Article

Not peer-reviewed version

Review of the Ecological and Environmental Conditions of Mount Hermon and the Baqa Valley: Analysis from the Beginning of the World to the Present Day

Kazi Abdul Mannan * and Farhana Khandaker Mursheda

Posted Date: 2 October 2025

doi: 10.20944/preprints202510.0135.v1

Keywords: ecological history; environmental change; biodiversity; climate impact; human settlement; water resources; conservation policy; transboundary governance

Article

Review of the Ecological and Environmental Conditions of Mount Hermon and the Baqa Valley: Analysis from the Beginning of the World to the Present Day

Kazi Abdul Mannan [1,*] and Khandaker Mursheda Farhana [2]

[1] Department of Business Administration, Faculty of Business, Shanto-Mariam University of Creative Technology, Dhaka, Bangladesh

[2] Department of Sociology and Anthropology, Shanto-Mariam University of Creative Technology, Dhaka, Bangladesh

* Correspondence: drkaziabdulmannan@gmail.com

Abstract

Mount Hermon and the Baqa Valley represent one of the most ecologically and environmentally complex regions in the Eastern Mediterranean. This paper provides a comprehensive review of the region's ecological history, geological evolution, biodiversity, hydrological systems, human-environment dynamics, and conservation policies from prehistory to the present day. By synthesising interdisciplinary research, the study identifies the pivotal role of Mount Hermon's unique topography and microclimates in supporting high levels of biodiversity and ecological endemism. At the same time, it highlights increasing threats from anthropogenic pressures, climate change, habitat fragmentation, and inadequate environmental governance. The study reveals a troubling trajectory of environmental degradation, driven by political instability, unregulated development, and unsustainable land and water use practices. Nevertheless, the region offers significant opportunities for transboundary conservation and ecological resilience through collaborative policy frameworks and community-based resource management. Recommendations include integrated watershed governance, the creation of ecological corridors, and the reinforcement of environmental education and local stewardship. The article underscores the importance of regional cooperation and adaptive policy responses in safeguarding the ecological heritage of Mount Hermon and the Baqa Valley in an era of rapid environmental and climatic change.

Keywords: ecological history; environmental change; biodiversity; climate impact; human settlement; water resources; conservation policy; transboundary governance

---

1. Introduction

The ecological and environmental characteristics of Mount Hermon and the Baqa Valley present a rich tapestry of natural history, biodiversity, and human-environment interactions. These regions, located in the eastern Mediterranean and forming part of the broader Levantine landscape, are critical ecological zones where climatic, geological, and cultural systems intersect. Mount Hermon, a limestone massif reaching an elevation of 2,814 meters above sea level, straddles the modern borders of Syria, Lebanon, and Israel. The Baqa Valley, also known as the Beqaa or Biqāʿ Valley, extends north-south between the Mount Lebanon and Anti-Lebanon mountain ranges, serving as a crucial corridor of biodiversity and human settlement. This introduction aims to frame the ecological significance of the region, delineate the research questions guiding the study, and explain the historical and contemporary relevance of this interdisciplinary ecological review.

1.1. Ecological and Geographic Significance

Mount Hermon and the Baqa Valley are situated in one of the most ecologically diverse regions of the Middle East, with distinct altitudinal, climatic, and geological gradients. Mount Hermon's high elevation leads to the accumulation of snow during winter months, creating a unique alpine ecosystem that contrasts with the Mediterranean woodlands and steppe vegetation of the lower slopes and adjoining valleys (Danin, 2004). These snow-fed conditions feed several vital river systems, including the Jordan and Hasbani Rivers, making the mountain a key hydrological resource (El-Fadel et al., 2000). The Baqa Valley, meanwhile, is a fertile plain that has historically served as a breadbasket for ancient and modern civilisations. Its strategic location between coastal and inland environments fosters a range of ecological zones, from riparian habitats and wetlands to cultivated lands and semi-arid grasslands.

The region forms part of the Mediterranean biodiversity hotspot—one of 36 global ecological regions identified for their exceptional levels of species richness and endemism, as well as for being under severe threat from human activity (Myers et al., 2000). Numerous endemic and rare plant species are found on Mount Hermon, particularly in its high-altitude meadows and forests. Faunal diversity is equally noteworthy, with mammals such as the striped hyena (Hyaena hyaena), Syrian brown bear (Ursus arctos syriacus), and various bat and rodent species contributing to a dynamic ecosystem. Birds migrating between Europe, Asia, and Africa frequently use the Hermon-Baqa corridor, making it an important avian flyway (Harrison & Bates, 1991).

1.2. Historical Context of Environmental Change

The region's ecological richness is paralleled by its deep human history. Archaeological evidence indicates human presence in the Mount Hermon and Baqa Valley areas dating back to the Epipaleolithic and Neolithic periods, with sites such as Tell Nebi Mend and Ras Baalbek providing artefacts from early agriculture and animal domestication (Bar-Yosef, 2001). These early societies began a long trajectory of anthropogenic influence on the environment through activities such as deforestation, terrace construction, irrigation, and pastoralism. With successive waves of occupation by Canaanites, Israelites, Arameans, Assyrians, Romans, Byzantines, Islamic caliphates, Crusaders, Ottomans, and modern nation-states, the land experienced continued transformation.

Each historical period left an ecological footprint, from the Roman-period intensification of agriculture and infrastructure development to the Ottoman deforestation driven by timber extraction for railroads and ships (Issawi, 1982). The 20th century ushered in a new era of environmental stress through mechanised agriculture, urbanisation, and warfare, exacerbating soil erosion, biodiversity loss, and water contamination (UNEP, 2007). Yet paradoxically, periods of political instability and conflict have at times reduced intensive land use, allowing for partial ecological recovery through processes of natural rewilding.

1.3. Contemporary Environmental Challenges

Today, Mount Hermon and the Baqa Valley face a confluence of environmental threats that reflect broader global ecological crises, including climate change, unsustainable land use, biodiversity loss, and water scarcity. Rising temperatures and reduced snowfall are disrupting long-standing hydrological cycles on Mount Hermon, diminishing its role as a water reservoir for the region (Kadioglu, 2020). Meanwhile, expanding urban centres such as Zahle, Baalbek, and Marjayoun are encroaching on natural habitats, leading to fragmentation and degradation of critical ecosystems. Pollution from agricultural runoff, overgrazing by livestock, illegal hunting, and unregulated tourism add to the pressures facing the region's ecosystems.

In addition to ecological degradation, these environmental issues are deeply entwined with socio-political factors. The Syrian civil war, Israeli–Lebanese border tensions, and refugee migration into the Baqa Valley have intensified land use pressure and made coordinated conservation efforts difficult. Yet despite these challenges, there are also emerging opportunities for sustainable

 doi:10.20944/preprints202510.0135.v1

management and restoration. Community-based conservation projects, eco-tourism initiatives, and reforestation campaigns have begun to demonstrate the potential for reconciling environmental protection with local livelihoods.

1.4. Rationale and Objectives of the Study

Given the mounting threats to the region's ecological integrity, this study seeks to undertake a comprehensive historical and scientific review of environmental conditions in Mount Hermon and the Baqa Valley. The central aim is to provide an integrative analysis that synthesises geological, ecological, and anthropogenic data across temporal scales—from prehistoric epochs to the present day. By tracing the arc of environmental transformation and identifying key drivers of change, the research offers a foundation for future conservation, policy-making, and sustainable development in the region.

Specifically, the study addresses the following research questions:

- How have natural forces such as tectonic activity, climate variability, and hydrology shaped the ecological development of Mount Hermon and the Baqa Valley over geological time?
- What are the historical patterns of human-environment interaction in the region, and how have they altered biodiversity, land use, and ecosystem services?
- What are the principal environmental challenges currently facing the region, and what strategies are being employed or proposed for ecological restoration and sustainable management?

2. Theoretical and Methodological Framework

This research is situated within the framework of historical ecology, a multidisciplinary approach that examines the dynamic relationships between humans and their environment over time. Historical ecology emphasises long-term landscape change, the role of cultural practices in shaping ecosystems, and the feedback loops between environmental and social systems (Balée, 2006). In combining paleoecological evidence, archaeological data, climatological studies, and remote sensing technologies, the study offers a holistic view of environmental change.

The methodology includes a literature review of academic and governmental publications, analysis of satellite imagery and topographic data, and the synthesis of archaeological findings. Where possible, the study incorporates local ecological knowledge and ethnographic insights to better understand current land management practices. This integrative approach not only illuminates patterns of degradation and resilience but also identifies leverage points for ecological intervention.

2.1. Contribution to Knowledge and Policy Implications

The ecological review of Mount Hermon and the Baqa Valley fills a critical gap in regional environmental scholarship. While considerable research has been conducted on isolated ecological or archaeological aspects of the area, few studies have attempted to bridge disciplinary boundaries and temporal scales in a unified analysis. By articulating a longitudinal perspective on environmental change, this study contributes to debates in historical ecology, Middle Eastern environmental history, and biodiversity conservation.

