

Management Plans for Soudah Waterfall

March 2024

SOUDAH WATERFALL: OUTLINE OF A SITE-SPECIFIC MANAGEMENT PLAN

Contents

SOUDAH WATERFALL: OUTLINE OF A SITE-SPECIFIC MANAGEMENT PLAN	2
Executive Summary	4
1. Description	4
1.1 Introduction	4
1.2 Land Tenure	5
1.3 Legislation	5
1.3.1 Legal Protection Measures for Biodiversity	6
1.3.2 Habitat and Ecosystem Protection	6
1.3.3 Community and Cultural Heritage	6
1.3.4 Water Quality and Protection of the Wadi	6
1.3.5 Penalizing Wildlife Poaching	6
1.3.6 Regular Review and Adaptation	6
1.4 Physical Features	7
1.5 Biological Features	8
1.5.1 Refuge for Aquatic and Terrestrial Biota	8
1.6 Threats and Challenges	9
1.6.1 Climate-sensitive Challenges	9
1.6.2 Biotic Threats	9
1.6.3 Hydrological and Water Quality Challenges	9
1.6.4 Poaching and Disturbance of Wildlife	9
1.6.5 Cooperative Adaptive Management	9
1.6.6 Research-based Conservation	9
1.7 Cultural Features	10
1.8 Impact of Climate Change	11
2. Evaluation, Formulation of Vision, and Site Objectives	13
2.1 Site Analysis	13
2.2 Site Management Policy	13
2.3 Long-term Vision for Soudah Waterfall	14
2.4 Site Management Objectives	15
3. Action Plan for Soudah Waterfall	16
3.1 Identification and Outlines of Projects:	16
3.1.1 Habitat Restoration	16
3.1.2 Management of Invasive Species	16
3.1.3 Climate Resilience	17
3.1.4 Sustainable Water Management	17
3.1.5 Community Engagement	17
3.1.6 Ecological Dynamics	17
3.1.7 Joint Conservation Efforts	18
3.1.8 Utilization of Advanced Technologies	18
3.1.9 Educational Initiatives to Raise Awareness	18
3.1.10 Adaptive Management Strategies	18
3.1.11 Regular Evaluation of Conservation Measures	18

3.1.12 International Cooperation and Support	19
3.1.13 Awareness Programmes	19
3.1.14 Community Engagement	19
3.1.15 Environmental Education Initiatives	19
3.1.16 Cultural and Recreational Engagement	19
3.2 Contingency Plan for Soudah Waterfall.....	20
3.2.1 Development of Contingency Plan and Activation of a Crisis Response Team	20
3.2.2 Monitoring Emergencies	20
3.2.3 Crisis Communication and Public Awareness	20
3.2.4 Habitat Protection Measures.....	20
3.2.5 Legal Emergency Response	21
3.2.6 Joint International Support.....	21
3.2.7 Emergency Funding for Nature Conservation	21
3.3 Funding and Resources.....	21
3.3.1 Financial Resources	22
3.3.2 Human Resources	23
3.3.3 Possible Funding Sources	23
3.4 Proposed 10-Year Implementation Roadmap of Soudah Waterfall Protected Area Management Plan	25
3.5 Evaluation and Adaptation	28
Conclusions	28
References.....	30

Executive Summary

Located in the picturesque Asir Mountains of south-west Saudi Arabia, Soudah Waterfall is an important wetland in the Soudah Cloud Forest Reserve (SCFR), a Protected Area (PA) that is an integral part of Saudi Arabia's burgeoning tourism sector. This Management Plan is a crucial step in outlining the purpose, values, vision, and objectives for sustainable development of the SCFR, which closely aligns with the conservation ethos of the Soudah Development Company (SD). The Management Plan is designed as an adaptable framework, able to respond flexibly to new challenges and developments.

The Soudah Waterfall, which covers a modest area of 70 ha and is due to be nominated as a Ramsar Site, pending ratification of the Ramsar Convention by Saudi Arabia, epitomises the Ramsar principles in its management approach. Its fascination lies in its deep gorges, perennial pools, seasonal wadi streams, and a scenic seasonal waterfall surrounded by lush flora. The site hosts a rich biodiversity, including endemic, rare, and endangered species. Five species are threatened or near-threatened, according to the International Union for the Conservation of Nature (IUCN) Red List.

The management strategy centres on maintaining the water flow and water quality, which form the basis of the health of the ecosystem. Other key aspects include visitor management and conservation advocacy. The site is currently under jurisdiction of SD. Management is planned to be transferred to a government agency mandated with PA management. Until formally gazetted as a PA, Soudah Waterfall will fall under "Other Effective Area-Based Conservation Measures (OECM)" like the entire SCFR, a category to be recognised by the IUCN.

Given the significant interaction between humans and nature at Soudah Waterfall, the Management Plan takes a holistic approach to address threats such as water resource depletion, pollution, invasive species, and climate change. An in-depth assessment forms the basis for targeted strategies that emphasise resource conservation, cultural respect, and community engagement.

Management priorities will be established to maintain water flow, habitat diversity, and biodiversity while enhancing the visitor experience and community involvement. The long-term vision emphasises the SCFR's goals of conserving biodiversity, preserving cultural heritage, and promoting sustainable development.

The site-specific objectives centre around the protection of critical habitats, biodiversity conservation, habitat restoration, sustainable tourism, and community involvement in nature conservation. An Action Plan outlines a number of priority actions in the areas of conservation, monitoring, research, community engagement, and education, emphasising the need for a contingency plan and a team trained in emergency response. Resource requirements and an implementation roadmap spanning a decade ensure systematic progress towards site-specific development and management goals.

1. Description

1.1 Introduction

Soudah Waterfall, earmarked as a future Ramsar Site, epitomises the complex interplay of climate, geography, geomorphology, and hydrography. Nestled in the Asir Mountains, and being part of the Soudah Cloud Forest Reserve, this wetland offers a picturesque waterfall and varied wadi terrain. Apart from its stunning natural features, Soudah Waterfall serves as a haven for a variety of rare and endemic species, including dragonflies, amphibians, birds, and mammals, all of which find refuge in this ecological sanctuary.

