

THE INTERACTION BETWEEN CLIMATE CHANGE, BIODIVERSITY LOSS AND HUMAN MOBILITY IN IRAQ



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This publication was made possible through the support of the Government of Canada. The opinions expressed herein are those of the author and do not necessarily reflect the views of the Government of Canada.

Publisher: UN Iraq (Diwan),

International Zone,

Baghdad/Iraq

Email: iomiraq@iom.int

Website: <https://iraq.iom.int>

This publication was issued without formal editing by IOM.

This publication was issued without IOM Publications Unit (PUB) approval for adherence to IOM's brand and style standards.

Required citation: International Organization for Migration (IOM) (2026). The Interaction between Climate Change, Biodiversity Loss and Human Mobility in Iraq. IOM, Baghdad.

Cover photo: Caption. © International Organization for Migration, 2024 / Anjam Rasool

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FOREWORD

The Kurdistan Region of Iraq is witnessing a concerning decline in biodiversity driven by vegetation loss, water scarcity, and climate change. Forest areas in the region have declined by approximately 66% between 1948 and 2015, while major rivers experienced significant reductions in water flow during 2024–2025. This environmental degradation extends beyond ecosystem impacts, directly influencing population movements by accelerating rural displacement, undermining livelihood security, and increasing pressure on urban centres. The interlinkage between biodiversity loss and human mobility in the Kurdistan Region therefore represents not only an environmental concern, but also a developmental and socio-economic challenge with long-term stability implications.

Heval Ahmed Mohammed
Director of Climate Change Directorate
Environmental Protection and Improvement Board (EPIB)- KRG



The findings indicate the increasingly complex relationship between biodiversity loss, climate change, and climate-induced migration in Iraq. Environmental degradation is no longer merely an environmental issue; it has become a structural factor that exacerbates socio-economic vulnerability and affects livelihoods, particularly in rural communities that rely heavily on natural resources. The analysis shows that ecosystem degradation weakens economic stability and increases the likelihood of displacement, while biodiversity-rich areas can contribute to strengthening community resilience. Addressing these challenges requires integrated approaches, including nature-based solutions, improved environmental governance, and enhanced community participation. In this context, Alaghshan Foundation for Agricultural and Environmental Development contributes to supporting sustainable practices, protecting ecosystems, and promoting long-term environmental sustainability.

Associate Professor Dr. Khalid Naji Asal
Faculty of Agriculture
Chairman of the Board,
Alaghshan Foundation for Agricultural and Environmental Development
www.alaghshan.org



Climate-induced migration is no longer a distant risk—it is already shaping realities across Iraq. As of November 2025, IOM data indicates that over 186,000 individuals have been displaced due to climate and environmental factors.

This report builds on the International Union for Conservation of Nature's Planet on the Move initiative to explore the critical nexus between climate change and human mobility in Iraq. Understanding this relationship is essential—not only to mitigate displacement, but to support ecosystem-based adaptation, strengthen climate resilience, and promote nature-based solutions.

IOM is committed to supporting its national partners in aligning mobility governance with ecosystem-based adaptation and nature-based solutions. Through integrated approaches, Iraq has the opportunity to strengthen local economies, communities and the ecosystems upon which they depend, transforming vulnerability into resilience.

Pascal Andre A. Reyntjens
IOM Iraq Chief of Mission



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ACRONYMS

CBD	Convention on Biological Diversity
COP	Conference of the Parties
DTM	Displacement Tracking Matrix
EbA	Ecosystem-based Adaptation
ESA	European Space Agency
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
GEE	Google Earth Engine
GBIF	Global Biodiversity Information Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GIS	Geographic Information Systems
IDMC	Internal Displacement Monitoring Centre
IDP	Internally Displaced Person
IOM	International Organization for Migration
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
KII	Key Informant Interview
KRG	Kurdistan Regional Government
MoEnv	Ministry of Environment (Iraq)
MoLSA	Ministry of Labour and Social Affairs (Iraq)
MoMD	Ministry of Migration and Displacement (Iraq)
MoWR	Ministry of Water Resources (Iraq)
NASA	National Aeronautics and Space Administration
NbS	Nature-based Solutions
NBSAP	National Biodiversity Strategy and Action Plan
NDC	Nationally Determined Contribution
NDVI	Normalized Difference Vegetation Index
SDG	Sustainable Development Goal
SPEI	Standardized Precipitation Evapotranspiration Index
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP-WCMC	UNEP World Conservation Monitoring Centre
UNESCWA	United Nations Economic and Social Commission for Western Asia
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
VCI	Vegetation Condition Index
WaPOR	Water Productivity through Open-access Remotely-sensed derived data
WFP	World Food Programme
WorldClim	Global Climate Data platform
CMIP6	Coupled Model Intercomparison Project Phase 6

EXECUTIVE SUMMARY

Iraq is facing an accelerating convergence of climate change, biodiversity loss, and human mobility, each compounding the others to create heightened vulnerability across ecosystems and communities. Prolonged droughts, land degradation, and water scarcity have increasingly undermined rural livelihoods, especially in the southern and central governorates. Simultaneously, displacement, labour migration, and disruptions to traditional pastoral systems are reshaping demographic patterns and placing additional stress on fragile ecosystems.

This study investigates the bidirectional relationship between biodiversity loss and human mobility. It explores how environmental degradation, including deforestation, desertification, and collapse of ecosystem services, contributes to population movement, and how, in turn, different forms of human mobility, whether forced, planned, or seasonal - can exacerbate biodiversity pressures. The research is anchored in the principles of ecosystem-based adaptation and seeks to inform nature-based, inclusive, and conflict-sensitive strategies for adaptation and resilience.

The methodology combines remote sensing and geospatial analysis, a review of international and national frameworks (e.g., CBD, UNFCCC, NBSAPs, NDCs), and a series of Key Informant Interviews with environmental experts, government officials, and civil society actors. Findings reveal clear spatial correlations between biodiversity-rich areas and longer-term settlement by internally displaced persons, while ecologically degraded zones tend to be associated with shorter stays or onward movement. Areas such as Qara Dagħ, Gara Mountain, and the Halgurd-Sakran Reserve illustrate how ecosystem services, such as water, forage, and shelter, can function as pull factors, while ecological collapse, conflict, and land-use disputes act as push factors.

The mapping analysis and overlays further highlight the tension zones where ecological stress and human movement converge, pointing to critical sites for intervention. The KIs reinforce these insights, providing qualitative evidence of localized knowledge systems, governance gaps, and community coping strategies.

Based on this integrated analysis, the report offers recommendations across four domains: (i) Policy: mainstreaming biodiversity–mobility linkages in national strategies; (ii) Programming: developing biodiversity-sensitive livelihoods and expanding mobility tracking tools; (iii) Technical: investing in RS-GIS monitoring and decision-support systems; and (iv) Community-based Action: revitalizing traditional ecological knowledge and empowering local conservation actors.

Addressing the interlinked challenges of biodiversity loss and human mobility in Iraq requires integrated, cross-sectoral responses that leverage both scientific tools and community experience and wisdom. This report serves as a foundation for future programming and policy action in line with the Kunming-Montreal Global Biodiversity Framework, the Paris Agreement, and Iraq's national development and environmental priorities.

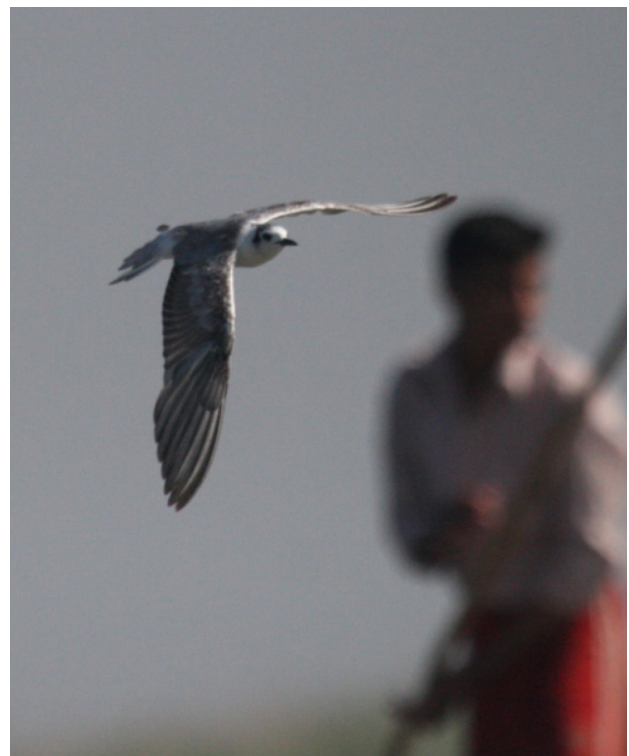


Photo 1: White-winged Tern (*Chlidonias leucopterus*) and a boatsman, Central Marshes, KBA IQ075 Credit Dr. Korsh Ararat

1. INTRODUCTION

Iraq is experiencing the compounded impacts of climate change, biodiversity loss, and human mobility at an accelerating pace. Prolonged droughts, rising temperatures, water scarcity, land degradation, and habitat fragmentation have critically weakened ecosystems and undermined rural livelihoods (IPCC, 2022; FAO, 2021). These environmental pressures, exacerbated by pollution, unsustainable land use, and conflict legacies, as well as weak governance and legal structures, are contributing to various forms of human mobility, including both international and internal displacement, labour migration, and the disruption of traditional transhumance patterns.

At the same time, mobility, particularly displacement, economic migration, trapped populations, when unmanaged or protracted, can intensify pressure on fragile ecosystems, compounding biodiversity loss through land conversion, resource overuse, and altered land management practices. Despite growing recognition of these interlinkages, Iraq lacks integrated data, spatial analysis, and cross-sectoral coordination to address them effectively. This research responds to this critical gap by providing evidence and actionable insights at the intersection of climate change, biodiversity, and mobility, aligned with national priorities and global agendas such as the Kunming-Montreal Global Biodiversity Framework (KMGBF) and the Paris Agreement (CBD, 2022; UNFCCC, 2015).

The objective of this study is to examine the bidirectional relationship between biodiversity loss and human mobility in Iraq within the broader context of climate stress. Specifically, it aims to: (i) assess the state of biodiversity across key ecosystems; (ii) identify areas and populations most affected by climate-induced displacement; (iii) map the institutional landscape for biodiversity and migration governance; and (iv) generate recommendations that promote nature-based, inclusive, and conflict-sensitive approaches to resilience and adaptation.

While the scope of the study is national, it places emphasis on subnational case studies where biodiversity degradation and climate-related mobility pressures converge, including in both southern marshland zones and the northern mountainous

regions of the Kurdistan Region, to account for the different geographical, socio-economic contexts, with varied natural resources, bio-climatic conditions, demographics, local and regional politics, various ethnic groups and religious affiliations. The research explores how environmental degradation, such as ecosystem fragmentation, species decline, or the collapse of ecosystem services, can drive displacement, and how, in turn, human mobility affects biodiversity through land use change, pressure on ecosystems, or loss of traditional conservation practices. The study also identifies institutional and governance gaps that hinder integrated responses across the biodiversity, climate, and migration sectors.

This study seeks to explore the complex and currently underexamined linkages between biodiversity and human mobility, with a focus on identifying ecological push and pull factors that influence displacement dynamics in Iraq. Drawing on comprehensive datasets, including information on internally displaced persons (IDPs), returnees, and climate-induced displacement, the analysis aims to determine whether patterns of movement correspond with variations in ecosystem health and biodiversity richness. Key research questions include: Do biodiversity-rich areas attract and retain displaced populations for longer durations, suggesting that intact ecosystems may contribute to sustainable livelihoods or provide climate-buffering functions? Conversely, do biodiversity-poor or ecologically degraded areas correspond with shorter stays or higher rates of onward movement, indicating insufficient conditions for long-term resettlement? The study also examines whether displaced populations tend to relocate from low-biodiversity zones to areas with greater ecological integrity. And finally, does the loss of biodiversity act as a driver for human mobility?

By uncovering these spatial relationships, the research informs more integrated and ecosystem-sensitive responses to climate change, displacement, and environmental degradation.

2. METHODOLOGY

This study adopted a four-pillar methodology designed to integrate evidence-based analysis with stakeholder insight and spatial intelligence.

The first pillar involves a comprehensive desk review and thematic synthesis, including analysis of international frameworks (CBD, UNFCCC), national policies (NBSAPs, NDCs), and regional strategies. It also includes a deep dive into IOM's Displacement Tracking Matrix (DTM) climate datasets, alongside geospatial mapping of displacement flows. Biodiversity trends are assessed using global indicators such as the IUCN Red List, GBIF records, and UNEP-WCMC data, complemented by Earth Observation tools (e.g., ESA Sentinel, NASA Landsat). Comparative insights are drawn from analogous regional contexts, such as Syrian Arab Republic, Islamic Republic of Iran, to contextualize Iraq's situation within broader environmental and mobility dynamics.

