non-governmental, national, and international organizations concerned with hospitals and development, as well as the created institutions and individuals who realize the importance of creation incentives

to maintain or resort to the environmental system services with attention if there are no agencies in general or especially in a specific region that will not succeed. The system will not succeed. The other main challenges include the implementation of the defenses for the environmental services are the definitions of the same payments, at any level, and to any amount and on any pillars (Local financing mechanisms for forest and landscape restoration, FAO, 2021).

Decision support tools are an important direction between science, policy, and practice in the field of the natural forests. There is a need for more data on the costs of restoring and its determination, in which the process of analysis can include the cost of repercussions and interference, as it is considered to be "the problem", and the restoration is " "The solution." but restoration is not the goal. Rather, it is a means to achieve multiple goals. The problem is food security, the sufficiency of water supplications, the rise in the risk of disaster, the climate change, and the lack of types (Chazdon and Guariguata, 2016).

Therefore, modeling large wildfires is still an immature field with significant knowledge gaps and is based on economic models with a limited amount of funding, equipment, personnel and resources, decision makers must decide on the most efficient allocation of alternative fire management options such as pre-fire practices, fuel treatments and pre-fire practices (planning and preparedness),and restoration procedures. Achieving this requires the ability to assess the extent of wildfires and their impacts on the monetary value of destroyed or damaged assets and to assess the spread of a fire and its impacts requires a significant amount of exposure to information, which in many cases is not available, particularly to the general community (e.g., environmental values and air pollution) short- and long-term impacts. This leads to a lack of resource value metrics to guide prioritization across fires and resources at risk.

The fire economics assessment system does not always take into account impacts on non-markets for resources (e.g., recreation, flora and fauna, soils), and the impact of interacting social and environmental factors on wildfire severity. Thus, the need to understand the non-linear relationships of systems interconnected physical, biological and cultural aspects to be able to effectively reduce the vulnerability of ecosystems and human communities, through improved and proactive risk management (Ongolo *et al.*, 2021).

This needs decisions about where restoration should take place in the landscape, the size of the restoration area, vegetation design specifications and management of these forest areas. Achieving restoration success, then, requires integrating the natural and social sciences in a way that produces effective landscape management plans and encourages their implementation.

The restored ecosystem acts as natural capital for the accumulation of these goods and services. Another goal of a restored ecosystem may be to provide habitat for rare species or to house a diverse of selected species to protect and restore natural and cultural values while promoting sustainable economic development through the adaptive reuse of site-built infrastructure.

In the field of the economy, the first brief basis is the measurement of the proof, such as the total local product, where the income or the total local product is appreciated the individual's division. Nevertheless, the researchers often use economic indicators such as family income or total local product, these indicators are important to the electoral system of the forests(Takahashi *et al.*, 2021).

Communities also benefit from the authority and services funded through the mechanism of compensation, which ranges from the infrastructure to provide drinking water to the solar widgets and improved roads. The use of the forests and their protection led to the creation of job opportunities directly and the support of the new economic activities in an indirect manner such as the production of improved sales and the cultivation of the fruit trees(Arduino, 2021).

It is noted that forest restoration treatments after fires have led to improving the overall health of forests and reducing the risk of future fires.

From the above, it appears that: there have been many studies dealings with the topic of fire

restoration, but few have noted how these studies deal with the topic of post-fire forest restoration. In addition to the multiple environmental services during the treatment of natural disturbances ,and taking into account the changes in climate and in the hierarchy structure to plan at different levels on the basis of a comprehensive modern classification of the problems of managing the forests and the need for a high level and a suitable place for the program of regulations.

The multiple environments are for the face of these challenges, different tools were developed to make the decision to overcome the complexity the balance of the problem of expensive management planning, i.e., the need for the study between the political, economic, environmental, social, and cultural dimensions during the guarantee of efficiency, as well as acceptance of the plans of the forest management, as the abuse of competitors remains competing. Performing, non -clear, and institutional capacity to implement effective implementation of legal frameworks related to forests. Using the DSS support systems to fulfill these methods and provide more information about the preferences between planning criteria, as the decision-making is characterized by a lot of more decision -makers and / or other parties that have no authority. The decision is not affected, or it may be affected by the decision(the owners of the interest)and consequently the need to plan a cooperative and methods of building the consensus, where the decision-makers and the owners of the interest are required to look at a wide range of goals in many times, and either the level of success the requests or deterioration of the goals, so it is necessary to find a communication and coordination of two forces between institutions the state and the owners of the civil interests, and the effective use of decision-making tools for effective communication between the owners of the interests.

The stages of organized participation consist of two stages, the first stage is the identification of the owners of the interests and the effective parties, the local agencies and the provisions, industries and engineering societies, scholars, local politicians, and many organizations. The second stage is the creation of awareness among the owners of interest in the case of the ecological systems of the forests and the contribution of natural resources in the quality of the human life of the effective destinations to appreciate the importance of using sustainable for the environmental system services. This is why we find that the process of planning and managing forests is not a linear process. Rather, it is frequently learning to adapt as the outputs are monitored decisions and supplies and evaluate and return them with a purpose, which leads to the restoration of the plan and its disturbance for the effective implementation of decision on the land of the fire to each organizational or category level in management including time, management level, spatial coverage, and the source of information and their details, and risks and a number of stakeholders associated with the product. Therefore, the planning is an important element in the management of the forests where there is a large trend related to the use of spatial planning, and the development of the environmental system services with action that the decision support system may not equal between all aspects of planning framework. This is mainly due to the availability of providing or sufficient data, and many of the merits, and the problems ,number of technical capabilities, the non-good governance and the learning through the practical experiences , the analysis of the preference is more than supporting the processing of contracting interactions of the managers who are trying to bind the services of the environmental system in many times.

Previous studies referred to the restoration of forests after fires, and they found that most studies recommended the necessity of changing the old way of thinking in both methods and management and how to carry out this restoration because we live in a changing world, especially in recent years that have proven to local and national decision-makers the failure of the methods used in restoring forests after fires, unless this restoration is coupled with its factors (environmental, economic, social, cultural, aesthetic, scientific, administrative, and decision-making, planning sciences, political and legal sciences).

Economic prosperity, political stability and scientific and technical progress are currently

concentrated in North America, Europe and the countries of East Asia such as South Korea and Japan, the two countries that have supported and financed studies and projects to forest restoration, especially after fires, and this has had a biasing effect. By conducting the latest research and applied studies conducted in those regions or countries with high credibility in the field of forest restoration due to the presence of sufficient funding, this makes the administration better managed, especially by using the latest equipment and techniques that detecting points of administrative deficiency after creating a comprehensive database to help determine percentage, and classification of damage and resulting deterioration, or when using this spatial data to facilitate and weigh the optimal administrative decision and determine priorities that must be consistent with restoration objectives and that take into account the characteristics of the place and the forest(topographical - geographical - agricultural - hydrological - environmental characteristics-biological- demographic-aesthetic and genetic) with guidance on the history of fire information, which facilitates knowledge of areas at risk of catastrophic fires, i.e. their intensity, frequency and definition, and paying more attention to the resilience of forests in resisting fires, in addition indicates that financing should not be the biggest hurdle when restoring forests because integrated spatial planning is able to prepare a national restoration program to manage limited funding or resources by prioritizing according to the current situation of forest burning and fuel processing (adaptive management) while supporting local economies by marketing products, or selling burned timber, i.e. mobilizing resources for sustainable implementation.

This makes it necessary to engage local community and public land managers with stakeholders in forest restoration management processes to balance multiple forest restoration objectives with monitoring and evaluation of outcomes when establishing regional networks. Collaborative integration will promote greater access to post-fire forest landscape restoration with increased scientific research aimed at better planning practice to meet future requirements for sustainable development. In addition to taking responsibilities ,due to the lack of a framework that sets priorities, saving effort and time to obtain the desired results, and this requires wisdom and sound vision by planners and planning methods for managing forests after fires with the aim of restoration, In addition to integrating economic and social factors (especially local community and local livelihood diversification) and actual stakeholders to overcoming challenges and difficulties by resolving conflicts with multiple landowners, understanding risks and understanding uncertainties.

In the face of climate change, strengthening local value chains and creating a network from local producers to build capacity, exchanges and raise funds. Local agriculture, handicrafts, tourism, and forests have great possibilities to provide a long-standing livelihood for local societies for setting forests aside long enough to allow them to recover.

III. Materials and methodology

3.1. Research Design

It is the structure and plan for collecting and analyzing data to reach the goal of the study. Identifying the most suitable areas for restoration.

The research design for this study will be inductive and descriptive approach.

3.2. Research Methodology

The research is based on a working mechanism and methodology, which is a set of steps that stem from the theoretical background and current and previous concepts about forest restoration after fires, in addition to analyzing the results of theoretical studies and global experiments by reviewing method and following up on all theoretical parts to answer the research questions.

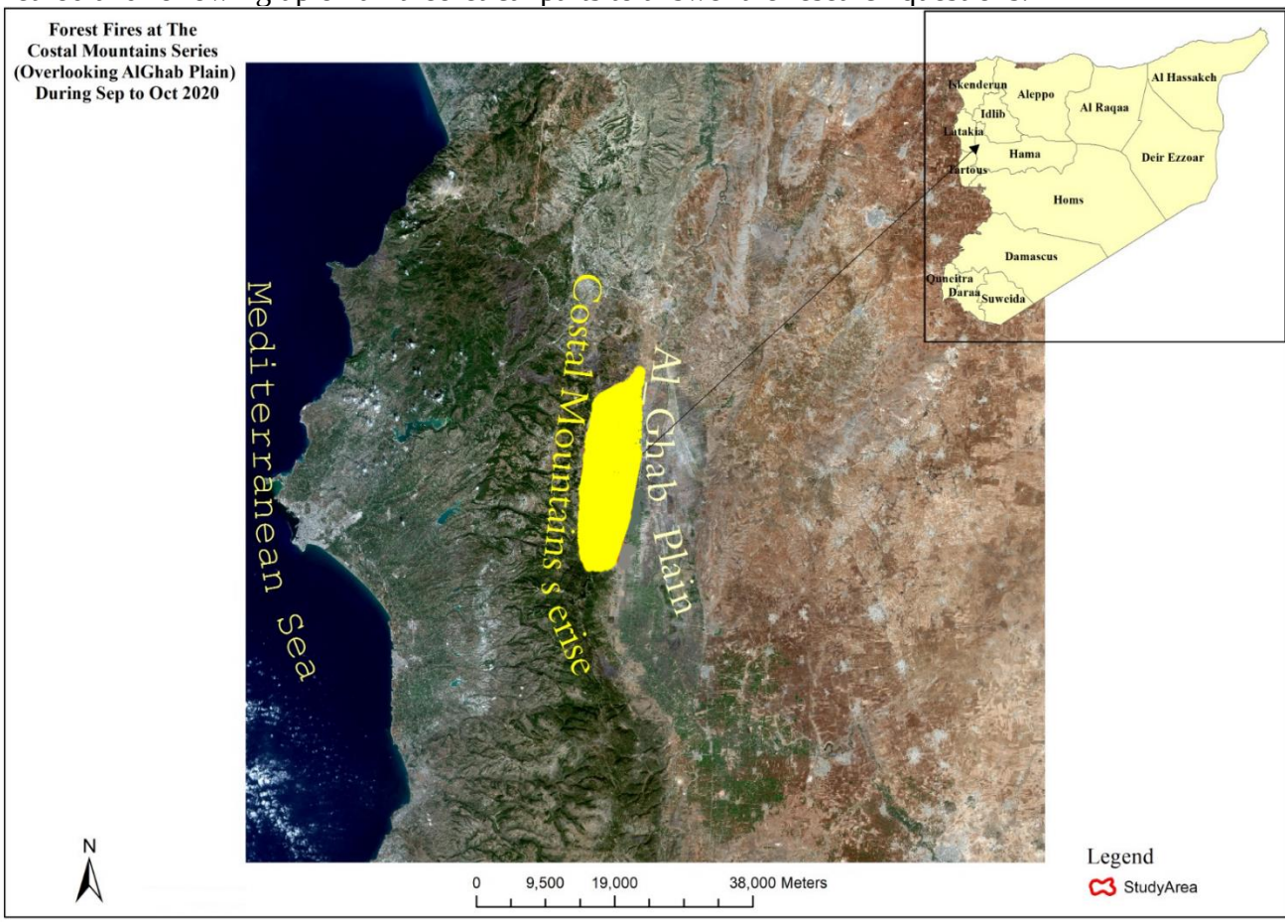


Figure 3.The study area.

(Own editing, 2022)

A section/part of the Ghab Plain (colored with a yellow border), and is considered a study area or as a practical model in which post-fire forest restoration criteria are tested, and then the results are generalized to all of the Ghab Plain so that the appropriate area for each criterion is identified separately for the six specific criteria for restoration to reach the results that are used to make the best decision to restore forests in the Al-Ghab Plain, which is the area most affected by the Syrian forest fires in 2019.

In the end of 2020,the area of burned forests in the study area is about 4,718 hectares, which is equivalent to 12% of the total area.

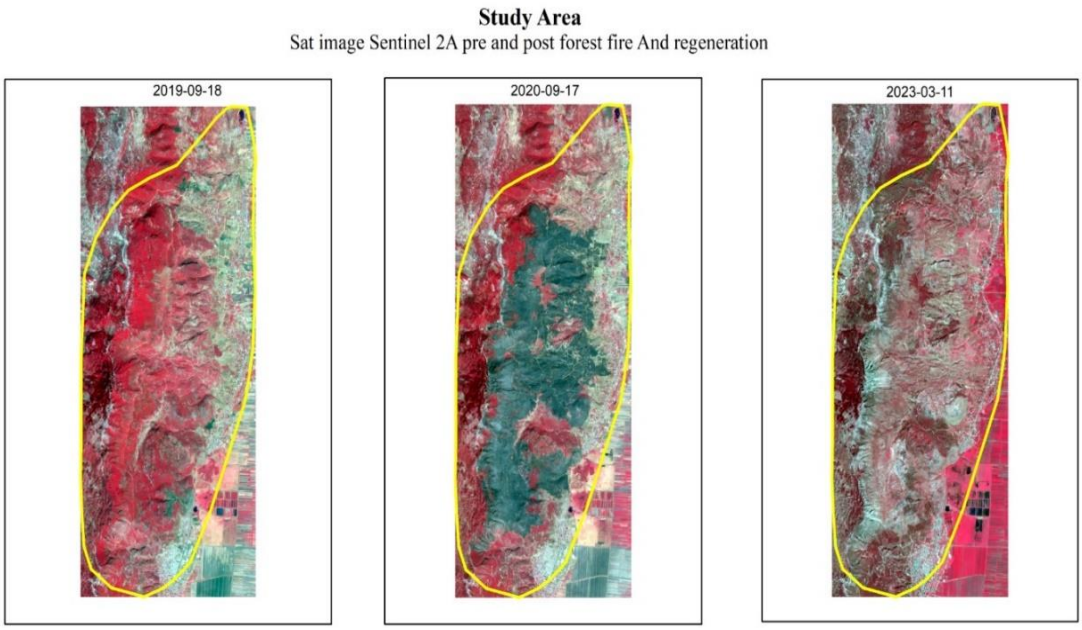


Figure 4.Effected the land-cover from fire in the study area

(Own editing, 2022)

The first stage of research method is field study by conducting a survey, recording observations, and personal interviews and field visits to find out what has been accomplished to restore the Syrian forests, as well as the information contained in the maps from a natural and cultural database, from sources at the regional plan level with regional information and data exchange centers or observatories, governorate centers, including decision support directorates in governorates or municipalities and from other sources, climate, soil and water conservation authorities of the country of natural resources.(Agropolis Special Agricultural Zone-Al-Ghab, 2011; Total Population by Governorate 2015 according to civil affairs records, and Estimates of population by governorate, 2015), The following data sources were relied upon primary data through field visits to public and private sector facilities, some educational institutions and non-governmental organizations (Nizar et al. et al., 2022), and conducting interviews with specialists and decision -makers in the field of forest management in Syria. Available maps in local authorities are another research tool by asking questions, and conducting personal interviews with decision makers. Statistical methods and knapsack method for the best economic restoration project of the Syrian authorities, and coefficients (majority, minority, average, and median) ,and other tools are infrared color satellite image analysis program (where the green color depends on the absorption of infrared radiation)/Sentinel 2A and finally decision-making methods using multiple criteria (analytical hierarchy process)that is integrated with the Decision-Making and Evaluation Experiment Laboratory (DEMATEL).

To enhance spatial decision support systems and forest fire restoration, it's crucial to address duplication, ambiguity, and clarity in map database processing. This involves standardizing databases for comparison and integration, analyzing redundancy to identify datasets with similar coverage, and incorporating multisource data like satellite imagery, aerial photography, LiDAR, and terrain models. Validation and quality assurance can be achieved through field surveys, cross-validation with independent sources, and ground truthing. By addressing these issues, the spatial decision support system can provide more accurate, reliable information for managing and restoring forest fires, promoting sustainable resource management techniques and enhancing decision-making processes.

3.3. Data collection

- All data have been collected, in vector format and converted to the same geographic projection. To facilitate the recent analysis of the compositions, improve the spatial integrity, then each Vector file was transformed into the 30 x 30 m network that covers the study area with its entirety, and the establishment of this geographic data base and its analysis in the ArcGIS10.8 program, and for this reason, the sites are carefully selected, and the priority and the most is a good restoration and according to the collection of the stimulants in the constituent structure that had applied to different characteristics.
- Some mistakes of the drawing may occur due to the reduced spatial accuracy causes that have limited effects and analyzes the map of the land covering, and land uses, social and economic information, map to create an effective forests mechanism.
- This study also included the use of many data, which were obtained from various bodies and sources, including the Regional Planning Authority, the General Authority for Remote Sensing, the General Company for Engineering Studies .These data were processed and worked on using the ArcGIS 10.8 program, cellular representation (Raster) and reconstruction by classification of the six criteria which were represented as layers then classify them into five classes on the same scale to analyze and produce the suitability of restoration map because each of the criteria had different measurement characteristics. Therefore, all criteria maps were unified on a unified scale from 1 to 4 in order to make it possible to comparison, by reclassifying all maps, with values arranged in ascending order of priority.
- This study also used scientific articles, as well as national and international assessments and reports. The Arab literature and documents that Syrian universities have published on the widest and benefited from them, and examining the documents through the internet is also used.
- The initial data was reassured through the institutions of the public and private sector institutions, some educational institutions and organizations with the specialists and industries the decision in the field of forest management in Syria.
- The first open answer question, and its extension of the collection of information on the most important of the outstanding criteria of the development criteria of the six sustainability, and their effects of the influence of forest fires and the designing the Analytic Hierarchy Process(AHP) model to measure the weights of the criteria that were determined.
- The interviews were also conducted with the relevant frameworks, which were the interviews with the owners of the interlocutor to retrieve the information about the policies ,and formulation process.

3.4. Reason for choosing method

One of the most important advantages of the AHP program is that provides goal and objective decisions and its related relationships in a balanced hierarchical structure that defines prior relationships between the criteria, which gives decision makers great comfort in making the right decision and the appropriate solution for the problem. In addition to qualitative data based on the experiences of the decision maker to evaluate information gathered from literature and workplace observations, and through the exchange of ideas by 21 Local experts, they are from academics and forest engineers owners and decision-makers(Unver,Ergenc, 2020,Laha, Balasubramanian and Sinha, 2021).The integrated results were used by the multidisciplinary regional team to identify high-priority spots to focus on restoration goals (Cannon, Hickey and Gaines, 2018). After that, the four proposed alternatives are evaluated, to determine the most suitable forest restoration in the Syrian case based on a set of foundations and criteria.

3.5. Current Syrian forests Situation

Forests in Syria have significantly compared to its economic and environmental importance, as the forest control in Syria is more than 52,7234 hectares, which is equivalent to 3% of the country's area, that makes interest in its multiple positions and its varied productivity increases steadily with the increase in the number of population and with the increase in the effects of climate change, so it has emerged as a significance of the importance of the natural resources and its development because of the possibility of mitigating crown fires in the forests.

The importance of the Syrian forests is important in term of environmental societal and tourism, and the Syrian forests are considered a source of livelihood, an a provider job opportunities for many unemployed people, as approximately 12 thousand workers work in the fire field (National Report 5 of the Convention on Biological Diversity, 2016).

In the Al-Western mountainous more than 28 thousand hectares of various natural forests belong to Mediterranean forests. These forests constitute a beautiful tourist nature within a steep, topographically gradual mountain strip, with altitudes ranging from 250 to 1,500 meters above sea level and a length of 70 km. Among the endangered plant species of economic, environmental and scientific importance are the Syrian elm and the Turkish oak, as for endangered trees whereas the endangered animals like Syrian hyena, deer and wolf. Some of them are already extinct, such as the Syrian bear and the Syrian tiger. On the contrary, common species such as wild boars, rabbits, rodents, various reptiles, snakes, lizards, and squirrels, as well as birds that are well found in the forests , such as the great and small partridges, jays, and blackbirds, but they have begun to suffer from multiple pressures and violations (Allaham, 2010).

Recently the coastal mountains in Western Syria, which is approximately 80 % of Syria's forests have lost 24 % in the midst of the forests, with more than 9 % of the area of the research case study during the war has lost as well. These forests loss can be attributed to a large limit to the unimaginable harvest, legal and non -legal productive production, and the forests are spread due to the burning and lighters, and the agricultural assaults.

Nevertheless, absence of the management in the Syrian forests causes a lot of loss like the critical cover that has vanish for the long-term. The drainage of the forests also leads to a wide range to increase the risk of viability, erosion, and negatively affects the quality of water, the costs of processing, the projections of biological diversification, and the transportation of products and losing other future profits related to forests, and the disability of the restoration efforts in general.

To alleviate these effects, the principles of directing planning tools, and open-source programs have been proposed to support the management of the finances, and strengthening the search for external support sources, coordinating between the Ministry of Agriculture and Reforms and the directorates to put plan at the level of the tourists, as well as increasing the joints of the local community and its income through the programs and processing the suitability of climate change environmental systems for the cultivation of trees allocated to support the basic needs of the farms in the forests.

The costs of the processing of Syrians were estimated for 45 million dollars(Najim and Hajjar, 2022).

The milestones work in Syria, on the accustomed cutting of trees, which has become a special justification, as it is the case with any harvest after the compensation, while taking some of the needs, such as avoiding the cuts of the tree in the forest, and around the roots and the water body, as well as all tree of a certain type and a certain size.

The percentage of the surface runoff is coefficient generally but limited during the monitoring period in burned and unburned areas.(it did not exceed 4-16%).

There was a value in the burned part 7.22 tons/ha compared to 0.1 tons/ha in the unburned part, in addition to the fact that the soil is dry after a long, dry summer, its ability to absorb water is greater.

The relative increase in the surface runoff coefficient can be attributed later.Also, soil moisture gradually increases during the rainy season because it can destroy the construction of the surface layer

from the soil after rain as it limits the infiltration capacity of the soil,this causes increased flow in the unburned area.The value of the amount of soil eroded was larger in the burned part compared to the unburned part, from here come importance of plant cover that appears in limiting from soil erosion, especially the vegetation cover of the forest a mixed forest of conifers and leaves,where the amount of the soil after 6 months of the fire was 0.0015 tons / hole for the vertical part of 0.009 tons / hole for the burning part of the forest with the necessity to note that these ratios were calculated where the burning is a mediator. It is necessary to note that these ratios were calculated where the severity of the fire was moderate,while in another study, monitoring continued for 8 months within the same area where the forest was exposed to a low intensity fire, then the erosion rate reached 0.07 tons/ha.
This is compared to 4.34 tons/ha in a forest of the same species that was exposed to severe fire.
The results also showed that the average PH value of the eroded soil reached 6.9 in the burned part and 6.2 in the unburned part.This difference between burned and unburned areas can be attributed to the ash resulting from burning plant cover above the surface of the soil,which in turn increases the PH value due to its richness with basic cations that solubilied,and its with seepage water into the soil after rainfall (Alali et al . et al., 2014).
Under the current circumstances, many Syrians will continue to turn to the forest as a source of fuel. So, it can be repurposed wood harvest residues as biofuel, which leads to fewer carbon emissions than fossil fuels, while international funders may also support Syria's transition to sustainable energy. It can also be used for periodic products, which are used sometimes to increase the fruit production .
It is possible to preservation to enhance the resilience of Syrian forests in the face of climate change by increasing the area of protected forests parallel with biological diversity, structural complexity, functional diversity and redundancy. In addition to the necessity of connecting environmental axes to allow the flow of genetic material in Syria.
Ecological corridors may include stream or river systems with extensive forest or river barriers, these axes may contribute to the economy through services to protect the water community, as well as opportunities for cultural and environmental tourism(Najim and Hajjar, 2022).
It is interesting to the concern that in the years before the conflict led to the burning of a lesser area for example, 82 fires in 1999 and 133 hectares were burned, and 94 fires in the year 2000 and 24 hectares were burned, and 102 fires in the year 2002 were burned through 13 hectares. More than half of these burners were causing unbroken reasons, but most of them can be attributed for heating .
As for the first years of the war (2011-2015) Latakia faced an increase in fires, with a capacity of 5.7, until the year 2020, in which the burning rate reached more than 30 weakness compare before the war (Najim and Hajjar, 2022). Deforestation causes to extremes hydrographic which leads to amplification of the current tendency towards western Syria to spring floods and drought water courses in the summer. The drainage of the forests comes in a large cost of the region, including the loss of 164 thousand dollars in the wooden forest products alone and a loss of more than 4 million US dollars annually in the water reserve services. It is likely that the harvest leads to a decrease in the future as well , despite the fact that the future economic losses have not yet been appreciated, it was found that for the role of the forest in water purification, every 1% increase in forest area is equivalent to a 3% decreased in turbid water. Therefore, the decrease is estimated at 24.3% in the forest area observed in western Syria, turbidity increased by 72%.Reducing access to clean drinking water by 22%,which could double the cost of traditional filtration. Thus, increasing financial and health costs for consumers.
Despite the fact that the contribution to the assets of the forests in Syria in the public health status, but it is possible that the water is possible to develop some of the diseases ,and infection, and deforestation increases people's exposure to infectious diseases, by changing habitats (Chivian et al. *et al.*, 2015). Non-productive environmental systems can increase the risks of infection with malaria, diarrhea and food insecurity, floods and asthma.

One of the health risks of climate change by improving the quality of the air, lowering the high temperatures, and improving the nutritional lies of our environment (Community Organizing Toolkit on Ecosystem Restoration, Gland, Switzerland: IUCN, 2021) where the regions that suffer from greater disorder are higher in the forest (Cavalcante *et al.*, 2022). As the production of charcoal, non-legal approach is a multi-pronged approach. It is favored by society and attracts investors due to its high returns while estimating the costs of forest restoration and participatory management also makes it possible to neutralize land degradation in Syria. It reflects the loss of forests amounting to 45 million US dollars, it also aims to finance 50% of this effort internally and search for the rest in international financing, when deforestation is seen as an environmental crisis. Humanitarian, require searching for funding within the European Union, Russia, Iran, and China, beyond and begin implementing an array of sustainable management options for forest loss while supporting the needs of communities devastated by conflict. For forest products, livelihoods and watershed services.

Management options may also include conservation, restoration, and management of equal, unequal, and unfair situations. So, planning must be coordinated between governorates and affected societies with the owners of the main interests to reach the comprehensive evaluation of the current forest health and the distribution of future and species expectations. However, planning and multiple targets management plan can only be achieved in the context of the rule of judgment, economic stability, food security and essential facilities. This reduces pressure on forests and provides citizens with the necessary security to change their situations (Najim and Hajjar, 2022).

According to the Syrian forest's Law for the year 1953, which was reaffirmed by the forests law No. 6 for the year 2018, the forest cover in Syria, is the property of the state. Although forest governance management has changed several times, while the responsibility for the Syrian forests was on the Ministry of Agriculture and the agricultural reform.

Many studies indicate that the forests are deterred on a wide range in the last century because of the agricultural expansion and unlimited harvest, as the current critical covering in Syria covers about 2.6% of the total area of the Syrian land (Syrian Refugee Resilience Plan 2019,FAO, 2018), and the loss of approximately 83-92% of Syrian forests

During the past century, the weakening of Syria will reveal in front of the assets of the forests, especially in the absence of wisdom and the monitors, while the normal forests in the west of Syria are not a small part of the total area of the country, but they play an important role in the production of water and its existence, and the critical economic products, biodiversity, habitat provision, recreation, and the ability to adapt to the climate (Warziniack et al., 2017).

According to the previous reviews of the environmental, societal and economic circumstances in Syria(Croitoru et al. et al., 2013). Four basic goals have been selected as a foundation for a major plan to restore the restoration of after the conflict in Syria which are as following: 1) The continuation of the livelihood and the services of the environmental systems for present and future generations.

2) Mitigating the effects of climate change and adapting to it to achieve social and environmental resilience.

3) Protecting forest ecosystems and biological diversity.

4) Forest restoration management and capacity building(Najim and Hajjar, 2022).

The strategic plan "Syria 2030" expects implementing the five pillars in four stages over the next ten years, mainstreaming environmental sustainability as the crisis has exacerbated a number of environmental problems and a deep shortage of natural resources through its four pillars and outcomes to enhance environmental protection, regulatory control of emissions, effective water management('UN Strategic Framework For The Syrian Arab Republic 2022-2024', 2022).

Currently, the largest amount of 69% of forest loss to areas barren, while 28% was converted almost from forest loss to agriculture and 3% to urbanization.

As a guide, which actually led to the transformation of the land from a general forest of the state to

private lands, which led to an increase in the disputes over the land, which in turn may affect the preparedness of the user (Najim and Hajjar, 2022). So, it follows the state's lines; since the sixties of the last century, without achieving all development goals, especially regional ones; all these plans were concentrated on the time, and the sector development, without sponsorship of the place; which is considered an essential part of the national planning strategy, which led to the social balance, the economic, and the disturbance in the placed environment, and the cases of a long-standing balance, and determination of their dimensions, and the establishment of its developments, in terms of importance in place; that is to the achievement of the balance between the three elements, the economy, the human being, the place which is called the target triangle(Matouk, 2009), and improving agricultural practices of importance increasing sustainable development to provide the services of the ecological system, the drawing of the land maps is necessary, and identification of indicators that is indispensable for local stakeholders when planning landscape restoration(Poccard-Chapuis *et al.*, 2021).Also, the efforts supported by society which are carried out by the government to restore the cultivation of regions from which the gaps are actually in Syria by local forestry departments, and financed by the Ministry of Agriculture and Agrarian Reform with the participation of community groups, also in organization and agriculture in order to participate in reforestation efforts on state lands, and local organizations require permission from the relevant governorate, which determines the time and place of reforestation and the availability of seedlings. However, some forest specialists note that in western Syria, so far, efforts have been poorly coordinated among stakeholders. There is often a lack of experience in the field of forestry and post-agricultural care and monitoring, such as failure to cultivate species which is very easy to find the most sensitive types, and the failure to irrigate the recruitment sites or its monitoring which makes it vulnerable to widespread loss of seedlings due to lack of rainfall. However, the recent government efforts to enhance the areas of forest management, in addition to community encouraging for local participation. Therefore, forest restoration efforts can maximize the benefits by seeking external financing, to support or create local capabilities, coordinate efforts between the Ministry of Agriculture and Cultivation ,local directorates and environmental organizations are based on accurate maps of priorities at the district level. Increase community participation and support through stakeholder input between community agricultural programs, and forestry and livelihood programs, using reforestation efforts to enhance adaptation to climate change and resilience, such as increasing landscape connectivity and species diversity, Fuelwood, timber, food and fodder to support basic needs while mitigating deforestation and Providing locally relevant educational materials in the Arabic language which may facilitate Syrian efforts with arranging awareness campaigns conducted in partnership with organizations may also lead to local environmental universities to increase public participation, which has the benefits of community also include opportunities to take into account the wishes and interests of the locals to increase the effectiveness of forest management through local knowledge like planting trees, monitoring and protecting resources, whereas the social management options and economic support to the livelihoods, even when the land is converted to agriculture, it can be grown as crops the desired tree such as citrus fruits, olives, pomegranates, and figs, as garden plants or windbreaks, and to enhance carbon storage, and support food security and livelihoods, Providing soil protection services ,and watersheds (Torras et al. *et al.*, 2008).

