

Tourist Circuits Map Mechanism for Developing Mountain Tourism: An Applied Study of the Sefrou Province

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Abstract. The geological and geomorphological sites in the Sefrou region of Morocco represent key assets for sustainable mountain tourism, given their diversity and richness in landscape natural phenomena. These sites constitute a significant attraction for tourists interested in nature and adventure, contributing to the development of the local economy and the creation of new job opportunities. Scientific studies confirm the effectiveness of utilizing Geographic Information Systems (GIS) in planning and developing mountain tourism, specifically through the creation of precise tourist maps that facilitate the exploration of these sites for visitors. This study has led to the identification of 32 distinct geological and geomorphological sites in the Sefrou region and the design of three primary mountain tourism trails. These trails allow visitors to enjoy stunning natural landscapes and discover rock formations, caves, and valleys, in addition to learning about the geological history of the region. This study represents a significant step towards strengthening sustainable mountain tourism in the Sefrou region, by providing accurate and comprehensive information to tourists and highlighting the importance of preserving these unique natural sites for future generations

Keywords: Tourism Circuit Maps, GIS, Natural and Cultural Heritage, Sefrou.

1. Introduction

The development of a mountain tourism strategy, aimed at preserving natural heritage within a framework of sustainable development, relies on a meticulous and organized process (

Francesco Piras, Eleonora Sottile, Italo Meloni). This process encompasses a comprehensive inventory of the diverse geological and geomorphological sites that abound in the study area. The global need to develop mountain tourism has prompted numerous specialists and academics to explore innovative approaches. The aim is to harness this economic activity for economic and social development while ensuring environmental conservation.

Geological and geomorphological heritage has garnered significant attention from researchers across various universities worldwide. This interest stems from the paramount scientific importance of these sites, offering insights into Earth's history and climate (Brilha, Gray, Pereira, & Pereira 2018; Gray, 2013; Catto et Kovanen, 2020). Furthermore, these sites hold economic significance, as their exploitation can generate new economic activities. Additionally, the protection of these sites as vital natural heritage is crucial.

Morocco boasts breathtaking natural landscapes, earning it the reputation of a paradise for geologists and geomorphologists. The country enjoys a diverse climate, encompassing Mediterranean, semi-arid, and desert conditions. This natural diversity plays a pivotal role in shaping a multitude of natural attractions, including mountains, valleys, deserts, waterfalls, and lakes. Morocco has actively sought to capitalize on these natural wonders by positioning tourism as a cornerstone of its national economy through various tourism plans and programs.

The Middle Atlas stands out as a geographical area endowed with a captivating natural heritage. It primarily comprises significant geological, geomorphological, and ecological sites, such as caves, high peaks, lakes, waterfalls, and cedar forests. These territorial resources constitute a fundamental pillar for the development of sustainable tourism, thereby contributing to comprehensive regional development.

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The diversification of tourism offerings and the utilization of diverse tourist destinations are the primary motivations behind adopting a Geographic Information Systems (GIS) approach. This approach facilitates the inventorying, data collection, evaluation, and analysis of tourist sites. Ultimately, this enables their assessment and representation on geo-spatial maps. These maps will illustrate the spatial distribution of sites while creating circuits and tourist routes connecting them. To achieve this objective, we utilized ARCGIS 10.7.1 software alongside a suite of other techniques that will be elaborated upon in the methodology section.

2. Study Area

The study area is geographically situated within the Middle Atlas Mountain range of Morocco, falling between longitudes $4^{\circ} 10''$ and $5^{\circ} 04''$ West, and latitudes $33^{\circ} 33''$ and 34° North. The region encompasses two distinct topographical units: a plateau in the north characterized by flat to gently undulating terrain, and a mountainous unit in the south distinguished by intense folding, rugged topography, and high peaks. Administratively, the study area falls within the Fès-Meknès region. The region experiences a humid to sub-humid climate, receiving significant annual precipitation, including snowfall, averaging 600 mm (Labhar, 1988).