The second and third pillars centred on stakeholder mapping and ten key informant interviews (KIs). Stakeholder mapping captures institutional, civil society, academic, and international actors involved in climate action, biodiversity governance, migration, and peacebuilding in Iraq. A 2x2 influence-interest matrix is used to identify coordination gaps and areas of synergy. KIs targeted government officials, environmentalists and scientists, and community representatives representing national and subnational agencies and local NGOs and research institutions. The interviews were guided by a thematic framework covering biodiversity loss, community perceptions of environmental stress, displacement drivers, and gender-sensitive experiences. The fourth pillar involved spatial and temporal overlay analysis, using GIS to integrate biodiversity hotspots with climate displacement data. This produced visual outputs, such as vulnerability maps and priority intervention zones, to guide practical, ecosystem-based adaptation strategies and inform anticipatory planning for areas where conservation and human mobility may interact or conflict.

Geospatial and remote sensing analysis informed the identification of high-risk areas where climate-induced displacement and biodiversity degradation intersect. The study produced spatial overlays, vulnerability maps, and trend visualizations to guide targeted policy responses. Key outputs included maps highlighting priority intervention zones, areas of ecological degradation, and potential tension points between conservation and mobility.

KEY INFORMANT INTERVIEWS AND LINES OF ENQUIRY

The Key Informant Interviews (KII) were conducted in person, by phone, or virtually, depending on the informants' location and availability. Each interview followed a semi-structured, conversational format, lasting approximately 60 minutes, and was conducted in Arabic, Kurdish, or English according to participant preference. Prior to each interview, participants provided verbal consent, and the purpose and confidentiality of the discussion were clearly explained. In total, ten KIIs were carried out across the southern, central, and Kurdistan regions of Iraq, ensuring wide geographic and institutional coverage. The respondents represented government ministries and offices (including the Iraqi Prime Minister's Office and the Kurdistan Regional Government's Board of Environmental Protection and Improvement), universities and research centres (such as the University of Soran), national and international NGOs (including Nature Iraq and the Berghof Organization), UN agencies (notably UNDP), and local community representatives (activists and villagers). These participants occupied positions such as senior officials, researchers, technical experts, and local leaders, all directly engaged in biodiversity conservation, climate change adaptation, and ecosystem management.



Photo 2: Man walking across a dry marsh landscape, Central Marshes, Credit: Anjam Rasool

Lines of Enquiry

- **Drivers & Livelihood Impacts:** Identify the perceptions about the main drivers of biodiversity loss (dams, deforestation, pollution, overuse of water) and describe how these affect local livelihoods.
- **Perceptions of Environmental Change:** Explore community perceptions of climate and ecological change.
- **Biodiversity Loss - Mobility Interlinkages:** Investigate how environmental degradation influences migration/displacement.
- **Conservation & Conflict Risks:** Query any conflicts related to conservation or resource use.
- **Gender-Disaggregated Impacts:** Ask how environmental changes affect women and men differently.

GIS MAPPING

Spatial and temporal overlay analysis was employed to integrate climate-induced displacement data with biodiversity hotspots using Geographic Information Systems.

The DTM's Climate Displacement Tracking tool developed by IOM Iraq systematically collects data on climate-related mobility through a combination of key informant interviews, location-based assessments, and multi-sectoral vulnerability analysis. The methodology involves quarterly surveying thousands of locations across Iraq to detect movements specifically attributed to environmental stressors, such as drought, water scarcity, extreme heat, and land degradation. Data is collected from local authorities, community leaders, and humanitarian actors and triangulated with other IOM data sources to ensure accuracy. Displacement events are then classified based on whether they are sudden or slow-onset and whether climate

change is a primary or contributing factor. The tool also integrates geographic information to map the spatial distribution of climate-induced displacement and highlight emerging hotspots of environmental vulnerability. This evidence base supports early warning, targeted assistance, and climate-resilient planning at both national and subnational levels.

This approach enabled the development of layered visual outputs to identify: (a) priority areas for biodiversity restoration that are under threat from current or projected human mobility trends, and (b) potential zones of tension or competition between conservation efforts and displaced populations. By combining spatial and temporal datasets, the analysis highlighted dynamic risk convergence areas where ecological degradation and mobility pressures intersect. These overlays directly informed practical, location-specific recommendations, such as the feasibility of ecosystem-based adaptation (EbA), nature-based livelihoods, or managed relocation strategies that are ecologically sound and socially inclusive. This spatial dimension aimed to support evidence-based decision-making and the strategic targeting of interventions across Iraq's most ecologically and socially vulnerable regions.

Geospatial and remote sensing analysis informed:

- The identification of high-risk areas where climate-induced displacement and biodiversity degradation intersect.
- The study produced spatial overlays, vulnerability maps, and trend visualizations to guide targeted policy responses.

Key outputs included maps highlighting priority intervention zones, areas of ecological collapse, and potential tension points between conservation and human mobility.

MAP TYPE	KEY QUESTIONS ADDRESSED	TYPE OF SPATIAL & OVERLAY ANALYSIS EMPLOYED	EXPECTED INSIGHT
1	<i>Where do IDPs and returnees concentrate in relation to biodiversity hotspots?</i>	- Overlay of IDP/returnee location data with KBA, NDVI, land cover, and protected areas.	Identifies whether biodiversity-rich areas act as pull factors, supporting longer-term displacement or return.
	<i>Do people stay longer in areas with high ecosystem productivity?</i>	- Temporal layer showing duration of stay (DTM rounds or return intentions).	
2	<i>Which biodiversity-poor areas show high out-migration?</i>	- Overlay of outflow IDP data with areas of low vegetation cover, soil degradation, and historical droughts (CHIRPS/SPEI).	Helps detect push factors linked to environmental degradation or collapse of natural resources.
	<i>Are people leaving degraded or ecologically stressed areas?</i>	- Ecosystem degradation index over time.	
3	<i>What is the direction and pattern of movement between poor and rich biodiversity areas?</i>	- Flow maps of IDP movements (from DTM) overlaid on biodiversity integrity metrics (NDVI change, land use quality, ecosystem extent).	Visualizes mobility gradients between degraded and intact ecosystems. Indicates biodiversity as a resilience anchor.
	<i>Are people moving from ecologically degraded zones to better-functioning ecosystems?</i>	- Migration corridors visualized.	
4	<i>Are there tensions between conservation priorities and displaced populations?</i>	- Overlay of IDP settlements with protected areas, KBAs, and Ramsar sites.	Highlights potential conflict zones between conservation and humanitarian needs; informs land-use planning.
	<i>Where are protected areas affected by high displacement?</i>	- Proximity analysis around biodiversity-sensitive areas.	
5	<i>How do displacement hotspots align with areas targeted for biodiversity restoration or EbA?</i>	- GIS overlays of priority restoration zones (from MoEnv, NBSAP) with IDP inflow or returnee data.	Identifies opportunities for integrated programming: using restoration/EbA to stabilize return and reduce vulnerability.
		- Suitability mapping for EbA interventions.	

Research Limitations

Despite the report's practical and robust methodology and the multidisciplinary lens, several limitations have shaped the scope and depth of the findings.

1. Data Availability and Quality: Access to high-resolution, localized biodiversity and climate data

in Iraq remains limited. Many national datasets are fragmented across institutions and are not publicly accessible, particularly those managed by the Iraqi Meteorological Organization or sub-national ministries. Biodiversity monitoring data, such as species abundance, ecosystem health indicators,

or land degradation metrics, are outdated or non-systematically collected. While global datasets (e.g., MODIS, Sentinel, GBIF) have filled some gaps, they lack the granularity and local validation needed to inform policy at the governorate or community level. Similarly, displacement data from IOM's DTM, while extensive, often lacks ecological variables, which limits direct correlation with environmental drivers.

2. Spatial and Temporal Constraints: The spatial overlays developed in this report are based on available satellite imagery and composite indices, which are useful for identifying broad trends but may mask micro-level dynamics such as localized land use conflicts or seasonal migration routes. The temporal resolution of data, particularly for vegetation health and displacement flows, also presents a challenge, as many relevant changes occur over short timeframes or fluctuate seasonally. This affects the ability to establish definitive causal relationships between biodiversity loss and mobility patterns, especially in rapidly changing areas like Qara Dagħ or Halgurd-Sakran.

3. Desk-based research modality: In line with the scope of this study, the methodology was designed as a desk-based exercise without field visits or on-site ground-truthing. Remote sensing and secondary data sources offered valuable insights into ecosystem conditions and mobility patterns but naturally provided only a partial picture. On-the-ground dynamics, such as community perspectives, localized land-use practices, and real-time biodiversity pressures, remain beyond the reach of this phase. This is particularly important in ecologically sensitive and socio-politically complex areas such as Gara Mountain and other Key Biodiversity Areas (KBAs), where displacement, resource use, and ecosystem resilience are deeply intertwined. Framing this study as a foundational step, the findings highlight strong opportunities for future field missions that can enrich and triangulate the desk-based evidence with lived experiences, strengthening both analytical depth and programmatic relevance.

4. Stakeholder Representation and KII Gaps: While the study includes a stakeholder mapping and KIIs, certain groups remain underrepresented, including nomadic herders, rural women, and displaced persons themselves. This limits the social depth of the analysis, particularly regarding the gendered impacts of biodiversity degradation or the cultural dimensions of mobility decisions. Future studies would benefit from a more inclusive and participatory approach, especially in pastoralist regions where traditional ecological knowledge is high.

5. Conceptual Complexity of Nexus Analysis: The climate–biodiversity–mobility nexus remains a nascent and complex field. Disentangling the directionality of influence, e.g., whether mobility causes biodiversity loss or vice versa, is analytically challenging due to overlapping drivers such as conflict, economic instability, and governance weaknesses. While the study attempts to isolate environmental variables, the multi-causal nature of displacement makes attribution difficult without long-term, multi-disciplinary data.



Photo 3: Kurdistan Newt (*Neurergus derjugini*), Halgurd Mountain KBA IQ017 Credit Dr. Korsh Ararat

3. CLIMATE – BIODIVERSITY – HUMAN MOBILITY NEXUS IN IRAQ

Iraq is among the most climate-vulnerable countries globally, facing increasingly frequent and intense droughts, rising temperatures (over 2°C above pre-industrial levels in some areas), water scarcity, salinization, and desertification are contributing to the degradation of ecosystems and the destabilization of rural livelihoods. These stressors are especially, currently, acute in the Mesopotamian Marshes, the Tigris-Euphrates basin, and the southern governorates of Thi-Qar, Missan, and Al Najaf - regions that simultaneously host critical biodiversity zones and are hotspots of climate-induced human mobility. Conversely, we see increased incidences of massive natural, forest fires and floods in the north of the country due to changing rainfall patterns, land use management and lack of reactive, responsive measures.

Years of conflict, unregulated development, weak governance, and climate stress have driven a severe deterioration of Iraq's natural resource base. With state priorities long absorbed by instability and recovery from conflict, environmental regulation and sustainable resource management have often been sidelined. As a result, desertification now affects 39% of Iraq's land and threatens 54%, according to UNEP. Water availability has fallen by more than 50% in the past two decades, shaped both by upstream damming and climate-induced variability. Agricultural land degradation, groundwater depletion, and widespread pollution, particularly in oil-producing regions, have further compounded ecological fragility.

At the same time, Iraq's biodiversity came under severe threat. The Mesopotamian Marshes, recognized as a UNESCO World Heritage Site since 2016, have been reduced to a fraction of their historical size due to upstream water diversions and prolonged droughts. Endemic species such as the Basra reed warbler and Euphrates softshell turtle face extinction. Land degradation, pollution (especially oil, heavy metals, and agrochemical runoff), and habitat fragmentation have led to loss of species richness, collapse of traditional agroecological systems, and a decline in ecosystem services vital for food security and livelihoods.

The draining of the Mesopotamian Marshes under Saddam Hussein's regime represents a stark historical example of how political decisions and

man-made interventions can devastate ecosystems, displace communities, and erase cultural heritage. Entire marshland populations were uprooted, and biodiversity collapsed as habitats shrank and wetlands turned to wasteland. While partial restoration efforts since 2003 have revived some ecological functions and reestablished parts of the cultural landscape, today's marshes face renewed stress. Reduced surface water, climate variability, and upstream diversions are producing dynamics reminiscent of past human-induced degradation.

Climate Mobility nexus wise, as a result, Climate Change has now become a structural driver of displacement in Iraq. According to IOM's Climate Vulnerability Assessment: Iraq (2025), climate-induced mobility has been recorded across 473 studied locations of displacement in 12 governorates of Iraq, and the majority of these were linked to water scarcity, failing crops, and livelihood collapse in agriculture-dependent communities. These patterns are often layered upon existing vulnerabilities, including conflict legacies, socio-economic marginalization, and gender inequality.

What we are evidencing now is a bidirectional interaction between biodiversity and human mobility. On one hand, biodiversity loss (e.g., degraded wetlands or deforested catchments) undermines the resilience of rural livelihoods, contributing to displacement. On the other, large-scale displacement may exert pressure on host ecosystems and biodiversity (e.g., overgrazing, deforestation near IDP settlements). Additionally, conflict-sensitive conservation measures, or actions designed to achieve their objectives while minimizing harm, preventing escalation of tensions, and reinforcing peace and social cohesion, if poorly designed, can restrict access to resources or provoke land-use tensions.