The Al-Ghab Plain in Syria is home to numerous tree species that are native or have evolved to thrive in the region due to its unique ecosystem. When considering forest fire restoration initiatives, it is crucial to choose tree species that are fire-resistant and suited for the local climate. Some of these tree species include the Aleppo Pine(Pinus halepensis) , Evergreen Oak (Quercus calliprinos) , Turkish Pine (Pinus brutia) , Eastern Strawberry Tree(Arbutus andrachne) , Carob Tree(Ceratonia siliqua) , Tamarisk, and Oleander (Tamarix spp.) . The Aleppo Pine is hardy and can withstand drought and grow in arid Mediterranean conditions. It thrives in rocky or sandy environments and likes well-

drained soils. Evergreen oaks thrive in Syria's Mediterranean climate and are resistant to drought and mild fires. Turkish pine, found in lowland locations, prefers deep, well-drained soils and thick bark to protect against fire damage. The Eastern Strawberry Tree, native to the Mediterranean area, can withstand dryness and thrive in various environments. Carob trees, often found in Mediterranean climates, are drought-tolerant and can regrow from root sprouts following fire occurrences. Tamarisk trees, acclimated to saline and wet soils, are prized for their resistance to drought and salt spray and are often planted to reduce erosion. Oleander (Nerium oleander): , an evergreen shrub or small tree, is popular for landscaping and ornamentation due to its eye-catching blooms and resilience to coastal conditions. In the Al-Ghab Plain and other similar biological zones in Syria, it is essential to consider the unique ecological needs of individual tree species and their fire resistance when restoring ecosystems.

As for the Syrian land administration system it requires urgent modernity and conducting some of the structural actions to enhance the restoration, and amending the settlement system as disputes between landowners, and increase agricultural workers without regard to their economic and social characteristics and subtle differences. These procedures and criteria are applicable to different levels of local administration which can all be regulated through legal, institutional and administrative arrangements, and establishment data-base which is not associated with and non-compromising the exchanged operating with other spatial data, For example, plans to land use or natural resource labels, as well as the need to update legal and institutional frameworks and those in land. In addition, there is an inefficient bureaucratic system restoration measures and reconstruction programs will be adopted on the economic conditions of the country and will be closely linked to political conditions, Therefore, it is likely that the effects of public restoration programs are limited to small agricultural enterprises with medium sized projects to enhance the income of farmers' families and implementation the plans. So far, poor quality does not take into account local characteristics identity, and sustainable development considerations (land administration system in Syria analysis and recommendations, 2022). So, there is a need for more funding to implement the strategy completely, as the strategy that did not fully clarify the responsibilities and reforms of each part regarding the management of forests, this ambiguity led to overlapping administrative duties, duplication of work, and general inefficiency. And the owners of the interests also receive the inactive implementation of the strategy on the deficiency of financing from the government and international donors. This raises questions about government financing, can this be achieved by studying the stipulated milestones before strategic, and the current work relationship between the relevant institutions?.

3.6. Obstacles of restoration Syrian forests after fires

The climate changes which the temperatures can reach 50 ˚in summer season that make Syria is more exposed than ever to disastrous fires. Conflict and poor forest management as dry fuel continues and can increase the risk of unexpected fire behavior. Intensity of winds and other weather factors. Nevertheless, that the area for the 2015, 2019 and 2020-2023 days have exceeded in a large way that is expected through the climate-standing model, because the pollutatnts were formed to reach 62 % of the surrounding area in the year, 2019 and less than 14% of that in 2020 as the climate played only a secondary role in causing the fires compared to the years before the armed conflicts (Almohamad, 2020) .

The losses were further exacerbated by the dispersion of legal property through the influence of the right of guardianship, inheritance, and ownership into small parts, as individual possessions became distributed.Under the Agrarian Reform Law, the amount is about 25 Acres, distributed among 4-5 families in a way that is not recognized or officially registered on the property. This will increase disputes over land and increase its fragmentation, as well as the illegal seizure of land- properties,

which allows land tenure to be obtained by statute of limitations, after a long period of time (‘Agaropolis studies and projects,Structural planning for Al-Ghab area’, 2011, Population Assessment Survey, 2015).

When asking local residents about the damage caused during the period of their residence near the forest, it was found that 34% of the individuals in the studied sample owned agricultural plots. The fire caused damage to their possessions of varying sizes, from burning trees to several Acres. 45% of the sample members had various damages to their material possessions (Suleiman et al. *et al.*, 2020).

Excessive harvest of firewood also leads whether, for the sufficiency or the way of living, or to increase the great loss in the intensity of the rushing, and thus fears of the turning of the forests which lead to 69 % of the forests loss in the western Syria,including 11,000 hectares in the year 2020, forests that are part of the historical discipline are usually reinterputing by the forests, but they do not lead to the draining of the forests in a permanent way. Fire in the West of Syria, where most of the studies are limited with short and incomplete timelines to re-build a historical period to be used to use tree studies that extend for several hundred years of ages(Zubkova *et al.*, 2022).

The most prominent problems of forest restoration in Syria lies in the deficiency of financing, which is a major factor that limits sufficient organizations to managing the burners, as well as the inclusion of the application of the laws and environmental systems with the necessity of reference and updating the re-projections law to take into account the need for a comprehensive administration of the gaps.The obligation to impose two special laws for the mobilization issues. Strictly,the same applies to hunting, the compatriots must be punished with the criminals of land and the protection of recruitment and targeting the plants, lives and maintaining the exchange of hereditary material and work to reduce incursions and forest fragmentation expanding their size and creating corridors to connect them with active procedures and a general awareness campaign of forest fires, improve environmental impact assessments before granting agricultural and industrial permits, publishing information to increase knowledge and to preserve the fungal life of forest systems and allocate a budget for services with the consequences of the campaign(Alkhouri, 2006).In addition to the lack of appropriate equipment and techniques of access to a large part of the forest areas located on the severe minorities,which limits the use of fire engines. The lack of weather-fighting equipment in the area, as well as water pumps and other forest tools suitable for the high terrain, also led to support of rescue competencies to the difficulties of the expert managers to apply the advanced technologies, as this in turn led to poverty for the capabilities of the speedy and effective response which helped spread the burnings more broadly. Likewise, the lack of necessary capabilities to organize sufficient systems for the early warning of the gab fires and the lack of capabilities to evaluate the effects of climate change in the ecological systems of the forest, which opens the way to develop action plans to respond to the potential changes (Ulander,Ter-Zakaryan, 2012)..The political stability in the region also plays a basic role in weakening the bonds with commercial markets around economic growth opportunities in addition to the lack of response to the demands(Regato et al., 2020).

Also, exchange rates fluctuate had a negative impact on prices, this works to reduce or implement the contribution of environmental organizations and international agriculture in any environmental projects such as the completion of the availability of financing from the Global Environment Facility (GEF),and the International Bank or any entity to inform the protection programs for biodiversity and reserves from 2011 and even its history.

A agricultural in the total local product in Syria is between 25-17 %, and the forest contributes to a rate that does not exceed 0.1 %in the form of wood and electrocution (industrial firewood and firewood) , and the Syrian individual quota of women is 0.3 he ,and it is much less than the individual quota in the world amounting to about 0.62 hectares(National Report 5 of the Convention on Biological Diversity, 2016).

ESCWA acheived by calculating the cumulative loss in the total of the potential local product, which ranges between 289 and 300 billion US dollars during the period 2011-2018, due to the damages that have caused material and procedure for the result . In addition to the cultural loss as a result of changing the identity of the rural societies, which led the lands of use their lands in activities with higher buds than agriculture(Devadas, Elbadawi and Loayza, 2019).

There is an urgent need to collect new field data for use in determining criteria,such as current forest inventory data and more information on the environmental impacts of various human activities

the information obtained is then integrated into a range of different scales. Management decisions cannot be made perfectly at the landscape scale. Due to the lack of appropriate spatial planning for processes related to indigenous forests and their degradation, another major challenge is the integration of various modeling activities in a way that supports decision-making, as the process of consultation with stakeholders takes place with the participation of representatives from local communities ,and private landowners, as well as governmental and non-governmental organizations to focus on the role of forests in supporting livelihoods, as well as on biodiversity (Newton et al. *et al.*, 2009).

3.7. Local efforts to restore the Syrian forests after fires

The Syrian Ministry of Agriculture and Agrarian Reform worked to develop a proposal for a firefighting plan, starting from the first of May until the rainy season at the end of 2023, raising readiness to the maximum level continuing work in the relevant centers 24 hours a day, preparing the machinery and equipment used for firefighting, securing tools, and placing groups of forest firefighting personnel in a number of fire-sensitive and remote forest sites to defend these sites against fires and encroachments. So that this plan ensures initial intervention in any spot throughout the governorate within the shortest possible period of time, as early fire warning systems consist of 13 fire protection centers., 26 Forests watchtowers, 102 forest stations, equipping 179 fire engines and firefighting tanks with the necessary pumps and hoses, cars, rapid intervention teams, trucks supplying water and the necessary supplies for cars and firefighters in all governorates, in addition to preparing all available water sources and intakes, which number 197 water sources for use. Including water supply points during fires, distributing a number of concrete and plastic water tanks in areas with a high fire risk index, coordinating with the relevant authorities to prepare two helicopters and a cargo plane to extinguish fires, appointing permanent guards for forest sites, numbering about 807 site guards, preparing and organizing trained fire brigades. In groups of limited numbers according to the capabilities and specifications of fire engines, rehabilitating and maintaining equipment designated for extinguishing fires, and implementing the work of constructing and restoring forest roads and fire lines within natural forests and afforestation sites. The ministry also worked to take all administrative and logistical measures to forest fires, and intervene quickly if they occur, as well as benefit from early warning techniques and continue working on the electronic fire platform, which works to produce maps of forest sites to determine the degree of fire danger and the probability of its occurrence, based on climate data (degree temperature, humidity, and wind speed), and preparing a basic map (roads, fire lines, infrastructure, wells and water sources, firefighting and forest protection stations, watchtowers, forest outposts) for the state's forests and identifying the most sensitive sites for fire outbreaks, which gives the greatest opportunity for forestry cadres and fire suppression teams. To take appropriate measures in the fire of a fire, determine the level of danger, quickly control it, and limit its spread,the tasks of this platform also focused on proposing strategies for managing burned forest sites and rehabilitating them, preparing maps to predict the possibility of fires occurring on a weekly basis, and taking logistical measures within sensitive sites with a high risk of possibility. The outbreak of fires, defining and demarcating the area and boundaries of burned forest sites, monitoring changes occurring on the boundaries of forests and vegetation, determining the degrees of vulnerability of vegetation to fires, and monitoring changes that occurred in vegetation cover by

calculating some vital indicators of vegetation cover (NDVI). The role of the Ministry of Agriculture and Agrarian Reform also extended to coordination with all parties such as the Ministry of Communications and Technology and the General Authority for Remote Sensing, to take advantage of the available mechanisms when necessary and distribute them in the sites and carry out the work of cleaning roadsides from grasses and pruning trees teams in the forestry departments in coordination with the administrative units in the governorates, and the work of raising and developing forests, which improves their growth and reduces the possibility of fires, and developing an integrated plan to combat fires at the national level in cooperation with all parties related to extinguishing fires and circulating it at the level of each governorate,as well as developing an integrated work plan that includes a mechanism for intervening in burned sites and rehabilitating them in a way that is consistent with the specificity of each site and gradually over time, taking into account the periodic assessment of the reality of natural regeneration and the degree of protection existing in these sites, and the formation of a central room linked to subsidiary operating rooms in the governorates to manage fire response operations and achieve the required speed of intervention, and modernizing the wireless communications network(Wassouf, et al. *et al.*, 2023).

The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) provided technical, logistical, and material assistance to help overcome the hardships faced by farmers in areas affected by the fires. At the end of 2020, direct support in the amount of one hundred million Syrian pounds [1]was provided for fire extinguishing equipment. It was also agreed to provide 50 thousand olive seedlings, as well as to contribute to the rehabilitation of degraded mountainous lands by monitoring and identifying the locations of lands that were exposed to fires, and calculating their areas by using satellite images and preparing maps of these lands before and after the fire. In addition applying procedures for rehabilitating degraded lands (soil maintenance, restoring natural and cultivated vegetation (fruit trees,forestry ,cash crops , tobacco, medicinal and aromatic plants... etc.) and creating a joint scientific team with the Ministry of Agriculture to follow up on the issues of rehabilitating forest areas affected by fires, studying forest species threatened with extinction, and working to establish a breeding field for medicinal and aromatic plants, as well as implementing /6/ water dams with a storage capacity of /200/ thousand cubic meters in mountainous areas, in addition to training courses on the importance of the forest and the protection of natural resources, and the importance of spreading the concept of biodiversity among the local community. In addition to implementing research activities and projects that serve the forest wealth in Syria, including preparing a scientific database on forest species, their scientific classification, and areas of their distribution, and using remote sensing technologies for this purpose(‘Aid to mitigate the effects of fires in Syria’, 2020).The services included contracting services of directing the laws such as the contracts and the services of support the adherence of the food, the medical segmentation, the preparation of the supplies, and other examples. The total excesses of forests and geographic prohibitions affected the spending part on the incest(Ellison, Moseley, Evers, *et al.*, 2012).

The difficulties that may be established are the insurance of the funding of the grants with the required volume, as well as the fulfillment of the criteria of each request because it is often the amount of the grants, especially those that the civil society funds small, therefore, it is more appropriate to the beginning of the primary activities, small volumes, institutions, and plans to support the restoration of forests in the targeted areas (*Local financing mechanisms for forest and landscape restoration*, FAO, 2021). The government can also provide financial support through revolving loan funds, guarantee funds, matching grants and capacity building of small rural producers in the field of agricultural processing (dairy products, wool products, canning vegetable, leather products) and food safety systems to enable industrial facilities. Agricultural in the Al -Ghab region from meeting

[1] 1 US Dollar $ = 2500 Syrian Pounds (S.P.) in the end of year 2022

international technical requirements, and this requires a legal framework for a new business model and activities, and a training program to raise the capabilities of beneficiaries in the field of management and marketing(Almasri, 2015),and to provide opportunities for the well-being in the non-agricultural activities such as the socialization, preparation, transportation and settlement of the accessories.

Creating employment skills and technology to gain the sufficiency and to provide a power of high quality to support the national economy in total(Barakat. et al., 2019).Cultivation and producers of the agricultural afforestation with the length of the cultivation courses (3-18 months)the availability of access to the capital and can be allowed to produce ,as soon as possible. These loans can be large or medium -sized (small credit), provided by public and/or the investment funds, companies, or small financing institutions, and the credit plans can also be created. Social organizations, producers, or governmental organizations, by financing from community members themselves, NGOs, companies, or government grants(Local financing mechanisms for forest and landscape restoration, FAO, 2021).

The effect of deforestation in Syria depends on the ability to withstand future climate change, it is likely to support the characteristics of natural regeneration types in many of the burned areas.

The transmissible species include, for example, palaestina Pistacia and Pseudocerris subsp. L. cerris Quercus, and Brutia Pinus they are the first types that have been restored. However,recent conflict may further weaken forests, putting western Syria at risk of decline,and biological diversity,the deterioration or loss of sacred and preserved places,decline or loss of sensitive species and the conversion of forest areas and woodlands to urban or agricultural uses unsustainable harvesting also disrupts the function of the ecosystem and the availability of its services, which increases the chances of permanent loss.In some areas, these incursions lead to the sizes of a large number of forests and reduce communication between the spots, and both of them reduce the edition of the environmental system by exposing to the risk of actual disappearance from the Syrian mountains or the proliferation of plants to areas more suitable for the climate (Ward Thompson and Aspinall, 2011).

3.8. Study area

The Al-Ghab Plain is located northwest of the city of Hama Governorate in central Syria and covers about 47 km2. Its height ranges between 146-176 m above sea level (Khallouf, Shamsham and Idries, 2022).It also has a strategic geographical location (in middle of the road between Aleppo and Damascus), and close to the most natural tourism and archaeological sites (Barakat et al. *et al.*, 2019).

The site has a humid and temperate Mediterranean climate. The rainy season extends from October to the end of May.The rains reach their peak in December when the annual rainfall reaches 1000 mm. The declining clusters of 'Quercus Calliprinos Webb' are scattered within the true Mediterranean vegetation in different environmental conditions in terms of slope and height above the surface level of the sea. This slope has significant topographical variations and slopes starting at 180 meters above sea level and reaching the highest peak (Nabi Matthew) at 1560 meters up to 10 kilometers.

There are many forest villages inside and outside the site, the residents have used different forest resources for a long time, setting a model for the mutual relationship between forest and man in areas as wide as the selected area (Almahmoud, 2016),the number of residents of Al -Ghab plain, according to the statistics of 2014, was 575,000 (Khadka et al. *et al.*, 2015) ,and the projects (Structural planning for Al-Ghab area', 2011),where the population ratio of those in the age of 18-20 years at 60 %, or 345,000 workers, including 163635 people do agricultural work where the percentage of workers is about 47.43 %, while those working in the industry sector are their rate is 4.54 %, while the percentage of workers in the services sector and the rest of the sectors is 48.03 % of the total number of residents of the region, and the percentage of females is 52 %, or 299,000 females, while the rate of male is 48 %, or 276,000 males of total number of residents of the area('Agaropolis studies and projects, Structural planning for Al-Ghab area', 2011, Khadka et al. *et al.*, 2015) It should be noted that the percentage of fertile agricultural soil is 62%, 26% is forests, 2.3% is pastures, and 9.6% is slopes and

unsuitable for agriculture. The total for the area is approximately absorbed by industrial and commercial activities related to agriculture to support it ('Agaropolis studies and projects,Structural planning for Al-Ghab area', 2011), as we note that agricultural workers cut firewood from the forest due to the low financial return accruing to them, and to secure a source of additional income resulting from the sale of these firewood, and the provision of firewood for heating and other household chores, while 72% of the forest residents continued to harvest firewood without the knowledge of the forest police officers, but the most important question is remain how long will the forest provide the local population's need for firewood ? The majority of those to whom the open answer questions was distributed agreed that they did not know the answer (Suleiman et al. et al., 2020). Local residents also cultivate one holding with more than one crop. Farmers cultivate the land with more than one crop to cover most daily needs, in addition to cultivating crops to get income ('Agaropolis studies and projects,Structural planning for Al-Ghab area', 2011). 84.6% of the families of the local community in Al-Ghab have at least one member of the family holding a job within the government sector; while the rest of the activities were distributed in varying proportions between trade and skilled work, such as carpentry, tailoring, barbering, etc., and small projects, which provide an important income relative to the rest of the activities. Among the non-agricultural sources of income are 3.7% of families depend on remittances from relatives or family members who work in other regions or live outside the country, while 50.7% of families were forced to rely on their savings or sell assets as a source of income as a result of insufficient income from other sources (Almukadam et al., 2021) .In addition to the manufacture of pottery, straw hand-made, and animal dairy products such as cheese, butter, and cottage cheese, drying medicinal herbs such as wild thyme, with the reliance is on four strategic crops (wheat, cotton, sugar beets, and tobacco) ('Agaropolis studies and projects,Structural planning for Al-Ghab area', 2011), where the percentage of the area cultivated for wheat is 56.31%, while the percentage of the area cultivated for sugar beets is 6.63%, cotton is 17.31%, and tobacco is 19.75% (Khadam et al. et al., 2019).In addition to potatoes, where production can reach 32,240 tons, and yellow and white corn ,and the interest in cultivating the fruits (grape-olive-two-pomegranate) decreases a measure of other cruises, as this agriculture in the western parts increases (Allaham, 2010), and honey is also produced as the average annual production costs of the produced cell reached 55132 l. The production return was 117,230 SP, with an average profit of 62,098 SP, while its net profit amounted to 47,682 SP, and the payback period was about 2.6 years. The area of fish farms reached 6459 Acres, with a production capacity of 4089 tons/year, which is equivalent to 68% of the national production of freshwater fish. Likewise, the number of poultry farms has reached 47 farms with a capacity of 1.11.That is, 6,400 birds/year, which produces 2,000 tons of meat/year and 17,657,000 eggs/year. However, the amount invested in these resources has not yet exceeded 35% annually (Ghush et al., 2021) as for the use of the forest as pasture for animals. It did not differ from what it was before the fires occurred, because all members of the sample had previously answered that it was not good pasture for animals, as the average number of sheep per year is 134,936, 1,109 heads of buffalo, and 37,186 cows and goats. 36088 head (Suleiman et al. *et al.*, 2020).

The statistics or accurate studies of the nominal types and its effects are not present, and perhaps from the clear examples about what the caused by some strange types of mud in the environmental systems, by the Nile's plants Elyhornia Crassips to the Al-Ghab area, which is an ornamental plant causing blocking irrigation and drainage channels, and the destruction of the ecosystem of waterways because this plant obstructs the movement of water through it, in addition to the huge costs of maintaining these sewers (*National Report 5 of the Convention on Biological Diversity*, 2016).

3.9. Reasons for choosing the case study

Al-Ghab plain have many features/ingredients that make it get a high-chance to restoration as the following points:

- The widespread fires in the past three years (especially in the last quarter of 2020) have caused huge losses (human - material - environmental) and the decline of vegetation and local plant and animal species, especially endangered species, in addition to 7,000 people being affected by fires ,and 34 villages were affected, from the destruction of their homes and property, in addition to agricultural land, the loss of local infrastructure in electricity and water supply, and limited access to services which increases the risks of fire spread, and the multiplicity of hazards.
- Damage to vegetation, fires cause complete or partial destruction of vegetation, the effect of fires on trees varies according to their type, size, thickness, and degree of burning. Latakia forest fires in 2020 destroyed 340.1 million citrus trees, 370.3 million olive trees, 259 thousand trees of various types, 220 Acres planted with autumn vegetables, and 1,100 ((MAAR)Ministry Of Agriculture And Agrarian Reform Statistical Group, 2021).
- Soil damage: forest soil contains decomposed materials from plant and animal remains, in addition to microorganisms that live in the soil that decompose these remains, as significant changes have occurred in the structure of the soil and the amount of organic or mineral materials in it, and fires remove vegetation, causing the soil surface thus exposing it to erosion.
- Water pollution: fires affect ground and surface water in fire areas, and air pollution with rising and charged vapors because it contains small particles of ash and oxides of carbon, nitrogen, and sulfur, which causes difficulty in breathing and thus serious health problems for humans suffering from allergies and other medical problems ((ACSAD) Journal of Agriculture in the Arab World, 2021).
- Worsening global warming: due to the amounts of carbon dioxide emitted from forests fires that contribute to the destruction of the forest ecosystem and negatively affect the biodiversity of the forest, and applying planned fires and precautionary measures that will reduce the occurrence of fires(Gromtsev, 2002).
- Lack of spatial planning makes the damage caused by forest fires worse, in addition to that no official document has been issued yet by decision-making bodies to manage and reorganize post-fire restoration in the affected areas. It is only issuing instructions to the relevant institutions like Forest Development Authority and Agriculture directorates to protect burned sites for two years to allow natural regeneration. Although these forests are considered a rich development material that can contribute to the Syrian gross domestic product. Multiplicity of these forests constitute sources of income for residents of rural areas and secure their needs as food self-sufficiency, where most forest villages are located on the eastern slope of the coastal mountains and suffers from poverty and lack of livelihood and job opportunities, which increases its dependence on forest resources such as firewood for heating, cooking and other household uses.
- In addition, the flora of this region constitutes an important source of medicinal and aromatic plants, which are collected for domestic use and sometimes for trade.
- Most of the northern lands of the Al-Ghab Plain contain a high level of clay 43.4-60.7% lies in the southern ,while the sand content ranges from 20.7 to 59.6 %, with a high concentration in the north western part. The sample rate also ranges in the northern lands from 11.2 to 46.9%.(Khallouf, Shamsham and Idries, 2022).
- Temperatures range between 20 and 42 in summer and between -2 and 18 in winter, where frost occurs frequently, especially in the months of December and January. The average relative humidity is 60% in winter and 27% in summer. The highest intensity of rainfall recorded so far is 200 mm/day, as the average number of days of precipitation is 65 days/year, and the number of days of snowfall is one day. As for drought years, it does not exceed the total rainfall for the season which is 1100 mm, so the average annual volume of surface runoff

disbursed is about 250 million m^3('Agaropolis studies and projects,Structural planning for Al-Ghab area', 2011).

- The total annual water needs of the Al-Ghab Basin are estimated at approximately 500 million m^3 to irrigate 80 thousand hectares. Therefore, the average need rate is 6000 m^3 / hour per year, as the Al-Ghab Plain relies on an advanced irrigation network around two main canals and 8 dams with total capacity 152 millionm^3. The length of the subsidiary irrigation canals is 882 km, while the main and secondary drainage channels are 1140 km, the imports of springs number are 22 springs, as the rate of the exposure of the plants is 100 million m^3 and it is more than 20 mm for irrigation ، and 12 mm ^{3} for the home use ، and the luggage from it to dams and another section. The total number of wells is about 5,200 wells, and the annual imports of these wells are about 176 million m3. The annual renewable volume of groundwater reaches 130 million m3 in dry years, and rises to more than 300 million m3 in wet years (National Framework of Regional Planning, Syria 2030, 2019,Allaham, 2010).
- The water quality is generally good, and there are only a few sources of pollution, which are the power plant and factories, in addition to emissions from automobile transportation, and the main source of noise is highways due to the movement of cars. The area's most susceptible to groundwater contamination are the western and eastern parts, and the least susceptible to contamination are the central and northern parts of the soil as a result of intensive agriculture and the unwise use of chemical fertilizers('Agaropolis studies and projects,Structural planning for Al-Ghab area', 2011).
- The total length of the main roads for both first and second class in Al-Ghab is 361,628 km, while the total length of the secondary road network that serves urban areas is 270 km. The total length of the railways inside Al-Ghab is 15.14 km, and the closest railway distance from the north is 1.3 km (Allaham, 2010).
- Religious sites like mosques, and shrines that are available according to sects. A cultural and historical site and 15 natural sites registered by the Ministry of Tourism, and the most important archaeological areas in Al-Ghab plain are Apamea with number of tourists who were visited it in 2010 about 16,066 visitors. Likewise, the historical sites of Horta - Akhab Al-Ashrna - Al-Lataminah site - Mirza castle and Shizar castle that all had recorded the number of visitors for the same year at 1,810 visitors, thus, 67% of restaurants contributed to the highest share of income for the tourism sector (Allaham, 2010).

3.10. Fires history in Al-Ghab plain

The number of fires that occurred in Al-Ghab forests during the period (1982-1998) reached 341 fires. The average number of fires per 10,000 hectares for the period (1999-2002) reached 5.58 fires/year, while the average number of fires per 10,000 hectares during the period (1982-1998) was 3.47 fires/year. The annual average increased of fires averaged 60.8% in the forest. This indicates a decrease in the effectiveness of planned fires on the occurrence of fires.

The fires also diversified in the forests to include surface fires, coronary fires, comprehensive fires, and land fires. The ground fires were considered the same superficial fires and so that it returns to the length of the plants and the number of the releasing to be descended into the forests and turns into total fires, while crown fires were absent, and surface fires recorded the largest number during the period (1982-1998).It reached 50 fires and constituted a high percentage, approximately 79.37% of the total number of fires, this is due to the high density of plant cover.

Near the surface of the ground where Maki trees are abundant, while the overall numbers of fires was low. As there were 13 fires, representing 20.36% of the total number of fires,this is due to early fire control, and to the nature of the vegetation, where broad leaves prevail, which are considered less flammable combustion with comparison to conics (Manzello, 2020).

The molecular place in comprehensive fires was in the period during the period (1999-2002) 88.51 hills and formed a percentage of 90.32 %, and this area is higher than that of free places in the flat fires, which reached 9.49 hills that were the percentage of 9.68 % has been entrusted, given the failure of the successful majeure areas burned by comprehensive fires, while the largest portion of the areas burned are in Al-Ghab forests. As for the causes of fires, it was a result of burning because of the sponsorships, up to 26.26%, and to 23.89%, due to smoking, and this may be due to the many ways, including forest regulations or for many places of comfort . The attributes rates were 19.7% and at 30% for unknown causes.

On the basis of comparison, the fires get the number during the period (1998 - 1982), and it reached 46.39 %, while it was reduced to 17.59 % during the period (1999-2002). Fires resulting from the agricultural burning came in the first rank in terms of setting fires during the period (2002 - 1999) by 26.26 % in the time of 4,22 % of them. The period (1998 - 1982), where it came in fifth place, while the intended reasons were low, from 66.96% during the period (1982-1998) to 15.48% (909-2012 period). As for smoking, it caused, on average, the burning of 1,034 hectares/year, a rate of 4.673%, during the same previous period(Ali, 2004).