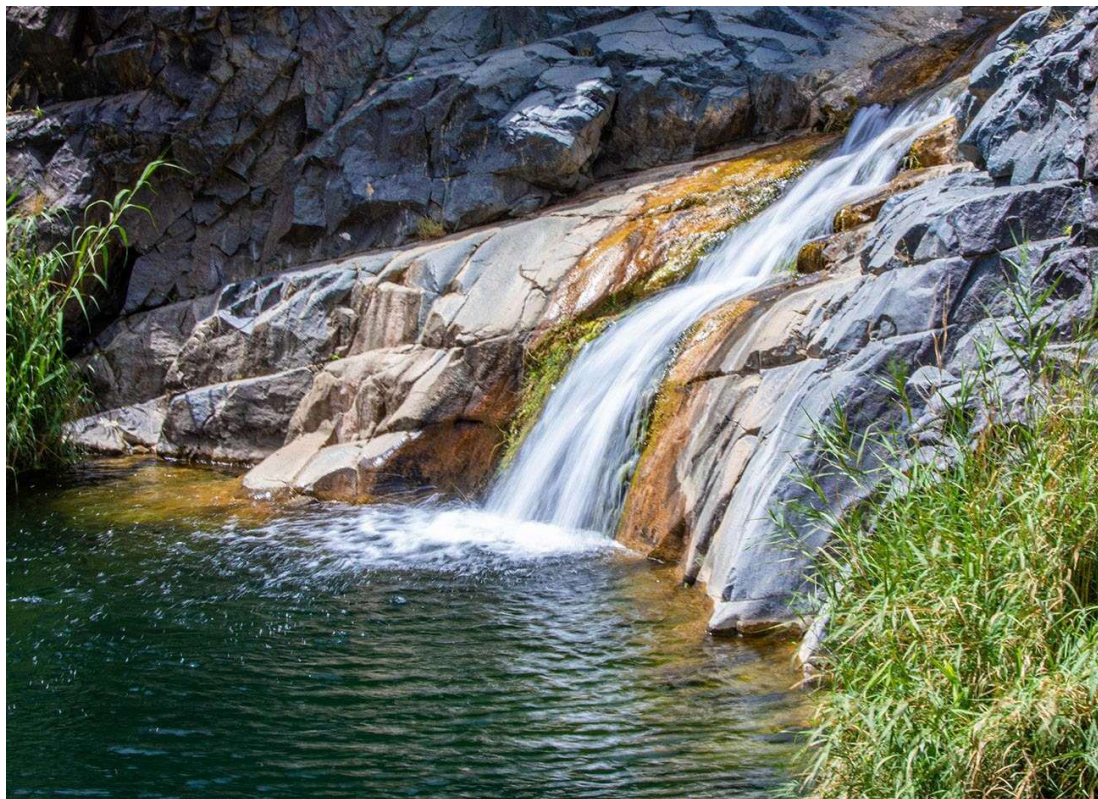


Figure 1: Seasonal Waterfall

However, this unique wetland is not immune to the threats posed by human activities, aggravated by the effects of climate change. Without proactive conservation measures, it remains vulnerable. The site's proximity to the historic palaces of Abu Sarrah provides a unique opportunity to raise awareness about nature and culture. This management plan aims at preserving the site's exceptional ecological features, vegetation cover, rich and unique biodiversity.

1.2 Land Tenure

Land ownership at Soudah Waterfall consists mainly of public land, administered by the government. However, there is also a limited area of privately owned land. This requires a cooperative approach between public and private stakeholders to ensure effective management and conservation strategies for Soudah Waterfall and its surroundings.

1.3 Legislation

Islamic water law, which is derived from Islamic jurisprudence, prioritises water as a communal resource that is accessible to all. Public ownership and distributive justice ensure fair access to water. The framework emphasises the preservation of water quality, discourages pollution and allows the reuse of grey water (Abderrahman, 2009). Efficient water use is encouraged, and water hoarding is prohibited, which promotes sharing.

This approach is in line with the principles of community-based resource management, where local communities work together to conserve wetlands and other natural resources. Islamic stewardship promotes environmental responsibility and demonstrates cultural respect for biodiversity and ecosystems.

1.3.1 Legal Protection Measures for Biodiversity

Biodiversity protection: Stricter enforcement of regulations is required to protect important species such as *Pseudagrion arabicum*, *Pinheyschna yemenensis*, *Miniopterus schreibersii*, *Acacia origena*, and *Turdus menachensis*. Enforcement of existing laws and regulations will prevent activities that pose a threat to these vital components of the Soudah Waterfall's biodiversity.

1.3.2 Habitat and Ecosystem Protection

Legislative provisions will specifically target the conservation of unique habitats, particularly the waterfall and nearby scrubland dominated by *Juniperus procera* and *Acacia origena*. Any activities that affect the ecological balance of these critical areas will be subject to strict regulatory oversight.

1.3.3 Community and Cultural Heritage

Environmental legislation takes into account the perspectives of local communities. Working with local residents will ensure that conservation measures respect cultural sensitivities and traditions and promote a shared commitment to the protection of the Soudah Waterfall.

1.3.4 Water Quality and Protection of the Wadi

Strict regulations address water quality issues in the wadi to protect the diverse aquatic communities. Enforcing policies to prevent overgrowth of vegetation in aquatic ecosystems will contribute to the overall health of Soudah Waterfall.

1.3.5 Penalizing Wildlife Poaching

Adequate penalties will be imposed for activities such as poaching that endanger wildlife, particularly large carnivores such as the Striped Hyaena and endangered migratory birds of prey. The legal framework and enforcement act as a deterrent and ensure the conservation of key species.

1.3.6 Regular Review and Adaptation

Environmental regulations will be reviewed at regular intervals to adapt to changing circumstances. This dynamic approach will allow the regulatory framework to evolve in response to new threats and conservation needs.