Understanding these interlinkages is critical for integrated policy responses. Iraq's National Biodiversity Strategy and Action Plan (NBSAP), its updated Nationally Determined Contribution 3.0 (NDC) and National Adaption Plan (NAP) under the Paris Agreement both recognize the need for synergistic approaches that link climate adaptation, biodiversity conservation, and human development. Yet operational data and integrated assessments remain scarce.

3.1. CLIMATE CHANGE IMPACTS IN IRAQ

Iraq is facing a convergence of rising temperatures, intensifying droughts, and increasing water scarcity that threatens livelihoods, ecosystems, and long-term stability. Situated in the heart of the Middle East, Iraq is already experiencing climate impacts that are more severe and more rapid than global averages. These changes are compounding long-standing governance, conflict, and infrastructure challenges, with far-reaching implications for natural resources, rural economies, and displacement trends.

Current and Projected Climate Trends

Over the past four decades, Iraq has witnessed a significant increase in average annual temperatures, with observed warming of $+0.7^{\circ}\text{C}$ per decade in some regions, well above global trends. Projections under high-emission scenarios suggest that average temperatures could rise by $2\text{--}3^{\circ}\text{C}$ by mid-century, particularly in southern and central Iraq, which already experience some of the highest baseline temperatures in the world ([World Bank CCDR, 2022](#)).

At the same time, annual precipitation is projected to decline by up to 13% by 2050, with increasingly erratic rainfall patterns and a reduction in the number of rainy days, especially during the winter season, which is critical for rain-fed agriculture ([Climate Risk Profile – Iraq, 2022](#)). The combination of rising temperatures and declining precipitation is expected to increase evapotranspiration rates, reduce soil moisture, and accelerate desertification processes across large parts of Iraq.

These climatic shifts are also driving more frequent and intense extreme weather events, including heatwaves and dust storms. According to UNEP, Iraq is experiencing a surge in sand and dust storm (SDS) frequency, attributed to land degradation, vegetation loss, and prolonged droughts. While there is variability in projections, the trend points toward a substantial increase in the number of SDS days per year, with severe implications for public health, visibility, and agriculture ([UNEP, 2023](#)).

Key Regional Vulnerabilities

The impacts of climate change vary across Iraq's ecological zones, with each region exhibiting distinct vulnerabilities:

- Southern Iraq (Basrah, Maysan, Thi Qar) is the epicentre of wetland degradation and salinization. The Mesopotamian Marshes, once the largest wetland ecosystem in the Middle East, are increasingly des-

iccated due to upstream water diversion, reduced rainfall, and high evaporation. Livelihoods based on fishing, reed harvesting, crop production and water buffalo herding are under existential threat (UNESCO, 2025; FAO, 2023; IOM, 2022).

- Central Iraq (Anbar, Babil, Wasit) faces desertification, declining groundwater, and agricultural collapse. Rain-fed agriculture is no longer viable in many areas, leading to sharp declines in rural employment and increased out-migration. The degradation of agricultural lands is also contributing to food insecurity and land-use conflicts (UNEP, 2016; World Bank, 2022; IOM, 2025).
- Northern Iraq and the Kurdistan Region (Erbil, Sulaymaniyah, Dohuk), while relatively greener, are not immune. Shifting precipitation patterns are increasing the risk of flash floods, wildfires, and forest dieback. Overgrazing and deforestation, combined with changing climate conditions, threaten ecosystem integrity in the region's oak woodlands and mountain pastures (Republic of Iraq, 2015; Weathering Risk / UN, 2022; UNDP Iraq, 2025).

These regional impacts are further exacerbated by transboundary water issues, particularly with upstream countries such as Turkey and Iran, whilst not having clear water sharing agreements, have also constructed dams that regulate water flow into Iraq's key rivers.

Impacts on Natural Resources and Livelihoods

Climate change is severely straining Iraq's natural resource base, especially its water networks and agricultural capacity. Per capita water availability is falling below the international threshold for absolute water scarcity ($1,000\text{ m}^3/\text{year}$), with projections indicating further declines as river flows dwindle and demand increases ([Gol First National Communication, 2016](#)). This water stress is already limiting irrigation potential and threatening food production.

In agriculture, the primary source of income for millions of rural Iraqis, climate impacts are visible through lower yields, soil degradation, and pest outbreaks. Crops such as wheat and barley are underperforming due to insufficient rainfall and higher temperatures, while traditional herding systems are collapsing under reduced pasture availability. According to [FAO \(2017\) assessments](#), climate-related shocks are a leading driver of rural displacement, as households lose access to productive land and resources.

Biodiversity and ecosystems are also deteriorating under the combined pressure of climate change and human activity. The drying of wetlands, deforestation, and increased fire frequency are diminishing habitats for endemic and migratory species. This loss of ecosystem services, such as water purification, erosion control, and climate buffering, further undermines the resilience of both communities and landscapes.

3.2. STATUS OF BIODIVERSITY IN IRAQ

Iraq is home to a rich mosaic of ecosystems, spanning the Zagros forest-steppe in the north, the Mesopotamian marshes and floodplains in the central region, and the arid deserts of the south. Among these, the Mesopotamian Marshes hold particular global significance as one of the world's most important inland wetland systems and a designated UNESCO World Heritage site since 2016. These ecosystems not only support unique biodiversity, including endemic and migratory species, but also sustain traditional livelihoods and cultural heritage, particularly in rural and indigenous communities.

Iraq lies along the East African–Eurasian Flyway for migratory birds, making it a vital stopover and wintering ground for millions of waterbirds, raptors, and passerines moving between Africa, Europe, and Asia. The country hosts 70 Important Bird Areas (IBAs) and 82 Key Biodiversity Areas (KBAs), many of which safeguard critical habitats for globally threatened bird species. This highlights Iraq's pivotal role in maintaining avian diversity at a regional and international scale.

However, Iraq's biodiversity is under mounting pressure from a combination of natural and anthropogenic drivers. Water scarcity, prolonged droughts, and upstream damming have drastically altered hydrological systems, while deforestation, overgrazing, pollution, and conflict have accelerated land degradation. The drainage of marshlands, both historically and more recently, has severely damaged wetland habitats, and the advance of

desertification poses an existential threat to already fragile ecosystems. Additional stressors include oil extraction, overfishing, and unregulated development, which continue to erode ecological integrity.

In response, Iraq's National Biodiversity Strategy and Action Plan (NBSAP) and complementary frameworks emphasize key conservation priorities. These include the restoration of marshlands, protection of wetlands and forests, expansion of protected areas, pollution control, and the conservation of endangered and endemic species. Various initiatives are underway, such as the National Strategy for Protection of the Environment, rehabilitation of the southern marshes, and Kurdistan Regional Government-led conservation efforts. Notable recent developments include the establishment of a national seed and gene bank in Sulaymaniyah, and ongoing KBAs mapping by Nature Iraq (2010) in collaboration with the IUCN, marking important steps toward integrated biodiversity management.



Photo 4: Western White Stork (*Ciconia ciconia*) Bahrka KBA IQ020, credit Dr. Korsh Ararat

3.3. HUMAN MOBILITY IN THE CONTEXT OF CLIMATE AND ECOSYSTEM CHANGE

Human mobility in Iraq is increasingly shaped by environmental degradation and climate variability, with evidence emerging of how slow-onset hazards such as drought, water scarcity, and land degradation are driving displacement, altering migration patterns, and creating new vulnerabilities. These mobility dynamics interact closely with ecological changes, particularly in the south and central regions of Iraq where livelihoods are highly dependent on fragile natural resource systems.

Types and Patterns of Climate-Induced Mobility

The most visible form of climate-related movement is internal displacement triggered by environmental stressors. The IOM has documented over 20,000 individuals displaced due to water scarcity, high salinity, and drought-like conditions across 10 governorates (IOM, 2021: [Migration, Environment and Climate Change in Iraq](#)). More recent data from the DTM confirms that drought and declining water availability remain key predictors of displacement in origin areas, particularly in the south and centre, where, as of September 2025, 31,001 families (186,006 individuals) remain displaced across 12 governorates in central and southern Iraq due to climatic and environmental factors (IOM DTM, 2025: [Climate Vulnerability Assessment](#)).

Labour migration is also gaining prominence as a coping strategy, especially among rural households affected by declining agricultural yields and resource degradation. While comprehensive national data is lacking, qualitative research in Salah al-Din indicates that young adults are increasingly migrating to urban areas for seasonal or informal employment when local farming or herding becomes nonviable (People in Need, 2023: GESI Climate-Migration Study). Contrary to rural to urban migration is significant of rural-to-rural displacement (DTM), whereby rural communities rent land in resource available locations to support their livelihood practices.

There is also growing attention to “trapped populations”, households who lack the financial, social, or physical capacity to move away from degraded or water-scarce environments. These groups are often found in remote rural areas, marshlands, or post-conflict zones. While planned relocation remains rare in Iraq, some policy efforts are beginning to explore it as a last-resort option in areas experiencing irreversible ecosystem collapse. The Norwegian Refugee Council (NRC) has initiated dialogue around climate-induced displacement and relocation in Ninewa, noting a gap in legal frameworks, policy and institutional capacity to respond or absorb displacement caseloads (NRC, 2022: [Policy Guidelines on Climate-Induced Displacement](#)).

Geographic Trends and Hotspots

Geographic patterns of displacement are currently strongly concentrated in southern Iraq, where immediate climate-related push factors are most severe. Governorates such as Al Qadisiyah, Basrah, Thi Qar, and Maysan have experienced recurring waves of displacement as a result of reduced freshwater inflows, salinity intrusion, marshland drying, and deteriorating agricultural livelihoods (IDMC/NRC, 2020: [When Canals Run Dry](#)). Field data show that in many areas, displacement becomes prolonged or permanent as return is no longer viable due to degraded water systems or salinized soil.

Central governorates such as Wasit, Babil, and parts of Anbar have also shown signs of climate-induced mobility. While less affected by marshland collapse, these regions experience prolonged droughts and groundwater depletion, affecting rain-fed agriculture and livestock systems. IOM’s 2025 Climate Vulnerability Assessment notes hotspots in districts such as Al-Hay and Al-Diwaniyah, where environmental pressures coincide with socioeconomic vulnerability (IOM DTM, 2025).

In contrast, the northern region and Kurdistan Region of Iraq, including Erbil, Dohuk, and Sulaymaniyah, is currently less exposed to displacement from climate impacts, though early warning signs are present. Studies point to disruptions in pastoralist routes, forest degradation, and changing precipitation patterns that are placing increasing stress on agro-ecological systems (People in Need, 2023). Earlier assessments, such as the 2009 and 2014 UNESCO report on drought, already warned that prolonged dry spells were triggering rural-to-urban migration and displacement from upland agricultural zones in the north, illustrating that such trends have deeper historical roots (UNESCO, 2009, 2014).

Vulnerabilities and Community Coping Strategies

Vulnerability to climate-induced displacement is highly uneven. Rural farming and herding communities, especially in marshland areas, are most exposed due to direct reliance on natural resources and limited access to infrastructure or adaptation support. Women, the elderly, and people with disabilities are disproportionately affected, often lacking the autonomy or resources to migrate even when environmental conditions worsen (People in Need, 2023).

Coping strategies vary by region and livelihood group, but common mechanisms include seasonal labour migration, reliance on remittances, diversification of income sources, and reductions in consumption or livestock holdings. Many communities adopt a “wait-and-see” approach, migrating only when multiple stressors

converge, such as prolonged drought coupled with loss of income or food security (IOM DTM, 2025). In the 2023 CVA for Iraq, the IOM (2023) found that sending a household member to another location for work emerged as one of the top coping strategies in response to environmental and livelihood stress.

Despite these strategies, the adaptive capacity of communities is declining as climate shocks become more frequent and prolonged. This increases the risk of protracted displacement, social marginalization, and in some cases, secondary displacement when destination areas are unable to absorb incoming populations.

3.4. STAKEHOLDER LANDSCAPE

The identification of key actors involved in the climate – biodiversity – mobility nexus in Iraq reveals a wide and diverse stakeholder landscape. These include national ministries, such as the Ministries of Environment, Water Resources, Agriculture, and Planning – as well as the Kurdistan Regional Government’s Environmental Protection Board and relevant line ministries. Academic institutions and universities play a critical role in data generation and technical analysis, while UN agencies, NGOs, community-based organizations, and private sector actors contribute to implementation, advocacy, and innovation on the ground. This broad actor base reflects the intersectoral nature of environmental governance and the need for multi-level coordination.