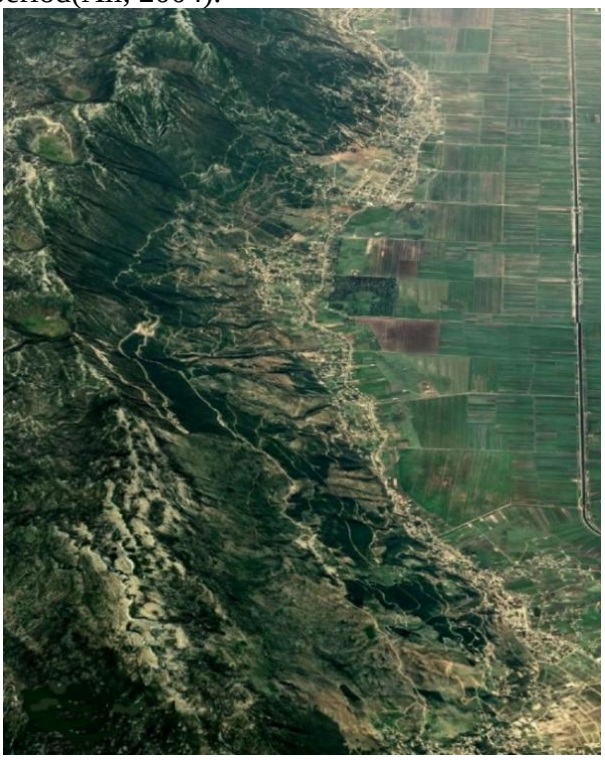
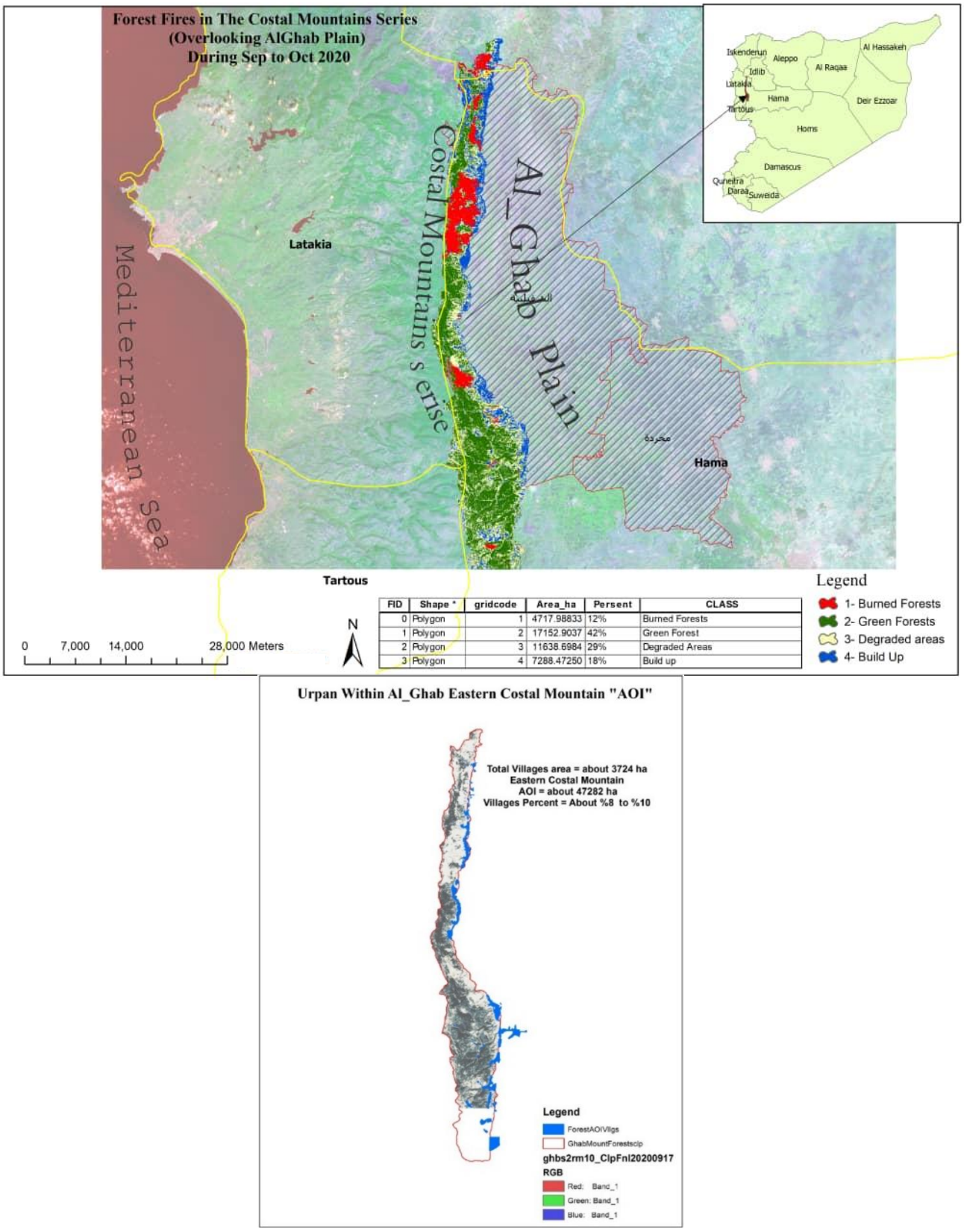


Figure 5.Three Dimensions aerial photograph showing the forests in the case study in 2010

Source: (National Centre for Argo. Inform. and Documentation, Ministry of Agriculture and Agrarian Reform (NCAID), 2023)



FID	Shape *	gridcode	Area_ha	Persent	CLASS
0	Polygon	1	4717.98833	12%	Burned Forests
1	Polygon	2	17152.9037	42%	Green Forest
2	Polygon	3	11638.6984	29%	Degraded Areas
3	Polygon	4	7288.47250	18%	Build up

Figure 6.The amount of forest fires in the case study

Source: (Sentinel -2A, satellite image 10×10m^2 high spatial resolution 10×10m^2)

We noticed that the burned area was in the end of 2020 about 47282 ha ,where AOL: Area Of Interest. The basic initial costs for restoring forests after the fire were estimated at 969,272 SY.P or 388$, which includes the total labor wages for agricultural operations plus the total material costs for all these operations. The relationship was studied and it was found that the total production costs amounted to 685,180 SY.P/ha. It was also noted that the capital required in the first year is higher than the rest of the years, in order to carry out most of the agricultural operations, including reclaiming the land and preparing it for agriculture, in addition to the process of cultivation, and irrigation, 840,921 SY.P. It is also noted that the cost of reclaiming the land and preparing it for agriculture is significantly higher than the rest of the agricultural operations by 48.53%, and this is due to the high costs of using agricultural machinery and the fees for digging holes, which may increase due to calculating the cost on the basis that the private sector does not own these machines. Rather to rent it, and the patching process is the least expensive among agricultural operations at a rate of 2.36%, due to the decrease in the number of plants needed for the patching process, the low wages of workers, and the lack of need for machines at this stage, while it was noted that the capital required for the restoration process decreased in the second year. To implement a smaller number of agricultural operations, such as patching and watering, which amounted to 200,000 SY.P starting from the third to fifth year,and the costs become small, as they collectively amounted to 108,351 SY.P, due to the years being limited to service operations such as watering, weeding, and fertilizing (Suleiman et al. *et al.*, 2020)

Hence, forest protection areas represent a priority, because preserving them contributes to forest wealth and keeping the area clean because the forests area are considered a national wealth that everyone must cooperate and join hands in order to protect it and increase the area of vegetation there. About 180 hectares were reforested by the General Authority for Forest Management and Development of the Syrian Ministry of Agriculture and Agrarian Reform in sites that were exposed to encroachments and fires during the last period, and planted with more than 100,000 plants of various forest species in the sites of Jurin, Shatha, Ain al-Krum, Annab and Ma'rin al-Salib. Distributing 25,000 various forest plants free of charge to citizens, in order to plant them in their areas, especially those that witnessed fires or unjust deforestation. In 2023, roads were built for a distance of four kilometers out of the total planned plan, amounting to 13.5 kilometers, in preparation for the fire season, in rugged and difficult mountain to reach places, and the necessary plan is currently being prepared to confront the fires that usually break out in the summer, as citizens' cooperation and reporting infringements in a timely manner that played an important role in suppressing violations of forest wealth (Wassouf, 2023).

A forest planting project was also implemented in the Salhab nursery, which has an area of 9 hectares, with a production capacity of 2 million plants, its current production amounts to 1.2 million plants from different forest types suitable for providing farmers with windbreaks and constructing homes. Ensuring the need for artificial afforestation projects in degraded forest sites ('Al-Ghab Development Projects', 2023).

The dominant plant species in the study area is the Calabrian pine(Pinus Brutia),and the Aleppo pine (Pinus Halepensis).They are the two prevailing types in the mountains up to 900 types along of the sea surface. These trees are often associated such as the Palestinian Pistacia, Calliprinos Quercus, the pseudocerris Subsp. Cerris ,and wild Cilicica Abies ,Cedrus Lebanon of Cedar, Infectoria Quercus, Turkish Oak ,Ornus Fraxinus ,Drupacea Juniperus, or the turpentine tree, and others. It has been noted that Calabrian and Aleppo pine tolerate drought to a high degree with the foundation of the disturbances and a wide range of soil that allows them to stability in the post -burning sites (Najim and Hajjar, 2022).

In the study area, work was limited to compensating loss for local residents for those who have Olive trees (small farms within the villages) and appointing seasonal workers in accordance with the

firefighting plan. The fire rate in the villages reached 8-10%, meaning 1,500 Olive trees,with the percentage of fires that occurred in 2020, the compensation was 30,000 SY.P or 12$ for each affected farmer, i.e. $4, over a period of 3 years as follows: The first year after the fire in 2021, the local residents, i.e. each affected farmer, were given an amount of 15,000 SY.P for each olive tree. In the second year, in 2022, local residents were given an amount of 10,000 SY.Pfor each olive tree, and in 2023, they were given an amount of 5,000 SY.P for each Olive tree. Temporary fire workers were also appointed for a period of six months during the fire season (May until the end of October), and they numbered (500 seasonal workers with a salary of 92,500 SY.P or 37$). There are also 100 permanent workers distributed among 11 forest stations, a forest fire control center, and administrators and technicians with an average salary, while the monthly salary for workers is about 135,000 Syrian pounds, or $18 per month (Nassour, 2023).

For the purpose of protecting forests in Al-Ghab, 11 forest centers were allocated with two observation towers and two fire-fighting centers equipped with a wireless communications network, fire tanks, service vehicles, and a trained technical staff (Allaham, 2010).

The region also suffers from the social, economic and environmental problems ,such as the lack of irrigation water that is necessary for agricultural crops in some regions.In addition to random urban expansion of the expense in the area of agricultural land, this leads to limited agricultural production, there is a scarcity of laboratories in the region.And the is only one suger factory in the region. Despite the large agricultural production, a variety of agricultural crops and livestock,merchants also control on the marketing process, which led to a decrease in farmers' profits and the spread of private markets (Alloush et al. et al., 2016).

The main problem with environmental and social (ES) flux over decades is that various research years and different geographic scales may have inconsistent or sparse data from official information sources(Taboada *et al.*, 2021).

3.11. Method steps

A total of 23 open answer questions and interviews were obtained to meet consistency and assigned weights requirements that is uesed in AHP.Therefore, there is a need to find more experienced experts to participate in the work,where the results of evaluation can be divided into four levels, highly suitable and moderate suitable and not suitable to restore.

Based on 6 basic criterions and 25 sub-criteria or indicators were reached (economic, social, environmental, managemental and legal, cultural and aesthetic, infrastructure and education. As shown in the following table(1):

Table 1.The used Criteria and indicators that used in the study area

Criterion	Indicators
Economic	1- Economic benefits of restoration(Timber and non-timber products and density), production and investment to multiple types of capital (Human, natural, social and financial).-projects"-inputs). 2- Economic assessment self-sufficiency after the restoration. 3- Changes in Local Economy and Business: Employment and new opportunity job created, incomes "Changes in sources and quantities." and local business related to reforestation(GDP local level of forest sector). 4-Costs of restoration : cost of fences, value of lands, labor cost, monetary cost, Willingness/ability to pay for fire mitigation actions-Evacuation costs and burn properties- costs of site preparation- treatments, seeding, planting and Irrigation costs, budget sufficiently-resources-,future funding and partnerships (external-local) and payments of services or preservation.

Environmental	1-Changes in Environmental Soundness: quality, flexibility , resilience-self maintenance, richness of species. 2-Changes in biodiversity of species after restoration ,biological community ,Genetic diversity ,reproduction habitat :Birds-Flora-Fauna-Fungi (Biota) (Planted ,species lists endangered). 3-Landscape connectivity ,land cover and use changes. 4- Forest characteristic(Biomass accumulation ,Shrubs and the regeneration and treatment of invasive species) and forest Structure. 5-Changes in forest components (Soil: Physical , biological and chemical characteristic-Erosion costs -Succession -Hydrology :Flow-Storage-Water and air quality).
Social	1- Life quality changes, health impacts and well-being of local communities, Therapeutic value and productivity after forest fire. 2- Local communities benefits of outcomes of restoration(Collaborative participation),and livelihood opportunities (Provision of wood, sustainable tourism products and fuel),and food security and provision from plantation(High quality for a community in reasonable prices). 3-Contribution to the restoration (number of volunteers), Communities Engagement, responsibilities and communications.
Infrastructural and Educational	1-Access of Infrastructure networks, and Services to sites that need to be restored. 2- Knowledge acquisition and outreach benefits: scientific researches purposes , technical support ,education , training , and awareness(Traditional knowledge and understanding based on local history: migration settlement, the length of the growing season and blooming time over time) to reduce risk of forest fires. 3-Number of institutions that involved and responsible for and supportive of restoration. 4-Understanding of fire sciences : suppression and limitations.
Cultural and Aesthetic	1-Cultural identity and spiritual values changes. 2-Changes of cultural purposes. 3-Changes in Ecotourism or recreational visits and archaeological sites.
Managemental and Legal	1-long-term Restoration Plans for the main factors and drivers (Social, economic and environmental diagnosis)- implementation schedule, networks effectiveness and feedback. 2-Stakeholder Engagement(Policy makers practitioners, managers and educational institutions). 3-Managing Local Communities cooperative participation, restoration practices and challenges. 4-Strategic Monitoring in the natural and planted forests (complete and update data repository assets: human, financial ,natural, physical and social). 5-Strengthen and Revise of Laws and rules to aid restoration process and to resolve tenure disputes and measures of governing forests scale and integration(stimulation or discourage restoration activities). 6-Historical Management Records on the exist one and data analysis (Process management-ecosystem approaches).

(Own editing, 2022)

3.11.1. GIS-AHP method step

A number of steps are implemented by using the spatial analysis of the tools box in ArcGIS 10.8. The region of each criterion is divided into categories to suit the requirements, and then estimate a suitable weight for each category to determine the final map based on the current criterions, which can be divided in the following ways: (1). Review previous literature to derive principles, criteria and indicators for assessing forest restoration according to sectors, disciplines and spatial scales. Consult subject area experts from regional science and economic development, taking into account the social and cultural histories and governance arrangements affecting areas of conservation and development to determine what aspects and values forest ecology being restored and addressing social, political and environmental potential.These criteria and sub-criteria/indicators can be tangible or intangible; when criteria are intangible, and there is no way to measure them, all criteria to obtain the total ranks required for the alternatives (Russo and Camanho, 2015a). (2) Determine the weights of the sub-criteria based on expert opinion.(3) Determine the environmental and scientific requirements and government regulations. (4). Determine the decision problem and the weights of the criteria using the

AHP model. Assigning a weight to each layer from 1 to 9 to reach the pairwise comparison matrix where the number 1 expresses equal importance, while the number 3 expresses moderate importance, 5: important, 7: very important. Very important, while the numbers 2, 4, 6, 8 express medium importance, and the ratios express 1/3,1/5.1/9 on the inverse comparison values, i.e. the row element/column element in the pairwise comparison table.

By repeating these comparisons in pairs helps make the analysis more precise and build knowledge about the elements of the problem. The superiority of this method lies in its ability to give relative weight to all elements of the problem, tangible and intangible, and to build a hierarchy of their relative importance according to the priority of criteria; then evaluating matrix consistency by calculating eigenvalues to compare with random consistency depending on the size of the matrix, if there is a consistency problem, the decision maker should review his comparisons to improve.The arithmetic values for each alternative for each criterion are included in a single matrix, applying the calculated priority and adding the values of each alternative to get the final value. After that, the main and sedimentary criterions will be identified and thus the following main steps are summarized by the following rules and the preparation of the wild comparison descriptions in which the importance of the criteria. The xij element of the matrix (k) of size (n) x (n) indicates the importance of criterion i to criterion j based on a basic measure from 1 to 9 after obtaining weights, and the consistency indicator where λmax is the maximum value for each matrix and n number of criterions and the following steps:

a) calculating the total of each pillar ,b)division of each input on the total of its column, c)finding the average description to obtain the relative weights, then calculate the Consistency Ratio (CR) to ensure the comparison (K) by comparison matrix used in AHP to improve the validity (Russo and Camanho, 2015a). According to experts, the ratio called "Consistency Ratio (CR)" indicates any discrepancies that may have occurred during the pairwise comparison process. The CR is designed in such a way that if the consistency level of CR in the pairwise comparison matrix is <0.10, the ratio indicates the (reasonable) criterion assumed in the measurements that should be taken into account in the decision-making process using AHP. For potential management actions, alternative scenarios can then be developed as a probability of the relative importance of the values of the five principles chosen in the studies; But if CR > 0.10, that is, when the comparison matrix contains inconsistency, it indicates inconsistent judgments. In such cases, one must reconsider and review the original values in the pairwise comparison matrix (Valente, Petean and Vettorazzi, 2017).

The integrated model of GIS-AHP will be used to examine more potential sites for restoration priorities in the forest area. AHP is still the most applied to a wide range of time or built with other MCDM models due to the following: it is simple and easy to implement in addition to its ability to deal with the quantitative and natural data, like topography ,land-use,and slope (Russo and Camanho, 2015a),to preparing the required map layers within Geographic Information Systems (GIS) as individual maps or layers,such as roads and urban centres,villages and infrastructure.

The sub-layers were appointed to each layer of 0-10 through the total of the weight of each criterion that weighing from AHP on the basis of the weight of each point of view of every criterion,to finally create final map to choose the best alternative that is the one has the highest value (priority) for each rule and each overall goal(Allen, Chhin and Zhang, 2019). Sensitivity of results can be examining by identifying risk management priorities of the areas in the maps that help in decision making (Pasqualini et al. *et al.*, 2011, Nizar et al. *et al.*, 2022).

Priority includes all criteria and then re-ranked according to the local experts from different aspects of forest restoration after fires (field of environment and biodiversity - forest policies - ecotourism - Ministry of Agriculture and Agrarian Reform) via correspondence, interviews by mail and telephone to evaluate the importance of each criterion and indicator within each layer to make a decision according to the desired goal (restoration), to create maps for each criterion and each overall goal,

then examine the sensitivity of the results, and to prioritize risk management areas in decision aid maps (Pasqualini et al. *et al.,* 2011,Chabuk *et al.,* 2017; Alkaradaghi *et al.,* 2021, Sathiyamurthi *et al.,* 2022).

As a preference for restoration,obtaining NDVI data is very essential,where wood products are calculated per year,while the loss in green space is calculated by the area of each fire polygon to determine its category through the land cover map in hectares × tons according to the FAO. As for non-wood products like the rate of medicinal herbs, and Aromatic tons/year, to determine the distribution of fire severity and sensitivity.

We use the NBR Normalized bare ratio tool, and its classification according to category of a satellite image with the European satellite SentinalA2 sensor in the case study, before the forest fires 09/18/2019 and after the forest fires that happened in 09/17/2020 with a resolution of 10 m, i.e., 100 m^2 / pixel ,before and after the fire with raster calculator.Then calculate the ΔNBR changes from 2019 till 4/15/2023with red and yellow colors , red one is from 0-1, whereas yellow is the middle value from 0.9 - 0 are small grassy areas that are not forest, while - 1 is not burned , or it is slightly affected. A satellite image and NDVI values are taken (1 up -1) From NASA 2019-9 before the fire and in 9-2020 immediately after the fire and after its natural regeneration 4/15/2023,and multiplying it by the AHP values to obtain the final map. And estimating biomass and water status, as well as the growth and density of vegetation cover, and meteorological conditions (Keramitsoglou et al., 2004).

Using the Sentinel Natural Application Platform program, in order to estimate the indicators biophysical plants, and calculate the vegetation cover index Changes in vegetation cover are monitored according to the color gradation and to its type like herbs, trees, forests, area calculations, in a year. One year after the forest fire and a current photo to combare and to divide the categories into 3 degrees severe - moderate - light using the spatial analysis toolbox via the raster calculator tool ,and Euclidian Distance (ED) in Arc GIS.These steps are used to calculate the following: productivity, habitat dispersion, degree of resilience, natural regeneration, and the most affected villages, then Reclassification with the aim of obtaining images in a specific format.

Due to random human intervention, such as cutting, logging, and building roads to facilitate fire extinguishing, this is caused an increase in grass due to the presence of sunlight that was blocked by the dense tree canopy. As for forests regeneration, was weak and the height there was less than 1, because the southern regions are more exposed to the sun and have a higher quality of growth.And to clarify distribution of the values of the plant coverage index, and the highest value of the index was in the fourth month, where the spring season begins, and the concentration of chlorophyll increases, which is responsible for recording the reflection value on vegetation coverage index(Alhasnou et al. et al., 2019).The temporal difference between pre- and post-fire NBR is expressed to produce a different normalized burn severity index. Vegetation regeneration assessment was also performed based on multiple temporal analysis of NDVI and SAVI images. The NDVI calculation was based on the red (R) band ,and NIR image, to investigate the potential impact of post-fire vegetation restoration dynamics, topographic slope entities were studied, to extract vegetation information, regarding to the terrain aspect (Tonbul ,et al. et al., 2016).

NDVI=(NIR-Red)/(NIR+Red).

Δ NDVI = Prefire NDVI - postfire NDVI.

The Normalized Burn Ratio (NBR) was used to measure fire calculations for example the NBR for the Syrian forests is 755.19 by a year , and the largest was of Brutia Pinus, that revealed by the damage of the forests via the new Sentinel-2A that launched in June 2015(Navarro et al., 2017), to evaluate the degree of heterogeneity of fires, and to show the precise variation on the effects of fires across large areas and understanding the causes, and the consequences of spatial variation of post-fire effects. In addition, the data can be use later to be integrated into mapping algorithms to improve the accuracy of area maps (Al-hasn and Almuhammad, 2022).

However, the effect of combustion severity on ecosystem functions is also depends on the pre-fire environment and types of vegetation. Therefore, the producing of the maps of the intensity of the burning is provided with information that gives a view to the covering patterns after the fires and also helps to direct the forest managers in conducting the preparation of their own residency(Navarro et al., 2017).

The criteria of the severity depend on different factors, such as the intensity, the properties of the soil, and the characteristics of the land cover after 2-16 years, in result sites were classified into three categories(1)sites with successful regeneration of > 2000-3000 seedlings.(2) sites with weak regeneration, 100-3000 seedlings, and (3) sites with failed regeneration (less than 100 seedlings)(Shvetsov et al., 2019,Rajaonarivelo and Williams, 2022).

Figure 7. Diagram illustrates the hierarchical structure of both AHP and DEMATEL methods (Own editing, 2024)

Table 2. Input data, Source and processing method

Characteristic (Layer)	Source/Resolution	Processing Method - platform
Villages – Settlement– Roads- Restaurants-Shrines Institutions and Local Facilities	Google maps- http://maps.google.com / 1meter	Spatial Analysis toolbox – Inverse Distance Weighted

LULC – NDVI – NBR-Slope-Aspects Biodiversity changes: Biomass/Carbon sequestration	Satellite Image Sentinel-2A -/ 10meter https://scihub.copernicus.eu/dhus/ Normalized Burn Ratio (NBR) | UN-SPIDER Knowledge Portal NDVI changes by Satellite Image	Maximum Likelihood classification-Image analysis Spatial analyst toolbox Vector to Raster then raster - calculator Reclassify classification
Soil erosion	Remote and traditional approaches	Soil loss equation USLE Formula Spatial Analysis toolbox – Inverse Distance Weighted

(Own editing, 2024)

3.11.1.1. Production the spatial maps according to the six Criteria restoration after fires

The following chart was extracted based on Table No. (1) and from that table also all charts related to each of the six criteria will be extracted and derived separately.

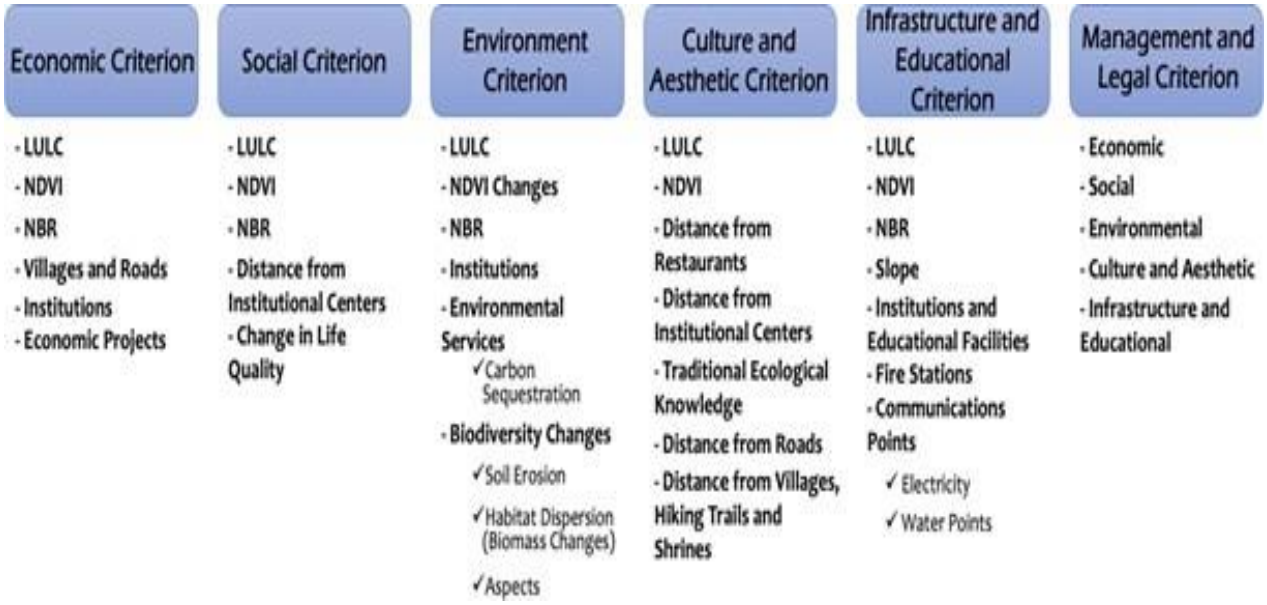


Figure 8.The six main criteria and their indicators in ArcGIS

Where: LU/LC is Land-Use/Land-Cover, NDVI: Normalized Differences of Vegetation Index, NBR: Normalized Burn Ratio.

3.11.2. Implantation of the DEMATEL method of the six criteria of forest restoration after fires

The DEMATEL method, which was originally developed by Battelle Institute's Science and Humanities Program in Geneva, it was aimed to studying and solving the unable to contract and corresponding problems (Yang *et al.*, 2008).

DEMATEL method is used as the structural technology to determine the connection between the system elements through a reasonable scheme to the visualization the basic concept of the economic

relationships and the strength of power in the effect of the elements that can be described by the DEMATEL method (Wang and Tzeng, 2012).

DEMATEL is also considered a useful method for the perception of the structure of causative relationships with the use of relations diagram. Relationship can be transformed between the criteria of reason and the result into a paralytical mode in a hierarchical manner, it is completely different from the AHP method, as it is imposed only that the criterions are independent while the DEMATEL method is determined between the problematic criteria, where the effect of each of the DEMATEL is the effect of it as digital and thus assist the decision-makers. Determine the criterion, which is affected and influenced by other criteria that clarifies the schedule for a prominent way from the positions used in the DEMATEL method to determine the numbers of relations between the different criterions and according to the opinion of the experts. It is divided to two groups, the group of reason and the effect group. The criteria in the effect group are affected by the criteria in the cause group. Therefore, strengthening the cause group will also strengthen the effect group. As a result, this curriculum can be decided to reach high quality performance regarding to the criteria and the influence group in all fields (Falatoonitoosi et al., 2013). DEMATEL method, a valuable tool that has been widely used in exploiting geographic information to analyze spatial analyzes that provide an in-depth assessment of the suitability of a site for restoration(Pasqualini *et al.*, 2011; Russo and Camanho, 2015, Rekik and El Alimi, 2023),through the Raster calculator, the elements are grouped together according to four degrees, then merging the layers, then reclassification to reclassify the categories into colors according to the degree and unify the layer to be grouped according to the pixel distribution(color gradient).

The DEMATEL calculation process consists of four steps as the following: (1) create the direct effect matrix. (2) obtaining the measured direct influence matrix; (3) building the overall relationship matrix; (4) building a "relations between the elements" and the calculation of the factors r and C, which is set the group of elements in the classes and the columns in the description of the total relationship, where t the matrix “relationship between the elements” is formed of the following columns, R, C, C + R, and C- R. For the first step. It enables pairwise comparisons between items. In this method, the expression of the direct effect is created, as comparisons can be indications, criteria, procedures, and so on.

The digital values of the table are inserted into the direct influence (k) and it is classified as kij. The description is not represented, (kij / 1 = kijj), which is the main disagreement of the AHP comparison descriptions that were established by the decision to use a measure of 9 levels. As well as bilateral plan for the perception of causative relations between the elements, where one of the elements can be influenced by the other, while this other element cannot be an effect on the first element and the presentation for the results of any of these criteria . In addition, the descending arrangement of the criterions is also obtained as it can directly to the arrangement of criterions, which makes the implementation of this multi -criterion analysis the most subjective, documentary and transparent. DEMATEL is conspiring as it is the most proportional way for this analysis because it is the way to the way. The occasion of evaluating the set of criterions and analyzing relationships between them deeply, and this method is given a detailed view of the criteria and their exchanged relations, as a framework for the problem of the decision-making processes with the criteria and alternatives are considered, where the problems are organized in a different way with additional levels of criteria and indicators and all of this can be applied to many problems of other forest management, such as restoration after fires, which require an analysis of a group among the relevant alternatives that can be implemented even without a real decision maker; and examining the final results to take decisions and avoid risks(Lakicevic and Srdjevic, 2022). By Calculate the average of the matrix. All the respondents are required to evaluate the direct effect between the criteria through a correct degree that ranges from 0-4 which represents no effect and intermediate effect on the sequence and to

summarize the opinions of the respondents by using an equation that expresses the average of the matrix.

Table 3.Scales and their strength in DEMATEL

Scale	Linguistic term
0	No influence
1	Low influence
2	Medium influence
3	High influence
4	Very High influenc

$$aij = 1/H \sum_{k=1}^{H} x^k ij.$$

The notation xij represents the degree to which the respondent believes factor i influences factor j, while the number of respondents is H.

Mechanisms of Reliability and validity of Data and Analyses

•Data triangulation and documentation involved multiple local data sources.

•External validation confirmed data accuracy through similar case studies (Mediterranean).

• Comparing data against ground-truth observations, historical records confirmed its reliability.

•Expert judgment and assessments and stakeholder feedback also helped identify and address potential biases.

•The pairs of AHP consider the decision is irrelevant if there is over 10% or conflicts of interest.

•GIS with final suitability maps to help decision-makers identify hidden indicators. By implementing these strategies, the objectivity of expert evaluations can be controlled, ensuring that weighting results are based on informed judgments and consensus among experts rather than individual biases or preferences. This enhances the credibility and reliability of the evaluation outcomes, thereby strengthening the integrity of decision-making processes in forest restoration planning.

IV. Research Results and Discussion

4.1. Using AHP method for the six main Criteria

The first order of the hypothesis of principles is :economic - social – managemental and legal - environmental - cultural and aesthetic- infrastructural and education.

Table 4.Pairwise comparisons between main six criteria of forest fire restoration

	ECO	**SOC**	**ENVI**	**MANG**	**INFRA**	**CULT**
ECO	1	2	4	3	6	5
SOC	0.5	1	3	2	5	4
ENVI	0.25	0.33	1	0.2	4	2
MANG	0.33	0.5	5	1	5	3
INFRA	0.16	0.2	0.25	0.2	1	0.5
CULT	0.2	0.25	0.5	0.33	2	1
SUM	2.45	4.28	13.75	6.73	23	15.5

Example: economic = 4x value, environmental = x value (column value / row value), economic = 2x value, social = x value, economic = 6x value

, culture = x value, economic = 3x value, legal = x value, social = 3x value

In table(4), pairwise comparisons are made, which in turn determine the differences between different criteria according to their importance in the decision-making process, and then the value of each cell in one column (criterion value) is divided by the final sum. Then a normal pairwise comparison matrix is generated, and the weight of the criterion is divided by the sum of the results by the number of criteria (the mean).