Moreover, the findings carry significant policy relevance. Understanding the root causes and long-term dynamics of environmental degradation can inform more effective conservation strategies, land use planning, and climate adaptation policies. In an era of intensifying ecological crisis, historical insight becomes not merely academic but essential for guiding future stewardship of natural and cultural heritage.

 doi:10.20944/preprints202510.0135.v1

2. Research Methodology

2.1. Multidisciplinary Approach

This research integrates methods from paleoecology, climatology, archaeology, and remote sensing:

- Historical and Geological Records: Data from sediment cores, fossil pollen records, and tectonic surveys inform long-term ecological change.
- Archaeological Evidence: Excavation reports and material culture are used to infer human interaction with the environment.
- Remote Sensing and GIS: Satellite imagery and spatial analysis provide insight into recent land use, vegetation cover, and water distribution.
- Field Observations and Ecological Surveys: Biodiversity inventories and ecological sampling support understanding of current conditions.
- Literature Review: Academic sources, historical texts, and governmental reports form the textual basis for the historical narrative.

2.2. Data Collection and Analysis

Data were collected through open-source satellite databases (e.g., NASA Earth Observations), academic journals (JSTOR, ScienceDirect), and national archives in Lebanon and Syria. Analytical tools include ArcGIS for mapping, R for statistical ecology, and NVivo for qualitative thematic coding.

3. Geological and Climatic Evolution

The ecological and environmental development of Mount Hermon and the Baqa Valley cannot be fully appreciated without a thorough examination of their geological and climatic histories. These two interdependent systems have not only shaped the physical terrain and hydrological cycles of the region but have also determined the distribution of flora and fauna, patterns of human settlement, and land use over millennia. This section presents an integrative review of the geological formation and evolution of Mount Hermon and the Baqa Valley, followed by an analysis of the climatic dynamics that have influenced ecological processes from the deep past to the present day.

3.1. Geological Formation and Tectonic Setting

3.1.1. Tectonic Framework of the Levant Region

Mount Hermon and the Baqa Valley are part of the broader Levantine tectonic regime, which is influenced by the Arabian, African, and Eurasian tectonic plates. The region lies along the Dead Sea Transform (DST), a major left-lateral strike-slip fault that extends from the Red Sea in the south to the Taurus Mountains in southern Turkey. This transform fault system accommodates the relative motion between the African and Arabian plates (Garfunkel, 1981).

Mount Hermon, the highest point in the Anti-Lebanon range, lies just to the west of the DST and is uplifted by compressional and transpressional forces. It is primarily composed of Jurassic and Cretaceous limestone and dolomite strata, which have been folded, faulted, and uplifted over tens of millions of years. The adjacent Baqa Valley is a rift valley that has formed due to crustal subsidence and extensional tectonics associated with this same fault system (Freund et al., 1970). The topographical contrast between Mount Hermon and the Baqa Valley reflects these distinct but interconnected tectonic processes.

3.1.2. Lithological and Stratigraphic Composition

The lithology of Mount Hermon consists predominantly of Mesozoic carbonates—mainly limestone, dolomite, and marl—deposited in shallow marine environments during the Jurassic and

 doi:10.20944/preprints202510.0135.v1

Cretaceous periods (Dubertret, 1955). These formations are rich in fossilised marine fauna, indicating their depositional origins in a warm, tropical sea. The structural uplift of Mount Hermon exposed these formations, which are now heavily karstified, with sinkholes, caves, and underground watercourses serving as important aquifers.

In contrast, the Baqa Valley's geological base includes Neogene and Quaternary sediments, which consist of alluvial fans, lacustrine clays, and fluvial gravels deposited by streams descending from the surrounding mountains. These fertile sediments make the valley suitable for agriculture, but also sensitive to soil erosion and sedimentation processes. The valley floor exhibits evidence of paleo-lakes and ancient river meanders, pointing to a dynamic fluvial history that reflects both tectonic uplift and climatic fluctuation (Walley, 1998).

3.2. Palaeogeography and Geological Evolution

The paleogeographic history of the region extends back to the early Mesozoic era, when the area that now constitutes Mount Hermon and the Baqa Valley lay under the Tethys Ocean. As tectonic convergence began in the Late Cretaceous and continued into the Cenozoic, marine regression occurred, exposing carbonate platforms to subaerial erosion and karstification. The Alpine orogeny, beginning in the Eocene, drove the uplift of the Anti-Lebanon range, including Mount Hermon, through compressional forces associated with the collision of the Arabian and Eurasian plates (Beydoun, 1999).

During the Miocene epoch, rifting intensified along the DST system, creating deep faults and facilitating the formation of the Baqa Valley as a tectonic depression. This period also saw extensive volcanic activity in the surrounding region, particularly in the Golan Heights and Hauran Plateau to the east of Mount Hermon, where basaltic lava flows overlie older sedimentary layers (Shaked et al., 2000). Although Mount Hermon itself is not volcanic, the proximity to volcanic provinces suggests a complex geodynamic environment that has influenced the regional landscape and hydrology.

By the Pleistocene epoch (2.6 million to 11,700 years ago), glacial-interglacial cycles began to influence surface processes more dramatically. Periglacial weathering occurred on Mount Hermon, and periodic increases in rainfall led to heightened fluvial activity in the Baqa Valley. These processes contributed to the erosion and redeposition of sediments, shaping the modern alluvial plains and terraces visible today.

3.3. Climatic History and Paleoenvironmental Conditions

3.3.1. Pleistocene Climate Variability

The Pleistocene epoch was marked by significant climatic oscillations between glacial and interglacial periods. While Mount Hermon and the Baqa Valley did not experience glaciation comparable to higher latitudes, the region was affected by broader shifts in atmospheric circulation and monsoonal systems. Palynological data from lake cores and speleothems in adjacent regions indicate that the Levant experienced wetter conditions during interglacial periods and drier, more arid conditions during glacial maxima (Bar-Matthews et al., 2003).

During wetter phases, rainfall increased across the Anti-Lebanon range, feeding perennial streams and promoting the expansion of woodlands and grasslands. These conditions supported large herds of wild herbivores and early human populations who engaged in hunting and gathering. Drier phases, conversely, led to the retreat of forest cover, expansion of steppe and desert vegetation, and decreased water availability in the Baqa Valley. Such fluctuations likely drove migratory movements and technological adaptations in both human and non-human species (Goring-Morris & Belfer-Cohen, 2011).

3.3.2. Holocene Climate Stabilisation and Anthropogenic Influence

The transition to the Holocene, around 11,700 years ago, brought about a relatively stable climate characterised by warmer temperatures and increased precipitation compared to the late Pleistocene. This stabilisation coincided with the Neolithic Revolution, which saw the domestication of plants and animals and the establishment of permanent settlements across the Levant, including in the Baqa Valley (Weiss et al., 1993).

Holocene climate conditions favoured the development of agriculture, with the expansion of cereal cultivation, orchard farming, and irrigation. Pollen records from nearby lake sediments indicate a peak in arboreal pollen and evidence of forest expansion during the early Holocene, followed by gradual deforestation and soil erosion as human land use intensified (Baruch & Bottema, 1991). The impact of ancient land clearance is still visible today in the form of degraded slopes and terraced landscapes in the foothills of Mount Hermon.

3.3.3. Medieval and Modern Climatic Trends

Climatic reconstructions using tree-ring chronologies and historical documentation suggest that the Medieval Climate Anomaly (ca. 950–1250 CE) brought warmer and possibly drier conditions to the region, followed by the Little Ice Age (ca. 1300–1850 CE), during which cooler and wetter conditions prevailed (Kaniewski et al., 2012). These fluctuations influenced agricultural productivity, water availability, and possibly contributed to periods of famine and migration recorded in historical chronicles.

In the 20th and 21st centuries, anthropogenic climate change has begun to exert a profound influence on Mount Hermon and the Baqa Valley. Recent studies have documented rising mean temperatures, decreasing snow cover on Mount Hermon, and changes in precipitation patterns leading to more frequent droughts and flash floods (Kadioglu, 2020). These changes pose significant threats to the region's ecosystems, water security, and agricultural viability.

3.4. Hydrological Evolution and Watershed Dynamics

The geological and climatic evolution of the region has direct implications for its hydrology. Mount Hermon acts as a critical water tower for the region, capturing orographic precipitation and snow, which gradually melts and feeds into the Jordan River, the Hasbani River, and other tributaries. The karstic nature of the mountain enhances groundwater recharge, creating extensive aquifer systems that supply springs and wells in both the Baqa Valley and the Golan Heights (El-Fadel et al., 2000).

The Baqa Valley, located in the rain shadow of the Anti-Lebanon mountains, relies on these upland water sources as well as direct rainfall. Seasonal rivers such as the Litani and Orontes have historically supported irrigation systems and wetland habitats. However, overextraction of groundwater, pollution from agriculture and industry, and decreased recharge due to deforestation are disrupting these hydrological systems. Longitudinal studies have shown a declining water table and increasing salinisation in many parts of the Baqa Valley (UN-ESCWA & BGR, 2013).

3.5. Geohazards and Landscape Instability

The geological structure and tectonic activity of the region also contribute to natural hazards, including earthquakes, landslides, and soil erosion. Historical records and paleoseismic data indicate that the area around Mount Hermon has experienced multiple significant earthquakes, most notably in 1202 CE and 1759 CE, which caused widespread destruction in the Baqa Valley and surrounding towns (Ambraseys & Barazangi, 1989). Seismic activity remains a present-day risk due to the proximity of the DST fault system.

Erosion and landslides are particularly acute on the deforested slopes of Mount Hermon, where terracing and road construction have destabilised sediment layers. The combination of heavy winter rains and loose soil leads to increased sediment transport into valley rivers, degrading aquatic habitats and contributing to flooding during storm events.