To structure engagement, each stakeholder will be placed within a power – interest matrix, categorizing them as: key players (high influence, high interest), context setters (high influence, low interest), subjects (low influence, high interest), or bystanders (low influence, low interest). This classification enables a strategic approach to stakeholder collaboration, ensuring that high-impact actors are

prioritized while marginalized but invested groups are not overlooked. Influence and interest ratings were determined through a combination of desk research and insights gathered during KIs, allowing for nuanced understanding of roles, mandates, and institutional dynamics.

Based on this mapping, the stakeholder engagement strategy was tailored accordingly. Strong collaboration will be fostered with key players to ensure policy alignment and resource mobilization. Subjects, often local actors with deep contextual knowledge, will be empowered and included in planning processes. Engagement with context setters will aim to build interest and align strategic priorities, while bystanders may be monitored for emerging relevance. This structured approach will support inclusive, effective, and adaptive engagement across the research and implementation phases.

The climate–biodiversity–mobility nexus in Iraq involves a diverse array of stakeholders, spanning national and regional government bodies, international organizations, UN agencies, civil society groups, academic institutions, and local communities. These actors engage in various aspects of policy development, implementation, research, and community-level response across the fields of climate change adaptation, biodiversity conservation, human mobility management, and peacebuilding.

The landscape is characterized by overlapping mandates, sectoral fragmentation, and limited coordination mechanisms, particularly between environmental and humanitarian sectors. Some actors hold significant policy influence but limited operational reach, while others are deeply embedded at the community level yet lack institutional power. Mapping these dynamics is essential for identifying leverage points for collaboration, entry points for inclusive programming, and gaps where mandates or capacities are missing.

	High Interest	Low Interest
High Influence	<u>Key Players</u> – Ministry of Environment – Ministry of Planning – KRG Environmental Protection Board – UN IOM – UNDP – FAO – UNEP – Donor agencies (EU, GIZ, SDC)	<u>Context Setters</u> – Ministry of Oil – Ministry of Finance
Low Influence	<u>Subjects</u> – Local CSOs (e.g., Nature Iraq, Waterkeepers Iraq) – Displaced communities – Academic institutions – Tribal leaders / local councils	<u>Bystanders</u> – Some private sector actors – Media outlets – Agricultural cooperatives (unlinked to environmental programming)

4. DATA ECOSYSTEM

The current data ecosystem relevant to climate-induced mobility, biodiversity loss, and environmental degradation in Iraq is fragmented, yet evolving. While notable efforts have been made by national institutions, UN agencies, and civil society to monitor ecological and displacement trends, data remains siloed across sectors. For instance, biodiversity data, such as species distribution or ecosystem health, is primarily held by academic institutions and NGOs like Nature Iraq, while climate datasets are sourced from international platforms (e.g., NASA, CHIRPS, ESA) and limited national meteorological records. Mobility data, particularly linked to environmental drivers, is consolidated under IOM's Climate Displacement Tracking Tool. However, interoperability between these datasets is limited, and geospatial integration remains underutilized.

The lack of a centralized or harmonized national platform for environment-mobility data constrains evidence-based policymaking. Key indicators such as land degradation, salinization, or habitat loss are not routinely linked to socio-economic vulnerability or displacement trends. Furthermore, biodiversity data is often outdated, lacking systematic monitoring at the governorate or ecosystem level. Displacement datasets, while rich, seldom capture the nuanced environmental push factors or track the longer-term ecological impacts of population movements. This disconnection hinders anticipatory action and the design of nature-based solutions that align with both conservation and human resilience objectives.

Despite these gaps, there are promising entry points for strengthening the data ecosystem. Iraq's National Biodiversity Strategy and Action Plan (NBSAP) and its updated Nationally Determined Contributions (NDCs) under the Paris Agreement provide a foundation for cross-sectoral data integration. IOM's leadership in climate mobility tracking, combined with tools like GIS overlays and Earth Observation technologies, offers significant potential to visualize risk convergence zones and inform targeted interventions. Enhancing coordination between the Ministry of Environment, Ministry of Migration and Displacement, academic institutions, and UN agencies will be essential to institutionalize integrated data practices. Ultimately, a robust and interoperable data ecosystem will be key to shaping effective, equitable, and ecologically grounded policy responses.

The data ecosystem on climate change in Iraq is evolving but remains fragmented across institutions and sources. Most comprehensive datasets are hosted by

international platforms global and national datasets to assess biodiversity and climate-related risks. Key remote sensing sources include NASA's MODIS and Landsat archives, which offer time-series data on vegetation indices, land surface temperature, and drought indicators critical for tracking ecological change. ESA's Sentinel-1 and Sentinel-2 provide high-resolution imagery suitable for monitoring land cover dynamics and the status of water bodies in ecologically sensitive areas. For climate variables, datasets such as CHIRPS and ERA5-Land offer reliable precipitation and climate reanalysis data, while CMIP6 and WorldClim provide climate projection models that support forward-looking risk assessments. At the national level, data from the Iraqi Meteorological Organization, including rainfall and temperature observations, can enhance localized accuracy, although access remains limited and data availability is often constrained by institutional or technical barriers.

On the mobility side, the most consistent source is IOM's Displacement Tracking Matrix (DTM), which provides detailed displacement records at governorate and district level. IOM has also piloted a Climate Displacement Tracking Tool, which offers a basis for linking mobility to environmental drivers, though integration with ecological datasets remains limited. Additional displacement data (though employing different methodologies for monitoring human mobility) is available from the Ministry of Migration and Displacement (MoMD), while UNHCR and OCHA maintain complementary humanitarian mobility statistics.

Despite the richness of these datasets, they are rarely interoperable. Climate data is typically analysed separately from mobility datasets, and mobility records seldom capture the environmental push factors (such as drought severity or salinity spread) that drive displacement. This limits Iraq's ability to anticipate climate-induced mobility trends or link them to ecosystem degradation.

Through the proposed study, GIS overlays and remote sensing analysis will be applied to integrate climate indicators (e.g., drought, precipitation anomalies, temperature rise) with mobility hotspots from IOM DTM and MoMD data. This integration will identify high-risk convergence zones where environmental degradation, biodiversity loss, and human displacement intersect. These products will not only fill current data gaps but also provide policy-ready evidence to inform ecosystem-based adaptation and managed relocation strategies.

4.1. BIODIVERSITY DATA

Understanding the state of biodiversity in Iraq is essential to assessing its role in shaping human mobility patterns and resilience to climate change. Given Iraq's diverse ecoregions, from the Mesopotamian Marshes to the

Zagros Mountains - reliable and up-to-date biodiversity data is critical for identifying ecosystem degradation trends and potential ecological pull or push factors that influence displacement, migration, and return dynamics.

DATA	SOURCE	LINK
Species occurrence (esp. endemic/threatened)	GBIF, IUCN	GBIF, IUCN Red List
Biodiversity hotspots & KBAs	BirdLife, Nature Iraq, IUCN	Key Biodiversity Areas Iraq
Ecosystem health / degradation status	UNEP-WCMC, remote sensing	UNEP-WCMC
Impacts of oil pollution/ agriculture on biodiversity	Peer-reviewed & national reports	e.g., Korsh Ararat et al. Ecological Informatics 2021
Protected areas / conservation zones	MoEnv Iraq, IUCN, local NGOs	IUCN CEESP
Invasive species data (if available)	Academic studies	Google Scholar or MoEnv reports



Photo 5: Eastern Imperial Eagle, (Aquila heliaca) Barzan Area & Gali Balinda KBA IQ004 credit Dr Korsh Arat

4.2. CLIMATE CHANGE DATA

The climate data ecosystem for Iraq draws on both international platforms and limited national sources. While international datasets provide long-term, spatially consistent records of temperature, precipitation, and drought, national institutions (e.g., Ministry of Water

Resources, Meteorology) provide localized but less accessible datasets. For the purposes of this study, priority will be given to datasets that can be integrated geospatially with biodiversity and mobility indicators.

DATA	SOURCE	LINK
Temperature and precipitation trends (historical & future)	CMIP6, WorldClim	WorldClim, CMIP6
Soil salinity, erosion, and degradation	ESA Sentinel, MoEnv	ESA Sentinel
Dust storm frequency & trends	MODIS, Iraqi Meteorological Organization	NASA MODIS
Drought indices (SPEI, VCI)	CHIRPS, Copernicus, FAO	CHIRPS, FAO Drought Portal
Climate vulnerability maps	UNDP, IOM, GIZ	Project-specific portals / country dashboards (e.g., UNDP Iraq Climate Risk Portal)
River flow and water scarcity	Ministry of Water Resources (MoWR), UN-ESCWA	UN-ESCWA, MoWR Iraq (request based)

4.3. HUMAN MOBILITY DATA

Human mobility data in Iraq is relatively rich compared to biodiversity or climate datasets, largely due to IOM's extensive displacement tracking systems. The Displacement Tracking Matrix provides the most up-to-date information on climate-induced displacement, with geographic detail down to location level. Complementary sources include the Ministry of Migration and Displacement and the Ministry of Labour and Social Affairs, which provide records on migration

and labour mobility. Additional insights come from UN agencies such as UNHCR, FAO, and WFP, as well as global platforms like IDMC. Despite the availability of multiple sources, mobility data rarely captures the full environmental push factors driving displacement or the long-term ecological impacts of mobility. To address this, the study will combine structured datasets with new evidence from KIIs and participatory assessments.

DATA	SOURCE	LINK
Climate-induced displacement records	IOM DTM	IOM Iraq DTM, Mar 2025 Report
Labour migration trends	IOM Iraq, MoMD	IOM Reports, MoLSA Iraq
Pastoralist routes & disruptions	FAO Iraq, local field research	FAO Iraq
Trapped populations	UNHCR, IOM	UNHCR
Case studies on conservation-induced displacement	IUCN CEESP, academic publications	Planet on the Move
Historical displacement trends (pre-2018)	IDMC, IOM, WFP	IDMC Iraq
Perceptions of displacement drivers	KIIs, FGDs, participatory assessments	IOM

4.4. INFORMATION AND DATA GAPS CLIMATE CHANGE

Despite the availability of global datasets, significant climate data gaps constrain the accuracy and applicability of localized analysis in Iraq. National meteorological data, particularly rainfall and temperature records, remains limited and fragmented across institutions, with restricted public access, hindering fine-scale climate assessments. While satellite-derived data from platforms such as Sentinel and MODIS provides valuable insights into soil salinity, erosion, and dust storm frequency, these datasets are rarely validated with in-situ measurements, reducing their reliability for planning and early warning purposes. Furthermore, future climate projections from models like CMIP6 and WorldClim are available at a global scale but are not yet downscaled to the governorate level, limiting their utility for site-specific vulnerability analysis and anticipatory adaptation planning. Addressing these gaps will be critical for integrating robust climate information into biodiversity and mobility risk assessments.

Mobility and Ecosystem Data

Current data limitations significantly hinder the analysis of the nexus between human mobility and environmental change in Iraq. Environmental push factors such as drought, land degradation, and water scarcity are not consistently captured making it difficult to establish direct linkages between ecological stress and displacement patterns. Information on pastoralist mobility and its disruption due to climate pressures remains scarce and anecdotal, with little systematic tracking or spatial data. Moreover, the long-term ecological impacts of displacement, including overgrazing, firewood collection, and water stress near IDP settlements, are largely unmonitored, despite their relevance to conservation planning and conflict-sensitive land management. Additionally, data on labour migration trends and trapped populations is fragmented across institutions such as

the MoMD, MoLSA, and various humanitarian actors, with no standardized framework for integration or joint analysis. These data gaps pose challenges for developing evidence-based, integrated responses to climate, biodiversity, and mobility risks. However, as part of the international community efforts, IOM's Displacement Tracking Matrix has progressively integrated environmental indicators through its Climate Vulnerability Assessments starting in 2022, with more granular data introduced in 2023 and 2025 assessments.



Photo 6: Blue-cheeked Bee-eater (*Merops persicus*) Razzaza Lake KBA IQ058 credit Dr. Korsh Ararat

5. ANALYSIS AND FINDINGS

The research aimed to explore the multifaceted interconnections between environmental degradation, biodiversity loss, and human mobility in Iraq. It also aimed to assess how this biodiversity decline is undermining the viability of agricultural livelihoods, particularly in climate affected and ecologically fragile areas. In parallel, the study was designed to reflect on the diverse types of climate-induced human mobility observed in Iraq, including internal displacement, labour migration, pastoralism, trapped populations, and planned relocation, such as camp based populations. Finally, a central focus of the research was the bidirectional relationship between biodiversity and mobility, investigating how population movements contribute to ecosystem degradation and, conversely, how environmental loss acts as a driver of displacement.



Photo 7: A traditional mudhif (المضيف) made by the Ahwari people of the southern marshes, Hawiza KBA IQ073 credit Dr. Korsh Ararat

5.1. INTERLINKAGES BETWEEN BIODIVERSITY LOSS AND HUMAN MOBILITY

The research explores the complex and dynamic interlinkages between biodiversity loss and human mobility in the context of Iraq's changing environmental and socio-political landscape. It examines how the degradation of ecosystems, including the loss of key habitats, species decline, and disruption of ecosystem services, can act as a driver of displacement by pushing individuals and communities to leave areas where livelihoods are no longer sustainable. Conversely, it considers how different forms of human mobility, such as internal displacement, labour migration, and seasonal movements, can place additional pressure on fragile ecosystems, accelerating deforestation, overgrazing, and land degradation.