Table 5.Pairwise comparisons and criteria weights C/Sum

Normalized Pair-Wise comparison Matrix						**Criteria Weights**
0.40	0.46	0.29	0.44	0.26	0.32	0.36
0.20	0.23	0.21	0.29	0.21	0.25	0.23
0.10	0.07	0.07	0.02	0.17	0.12	0.09
0.13	0.11	0.36	0.14	0.21	0.19	0.19
0.06	0.04	0.01	0.02	0.04	0.03	0.03
0.08	0.05	0.03	0.04	0.08	0.06	0.06

Then we calculate consistency by multiplying the value of the criterion by its weight

λmax is the result of dividing the sum of the ratios of the values by their number (the average of the values), so the consistency index is equal to and where n is the number of comparison criteria. λmax =6.350 Consistency Index (CI)=0.07

$$CI=\frac{\lambda max-n}{(n-1)}$$

Where CI:consistency index, CR:consistency ratio, while the consistency ratio is: C. R=CI/RI .

The consistency index must be calculated by the corresponding mean of the random consistency index(Pan,and Wu, 2011),where R.I is the expected consistency coefficient obtained from random comparisons that generated from the same number n, estimates from 2 to 14. CR=0.07/1.24=0.0564 <0.10 (Saaty, 1987). The ratio indicates the (reasonable) criterion assumed in the measurements to be

factored into the decision-making process using the AHP (Segura, Ray et al.,2014; Valente et al., 2017). These findings can support the recommendation for future studies on the difficulties of applying an AHP to select the best criteria, obtaining consensus, and whether the results meet stakeholder expectations or whether the structure should change(Russo and Camanho, 2015).

n	1	2	3	4	5	6	7	8	9	10
Random consistency index (R.I.)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

We note that the economic evaluation index is the heaviest or relatively the largest between the six criteria ,it takes 36.583% of the total percentage while the the infrastructural criterion takes 3.972% of the total percentage for the importance according to the experts's opinions in forest-fires restoration.

The Analytic Hierarchy Process (AHP) is a decision-making method that divides complex issues into a hierarchy of options and criteria, followed by pairwise comparisons to determine the relative weight of each criterion. In GIS-AHP, appropriateness categories are created, such as ecological suitability, management feasibility, societal acceptability, and economic viability. Participants evaluate each pair of categories using a scale like the Saaty scale, ensuring consistency by examining the consistency of pairwise comparisons. Consistency ratios are computed to determine the level of inconsistency, and changes may be made to pairwise comparisons if necessary. Weight calculation is done using mathematical procedures like the eigenvector approach or the geometric mean method, creating a priority vector showing the importance of each category in relation to others. The weights of the suitability categories are combined with the corresponding ratings or scores of the sub-criteria or alternatives within each category.

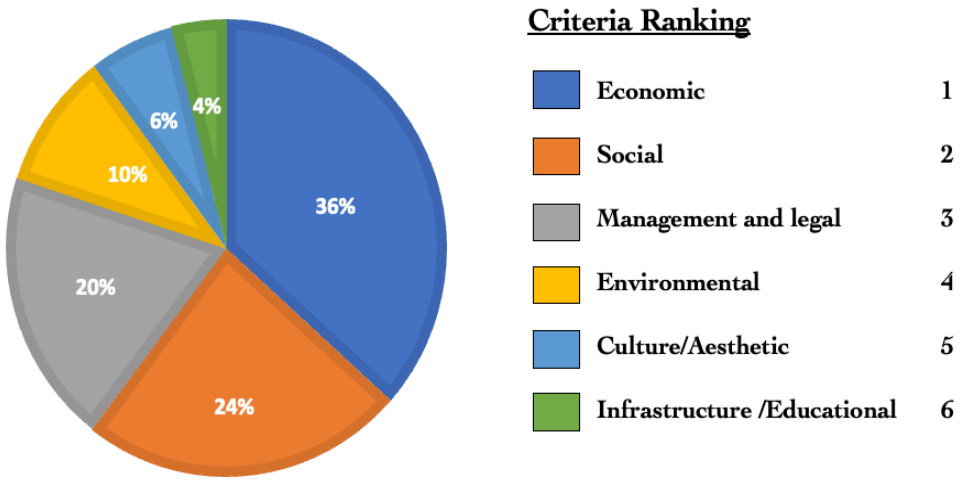


Figure 9. Figure 9.The six Criteria weights and their percentages

Table 6.Ranking of the Main Six Criteria

Economic	1
Social	2
Management and legal	3
Environmental	4
Culture/Aesthetic	5
Infrastructural /Educational	6

By comparing indicators for each of the six basic criteria separately.

A) The First criterion Economy

Economic Benefits(E.B)
Economic Assessments(E.A)
Changes in Local Economy and Business (C.E)
Costs of restoration(C.R)

Table 7.Pairwise comparisons between indicators of the Economic Criterion

	E.B	E.A	C.E	C.R
E.B	1	**0.5**	**5**	**3**
E.A	**2**	1	**6**	4
C.E	**0.2**	**0.16**	1	**0.2**
C.R	**0.33**	0.25	**5**	1
SUM	**3.53**	**1.91**	**17**	**8.2**

Table 8.Comparisons between values the indicators of the economic criterion

C/SUM	**Normalized Pair-Wise comparison Matrix**				**Indicator Weights**	**Indicator percentage**	**Weighted Sum Value**	**From Total Percentage**
	0.28	0.26	0.29	0.36	0.30	30.09	1.30	**11.01**
	0.56	0.52	0.35	0.48	0.48	48.21	2.06	**17.63**
	0.05	0.08	0.05	0.02	0.05	5.66	0.22	**2.07**
	0.09	0.13	0.29	0.12	0.16	16.02	0.66	**5.86**

C.I=0.067,C Ratio=0.0754,Ymax=4.2037
Therefore, the indicators of the economic criterion are arranged in the following order:

Table 9.Ranking of the Indicators of the economic criterion

	Indicator	**Abbreviations**	**Ranking**
Economic	Economic Benefits	E.B	2
	Economic Assessments	E.A	1
	Changes in Local Economy and Business	C.E	4
	Costs of restoration	C.R	3

B) The Second criterion Social

Life -Quality Changes(L.C)
Communities Contribution(C.C)
Outputs Benefits(O.B)

Table 10.Pairwise comparisons between indicators of the Social Criterion

L.C	1	**2**	**0.6**
C.C	**0.5**	1	**0.2**
O.B	**1.66**	**5**	1
SUM	**3.16**	**8**	**1.8**

Table 11.Comparisons between values the indicators of the social criterion

C/SUM	**Normalized Pair-Wise comparison Matrix**			**Indicator Weights**	**Indicator percentage**	**Weighted Sum Value**	**From Total Percentage**
	0.31	0.25	0.33	0.29	29.97	0.90	**7.13**
	0.15	0.12	0.11	0.13	13.13	0.39	**3.12**
	0.52	0.62	0.55	0.56	56.89	1.72	**13.54**

C.I=0.009,C Ratio=0.0158,Ymax=3.0183

Therefore, the indicators of the social criterion are arranged in the following order:

Table 12.Ranking of the Indicators of the social criterion

	Indicator	**Abbreviations**	**Ranking**
Social	Life-Quality Changes	L.C	2
	Communities Contribution	C.C	3
	Outputs Benefits	O.B	1

C) The Third criterion Managemental

long-term Restoration Plans(L.R.P)
Stakeholder Engagement(S.E)
Managing Local Communities(M.L.C)
Strategic Monitoring of restoration(S.M.R)
Strengthen and Revise of Laws (S.R.L)
Historical Management Records(H.M.R)

Table 13.Pairwise comparisons between indicators of the managemental Criterion

	L.R.P	S.E	M.L.C	S.M.R	S.R.L	H.M.R
L.R.P	1	**3**	**4**	**2**	**7**	**5**
S.E	**0.33**	1	**2**	0.5	6	4
M.L.C	**0.25**	**0.5**	1	**0.3**	3	2
S.M.R	**0.5**	2	**3.33**	1	**5**	4

S.R.L	**0.14**	0.16	0.33	**0.2**	1	**0.6**
H.M.R	**0.2**	0.25	0.5	0.25	**1.66**	1
SUM	**2.42**	**6.91**	**11.16**	**4.25**	**23.66**	**16.6**

Table 14.Comparisons between values the indicators of the managemental criterion

	Normalized Pair-Wise comparison Matrix						**Indicator Weights**	**Indicator percentage**	**Weighted Sum Value**	**From Total Percentage**
C/SUM	0.41	0.43	0.35	0.47	0.29	0.30	0.37	37.86	2.36	**7.42**
	0.13	0.14	0.17	0.11	0.25	0.24	0.17	17.88	1.09	**3.50**
	0.10	0.07	0.08	0.07	0.12	0.12	0.09	9.71	0.59	**1.90**
	0.20	0.28	0.29	0.23	0.21	0.24	0.24	24.68	1.55	**4.83**
	0.05	0.02	0.02	0.04	0.04	0.03	0.03	3.97	0.24	**0.77**
	0.08	0.03	0.04	0.05	0.07	0.06	0.05	5.88	0.35	**1.15**

C.I=0.029,C Ratio=0.0235,Ymax=6. 145

Therefore, the indicators of the managemental and legal criterion are arranged in the following order:

Table 15.Ranking of the Indicators of the managemental criterion

	Indicator	**Abbreviations**	**Ranking**
Managemental and Legal	long-term Restoration Plans	L.R.P	1
	Stakeholder Engagement	S.E	3
	Managing Local Communities	M.L.C	4
	Strategic Monitoring of restoration	S.M.R	2
	Strengthen and Revise of Laws	S.R.L	6
	Historical Management Records	H.M.R	5

D) The Forth criterion Environment

Environmental Soundness Changes(E.S.C)

Biodiversity Changes(B.C)

Forest Components Changes(F.C.C)

Landscape connectivity ,land cover and use changes(L.C.C)

Forest Structure Changes (F.S.C)

Table 16.Pairwise comparisons between indicators of the environmental Criterion

	E.S.C	B.C	F.C.C	L.C.C	F.S.C
E.S.C	1	**0.5**	**0.3**	**0.4**	0.1
B.C	**2**	1	**0.5**	0.4	0.2

F.C.C	**3.33**	**2**	1	**3**	0.3
L.C.C	**2.5**	2.5	**0.33**	1	0.5
F.S.C	**10**	5	3.33	**2**	1
SUM	**18.83**	**11**	**5.46**	**6.8**	**2.1**

Table 17.Comparisons between values the indicators of the environmental criterion

	Normalized Pair-Wise comparison Matrix					**Indicator Weights**	**Indicator percentage**	**Weighted Sum Value**	**From Total Percentage**
C/SUM	0.05	0.04	0.05	0.05	0.04	0.05	5.19	0.27	**0.50**
	0.10	0.09	0.09	0.05	0.09	0.08	8.85	0.46	**0.86**
	0.17	0.18	0.18	0.44	0.14	0.22	22.51	1.20	**2.19**
	0.13	0.22	0.06	0.14	0.23	0.16	16.12	0.82	**1.57**
	0.53	0.45	0.60	0.29	0.47	0.47	47.31	2.50	**4.61**

C.I=0.064,C Ratio=0.057,Ymax=5.258

Therefore, the indicators of the environmental criterion are arranged in the following order:

Table 18.Ranking of the Indicators of the environmental criterion

	Indicator	**Abbreviations**	**Ranking**
Environmental	Environmental Soundness Changes	E.S.C	5
	Biodiversity Changes	B.C	4
	Forest Components Changes	F.C.C	2
	Landscape connectivity ,land cover and use changes.	L.C.C	3
	Forest Structure Changes	F.S.C	1

E) The Fifth criterion Cultural and Aesthetic

Cultural identity Changes(C.I.C)

Cultural Purposes Changes(C.P.C)
Ecotourism Changes(E.C)

Table 19.Pairwise comparisons between indicators of the cultural and aesthetic Criterion

	I.C	P.C	E.C
C.I.C	1	**0.5**	**0.1**
C.P.C	**2**	1	**0.3**
E.C	**10**	**3.33**	1
SUM	**13**	**4.83**	**1.4**

Table 20.Comparisons between values the indicators of the cultural and aesthetic criterion

	Normalized Pair-Wise comparison Matrix			**Indicator Weights**	**Indicator percentage**	**Weighted Sum Value**	**From Total Percentage**
C/SUM	0.07	0.10	0.07	0.08	8.39	0.25	**0.52**
	0.15	0.20	0.21	0.19	19.16	0.57	**1.20**
	0.76	0.68	0.71	0.72	72.43	2.20	**4.55**

C.I=0.009,C Ratio=0.015,Ymax=3.018
Therefore, the indicators of the cultural criterion are arranged in the following order:

Table 21.Ranking of the Indicators of the cultural and aesthetic criterion

	Indicator	**Abbreviations**	**Ranking**
Cultural	Cultural Identity Changes	C.I.C	3
	Cultural Purposes Changes	C.P.C	2
	Ecotourism Changes	E.C	1

F) The sixth criterion Infrastructural and Educational

Access of Networks and Services(A.N.S)
knowledge Acquisition and Outreach Benefits(K.O.B)
Understanding Fire sciences and limitations(U.F.L)
Number of Institutions that involved of restoration(N.I.R)

Table 22.Pairwise comparisons between indicators of the infrastructural and educational Criterion

	A.V.S	K.O.B	U.F.L	N.I.R
A.N.S	1	**3**	**2**	**5**
K.O.B	**0.33**	1	**0.6**	3
U.F.L	**0.5**	**1.66**	1	**4**
N.I.R	**0.2**	0.33	**0.25**	1
SUM	**2.03**	**6**	**3.85**	**13**

Table 23.Pairwise comparisons between indicators of the infrastructural and educational Criterion

C/SUM	Normalized Pair-Wise comparison Matrix				Indicator Weights	Indicator percentage	Weighted Sum Value	From Total Percentage
	0.49	0.5	0.51	0.38	0.47	47.39	1.92	**1.88**
	0.16	0.16	0.15	0.23	0.17	17.93	0.72	**0.71**
	0.24	0.27	0.25	0.30	0.27	27.27	1.10	**1.08**
	0.09	0.05	0.06	0.07	0.07	7.39	0.29	**0.29**

C.I=0.013,C Ratio=0.014,Ymax=4.039

Therefore, the indicators of the infrastructural criterion are arranged in the following order:

Table 24.Ranking of the Indicators of the infrastructural and educational criterion

	Indicator	Abbreviations	Ranking
Infrastructural and Educational	Access of Networks and Services	A.N.S	1
	knowledge Acquisition and Outreach Benefits	K.O.B	3
	Understanding Fire sciences and limitations	U.F.L	2
	Number of Institutions that involved of restoration	N.I.R	4

Defining the problem begins with the goal, which is arranged according to the restoration priorities,in order to make the optimal decision to develop an integrated framework and determine the six main criteria, as well as the indicators that were approved based on the open answer questions and the interview that was made,ending with the available alternatives,these arrangements can take priorities of effective and influencing criteria in the restoration process (Abuwatfa, 2014).

4.2. AHP for the Four Alternatives

By applying the AHP method that was applied to the six criteria,and indicators. And to the four alternatives which as the following:

- Forest Restoration Techniques (Passive-Active-Nucleation-Site prepration-Slavaging).
- Integrated Forest- Fire Decision Making.
- Forest-Fire Investment Planning System
- Suitable and Subsequent Treatments and comparing them for each of the six basic criteria separately.

Table 25.Pairwise comparisons between the four alternatives

Alternatives	Forest Restoration Techniques	Integrated Forest-Fire Decision Making	Forest-Fire Investment Planning System	Suitable and Subsequent Treatments
Forest Restoration Techniques	1	0.4	0.6	3
Integrated Forest- Fire Decision Making	2.5	1	4	7
Forest-Fire Investment Planning System	1.66	0.25	1	5
Suitable and Subsequent Treatments	0.33	0.14	0.2	1
Sum	5.5	1.79	5.8	16

C.I=0.0441 , C Ratio=0.049

Table 26.Ranking of the four alternatives

Alternatives	Ranking
Forest Restoration Techniques	3
Integrated Forest- Fire Decision Making	1
Forest-Fire Investment Planning System	2
Suitable and Subsequent Treatments	4

The economic situation in Syria was the main driver in how the decision-maker with their priorities in case of the local authorities facing obstacles and difficulties that cause delay or extract the forest fire restoration ,that's why the need of ranking alternatives is extremely high.

alternative rank 1:Integrated forest-fire decisions-making

that represented by the proposed activities aim to develop an integrated fire control plan that supports holistic landscape, land use, and forest management. Changes in fire regimes under various scenarios should be evaluated, understand structural reasons for catastrophic wildfires, and investigate the compromises and benefits between environmental, climatic, and socioeconomic factors. Techniques for reducing susceptibility to wildfires are also proposed.

the second alternative is:

forest fire investment planning system: designed to carry out risk-based analysis of wildfire outcomes and fire management operations for alternative investments in large fire suppression, hazardous fuels, and preparedness. For all areas and agencies, analysis is done at user-specified scales ranging from local (such as districts and national forests) to regional and national, covering the impacts of seasonal variation on fire control performance measures. It is possible to specify ranges of resources for preparation, treat fuel, and assess the sizes, prices, and demographic implications of huge fires.

third alternative is forest restoration techniques:forest restoration may include simply protecting remnant vegetation (fire prevention, cattle exclusion etc.) or more active interventions to accelerate natural regeneration, as well as tree planting and/or sowing seeds (direct seeding) of species characteristic of the target ecosystem.

the final alternative is suitable and subsequent treatment.The FAO Forest Resource Assessment 2000 aims to standardize the classification of forests, other wooded land, and other land. Forests are defined as areas with over 0.5 hectares and a tree crown cover of more than 10%, with mature trees growing to a minimum height of 5 meters. Other land includes areas with 5-10% trees or more than 10% bushes or shrubs that cannot grow to a height of 5 meters. If recurrent wildfires hinder the regeneration of "other land," notification is required. Wildfires can occur in various forms, including surface, ground, wildfires, wildland fires, and crown fires. Forests have a minimum height of 5 meters and a tree crown cover of more than 10%. Other forested terrain includes fewer tree height, shrub cover, and less crown cover. Wildland fires are unplanned, uncontrolled flames that may require suppression response or other action. And when taking the first and second alternatives with the highest percentages, namely Integrated Forest-Fire Decision Making and Forest-Fire Investment Planning System, and comparing them with each of the six criteria separately using the AHP method. It was found that the third criterion, Forest-Fire Investment Planning System, was the most important among the four alternatives with a very slight difference of 0.71% between the second and third alternatives, this shows the importance of the AHP method as an accurate method and an aid in making the decision regarding the restoration of Syrian forests after fires.

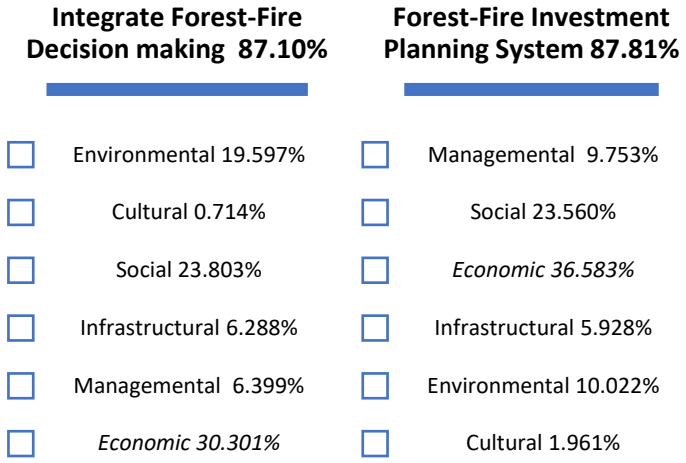


Figure 10.Alternatives weights and percentages for each of the criteria

When evaluating each alternative in relation to the six main criteria for forest restoration and indicators, the evaluation is based on the basic criteria

Table 27.Pairwise comparisons between the alternatives according to the economic criterion

ECONOMIC	Forest Restoration Techniques	Integrated Forest-Fire Decision Making	Forest-Fire Investment Planning System	Suitable and Subsequent Treatments
Forest Restoration Techniques	1	0.7	0.4	0.8
Integrated Forest- Fire Decision Making	1.42	1	0.6	4
Forest-Fire Investment Planning System	2.5	1.66	1	2
Suitable and Subsequent Treatments	1.25	0.25	0.5	1
Sum	**6.17**	**3.61**	**2.5**	**7.8**

Table 28.Pairwise comparisons between alternatives according to the social criterion

SOCIAL	Forest Restoration Techniques	Integrated Forest-Fire Decision Making	Forest-Fire Investment Planning System	Suitable and Subsequent Treatments
Forest Restoration Techniques	1	0.5	0.1	2
Integrated Forest- Fire Decision Making	2	1	2	5
Forest-Fire Investment Planning System	10	0.5	1	4
Suitable and Subsequent Treatments	0.5	0.2	0.25	1
Sum	**13.5**	**2.2**	**3.35**	**12**

Table 29.Pairwise comparisons between alternatives according to the environmental criterion

ENVIRONMENTAL	Forest Restoration Techniques	Integrated Forest- Fire Decision Making	Forest-Fire Investment Planning System	Suitable and Subsequent Treatments
Forest Restoration Techniques	1	0.5	0.7	0.9
Integrated Forest- Fire Decision Making	2	1	2	5
Forest-Fire Investment Planning System	1.42	0.5	1	2
Suitable and Subsequent Treatments	1.11	0.2	0.5	1
Sum	**5.53**	**2.2**	**4.2**	**8.9**

Table 30.Pairwise comparisons between alternatives according to the managemental and legal criterion

MANAGEMENTAL	Forest Restoration Techniques	Integrated Forest- Fire Decision Making	Forest-Fire Investment Planning System	Suitable and Subsequent Treatments
Forest Restoration Techniques	1	0.5	0.2	3
Integrated Forest- Fire Decision Making	2	1	0.8	5
Forest-Fire Investment Planning System	5	1.25	1	7
Suitable and Subsequent Treatments	0.33	0.2	0.14	1
Sum	**8.33**	**2.95**	**2.14**	**16**

Table 31.Pairwise comparisons between alternatives according to the cultural and aesthetic criterion

CULTURAL	Forest Restoration Techniques	Integrated Forest-Fire Decision Making	Forest-Fire Investment Planning System	Suitable and Subsequent Treatments
Forest Restoration Techniques	1	0.8	2	3
Integrated Forest- Fire Decision Making	1.25	1	4	5
Forest-Fire Investment Planning System	0.5	0.25	1	3
Suitable and Subsequent Treatments	0.33	0.2	0.33	1
Sum	**3.08**	**2.25**	**7.33**	**12**

Table 32. Pairwise comparisons between alternatives according to the infrastructural and educational criterion

INFRASTRUCTURAL	Forest Restoration Techniques	Integrated Forest- Fire Decision Making	Forest-Fire Investment Planning System	Suitable and Subsequent Treatments
Forest Restoration Techniques	1	0.3	0.8	2
Integrated Forest- Fire Decision Making	3.33	1	0.9	3
Forest-Fire Investment Planning System	1.25	1.11	1	5
Suitable and Subsequent Treatments	0.5	0.33	0.2	1
Sum	**6.08**	**2.74**	**2.9**	**11**

4.2.1. Final Selection of The Most Suitable Alternative

Evaluation according to indicators in order to choose the best alternative, each alternative must be evaluated along with the indicators as well to ensure the correct selection of the best alternative for restoring Syrian forests after the fires.

Table 33.Weights for all criteria and indicators

From Total Percentage %												
Economic		**Social**		**Management**		**Environmental**		**Cultural**		**Infrastructural**		
Economic Benefits	11.01	Life - Quality Changes	7.13	long-term Restoration Plans	7.42	Environmental Soundness Changes	0.50	Cultural Idenity Changes	0.52	Access of Networks and Services	1.88	
Economic Assesme-nts	17.63	Commu-nities Contribution	3.12	Stakehold-er Engagment	3.50	Biodiver-sity Changes	0.86	Cultural Purposes Changes	1.20	Knowledge Acquisition and Outreach Benefits	0.71	
Changes in Local Economy and Business	2.07	Outputs Benefits	13.54	Managing Local Communities	1.90	Forest Components Changes	2.19	Ecotourism Changes	4.55	Understanding Fire sciences and limitat-ions	1.08	
Costs of Restoration	5.86			Strategic Monitoring of restoration	4.83	Landscape connectivity, land cover and use changes.	1.57			Number of Institutions that involded of restoration	0.29	
				Strengthen and Revise of Laws	0.77	Forest Structure Changes	4.61					
				Historical Manangment Records	1.15							
Percentage %	***36.58***		***23.80***		***19.59***		***9.75***		***6.28***		***3.97***	

4.3. Using spatial decision support systems (AHP-DEMATEL) of the six criteria for forest restoration after fires

By calculation of the Initial Direct Relationship Matrix Normalized (D) is performed as the managers that are invited to answer the open answer questions. The pairwise comparison matrix using individual judgments that are aggregated by the weighted geometric mean method, so each item in the matrix D lies between (0-1).

Table 34.Relationship Pairwise comparisons between the main six criteria

	ECO	**SOC**	**ENVI**	**MANG**	**INFRA**	**CULT**	**SUM**
ECO	0	3	4	3	4	3	17
SOC	4	0	3	3	3	3	16
ENVI	4	3	0	4	2	2	15
MANG	4	3	3	0	3	3	16
INFRA	3	2	1	2	0	2	10
CULT	3	4	2	2	1	0	12

D=A×S,where:

$$S = \frac{1}{\max_{1 \le i \le n} \times \sum_{j=1}^{n} aij}$$

$$D = \mathrm{A} \times \frac{1}{\max_{1 \le i \le 6} \times \sum_{j=1}^{6} aij}$$

The results of the DEMATEL method are shown in the table(36). The direct and indirect influence of the criteria represented by the following equation:

T=D(1-D)-1

Calculate the total relationship matrix, T. And by calculating that (ri) is the sum of the first row in the matrix T, (ri) summarizes the direct and indirect effects that the criterion (i) that gives to the other factors. Moreover, if (ri) is positive, then factor (i) is a cause, while factor (i) is independent, including vectors (ci), relationship values (r + c),(r – c), and threshold values, and when the results are reached (r + c) that determines the order of the criteria according to their importance, and the relationship between the matrix of criteria. Values of (ri - ci) are considered effects and which values (ri+ ci) are considered causes.

Based on the decision maker's assessment, C3, C4, and C2 are ordered as follows: C2 > C4 > C3. The order of criteria is used in the rest of the process evaluation, values close to 0 ,are acceptable. Therefore, there is no need to repeat the evaluation process, by analyzing the performance of all alternatives (management plans) that are related to the specified criteria. It can be noted that the different alternatives have the best result for different criteria, if there is only one alternative with the best performance across all criteria, but when a group of alternatives has different degrees of performance towards a set of criteria, it is necessary to have further analysis after developing the proposed framework, with analyzing the order of alternatives as a next step, as these results can be summarized by applying the diagram to obtaining the results of applying the proposed approach DEMATEL that expresses the importance of the order of the criteria and their relationships (Lakicevic and Srdjevic, 2022).

Table 35.Total relation matrix T=Y(inv(I-Y))

1-Y		**Ri**					
C1	1.14	1.12	1.07	1.07	1.07	1.01	*6.51*
C2	1.29	0.94	1	1.04	1	0.99	*6.27*
C3	1.26	1.06	0.83	1.06	0.94	0.92	*6.08*
C4	1.29	1.09	1	0.89	1	0.99	*6.27*
C5	0.87	0.72	0.62	0.69	0.57	0.66	*4.16*
C6	1.03	0.95	0.79	0.82	0.74	0.67	*5.03*

Table 36.Relation matrix of Criteria and their identities in DEMATEL

	Ri	**Ci**	**Ri+Ci**	**Ri-Ci**	**Identity**
ECO	6.51	6.89	13.41	-0.37	Effect
SOC	6.27	5.89	12.17	0.38	Cause
ENVI	6.08	5.34	11.43	0.73	Cause
MANG	6.27	5.58	11.86	0.68	Cause

INFRA	4.16	5.35	9.51	-1.18	Effect
CULT	5.03	5.26	10.30	-0.23	Effect

Then Preparing a threshold value to obtain the relationship diagram, since the T-matrix provides information about how one criterion affects the other. It is necessary for the decision-makers to prepare a threshold value to filter out some negligible effects, where only the effects greater than the threshold value (alpha) which is 0.95, will be selected and depicted in the relationship figure, so that the threshold value is determined by averaging the criteria in the T matrix (Unver,Ergenc, 2020).

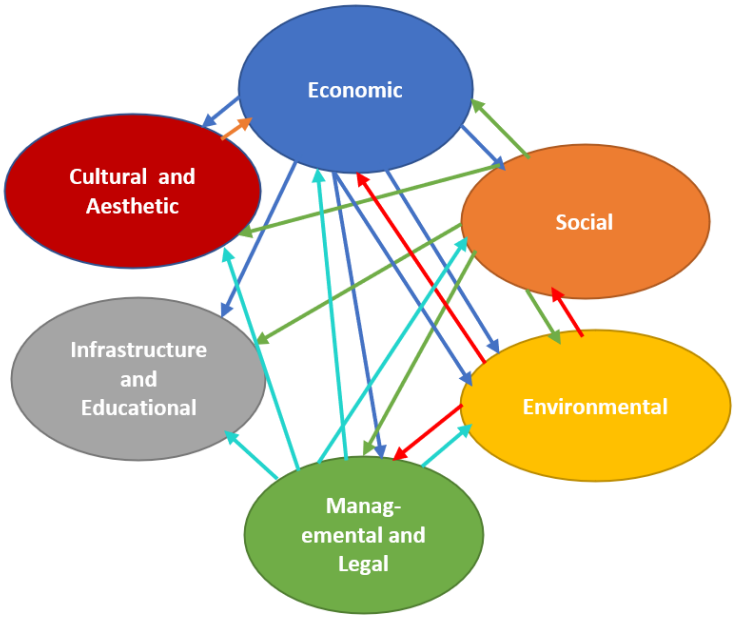


Figure 11. The causal relationship between the criteria

Based on the figure(16),the table(36),and the results, C1 is the preferred economic criterion that the decision- makers chosen, while they rated C6 as least favorable criterion. Hence, the use of the AHP method can help the decision maker to rank and select the best alternative when considering multiple criteria. Due to the positive values in each of the economic, infrastructural and cultural criteria, (R + D).while the criteria that belong to the causative group were both social, environmental and managemental criteria based on negative values in (D-R)(Falatoonitoosi et al., 2013; Gardas et al., 2019). There are no criteria affected by the infrastructural criterion (C5), but rather all criteria that are affected by the economy criterion, the social criterion over the economic is also causative for the rest of the restoration criteria. The environmental criterion is causative only for three criteria, which are economic, social and administrative, where the managemental criterion is considered causative for all restoration criteria. Finally, the cultural and aesthetic criterion affects the economic criterion only, while the infrastructural criterion does not affect any one of the other criteria, that what makes the restoration application so complex in practice is its multi-purpose nature, and landscape-based planning.