For the custodians of the ecological heritage of Soudah Waterfall, the enforcement of environmental legislation is not just a legal formality, but an unwavering commitment to the sustainable protection of this unique proposed Ramsar Site. Rigorous enforcement and adaptive legal measures aim to strengthen the resilience of Soudah Waterfall against potential threats and safeguard its ecological and cultural significance for future generations.



Figure 2: Pool below the Main Waterfall

1.4 Physical Features

Located in the enchanting Asir region in south-west Saudi Arabia, Soudah Waterfall is a fascinating wetland that deserves classification as a Ramsar Site. This region, where different biogeographical zones meet, is characterised by an impressive landscape defined by a north-south mountain range that runs parallel to the Red Sea, making the Soudah Waterfall a unique jewel in the Arabian Peninsula.

The fascination of this picturesque wetland lies in the enchanting waterfall and the winding wadi with its perennial pools that form a carpet of ecosystems in the midst of an otherwise arid environment. Soudah Waterfall is captivating not only for the natural splendour of its waterfall, but also for the rich diversity of its unique flora and fauna, demonstrating the harmonious coexistence of life in this vibrant oasis.

1.5 Biological Features

Soudah Waterfall hosts species assemblages that are part of the outstanding biodiversity of the Asir Region. The presence of important trees such as *Juniperus procera* and *Acacia origena* plays a crucial role in the conservation of various associated species. The fauna is characterised by species such as the dragonflies Arabian Sprite (*Pseudagrion arabicum*) and Pinhey's Aeshnid (*Pineyschna yemenensis*), vulnerable amphibians, including the rare Arabian Toad and the Arabian Tree Frog, birds such as the Yemen Thrush and the Arabian Partridge, and various mammals including Schreibers' Long-fingered Bat and the persecuted Spotted Hyaena, which is classified as Near Threatened (NT) by the IUCN Red List. These species contribute to the ecological richness of the wetland and provide important habitats. The biodiversity highlights at Soudah Waterfall are a mixture of important floral and faunal elements, including species endemic to the region.

Figure B-3 The Broad Scarlet (*Crocothemis erythaea*) occurs at Soudah Waterfall



Figure 3: The Broad Scarlet (Crocothemis erythaea) occurs at Soudah Waterfall

1.5.1 Refuge for Aquatic and Terrestrial Biota

Soudah Waterfall plays an important role as a refuge for a variety of species, which emphasises its ecological distinctiveness. Rare amphibians and reptiles such as the Hadramaut Agama and the Asir Rock Agama find a safe habitat at this refuge. The thriving bat community, which includes the endangered Schreibers' Long-fingered Bat, further emphasises the ecological importance of the site. Predators, including the White-tailed Mongoose, Arabian Red Fox, and Striped Hyaena not only contribute to the ecological richness, but also emphasise the importance of Soudah Waterfall for

species that are threatened in their wider habitats. The aquatic and terrestrial biota occurring here underline the site's conservation value.

1.6 Threats and Challenges

Soudah Waterfall faces a number of potential threats that require careful assessment and response strategies. The intricate ecological web, characterised by *Juniperus procera* and an abundance of other species, requires a science-based approach to ensure long-term resilience.

1.6.1 Climate-sensitive Challenges

Climate change: Anticipated changes in wind patterns are impacting the monsoon and pose a significant threat. Climate variability, the frequency of droughts, and the potential intensification of heavy rains and thunderstorms should be closely monitored. Similarly, prolonged periods of drought can weaken trees and other flora and fauna and cause massive dieback. Adaptive strategies will be developed to overcome these challenges (see 1.8).

1.6.2 Biotic Threats

Pathogens and dieback: The susceptibility of *Juniperus procera* to pathogens needs to be thoroughly researched. Adaptive silvicultural practices and vigilant monitoring will be used to address the problem of dieback and maintain the ecological role of this keystone species.

Invasive species (*Opuntia ficus-indica*): The encroachment of invasive plants poses a threat to the fragile balance in this ecosystem. Strict control measures, including regular monitoring and removal, are being enforced to prevent the displacement of native vegetation.

1.6.3 Hydrological and Water Quality Challenges

Maintaining the aquatic ecosystem: To protect aquatic communities, efforts will focus on maintaining optimal water quality. Through regular monitoring, potential threats will be assessed ensuring the conservation of this important aspect of Soudah Waterfall's biodiversity.

1.6.4 Poaching and Disturbance of Wildlife

Large carnivores, particularly the Striped Hyaena, as well as large birds of prey and other migratory birds, are at risk of persecution. Strict monitoring and law-enforcement measures are being introduced to prevent poaching and disturbance and to ensure the stability of the ecosystem.

1.6.5 Cooperative Adaptive Management

Community involvement: Local communities will play a central role in identifying and responding to emerging threats. Site-specific conservation measures will be developed that combine traditional knowledge with modern approaches to improve the resilience of Soudah Waterfall.

1.6.6 Research-based Conservation

Dynamic conservation measures: Continuous research initiatives will inform adaptive conservation strategies. The management plan will be updated on a regular basis to ensure that effective actions are taken in response to changing threats.

By recognising, understanding, and proactively addressing potential threats, the management plan aims to strengthen the resilience of this exceptional Ramsar Site candidate and ensure the preservation of its ecological richness for future generations.



Figure 4: Project Scientists studying water courses at Soudah Waterfall

1.7 Cultural Features

Soudah Waterfall is a testimony to the harmonious combination of traditional knowledge and modern conservation practices and serves as a beacon of exemplary wetland management. Adjacent to this ecological marvel is the treasured heritage site of the historic palaces of Abu Sarrah, which enrich the region's cultural offerings. These palaces, whose rich history spans more than a millennium, offer a glimpse into the cultural heritage and architectural finesse of the region, reflecting an ancient lifestyle and architectural prowess.

Various cultural aspects emphasise how Soudah Waterfall embodies the integration of traditional knowledge in its management and preserves its ecological essence:

Indigenous agricultural practices: The use of indigenous terrace farming techniques optimises land use while curbing soil erosion. This is in line with the local communities' ancestral agricultural knowledge of sustainable farming practices.

Community Engagement and Commitment: The active involvement of local communities in wetland management is based on traditional knowledge passed down through generations and fosters a sense of ownership and responsibility that is critical to conservation efforts.