The analysis identifies feedback loops, where biodiversity loss and mobility reinforce each other, leading to compounding risks for both human and ecological systems. Through the lens of push and pull factors, the sub-chapter assesses how ecological conditions shape decisions to move or stay, and how biodiversity-rich or degraded areas influence settlement patterns. It also addresses the conflict and social tension dimensions associated with resource competition, militarized landscapes, and overlapping land claims in biodiversity hotspots, highlighting the need for integrated responses that balance conservation with human mobility management.

Whilst the relationship in the Iraqi Marshlands is relatively well recognised, including from a historical context, in the Kurdistan Region of Iraq, KBAs such as Gara Mountain and Garagu (IQ007), Halgurd-Sakran (IQ017 and IQ019), and Qara Dag (IQ039) - situated within the globally recognized Irano-Anatolian biodiversity hotspot, renowned for its exceptional species endemism and ecological diversity, exhibit complex dynamics between biodiversity richness and human mobility, influenced by resource availability and ongoing conflicts.

These rugged montane sites, featuring dense deciduous oak forests (primarily *Quercus* spp.) that provide substantial water resources through springs and streams, along with abundant food sources such as acorns, wild fruits, and forage for livestock, deliver crucial ecosystem services including provisioning of fresh water, timber, non-timber forest products, and habitat support, which fundamentally drive both pull and push factors in human movements by offering livelihoods and strategic advantages while also intensifying resource-based tensions.

These attributes serve as pull factors for various groups; for instance, Gara and Halgurd-Sakran attract Kurdish fighters from Turkey and Iran seeking strategic terrain, natural cover, and sustenance from the forests and water sources for prolonged operations, while Halgurd-Sakran draws nomadic herders during summer for its abundant pastures, and Qara Dagħ pulls internally displaced persons (IDPs) to engage in herding domesticated animals and managing farms amid its arable slopes and pistachio groves, fostering longer stays through livelihood opportunities tied to these vital ecosystem services.

Conversely, push factors arise from conflicts over land use and security threats, with Gara and surrounding areas witnessing the abandonment of over 180 villages and putting more than 600 at risk due to intensified clashes between the PKK and Turkish forces in 2024-2025, displacing civilians as access to water and food resources becomes contested or degraded; Halgurd-Sakran experiences tensions between nomads and other users over pasture access, exacerbated by wildfires, landmines, and overgrazing that degrade biodiversity, oak forests, and ecosystem services, prompting seasonal outflows; and Qara Dagħ faces pressures from oil development, illegal logging, and grazing disputes, potentially driving short-term migrations when resource scarcity intensifies and undermines the availability of water, forage, and other provisioning services.

The relationship between biodiversity loss and human mobility is increasingly recognized as a complex, bidirectional dynamic that shapes ecological integrity, human livelihoods, and displacement patterns, particularly in fragile environments affected by climate change and conflict. In Iraq, and notably in the Kurdistan Region, the interplay between ecological degradation and population movements is influenced by a mix of environmental, socio-political, and economic drivers. Understanding how biodiversity acts as both a push and pull

factor in mobility scenarios is essential to designing integrated, resilience-oriented responses that bridge humanitarian and conservation objectives.

Biodiversity Loss - Mobility nexus

Ecosystem degradation, including deforestation, overgrazing, habitat fragmentation, and water scarcity, undermines the provisioning of essential services such as food, fuel, water, and shelter. When these services collapse or diminish, affected communities often face constrained livelihood options, leading to displacement or seasonal migration in search of economic opportunity. In Qara Dagħ, for example, overexploitation of oak forests, grazing pressure, and land degradation threaten the viability of farming and herding activities. As a result, some residents and pastoralist groups are compelled to relocate in search of better conditions, either temporarily or permanently. Similarly, when biodiversity-rich areas are degraded by illegal logging or oil exploration, the resulting decline in forage and water availability may force IDPs or returnees to abandon resettlement efforts, thereby perpetuating displacement cycles.

These patterns are broadly reflected in findings from IOM's Displacement Tracking Matrix, which reports climate-induced displacement in over 1,000 locations across Iraq, particularly in southern governorates such as Thi-Qar, Missan, and Qadissiya, areas facing severe water stress, cropland degradation, and diminishing rural livelihoods (IOM DTM, 2025). The Climate Vulnerability Assessment also highlights that agriculture-dependent populations are especially vulnerable to climate shocks, supporting the linkage between ecological degradation and mobility.

Human Mobility and Biodiversity Pressures

Mobility, particularly when unplanned or unmanaged, can impose significant stress on fragile ecosystems. Internally displaced populations often settle in marginal lands or biodiversity hotspots where environmental governance is weak (IOM, 2022), leading to increased extraction of forest products, overgrazing, and pollution. In Halgurd-Sakran, for instance, seasonal in-migration of nomadic herders has intensified competition over pastures, leading to overgrazing, soil compaction, and forest degradation. Displacement-related population concentrations can also amplify pressures on water sources, fuelwood collection, and land use, especially when support services are lacking and communities depend directly on local ecosystems for survival. The compounding of mobility and ecological stress can, in turn, accelerate biodiversity loss.

Feedback Loops and Compounding Risks

The intersection of mobility and biodiversity loss often creates feedback loops that exacerbate both ecological vulnerability and displacement risks. As ecosystem services degrade due to overuse or conflict, communities may be forced to move, which in turn can lead to further degradation in the areas they move to. This is evident in Gara and surrounding areas, where conflict-driven displacement has not only depopulated biodiversity-rich villages but also left forests unmanaged, increasing the risk of wildfires, invasive species, and illegal resource extraction.

Additionally, displaced populations settling in nearby forested zones increase human pressure, creating a cycle of degradation and secondary displacement. This feedback underscores the importance of addressing both mobility and biodiversity holistically, rather than in isolation.

Push and Pull Factors in Biodiversity–Mobility Dynamics

The push factors that drive people away from certain areas include biodiversity degradation, conflict, environmental hazards, and resource scarcity. In Gara, for example, recent clashes between the PKK and Turkish forces have not only caused displacement but also disrupted access to key ecosystem services such as water and food, forcing communities to abandon traditional villages. Similarly, Halgurd-Sakran has seen biodiversity decline due to wildfires, landmines, and overgrazing, prompting seasonal outflows and limiting the viability of long-term settlement.

Conversely, biodiversity-rich areas often act as pull factors, attracting both displaced populations and groups seeking strategic advantage or livelihood opportunities. The oak forests and spring-fed water systems of Qara Dag and Halgurd-Sakran support herding, farming, and foraging, making them appealing destinations for IDPs, nomadic herders, and even armed groups. However, this attractiveness can also generate resource-based conflicts and increase the burden on local ecosystems, particularly when governance structures are weak or fragmented.

Conflict and Social Tension Dimensions

The competition over biodiversity resources often intersects with broader social, ethnic, and political tensions, particularly in regions like the Kurdistan highlands, where land tenure is contested, and the presence of non-state armed actors complicates conservation and development efforts. In Gara, for

instance, the presence of Kurdish armed factions and cross-border military operations has weaponized access to nature, turning biodiversity-rich areas into both sanctuaries and battlegrounds. This undermines not only ecological sustainability but also community security and governance legitimacy. Similarly, the return of displaced populations to high-biodiversity areas can lead to friction with nomadic herders or local landholders, especially when natural resources are already under stress.

In Iraq's southern governorates, IOM (2022) highlights that resource scarcity, especially water and arable land is intensifying local tensions, with nearly one in four surveyed households reporting disputes linked to farmland boundaries or irrigation access, further exacerbating fragility in ecologically vulnerable areas. Additionally, according to IOM (2025), environmental stress (including extreme weather events and slow onset events) - especially water scarcity and deteriorating agricultural land - was cited by a significant portion of respondents as a contributing factor to emigration decisions, as such, for South of Iraq, Thi-Qar and Missan, 100% and 60% of respondents indicated extreme weather events among the primary reasons for migration. These underscore how ecological degradation is increasingly intersecting with security and economic motives in mobility choices.

Weaponization of Nature

The weaponization of nature refers to the strategic use or targeting of natural environments, such as forests, mountains, and water bodies, in conflict settings. In northern Iraq, forested biodiversity hotspots like Gara Mountain and Qandil have become militarized zones, used by armed groups for concealment, survival, and tactical advantage. As a result, these ecosystems face deliberate destruction, including deforestation through aerial bombardment, landmine contamination, and inhibited conservation access. This militarization not only accelerates biodiversity loss but also restricts the ability of displaced communities to return, access resources, or engage in sustainable land use. The long-term impacts of such practices include ecosystem collapse, loss of endemic species, and a perpetuation of displacement rooted in environmental insecurity.

The Kunming-Montreal Global Biodiversity Framework and Human Mobility

The Kunming-Montreal Global Biodiversity Framework (KMGBF) is accompanied by a detailed monitoring

framework comprised of a set of agreed indicators for tracking progress towards the Goals and Targets of the Framework. The monitoring framework, which was adopted by The Conference of The Parties to the Convention on Biological Diversity (CBD/COP/DEC/15/5, 19 December 2022), includes headline indicators which are recommended for national, regional and global monitoring, and more detailed component and complementary indicators.

The Framework plays a critical role in enabling countries and stakeholders to track progress toward the global biodiversity targets and to identify areas where additional action is needed. Its structured set of headline, component, and complementary indicators provides a coherent basis for measuring biodiversity loss and conservation outcomes across ecosystems, sectors, and governance levels.



Photo 8: Black-winged Kite (*Elanus caeruleus*), Iraq, credit Dr Korsh Ararat

For countries like Iraq, where biodiversity degradation, climate stress, and displacement overlap, these indicators offer an evidence-based tool to analyze how environmental change affects human mobility and vice versa. By applying indicators related to ecosystem extent, species status, and sustainable use (e.g., Targets 2, 10, and 11), one can assess how climate-induced migration pressures intersect with biodiversity decline, and where ecosystem-based solutions may reduce vulnerability. The KMGBF's monitoring framework facilitates integrated, policy-relevant assessments that are essential for aligning national actions with global biodiversity and climate commitments.

5.3. A SYNTHESIS OF KEY INFORMANT INSIGHTS

Interlinkages Between Biodiversity Loss and Human Mobility

This chapter presents a detailed analysis of ten KIs conducted with environmental experts, conservationists, community representatives, and practitioners across Iraq. The interviews aimed to validate conceptual linkages between biodiversity loss and human mobility, explore localised displacement patterns in relation to ecological changes, and generate actionable insights to inform ecosystem-sensitive policy and programming. Taken together, the KIs provide critical perspectives that illuminate how biodiversity degradation both drives and is affected by human movement, within a context of climate change, resource competition, and institutional fragmentation.

Across regions, experts noted the two-way relationship between biodiversity and mobility. Ecosystem degradation, including desertification, drought, and habitat loss, was repeatedly mentioned as a push factor behind internal displacement, rural-urban migration, and the erosion of traditional livelihoods. Conversely, biodiversity-rich areas were said to attract displaced

populations, herders, and others seeking access to water, pasture, or forest resources, creating pull dynamics that place further strain on already fragile ecosystems. This bidirectional pattern has created a feedback loop, where movement exacerbates environmental degradation, which in turn contributes to new displacement risks.

Biodiversity Loss as a Driver of Displacement

Several informants from the southern governorates, including Maysan, Basrah, and Thi-Qar, observed that prolonged drought and declining biodiversity have rendered agricultural livelihoods unviable, forcing rural households to abandon farmlands. As Dr. Ibrahim Al Sudani explained:

“water scarcity and loss of vegetation have changed the logic of settlement in southern Iraq. Communities are increasingly leaving once-productive areas.”

He highlighted examples where date palm groves and fishery-dependent settlements have been left behind due to rising salinity and biodiversity collapse in marsh ecosystems.

In central Iraq, particularly in Wasit and Al-Qadisiyah, respondents noted that shifts in flora and fauna patterns have disrupted seasonal grazing and farming cycles. According to Mr. Laith Ali, degraded pasture quality and the disappearance of native plant species have directly affected the viability of agro-pastoral livelihoods. These disruptions have led to temporary or permanent outmigration, especially among young male populations.

Meanwhile, in the northern governorates, experts such as Mr. Ayub and Mr. Haval emphasized how environmental decline intersects with conflict, compounding risks to biodiversity and displacement alike. In Qara Dagħ and Halgurd-Sakran, they described how land degradation, illegal logging, and uncontrolled grazing threaten the ecological balance of forested landscapes, which in turn affect the viability of herding and farming, activities central to community stability in these areas

The Impact of Mobility on Biodiversity

Several experts raised concerns that mobility, especially when unregulated or conflict-driven, contributes to biodiversity degradation. For example, Dr. Omar Al-Sheikhly noted that in marshland regions:

“the return of populations without restoration plans can lead to overfishing, unsustainable reed harvesting, and disturbance of bird migration zones.”