4.4. Using result of (AHP -GIS) method of the six Criteria and its indicators

Prioritize forest restoration areas, a common issue in nature conservation projects due to the expectation of meeting a variety of social, economic and environmental goals. In this way, the tools of the quantity are required to assist in examining the spatial patterns of the natural product, in order to determine the locations of the priority regions, add different categories of variables in view of the nature of the multiple purpose of the problem, and the evaluation of the preferences between the

different resistance techniques. The related previous studies were also based on the analysis of the multiple criteria (MCA) and the geographical information systems (GIS) that have proven successful in variety of applications related to forest conservation, management, restoration and planning, where the analysis provides multiple criteria a variety of tools and techniques to organize the problems of decision, in addition to the analysis and arrangement approximately for every standardized criterion, and the ability to design options for regions priority restoration. As the analysis of the depends on the identification of a group of resetting criteria to obtain the GIS dates available for each criterion, to visualize the analysis, and the potentials for restoring forests. see figure 12-13, where NDVI is: Normalized Difference Vegetation Index.LU/LC is Land Use/Land Cover. NBR: Normalized Burn Ratio.

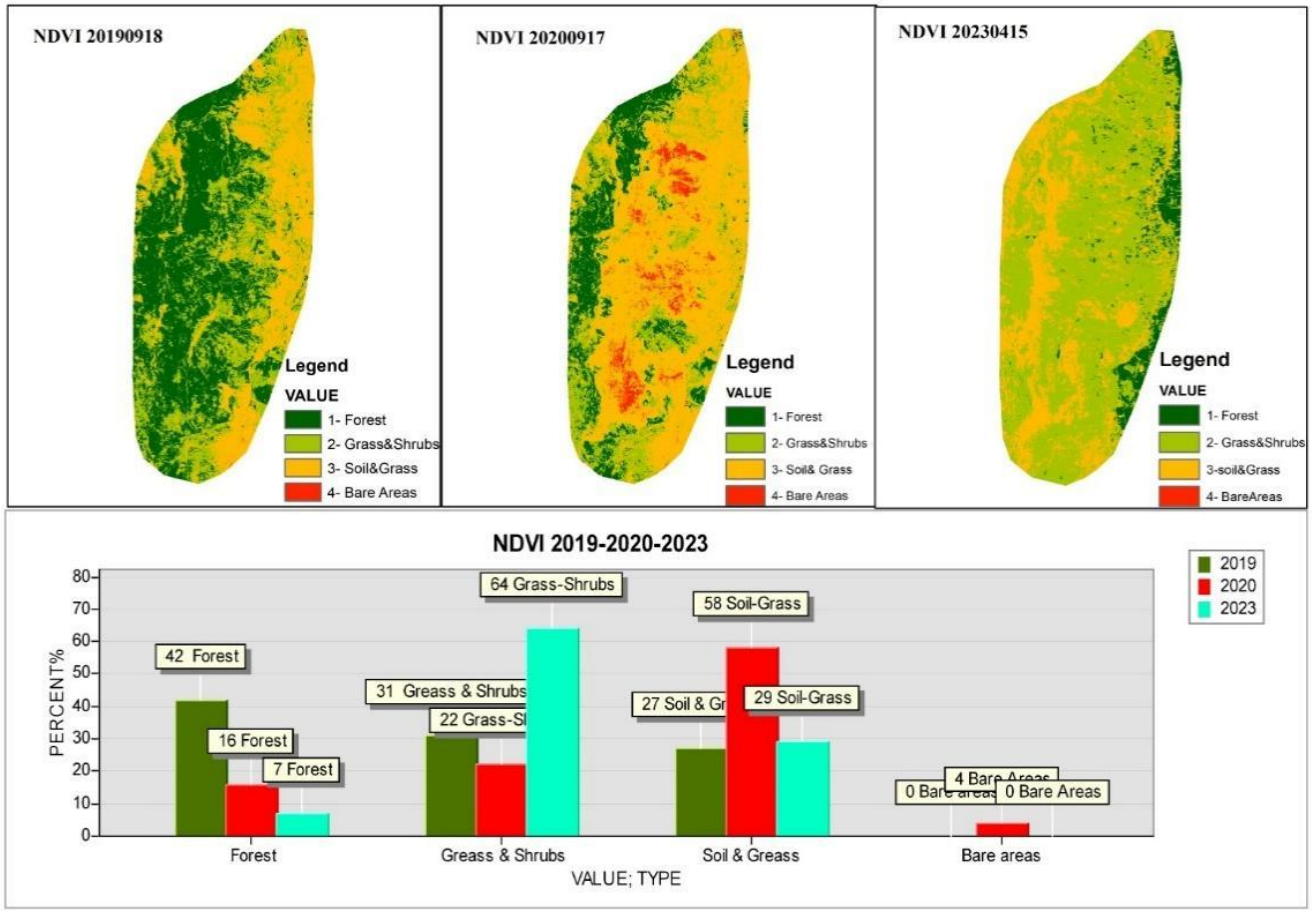
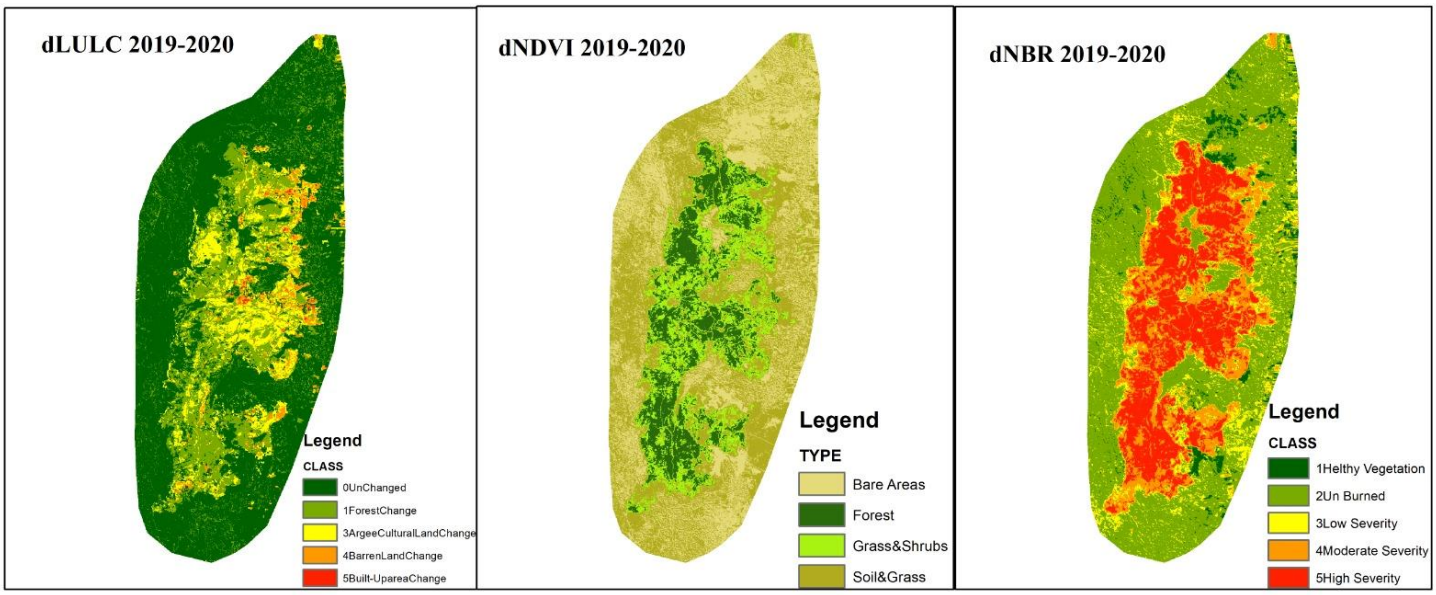


Figure 12.NDVI changes in the period between 2019- 2023



LULC - NDVI - NBR tables of Changes values

VALUE	CLASS	AREA_HA	PERCENT%
1	0UnChanged	5276	53%
2	1ForestChange	1836	18%
3	3ArgeeCulturalLandChange	917	9%
4	4BarrenLandChange	317	3%
5	5Built-UpareaChange	19	0%

VALUE	TYPE	AREA_HA	PERCENT%
1	Forest	1142.16	14%
2	Grass&Shrubs	1292.31	15%
3	Soil&Grass	3460.51	41%
4	Bare Areas	2470.43	30%

VALUE	CLASS	AREA_HA	PERCENT%
1	1Helthy Vegetation	297.18	4%
2	2Un Burned	4119.42	49%
3	3Low Severity	912.73	11%
4	4Moderate Severity	1304.34	16%
5	5High Severity	1732.54	21%

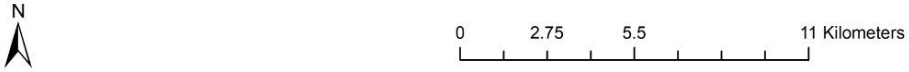


Figure 13.Changes of NDVI -LU/LC-NBR in the period between 2019-2023

The integration of spatial suitability studies into forest fire restoration planning involves examining forest cover, ecological network positioning, larger settlements, recreational demand, and integrating spatial data using GIS technology. This process involves mapping forest areas, identifying ecological corridors, and establishing connections across ecosystems. The development of spatial decision support systems (SDSS) provides spatial data and analytical model-integrated tools to aid decision-making in forest fire restoration.

Stakeholders from government departments, nonprofits, local communities, and academic institutions should be involved in the spatial planning process to ensure restoration activities align with their requirements and goals. Syria's unique environmental management and spatial planning setting requires further research.

Evaluating site suitability for forest fire restoration involves prioritizing species and restoration techniques that optimize wood yields and economic advantages, improving the forest's aesthetic and recreational aspects while considering ecological functions, and prioritizing native species and ecological processes that support biodiversity and ecosystem resilience.

Adapting restoration operations to achieve multiple aims can be achieved by including these objectives into land suitability evaluations. By using an integrated strategy, forest fire restoration can repair biological damage while supporting socioeconomic and environmental goals. Stakeholder

engagement is crucial to ensure restoration plans meet the needs and preferences of nearby communities and other stakeholders involved in forest management.

i. The following criteria were selected for the six criteria:

The settlement map was produced using Sentinal2 satellite images and verified by a Google Earth map. As for the producing of the map of the land use / land covering (LU/LC) from the database groups for the year 2021 of the study area. The data was collected from the control of the US - American Scanner, the USGS and Kappa is 0.35- 0.50. A map of each criterion has been established at the volume of 30 m cell with the use of the geographical information system (GIS),where the average map is treated by the Google images as a reference to more accuracy. The classification process depends on the (ECCS) Extended Clearance Classification System (LCCS), and Land Cover Classification System which the Food and Cultivation Organization for the FAO (Sathiyamurthi et al., 2022).Including accuracy by determining of a random sample point on the classification map and comparison of the same points on a reference map such as the Earth Google for 2023 to know whether the category in the description of landmarks that represent the map, and also allows the identification of categories. After that, each criterion map is integrated with an analysis of multiple-criteria for the establishment of the final suitability map.

Land Use and Land Cover (LU/LC)maps is prepared by Maximum likelihood Supervised Classification which is taken from satellite image Copernicus Sentinel A2 from 9-18-2019 till 9-17-2020. It is also possible to evaluate the different criteria through a multi-criteria method to obtain a map of all aspects, relying on the level of accuracy of the integrated maps (Rajaonarivelo and Williams, 2022). In the process of categorization, the maps of the criteria to four categories, not appropriate (S3) is unsuitable (S2) marginally suitable(S1) highly suitable, and the values are ranged from 1 to 4, where each criterion is analyzed in an individual way for its inception depending on the basis set by the Food and the Agriculture Organization(FAO), then all the layers have pairwise comparison, and preparing the land suitability layer (LS) through weighted linear overlay analysis(Yingbin Feng et al., 2020).

4.5. Evaluation the aforementioned development economic projects using Knapsack method

4.5.1. The Economics projects in AL-Ghab plain

Economic projects established locally within the framework of the cooperation program between the Ministry of Agriculture and Agrarian Reform, the General Authority for Fisheries and Aquatic Resources, and the Food and Agriculture Organization of the United Nations to activate development work to support rural families in villages, starting from 4/15/2022 until 10/31/2022. The village of Qatrat Al-Rayhan is considered the first development model in the Al-Ghab region, where the Ministry of Agriculture and Agrarian Reform, through the directorate of Rural Agricultural and Family Development, provided all the necessary and essential facilities to support these development projects and make them successful, to be a nucleus for similar projects that include all neighboring villages. Five villages were nominated to be the first model for implementing the initiative, and after comparison between these villages, one of them was Qatrat Al-Rayhan village that was chosen to be a development model, for the following reasons: Qatrat Al-Rayhan village has a moderate population (about 660 people), and this village is considered one of the villages that possess a resource. A diverse tourism economy in the region, and since the village of Qatrat Al-Rayhan has a surplus of vegetables and milk, which required the presence of experience among most of its residents in manufacturing dairy products, in addition to the rare of occurrence of disagreements or disputes between the people which want to participate in development work to improve their income and living situation, and to fill the acute shortage of services and infrastructure in the village. On the other hand, neither the local

communities nor any of the homes were damaged by fires which led to the absence of the need to provide shelter centers or any fees for evacuation and its arrangements, including fuel and drivers' wages.

When calculating the restoration costs incurred so far by the government, they are: The costs required to feed firefighters throughout the fire season are about 70 million SY.P/season or 28000$/season. By estimating the need for fire extinguishers (water hoses, fuel, and maintenance) is about 100 million SY.P/season or 40000$/season, while disbursing a firefighting bonus to each worker is approximately 25,000 multiplied by 500 workers during the fire season, i.e., 12,500,000 SY.P or 5000$. And costs for equipment and individual tools for firefighters (back pumps, shovels, axes, scythes, and drinking water bottles) are about 100 million SY.P/season. In addition the costs of uniforms and shoes for firefighters are about 85 million SY.P / season or 34000$/season(Nassour, 2023).

4.5.1.1. Proposals and future projects in the future in Qatrat Al-Rayhan village

The preparation stage for starting development projects in Al-Ghab is by establishing a food processing unit in the village. The manufacturing unit began under the supervision of the Ministry of Agriculture and Agrarian Reform to assist male and female workers in opening marketing channels and securing work supplies. A project was provided by the head of the development committee in the village for a period of two years. Choosing machines and equipment according to the products that the manufacturing unit will produce and how to store them, recording the raw materials that the manufacturing unit needs, and recording the materials that will be sold with profits. Several months before the unit began its work, the Ministry of Agriculture trained female farmers for 5 days. Special training courses were also held, including the following:

- A training course for members of the Local Development Committee in the village of Qatrat Al-Rayhan was attended by 15 members of the local community, in order to help achieve a deeper understanding of the development projects that can be established and how to apply them to achieve their economic feasibility.

- A social survey course for rural families to study and analyze the social reality in terms of number of family members - their ages - educational stage - work, attended by 30 trainees from the village's sons and daughters.

- Holding a training course entitled (How to establish your own project for rural families), attended by 30 male and female trainees from all youth groups, through which they were trained on the principles that must be followed for establishing small family projects and how to prepare appropriate studies for it in a way that ensures achieving the best production and marketing it according to the best criteria to achieve a good profit margin contributes to achieving a better standard of living for these agricultural families.

- Organizing an organic fertilizer production course attended by 25 trainees from the village.

- Holding two courses at the end of 2022 entitled "Entrepreneurship, Start Your Project," and 72 people benefited from them.

- A special course for fish ponds, through which the target group was trained on how to prepare ponds and fill them with organic materials, which eliminates the need for adding chemical fertilizers and at lower prices.

- Supporting livestock by compensating for lost livestock and providing appropriate fodder units. 40 early mastitis detection devices were distributed to breeders in the village.

- Establishing a livestock development project and providing all the equipment and expertise required to establish a biogas production unit that relies on organic waste available in the local community's environment, which contributes to the production of biogas as an alternative to regular gas, which is expensive and often unavailable.

- Providing a number of mechanical presses to produce firewood from the raw materials available in the area (wood - broken tree branches - crop residues), as most of the local residents in the village depend on this wood to produce many types of bread and pies.

➢ Implementation phase:

Seven months trial phase will begin ,while the established development projects will be examined and evaluated, such as returns, total net profit, and monitoring of the work progress plan as the following phases:

1) An operational plan was developed by a month for the food manufacturing unit .And milk is considered a permanent input material. The project started in March until September, and a special section was allocated for the production of all milk diary (cheese - yoghurt - labneh - Quraysh - butter). Ten rural women were involved in the village invites those who have experience in the food manufacturing process to participate in work and production, as this production unit contributes to providing job opportunities for them. It also works to supply the local and neighboring markets with its various products at lower prices, and this has directly benefited the breeders, and the profits have been distributed to the beneficiaries within unit. As for agriculture, it was divided into three cycles, from the month of March until the month of June, flowers ,medicinal and aromatic herbs are planted, while the months of May and June are assigned to the cultivation of wheat and barley, and from the month of July until September, various vegetables are grown, the most important of those vegetables are okra, peppers and tomatoes. Manufacturing dryers for vegetables, fruits, utilize with a solar energy system instead of fuel and to assure the continuity of work. The total costs of the raw materials for the production process during the seven months were estimated at 33,986,000 SY.P or 13600$, with a value of 4,855,142 SY.P/month on average. The cost includes milk - vegetables and fruits - transportation costs - gas, electricity and water - packaging and preservation and other materials (Salt - cleaning materials - tools). As for the manufactured materials like jams - vegetables and dried fruits, so the total sales for seven months were 38,168,000 SY.P or 15000$, meaning 5,452,572 SY.P/month or 1300$. As for the total amount Net profit is 4,074,000 SY.P, or 1630$, and582,000 SY.P/month or 233$/month.

The shortcomings faced by the food processing unit in Qatrat Al-Rayhan village are summarized as follows:

o Lack of operating capital for the unit.

o The need for a commercial register to place labels along with the need to provide industrial gas cylinders, hot water, and a refrigerated means of transportation of products keeping.

o There is no specific administrative organization followed. Everyone does the work with concerted efforts, according to possibility, and under the supervision of the quality of the product based on personal information and experiences.

3) o Pricing is done by primitive calculation of costs with profit margin, a small profit margin is determined so that it is competitive with the prices of similar products in the market, but the resulting profit is distributed equally among the farmers in the manufacturing unit('Agaropolis studies and projects,Structural planning for Al-Ghab area', 2011).

4) A large number of agricultural baskets were distributed to farmers, which include a set of summer and winter seeds, approximately 14 kg, to 270 families, or 18.5 kg/family, during the 7 months. The total price of the seeds was estimated at 450,155 SY.P or 180$. In addition, one plastic tunnel was constructed, including costs of packaging, drip irrigation and fertilization for the production of various types of vegetable seedlings. Costs were estimated at 5,000,000 SY.P or 2000$ to meet the needs of rural families for all kinds of vegetables which were grown in home gardens. This achieved the fulfillment of the nutritional needs for the entire summer season of these vegetables, and the drying, pickling and preservation of the surplus, also cultivation different types of medicinal and aromatic plants to distill the oils extracted from them. The amount of agricultural production has been estimated at 300-500 kg, meaning an average of 57.14 kg/month. Thus, the value of total sales reached 18,000,000 SY.P or 7200$ within 7 months .

5) Biogas was produced, in which the number of beneficiaries was estimated at one family. The need for this production process was estimated with the raw materials amounting to 45 kg of cow manure and 45 liters of water. The resulting materials are methane gas, which is used in household chores and is delivered directly for use and operates for three continuous days.

6) About 4 kilograms of fertilizer are produced daily and are sold or used personally by one family. Units for chopping crop residues were set up for use as animal feed and organic fertilizer for agricultural crops. Fertilizer production during the season reached 51 kg, and the average production of this fertilizer during the 7 months was estimated at 700 kg. Thus, the total price of organic waste reached 1,750,000 SY.P or 700$, i.e., 250,000 SY.P or 100$/month.

7) Establishing a vermicompost pond with an area of 4 m^2 with an input value of 186,700 SY.P or 75$ and an output value of 1,047,975 SY.P or 420$ with a net profit of 861,275 or 345$ SY.P during the 7-month trial period. The number of beneficiaries is one family.

8) Development projects for family fish ponds. The number of beneficiary families reached 22 families, and each family has a small pond. The Ministry of Agriculture, through the General Authority for Forest Management and Development, provided the appropriate mechanisms to equip these fish ponds, whose area ranges between 100-250. m2. Preparing what is required for it is to start raising fingerling fish with a number of 3,500 fish fingerlings with an average weight of 25 g/each, which contributes to securing the important food item and providing job opportunities and income for many rural families in the village, so that the total weight of the chick of the fish fingerlings increases from 50 g to 1,500-1,700 g/month. It is worth noting that family fish farms need a total of 174 kg of feed during the 7 months, i.e., 24.85 kg/month. The total number of dead fish during the 7 months is 148 fish, and the Net profit at the end of the production season is estimated at about 31 million SY.P or 12400$.

9) 250 plates designated for growing sprouted barley were distributed to 15 beneficiaries. These plates provided 50% of the fodder, producing on average about 450 kg/day, or 50 tons, or an estimated 25 million SY.P or 10000$. There is a great deal of adoption of this technology, with the exception of the months of July and August, when work stops due to high temperatures.

10) Distribution of 750 kg of barley seeds to 15 beneficiaries, i.e., distribution of 50 kg/beneficiary. The average value of the green materials resulting from planting 1 kg of barley seeds reached 7-9 kg, i.e., 5250-6750 kg over 7 months, i.e., 750-965 kg/month. This green material contributes significantly to providing fodder in a shorter time, and thus the value of the total output amounts to 3,600,000 SY.P or 1440$.

11) 6,000 smooth cactus palms worth 9 million SY.P or 3600$ were received, with the price of each palm reaching 1,500 SY.P, and they were distributed as 3,050 palms were planted around the Syrian Elm forest in the village of Qatrat al-Rayhan to contribute to protecting the forest from encroachments, as well as providing the fodder material for pets, where every 5 kg of Aloe Vera is equivalent to 1 kg of fodder, and 2,950 palms were distributed to the beneficiary families and breeders to plant it as a fence around their land in the village to benefit from it for feeding animals, in addition to its edible fruits. The number of beneficiaries reached 19 families, forming the equivalent of 250 kg as an alternative to fodder, 3,500 kg of fruits, meaning that the value of the total output amounts to 21,600,000 SY.P or 8640$.

12) Establishing a financial fund, through five experimental loans worth one million SY.P or 400$, were distributed to five beneficiaries, through two female sheep were purchased('Al-Ghab Development Projects', 2023, 'Agaropolis studies and projects,Structural planning for Al-Ghab area', 2011, Population Assessment Survey, 2015).

13) An action plan was developed by government agencies to develop the service and educational sector in the village, including:

- Improving sewage networks and improving agricultural roads.

- Establishing classes, kindergartens and institutes to develop the educational process in the village.

- Introducing 30 micro-projects for rural women, with the necessary networking with some private and government banks to secure financing. As for small and medium enterprises, cooperation is taking place between the General Authority for Small and Medium Enterprises Development and private banks for the possibility of granting loans that suit the needs of the beneficiaries ,and take into account the guarantees that are available to start projects to ensures achieving the best production and marketing, to achieve a good profit that contributes to achieving a good standard of living for these agricultural families, such as renewable loan funds, guarantee funds, matching grants and empowering the capabilities of small rural producers in the field of agricultural manufacturing such as dairy products, wool products, canned vegetables and leather products('Agaropolis studies and projects,Structural planning for Al-Ghab area', 2011).

4.5.1.2. Propagation and cultivation of important non-traditional forest species "Al-Ghab-Salhab Nursery"

Project duration: 6 months (1.5 preparation - 4.5 months implementation)

The Ministry of Agriculture and Agrarian Reform aim to reconsider the adoption of the few typical species used in restoration of burned areas, and to cooperation with the expertise of the Syrian Society for the protection, and naturally forest species of wildlife, within their common view of achieving the preservation and rehabilitation of natural habitats to increasing biodiversity and the rapid restoration of forests , with the support of the United Nations Development Program in coordination with the General Authority for Forest Development and Investment in Hama in order to provide technical support in the field of agriculture (UNDP).

The forest species distinguished by rapid reproduction after cutting and fire, such as Oaks and Conifers which are widely used in all government nurseries specializing in forestry with the help of international information about methods of their propagation and special treatments, and then adopt the results in the future. The project also aims to achieve a number of scientific and practical objectives, the most important one is developing the capabilities of individuals and preparing to update available and relevant information by multiplying many wild forest species and establishing a data bank based on scientific foundations and supporting a nursery for the production of forest

seedlings in Salhab, so as to raise the level of work in terms of "quantity and quality" and provide forest seedlings in the targeted areas which contributes to preserving natural plant diversity and quickly restoring damaged forests to their natural plant diversity. Therefore, the project is summarized in the following points:

- Training workers to identify important and rare plant species, which are considered threatened with extinction in their original environment. Planning to protect its shape, the locations of its spread, and the processes of collecting its seeds, and continuation of this process in the future.

- Conducting experiments on seed treatments of different target species by applying appropriate treatment and preparation methods and identifying the best treatments for each type that give the highest germination rate.

- Monitoring the germination and growth processes, organizing all the results and outputs of this experiment in special computer tables, and following up with the Ministry of Agriculture to benefit from the experience of the trained workers in charge of this experiment.

i. <u>The project justification</u>

Huge damage to the forestry sector as a result of fires, random cutting, and the loss of the genetic origins of many plant species.

- Providing job opportunities in the field of agricultural business, especially in areas where these nurseries are located.

- Preserving the genetic origins of wild fruit trees, trees, shrubs, and perennial forest plants, and they can later be distributed to farmers in the targeted areas as adapted seedstock, according to each region.

- The importance of spreading awareness about the great benefits of wild plants, especially medicinal, aromatic and ornamental plants, and its great economic return for the population living near the targeted forests.

- Providing 86 temporary job opportunities, distributed as 26 direct beneficiaries and field training, and 60 beneficiaries of field work.

Preparation stage:

- A technical committee will be formed to supervise the project.

- Selection of the work team, the project manager, specialized supervisors, and experts.

- Selecting workers according to targeting criteria and the type of work.

- Purchasing the necessary materials to start the business and field equipment.

Implementation phase:

- Supplying and securing the necessary supplies and equipment of the project and handing them over to the General Authority for Forest Development and Investment.

- Preparing and dividing the nursery fields, and planting.

- Preparing periodic work progress and follow-up and evaluation reports. And paying workers' wages and entitlements.

ii. Budget summary

Table 37.Costs of Al-Ghab-Salhab Nursery Project

Element of the project	Cost in Syrian Pounds(S.P)	Cost in US Dollars($)
Equipment and materials for a salhab nursery	14,010,000	5604
Fixed assets (equipments, furniture)	19,350,000	7740
Operating expenses	13,695,000	5478
Human resources and capacity development (wages and compensation)	27,945,000	11,178
Total	**75,000,000**	**30,000**

iii. Risks and obstacles

- Difficulties in contracting with suppliers to supply tools and equipment due to the instability of the exchange rate in the local market, thus delaying the implementation of project activities('Propagation and cultivation of important non-traditional forest species "Al-Ghab - Salhab Nursery"', 2022). The bag algorithm is used to obtain a set of alternatives under certain condition ,and to provide with specific indicators to select the most post-wildfire economic projects under restoration conditions.

iv. Knapsack method

It is applied to determine the instances that are not necessary, dependent on the priorities of the decision-makers. In the fire, the restoration index (SI) is evaluated and ranked for alternatives, whether individual alternatives or groups of ones, and tool to determine the improved results through several stages, the stage of data collection to provide a decision including three levels . through the comprehensive review of previous studies on the performance of restoration projects, 7 initial groups of indicators have been modified through the restoration activities with users of multiple specializations, professionals, investigators, project managers and director.Finally, 6 indicators are selected by the most representative and independent ones which can be expanded through the inclusion of new indications. In this case, the complete approach is valid and applied. Also, the quantitative measurement process must be followed for each indication, and to be applied to any development project. However, it is improved to use local databases to evaluate these indicators that were obtained from the Knapsack models to determine the most beneficial groups are economically beneficial,in addition to the preferences of the owners of interest and local systems. This model will also facilitate the tasks of the decision-makers to increase accuracy and benefit, due to the use of the problem, and documents to compare the results and choice for the most accurate, speedy and easy to use (Gilani *et al.*, 2022).

It also represents the problem to choose a group of elements that increase the total profit with the accumulation of the total weight to determine elements that are not less than the capacity of the elements for a period of the product, where the problem is solved to acheive the overall priority required level. Knapsack is to a highly performance in the practical time to increase the wills to the maximum limit to conduct many of the duties to obtain a compulsory equivalent of an expected approach as a first step. When the weight of the item exceeds the target bag capacity, a negative assestment is given, where the initial capacity is a valid number of random number between the lowest limit to weighing the groups of elements and the maximum capacity C, or when the total

elements are chosen amending or tested , and if the choice is not selected or neglected after its weight was less than or equal to the maximum capacity, the element of the subordinate component will be chosen, and on this basis the element is classified as a limited element and is excluded from it.
We use the greedy algorithm of a simple on the most maximum profit component of the weight, as the element is used to a large number of capacity and the optimal result is the perfect condition for the profit proportion in the capacity of the knapsack method(Sur *et al.*, 2022). As each process has a proven weight cost to pay or not to pay; there are no different levels of expenditure in one treatment, of concern to policy makers is the sensitivity of these results to changes in the weights of index indicators. These maximum weights and paired comparisons are then compared for different degree scenarios for all. where there is a need to build improved spatial and temporal dimensions . These results are indicative of policy makers because they appear how strong the results are, given that every provision of the maximum benefit is the total that can be achieved.
It also supplies the decision-makers with the ability to explore the investment contracts from the direction multicing to determine the optimum levels of spending on a continuous range, where investment decisions include subjective elements due to incomplete data and political pressures. Where the role of support and evaluation completed in improving accuracy and transparency can be represented in the evaluation of investment through the costs and benefits knowledge of alternative treatment to restore, and thus enable the decision-making industries to see the form of the ideal investment of the optimal strategy with the availability of new data and changing political facts, with the need to explain these amendments to the parties concerned and provide transparency in the process decision-making to ensure that the administration provides social benefits to the greatest extent possible(Hajkowicz et al., 2005).
Determing the maximum given profits based on the information about profit and weighing over the most of the elements that will be tested, and the capacity of the bag, then it indicates the number of problems that must be solved by selecting one item.(Cj) indicates the largest project capacity, and each problem contains a different target number, which is the number that contains the target number of the right one. It is imposed that there is a capacity of (M), which is agreed with (CM), C3, C2, C1, and it is sorted with a descending arrangement for the capacity of the sack capacity. C1 is located with the largest volume of the cap, and at the second, the C2 is located with the second largest volume of the cap, and at the end, the (CM) is with the small size of the cap. (Pi∑) , and (Wi∑)are the total profit ,and the total weight of the items.
The profit information and weights of the items are listed as in the following equation:

$$\text{Pni}=\frac{Pi}{P\,max}$$

Where (Pi) is divided by (Pmax), which is the maximum size of the given profits. (Pni) and Ci/Wi pairs are arranged with a link to a valu(Pi/Wi). Pi in the field of every element, the (Pni) is at first, and (C1/W2) is located at second. In the third is (Pn2), and in the fourth is C2/W2,the remaining elements are arranged in the same way. When the weight of the maximum period of element marks, the field value is given zero and that indicate no effect of the weight of the element because the only thing is that we need to know whether the weight is limited of the capacity range or not(Sur et al., 2022).