Biodiversity Conservation and Ethnobotanical Wisdom: Preserving traditional knowledge about flora and fauna, including the use of medicinal plants, contributes significantly to biodiversity conservation. Sustainable resource extraction practices rooted in traditional wisdom strengthen the resilience of ecosystems.

Inclusive Decision-Making: Traditional councils, led by knowledgeable elders, are involved in decision-making processes and combine modern conservation strategies with time-honoured practices for sustainable use of wetlands.

Adaptation to Climate Variability: Adapting traditional agricultural practices to regional climate variability is an example of a flexible and climate-resilient approach that ensures resilience to changing environmental conditions.

The cultural characteristics of Soudah waterfall emphasise the importance of integrating traditional knowledge into wetland management in order to preserve both ecological integrity and cultural heritage. This model of wise use of wetlands not only promotes the harmonious coexistence of nature and human activities but also serves as a model for regions seeking a balanced approach to community conservation and well-being.

1.8 Impact of Climate Change

The climatic dynamics of Soudah Waterfall, which are mainly influenced by the altitude and the seasonal climate influenced by the southwest monsoon, create a unique and diverse ecosystem. However, these intricate climatic patterns also make Soudah Waterfall particularly vulnerable to the effects of climate change. Possible impacts of climate change on the biodiversity of Soudah Waterfall based:

Shifts in Vegetation Distribution: Climate change may lead to shifts in temperature and precipitation patterns, which might alter the distribution of plant communities in Soudah Waterfall. Species that are sensitive to temperature or moisture fluctuations may have difficulty adapting, resulting in changes in vegetation composition and structure.

Impacts on Endemic and Rare Species: The diverse ecosystems of Soudah Waterfall likely harbour endemic and rare species that are adapted to specific climatic conditions. Changes in temperature and humidity conditions caused by climate change could threaten these species and lead to a decline in populations or local extinctions.

Increased Stress on Water Resources: Fluctuating temperatures and changing precipitation patterns can affect water availability in the region. This can stress aquatic ecosystems, affect the flow of streams and waterfalls, and reduce the suitability of habitats for aquatic species.

Ecosystem Disruptions: Extreme weather events associated with the southwest monsoon, including heavy rains and thunderstorms are likely to become more intense and/or occur unpredictably due to climate change. These events can cause disturbances such as flooding or landslides, disrupting ecosystems and impacting species habitats.

Loss of Ecological Resilience: Climate variability and extreme events can challenge the resilience of ecosystems at Soudah Waterfall. Species that are adapted to certain climatic conditions may have difficulty coping with rapid changes, resulting in reduced overall ecological resilience. Management approaches to conserve Soudah Waterfall need to consider these potential impacts of climate change. Strategies include:

Monitoring and Research: Continuous monitoring of ecological indicators and research into the effects of climate change will provide valuable data for our understanding and ability to mitigate impacts.

Adaptive Management: Implementing adaptive management strategies that allow conservation measures to flexibly adjust to changing climate conditions are likely to improve ecosystem resilience.

Habitat Restoration and Protection: Prioritising habitat restoration and protection measures to maintain ecological connectivity and support the ability of species to adapt to changing environmental conditions.

Community Engagement: Involving local communities in climate change adaptation efforts, raising awareness about the impacts of climate change on biodiversity, and promoting sustainable practices will help strengthen resilience.

International Collaboration: Collaboration with international partners and organisations working on climate change adaptation and biodiversity conservation will provide additional resources and expertise for effective management strategies. By incorporating climate change considerations into conservation planning and management, Soudah Waterfall is expected to improve its ability to withstand environmental challenges and maintain its unique biodiversity for future generations.

2. Evaluation, Formulation of Vision, and Site Objectives

2.1 Site Analysis

A comprehensive assessment of Soudah Waterfall's ecological, cultural, and socio-economic attributes will inform the formulation of management strategies.

Site Strengths	Site Weaknesses	External Opportunities	External Challenges
Rarity of wetlands in an arid environment	Vulnerability to climate change and hydrological changes	Recreational and educational offerings	Pollution, disturbance
Permanent flow	Water abstraction, drought	Sustainable agriculture, apiculture, recreational activities	Water quality, anthropogenic impact on vulnerable habitats
Relatively small area	Pressure on vulnerable species and habitats	Improve access through transportation and designated trails	Disturbance due to lack of buffer zones
High biodiversity	Invasive species Lack of data and knowledge	Setting up a discovery and educational centre Capacity building in environmental issues	Minimizing environmental impacts
Presence of globally threatened species	Illegal hunting and persecution of large mammals and raptors	Ecotourism (bird watching, dragonfly observation, photography, etc.)	Infrastructure that caters for all Monitoring threatened populations
Scenically highly attractive site	Concern about proliferation of baboons, mosquitoes, and venomous snakes	Remote access through cameras and drones Ecotourism	Reconciling ease-of access with wilderness

2.2 Site Management Policy

The management policy will prioritize the conservation and sustainable use of natural resources while respecting cultural values and promoting community involvement.

The Site Management Policy for Soudah Waterfall emphasises the commitment to sustainable management practices aimed at maintaining and enhancing the ecological integrity and cultural significance of the wetland. The main focus of the management plan is to protect and conserve the diverse habitats and species present at the site, while promoting responsible visitor engagement and community wellbeing.

To achieve these overarching goals, the following general management guidelines have been established. These management policies have been carefully selected. They adhere to the principles of sustainability and ensure that Soudah Waterfall remains a thriving and resilient ecosystem for the benefit of present and future generations.

Maintaining Water Flow: Ensuring a continuous and adequate flow of water in Soudah Waterfall is paramount to maintaining the ecological health of the wetland. This policy aims to maintain the hydrological processes that support diverse aquatic habitats and species. It aims at mitigating the negative impacts of water scarcity or over-abstraction.

Creating and Maintaining Habitat Diversity: The management plan emphasises to maintain temporary and permanent pools with a diverse native vegetation cover to support a rich assemblage of aquatic species, including insects, fish and amphibians. Maintaining habitat diversity supports the wetland in meeting the needs of resident wildlife. It also promotes the overall resilience of the ecosystem.