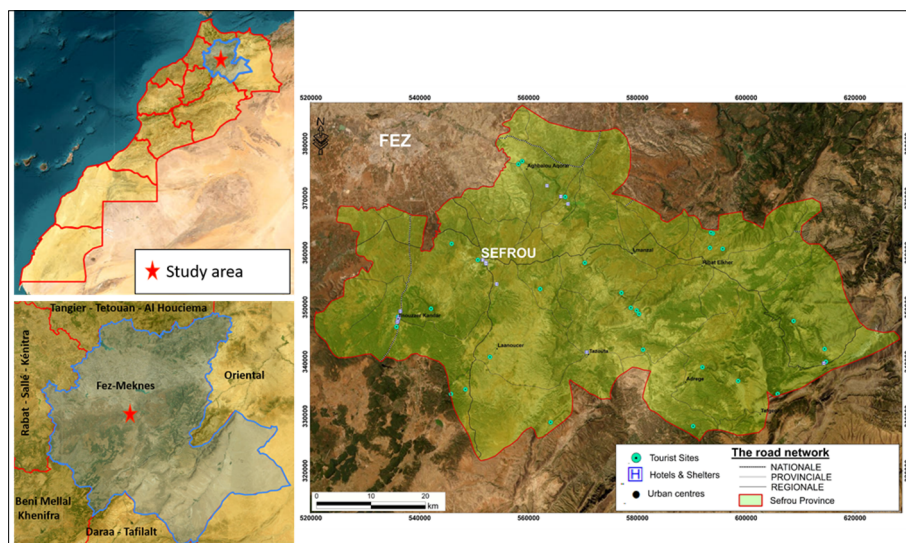


Fig 1: Location of the study area

3. Methodology

This study adopted a multi-faceted methodology centered around the collection and analysis of data. The initial phase involved a comprehensive review of bibliographic resources, including reports and surveys relevant to the study area. This aimed to establish an understanding of the formation processes, scientific significance, and economic potential of the selected geosites (Brilha et al., 2018; Grandgirard, 1999; (Bouzekraoui et al., 2018; Taibi, Ait omar, El Hannani, Khalki, & Redad, 2018). The subsequent methodological steps can be summarized as follows:

Fieldwork: A comprehensive inventory of geological and geomorphological sites present within the study area was conducted. This inventory relied on various spatial data sources, including topographic, geological map of Safrou 1/100000,, and geomorphological maps. Additionally, tools like Google Earth and offline mapping applications aided in the identification and geolocation of sites.

Data Evaluation: This stage involved a robust evaluation framework adapted from previous research endeavors while considering the unique local context of the study area. Building upon established evaluation criteria, the framework incorporated new parameters tailored to align with the specificities of Moroccan society. Each site was assessed and assigned a score ranging from 0 to 1, where 0 represented low significance, 0.5 indicated moderate significance, and 1 denoted very high significance. This evaluation process culminated in the selection of 10 sites deemed highly significant from both scientific and socio-economic perspectives (El Wartiti, et al, 2009; Brilha, Gray, Pereira, & Pereira 2018; Bouzekraoui, et al, 2017).

Data Processing: Data collected during fieldwork and the evaluation phase was processed and analyzed utilizing Geographic Information Systems (GIS). Specifically, ArcGIS software, alongside aerial imagery, facilitated spatial analysis and data visualization.

Data Output: Following data processing and classification, a series of graphical representations and thematic maps were generated. These outputs aimed to showcase the value of the identified sites within the framework of developing diverse geotourism routes.

4. Results

Following an extensive field survey of the study area, over 100 geological and geomorphological sites were identified and inventoried. These sites underwent a rigorous evaluation process employing the methodology described in ... (Taibi, Ait omar, El Hannani, Khalki, & Redad, 2018; Bouzekraoui, & al 2016 ; Rais, Barakat, Louz, & Barka 2021 ; Ait omar, 2021). This evaluation resulted in the selection of 32 sites deemed to possess significant scientific, aesthetic, and economic value. The following table provides a detailed overview of each site, outlining its nature, type, formation mechanism, and geographical coordinates.