$\sum_j.\sum_i pixij$ Total profit:max

Subject to Total weight: $\sum_i wixij \leq cj'$ $\sum_i xij \leq 1$

$for\ \forall i \in I, \forall j \in J,\ xij \in \{0,1\}$

Table38 .Heuristics algorithms: Profit to weight ratio(pi/w1)

I	Food processing unit (1)	Agricultural Seeds (2)	Compost and Vermicompost (3)	Aquariums (4)	Sprouted barley (5)	Green fodder (6)	Opuntia Ficus Indica planting (7)	Trial loans (8)
Weight Wi	10	270	1	22	15	15	19	5
Profit Pi	38168000	18000000	2611275	31000000	25000000	3600000	21600000	1000000
Ratio Pi/Wi	3816800	66666.66	2611275	1409090.9	1666667	240000	1136842.10	200000
Heuristics3 xi	**1**	**0**	**1**	**1**	**1**	**0**	**0**	**0**

Total Profit max=38168000+2611275+25000000+31000000=96,779,275.
Total weight max=10+1+15+22=48
The taken Items are:
1,3,5,4
Max Allowable weight C=50
Max Allowable profit Q=100.000.000

4.6. Suitability Analysis for the sixth criterion of forest fire restoration

The previous studies are based on the (MCA) Multi-Criteria Analysis and the geographical information systems (GIS), which have been successful in a varied group of implementations related to the restoration management of the forests, and planning ,where the analysis provides techniques to organize the problems decision. In addition to analyze and arrange criterion, and design options priorities regions . The suitability analysis depends on the following points: (1) determining restoration criteria(2) obtain GIS datasets available for each criterion (3) establishing maps for each criterion (4) visualization of the analytical analysis models (5) designing the potential sites of the restoration(Guidelines for Resilience Systems Analysis: How to Analyse Risk and Build a Roadmap to Resilience, 2014).Then combine them all to create the final suitability rating(Rajaonarivelo and Williams, 2022),with taking into consideration a comprehensive framework of the criteria.

A) Economic Criterion

The following chart was extracted based on Table No. (1) and from that table also all charts related to each of the six criteria will be extracted and derived separately.

The maps depicted in Figure (14) was represented the criteria specified for the economic criterion were collected between 2019 and 2020, one year after the fire, and encompass the following aspects: (1) evaluating changes in land uses and coverage, combined with fire intensity, to determine the average economic loss in both wood and non-wood products in forests or private agricultural lands resulting from the fire; (2) calculating the average amount of fuel or wood; (3) estimating the damage to residences and the number of properties in small villages within the research region, along with their proximity to roads; and (4) assessing the government's presence at administrative points and connected community assistance centers, as well as its willingness to fund restoration efforts by determining the expenses incurred in restoration thus far.

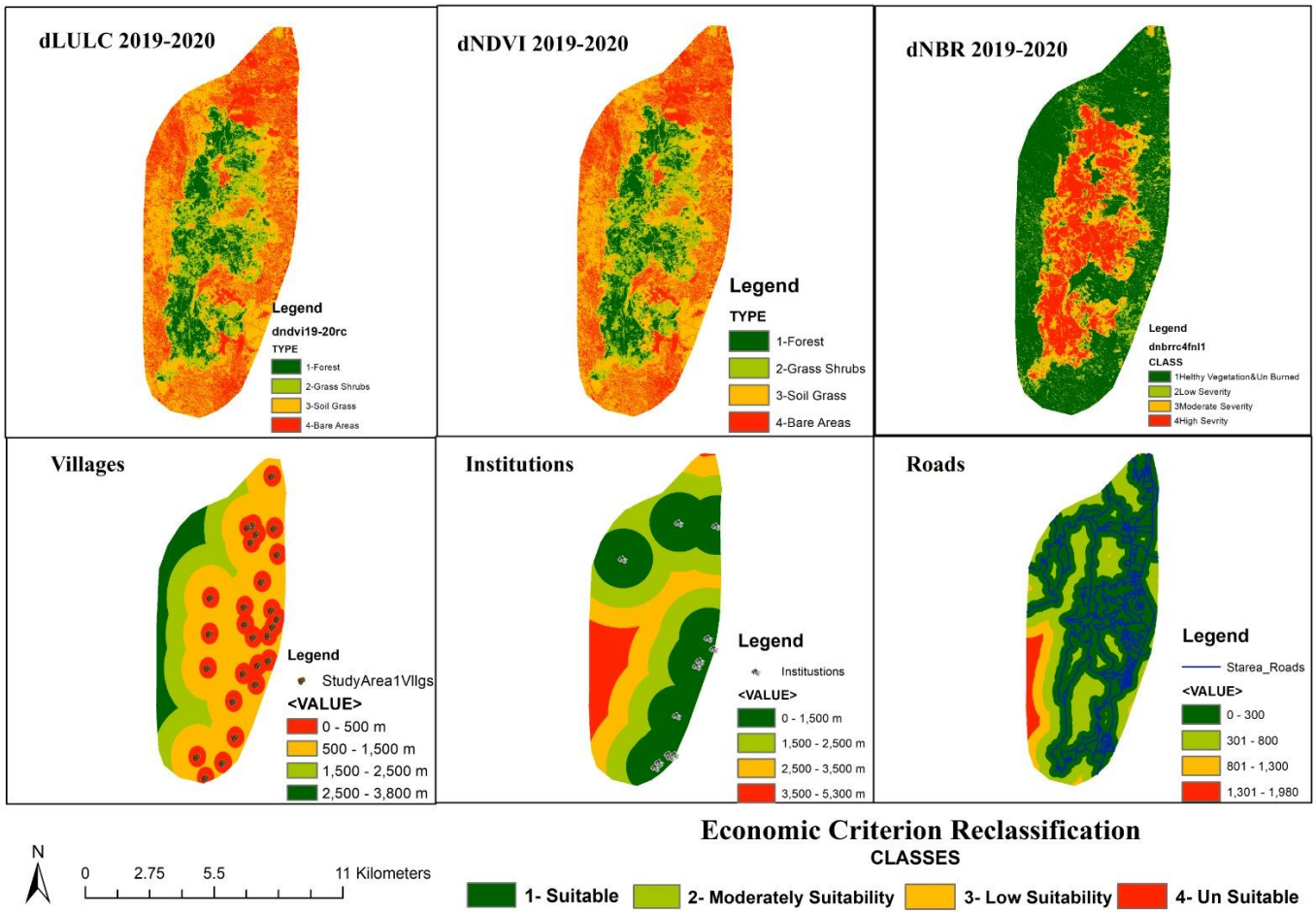
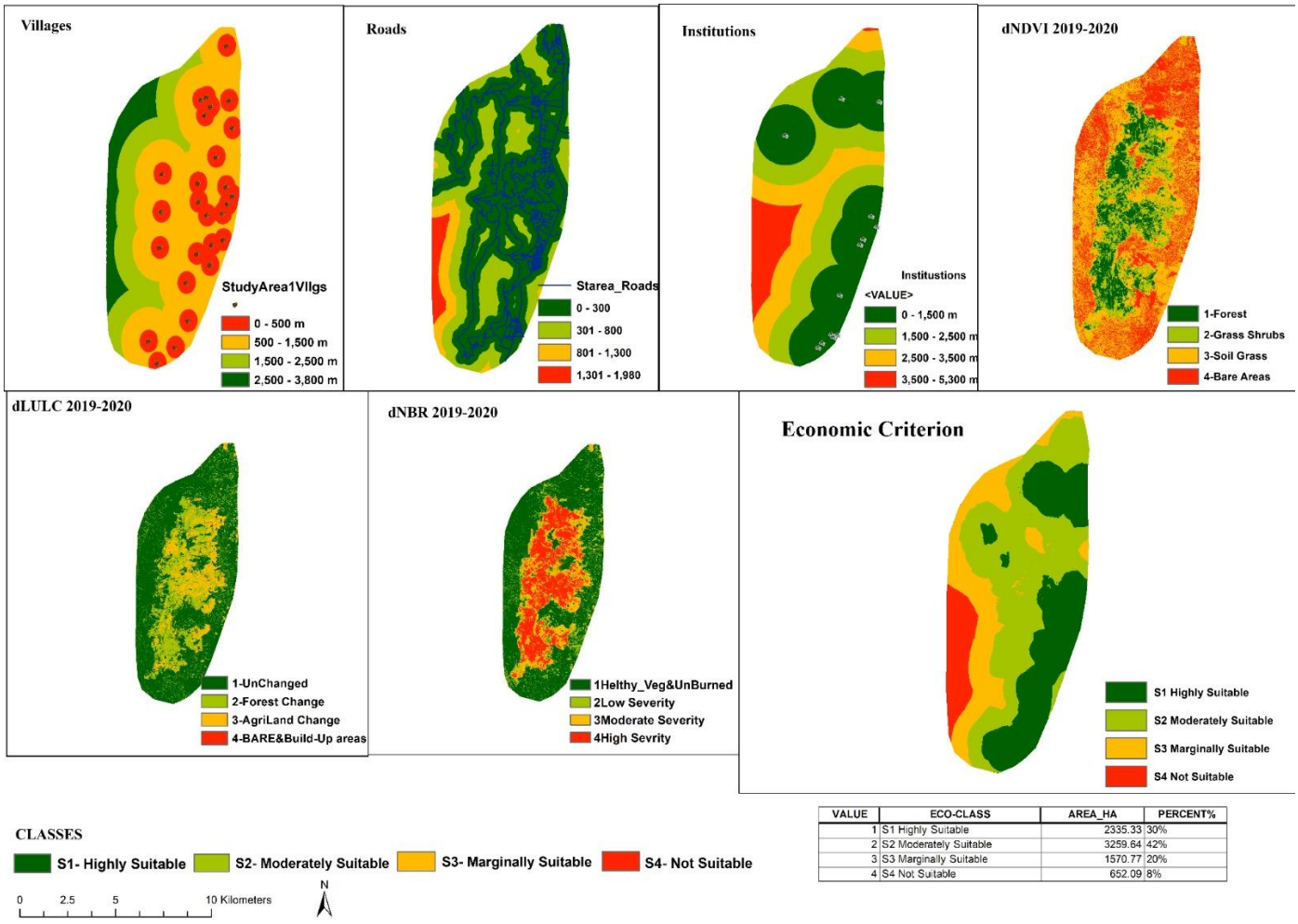


Figure 14.Economical criterion layers in ArcGIS



VALUE	ECO-CLASS	AREA_HA	PERCENT%
1	S1 Highly Suitable	2335.33	30%
2	S2 Moderately Suitable	3259.64	42%
3	S3 Marginally Suitable	1570.77	20%
4	S4 Not Suitable	652.09	8%

Figure 15.Economic Criterion and its suitability classes in ArcGIS

B) Social Criterion

The suitability analysis method involves five major phases: (1) selecting restoration criteria, (2) compiling available datasets for each criterion, (3) generating condition maps for each criterion, (4) establishing a suitability analysis model, and (5) identifying appropriate restoration locations. It encompasses social criterion eligibility criteria that define the quality of life, (6) changes in land use and coverage, and their combination with fire intensity to reflect the extent of ecological security, natural damage, and habitat.

The number of residents of Al -Ghalab plain, according to the statistics of 2014, was 575,000(Khadka et al., 2015), they are distributed over an area of 141,000 hectares and include 157 villages, 218 farms, 54 municipalities, 21 towns, and 8 cities. The population ratio of those in the age of 18-20 years at 60%, or 345,000 workers('Agaropolis studies and projects, Structural planning for Al-Ghab area', 2011)including 163635 people do agricultural work where the percentage of workers is about 47.43%, while those working in the industry sector their rate is 4.54 %, and the percentage of workers in the services sector and the rest of the sectors is 48.03 % of the total number of residents of the region, and the percentage of females is 52 %, or 299,000 females, while the rate of maleity is 48%, or 276,000 males (Khadka et al., 2015).

A social map that includes the layers were classified using the Euclidean Distance tool from closest to furthest to suit the restoration (the closest is the most appropriate), then the pixcles were divided

into equal distances from 190-525 m using the Equal Interval tool according to 4 layers from 190-275 m , 275-350m , 350-450m ,and 450 -525m. To estimate the workforce, whose limits range from 1 to 7,190 workers in the study area, with the workforce divided by Youth force, classified into 3 layers from 1-1000 / from 1000-3000, from 3000-5000 .

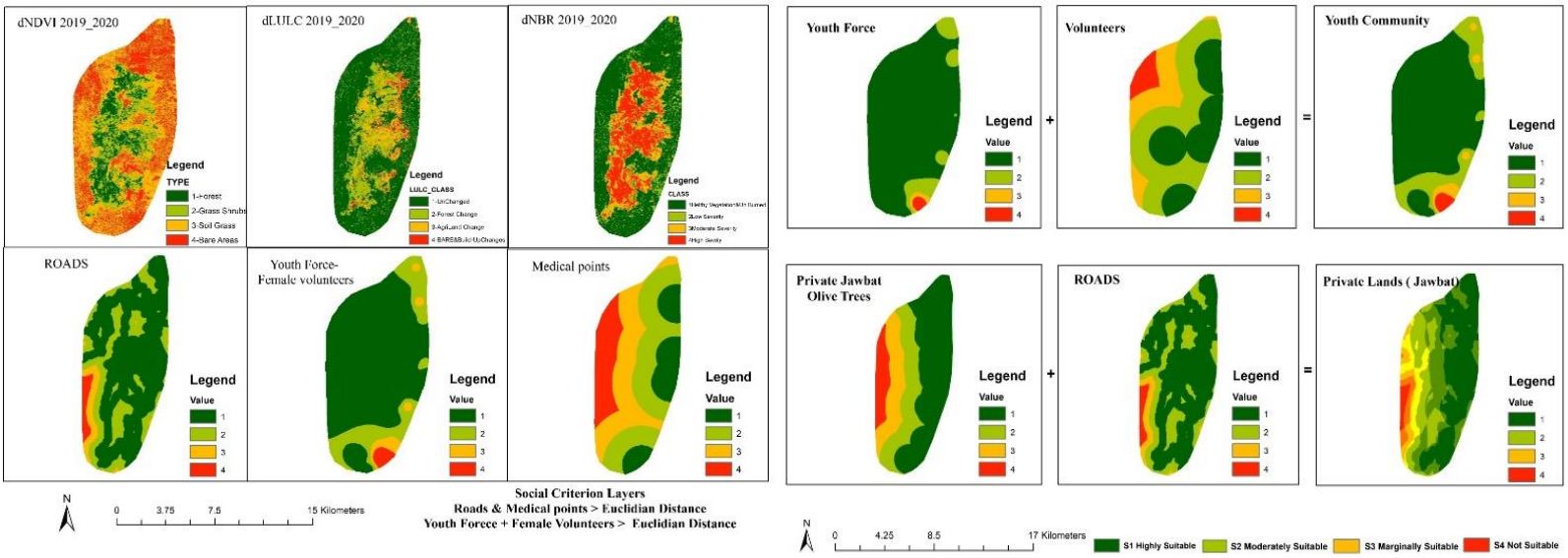


Figure 16. Social Criterion layers in ArcGIS

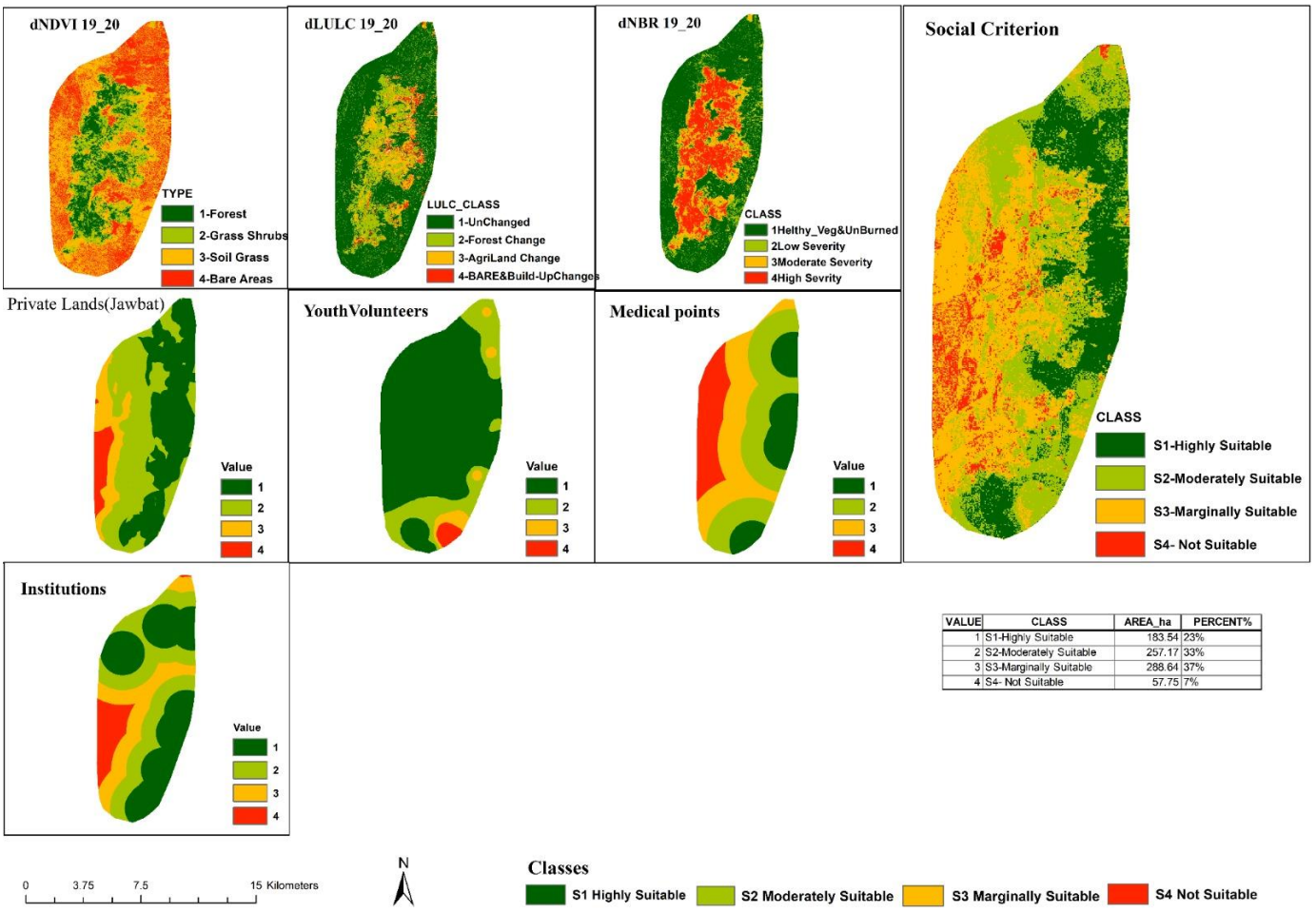


Figure 17.Social Criterion and its suitability classes in ArcGIS

C) Environmental Criterion

In the study area, it was observed that slopes exceeding 35 degrees are more prone to recurrent fires due to their rapid spread and decreased fire control capabilities, compared to the preferred gentle slopes ranging from 0-10%. Gentle slopes aid soil retention and enhance water storage, contributing to biodiversity stability. Plant species, humidity, and rainfall rates are influenced by elevation, with fir and Cedar trees thriving at altitudes exceeding 1000m. Aspect: Referring to the slope or orientation preference for southern, southeastern, and southwestern slopes, impacts sunlight exposure, resulting in a more favorable natural regeneration process in the forested regions categorized into four types.
Carbon sequestration accounts for half of the biomass in the vegetation cover (50%). Temperature exhibits minimal diversity in the study area due to its relatively small size compared to the entire Syrian Region(Ilari et al., 2022) .The NDVI serves as a method for estimating the C factor from remote sensing data, commonly employed in vegetation and biomass assessments .Ranging from 0 to 1, NDVI values above 0.26 indicate healthy plants in equilibrium with infrared reflectance, according to the FAO(National Report 5 of the Convention on Biological Diversity, 2016,Ghosh et al., 2023). The suitability criteria for the environmental criterion encompass: (1) assessing changes in land use and coverage combined with fire intensity to gauge vegetation cover resilience/resistance; (2) identifying alterations in environmental services, including carbon sequestration; (3) determining changes in biomass indicative of dispersal, loss, and deviations in vital habitats (flora-fauna); (4) evaluating changes in biodiversity, encompassing alterations in soil characteristics, soil loss/erosion,

and changes in hydrology post-fire; (5) assessing variations in the humus or fuel layer after the fire through vegetation cover changes; and (6) considering the presence of administrative points and local community support centers affiliated with the government(Rajaonarivelo and Williams, 2022).

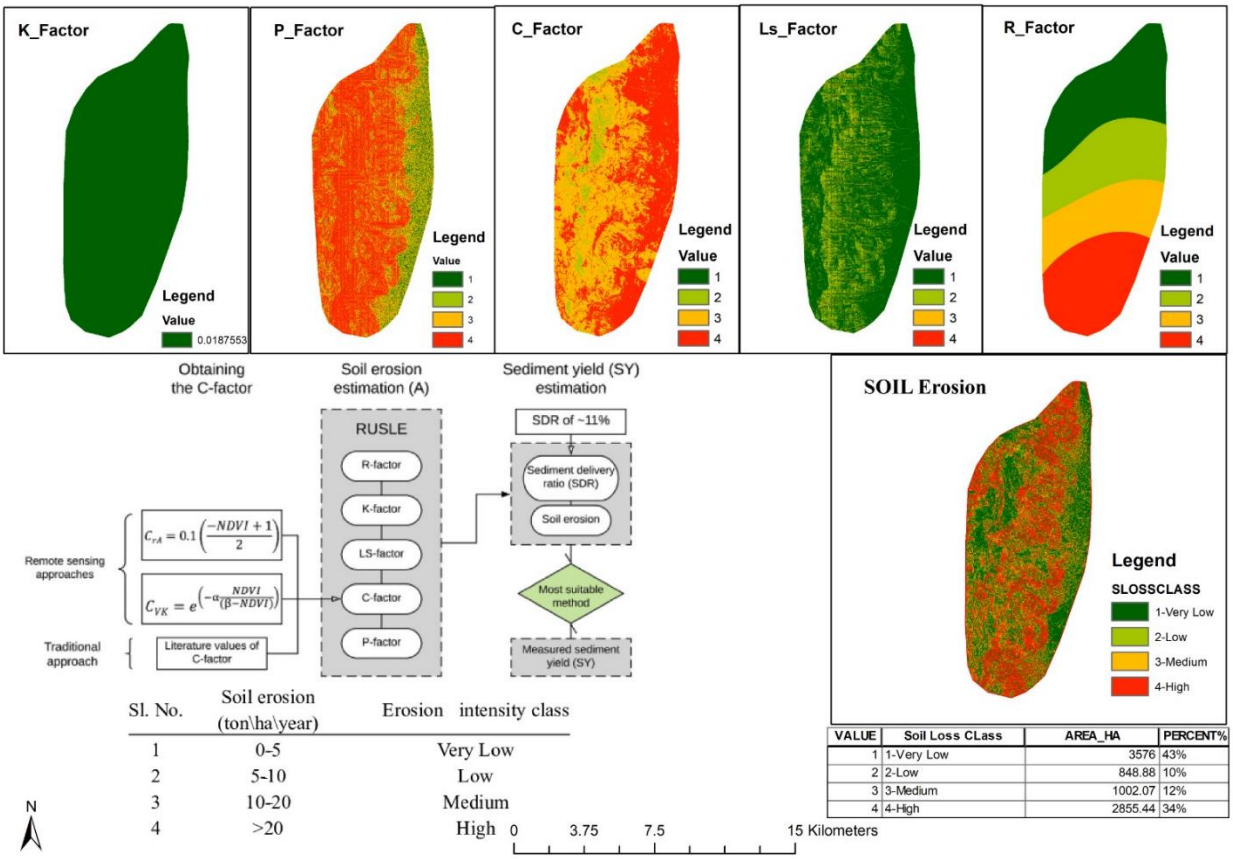


Figure 18.Soil erosion layers in ArcGIS

Soil erosion has been incorporated into the socioeconomic criterion as restoration efforts can contribute to preserving and stabilizing damaged areas. Convenience maps are typically generated by calculating distances, reflecting the proximity of environmentally significant sites such as forests and other vegetation, as well as the closeness to sources of disturbance like highways and residential areas. According to the technical guide to (USLE) use in Michigan,(NRCS-USDA) offic(Fales et al., 2016; USDA-N RCS, USA et al., 2018). The calculation of annual soil erosion in this study employed the Universal Soil Loss Equation (USLE) that was employed to compute soil erosion using the (USLE) Formula,which are considered to be the experimental models applied to a wide range to enrich the soil at the water. It has been achieved from this model until now in Syria, but it has been achieved in A number of Mediterranean regions (Portugal and Italy) that are similar to the Mediterranean region. The formula is relatively straightforward:

$A = R \times K \times LS \times C \times P$

where:

A represents the long-term average annual soil loss (measured in tons per hectare per year), R signifies erosion potential, dependent on rainfall and runoff in the geographical area, K is the soil erosion factor primarily influenced by soil texture, LS denotes slope steepness and length/slope factor, C accounts for crop type, cultivation method, and management factor, and P represents the agricultural support factor(Moore, 2005).Both the R and K factors of the area remain constant, but soil loss can be mitigated through measures such as terracing, altering crops, or modifying agricultural practices (Mezősi and Bata, 2016; Safwan *et al.*, 2021).The selection of these factors was guided by a literature

review, computability considerations, and data availability. From an environmental perspective, the criterion related to the distance between protected areas and forest areas was chosen. This choice aligns with the dual objectives of protecting water bodies and preserving life diversity,emphasizing the restoration goal of enhancing vegetation and forest cover in degraded regions. The criterion considering distance from dwellings and roadways was chosen from a socioeconomic standpoint, aiming to minimize restoration expenses. The C factor combines soil loss from a specific crop and soil loss from a specific land management technique. The P factor represents how an agricultural support practice will affect soil loss (Mezősi and Bata, 2016; Safwan *et al.*, 2021).

R Factor represents the erosion potential, based on the rainfall and runoff by geographic location. Runoff is the flow of water on the ground when it cannot rapidly infiltrate the soil.

The greater the rainfall duration and intensity, the higher the erosion potential,R Factor Equation

$R = E \times I30 \div 100$

Where:

I30 is the maximum rainfall intensity (cm/h),E is the total kinetic energy of the precipitation (J/m2) classification of the spatial distribution of rainfall values are <950, 950–1050, 1050–1150, 1150–1250, and >1250 mm(Abdo et al., 2022).K Factor is the soil erodibility factor. It's a measure of the susceptibility of the soil particles to detachment and transport by rainfall and runoff. The K factor is primarily influenced by soil texture, but it can also be impacted by structure, organic matter, and permeability.Sand has the lowest K factor of just 0.04 tonnes per hectare.The soil type with the highest K factor (0.96) is very fine sand, closely followed by silt loam (0.85). LS Factor represents soil loss dependent on slope steepness and length. The steeper and longer the slope, the greater than 9% of the risk of soil erosion (Almohamad, 2020).

Table 39. Details of the C factor and P values

The C factor		**The P factor**	
LandUse/Land Cover	**C factor**	**Slope %**	**Contouring**
Dense forest	0.0015	0.0-7.0	0.55
Degrated forest	0.0200	7.0-11.3	0.60
Agriculture Land	0.4000	11.3-17.6	0.80
Water	0.0000	17.6-26.8	0.90
Rock	0.0000	>26.8	1.00
Grassland	0.0150		

The loss of habitats after one year of fire was estimated at 36% of the area in the study area, this demostrates the biomass changes, which gives an idea of the species richness of plants and its deficiency, which leads to the lack of existing habitats, so the habitat expanded over a wider area to search for new place or safer surroundings,while Mean value of biomass /NDVI ×642.25 tonnes CO_2/ mean final NDVI ×area = C consequeration= Biomass×0.5(Ilari *et al.*, 2022).

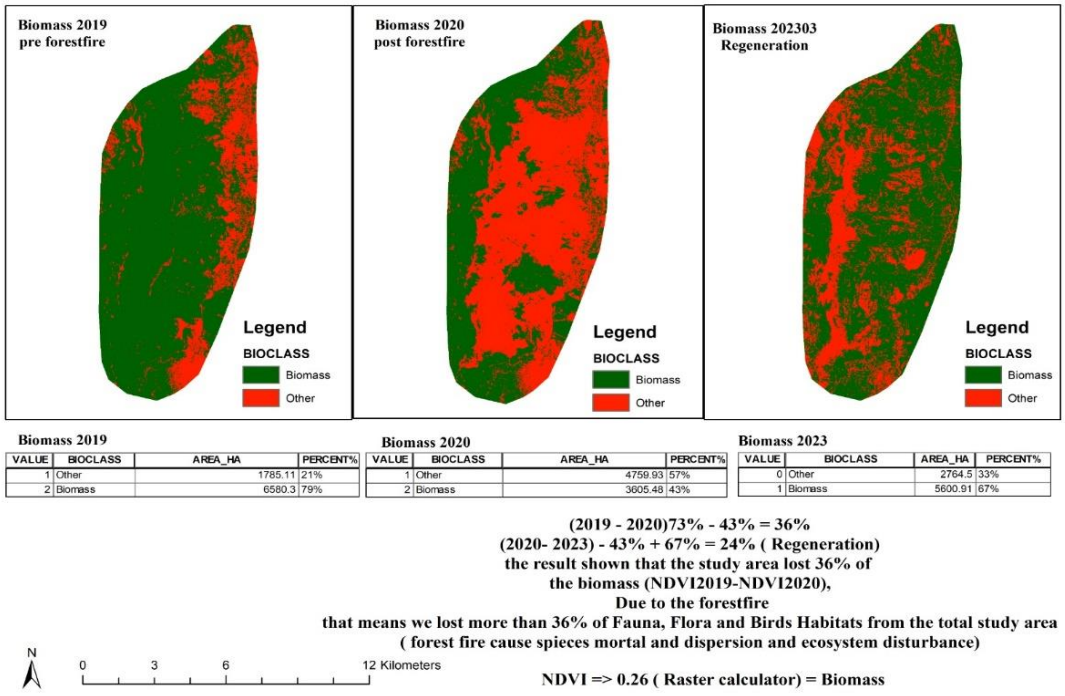


Figure 19.Analyzing the relationship between Biomass and NDVI

The map shows that the study area has lost 36% of the biomass which represents Fauna, Flora and Birds Habitats.