Conserving Biodiversity: Maintaining and, where required, restoring the natural biodiversity of Soudah Waterfall are key objectives. They will be achieved through targeted conservation and rewilding measures, such as habitat restoration and control of invasive species. Conservation management will be tailored towards optimising ecological conditions and to maintain natural levels of biodiversity.

Monitoring to Inform Management: Regular monitoring of water flow dynamics, water quality parameters, and biodiversity is essential for informed decision making and adaptive management. By systematically evaluating the effectiveness of conservation measures and management interventions, the wetland's capacity to cope with prevailing and new threats will be enhanced.

Promoting Visitor Enjoyment and Appreciation of Wildlife: Soudah Waterfall will become a place where visitors can immerse themselves in nature to develop a deeper understanding of habitats, wildlife and conservation requirements. The management plan aims to support outstanding visitor experiences and educational opportunities, while minimising the ecological impact of human activities through strategic design and interpretation.

Supporting Community Health and Well-being: Recognising and maintaining the interconnectedness of natural and cultural components of the proposed Ramsar Site, the management policy aims to promote the health and social well-being of local communities. By providing access to nature-based recreational opportunities and fostering a sense of stewardship and pride in the wetland, Soudah Waterfall contributes to exceptional visitor experiences and a holistic vitality of local communities.

2.3 Long-term Vision for Soudah Waterfall

The vision for Soudah Waterfall strongly supports the SCFR's overarching goals of protecting its distinctive biodiversity, preserving its cultural heritage, and promoting sustainable development for the mutual benefit of local communities and the environment.

Proposed Vision statement for Soudah Waterfall (for further discussion with stakeholders):

“Harmony Amidst Diversity – Cultivating a Sustainable Wetland Oasis at Arabia's Mountain Top”

Soudah Waterfall is a beacon of sustainable ecotourism that blends seamlessly with the natural environment of the Asir Mountains. It is a testament to responsible environmental stewardship and

offers immersive nature experiences that inspire awe and foster a deep connection with the diverse life in this protected area.

The management of Soudah Waterfall emphasises the conservation of vital habitats, improving water quality and ecosystem resilience through innovative agricultural practices tailored to meet conservation needs. Visitors are invited to embark on journeys of discovery accompanied by strategically positioned viewpoints and educational signage highlighting the ecological importance of the wetland and the delicate balance of the wildlife that lives there.

Exciting and innovative experiences await visitors of all ages, who are encouraged to actively participate in conservation efforts. Soudah Waterfall serves as a living classroom for environmental education and scientific research, fostering a deep understanding and appreciation of the region's ecological and cultural heritage. As a regional example of sustainable wetland management and conservation, Soudah Waterfall is a source of pride and encourages cooperation among all stakeholders committed to its permanent protection.

2.4 Site Management Objectives

Objectives include the protection and restoration of critical habitats and the conservation of threatened species, the restoration of degraded areas, the promotion of sustainable tourism and other human activities that are compatible with the site's conservation requirements, and the promotion of community engagement in conservation efforts.

1. Objective: Ensure the effective management of Soudah Waterfall as a vital biological resource that benefits both local communities and the environment in the Asir Region and Saudi Arabia as a whole.

Method: Implement comprehensive measures to regulate water flow, eradicate invasive species through targeted control measures, and conduct regular and systematic data collection to monitor the state of the ecosystem and its changes over time.

2. Objective: Achieve the legal PA designation and effective protection of Soudah Waterfall as a prestigious, nationally and internationally recognised Ramsar Site.

Method: Establish rigorous monitoring protocols to track site integrity and biodiversity levels; provide ongoing training and capacity building for staff to ensure effective management of the site; conduct detailed analyses of population trends; and maintain a rigorous data collection system to support compliance with Ramsar compliance.

3. Objective: To effectively manage existing habitats to create favourable ecological conditions for wildlife and promote biodiversity and ecosystem resilience.

Method: Continuously assess habitat quality and functionality, apply adaptive management strategies based on ongoing data collection and trend analyses, and implement habitat restoration and enhancement projects based on scientific evidence and best practice.

4. Objective: Proactively create and maintain new aquatic habitats or enhance existing habitats to support diverse insect and amphibian populations and reduce visitor pressure on natural habitats.

Method: Following a feasibility study, design and implement habitat creation initiatives, including the construction of strategically located ponds with native vegetation. Apply ecologically sensitive approaches to promote habitat connectivity and resilience, and monitor habitat utilisation and species responses to ensure effectiveness.

5. Objective: Promote responsible public access to Soudah Waterfall for nature-based tourism, balancing visitor enjoyment with conservation needs.

Method: Regularly assess visitor numbers and behaviour patterns, apply visitor management strategies to minimise disturbance while maximising visitor satisfaction, and use feedback mechanisms such as annual visitor surveys to inform adaptive management decisions.

6. Objective: To improve public awareness and legal knowledge of the conservation laws and regulations applicable to Soudah Waterfall.

Method: Conduct awareness campaigns to inform local people, other stakeholders, and visitors about the legal and regulatory framework that applies to Soudah Waterfall; develop user-friendly materials such as brochures and signage to communicate the legal requirements and the importance of complying with them; conduct workshops and training for local people to improve their legal knowledge and ensure active participation in conservation activities; work with local media to disseminate information about legal and regulatory aspects; and promote a sense of shared responsibility for the protection of Soudah Waterfall.

7. Objective: Establish Soudah Waterfall as a world-class environmental education facility that promotes national goals for environmental awareness and sustainability.

Method: Develop and implement innovative educational programmes tailored to a variety of audiences that combine hands-on learning experiences with scientific enquiry and interpretation, work with educational institutions to pilot and refine educational initiatives, and assess their impact through ongoing monitoring and evaluation.

3. Action Plan for Soudah Waterfall

3.1 Identification and Outlines of Projects:

Projects are identified that address priority needs such as habitat restoration, invasive species management, community engagement, and research initiatives.