4.1 Scientific, additional, and Exploitation Value of Selected Sites

The evaluation process yielded 32 sites distinguished by their high scientific and added value. This underscored the potential for their sustainable tourism development. The following map visually represents the calculated value scores for each individual site.

This concentration of high-value sites underscores the need for a comprehensive approach to geotourism development in the region. Future research will delve into specific strategies for harnessing the scientific, aesthetic, and economic potential of these sites while prioritizing their long-term conservation.

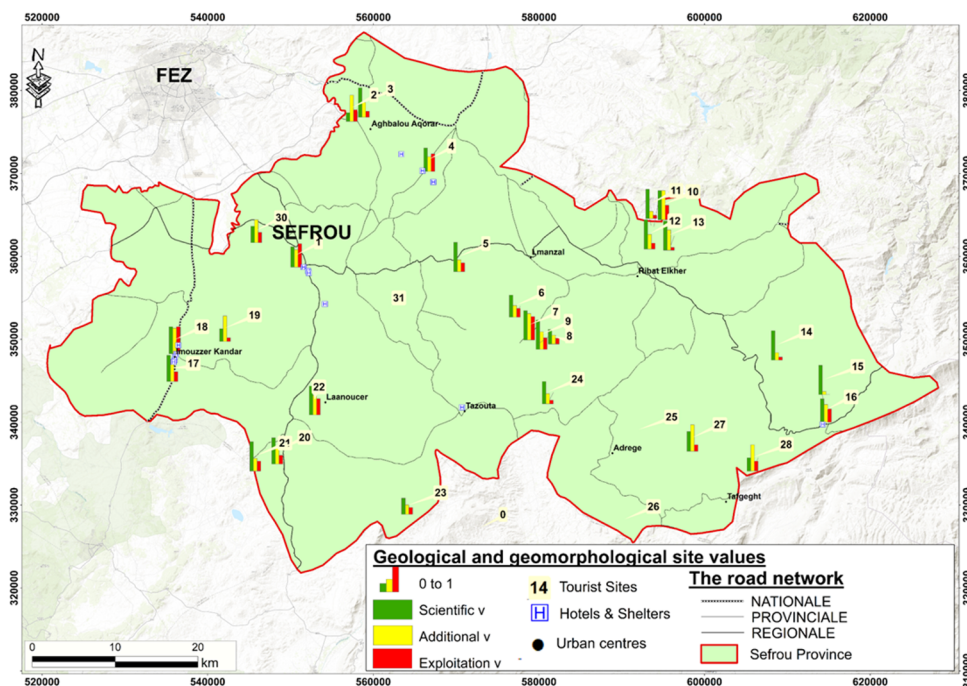


Fig 2: Scores for scientific, additional and utilization values for the studied geographical areas

As evidenced by the map, the selected sites exhibit high scores for scientific and added value. However, the exploitation value remains moderate or below average for the majority of sites. This disparity is primarily attributed to the currently underdeveloped state of tourism within the region.

This highlights a key challenge in leveraging geoheritage for local development. While the scientific and inherent value of these sites is undeniable, their tourism potential remains largely untapped due to factors likely related to infrastructure, accessibility, and marketing. Addressing these limitations will be crucial in transforming these high-value geosites into drivers of sustainable tourism.

4.2 The role of tourism route maps in promoting mountain tourism

Previous studies have highlighted the rich and diverse tourism potential of the Sefrou region, which is characterized by exceptional geological, geomorphological, and environmental features. This potential requires strategic investment through tourism initiatives capable of promoting sustainable regional development. Tourism route maps, derived from Geographic Information Systems (GIS), are emerging as valuable tools for the design of interconnected itineraries linking diverse attractions.

In this context, active engagement with local stakeholders, including civil society organizations, led to the proposal of three core tourism trails within the region. Together, these trails cover more than 368 kilometers, allowing visitors a multifaceted exploration of Sefrou's natural and cultural heritage. The development and dissemination of well-organised tourist trail maps is expected to significantly enhance the visitor experience, improve trail navigation, and promote the responsible discovery of this fascinating mountain destination.