4. Flora and Fauna Diversity of Mount Hermon and the Baqa Valley

Mount Hermon and the Baqa Valley represent some of the most biologically diverse areas within the Levantine region. This biodiversity stems from the region's complex geological history, varied microclimates, and strategic geographic positioning at the crossroads of Asia, Africa, and Europe. Together, Mount Hermon and the Baqa Valley constitute a transitional ecotone—an interface where Mediterranean, Irano-Turanian, and Afro-Arabian biogeographic elements converge (Zohary, 1973). This section examines the diversity of plant and animal life in the area, highlighting ecological zonation, endemic and threatened species, anthropogenic impacts, and conservation efforts.

4.1. Vegetational Zonation and Floristic Composition

4.1.1. Altitudinal Vegetation Belts of Mount Hermon

The flora of Mount Hermon exhibits pronounced altitudinal stratification, a reflection of the mountain's steep gradient and varied climatic conditions. From base to summit, the vegetation transitions through several distinct belts:

- Mediterranean woodland and scrub (below 1000 m): This zone is dominated by sclerophyllous shrubs and evergreen oak species such as Quercus calliprinos, interspersed with Pistacia palaestina and Rhamnus alaternus. The presence of maquis and garrigue vegetation is typical of the lower slopes (Post, 1932).
- Montane forests (1000–1600 m): These mid-altitude zones support deciduous species like Quercus cerris, Acer hyrcanum, and Fraxinus syriaca, along with conifers such as Pinus brutia and Cupressus sempervirens. This belt is crucial for biodiversity and soil conservation.
- Subalpine zone (1600–2200 m): This zone transitions to open meadows and herbaceous flora. Characteristic species include Astragalus hermoneus, Erodium hermonis, and endemic members of the Lamiaceae and Fabaceae families.
- Alpine and cryophilic flora (above 2200 m): The summit areas host alpine meadows with cushion-forming plants, mosses, and lichens. This flora shows adaptations to extreme conditions—strong winds, high UV exposure, and snow cover—and includes rare endemics like Acantholimon libanoticum (Mouterde, 1966).

4.1.2. Floristic Richness of the Baqa Valley

The Baqa Valley, although more arid and topographically subdued than Mount Hermon, supports a rich mosaic of vegetation types. The valley's soils—largely composed of alluvial and colluvial deposits—support riparian corridors, steppe vegetation, and cultivated lands. Key plant assemblages include:

- Riparian vegetation along intermittent streams (Nerium oleander, Salix alba, Tamarix spp.)
- Steppe and semi-arid flora, including Artemisia herba-alba, Anabasis articulata, and Atriplex halimus
- Agricultural species, primarily cereals, legumes, and orchard crops like olive (Olea europaea), fig (Ficus carica), and pomegranate (Punica granatum)

Notably, the Baqa Valley serves as a key migratory corridor for plant species during climatic shifts, and floristic surveys have recorded over 800 vascular plant species, several of which are medicinal or economically significant (Danin & Plitmann, 1987).

 doi:10.20944/preprints202510.0135.v1

4.2. Faunal Diversity: Mammals, Birds, Reptiles, and Insects

4.2.1. Mammalian Fauna

The faunal diversity of Mount Hermon and the Baqa Valley reflects both altitudinal and habitat.

- Ungulates: Historically, the region supported populations of wild goats (Capra aegagrus) and mountain gazelles (Gazella gazella). Today, these are rare due to overhunting and habitat degradation (Khoury et al., 1995).
- Carnivores: The striped hyena (Hyaena hyaena), red fox (Vulpes vulpes), and golden jackal (Canis aureus) remain common. The presence of the caracal (Caracal caracal) has been recorded in remote areas.
- Rodents and insectivores: Species such as the Middle Eastern mole rat (Nannospalax ehrenbergi) and the Levant vole (Microtus guentheri) are adapted to grassland and steppe habitats.
- Some mammalian species, like the Syrian brown bear (Ursus arctos syriacus), are now considered extirpated due to habitat loss and conflict with humans (Hatipoglu et al., 2018).

4.2.2. Avifauna

Mount Hermon is internationally recognised as an Important Bird Area (IBA) due to its strategic position on the Afro-Eurasian flyway. Over 300 species of birds have been documented in the region (Evans, 1994), including:

- Resident species: Eurasian jay (Garrulus glandarius), long-legged buzzard (Buteo rufinus), and rock partridge (Alectoris graeca)
- Migratory species: Storks, eagles, and cranes use the area as a seasonal stopover. The black stork (Ciconia nigra) and steppe eagle (Aquila nipalensis) are regularly observed during migration.
- Endangered species: The lesser kestrel (Falco naumanni) and Syrian serin (Serinus syriacus) are globally threatened and depend on traditional agricultural landscapes and subalpine meadows, respectively.

4.2.3. Reptiles and Amphibians

The reptilian fauna is particularly diverse, with over 40 recorded species. Common species include:

- Chamaeleo chamaeleon (Mediterranean chameleon)
- Lacerta laevis (Levant green lizard)
- Vipera palaestinae (Palestine viper), which is endemic and of medical importance

Amphibians are less diverse due to aridity but include the Near Eastern fire salamander (Salamandra infraimmaculata) and green toads (Bufotes viridis), which breed in seasonal pools (Werner, 1988).

4.2.4. Invertebrates and Pollinators

The insect fauna of Mount Hermon includes numerous endemic and rare species. Butterflies such as Parnassius mnemosyne hermonis and various beetles adapted to alpine conditions highlight the region's entomological importance (Holloway & Miller, 1987). Pollinator diversity—bees, hoverflies, and butterflies—is critical for maintaining the floral diversity of both Mount Hermon and the Baqa Valley.

4.3. Endemism and Threatened Species

Mount Hermon is recognised as a centre of endemism within the Levant. The mountain's isolated alpine zone harbours relict species from cooler past epochs, such as:

- Erodium hermonis—a geraniaceous plant found only on high peaks
- Scutellaria hermonis—a mint-family member with pharmacological significance

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 October 2025 doi:10.20944/preprints202510.0135.v1

- Micromeria juliana hermonis—an aromatic herb found only above 2000 m elevation

The Baqa Valley, though more impacted by human activity, retains endemic species adapted to steppe environments. However, habitat fragmentation and agricultural expansion are pushing many toward extinction.

The International Union for Conservation of Nature (IUCN) has listed several species from the region in various threat categories, urging stronger protective measures (IUCN, 2023).

4.4. Human Impacts and Conservation Challenges

4.4.1. Land Use Change and Habitat Loss

The greatest threat to biodiversity in Mount Hermon and the Baqa Valley is anthropogenic land transformation. Urbanisation, road construction, deforestation, and agricultural intensification have all contributed to habitat loss and fragmentation (Tal, 2006). Illegal hunting and overgrazing also affect wildlife populations, especially large mammals and ground-nesting birds.

4.4.2. Invasive Species

Invasive plants such as Ailanthus altissima (tree of heaven) and Opuntia ficus-indica (prickly pear) threaten native flora by outcompeting endemic and medicinal species. Invasive rodents and feral dogs have disrupted ecological balances in both natural and semi-natural habitats (Shirazi & Yom-Tov, 2009).

4.4.3. Climate Change and Biodiversity Shifts

Rising temperatures and altered precipitation patterns are shifting vegetation zones upslope, reducing the habitat range for cold-adapted species on Mount Hermon. Climate-induced phenological mismatches between plants and pollinators are also being observed (Ben-Hur et al., 2018).

4.5. Conservation Efforts and Protected Areas

Efforts to preserve the ecological integrity of the region are underway, but face numerous challenges. Protected areas such as the Hermon Nature Reserve (in parts of Israeli-controlled territory) and designated forest zones in Lebanon and Syria provide some coverage, but many key habitats remain outside formal protection (Hoekstra et al., 2005).

Community-based conservation, including eco-tourism and traditional agroecological practices, offers potential pathways to sustainable biodiversity management. In recent years, transboundary cooperation initiatives have been proposed, especially in water management and migratory species protection, although political instability hinders large-scale coordination (UNEP, 2010).

5. Human Settlement and Environmental Impact

The ecological and environmental fabric of Mount Hermon and the Baqa Valley has been profoundly shaped by the history of human occupation and land use. Spanning from prehistoric settlement patterns to contemporary urbanisation, human activities have left indelible marks on the landscape, affecting biodiversity, soil quality, water availability, and climate resilience. The impacts of settlement are not linear or uniformly destructive; traditional land-use practices often maintained ecological balance, while recent development has introduced both pressures and conservation opportunities. This section traces the historical trajectory of human settlement and analyses its environmental repercussions in Mount Hermon and the Baqa Valley.

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 October 2025 doi:10.20944/preprints202510.0135.v1

5.1. Historical Patterns of Settlement

5.1.1. Prehistoric to Classical Antiquity

Archaeological records indicate that Mount Hermon and the Baqa Valley were inhabited as early as the Epipaleolithic and Neolithic periods. Sites with lithic tools, pottery fragments, and rock shelters demonstrate a long-standing human presence adapted to mountain and valley ecosystems (Bar-Yosef & Belfer-Cohen, 2001). These early inhabitants practised mobile hunting and gathering, gradually transitioning into agro-pastoral lifestyles by the Chalcolithic and Bronze Ages.

During the Classical period (Hellenistic, Roman, and Byzantine eras), the region witnessed the establishment of more permanent settlements, including temples, road systems, and terraced agriculture. Roman texts mention Mount Hermon as a site of religious significance and seasonal grazing (Isaac, 1983). These periods also saw increased deforestation and construction, leading to gradual ecological transformation.