3.1.1 Habitat Restoration

Objective: Implement measures to restore degraded habitats, with a focus on areas important to threatened species.

Strategies and Actions:

- Identify degraded habitats and prioritise their restoration.
- Apply restoration techniques such as revegetation and erosion control.
- Involve local communities in habitat restoration.
- Monitor the success of restoration projects.

3.1.2 Management of Invasive Species

Objective: Develop and implement invasive species control plans, with a particular focus on the management of *Opuntia ficus-indica*.

Strategies and Actions:

- Conduct surveys to identify invasive species.

- Implement targeted control measures for *Opuntia ficus-indica*.
- Establish early detection and rapid response systems.

3.1.3 Climate Resilience

Objective: Implement climate-change related measures to mitigate the effects of frequent droughts and climate-related stress.

Strategies and Actions:

- Conduct vulnerability assessments.
- Implement water conservation measures.
- Promote sustainable land use practices.
- Develop adaptive management plans.

3.1.4 Sustainable Water Management

Objective: Develop and implement sustainable water management practices to safeguard water resources for the ecosystem.

Strategies and Actions:

- Monitor and regulate water abstraction.
- Promote efficient irrigation methods.
- Establish guidelines for water use in tourism facilities.
- Prevent pollution of water sources.

3.1.5 Community Engagement

Objective: Involve local communities in conservation efforts and emphasise the importance of the wetland.

Strategies and Actions:

- Conduct awareness campaigns.
- Involve communities in restoration and monitoring projects.
- Implement community-based monitoring programmes.
- Promote a sense of ownership among residents.
- Monitoring and Research

3.1.6 Ecological Dynamics

Objective: Improve understanding of ecological dynamics through ongoing research and monitoring.

Strategies and Actions:

- Conduct scientific research.

- Establish a comprehensive monitoring programme.
- Utilise data collection technologies.
- Share the research results.

3.1.7 Joint Conservation Efforts

Objective: Increase cooperation with conservation stakeholders.

Strategies and Actions:

- Facilitate partnerships with local communities.
- Collaborate with NGOs and government agencies.

3.1.8 Utilization of Advanced Technologies

Objective: Improved understanding through advanced monitoring approaches.

Strategies and Actions:

- Utilise advanced monitoring technologies.
- Set up monitoring stations.
- Collect real-time data.

3.1.9 Educational Initiatives to Raise Awareness

Objective: Raise awareness and promote sustainable tourism.

Strategies and Actions:

- Carry out educational programmes.
- Collaborate with educational institutions.
- Utilise multimedia channels.

3.1.10 Adaptive Management Strategies

Objective: Refine adaptive management strategies.

Strategies and Actions:

- Review and update management plans.
- Involve stakeholders.
- Consider the dynamic ecosystem in strategy development.

3.1.11 Regular Evaluation of Conservation Measures

Objective: Evaluate the effectiveness of measures and their overall status.

Strategies and Actions:

- Conduct regular assessments.

- Adapt strategies based on the assessment results.

3.1.12 International Cooperation and Support

Objective: Seek international co-operation for research and conservation.

Strategies and Actions:

- Establish collaborations with international institutions.
- Participate in knowledge exchange initiatives.
- Foster community engagement and education

3.1.13 Awareness Programmes

Objective: Develop educational programmes for ecological awareness.

Strategies and Actions:

- Design awareness-raising campaigns.
- Use a variety of communication channels.

3.1.14 Community Engagement

Objective: Engage communities in conservation efforts.

Strategies and Actions:

- Form committees at the community level.
- Hold regular community meetings.

3.1.15 Environmental Education Initiatives

Objective: Improve environmental knowledge.

Strategies and Actions:

- Integrate environmental education into school curricula.
- Build nature trails and organise excursions.

3.1.16 Cultural and Recreational Engagement

Objective: Promote cultural appreciation.

Strategies and Actions:

- Designate areas for responsible recreation.
- Showcase traditional practices and crafts.

By implementing these strategies and actions, Soudah Waterfall's Management Plan will promote comprehensive conservation measures and ensure the preservation of its unique ecological character.

3.2 Contingency Plan for Soudah Waterfall

3.2.1 Development of Contingency Plan and Activation of a Crisis Response Team

Objective: To develop an emergency plan and establish an operational team that can immediately respond to threats.

Strategies and Actions:

- Develop a comprehensive contingency plan, tailored to potential threats at Soudah Waterfall.
- Assemble a roster of professionals with the skills needed to immediately mitigate the threat, including ecologists, emergency responders, and communications experts.
- Conduct regular training and drills to ensure a rapid and coordinated response in crisis situations.
- Maintain an updated emergency contact list and communication protocols for rapid mobilisation and coordination.

3.2.2 Monitoring Emergencies

Objective: Establish a monitoring protocol to immediately identify and assess emerging threats.

Strategies and Actions:

- Integrate advanced monitoring technologies such as drones and remote sensors to collect real-time data and analyse ecological conditions.
- Utilise remote sensing tools to monitor changes in vegetation, water quality, and overall ecological condition.
- Work with local communities to collect data on unusual activities or disturbances that could indicate potential threats.

3.2.3 Crisis Communication and Public Awareness

Objective: Rapidly disseminate information to the public and stakeholders during emergencies.

Strategies and Actions:

- Assemble an emergency communications team that has multiple communication channels, including social media, local news outlets, and community networks.
- Develop ready-made crisis communication materials that can be quickly disseminated to inform the public about emergency situations.
- Utilise social media platforms, local news outlets, and community networks for immediate alerts and updates to raise public awareness.

3.2.4 Habitat Protection Measures

Objective: Implement immediate measures to protect critical habitats that are under threat.

Strategies and Actions:

- Designate certain zones within Soudah Waterfall as emergency protected areas with limited access to prevent further damage.
- Mobilise resources and work with local communities to take immediate action to restore habitat.
- Deploy temporary barriers, signage, or protective measures to prevent further damage to sensitive ecosystems in emergencies.

3.2.5 Legal Emergency Response

Objective: Ensure rapid legal responses to prevent or mitigate immediate threats.