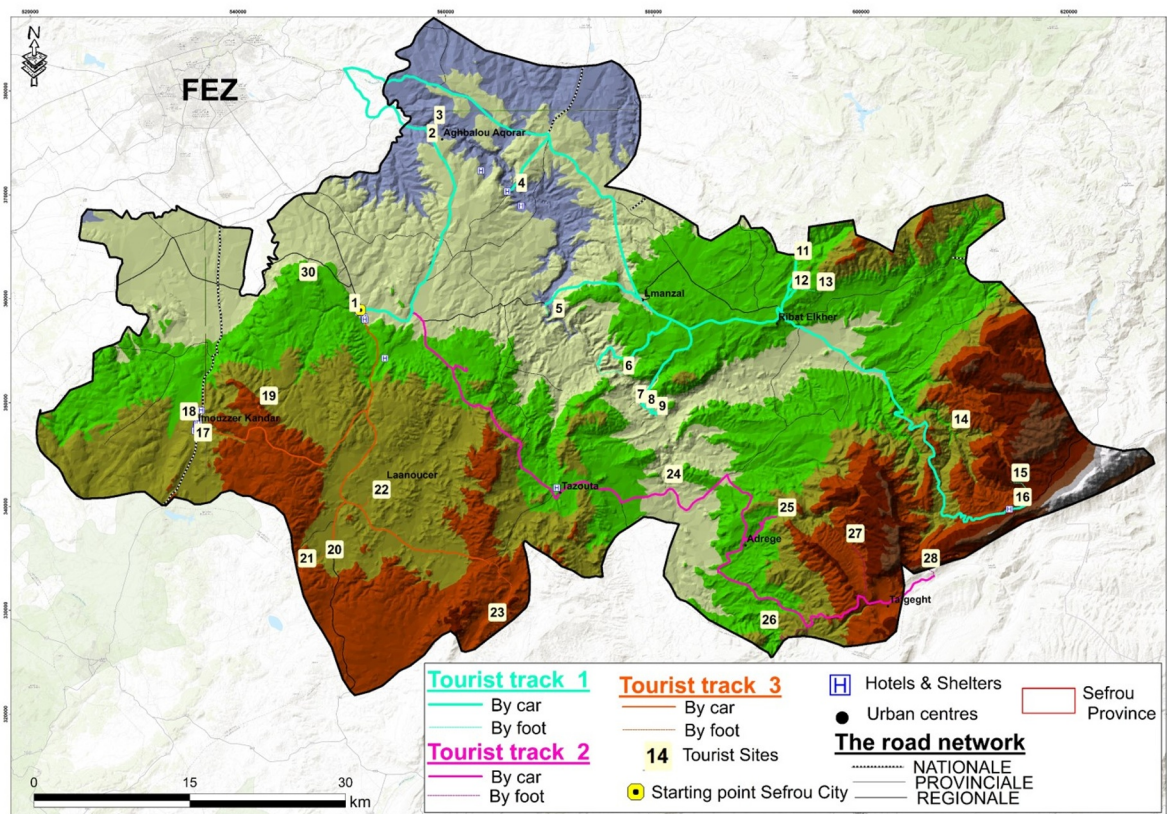


Fig 3: Proposed Tourist Routes

The map above illustrates three tourist circuits, exceeding 368 kilometers in total length, encompassing various forms of tourism: geotourism, educational tourism, and recreational tourism. A detailed description of each circuit is provided in the following sections of this article.

4.2.1 Itinerary 1: Hydrogeomorphological, Karstic, and Caving Sites

This first tourist circuit connects sixteen natural sites of exceptional scientific and aesthetic value, making it an ideal destination for nature enthusiasts and diverse tourist demographics. Spanning 165 kilometers, the circuit begins in the historic city of Sefrou and culminates amidst the captivating geomorphological landscapes of the Bou Iblane mountains. Exploration of this circuit is estimated to require between two to three days, allowing visitors ample time to appreciate the natural beauty and delve into the geological processes that have shaped the region. The accompanying map provides a detailed overview of the circuit's trajectory, facilitating trip planning and site selection for visitors.