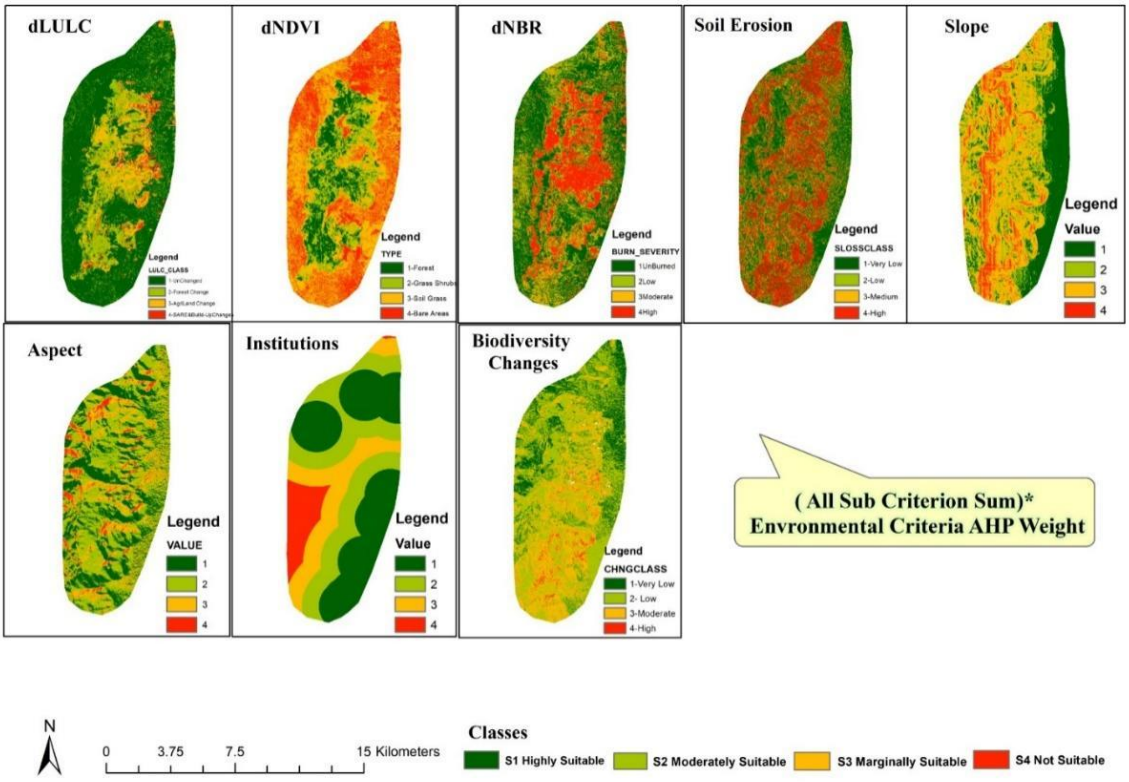
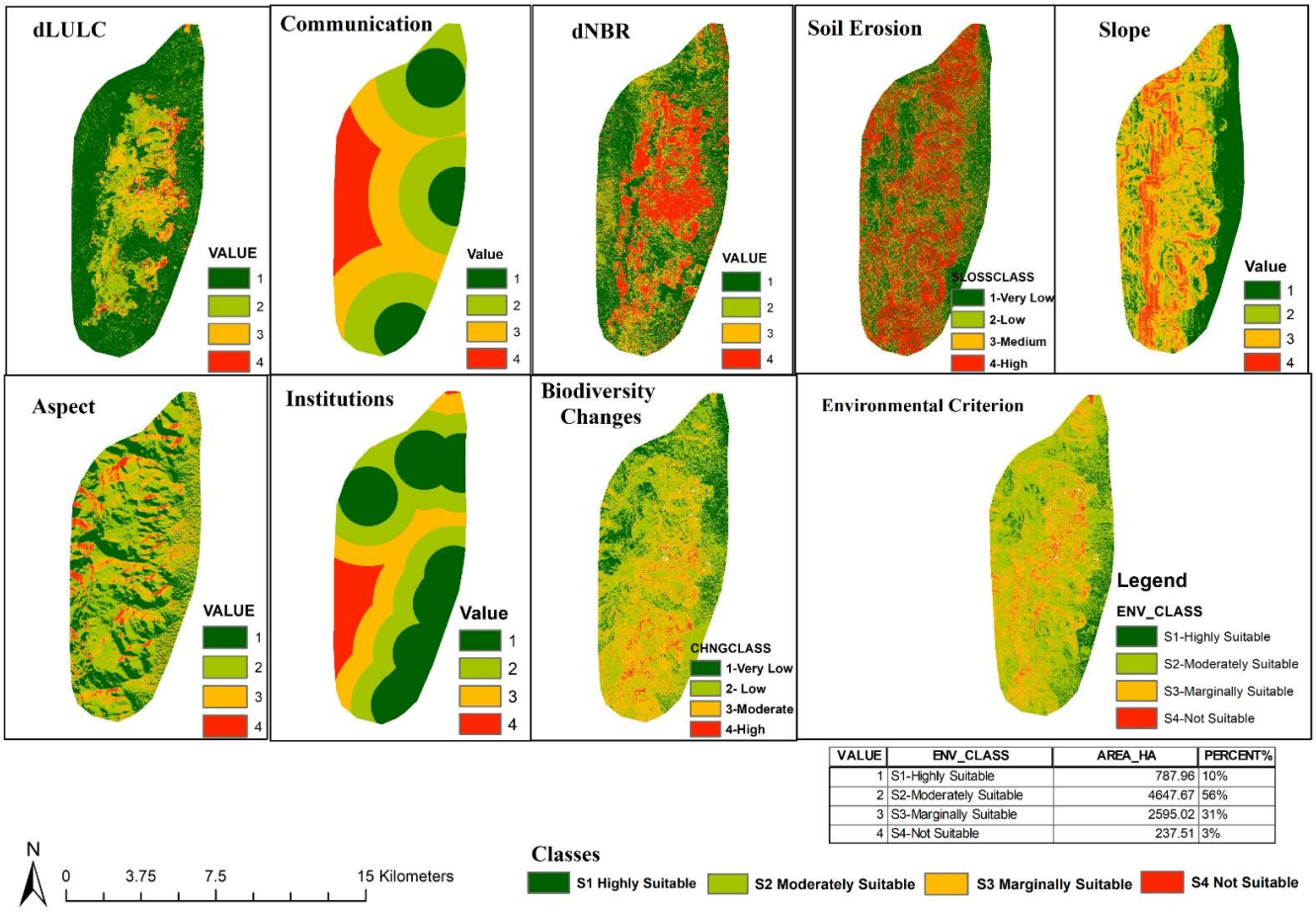


Figure 20.Environmental criterion layers in ArcGIS



VALUE	ENV_CLASS	AREA_HA	PERCENT%
1	S1-Highly Suitable	787.96	10%
2	S2-Moderately Suitable	4647.67	56%
3	S3-Marginally Suitable	2595.02	31%
4	S4-Not Suitable	237.51	3%

Figure 21.Environmental Criterion and its suitability classes in ArcGIS

Forest fire restoration can significantly enhance climate change mitigation by integrating it with spatial decision support systems (SDSS). This involves assessing carbon sequestration potential, prioritizing restoration activities in regions with high carbon stocks, and incorporating climate change scenarios into the SDSS. This approach allows for long-term carbon sequestration plans while maintaining resilience to changing climatic conditions. Climate-smart restoration practices should be integrated into decision-making processes, enhancing forest resistance to disturbances and supporting ecosystem-based strategies. Monitoring programs within the SDSS framework enable adaptive management techniques. Involving in carbon markets and incentive programs can reduce the carbon budget of forest fire restoration efforts. This strategy supports biodiversity preservation and sustainable forest management, promoting a low-carbon and climate-resilient future. By enhancing the carbon budget within forest fire restoration frameworks, it can enhance climate change mitigation efforts while restoring ecosystem resilience and health.

D) Cultural and Aesthetic Criterion

The following criteria were chosen related to Syrian case study where the villages is somehow isolated and that situation has become more complicated specially when theses villages lost the most economics profits from the external visitors who they used to a revive the ecotourism in particular the hiking/walking paths because of the ongoing war in Syria this kind of tourisim is strongly affected.Where as settlements are included human housing and infrastructure.The great focus of the human activities in the cities and villages is a movement to determine the lands and the exploitation of natural resources in the study area. For the cultural criterion, the following indicators were

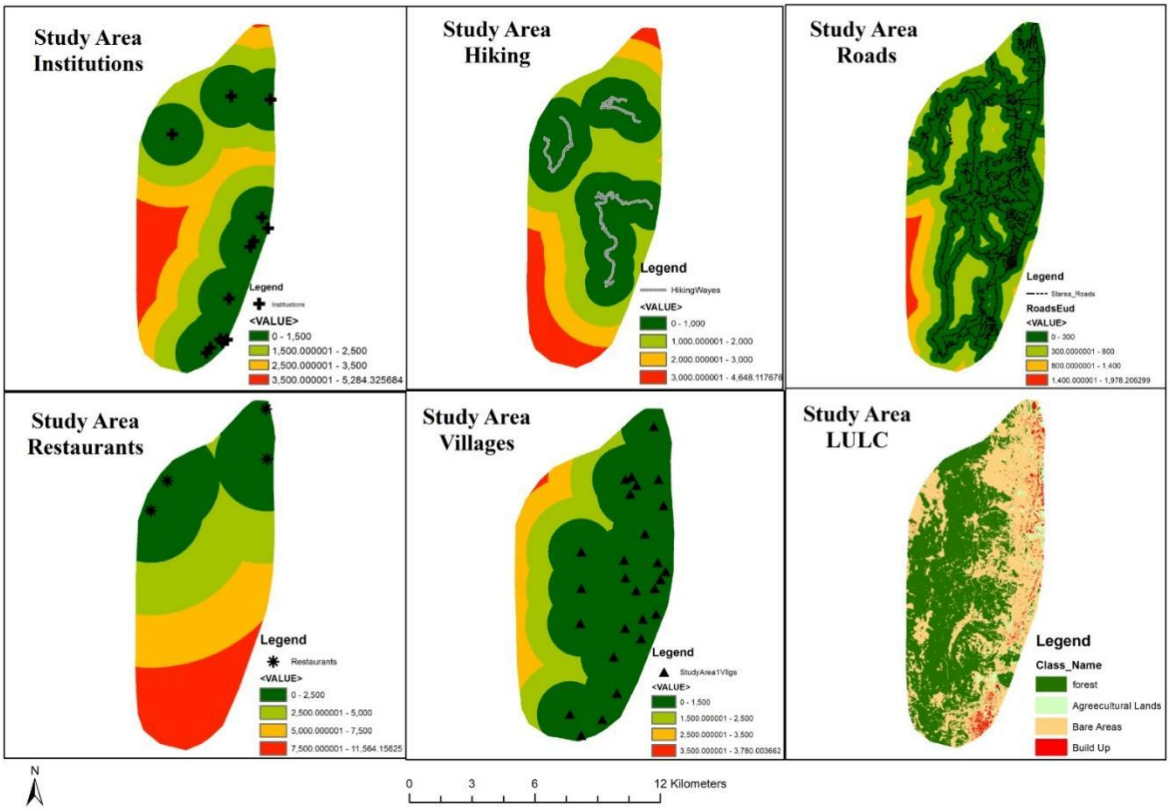
considered in the suitability analysis approach, encompassing five key steps: (1) identification of restoration criteria, (2) acquisition of available datasets for each criterion, (3) generation of suitability maps for each criterion, (4) formulation of the fitness analysis model, and (5) delineation of potential restoration locations. Cultural and aesthetic appropriateness involves factors such as (a) proximity to monuments and restaurants, (b) land cover classes, (c) distance to settlements, (d) proximity to roadways, (e) distance to walkways, and (f) proximity to local market locations.

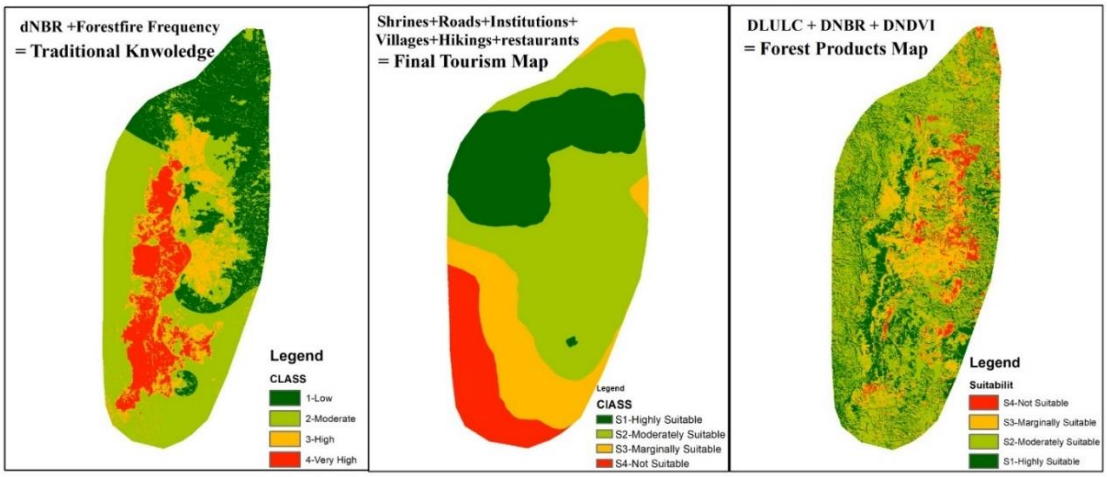
Distance from protected areas.Therefore, it was suggested that the extent of the influence of land users is a maximum of 1000 m from the original village, i.e. the best location between 2000-3000 m,which can be extrapolated to about 40 m2from the vicinity of the village.

The same dimensions were applied to both distance from walking paths and religious shrines. Religious sites like mosques, and shrines that are available according to sects. A cultural and historical site and 15 natural sites registered by the Ministry of Tourism. And the most important areas in term of Archaeology:Apamea, where the number of tourists who visited the museum in 2010 were about 16,066 visitors. Likewise, the historical sites of Horta , Akhab Al-Ashrana , Al-Lataminah Site , Mirza Castle and Shizar Castle where the number of visitors was recorded for the same year is 1,810 visitors(Allaham, 2010).Distance between administrative and governmental centers was determined between 1000-2000 m(Rajaonarivelo and Williams, 2022),(5) distance from the road,based on the previous urban development studies, and the effect of the human disturbances of road infrastructure(Sathiyamurthi *et al.*, 2022).

Table 40.Most suitable distances for Cultural and Aesthetic criterion(according to FAO classification).

Determinants	High Suitability(1)	Moderately Suitable (2)	Low Suitability (3)	Not suitable (4)
Distance from Villages	>3000 m	2000-3000 m	1000 – 2000 m	<1000 m
Distance from Roads	>1500 m	1000- 1500 m	500 – 1000 m	<500 m
Distance from Hiking ways	>3000 m	2000 – 3000 m	1000 – 2000 m	<1000 m
Distance from Shrines	>3000 m	2000 – 3000	1000 – 2000	<1000 m
Distance from Restaurants	>7500 m	5000 – 7500	2500 – 5000	<2500 m
Distance from Institutional monitoring center	<1000 m	1000 – 2000 m	2000 – 3000 m	>3000 m
NDVI	>0.5 µ- Dense Vegetation	0.3- 0.5 µ - Moderately Dense Vegetation	0.03 – 0.3µ Low Vegetation	< 0.03µ - Barren Land
LULC	Forest	Grass & Shrubs	Agricultural Land	Build-up & Bare areas





Traditional Knwoledge + Final Tourtism + Forest Products = Cultural Criterion

VALUE	CLASS	AREA_HA	PERCENT%
1	1-Low	2196.87	26%
2	2-Moderate	3765.76	45%
3	3-High	1247.37	15%
4	4-Very High	1149.47	14%

Value	CIASS	AREA_ha	PERCENT%
1	S1-Highly Suitable	2080.49	25%
2	S2-Moderately Suitable	3800.25	45%
3	S3-Marginally Suitable	1469.71	18%
4	S4-Not Suitable	1007.91	12%

Value	Suitabilit	Area_ha	PERCENT%
1	S1-Highly Suitable	2135.3	26%
2	S2-Moderately Suitabl	4024.79	48%
3	S3-Marginally Suitable	1749.33	21%
4	S4-Not Suitable	452.46	5%

Platform: arcgis- arcmap 10.8
Image Prossecing>Euclidian Distance
Maximum Likhliehood classification-Image analysis>Spatial analyst toolbox>
Reclassify-Raster Calculator

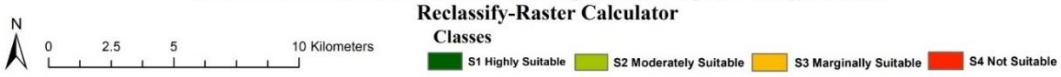


Figure 22.Cultural and Aesthetic Criterion layers in ArcGIS

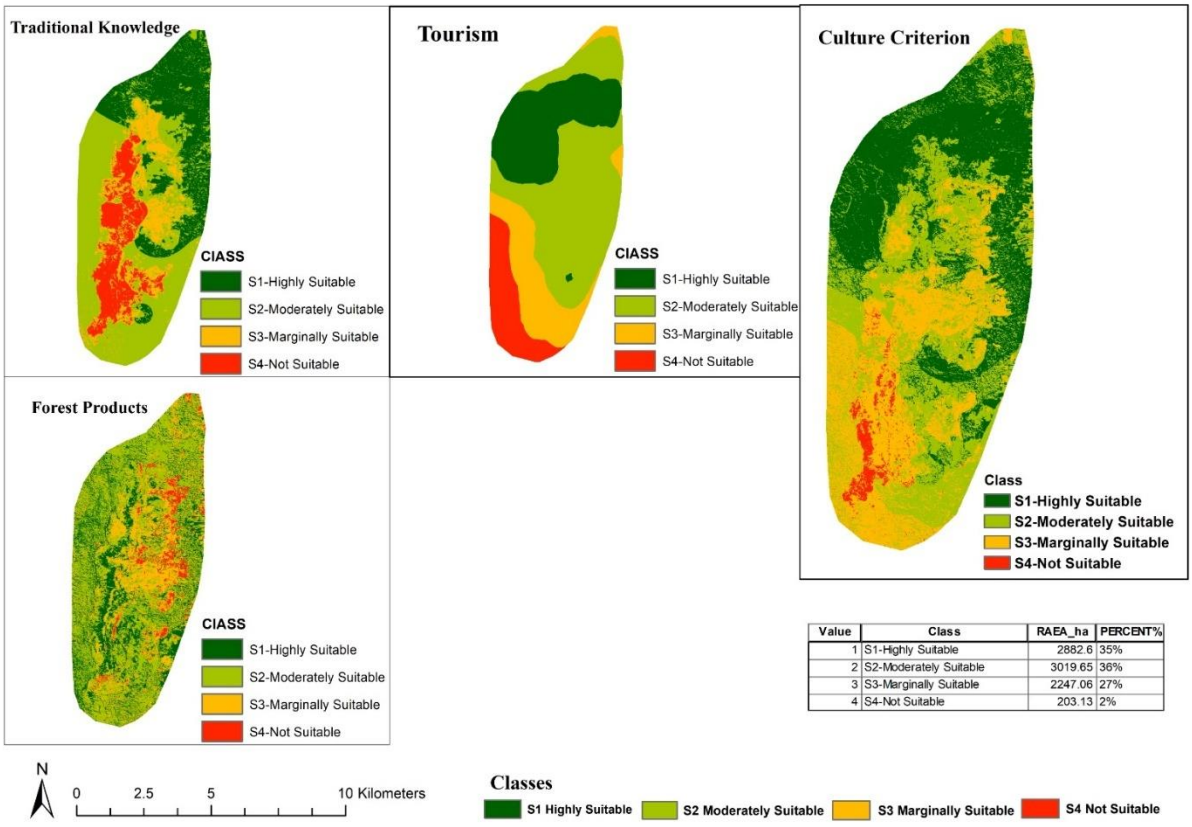


Figure 23.Cultural and Aesthetic Criterion and its suitability classes in ArcGIS

E) Infrastructure and Educational Criterion

The total annual water needs of the Al-Ghab Basin are estimated at approximately 500 million m^3 to irrigate 80.000 hectares. Therefore, the average requirement rate is 6000 m^3 / hour per year with total capacity 152 million m^3. The length of the subsidiary irrigation canals is 882 km, while the main and secondary drainage channels are 1140 km, while the imports of springs are 22. The total number of wells is about 5,200, and the annual imports of these wells are about 176 million m^3. The annual renewable volume of groundwater reaches 130 million m^3 in dry years, and rises to more than 300 million m^3 in wet (National Framework of Regional Planning, Syria 2030, 2019, Allaham, 2010).

The total length of the main roads for each of the first and second class in Al-Ghab is 361,628 km, while the total length of the secondary road network that serves urban areas is 270 km. The total length of the railways inside Al-Ghab are 15.14 km(Allaham, 2010).

Al-Ghab area also suffers, due to the lack of sewage treatment,waste is disposed after being collected in open dumps without any kind of treatment, or directly in the Orontes River, where domestic and industrial wastewater is also discharged into it (‘Agaropolis studies and projects,Structural planning for Al-Ghab area’, 2011).

In the study area, work was limited to compensating local residents for those who have Olive trees (small farms within the villages). The fire rate in the villages reached 8-10%, or 1,500 Olive trees that occurred in 2020, the compensation was 30000SY.P or 12$ for each affected farmer, over a period of 3 years, as follows: the first year after the fire in 2021, the local residents were granted an amount of 15000 SY.P or 6$ for each Olive tree. As for The second year, in 2022, local residents were given an amount of 10,000 SY.P or $4 for each Olive tree, and in 2023, they were given an amount of 5,000 SY.P or 2$ for each Olive tree. Temporary fire workers were also hired for a period of six months

during the fire season (May until the end of October), and they reach 500 seasonal workers with a salary of 92,500 SY.P or 37$. There are also 100 permanent workers distributed among 11 forest stations with two observation towers, a forest fire control center equipped with a communications network such as radio, fire tanks, service vehicles, and trained technical staff (Allaham, 2010), and administrators and technicians with an average salary. The monthly salary for workers is about 135,000 SY.P, or $18/month (Nassour, 2023,Wassouf, et al. *et al.*, 2023).

Sufficiency requirements for the infrastructural and education criterion include (1) evaluating changes in land use and coverage to estimate the extent of damage to infrastructure networks caused by fires, encompassing major and minor roads, sewage systems, communication networks, and power lines; (2) identifying the location of fire stations, considering their proximity to roads, slope, and estimating their response speed and effectiveness in reaching fire-affected areas; (3) incorporating traditional ecological knowledge from the local community, integrating it with stakeholders, and consulting experts and scientists. This involves considering the historical fire data in the study area, integrating it with fire severity, seasonality, behavior, and frequency, particularly in inclined regions; and (4) assessing the presence of governmental and international organizations' administrative offices, research or training facilities, and local community training resources.

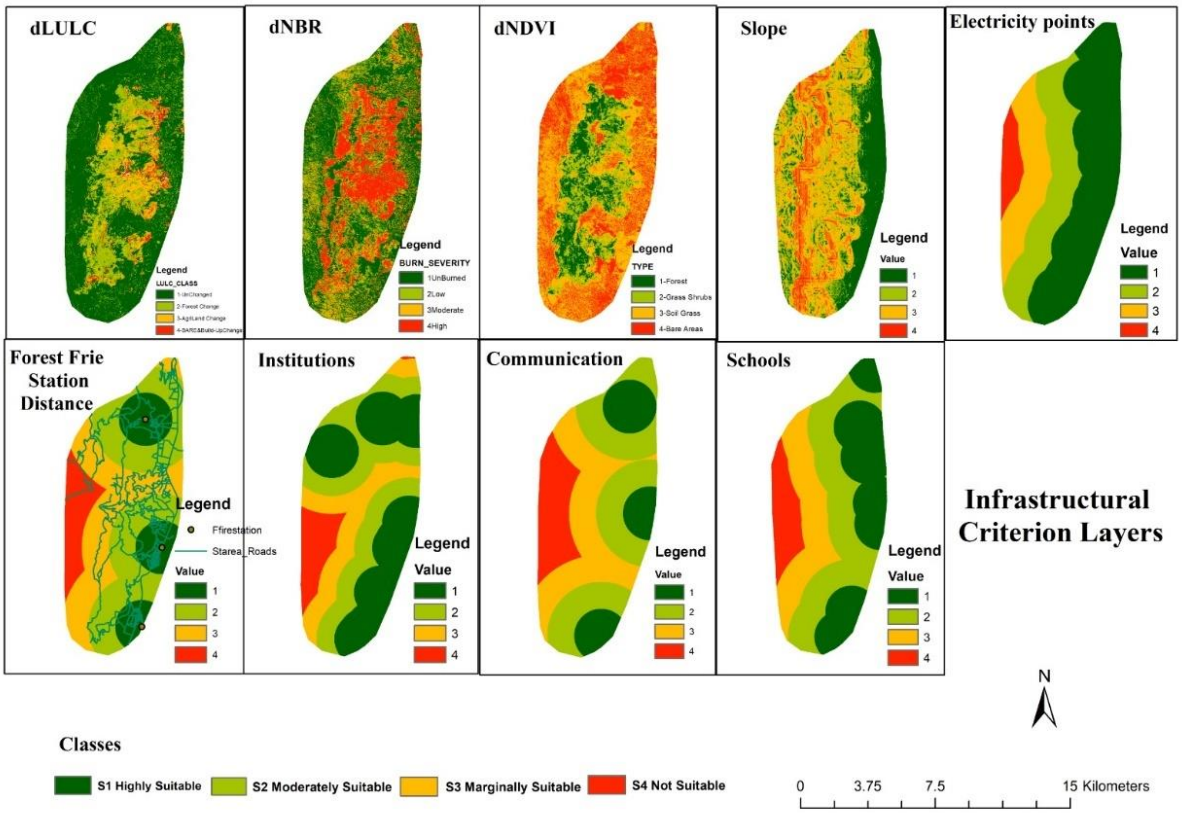
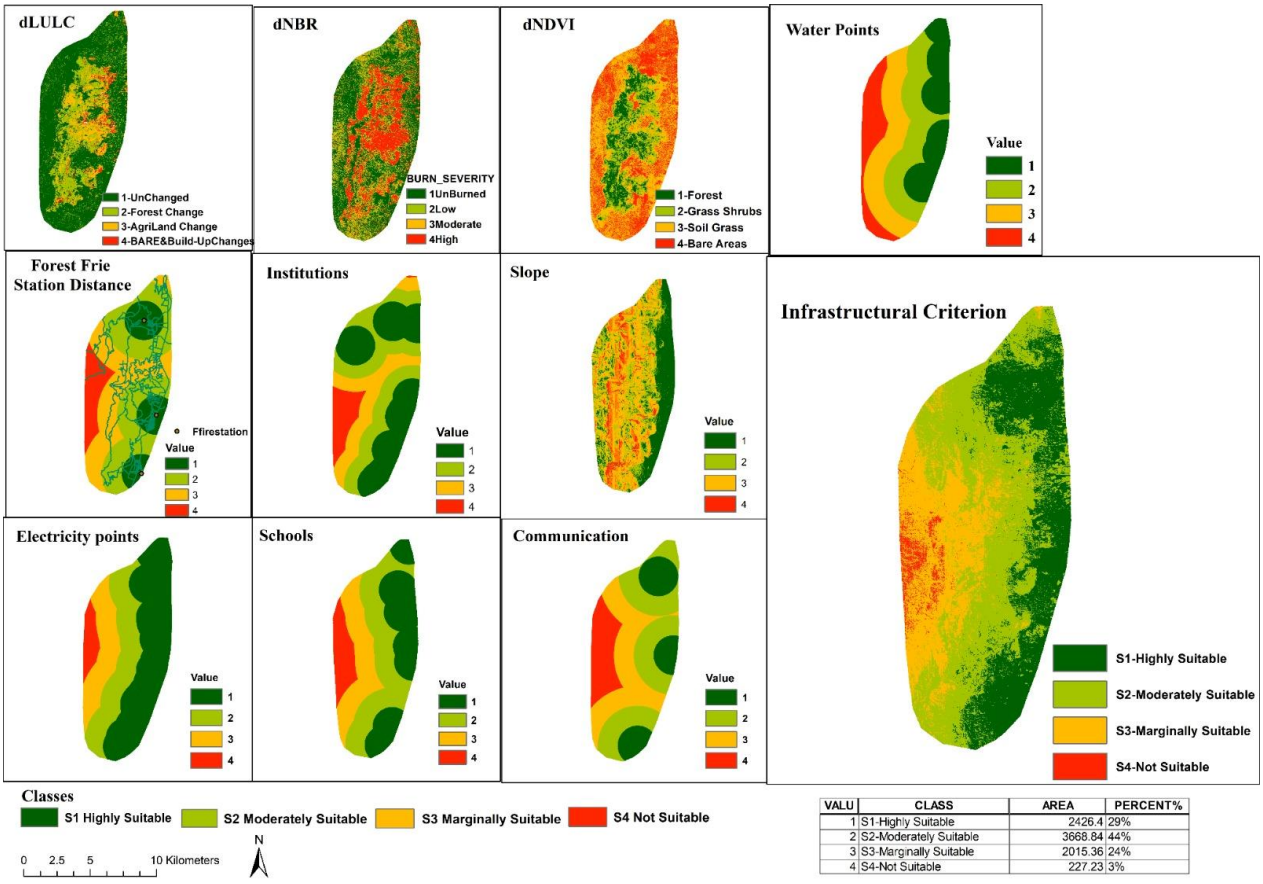


Figure 24.Infrastructural and educational criterion layers in ArcGIS



VALU	CLASS	AREA	PERCENT%
1	S1-Highly Suitable	2426.4	29%
2	S2-Moderately Suitable	3668.84	44%
3	S3-Marginally Suitable	2015.36	24%
4	S4-Not Suitable	227.23	3%

Figure 25.Infrastructural and educational criterion and its suitability classes in ArcGIS

F) Managemental and Legal Criterion

This criterion incorporates all previously considered factors and drivers (social, economic, environmental diagnosis, and historical management). It cannot be directly represented in spatial maps or layers as it has been included in each previous criterion separately. However, there were managerial indicators identified in each criterion, suggesting a potential influence on effective forest regeneration management post-fire. The concept of flexible management, explored in this study, seeks to balance the optimization of benefits for local communities with the imperative of environmental preservation.

In Conclusion, areas less likely to undergo successful restoration may incur restoration costs that are over 32% higher during a specific time-frame compared to the benefits gained in less suitable or unsuitable areas.

Our findings indicate that 28% of the study area is well-suited for post-fire forest restoration, with 45% moderately suitable for restoration,24% is marginally suitable for allowing for adaptive management expansion. In contrast, 3% of the lands are marginally suitable for restoration, suggesting unsuitability due to factors such as steep slopes exceeding 35 degrees or elevations above 1000 meters, leading to substantial soil erosion and the transformation of these areas into barren lands. This situation is made worse by weak or the absence of an administration or funding source that covers the costs of transporting and treating soil or a comprehensive protocol that takes into account all the criteria .