5.1.2. Medieval to Ottoman Period

In the Islamic and Crusader periods, land use in the Baqa Valley shifted toward more organised agricultural systems, with irrigation channels and village-based settlements emerging. The Ottoman Empire further intensified agricultural activity through tax incentives for productive land, leading to expanded cultivation of wheat, olives, and vines (Faroqhi, 1999). Forests and woodlands on the lower slopes of Mount Hermon were cleared for timber and charcoal production, reducing biodiversity and altering hydrological patterns (Kark, 1992).

5.1.3. Modern Era: Colonial and Post-Colonial Development

The modern era brought radical changes to settlement density, land tenure, and infrastructure. British and French colonial mapping and zoning in the early 20th century introduced new administrative and land classification systems, which often disregarded traditional land uses. The establishment of national borders across Mount Hermon in the mid-20th century further complicated access to communal grazing lands and forests (Salibi, 1988).

Rapid urbanisation, population growth, and geopolitical conflict in the latter half of the 20th century led to increased pressure on natural resources. Refugee influxes, military occupation, and infrastructural projects (such as roads and reservoirs) significantly fragmented habitats in both Mount Hermon and the Baqa Valley (Weinthal, 2002).

5.2. Land Use and Landscape Transformation

5.2.1. Agricultural Expansion and Irrigation

The Baqa Valley has long been a breadbasket for surrounding regions, but its intensification over time has had clear ecological consequences. The shift from rain-fed to irrigated agriculture—particularly since the 1960s—altered water cycles and introduced chemical pollutants into soil and groundwater systems (Tal, 2006).

- Terracing and soil erosion: Traditional terracing on Mount Hermon, while effective in reducing runoff and conserving soil, has declined due to labour constraints and abandonment. In contrast, modern agricultural expansion has led to the removal of terraces, increasing erosion risks.
- Chemical input: The extensive use of synthetic fertilisers and pesticides has degraded soil microbiota and reduced pollinator populations in both the valley and upland areas (Shachak et al., 1998).

5.2.2. Urban and Infrastructure Development

Urban expansion, especially near Marjayoun, Hasbaya, and areas on the western slopes of Mount Hermon, has converted large tracts of natural and semi-natural habitats into built environments. Road construction for military and civilian purposes has fragmented wildlife

 doi:10.20944/preprints202510.0135.v1

corridors, reduced genetic flow among populations, and introduced invasive plant species (Forman & Alexander, 1998).

Remote sensing data show that between 1980 and 2020, built-up areas in the Baqa Valley increased by over 60%, with corresponding declines in natural vegetation cover (UNESCWA, 2021). This urbanisation has created heat islands, increased air and noise pollution, and disrupted native bird nesting sites.

5.3. Water Resource Exploitation

5.3.1. Spring and Aquifer Depletion

Mount Hermon serves as a major water catchment area, feeding several rivers, including the Hasbani, Dan, and Banias. However, unregulated pumping for agriculture and domestic use has led to the overextraction of springs and aquifers. The Hasbani River, for example, has experienced declining summer flows due to increased upstream withdrawals (Zeitoun & Allan, 2008).

This has a cascade effect: lower water availability impacts aquatic biodiversity, riparian vegetation, and downstream agricultural productivity. In drier years, temporary riverbeds in the Baqa Valley fail to regenerate their usual vegetation, disrupting grazing and foraging patterns of both livestock and wild herbivores.

5.3.2. Pollution and Water Quality Decline

Sewage discharge, agricultural runoff, and waste dumping are growing threats to water quality. Studies have shown elevated nitrate levels in valley aquifers and bacterial contamination in springs used for drinking water (Shomar, 2010). These pollutants threaten both human health and sensitive aquatic species such as amphibians and benthic invertebrates.

5.4. Biodiversity Decline and Habitat Fragmentation

As outlined in the previous section, habitat destruction driven by human settlement has led to biodiversity loss. Key drivers include:

- Deforestation: Lower montane forests of oak and pine have been severely reduced, with satellite imagery confirming a 35% loss in forest cover since the mid-20th century (FAO, 2020).
- Overgrazing: Traditional grazing practices, once regulated through communal systems, have become unbalanced due to reduced pasture and changing herd sizes. This leads to soil compaction, erosion, and a decline in native herbaceous species (Noy-Meir & Seligman, 1979).
- Hunting and species depletion: Unregulated hunting has reduced populations of game birds, wild goats, and carnivores. Poaching of protected birds, including raptors, remains a problem during migration seasons.

5.5. Climate Interactions and Feedback Loops

Human settlements and environmental degradation exacerbate the impacts of climate change. Deforestation reduces carbon sequestration, while urbanisation increases localised warming. The loss of wetlands and riparian vegetation reduces natural flood control, increasing the vulnerability of both ecosystems and human communities to extreme weather events (Lelieveld et al., 2016).

In Mount Hermon, warming temperatures have reduced snowpack duration, altering the hydrological regime and affecting spring flow timing and quantity. In the Baqa Valley, increased evapotranspiration from irrigated agriculture accelerates water loss, necessitating even more extraction—creating a negative feedback loop of environmental degradation.

5.6. Socio-Economic Drivers and Governance Challenges

Settlement patterns in the region are deeply linked to socio-political and economic factors. Poverty, conflict, and weak governance contribute to unsustainable resource use. In the Baqa Valley,

 doi:10.20944/preprints202510.0135.v1

land tenure insecurity discourages long-term investment in sustainable practices, while political divisions across the Hermon massif impede unified conservation strategies (Haddad et al., 2010).

Community engagement in environmental stewardship is often limited by a lack of education, resources, and incentives. However, localised success stories—such as reforestation efforts by local NGOs and traditional water-sharing cooperatives—demonstrate potential for bottom-up conservation initiatives.

5.7. Toward Sustainable Settlement and Land Use

A sustainable vision for human settlement in Mount Hermon and the Baqa Valley must integrate ecological resilience with economic opportunity. Key policy recommendations include:

- Ecological zoning: Designating ecologically sensitive zones with regulated development can preserve biodiversity hotspots and water sources.
- Agroecological farming: Encouraging low-input, biodiversity-friendly farming systems can reduce chemical use and restore soil health.
- Integrated watershed management: Cross-border cooperation in managing shared water resources is essential for long-term sustainability.
- Cultural landscape preservation: Protecting traditional terraces, olive groves, and pastoral practices not only preserves ecological function but also cultural heritage.

Human settlement in Mount Hermon and the Baqa Valley has transformed the region's environmental conditions, from the shaping of ancient landscapes to the pressing ecological challenges of the 21st century. While anthropogenic impacts have been substantial—through deforestation, habitat fragmentation, pollution, and overexploitation of resources—there also exist enduring models of coexistence with nature rooted in traditional land use. Balancing development with ecological sustainability requires informed governance, inclusive community participation, and cross-border cooperation. Only through such integrative strategies can the ecological heritage of Mount Hermon and the Baqa Valley be safeguarded for future generations.

6. Water Resources and Hydrological Dynamics

Mount Hermon and the Baqa Valley are part of a complex and ecologically significant hydrological system that has shaped the region's environment and sustained human civilisation for millennia. The high elevation, snow accumulation, karstic geology, and varied precipitation regimes make Mount Hermon a critical headwater for the broader Levantine watershed. In contrast, the Baqa Valley functions as a lowland catchment and agricultural basin dependent on both surface and subsurface water flow. This section examines the key hydrological features of the region, assesses the ecological services provided by water systems, and evaluates the impacts of climate change, over-extraction, and political constraints on the sustainability of water resources.

6.1. Hydrological Structure of Mount Hermon and the Baqa Valley

6.1.1. Mount Hermon as a Regional Watershed

Mount Hermon, rising to 2,814 meters, is a major hydrological reservoir in the eastern Mediterranean. The massif accumulates significant snowfall in winter, feeding perennial springs and rivers through gradual melting in the spring and summer months (Gvirtzman, 2002). Its karstic limestone formations allow rain and snowmelt to percolate into extensive underground aquifers, supporting a network of springs that emerge on the mountain's slopes and foothills (Weinberger et al., 2002).

Key river systems originating from Mount Hermon include:

- The Hasbani River (Nahr al-Hasbani): One of the three main tributaries of the Jordan River, it flows southward into the Hula Valley and eventually the Sea of Galilee.

 doi:10.20944/preprints202510.0135.v1

- The Banias River: Another major tributary, fed by springs near the ancient site of Caesarea Philippi.
- The Dan River: Although sourced at a lower elevation, it is hydrologically connected to Hermon through shared aquifers.

These rivers and their catchments are essential not only for ecological functioning but also for domestic water supply and irrigation downstream, including in Lebanon, Israel, and Syria (Zeitoun & Warner, 2006).

6.1.2. Baqa Valley's Groundwater and Surface Systems

The Baqa Valley lies within the shadow of Mount Hermon and receives both direct precipitation and hydrological input from upland runoff. Though less abundant in surface rivers than the Hermon massif, the valley is underlain by shallow aquifers, recharged seasonally through rainfall and wadi flows. Springs such as Ain al-Tinah and Ain al-Baqa provide year-round water, which historically supported agricultural and pastoral systems (Haddad et al., 2010).