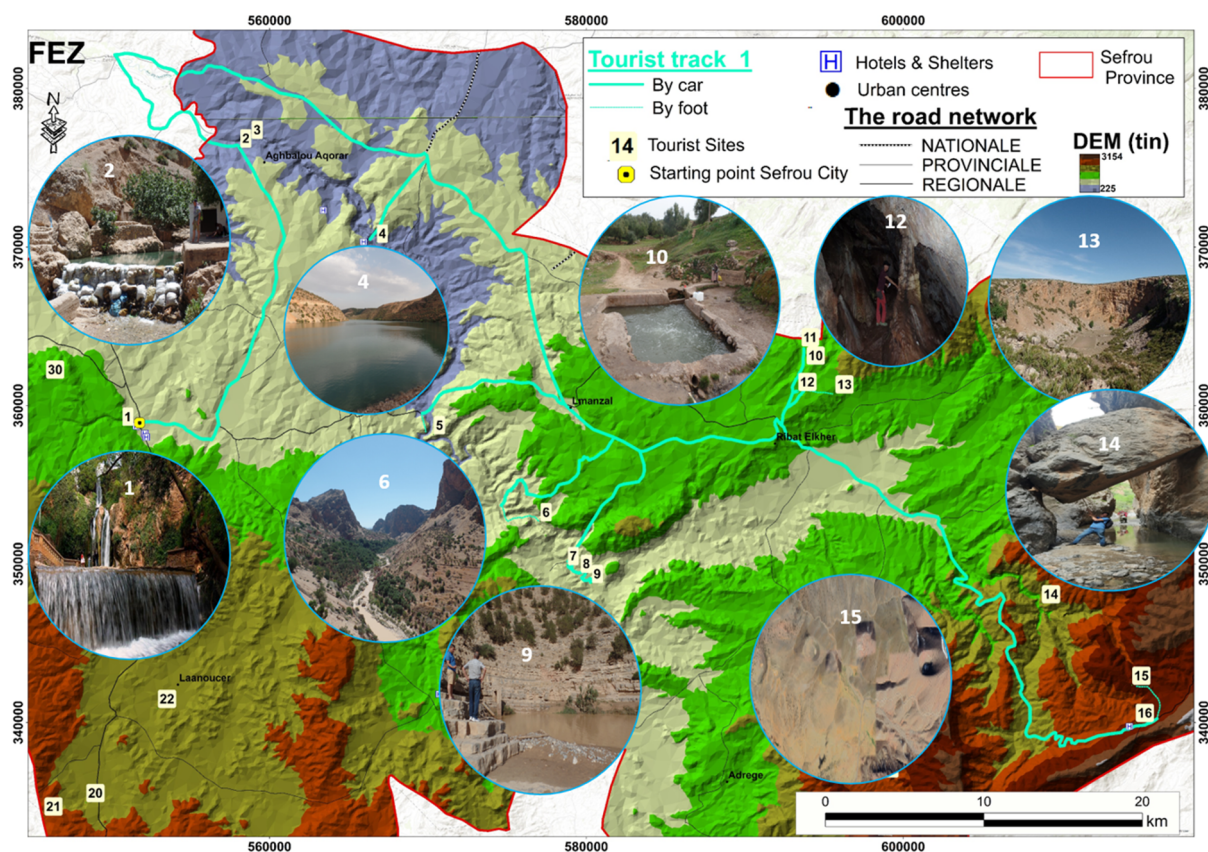


Fig 4: The first tourist route Diversity of landscapes

4.2.2 Itinerary 2: Mountain Landscapes and the Thrill of Mountaineering

The second circuit departs from Sefrou, traversing 93 kilometers of diverse terrain, commencing at the freshwater spring of Ain Rekada and culminating at the imposing Medaz Dam. Participants can anticipate a challenging 10-kilometer hike through narrow, rock-hewn passages (river gorges) leading to the discovery of the towering summits of Jebel Aderj and Tafejjigt.