Strategies and Actions:

- Designate a legal expert or legal advisory team to assess legal implications and options in emergencies.
- Establish temporary legal guidelines or restrictions to address the emergency, such as temporary bans or restrictions on certain activities.
- Coordinate with law enforcement agencies to ensure rapid enforcement of emergency measures to protect Soudah Waterfall.

3.2.6 Joint International Support

Objective: Obtain immediate international support to address serious ecological threats.

Strategies and Actions:

- Activate existing collaborations with international conservation organisations and networks to assist in emergencies.
- Seek support from global conservation networks and mobilise international experts for rapid assessments and recommendations.
- Coordinate efforts with international partners to address serious ecological threats and implement urgent conservation measures.

3.2.7 Emergency Funding for Nature Conservation

Objective: Ensure the immediate availability of funding for urgent conservation measures.

Strategies and measures:

- Establish an emergency fund specifically earmarked for immediate responses to threats at Soudah Waterfall.
- Secure emergency funding through partnerships with government agencies, NGOs, philanthropic organisations, and private donors.
- Provide emergency fund resources for urgent conservation efforts such as habitat protection and restoration and crisis response initiatives.

3.3 Funding and Resources

3.3.1 Financial Resources

3.3.1.1 Habitat Restoration and Conservation

Allocation of Budget: Provide a specific budget for habitat restoration projects, taking into account the scale and urgency of restoration needs.

Expertise Funding: Provide funding for experts specialising in habitat restoration, including ecologists, botanists, and landscape architects.

Procurement of Equipment and Materials: Procure the necessary equipment and materials for restoration activities, such as native plant seeds, erosion control materials, and specialised tools.

3.3.1.2 Monitoring and Research

Investment in Advanced Technologies: Invest in advanced monitoring technologies, satellite imagery, and remote sensing tools for comprehensive data collection.

Support for Research Grants: Provide funding to support ongoing research projects, including grants to academic institutions and independent researchers.

Resources for Data Analysis: Provide resources for data analysis tools and software to gain meaningful insights from the ecological data collected.

3.3.1.3 Community Engagement and Education

Funding for Education Programs: Provide resources for the development and implementation of educational programmes aimed at local communities, visitors, and other stakeholders.

Establishment of Outreach Teams: Establish teams to actively engage with local residents and promote awareness of conservation issues.

Development of Educational Materials: Develop and distribute educational materials, including brochures, signage, and online resources, to increase public knowledge.

3.3.1.4 Legal and Institutional Framework

Allocation for Legal Advice: Allocate funding for legal advice to ensure compliance with conservation laws.

Investment in Institutional Partnerships: Invest in building partnerships with government agencies and NGOs through financial commitments and collaborations.

3.3.1.5 Conservation and Restoration Strategies

Funding for Restoration Projects: Provide funding for conservation and restoration projects, including captive breeding programmes, native species reintroduction, invasive species control, and climate change mitigation.

Establishment of an Adaptive Management Fund: Establish a fund to support adaptive management strategies and respond flexibly to emerging threats.

3.3.2 Human Resources

3.3.2.1 Habitat Restoration and Conservation

Engagement of Ecologists and Biologists: Engage experienced ecologists to lead habitat restoration and conservation initiatives.

Field Staff Involvement: Involve field staff to conduct restoration work in the field.

3.3.2.2 Monitoring and Research

Engagement of Research Teams: Engage research teams and data analysts for surveys, research, and monitoring.

3.3.2.3 Community Engagement and Education

Involvement of Educators: Involve educators in the design and delivery of educational programmes for different audiences.

3.3.2.4 Legal and Institutional Framework

Engagement of Institutional Liaisons: Liaise with government agencies and NGOs.

3.3.2.5 Conservation and Restoration Strategies

Engagement of Conservation Manager: Assign a conservation manager to oversee the implementation of conservation and restoration strategies.

Dedicated Specialists for Adaptive Management: Engage specialists to monitor emerging threats and develop adaptive management measures.

3.3.3 Possible Funding Sources

Potential sources include government grants, corporate partnerships, philanthropic foundations, tourism revenue, and public-private partnerships (see KBD Sustainable Financing report for more details).



Figure 5: Small Streamlet at Soudah Waterfall Connecting Isolated Pools During the Dry Season

3.4 Proposed 10-Year Implementation Roadmap of Soudah Waterfall Protected Area Management Plan

The phased approach outlined in the management plan will guide the implementation of the Management Plan over a 10-year period, ensuring systematic progress towards achieving site-specific management objectives. The following timetable is proposed for the gradual implementation of the Soudah Waterfall PA Management Plan:

Timeframe	Year 1				Year 2				Year 3				Year 4				Year 5			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Phase 1: Initial assessment and planning																				
Project initiation: Assemble project team; preliminary site assessments, surveys and stakeholder consultations																				
Collect baseline data: Identify experts for ecological surveys; collect data on habitats, species and threats																				
Stakeholder consultations, target setting: Work with local communities, Government agencies and NGOs; establish short- and long-term conservation goals																				
Phase 2: Develop management strategies																				
Plan habitat restoration and conservation: Identify priority areas for habitat restoration; develop habitat conservation and restoration strategies																				
Research and technology integration: Advanced monitoring technologies and remote sensing tools; research initiatives on ecological dynamics																				

Timeframe	Year 1				Year 2				Year 3				Year 4				Year 5			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Develop the legal framework: Legal expert to review and update the management plan; ensure compliance with conservation laws and regulations																				
Phase 3: Implement conservation strategies																				
Habitat restoration: Initiate habitat restoration projects; deploy specialists to reintroduce native species																				
Invasive species management: Develop and implement invasive species control plans; focus on <i>Opuntia</i>																				
Climate resilience measures: Integrate climate resilient practices into conservation efforts; monitor and adapt strategies to combat climaterelated stress																				
Phase 4: Community engagement and education																				
Community engagement: Launch awareness programmes for local community; establish community engagement teams																				
Sustainable tourism practices: Implement initiatives to promote sustainable tourism practices; conduct workshops for local population on responsible tourism																				

Phase 5: Monitoring, Research and International Co-operation (year 6-10)

- This timeline considers short-term goals to address immediate threats and long-term goals to ensure the sustainable conservation of Soudah Waterfall. Regular assessments, adaptive management and international co-operation will contribute to the effectiveness and success of the management plan over a 10-year period.