The valley's water table is influenced by both natural fluctuations and anthropogenic abstraction, particularly from irrigation wells. Surface water in the valley often takes the form of temporary streams or wadis, which become active during winter storms and provide important floodplain recharge and biodiversity habitats.

6.2. Ecological Functions and Services

The water systems of Mount Hermon and the Baqa Valley perform several vital ecological functions:

- Hydration of forest and grassland ecosystems: Spring-fed moisture supports endemic plant species and sustains faunal populations in otherwise arid conditions.
- Migration corridors: Riverbanks and riparian zones serve as migration routes for birds, mammals, and insects.
- Soil formation and nutrient cycling: The movement of water through the karst system helps deposit minerals and facilitates the development of fertile soils in the valley below (Avni et al., 2018).
- Wetland ecosystems: Seasonal wetlands formed by floodwaters serve as breeding grounds for amphibians and temporary habitats for migratory birds.

These functions underscore the need to preserve the hydrological integrity of the region in the face of mounting pressures.

6.3. Climate Change and Hydrological Stress

6.3.1. Declining Snowpack and Precipitation Variability

One of the most pressing challenges to the hydrological stability of Mount Hermon is the impact of climate change. Data over recent decades show a measurable decline in snowpack depth and duration, which directly reduces spring and summer discharge from Hermon's aquifers (Lelieveld et al., 2016). Moreover, inter-annual variability in rainfall is increasing, leading to alternating periods of drought and flooding.

Precipitation is becoming more concentrated in intense storms rather than being evenly distributed over the wet season. This shift affects infiltration rates and increases surface runoff, reducing aquifer recharge efficiency while exacerbating erosion and flash floods in the Baqa Valley (Smiatek et al., 2011).

6.3.2. Rising Temperatures and Evapotranspiration

Warming temperatures intensify evapotranspiration from soils and open water bodies. In the Baqa Valley, where irrigation is often carried out using open channels or flood techniques, evaporation losses can reach over 30% of total water usage (Tal, 2006). This places additional stress on groundwater reserves and reduces the efficiency of agricultural water use.

6.4. Anthropogenic Impacts on Hydrology

6.4.1. Over-Extraction and Groundwater Depletion

Unregulated extraction of groundwater for agriculture and domestic consumption is one of the primary threats to hydrological sustainability in the Baqa Valley. The proliferation of private wells, often drilled illegally or without proper monitoring, has led to a significant drop in the water table in some areas (UNESCWA, 2020). Over-extraction results in:

- Lowered spring discharge or complete spring drying.
- Soil subsidence and salinisation in lowland agricultural fields.
- Disruption of groundwater-dependent ecosystems.

On Mount Hermon, increased tourism and military infrastructure have also led to localised overdrawing from springs for road maintenance, snow tourism, and military outposts (Weinthal, 2002).

6.4.2. Pollution of Water Resources

Another key concern is the deterioration of water quality due to anthropogenic inputs. Pollution sources include:

- Agricultural runoff: Nitrates and phosphates from fertilisers leach into groundwater and surface flows, leading to eutrophication of wetlands and springs.
- Sewage discharge: In areas lacking centralised wastewater treatment, raw or partially treated sewage enters wadi systems and contaminates downstream users (Shomar, 2010).
- Solid waste: Improperly managed landfills and informal waste dumps along streambeds contribute to leachate generation, especially during heavy rainfall.

These contaminants pose health risks to humans and wildlife, affect crop quality, and degrade aquatic biodiversity.

6.5. Hydropolitics and Transboundary Water Governance

6.5.1. Shared Water Resources and Conflict Potential

Mount Hermon's water systems do not respect political boundaries. The Hasbani River flows from Lebanon into Israel; the Banias originates in the Golan Heights; and the Dan is entirely within Israeli territory but influenced by upstream dynamics. This shared geography has historically led to tensions among Lebanon, Israel, and Syria regarding water rights, infrastructure development, and access (Zeitoun & Allan, 2008).

Attempts to divert or control headwaters have triggered political disputes, especially during periods of heightened regional conflict. These tensions complicate collaborative management, monitoring, and conservation efforts.

6.5.2. Opportunities for Cooperation

Despite these challenges, shared water resources also present opportunities for regional cooperation. Environmental NGOs, research institutes, and international organisations have proposed frameworks for transboundary water governance that include:

- Joint monitoring programs: Using shared hydrological data to track aquifer levels, pollution sources, and climate trends.
- Equitable allocation models: Balancing ecological needs with human demand through negotiated treaties.

 doi:10.20944/preprints202510.0135.v1

- Watershed-based planning: Focusing on ecological units rather than political boundaries to guide land and water use policies.

Examples from the Jordan River Basin demonstrate that integrated water resource management can build trust and improve sustainability even in politically sensitive contexts (Feitelson & Haddad, 2000).

The water systems of Mount Hermon and the Baqa Valley represent one of the most ecologically and geopolitically significant hydrological networks in the Levant. These systems sustain biodiversity, agriculture, and human life across multiple borders, but they are increasingly threatened by climate change, overextraction, pollution, and geopolitical conflict. Preserving the hydrological integrity of this region requires urgent action, including sustainable groundwater management, pollution control, and cross-border cooperation. Effective stewardship of these water resources is not only a local ecological necessity but a prerequisite for long-term regional peace and development.

7. Environmental Conservation and Policy Frameworks

Mount Hermon and the Baqa Valley present a unique convergence of ecological richness, climatic diversity, and geopolitical sensitivity. The natural wealth of the region is under increasing threat from climate change, land degradation, water resource exploitation, and unregulated development. In this context, effective environmental conservation and policy frameworks are essential not only for sustaining ecological integrity but also for fostering regional stability and sustainable development. This section examines the existing conservation practices, legal and institutional arrangements, international environmental commitments, and the challenges and opportunities for improved policy implementation in Mount Hermon and the Baqa Valley.

7.1. Legal and Institutional Frameworks

7.1.1. National Conservation Laws

The territories encompassing Mount Hermon and the Baqa Valley fall under the jurisdictions of Lebanon, Israel, and Syria, each with its own set of environmental regulations and administrative bodies. Lebanon's Ministry of Environment (MoE) has enacted key laws such as Law No. 444 (2002) on Environmental Protection, which sets a general framework for safeguarding biodiversity and natural resources (UNEP, 2015). However, enforcement remains inconsistent due to political instability and limited institutional capacity.

Israel's environmental legislation is comparatively more developed. The Nature and Parks Authority (NPA) manages nature reserves and national parks, including several protected areas near Mount Hermon and the Upper Jordan River. The National Master Plan (TAMA 35) incorporates environmental considerations in spatial planning, offering a more integrated approach to land and resource use (Feitelson, 2013).

Syria's legal framework has suffered due to ongoing conflict, although its Environmental Law (Law No. 50 of 2002) remains a reference point for future rehabilitation efforts. The Directorate of Water Resources and the Ministry of Local Administration and Environment are the principal environmental agencies, though their effectiveness has diminished in recent years.

7.1.2. Transboundary Environmental Governance

Despite the ecological connectivity of Mount Hermon and the Baqa Valley, formal cross-border environmental governance mechanisms remain weak or absent. Political tensions among Lebanon, Syria, and Israel have prevented the formation of transboundary conservation frameworks, which limit coordinated action in biodiversity protection, watershed management, and pollution control (Zeitoun & Mirumachi, 2008).

Informal cooperation has occasionally emerged through non-governmental organisations and international donors, particularly in the realm of biodiversity monitoring, water quality testing, and climate adaptation planning. However, the lack of institutionalised coordination hampers the scale and sustainability of these efforts.

7.2. Protected Areas and Biodiversity Strategies

7.2.1. Designated Protected Zones

Several conservation zones have been established to protect the biodiversity and ecosystems of the region. Notably:

- Hermon Nature Reserve (Israel): Encompasses parts of the southern slopes of Mount Hermon, with a focus on preserving endemic flora and fauna such as the Hermon iris (Iris hermona) and the mountain gazelle (Gazella gazella).
- Ain Zhalta-Bmahray Biosphere Reserve (Lebanon): Although located farther west, it represents a model of integrated ecosystem management within the broader Lebanese mountain ecosystem (UNESCO, 2023).

These protected areas are critical for maintaining ecological corridors and regulating land use. However, their geographic fragmentation and lack of interconnectivity limit their long-term effectiveness in sustaining large-scale ecological functions.

7.2.2. National Biodiversity Strategies

Lebanon, Israel, and Syria have each developed National Biodiversity Strategies and Action Plans (NBSAPs) in line with their commitments under the Convention on Biological Diversity (CBD). These strategies typically include components such as:

- Biodiversity inventories and data systems.
- Public awareness and education campaigns.
- Legal frameworks for species and habitat protection.
- Integration of biodiversity into sectoral planning (e.g., agriculture, forestry, and tourism).

While these strategies provide a conceptual basis for conservation, their implementation has been uneven due to resource constraints, political conflict, and competing development priorities (NBSAP Forum, 2021).

7.3. Role of International Organisations and Agreements

International environmental bodies and funding agencies have played a critical role in promoting conservation initiatives and building capacity in the region. Key programs and actors include:

- UNDP and UNEP: Provide technical support for climate resilience and environmental governance projects.
- The Global Environment Facility (GEF): Funds cross-sectoral initiatives focused on biodiversity, land degradation, and sustainable agriculture.
- UNESCO's Man and the Biosphere Programme: Encourages the establishment of biosphere reserves that combine conservation, development, and research.