He also flagged the risk of endangered species loss in protected areas lacking enforcement.

From the mountainous regions, Mr. Haval described how the erosion of traditional grazing agreements has led to overuse of rangelands.

“Previously, there were communal rules about when and where to graze. Now, with conflict and displacement, those systems are weakened or gone,”

he said, adding that this has intensified degradation in ecologically sensitive oak forests. These observations underscore how displacement disrupts local conservation practices, leading to cascading environmental impacts.

Experts also noted that areas experiencing returnee influxes or secondary displacement often face increased demand for firewood, water, and arable land. Mr. Ammar Berghof emphasized the importance of designing return programs that consider ecological carrying capacity:

“If we push people back into damaged environments without support or planning, the outcome is more degradation.”

Push and Pull Factors: Ecological Determinants of Mobility Patterns

Discussions across KIs revealed consistent patterns in how biodiversity-rich ecosystems function as pull factors for various groups. High-altitude areas with permanent water sources, such as Gara Mountain and Halgurd-Sakran, offer shade, forage, and strategic terrain, drawing in herders, displaced persons, and in some cases, non-state actors. These ecosystems act as climate buffers and livelihood zones during periods of environmental and economic stress.

As Mr. Ammar Berghof explained, people instinctively move toward:

“places where there is water, vegetation, and seasonal predictability.”

However, he cautioned that these pull dynamics are fragile:

“If pressure builds without management, even the most resilient ecosystems will begin to collapse.”

In this sense, pull factors can quickly turn into push factors if ecosystem degradation outpaces recovery or exceeds local capacity to absorb new populations.

The concept of ecological unsustainability of return also emerged. Dr. Korsh reflected on how communities in areas like Sinjar attempted to return, but soon left again due to poor vegetation cover, insecurity, and lack of basic services. “They came back, but the land was not ready for them,” he observed, highlighting how biodiversity health is a prerequisite for durable solutions to displacement.

Compounding Risks and Institutional Gaps

Most respondents identified feedback loops between climate stress, biodiversity collapse, and human movement. For example, in Qara Dagh, respondents described seasonal migration patterns in which families leave during droughts and return during wet periods, repeating the cycle without long-term recovery. Each round of movement depletes ecosystem resources further, making communities more vulnerable with each displacement episode.

Institutional and governance issues were also widely cited. According to Dr. Azzam Alwash, “biodiversity and community wellbeing are inseparable, but our institutions still treat them as separate issues.” Several informants called for more integrated planning between ministries, improved cross-sectoral data sharing, and stronger local enforcement mechanisms. The lack of environmental indicators in the national displacement monitoring tools was also flagged as a gap that hinders effective response design.

Conflict, both latent and active, was seen as a major barrier to ecosystem governance. In regions like Gara and Zakho, conservation landscapes overlap with military zones, reducing access for researchers and weakening enforcement. As Mr. Haval noted, “Even when communities want to protect the forest, they are afraid to go there.”

The KIs collectively paint a complex picture of biodiversity and mobility in Iraq, one shaped by ecological fragility, climate pressures, conflict, and institutional inertia. While there is clear recognition of the interdependence between human and environmental systems, current policy and programmatic responses remain fragmented. However, the interviews also revealed considerable local knowledge and willingness to engage in conservation, restoration, and adaptation, provided these efforts are adequately supported.

In the words of Dr. Azzam Alwash:

“Biodiversity is not just a technical issue. It’s a human issue. And any strategy that ignores this connection will fail.”

This study affirms the need for ecosystem-based, conflict-sensitive, and community-driven approaches to address Iraq’s intertwined challenges of climate change, biodiversity loss, and human mobility.

5.4. RS-GIS ANALYSIS: KEY FINDINGS AND IMPLICATIONS

Key Findings

The RS-GIS analysis reveals strong spatial correlations between patterns of biodiversity loss and human mobility in Iraq. Several notable trends emerged:

Vegetation Decline in Displacement Hotspots: Southern governorates such as Maysan, Thi-Qar, and Al-Muthanna exhibit persistent vegetation stress and drought severity, as confirmed by multi-year analysis of NDVI and VCI indicators. The RS-GIS analysis highlights that these regions have experienced prolonged environmental degradation, including extreme vegetation conditions in Al-Muthanna and critical drought phases in Maysan and Thi-Qar, particularly between 2018 and 2024. These zones also correspond with areas of significant climate-induced displacement, as identified by IOM’s Climate Vulnerability Assessments and displacement tracking, and are noted for their low IDP return rates, as referenced by the DTM’s findings from September 2025, with 31,001 families (186,006

individuals) remaining displaced. The convergence of environmental stress and mobility patterns underscores the urgent need for integrated interventions that address both ecological resilience and durable solutions for displaced populations.

Pull Factors in Biodiversity-Rich Areas: Key Biodiversity Areas (KBAs) in the Kurdistan Region of Iraq, notably Qara Dagħ, Gara Mountain, and Halgurd-Sakran, demonstrate relatively stable vegetation conditions and sustained ecological health, as observed through RS-GIS overlays of NDVI, LULC, and cropland maps. These regions consistently show denser vegetative cover compared to degraded southern zones and have not experienced the same intensity of drought or cropland encroachment. According to the spatial analysis, they retain forested landscapes, natural springs, and seasonal pastures, making them ecologically attractive for mobile pastoralists, seasonal herders, and in some cases, displaced populations. However, the influx of people into these zones, including returnees and herders, can lead to mounting pressures on biodiversity, particularly in the absence of land-use planning or grazing regulation. According to IOM's DTM Master List Round 131 (August 2025), multiple locations within the Kurdistan Region, particularly in Sulaymaniyah and Erbil governorates, host returnee and IDP populations in or near biodiversity-rich areas such as Qara Dagħ and Halgurd-Sakran. The data shows that Sulaymaniyah alone hosted over 33,000 returnee individuals and 3,000 IDPs, many residing in semi-rural areas where natural resources are more accessible. Furthermore, the DTM Climate-Induced Displacement Dataset (2025) indicates that movements towards areas like Qara Dagħ were associated with environmental push factors such as drought and soil degradation in the south (e.g., Thi-Qar and Maysan), while the ecological integrity of KRG KBAs appeared to support longer-term or seasonal settlement. The dataset highlights that regions with sustained vegetation cover and water availability (as seen in RS-GIS overlays) often correspond with lower onward movement rates, suggesting stronger pull dynamics. This reinforces the importance of managing mobility into ecologically sensitive zones through ecosystem-informed programming and community-based conservation.

Land Cover Transformation and Ecosystem Stress: Across central Iraq, land use change maps show cropland and urban expansion into natural habitats. This conversion contributes to habitat fragmentation and reduced ecological resilience, which in turn exacerbates displacement push factors.

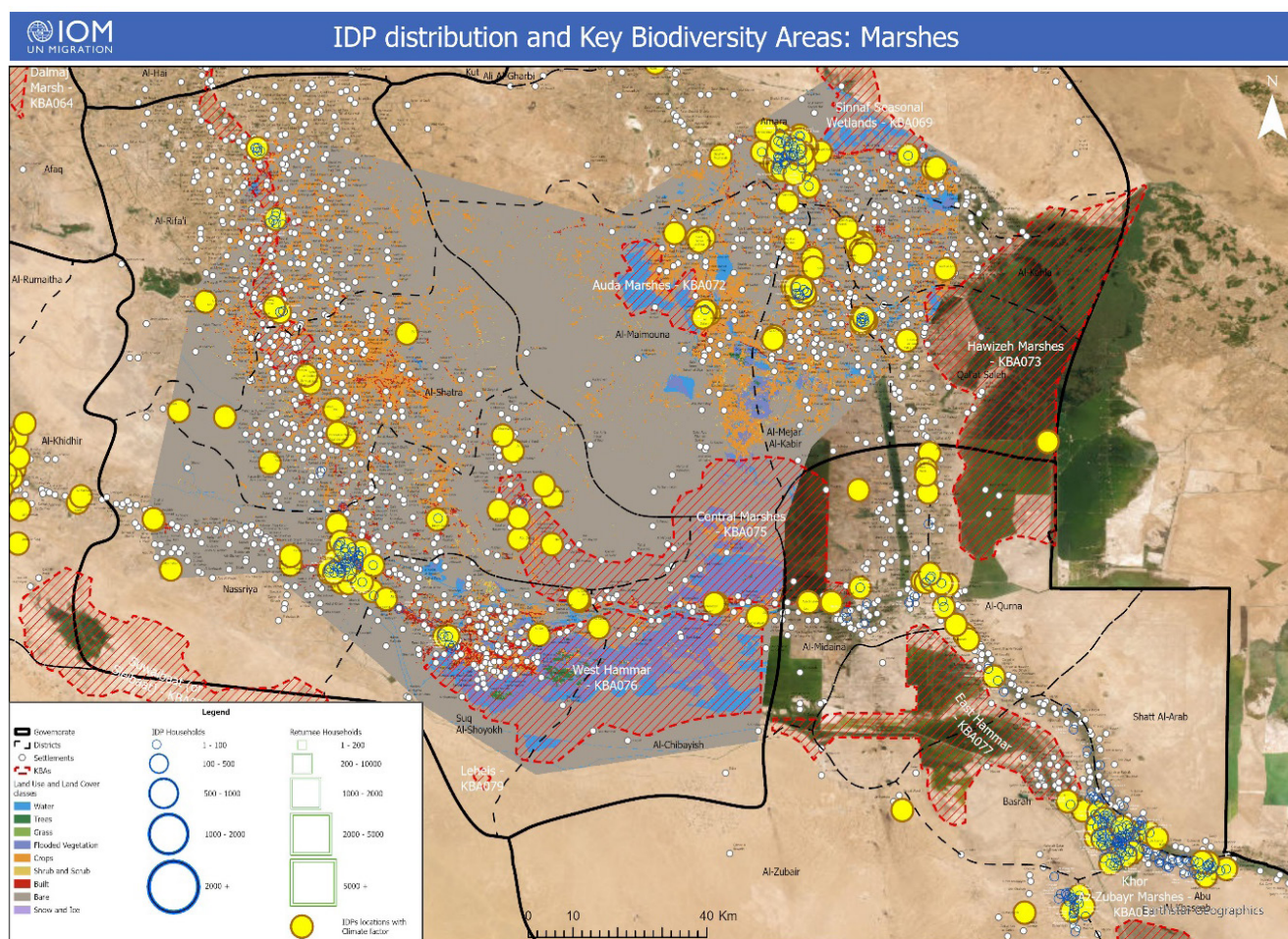
Mobility-Ecosystem Feedback Loops: Areas experiencing both ecological stress and population inflows (e.g., Sinjar, marshland peripheries, southern highlands) show signs of compounding degradation, suggesting that unmanaged return or settlement may further strain fragile ecosystems.

Spatial Inequity of Risk: While some areas suffer acute ecological decline and population outflows, other, ecologically preserved locations at higher altitudes, primarily across the Kurdistan Region of Iraq, which are under increased settlement pressure due to push factors in the south receive disproportionate inflows, creating uneven patterns of vulnerability, resource pressure, and conservation risks.