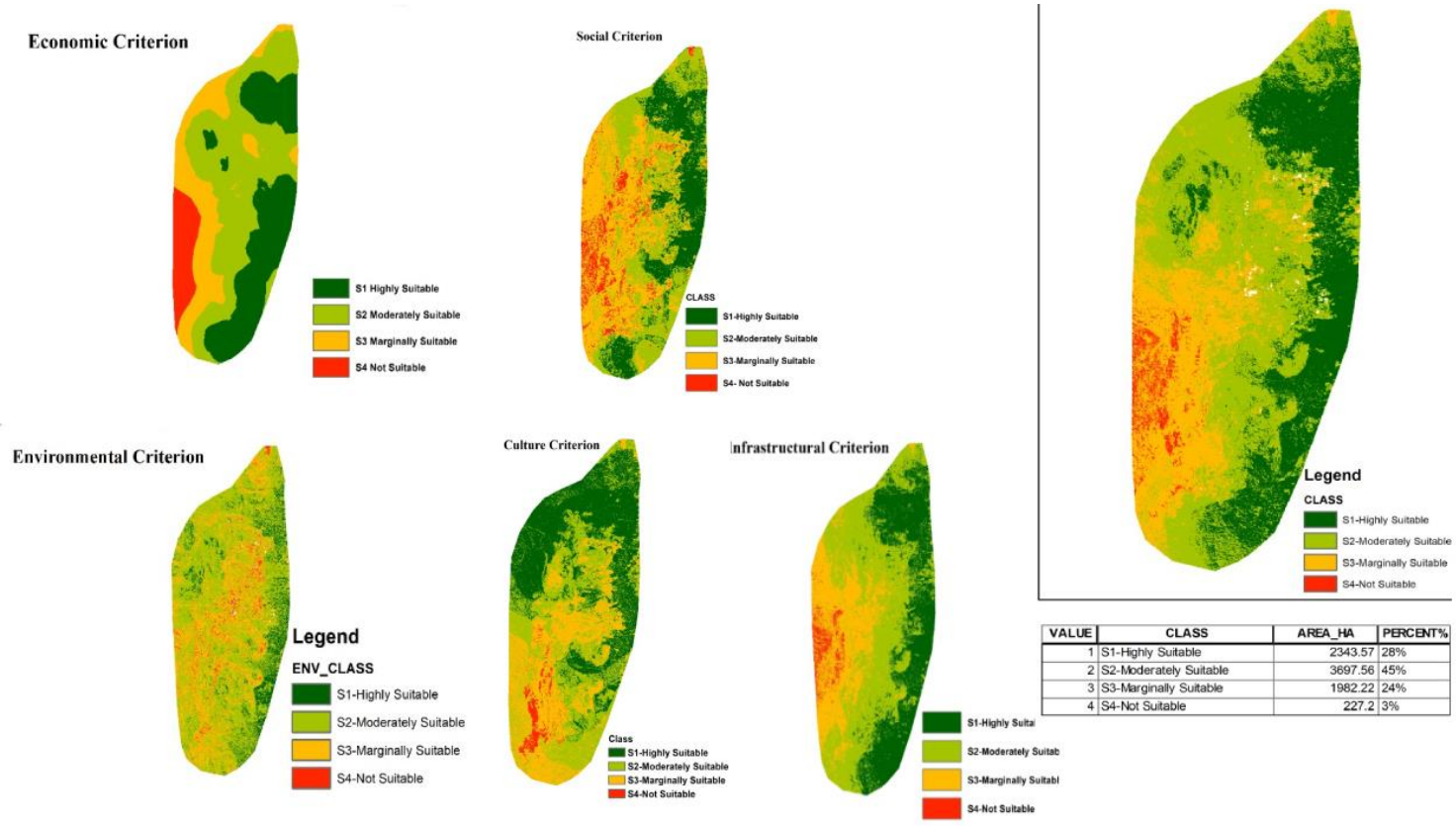


Figure 26.Managemental suitability classes in ArcGIS

The Food and Agriculture Organization (FAO) categorizes forest fire restoration regions based on factors such as biological conditions, topographical features, accessibility, and the likelihood of successful operations. These areas are classified into highly suitable, moderately suitable, marginally suitable, and not suitable. Highly suitable areas have favorable natural attributes like water availability, acceptable terrain, and good soil quality, which can be successfully restored with the right interventions. Moderately suitable areas may have experienced varied levels of fire damage and may present obstacles in the rehabilitation process. Marginally suitable locations have notable restrictions or constraints that might make restoration attempts less successful. Not suitable areas show signs of extreme deterioration or permanent damage that make significant restoration efforts impossible. Evaluating a site's appropriateness for forest fire restoration involves integrating layers of spatial data, such as topography, plant cover, soil properties, land use/cover, and fire history. Environmental factors may be given less weight than social management and economic considerations. Promoting environmental considerations in decision-making processes and emphasizing the importance of environmental preservation is crucial for sustainable forest management.

4.7. Discussion

Summarizing the results of the methods employed in this study, the priorities ranking, based on open answer questionss distributed to decision-makers in the Syrian government, indicates that the economic criterion holds the top position. This underscores the economic challenges faced since the beginning of the Syrian war, emphasizing the need for local authorities to strategically utilize leftover

wood and coal as resources for forest fire restoration. The social criterion, ranked second, highlights the importance of involving local communities in restoration efforts. This involves selling traditional materials and products, fostering a sense of connection between locals and the forests, and enhancing resilience against future fires. The significant gap in management methods in Syrian forest restoration is recognized, suggesting potential challenges, as each criterion encompasses management-related indicators.

In terms of the ranking of forest restoration strategies, economic considerations play a pivotal role for decision-makers facing obstacles or delays in restoration efforts. The top-ranking alternative is Integrated Forest-Fire Decision-Making, focusing on developing a comprehensive fire control plan to support landscape, land use, and forest management. The second alternative, Forest Fire Investment Planning System, aims to conduct risk-based analyses of wildfire outcomes and management operations. The third alternative, Forest Restoration Techniques, encompasses various interventions to accelerate natural regeneration. The fourth alternative, Suitable and Subsequent Treatments, involves standardizing the classification of forests, wooded land, and other land, emphasizing the importance of notification in areas with recurrent wildfires.

Analyzing the suitability maps, the eastern and northern parts emerge as the most suitable for restoration, with moderate to high fire intensity and severity. Notably, the infrastructural and environmental criteria suitability maps show almost no red areas, indicating a high potential for restoration in terms of these criteria. However, the western-southern parts are less suitable for restoration in terms of economic, social, and cultural criteria. The assessment of fire effects reveals that approximately 35% of the study area has been moderately affected by fires, represented by light green and yellow areas.

Evaluation of criteria maps through a multi-criteria approach provides a suitability map for each criterion, contributing to the creation of a final suitability rating. Priority areas for restoration are selected based on a combination of environmental, social, economic, cultural, infrastructural, and administrative criteria. The results may vary with the inclusion of additional criteria, emphasizing the importance of accuracy in the analysis. Supporting and monitoring landscape restoration is crucial for reducing fire risk, enhancing resilience to climate change, and fostering local capacity building and fundraising.

Updating the master plan based on current land use and dividing areas according to the land suitability map offers guidance toward sustainable development. The unification of all criteria maps on a standardized scale facilitates comparison, and re-classifying maps allows for prioritization. Weight assignment to indicators yields the final suitability map for primary restoration areas. The multi-purpose nature and planning of restoration applications contribute to naturalistic judgments, and the identification of priorities using a multi-criteria method aligns with protection projects encompassing social, economic, and environmental goals. Tools for quantity support are essential for examining spatial patterns and selecting preferences among various resetting technologies.

In conclusion, the study provides a comprehensive approach to post-fire forest restoration, integrating multi-criteria analysis tools, decision-making methodologies, and spatial decision support systems. The findings highlight the significance of economic, social, and environmental criteria in guiding restoration strategies, emphasizing the need for adaptive management for long-term sustainability.

Most of previous studies have analyzed and discussed the topic in a way that is either spatially or financially biased or specialized in one aspect of forest restoration criteria after fires (economic - social - environmental - legal, political - cultural and aesthetic). For the proposed approaches to decision-making supported by Spatial Decision Support Systems (Höhl *et al.*, 2020; Sankey *et al.*, 2021), the majority of the studies examined the need for multiple criteria (MCD) approach by establishing a framework of key criteria and indicators,using GIS and satellite images to determine the best outcome or solution for decision-making regarding forest management, conservation or

measuring forest sensitivity or even studying vegetation cover to study its impact after disasters or natural disturbances (climate changes- fires- winds - drought and floods). It also studies the formulation of decisions and their implementation in restoring forests after fires. The absence of specific funding, a shortage in the number of qualified and experienced personnel, or the absence of any party adopting restoration and lack of interest of this issue ,because it requires a longer time to obtain economic benefits that support the national economy. This requires wisdom and sound vision by planners and planning methods for managing forests after fires with the aim of restoration, by conducting a quantitative assessment (Höhl *et al.*, 2020; Sankey *et al.*, 2021).

Measuring success in restoring forest landscapes is complex and requires attempting to evaluate social impacts and environmental indicators at different levels and scales(Stanturf, Lamb and Madsen, 2012).

The role of integrated spatial planning in preparing a restoration program on a national scale that manages limited funding or resources and identifies priorities with multiple restoration objectives in optimal way that meets the requirements of the future and takes into account the characteristics of place and forest and makes trade-offs between outcomes desired, and finding the most effective paths, and this undoubtedly requires a monitoring and control system to evaluate the micro. The overall results at each stage of the process resolve forest restoration and enhance access to adaptive management for long-term resilience. This makes it necessary to take into account the complexity and changing nature of ecosystems, site conditions, diverse social and political systems and challenge economic, social, legal and technical as well as changes in forest structure; ecosystem services such as wildlife habitats, management especially of rare species or diverse genes of selected species, fire resistance, utility, recreation, and carbon sequestration by supporting local economies by marketing or selling burnt timber, for rural development(Höhl et al., 2020). Based on these criteria, we can produce maps, maps and graphs that are subsequently prepared to develop different alternatives or scenarios to support the decision-making process and to mitigate future risks of forest fires in the same place and time. It should also be noted that bias occurred in some previous studies due to the lack of sufficient studies concerned with the field of forest restoration after fires in an integrated manner, which makes it difficult to develop a comprehensive study that includes all stages and steps of forests. Bias can happen, also due to conflicting interests and local authorities on the ground due to lack of prioritization of management.

Precision in collected data is crucial for the effectiveness of solutions like Analytic Hierarchy Process (AHP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) in forest-fire restoration and decision-making frameworks, especially in Mediterranean forests. Consistency Ratio and Consistency Index (CI) measure overall consistency, guiding decision-makers in managing six main criteria. GIS provides spatial maps and final suitability maps, helping decision-makers identify hidden indicators for fire mitigation and prevention. Expert review validates datasets, providing assurance in consistency and accuracy, especially in complex domains like forest-fire restoration.

Based on skimming at least 700 articles and focusing on 36 studies that have the most common points that should be taken into consideration when extracting this comprehensive table which have the most important criteria and indicator that can be implemented world-widely when the fires burn forest and needed to be restored correctly.

Previous studies also referred to the restoration of forests after fires, and they found that the need to change the old way of thinking about both methods and management and how to implement this restoration because we live in a changing world, especially in recent years that have proven to local and national decision makers, and achieve balanced growth in the field of restoration forests after fires (Lakicevic and Srdjevic, 2022). Restoration that enhances the long-term sustainability of forests and increases their resilience to future fires to facilitate optimal integrated decision-making(Unver,Ergenc, 2020).

There is no denying that North America, Europe, and East Asian nations like South Korea and Japan, which have funded studies and initiatives in favor of forest restoration, particularly following fires, are currently home to the majority of the world's scientific and technological advancements, political stability, and economic prosperity. This has had a biased effect. The administration is better handled by utilizing the most recent research and applied studies carried out in those areas or nations with high credibility in the field of forest restoration due to the availability of enough financing, particularly when utilizing the newest tools and methods. Additionally, it shows that funding shouldn't be the biggest obstacle to forest restoration because Integrated Spatial Planning can create a national restoration program that prioritizes resources based on the current state of fuel processing and forest burning (adaptive management) and supports local economies by selling burned timber or promoting products, thereby mobilizing resources for long-term implementation. This means that in order to balance various forest restoration objectives with monitoring and assessment of results, it is essential to include stakeholders in the local community and public land managers.

Some recommendations can also be made to help decision-makers make optimal use of the most restored areas, through the results of the extracted spatial maps. In the economic criterion, the areas of the area's most suitable for restoration were about 30%, while non-suitable areas accounted for 8%.As for the social criterion, the areas of the most suitable for restoration were about 18%, while non- suitable areas constituted 10%. As for the environmental criterion, the areas of the most suitable for restoration were about 14%, while non- suitable areas constituted 1%. In the cultural criterion, the areas of the most suitable for restoration were about 35%, while non- suitable areas constituted 3%. and in the infrastructural criterion, the areas of the most suitable for restoration were about 30%, while there were non- suitable areas. Because there are a lot of locations that can be restored, it is possible to activate forest restoration economically in addition to meeting the cultural requirement. The environmental and infrastructural criteria should be prioritized because there are hardly any sites that cannot be restored. This means that funds are available for actions to restore forests following fires, which in turn focuses priority attention on sectors with significant financial returns, such as wood and non-wood products, medicinal, and pharmaceutical plants(Kabil et al., 2022), in conjunction with the revenue generated by tourist and cultural standards, offering a variety of activities that appeal to all those who like the outdoors, particularly because the infrastructure has not been impacted. The fires have had a significant impact on the process of supporting local development in terms of its economic, environmental, and cultural criteria. The local community and stakeholders have been involved in the available investments, guiding them toward areas with an economic and social future ,meaning the presence of returns that will aid in all aspects of restoration, including local and food products (Alayan, Rotich and Lakner, 2022).

As for the implications of the results for future policies and research, there is a need to identify spatial and temporal trends in restoration to manage them at regional levels in the long-term, develop a national database to link post-fire forest restoration with local development, integrate research results of scientific expertise, and integrate environmental science and current knowledge to improve the ability to restore forests after fires, bridging the knowledge gap and reviewing scientific literature related to forest conservation, action, ability to adapt to environmental and future changes and achieving balanced growth in the field of post-fire forest restoration, and support multi-disciplinary cooperation to promote access to large-scale forest restoration, adaptive protocols and collaboration. This, in turn, helps to re-build forest landscapes while not forgetting to greedy algorithm knowledge gaps in economic projects with an emphasis on forest science and technology and the need for further research to expand regional and social science knowledge (e.g. available knowledge, technical capacity and financing)(Stanturf, Lamb and Madsen, 2012).

V. New scientific results

1. This study is the first study in Mediterranean region that studies forest restoration after fires by developing a Comprehensive Criteria and Indicators (CCI) framework to produce spatial maps that show the most appropriate places of forest fire and making sustainable strategies of restoration.
2. The study makes forest restoration following fires as spatially impartial as possible by utilizing utilized the Analytic Hierarchy Process (AHP) and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods along with Spatial Decision Support Systems (SDSS) and developed into a new decision-making mechanism that didn't exist before in this form. This mixed methodology offers a number of noteworthy benefits over alternative approaches, providing a methodical, clear, and strong approach to forest restoration after fires. Its special feature is that it addresses geographic impartiality while taking into account both qualitative preferences and quantitative causal correlations among criteria. This all-encompassing strategy can result in more informed and successful decision-making, which will eventually improve the efforts for forest restoration's sustainability and success.
3. Implementation of spatially explicit decision support systems, the integration of Multi-Criteria Decision Analysis (MCDA) techniques, the quantitative assessment of restoration costs and benefits, the inclusion of ecosystem services assessment, and the evaluation of restoration effectiveness and adaptation strategies are just a few of the significant scientific contributions made by research on post-fire forest restoration management. The framework and methods have expanded as a result of these developments, improving the decision-making processes' robustness and scientific rigor.
4. The study has effective outcomes and impacts on reliability and validity of data and analysis in terms of CCI framework and Knapsack methodology to make it more beneficial and less expensive without any bias and eliminating the deception that decision makers may fall into when making a complex, multi-criteria decision.
5. The study finds the accurate percentages of the study area that are suitable for forest restoration after fires, while the remaining land is moderately vulnerable to restoration with extension and adaptive management using a CCI comprehensive framework that integrates six criteria: economic, social, environmental, cultural, aesthetic, infrastructural, education, administrative, and legal to extract the criteria and their indicators that are necessary to make the optimal decision, specially are needed in developing countries to direct their priorities to the area’s most suitable for forest restoration after fires By improving the decision-making processes' reliability and resilience, this integration makes it possible to evaluate repair options in a more methodical and transparent manner.

VI. Conclusion and Recommendation

5.1. Conclusion

This article elucidates post-fire forest health restoration through the integration of regional decision-making, employing multi-criteria analysis tools (specifically, Analytical Hierarchy Process - AHP) and decision-making/evaluation methodologies such as Decision-Making Trial and Evaluation Laboratory (DEMATEL). The application of these tools, manifested in maps and tables, provides decision-makers with a comprehensive and scientifically grounded basis for making informed and unbiased decisions on the ground. This approach optimizes both time and resources, aligning decisions with a well-studied scientific foundation within national and regional development frameworks. The article underscores the synergy between general post-fire recovery and multi-criteria decision-making systems, aiding decision-makers in strategically allocating limited investments to regions most suitable for recovery. In order to priorities restoration areas, assess landscape-level conditions, and optimize resource allocation, the research may also introduce new methodologies for creating spatially explicit decision support systems specifically designed for post-fire forest restoration. These methodologies would involve the use of geographic information systems (GIS), remote sensing techniques, and spatial data. This approach helps decision-makers priorities measures and use resources more wisely by offering scientific insights into the trade-offs and synergies among restoration objectives. Evaluating the success of forest landscape restoration reinforces post-fire restoration methods, necessitating analyses of social consequences and environmental indicators across diverse spatial and temporal scales. To enhance the management strategy's precision, a micro-assessment monitoring and control system is essential, facilitating adaptive management for long-term sustainability.

The study examines the rise in forest fires due to climate change in Mediterranean countries, focusing on Syria. It uses six criteria and indicators to create categories and standards for post-fire forest restoration. The research is the first of its kind in Syria, examining forest restoration following wildfires and creating an integrated framework for multisector management. To raise environmental awareness, a multimodal strategy including lobbying, policy measures, community participation, and education is needed. Strategies include effective forest management, inclusive legislation, effected region assessment, and fire intensity monitoring. Collaboration among stakeholders is essential for sustainable forest restoration. The study suggests that local community engagement, policy and governance frameworks, cultural heritage and land use practices, tourism and recreation, climate change adaptation, stakeholder collaboration, public awareness and education, and spatial decision support systems are necessary for successful forest restoration initiatives.

This necessitates a comprehensive framework encompassing economic, social, environmental, cultural, and aesthetic criteria and indicators, tailored to the unique circumstances of each nation. Priority should be given to areas more frequently damaged or affected after fires, ensuring a holistic approach to forest regeneration.

In conclusion, studies on post-fire forest restoration management have shown their worth in enhancing techniques, broadening the body of knowledge, and guiding evidence-based choices in the fields of ecological restoration and natural resource management.

5.2. Recommendations and future research

Forest restoration necessitates collaboration, multi-level cooperation, investment, resource allocation priorities, and low-cost, high-impact alternatives. Key elements include terrain elevation, anticipated climatic change, environmental safety, and available capacity. A sustainable forest loss reduction plan should enhance environmental knowledge, adaptive management, modeling, social improvements, implementation considerations, participatory monitoring, and communication at local, regional, and

global levels. The Comprehensive Criteria and Indicators (CCI) solution for post-fire forest restoration can be adapted to other nations and regions, with adjustments needed to accommodate different ecological, social, and economic circumstances. Expanding the framework to handle general environmental challenges, such as global warming, is also necessary. Regional adaptations include adjusting indicators to consider cultural and aesthetic requirements, infrastructure and education criteria, and global recommendations for environmental resilience, sustainable land use, community involvement, and capacity building programs.

1) limited cooperation with neighboring countries and international assistance on forest fire issues can achieved by developing post-fire forest restoration protocols and identifying spatial and temporal trends in forest restoration that will be managed at regional scales in the long term. The long-term goal is to balance multiple goals of forest restoration or management.

2) The possibility of developing a national database on forest fires based on statistics and post-fire open answer questionss will link post-fire forest restoration to local development of agroforestry technology to create strong incentives for local people to support restoration projects and also to avoid intensive practices such as logging and planting after fires. While amending existing legislation prohibiting the removal of burned trees and incorporating principles of environmental science and current knowledge of forest ecosystems to support both national and international networks as well as exchange of information and conduct of basic and applied research in restoration ecology to achieve greater growth in post-fire forest restoration.

3) Providing technical support, and contributing to the rehabilitation of lands degraded by fires, and determining the locations of lands that were exposed to fires using satellite images, and preparing comparing maps for these lands before and after the fire. Cultivated plants (fruit trees, forests, crops, medicinal and aromatic plants).

4) Contributing to determining the locations of fire lines in affected areas for use in extinguishing fires.

5) Reforesting burned lands, especially in sloping areas, as well as constructing and restoring. Or what was partly demolished in cultivated lands increased the number of fountains, points and water tanks, especially in coniferous forest areas that are sensitive to fire.

6) Finding a permanent technical staff trained to fight fires of various types and equipping them with the necessary tools to the fullest extent in protecting and managing forests, cleaning roadsides and forest floors, and burning agricultural waste in neighboring lands.

7) Applying strict penalties to anyone proven to be intentionally involved in forest fires.

Spatial Decision Support Systems (SDSS) is a methodical approach to connecting local and regional forest restoration initiatives with Sustainable Development Goals (SDGs). SDSS allows for targeted interventions based on ecological, social, and economic factors, addressing specific community concerns like soil erosion, water scarcity, or biodiversity loss. It promotes community involvement and interactive decision-making, ensuring that nearby communities are included in the formulation and execution of restoration initiatives.

SDSS also offers socio-economic benefits, such as increased access to ecosystem services, employment development, and income production for local populations. This helps maximize the benefits of restoration efforts on local livelihoods and well-being. Regionally, SDSS facilitates coordination of forest restoration actions among landowners and authorities at the landscape level, enabling them to identify and rank projects that fulfill regional conservation objectives and connectivity needs.

SDSS encourages multi-sectoral collaboration between government agencies, non-governmental organizations, businesses, and civil society groups to support sustainable development and forest restoration projects. It facilitates policy alignment by integrating environmental factors into wider development objectives and informs policy-making processes.

SDSS also facilitates monitoring and evaluation of forest restoration results at regional scales, allowing stakeholders to evaluate their progress towards (SDG)objectives and pinpoint areas in need of improvement. It offers real-time input on ecosystem health and restoration efficacy, enabling adaptive management and ongoing refinement of restoration tactics. By coordinating forest-fire restoration efforts with regional and local Sustainable Development Goals, while SDSS helps optimize the benefits of restoration projects on social equity, environmental sustainability, and economic development, ultimately aiding in the attainment of more comprehensive sustainable development goals.

5.3. Future research plan

• The survey method will be used to examine the relationship between wildfire restoration strategies and local organizational performance.
• Data will be collected using a open answer questions from local authorities.
• GIS and aerial maps to indicate optimal decisions and alternatives for wildfire restoration.
• Structural spatial decision-making modeling will be used to test research hypotheses.
• The decision-maker and stakeholders should have sufficient knowledge about their priorities to ideally complete the related surveies ,and periodic questionnaires ,the respondent covered several sectors, and data will be collected with the help of public organizations and ministries in Syria.
• Analyze the impact of criteria and indicators to reach multi-level outcomes as well as analyze similar wildfire damage with an emphasis on more integrated plans and knowledge that take a holistic approach to sustainable restoration based on innovation management.

5.4. Research limitations

Limitations associated with the ongoing conflict in Syria have posed challenges to the study, impacting data access and decision-maker engagement. The prevailing security concerns and reluctance to share information have restricted access to critical data banks and materials essential for a comprehensive analysis. Additionally, obstacles in reaching decision-makers at higher government levels, coupled with delays in appointments and procedural hurdles, have impeded direct engagement with key authorities.

Moreover, forest fire restoration has not been accorded a high priority in the Syrian national development plan. The country's economic crisis has diverted government attention and resources away from studies and initiatives related to forest restoration. This lack of prioritization reflects a broader challenge in allocating focus to environmental concerns amidst pressing economic issues. Furthermore, the study faces limitations stemming from the scarcity of national, local, and international research on forest fire restoration within the regional planning context. The absence of comprehensive studies and references hinders the ability to draw on existing knowledge and incorporate best practices into the research framework.

To address these limitations, future research efforts should explore collaborative data-sharing mechanisms, streamline engagement with decision-makers, advocate for the integration of forest restoration into national priorities, and promote initiatives that contribute to the existing body of knowledge on forest fire restoration in the Syrian context.

VII. Summary

Amidst the increasing frequency and severity of forest fires globally, the imperative of effective post-fire forest restoration has gained unprecedented significance. This study outlines a comprehensive approach to post-fire forest restoration and discusses its implementation through spatial decision-making systems. The methodology involves utilizing multi-criteria analysis (MCA) to identify and prioritize criteria based on their relative importance. This allows for the creation of easily assessable alternatives and their application to spatial maps, providing local officials with valuable information. To achieve optimal decision-making, the study utilized the Analytic Hierarchy Process (AHP) and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods along with Spatial Decision Support Systems (SDSS) to generate a suitability map to provide a comprehensive and up-to-date framework on the latest developments in forest restoration after fires and how forest restoration can be linked to sustainable development, whether local or regional, by defining requirements and a damage assessment mechanism and defining strategies, goals and operational plans to reach results. desired which includes all multiple planning levels using a variety of spatial and temporal strategies with monitoring and evaluation of forest restoration phases to better guide these strategies and enhance the accessibility of large-scale, multi-objective restoration according to the priorities and needs of the affected areas to rebuild all the values of burned forests combined, which can benefiting from these strategies when regional communication when collaborative integration is a prerequisite to reach a sustainable way and flexibly meets the requirements of changing reality.By examining the most recent advancements in forest restoration during the previous 22 years, this research is the first to frame post-fire forest restoration within an integrated framework. Over the past ten years, wildfires have had an increasing detrimental influence on the environment, the economy, and society, they have resulted in large-scale, expensive fires that destroy forest and grassland vegetation, and negatively affect wildlife habitat, recreation, tourism, water quality, supply, and values, the consequences, which include expenses associated with restoration, changed habitat for wildlife, decreased tourism income, and adverse health impacts on people, are crucial elements of risk assessment and wildfire management.

Forest restoration is an important field of research that calls for accurate planning and management that involves a national program that promotes fuel processing and forest burning while assisting local economies by selling burnt timber or marketing goods, and all parties involved must be involved for forest restoration to be successful and more flexible. .The results highlight that 28% of the study area is well-suited for post-fire forest restoration, with 44% moderately appropriate, while 3% is deemed unsuitable for restoration until the end of 2023 due to severe soil loss or inherent geographical challenges.

VIII. Appendixes

Appendix1:References

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Appendix 2: Open answer questions

Table A1. The positions of experts, their specialization, and scientific specialization

Name	Position
Dr. Akram Darwish	PhD. in Biodiversity – welfare NGO Consultant
Dr. Hunada Al Sadat	PhD. Environment- Head of Syrian Society for Conservation of Wildlife (SSCW)- Syria
Dr. Mwaffak Al_Shiekh ali	PhD. Environment- the Head of Earth Company for Environmental Studies (Environmental Effect Evaluation)
Dr. Ghaleb Faour	PhD. Remote Sensing & Climate Change – Director of National Center for Remote Sensing- Lebanon
Dr. Fadi AlMahmoud	PhD. Environment - Resilience Officer – FAO, Syria
Abir Zeno	MSc. Environmental Researcher -Energy & Environment, UNDP, Syria
Adnan Saad	MScl Agriculture- manager of Protected area management and biodiversity conservation project
Osama AlNouri	MSc. Economy- Bird Life international
Sami Tarabieh	MSc. Environment- Royal Society of Conservation of Nature (RSCN)-Jordan
Firas Shouman	MSc. Agriculture- Small Grants Officer- UNDP-

	Syria
Maher Dayoub	MSc. Agriculture- Biodiversity Researcher- Alfronloq protected area- Syria
Somar Mariam	MSc. Agriculture- Protected area Manager- Alfronloq Pa- Syria
Yasser Nassour	BSc. Forestry- Protected area Manager- Abu Qubies Pa- Syria
Fayiz Almuhammad	BSc. Forestry- Natural resources Manager in General Commision of AlGhab - Syria
George Daoud	BSc. Forestry- Biodiversity Researcher- Birds - Abu Qubies Pa- Syria
Eng.Wael Azouz	BSc. Agriculture – Head of foresty and Natural resources in General Commision of AlGhab Management and Development
Dr. Ali Firer Ahmad	Professor in Ancient Syrian languages and the Scientific deputy of Humanitarian department at Albaath university
Husein Mahkalouf	BSc. Ministry of Local Administration and Environment – Minister- Syria
Hassan Kattana	BSc. Ministry of Agriculture and Agrarian Reform – Minister- Syria
Dr. Ali Thabet	PhD. Agriculture- Director of Forestry Directorate- Syria
Aofa Wassouf	BSc. Agriculture – Director of General Commision of AlGhab Management and Development

- **Questions that were asked to owners and decision makers to use them in directing spatial decision support systems**

For the decision-makers

1. What is the best hierarchical order for the following six criteria: economic, environmental, social, administrative, cultural and infrastructure according to the national plan for restoring Syrian forests after fires?
2. Is there a budget for restoration and how much is allocated for it?
3. What are the impacts of restoration activities and appropriate benefit assessment at the national level?
4. What are the national efforts made for the restored Syrian forests or those forests that need to be restored?
5. What are the plans in place in the short or long-term to restore the Syrian forests after the fires?
6. Is it possible to imagine different realities and possible scenarios, such as applying the necessary policies and practices to achieve these scenarios collectively?
7. How can we achieve restoration goals in a beneficial, long-term and cost-effective manner?
8. What are the state's contributions to improving the condition of roads and infrastructure after the fire?
9. What are the types of projects undertaken by the state to restore forests after the fires, and were they implemented and revenues provided by government agencies or in coordination with international organizations?
10. What are the benefits and returns from the already or proposed restored forests?
11. How would you rate the degree of effective stakeholders?

For decision takers

1- Who are the stakeholders and what are their positions or educational qualifications (Master's or PhD degrees)?

2- How does the restored vegetation cover and its composition affect the state of support, supply, regulation and ecosystem services?

3- How much was the production of wood and non-wood products in the affected Syrian forests and is it able to meet the requirements of the local community after the fire?

4- How many job opportunities did you support or will support the local population after the fire due to local development projects?

5- What is the value of losses in private or public property?

6- How does the administration communicate with the local community regarding internal information (decision makers - managers - participants - experts and educational institutions)?

7- What is the cost of restoration, which was calculated, even initially, for all the works that took place and cooperation with the local community?

8- What are the changes in the quality of life of the local community after the fire?

9- How much research and technical support is needed to further integrate collective knowledge of fires?

10- What are the challenges and obstacles to extinguishing fire in the study area?

11- Have there been changes in the spiritual / aesthetic identity and tourism values of all kinds?

12- What are the additional losses that were found as a result of the lack of laws regulating the relations between the owners and the disputants after the forest fires?