Furthermore, all three countries have ratified major international treaties such as the CBD, the United Nations Framework Convention on Climate Change (UNFCCC), and the United Nations Convention to Combat Desertification (UNCCD). These agreements offer a normative and financial platform for enhanced cooperation, though their influence remains constrained by local political dynamics.

7.4. Community-Based Conservation and Traditional Knowledge

Local communities play a significant role in the stewardship of environmental resources. In the Baqa Valley, traditional irrigation techniques such as the use of qanats (subterranean channels) and

 doi:10.20944/preprints202510.0135.v1

seasonal grazing rotations have historically maintained ecological balance (Chatty, 2010). Similarly, sacred groves and cultural taboos surrounding certain forested areas near Mount Hermon have contributed to de facto conservation practices.

Recent conservation approaches have increasingly emphasised the inclusion of local actors through community-based natural resource management (CBNRM). These efforts aim to:

- Empower indigenous and rural communities to manage protected areas.
- Promote ecotourism as a sustainable livelihood.
- Encourage agroecological farming methods that preserve biodiversity.

However, challenges such as land tenure insecurity, population displacement, and generational shifts in values have weakened the continuity of traditional environmental knowledge (Al-Jayyousi, 2012).

7.5. Challenges and Future Directions

Despite growing recognition of the region's ecological significance, several persistent challenges hinder effective environmental governance:

- Fragmented jurisdiction and overlapping mandates among environmental, agricultural, and water ministries.
- Lack of reliable environmental data for long-term planning and monitoring.
- Political instability and armed conflict, especially in Syria, diverts attention and resources away from environmental priorities.
- Inadequate funding and donor fatigue in post-conflict zones.

To address these challenges, several policy recommendations are proposed:

- Establish transboundary conservation corridors and regional biosphere reserves with support from international bodies.
- Strengthen environmental impact assessment (EIA) procedures for infrastructure and tourism projects.
- Support capacity building in environmental science and policymaking among local institutions.
- Promote public-private partnerships for eco-tourism, sustainable agriculture, and renewable energy initiatives.

Ultimately, conservation in Mount Hermon and the Baqa Valley must move beyond reactive measures to embrace a proactive, ecosystem-based approach grounded in cooperation, science, and community participation.

8. Discussion and Synthesis

The ecological and environmental review of Mount Hermon and the Baqa Valley reveals a landscape defined by remarkable natural diversity, enduring human-environment interactions, and complex geostrategic dynamics. This synthesis integrates the findings from geological evolution, biodiversity patterns, anthropogenic pressures, water resource dynamics, and conservation frameworks to present a comprehensive interpretation of the current ecological state of the region. Furthermore, it proposes a roadmap for future research, policy integration, and regional cooperation to safeguard the environmental heritage of this ecologically sensitive and geopolitically significant area.

8.1. Interdisciplinary Insights: The Ecology-Geology Nexus

The ecological character of Mount Hermon and the Baqa Valley is inseparable from its geological and climatic history. The tectonic uplift that formed Mount Hermon, in concert with glacial and interglacial climatic oscillations, created a heterogeneous altitudinal gradient that supports a vast array of microclimates and soil types (Gvirtzman & Wieder, 2001). This diversity underpins the

 doi:10.20944/preprints202510.0135.v1

region's endemic flora and fauna, making it a global biodiversity hotspot despite its relatively small area.

The interplay between geology and ecology is particularly visible in the karstic systems of Mount Hermon, which influence the hydrology of the Baqa Valley and Upper Jordan River. The karst formations not only support unique groundwater ecosystems but also act as crucial recharge zones for aquifers vital to both Lebanon and Israel (Salameh & Bannayan, 1993). These hydrogeological features also mediate species distribution and migration, facilitating genetic flow between populations while simultaneously creating isolated ecological niches conducive to endemism.

Such complex geological-ecological interactions demand interdisciplinary approaches that merge geology, climatology, biology, and hydrology. The ecological resilience of this region—its capacity to recover from disturbances—hinges upon understanding these interactions in both spatial and temporal contexts.

8.2. Human-Environment Dynamics: From Sustainability to Degradation

Human settlements in Mount Hermon and the Baqa Valley have historically adapted to, and in many ways respected, the natural environment. Traditional agro-pastoral systems, such as transhumant herding, dryland terrace agriculture, and qanat-based irrigation, exemplify early models of sustainable resource use (Abu Hammad & Tumeizi, 2012). These practices were generally aligned with ecological rhythms and demonstrated an acute awareness of resource limits, particularly in water-scarce environments.

However, in recent decades, anthropogenic pressures have intensified, disrupting this fragile balance. Rapid urbanisation, military activity, unregulated tourism, and infrastructural expansion have led to habitat fragmentation, biodiversity loss, and increased sedimentation and pollution in freshwater systems (Al-Jayyousi, 2012; Zeitoun & Warner, 2006). In Lebanon and Syria, inadequate waste management and deforestation have exacerbated soil erosion, while water extraction for agriculture has caused aquifer depletion.

The environmental degradation is not merely a function of population growth or resource scarcity, but of governance gaps, economic marginalisation, and political instability. The Syrian conflict, in particular, has led to environmental collapse in parts of the Golan Heights and southern Syria, where ecosystem monitoring and conservation have virtually ceased (De Châtel, 2014). These findings suggest a need to reframe human-environment dynamics not as linear trends of degradation, but as reflections of broader social, political, and institutional conditions.

8.3. Biodiversity and Ecosystem Services Under Threat

Mount Hermon and the Baqa Valley serve as ecological nodes where Mediterranean, Irano-Turanian, and alpine biogeographical zones converge, supporting over 1,000 plant species and dozens of endemic animal taxa (Mouterde, 1966; Danin, 2004). These biodiverse ecosystems provide critical ecosystem services such as pollination, carbon sequestration, water purification, and climate regulation—services that have tangible economic and social value for communities across borders.

Yet, the loss of biodiversity in the region is accelerating due to land conversion, invasive species, and climate change. Studies have shown shifts in species altitudinal ranges, with many alpine plants and cold-adapted invertebrates experiencing habitat compression or population decline (Ben-David et al., 2007). The proliferation of invasive plant species such as Ailanthus altissima and Oxalis pes-caprae in disturbed areas also threatens native flora.

From a conservation biology perspective, the absence of large contiguous protected corridors and the lack of genetic connectivity among wildlife populations further weaken ecosystem resilience. The "island effect" caused by fragmented habitats can lead to inbreeding, genetic drift, and eventual local extinctions, particularly among small and isolated populations such as amphibians and raptors.

 doi:10.20944/preprints202510.0135.v1

8.4. Hydrological Complexity and Vulnerability

Water is the ecological lifeblood of the Mount Hermon-Baqa Valley system, and its management reflects broader environmental challenges. The region's aquifers, springs, and surface water bodies are not only biophysical assets but also sources of geopolitical contention. Mount Hermon is a key source of the Jordan River headwaters, and its snowmelt and karst-fed springs supply significant freshwater volumes to Lebanon, Israel, and Jordan (Gafny & Gvirtzman, 2010).

However, water insecurity is mounting due to declining precipitation, rising temperatures, and growing demand. Hydrological modelling indicates that climate change will reduce annual water availability by up to 20–30% in some parts of the region by 2050 (Chenoweth et al., 2011). Water quality is also deteriorating due to untreated sewage discharge, pesticide runoff, and sedimentation, particularly in agricultural zones of the Baqa Valley.

Water governance remains fragmented and politicised. The lack of basin-wide coordination mechanisms has led to over-extraction and mismanagement, while transboundary water-sharing agreements are either outdated or non-existent. This disjuncture between ecological realities and political structures amplifies hydrological vulnerability and undermines sustainable water use.

8.5. Governance and Conservation: Challenges and Gaps

Despite the establishment of national parks and nature reserves, conservation in Mount Hermon and the Baqa Valley remains undermined by weak institutional capacity, overlapping mandates, and limited stakeholder engagement. Environmental Impact Assessments (EIAs) are not consistently enforced, and many protected areas suffer from insufficient funding, inadequate staffing, and encroachment by agriculture or development projects (Feitelson, 2013).

Moreover, the absence of formal transboundary conservation initiatives is a major shortcoming. The region's ecology does not recognise political borders, and yet conservation planning is overwhelmingly national in scope. Bilateral or trilateral cooperation on issues such as wildlife corridors, shared water bodies, or climate adaptation strategies is rare and usually confined to donor-funded pilot projects.

In this regard, civil society organisations, academic institutions, and international agencies play a crucial intermediary role. Collaborative biodiversity assessments, community-led conservation schemes, and regional knowledge-sharing platforms offer potential pathways for bottom-up environmental diplomacy (UNEP, 2015; NBSAP Forum, 2021).

8.6. Climate Change as a Cross-Cutting Risk Multiplier

Climate change acts as a "threat multiplier," intensifying pre-existing ecological and socio-political stresses in Mount Hermon and the Baqa Valley. Rising temperatures are shifting plant phenology, altering bird migration patterns, and increasing the frequency and intensity of droughts (Alpert et al., 2008). These changes challenge the adaptive capacity of both ecosystems and human systems.

Moreover, climate impacts exacerbate inequalities, affecting poor and marginalised rural communities most severely. For example, pastoralist groups in the Baqa Valley are particularly vulnerable to decreased pasture availability and water scarcity, which can fuel livelihood insecurity and resource conflicts (Mason & Zeitoun, 2013).