This itinerary offers a unique opportunity to study mountainous landscapes and formations, comprehend the impact of natural forces on the environment, and explore the region's biodiversity.

Ideal for adventure and hiking enthusiasts, the circuit caters to various fitness levels with its diverse trails. This journey promises an unforgettable scientific exploration into the heart of the Middle Middle Atlas Mountains.

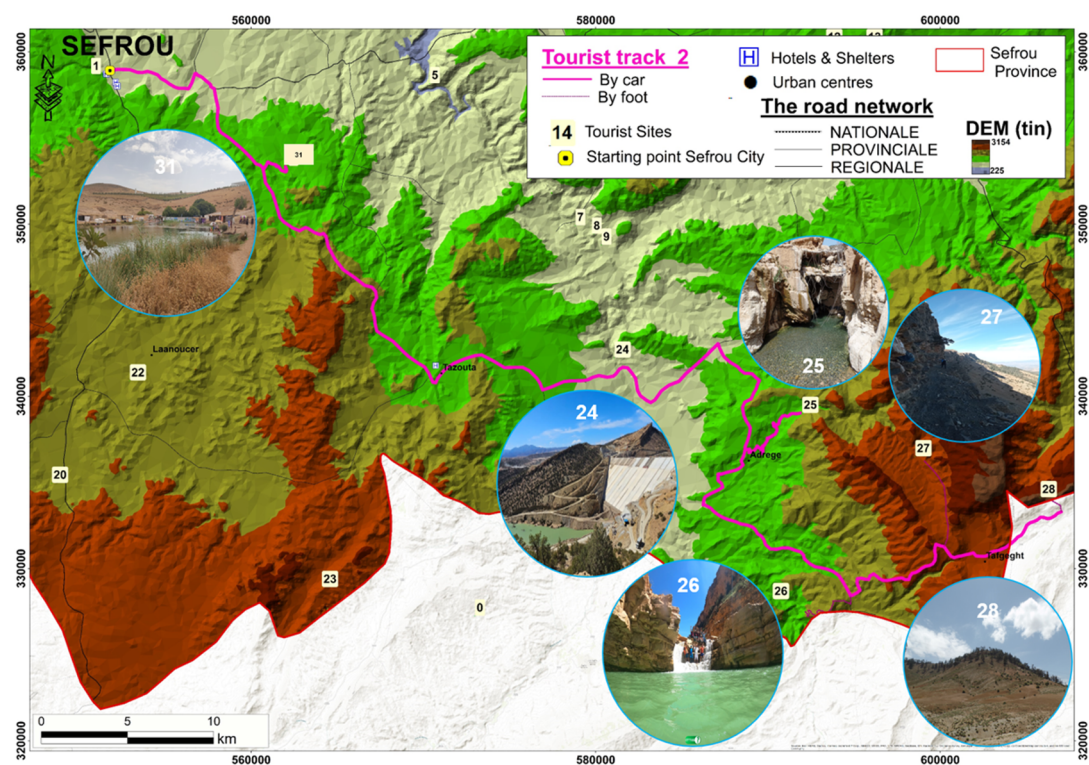


Fig 5: Second Tourist Route Nature and Adventure

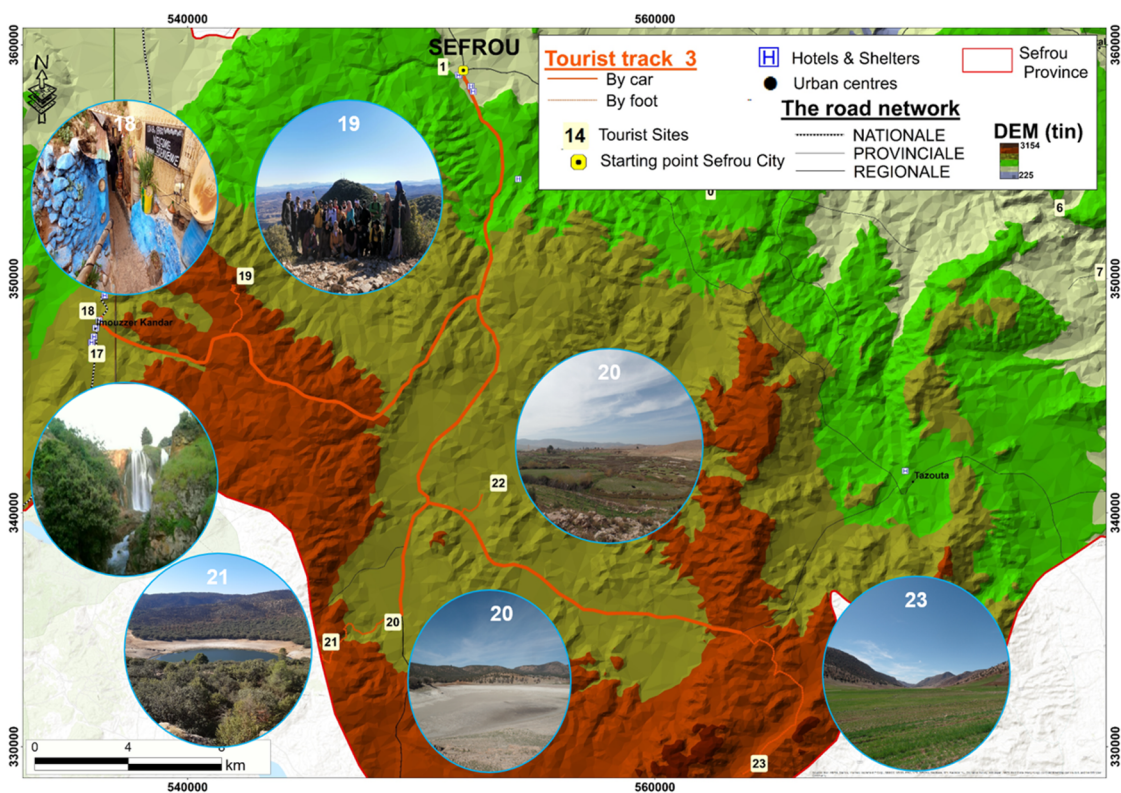


Fig 6: Third Tourist Route Diverse karst landscapes

4.2.3 Itinerary 3: Karstic Landscapes of the Limestone Plateau

This third itinerary offers a focused scientific journey within the boundaries of the Immouzzar Kandar plateau. Participants will encounter a captivating array of distinct natural attractions. Natural lakes, such as Lake Effer, stand out as jewels of the plateau, while dense forests of juniper and oak trees contribute a verdant touch to the landscape. Towering peaks, including Jebel Abad and Jebel El Kalaa, provide breathtaking panoramic views. This magnificent plateau can be explored along 110 kilometers by car, with a few kilometers on foot, in one or two days.

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Author Contribution

- Jaouad Chami: Editing the article.
- Jaouad Chami & Mohamed En-Nejmy : cartographic work.
- Zouhir Elbachiri & Hadou Achkir: Reviewing the design and methodology.
- Yahya El Khalki & Said El Azzoui: Final proofreading of the article in terms of linguistic and methodological and scientific aspects.

Ethics approval and consent to participate

Not applicable.

Consent for publication

All the authors have agreed to publish this article.

Competing interests

The authors declare that they have no competing interests.

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5. Conclusion

This study focuses on how Geographic Information Systems (GIS) can be used to promote mountain tourism in the Moroccan region of Sefrou. The study identified 32 sites of scientific and aesthetic value out of 100, and proposed three tourist trails with a total length of over 368 kilometres. These trails range from exploring hydrogeological phenomena to mountaineering and enjoying the beauty of the karst plateaus, contributing to the development of scientific and recreational tourism and sustainable development in the region.

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