Photo 9: Aerial view of drought-affected marshes and shrinking waterways, Central Marshes, Credit: Anjam Rasool

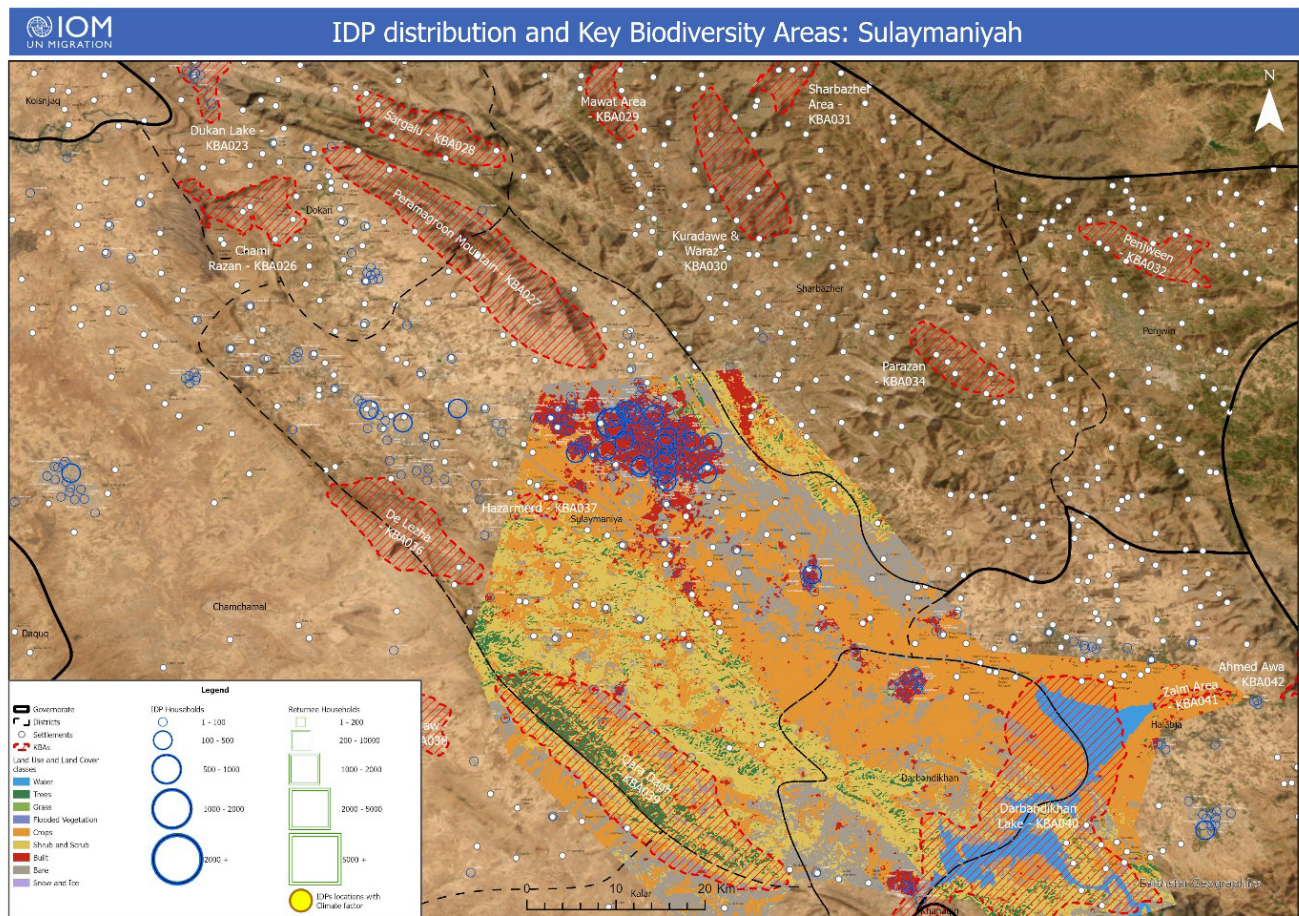
ZONE / LOCATION	GOVERNORATE	ECOLOGICAL RISK	MOBILITY PRESSURE	POTENTIAL EBA INTERVENTIONS
Chibayish and Southern Marshes	Thi-Qar	Wetland degradation, salinization, biodiversity loss	High climate-induced displacement	Wetland restoration, sustainable fishing, eco-tourism
Rumaitha and Khidhir	Al-Muthanna	Severe drought, vegetation loss, desertification	Seasonal and permanent displacement	Rangeland restoration, drought-resilient agriculture
Afaq and Diwaniyah	Al-Qadisiyah	Declining soil fertility, water stress	Persistent out-migration	Sustainable irrigation, agroforestry, community gardens
Eastern Maysan Plains	Maysan	Deforestation, agricultural collapse, dust storms	High IDP outflows and return failures	Reforestation, anti-desertification measures
Northern Wasit (Badra-Jassan)	Wasit	River degradation, wetland loss	Outflows tied to water scarcity	Riverbank rehabilitation, native species planting
Qara Dagh	Sulaymaniyah	Overgrazing, deforestation, resource competition	IDPs and herders competing over land and water	Oak reforestation, rotational grazing, sustainable forest use
Gara Vicinity	Dohuk	Forest fire risk, unmanaged ecosystems due to conflict	Conflict-displaced communities in ecological zones	Community forest management, invasive species control



Map 1: IDP Distribution and Key Biodiversity Areas – Marshes (Southern Iraq)

This map illustrates the strong spatial convergence between climate-induced displacement and Iraq's southern marshland KBAs, namely Hawizeh (KBA073), West Hammar (KBA076), and the Central Marshes (KBA075). A dense spread of IDP households, especially those linked to climate factors, can be observed in and around ecologically degraded marsh areas, where land cover has shifted predominantly to shrubland and bare zones. This pattern highlights both a push factor - due to collapsing wetland ecosystems and failed agricultural systems - and a potential pressure on residual biodiversity pockets. The Hawizeh Marshes still retain patches of

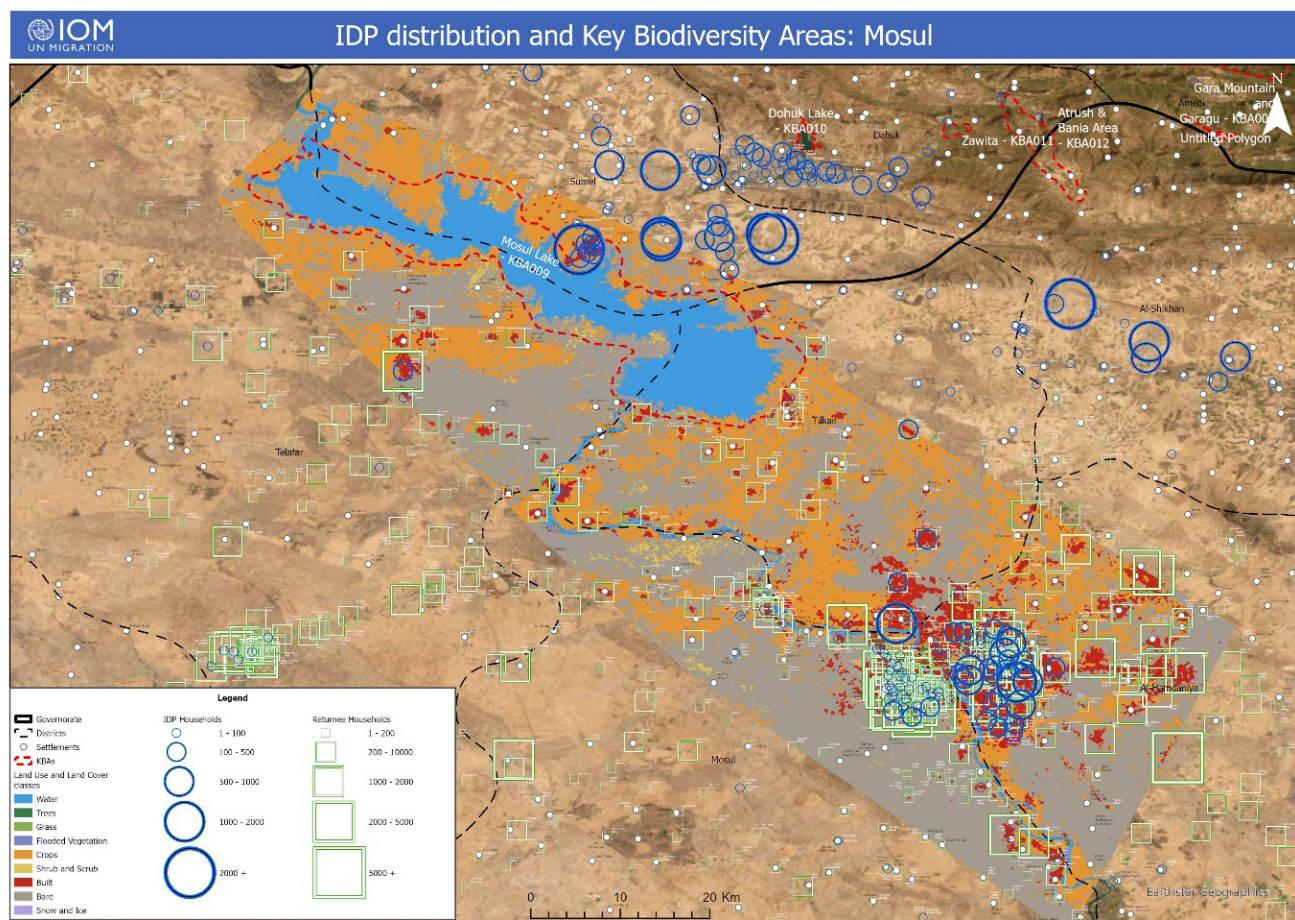
flooded vegetation and may act as a pull zone for displaced populations seeking access to water, reeds, or seasonal livelihood opportunities, but this adds strain to already-stressed ecosystems. Moreover, upstream water management and diversions are disrupting the hydrological balance, contributing to downstream marsh desiccation and likely intensifying both displacement and environmental degradation. These overlapping patterns point to a feedback loop, whereby displacement into or near KBAs both results from and contributes to wetland collapse, raising urgent questions around sustainable return planning and environmental recovery in the south.



Map 2: IDP Distribution and Key Biodiversity Areas – Mosul Region (Northwest Iraq)

The Mosul map reveals complex interactions between population movements and ecosystem integrity across the Ninewa and northern Duhok landscapes. Returnee households and IDP concentrations cluster notably around Mosul Lake (KBA099), indicating pressure on adjacent semi-natural areas and water resources. While many IDPs are located outside immediate KBA borders, they still maintain hydrological and ecological linkages. Importantly, KBAs such as Atrush and Bania (KBA011–012) and Gara Mountain (KBA006) remain largely undisturbed by large-scale settlement,

possibly due to terrain constraints, military activity, or limited accessibility. However, these intact KBAs are increasingly encircled by land conversion and human activity, which could erode buffer zones and increase indirect pressure on biodiversity. The land cover layer confirms expansion of built-up and cropland areas raising concerns of ecosystem fragmentation. This spatial dynamic highlights the risks of unplanned return into ecologically sensitive transition zones and the importance of integrating biodiversity safeguards into recovery efforts.



Map 3: IDP Distribution and Key Biodiversity Areas – Sulaymaniyah (Kurdistan Region of Iraq)

In the Sulaymaniyah region, the overlay indicates a generally lower level of displacement intensity, yet a notable spatial pattern emerges around degraded cropland and shrubland transition zones, particularly in peri-urban areas of Sulaymaniyah city. KBAs such as Hazarmerd (KBA037), Darbandikhan Lake (KBA040), and Zalm (KBA042) are still characterized by intact vegetation cover, with large swathes of forest and grassland showing relative ecological stability. IDP clusters remain primarily in buffer zones, avoiding core KBAs for now, suggesting a temporal delay or slower movement into more sensitive ecosystems. This spatial separation may reflect conservation status, difficult terrain, or stronger governance in KRI regions. However, land use patterns show gradual encroachment of agriculture and built areas along the fringes, particularly along the western

and southern margins of KBA037 and around the Darbandikhan reservoir. These edge pressures, if unmanaged, could accelerate future ecosystem fragmentation and reduce the capacity of these KBAs to serve as ecological and social stabilizers. The region offers a window of opportunity to proactively manage displacement patterns before irreversible degradation occurs. Displacement in Sulaymaniyah is heterogeneous: some Iraqi IDPs (including arrivals from southern governorates) have integrated into rural villages and small towns through agricultural and herding livelihoods, while camp-based concentrations around Arbat largely reflect Syrian refugee settlements. These are best captured and referenced using IOM datasets to clearly distinguish population groups and avoid conflating IDP and refugee patterns.

IMPLICATIONS

These findings highlight the urgent need for integrated spatial planning that accounts for both ecological and displacement dynamics:

- **Targeted Conservation and Restoration:** Biodiversity-rich areas that attract displaced populations require protection and sustainable resource management to prevent degradation and conflict over natural resources.
- **Ecosystem-Based Adaptation (EbA):** High-risk zones identified through spatial overlays (e.g., degraded agricultural zones with ongoing displacement) are candidates for EbA interventions, including rangeland restoration, reforestation, and nature-based livelihoods. The following table presents the high-risk zones that are strong candidates for Ecosystem-Based Adaptation interventions, based on spatial overlays of ecosystem degradation and displacement hotspots.
- **Informed Mobility and Resettlement Planning:** Geospatial insights can inform decisions on where to support safe, sustainable returns or managed relocation, avoiding ecologically sensitive or overburdened areas.
- **Monitoring and Early Warning Systems:** Continued use of remote sensing tools can enable early detection of stress patterns in vegetation, land use, and climate, guiding anticipatory action and adaptive programming.
- **Bridging Humanitarian–Development–Conservation Gaps:** Spatial integration of biodiversity and mobility data creates an entry point for cross-sector coordination among government, humanitarian actors, and environmental agencies.

5.5. SYNTHESIS OF KII INSIGHTS AND GIS ANALYSIS: CROSS-VALIDATING PERCEPTIONS AND EVIDENCE

This synthesis integrates the rich qualitative insights from Key Informant Interviews with the spatial evidence derived from Remote Sensing and GIS analysis. By cross-examining local perceptions with objective geospatial data, the study enhances its triangulation of findings and offers a more comprehensive understanding of how biodiversity loss and human mobility interact across different regions in Iraq.

1. BIODIVERSITY LOSS AS A DRIVER OF MOBILITY: PERCEIVED VS. OBSERVED TRENDS

Both the KII respondents and the spatial analysis consistently point to biodiversity loss and ecosystem degradation as key drivers of displacement and migration. Experts from southern Iraq, particularly Maysan, Basrah, and Thi-Qar, highlighted the collapse of fisheries, degradation of marshlands, and declining vegetation as principal reasons communities abandon their villages. These narratives are confirmed by the VCI-based drought maps and NDVI trend analysis, which indicate a severe decline in vegetation health over the last 5–7 years in the southern governorates. Composite drought severity overlays further validate these accounts by highlighting persistent stress zones in these areas.