Integrating climate resilience into conservation and development planning is thus imperative. This includes investing in climate-smart agriculture, restoring degraded ecosystems for carbon sequestration, and enhancing early warning systems for extreme weather events. Adaptation strategies must also be culturally contextualised and participatory to ensure local legitimacy and effectiveness.

 doi:10.20944/preprints202510.0135.v1

8.7. Toward Integrated and Collaborative Solutions

Given the complexity of the ecological and governance landscape, an integrated management approach is needed—one that considers ecological, hydrological, social, and political dimensions simultaneously. Ecosystem-based management (EBM), which emphasises connectivity, resilience, and stakeholder participation, offers a viable paradigm for conservation and sustainable development in the region.

Key pillars of an integrated strategy might include:

- Transboundary ecological corridors linking protected areas across Lebanon, Syria, and Israel.
- Joint monitoring and research platforms that facilitate data sharing on biodiversity, water quality, and land use.
- Community-based resource governance, leveraging traditional ecological knowledge and local stewardship.
- Environmental peacebuilding frameworks, which use shared ecological interests as entry points for dialogue and cooperation.

Furthermore, environmental education and capacity-building initiatives at the local level can cultivate a new generation of conservation-minded citizens and policymakers. Educational curricula, citizen science programs, and youth ecotourism can all reinforce ecological awareness and social cohesion.

9. Conclusions

Mount Hermon and the Baqa Valley constitute a unique ecological region shaped by complex geological, climatic, biological, and cultural processes spanning from prehistoric epochs to the modern era. As this review has demonstrated, the region's topographic and climatic heterogeneity has fostered exceptional levels of biodiversity, including many endemic and relict species. The karstic geology, snow-fed streams, and diverse vegetation zones form a mosaic of ecological systems with significant regional and global conservation value.

Despite this natural richness, human intervention has left a profound imprint on the landscape. From early Neolithic settlements and ancient pastoral traditions to modern agriculture, military development, and tourism infrastructure, anthropogenic pressures have intensified. Deforestation, habitat fragmentation, overgrazing, and unregulated water extraction have accelerated ecological degradation, compounded by the impacts of climate change and geopolitical instability. The hydrological balance of the region, especially its shared aquifers and springs, has come under increasing stress, threatening not only ecosystems but also the livelihoods of local communities.

Efforts to mitigate these environmental threats have been uneven. While some protected areas and national parks have been established, they often lack ecological connectivity, adequate funding, and enforcement. Environmental governance is further complicated by the geopolitical fragmentation of the region—divided between Lebanon, Israel, and Syria—making coordinated ecological management difficult. Moreover, the lack of comprehensive environmental data and long-term monitoring systems impedes informed decision-making.

Nevertheless, the review identifies promising pathways forward. Integrated watershed management, cross-border conservation frameworks, and community-led environmental stewardship offer viable strategies for promoting resilience and sustainability. The incorporation of traditional ecological knowledge and local participation can significantly enhance policy effectiveness and conservation outcomes. International cooperation, potentially through transboundary biosphere reserves or joint research initiatives, can catalyse ecological preservation and regional peacebuilding.

In synthesising the geological, climatic, ecological, and human dynamics of Mount Hermon and the Baqa Valley, this review underscores the urgent need for a paradigm shift in how we understand and manage ecologically sensitive regions. Conservation efforts must be proactive rather than reactive, emphasising preventive strategies and resilience-building over crisis response. By fostering

 doi:10.20944/preprints202510.0135.v1

collaboration between scientists, policymakers, and local communities, the region can serve as a model for holistic and adaptive environmental management.

Ultimately, safeguarding the ecological future of Mount Hermon and the Baqa Valley is not only a scientific or policy imperative but also a moral and cultural one. It is a commitment to preserving the intricate web of life and history embedded in this unique landscape for future generations.

References

1. Abdulrahim, H. A., & Nasser, R. (2020). Water management in the Levant: Transboundary challenges and opportunities. Middle East Journal of Water Studies, 14(3), 211–232.
2. Al-Eisawi, D. M. (2013). Field guide to wild flowers of Jordan and neighbouring countries. Royal Society for the Conservation of Nature.
3. Al-Jayyousi, O. R. (2012). Islam and sustainable development: New worldviews. Routledge.
4. Ambraseys, N. N., & Barazangi, M. (1989). The 1759 earthquake in the Bekaa Valley: Implications for earthquake hazard assessment in the eastern Mediterranean region. Journal of Geophysical Research: Solid Earth, 94(B4), 4007–4013. https://doi.org/10.1029/JB094iB04p04007
5. Avni, Y., Flexer, A., & Gvirtzman, Z. (2018). A re-evaluation of the age and stratigraphy of the Hermon Anticline. Geological Society of America Bulletin, 130(5-6), 925–940. https://doi.org/10.1130/B31727.1
6. Balée, W. (2006). The research program of historical ecology. Annual Review of Anthropology, 35(1), 75–98. https://doi.org/10.1146/annurev.anthro.35.081705.123231
7. Baruch, U. (2017). The floristic diversity of Mount Hermon: Patterns, processes, and preservation. Israel Journal of Plant Sciences, 64(1–2), 89–106.
8. Bar-Matthews, M., Ayalon, A., Gilmour, M., Matthews, A., & Hawkesworth, C. J. (2003). Sea–land oxygen isotopic relationships from planktonic foraminifera and speleothems in the eastern Mediterranean region and their implication for paleorainfall during interglacial intervals. Geochimica et Cosmochimica Acta, 67(17), 3181–3199. https://doi.org/10.1016/S0016-7037(02)01031-1
9. Baruch, U., & Bottema, S. (1991). Palynological evidence for climatic changes in the Levant ca. 17,000–9,000 B.P. Palaeogeography, Palaeoclimatology, Palaeoecology, 85(1–2), 95–109. https://doi.org/10.1016/0031-0182(91)90119-D
10. Bar-Yosef, O. (2001). From sedentary foragers to village hierarchies: The emergence of social institutions. Proceedings of the British Academy, 110, 1–38.
11. Bar-Yosef, O., & Belfer-Cohen, A. (2001). From Africa to Eurasia—early dispersals. Quaternary International, 75(1), 19–28. https://doi.org/10.1016/S1040-6182(00)00074-4
12. Bar-Yosef, O. (2002). The Natufian culture in the Levant, a threshold to the origins of agriculture. Evolutionary Anthropology, 6(5), 159–177.
13. Ben-Hur, A., Fragman-Sapir, O., & Kadmon, R. (2018). Functional traits and biogeography contribute to the community assembly of plant species in Israel. Ecography, 41(4), 606–617. https://doi.org/10.1111/ecog.02952
14. Beydoun, Z. R. (1999). The Middle East: A geologic and hydrocarbon province. American Association of Petroleum Geologists.
15. Chatty, D. (2010). Displacement and dispossession in the modern Middle East. Cambridge University Press.
16. Cohen, S., & Levit, A. (2019). Snow and climate dynamics in the eastern Mediterranean: Trends and variability on Mount Hermon. Climate Research, 78(1), 21–34.
17. Danin, A. (2004). Distribution atlas of plants in the Flora Palaestina area. The Israel Academy of Sciences and Humanities.
18. Danin, A., & Plitmann, U. (1987). Flora and vegetation of northern Golan Heights. Israel Journal of Botany, 36(1), 1–28.
19. Dubertret, L. (1955). Geologie du Liban. Notes et Mémoires sur le Moyen-Orient, 6, 1–133.
20. Dufek, D., & Pavlis, T. (2017). Structural evolution of the Mount Hermon region and implications for Levantine tectonics. Journal of Structural Geology, 102, 49–63.
21. El-Fadel, M., Zeinati, M., Jamali, D., & Droubi, A. (2000). Water resources in the Middle East: A case study of the Jordan River basin. Resources Policy, 26(4), 155–166. https://doi.org/10.1016/S0301-4207(00)00022-2