Moreover, RS-GIS overlays of land use change show expansion of cropland into previously natural or pastoral zones, indicating pressure on remaining natural habitats. This supports respondent claims, such as those by Dr. Ibrahim Al Sudani, that unsustainable land practices are both a symptom and a cause of biodiversity collapse, ultimately pushing communities into mobility.

The following table highlights cropland expansion areas, as observed in the RS-GIS analysis (particularly in the Land Use / Land Cover (LULC) Maps from 2014 to 2024):

GOVERNORATE / DISTRICT	OBSERVED TREND	IMPLICATION
THI-QAR	Expansion of cropland along wetland edges and former marshland zones	Encroachment on biodiversity-rich marshes; contributing to marsh degradation and reduced habitat
MAYSAN	Spread of agricultural land into rangelands and semi-natural zones	Increased fragmentation of ecosystems and overuse of marginal lands
AL-QADISIYAH	Agricultural intensification in formerly mixed-use or pasture zones	Pressure on soils, increased irrigation stress, and displacement from degraded areas
WASIT	Growth of cropland into previously fallow or naturally vegetated areas	Habitat loss and growing risk of salinization due to intensive use of irrigation
KHIDHIR AREA (AL-MUTHANNA)	Patchy cropland encroachment into dryland ecosystems	Overstretching limited water resources and reducing ecological resilience
NORTHERN SALAH AL-DIN	Agricultural development near ecologically sensitive uplands and seasonal streams	Potential degradation of transitional habitats and grazing areas

2. MOBILITY-INDUCED BIODIVERSITY PRESSURES: GROUND TRUTH AND REMOTE SENSING CORROBORATION

The KIs emphasized that population movements, particularly return migration or herder influxes, exert substantial pressure on local ecosystems. For instance, in areas like Sinjar, respondents described how returnees came back to “vegetation-less” landscapes, and in the highland KBAs (e.g., Qara Dagħ, Halgurd-Sakran), overgrazing and loss of rotational grazing customs have weakened ecological resilience. The land cover change maps and Sentinel-2 overlays confirm these pressures—showing increased degradation and fragmentation of forested landscapes in precisely these locations.

Geospatial analysis also confirms the localized impact of seasonal movements: grazing intensity patterns, when overlaid with biodiversity indicators (e.g., oak forest density), illustrate hotspots where ecological pressure coincides with known herder routes. While KIs did not quantify these pressures, their observations are corroborated by spatial evidence of degradation along mountain foothills, aligning with narratives from Kak Haval and others.

3. ECOLOGICAL PUSH AND PULL FACTORS: MAPPING WHAT THE EYE SEES

The concept of ecological pull factors emerged strongly in both the human and scientific datasets. KIs described areas with water, forage, and forest cover as destinations for displaced people or seasonal herders, highlighting the role of intact ecosystems as attractors. Notably, Gara Mountain, Halgurd-Sakran, and Qara Dagħ were mentioned repeatedly as biodiverse zones offering refuge and sustenance. GIS analysis supports this: biodiversity overlays combined with IDP movement data show that some of these KBAs, such as Qara Dagħ, Halgurd-Sakran, and Gara Mountain indeed correspond with higher IDP settlement duration and concentration. These KBAs feature higher NDVI values, stable vegetation cover, and less cropland encroachment, aligning with conditions conducive to longer-term settlement or seasonal return. Qara Dagħ emerges most strongly as a biodiversity-rich area that continues to host livelihoods linked to herding and small-scale farming, providing a relatively sustainable environment for displaced or semi-settled populations.

Conversely, push factors such as drought and biodiversity decline are evident in RS datasets showing reduced greenness and rising land surface temperatures in lowland agricultural zones. When correlated with displacement flows from IOM's DTM, the evidence suggests a positive correlation between ecological degradation and outward migration, especially in southern governorates.

Spatial overlays of displacement data and ecological indicators reveal a concerning dynamic: while biodiversity-rich areas such as Qara Dagħ, Halgurd-Sakran, and Gara Mountain serve as pull factors for displaced populations and seasonal herders, they often lack formal conservation safeguards. These overlays, combining data from the DTM, KBA boundaries, land use and land cover changes, and vegetation indices, demonstrate that human presence is increasingly overlapping with ecologically sensitive zones. In Qara Dagħ, for instance, LULC analysis between 2014 and 2024 shows expansion of cropland and settlements into previously natural or pastoral areas, suggesting unregulated land conversion likely driven by new displacement inflows. Similarly, NDVI and VCI data indicate localized vegetation stress along the edges of forested KBAs, particularly in zones adjacent to temporary settlements or grazing routes. Compounding this, many of these areas fall outside the boundaries of formal protected areas and show no overlap with ongoing conservation projects or ecological restoration efforts. The spatial analysis thus validates stakeholder concerns that unmanaged movement into fragile ecosystems, while often driven by necessity, risks accelerating biodiversity loss, reinforcing the need for integrated mobility and conservation planning.

4. CONFLICT AND COMPOUNDING RISKS: PERCEPTION VS. MAPPING

KII participants identified conflict, not only as a political factor but as a spatial disruptor of conservation and mobility patterns. For example, the militarized zones around Gara Mountain have restricted community access to water and forest resources, while also reducing the feasibility of formal conservation or data collection. GIS maps, while unable to capture conflict dynamics directly, indirectly support these claims. In areas with known security incidents (e.g., Turkish airstrikes), satellite imagery shows abandoned agricultural terraces, loss of forest canopy, and settlement retreat, all aligning with reports from KII respondents.

The concept of conflict as a spatial disruptor emerged clearly from key informant interviews, highlighting how armed violence does more than displace people, it reshapes the physical and ecological geography of entire regions. Rather than being viewed solely as a political or security issue, conflict was described by participants as a force that disrupts both human mobility patterns and ecosystem stability. Specifically, in areas like Gara Mountain, which are under frequent military activity, community access to forests, water sources, and traditional grazing routes has been curtailed. As KII respondents noted, the militarization of these landscapes makes conservation activities, sustainable land use, and data collection nearly impossible, as both civilians and field researchers are deterred from entering these zones. While the RS-GIS analysis did not directly measure armed conflict, the spatial consequences of conflict are visible. Satellite imagery and land cover maps show patterns of disruption: abandoned agriculture, reductions in canopy density, and shrinking settlement footprints in conflict-affected zones. This spatial dislocation fragments biodiversity corridors, weakens local conservation governance, and erodes the ecological integrity of otherwise high-value zones.

Furthermore, fire scars and landmine clearance zones mapped by UNEP and other partners (cited in GIS datasets) corroborate statements about invisible pressures on biodiversity and mobility not fully captured in climate or vegetation indices. This highlights the added value of human perceptions in enriching the interpretation of RS-GIS results.

5. FEEDBACK LOOPS AND PLANNING IMPLICATIONS

The integration of RS-GIS analysis with KII insights confirms the presence of feedback loops between mobility and biodiversity degradation. Displaced populations often move into fragile ecosystems, increasing extraction pressures (e.g., firewood collection, overgrazing), which in turn further degrade

these landscapes, making them less viable and triggering renewed movement. This cyclical pattern, frequently cited in interviews, is visualized in GIS outputs showing repeat degradation in resettlement zones such as parts of Thi-Qar, Nineveh, and Qara Dagħ.

Critically, while RS-GIS offers strong spatial validation of ecological drivers, it cannot independently capture human intent, conflict, or cultural land use practices, a gap filled by the KIIs. Conversely, RS-GIS provides temporal depth and macro-scale visibility that complements the localized, experience-based knowledge of the informants.

The comparative analysis affirms that local perceptions of biodiversity and displacement drivers are broadly aligned with geospatial evidence, lending credibility to both data streams. However, it also underscores the need for integrated analysis frameworks that combine RS-GIS data with human-centered qualitative insights. Together, they offer a more complete picture of the complex interactions shaping mobility and biodiversity in Iraq. Future programming should leverage this integration, prioritizing biodiversity hotspots not only for protection, but also for managed resettlement, conflict-sensitive conservation, and nature-based adaptation strategies.

5.6. RECOMMENDATIONS

Recommendations aim to ensure that human mobility and biodiversity strategies are mutually reinforcing, and that ecological integrity is preserved while supporting durable solutions for displaced populations, or mitigation environmental loss as a driver of forced displacement.

They are developed to strengthen IOM's position to lead on integrated programming at the intersection of climate, biodiversity (more generally environment), and human mobility.

POLICY-LEVEL INTERVENTIONS BY THE GOVERNMENT OF IRAQ & KURDISTAN REGIONAL GOVERNMENT

- Integrate biodiversity–mobility nexus into national strategies such as Iraq's NBSAP, National Climate Change Adaptation Plan, National Development Plan and Climate Mobility Investment Plan. This should include recognition of displacement risks linked to ecosystem degradation.
- Strengthen cross-sectoral coordination between the Ministries of Environment, Migration and Displacement, Agriculture, and Water Resources to align mobility responses with biodiversity conservation and restoration efforts.
- Establish legal safeguards for biodiversity-sensitive displacement sites, especially in and around Key Biodiversity Areas (KBAs), to prevent unsustainable settlement expansion and resource exploitation.
- Promote peacebuilding and land governance frameworks that address competing land and resource claims among IDPs, returnees, nomadic groups, and host communities in ecologically sensitive areas.
- Enhance public access to national meteorological data by consolidating datasets across institutions and removing access restrictions. Establishing an open-access climate data portal would support evidence-based policymaking, research, and early warning systems. Partnerships with international data providers can help fill temporal and spatial gaps while building national data infrastructure.

Programming Recommendations

A. Policy, Institutional, and Programmatic Recommendations (Focus: Institutional planning, capacity building, governance, and integrated programming)

- Support investment in protected areas and national parks as part of durable solutions for returnees and displaced populations, particularly in areas such as Qara Dagħ, Halgurd-Sakran, and the marshlands.
- Implement NbS and EbA in displacement-affected areas, using restoration to stabilize return, improve livelihoods, and reduce environmental stress.
- Build capacity of local and national authorities to monitor biodiversity-health indicators in displacement contexts, and to design ecologically informed relocation or return strategies.
- Support local environmental departments and protected area managers with tools and training to manage mobility pressures (e.g., grazing intensity, firewood collection) without compromising ecological integrity.
- Expand environmental indicators in displacement tracking: Both IOM and the Ministry of Migration and Displacement should enhance their methodologies to include more granular tracking of environmental push factors (e.g., pasture degradation, drought, deforestation) in coordination with other agencies.
- Support capacity development of subnational actors: Local departments, particularly in governorates affected by both mobility and ecological decline, require technical training in GIS, EbA, and nature-based recovery planning.
- Pilot ecosystem-informed relocation and return models: Where environmental degradation is irreversible, explore, as a last resort, pilot initiatives on managed relocation. These should be community-driven and based on spatial overlays of ecological collapse and displacement trends.
- Link ecological data with humanitarian assessments: Where possible, integrate biodiversity and ecosystem health indicators into multi-sectoral assessments used by humanitarian actors to better understand the full spectrum of vulnerability in return or resettlement zones.

B. SCIENCE, TECHNOLOGY

- Develop and operationalize early warning systems that incorporate environmental indicators (e.g., vegetation decline, water stress) into displacement risk forecasting.
- Expand geospatial analysis and data-sharing systems between humanitarian and environmental actors to track the impacts of mobility on ecosystems and vice versa.
- Capacitate state actors in institutionalizing GIS and remote sensing as planning tools: Continue building the use of RS-GIS platforms to track vegetation trends, land cover shifts, and ecological stress indicators. These tools should support early warning systems and inform settlement and return site selection.
- Develop and share decision-support maps: Produce visual overlays showing convergence between biodiversity loss and mobility to guide policymakers and field-level actors. These maps should be regularly updated and tailored to local planning needs.

COMMUNITY-BASED, CSO, ACADEMIA ACTION

- Empower community-based organizations (CBOs) to take part in ecological monitoring, natural resource stewardship, and conflict resolution related to biodiversity access.
- Support local environmental departments with tools, training, and monitoring capacities to manage biodiversity under mobility pressures (e.g., firewood collection, grazing).
- Promote inclusive research that documents gendered and community-specific impacts of environmental change and displacement.
- Promote community-led restoration initiatives that engage displaced and host communities in reforestation, soil conservation, and water resource management.
- Support environmental education and awareness campaigns targeting mobile populations (herders, IDPs, returnees) to foster sustainable resource use and biodiversity protection.
- Strengthen conflict-sensitive conservation by integrating risk mapping and mediation into biodiversity projects

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IOM IRAQ

iraq.iom.int

iomiraq@iom.int

UNAMI Compound (Diwan 2),
International Zone,
Baghdad/Iraq



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