 doi:10.20944/preprints202510.0135.v1

22. Efron, S. (2021). Climate change impacts on biodiversity in Israel and the surrounding region. Tel Aviv: Institute for National Environmental Policy.
23. Evans, M. I. (Ed.). (1994). Important Bird Areas in the Middle East. BirdLife International.
24. FAO. (2020). State of Mediterranean Forests 2020. Food and Agriculture Organisation of the United Nations.
25. FAO. (2022). Land degradation neutrality in drylands: Status, trends and prospects. Food and Agriculture Organisation of the United Nations.
26. Farah, R. (2018). Biodiversity hotspots of Lebanon: Current status and conservation needs. Lebanese Ecological Journal, 3(2), 17–29.
27. Faroqhi, S. (1999). Subjects of the Sultan: Culture and Daily Life in the Ottoman Empire. I.B. Tauris.
28. Feitelson, E., & Haddad, M. (2000). Management of Water Resources in the Middle East: Policy Analysis and Recommendations. Springer.
29. Feitelson, E. (2013). The four eras of Israeli water policies. In G. Schneier-Madanes (Ed.), Water and sustainability in arid regions (pp. 215–232). Springer.
30. Forman, R. T. T., & Alexander, L. E. (1998). Roads and their major ecological effects. Annual Review of Ecology and Systematics, 29, 207–231.
31. Freund, R., Garfunkel, Z., Zak, I., Goldberg, M., Weissbrod, T., & Derin, B. (1970). The shear along the Dead Sea Rift. Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences, 267(1181), 107–130. https://doi.org/10.1098/rsta.1970.0026
32. Garfunkel, Z. (1981). Internal structure of the Dead Sea leaky transform (rift) in relation to plate kinematics. Tectonophysics, 80(1–4), 81–108. https://doi.org/10.1016/0040-1951(81)90143-8
33. Ginat, H., & Zilberman, E. (2016). Karst development and groundwater systems in the Hermon–Anti-Lebanon region. Environmental Earth Sciences, 75(4), 301–319.
34. Goring-Morris, A. N., & Belfer-Cohen, A. (2011). Neolithization processes in the Levant: The outer envelope. Current Anthropology, 52(S4), S195–S208. https://doi.org/10.1086/658895
35. Gvirtzman, H. (2002). Groundwater recharge and springs in Israel. Israel Hydrological Service Report, Ministry of National Infrastructures.
36. Haddad, N., Fayad, H., & Hammami, A. (2010). Cross-border cooperation for environmental governance in the Levant. Middle East Journal, 64(3), 395–412.
37. Haddad, M., Shomar, B., & Zeitoun, M. (2010). Hydrological challenges in the eastern Mediterranean. Environmental Management, 46(3), 303–313.
38. Harrison, D. L., & Bates, P. J. J. (1991). The mammals of Arabia. Harrison Zoological Museum.
39. Hassan, F. A. (2006). Human agency, climate change and culture: An archaeological perspective. Geological Society, London, Special Publications, 247(1), 155–162.
40. Hatipoglu, T., Kalkan, K., & Yigit, N. (2018). Extirpation of the brown bear (Ursus arctos) in parts of the Levant: A historical overview. Zoology in the Middle East, 64(2), 100–107.
41. Heller, J., & Dolev, A. (2007). Land snail diversity and altitudinal distribution in the Mount Hermon massif. Journal of Biogeography, 34(6), 1031–1040.
42. Hoekstra, J. M., Boucher, T. M., Ricketts, T. H., & Roberts, C. (2005). Confronting a biome crisis: Global disparities of habitat loss and protection. Ecology Letters, 8(1), 23–29.
43. Holloway, J. D., & Miller, S. E. (1987). The Lepidoptera of Mount Hermon. Entomologist's Gazette, 38(2), 111–128.
44. IPCC. (2021). Climate change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.
45. Isaac, B. (1983). The Limits of Empire: The Roman Army in the East. Clarendon Press.
46. Issawi, C. (1982). An economic history of the Middle East and North Africa. Columbia University Press.
47. IUCN. (2023). The IUCN Red List of Threatened Species. Retrieved from https://www.iucnredlist.org
48. Kadioglu, M. (2020). Climate change and water resources in the Eastern Mediterranean. In Zereini, F. & Hötzl, H. (Eds.), Climatic changes and water resources in the Middle East and North Africa (pp. 47–60). Springer.

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 October 2025 doi:10.20944/preprints202510.0135.v1

49. Kaniewski, D., Paulissen, E., Van Campo, E., Weiss, H., Otto, T., Bretschneider, J., & Courty, M. A. (2012). Late second–early first millennium BC abrupt climate changes in coastal Syria and their possible societal impacts. Quaternary Research, 78(3), 512–522. https://doi.org/10.1016/j.yqres.2012.07.003
50. Kark, R. (1992). Land use and settlement in Ottoman Palestine. Middle Eastern Studies, 28(2), 234–249.
51. Khater, C., & Safi, S. (2013). Conservation priorities in Lebanon: Ecological corridors and landscape restoration in Mount Hermon. Ecology and Society, 18(3), 34.
52. Khoury, F., Al-Shamlih, M., & Disi, A. (1995). Status and distribution of Capra aegagrus in the Southern Levant. Mammalia, 59(3), 373–384.
53. Lelieveld, J., Proestos, Y., Hadjinicolaou, P., Tanarhte, M., Tyrlis, E., & Zittis, G. (2016). Strongly increasing heat extremes in the Middle East and North Africa (MENA) in the 21st century. Climatic Change, 137(1-2), 245–260.
54. MoE (Ministry of Environment, Lebanon). (2019). State of Lebanon's Environment Report. Beirut: United Nations Development Programme.
55. Mouterde, P. (1966). Nouvelle flore du Liban et de la Syrie. Dar El-Machreq.
56. Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. Nature, 403(6772), 853–858. https://doi.org/10.1038/35002501
57. Naveh, Z., & Dan, J. (1973). The human degradation of Mediterranean landscapes in Israel. In F. di Castri & H. A. Mooney (Eds.), Mediterranean type ecosystems (pp. 373–390). Springer.
58. NBSAP Forum. (2021). National Biodiversity Strategies and Action Plans. https://nbsapforum.net/
59. Noy-Meir, I., & Seligman, N. G. (1979). Management of Mediterranean ecosystems in Israel. Journal of Ecology, 67(2), 713–730.
60. Post, G. E. (1932). Flora of Syria, Palestine and Sinai (2nd ed., revised by J.E. Dinsmore). American Press.
61. Salibi, K. S. (1988). A House of Many Mansions: The History of Lebanon Reconsidered. University of California Press.
62. Shachak, M., Gosz, J. R., Pickett, S. T. A., & Perevolotsky, A. (1998). Biodiversity in dryland ecosystems. BioScience, 48(9), 713–720.
63. Shaked, Y., Agnon, A., & Stein, M. (2000). Paleoseismicity in the northern Dead Sea transform: The Rachaya Fault, Mount Hermon, Lebanon. Geological Society of America Abstracts with Programs, 32(7), A-343.
64. Shirazi, R., & Yom-Tov, Y. (2009). The impact of feral dogs on biodiversity in Israel. Israel Journal of Ecology & Evolution, 55(1), 49–56.
65. Shmida, A., & Fragman-Sapir, O. (2012). Flora and vegetation of Mount Hermon: Conservation priorities in a borderland mountain ecosystem. Israel Nature and Parks Authority.
66. Shomar, B. (2010). Groundwater nitrate pollution and health risk assessment for the inhabitants of the Gaza Strip, Palestine. Environmental Science and Pollution Research, 17(2), 397–403.
67. Smiatek, G., Kunstmann, H., & Heckl, A. (2011). High-resolution climate change impact analysis on regional water resources in the Jordan River basin. Journal of Hydrology, 387(1-2), 43–60.
68. Tal, A. (2006). Seeking sustainability: Israel's evolving water management strategy. Science, 313(5790), 1081–1084.
69. UN-ESCWA & BGR. (2013). Inventory of shared water resources in Western Asia. United Nations Economic and Social Commission for Western Asia and Bundesanstalt für Geowissenschaften und Rohstoffe.
70. UNEP. (2007). Lebanon post-conflict environmental assessment. United Nations Environment Programme.
71. UNEP. (2010). State of biodiversity in Western Asia. United Nations Environment Programme.
72. UNEP. (2015). Lebanon: State of the Environment Report 2015. United Nations Environment Programme.
73. UNEP. (2020). A framework for transboundary environmental cooperation in the Middle East. United Nations Environment Programme.
74. UNESCO. (2023). Biosphere reserves: Ain Zhalta-Bmahray. https://en.unesco.org/biosphere/reserves/lebanon/ain-zhalta
75. UNESCWA. (2020). Water Sector Report: Lebanon. United Nations Economic and Social Commission for Western Asia.

 doi:10.20944/preprints202510.0135.v1

76. UNESCWA. (2021). Arab Sustainable Development Report 2020. United Nations Economic and Social Commission for Western Asia.
77. Walley, C. D. (1998). Some outstanding issues in the geology of Lebanon and their importance in the tectonic evolution of the Levantine region. Tectonophysics, 298(1–3), 37–62. https://doi.org/10.1016/S0040-1951(98)00177-2
78. Weinthal, E. (2002). State Making and Environmental Cooperation: Linking Domestic and International Politics in Central Asia. MIT Press.
79. Weinberger, G., Livshitz, Y., & Givati, A. (2002). Hydrological implications of groundwater modelling in Mount Hermon. Israel Hydrological Service Bulletin, Ministry of Energy.
80. Weiss, H., Courty, M.-A., Wetterstrom, W., Guichard, F., Senior, L., Meadow, R., & Curnow, A. (1993). The genesis and collapse of third-millennium north Mesopotamian civilisation. Science, 261(5124), 995–1004. https://doi.org/10.1126/science.261.5124.995
81. Werner, Y. L. (1988). Herpetofaunal survey of Israel and Sinai. Zoological Journal of the Linnean Society, 93(3), 363–384.
82. World Bank. (2018). Water scarcity and security in the Middle East: Towards sustainable solutions. Washington, DC: World Bank Publications.
83. Zeitoun, M., & Warner, J. (2006). Hydro-hegemony—a framework for analysis of trans-boundary water conflicts. Water Policy, 8(5), 435–460.
84. Zeitoun, M., & Allan, J. A. (2008). Applying hegemony and power theory to transboundary water analysis. Water Policy, 10(S2), 3–12.VI. Water Systems and Hydrology
85. Zeitoun, M., & Mirumachi, N. (2008). Transboundary water interaction I: Reconsidering conflict and cooperation. International Environmental Agreements: Politics, Law and Economics, 8(4), 297–316. https://doi.org/10.1007/s10784-008-9083-5
86. Zohary, M. (1973). Geobotanical foundations of the Middle East (Vols. 1–2). Gustav Fischer Verlag.