KBD | SD | Ramsar Nomination – Soudah Waterfall

3.5 Evaluation and Adaptation

The dynamic ecological landscape of Soudah Waterfall requires an evolving management plan (MP) that responds to ongoing research and changing circumstances. To achieve this, the MP includes robust mechanisms for regular assessment and adaptation.

Continuous Monitoring: Through the use of state-of-the-art monitoring technologies and remote sensing tools, the MP commits to continuous monitoring and observation of Soudah Waterfall's ecological dynamics. This real-time data collection will provide critical insights into the effectiveness of the strategies employed and the ever-changing conditions of the wetland.

Adaptive Management Strategies: Recognising the unpredictable nature of ecological systems, the Management Plan is committed to adaptive management and endeavours to remaining flexible in the face of emerging threats or unforeseen changes, promptly adjusting conservation strategies to meet new challenges. This adaptive approach ensures that the Management Plan can respond to the evolving needs of Soudah Waterfall.

Stakeholder Involvement: Regular evaluations will include the active participation of local communities, government agencies, non-governmental organisations, and other national and international partners. By involving different perspectives, the Management Plan aims to improve the effectiveness of its strategies and gain valuable insights from people and organisations connected to the wetland.

Annual Assessments: Annual assessments, conducted by multidisciplinary teams, will thoroughly evaluate the impact of conservation measures on species, habitats, and the overall ecological status of Soudah Waterfall. The results of these assessments will guide the necessary adjustments and refinement of the Management Plan's conservation approaches.

Research Integration: Ongoing research initiatives will be integrated into the assessment process. New scientific discoveries and ecological findings will be promptly integrated into the Management Plan, to ensure that it remains at the forefront of conservation science.

Flexibility in Implementation: Flexibility and adaptive management are the cornerstones of the Management Plan's approach. Recognising that circumstances will change, the Management Plan is committed to being responsive and adapting Management Plan strategies and actions as needed. Whether due to climate variability, emerging threats, or advances in conservation science, the Management Plan will remain a living document that evolves to ensure the ecological integrity of Soudah Waterfall.

Conclusions

To summarise, the unique ecological features of Soudah Waterfall requires a nuanced and adaptive management strategy. This plan has been crafted to account for the intricate dynamics of the climate, emphasising the conservation of diverse ecosystems, and actively engaging local communities. These measures are designed to safeguard the uniqueness and ecological importance of Soudah Waterfall in the dynamic landscape of the Asir Mountains and the Arabian Peninsula in the long term.

Given the dynamics of climatic conditions that prevail in the region, this management plan emphasises proactive strategies designed to respond effectively to climatic variability. By addressing the challenges posed by climate change, it aims to strengthen the habitats of the Soudah Waterfall against potential threats and maintain ecological resilience.

At the centre of this plan is the conservation of diverse ecosystems, including the interconnected aquatic and terrestrial habitats dominated by keystone species. The focus goes beyond immediate threats and includes adaptive strategies to protect against factors such as vegetation overgrowth, fire,

beetle infestation, and invasive species. This holistic approach aims to ensure the sustainable health and diversity of the entire Asir region.

Understanding the close connection between local communities and the ecological health of Soudah Waterfall, community involvement is prioritised. The plan advocates for customised conservation measures that not only preserve the distinct ecological identity, but also empower local residents to actively participate in the preservation of this natural treasure.

As ecological dynamics are constantly evolving, research initiatives are an integral part of this plan. Active monitoring of threatened and near-threatened species and ongoing research on key species, such as *Juniperus procera*, will contribute to adaptive conservation strategies.

Enforcement of environmental laws is essential to preserving the special ecological and cultural identity of Soudah Waterfall. The legal framework will act as a vigilant watchdog against threats and penalise activities that endanger the wetland's diverse flora and fauna. This management plan, based on scientific rigour and community involvement, aims to ensure the sustainable health and resilience of Soudah Waterfall.



Figure 6: The Grey-headed Kingfisher (*Halcyon leucocephala*), a Bird Species with Afrotropical Affinities Occurring at Soudah Waterfall

References

- Abderrahman, W.A. (2009). Application of Islamic legal principles for advanced water management. *Water International* 2: 513-518.
- Abdou, W. 2023. 2023. Soudah Development. Baseline Assessment Terrestrial Biodiversity. Avifauna Survey Report. KAUST.
- Al-Kahem-Al-Balawi, H.F., al-Ghanim, K.A., Ahmad, Z., Temraz, T.A., Al-Akel, A.S., AlMisned, F. & Annazri, H. 2008. A threatened fish species (*Aphanius dispar*) in Saudi Arabia. A case study. *Pakistan Journal of Biological Sciences* 11, 2300-2307.
- Al-Namazi, A.A., Al-Ammari, B.S., Davy, A.J. & Al-Turki, T.A. 2020. Seed dormancy and germination in *Dodonaea viscosa* (Sapindaceae) from south-western Saudi Arabia. *Saudi Journal of Biological Sciences* 27, 2420-2424.
- Aloufi, A.A., Amr, Z.S., Abu baker, M.A. & Hamidan, N. 2019. Diversity and conservation of terrestrial, freshwater and marine reptiles and amphibians in Saudi Arabia. *Amphibian and Reptile Conservation* 13, 181-202.
- Beshah, F., Hunde, Y., Getachew, M., Bachheti, R.K., Husen, A. & Bachheti, A. 2020. Ethnopharmacological, phytochemistry and other potential applications of *Dodonaea* genus: A comprehensive review. *Current Research in Biotechnology*, 2, 103-119.
- Boland, C.R.J. & Burwell, B.O. 2020. Ranking and mapping the high conservation priority bird species of Saudi Arabia. *Avian Conservation and Ecology* 15 (2).
- Boland, C.R.J. & Burwell, B.O. 2021. Ranking and mapping Saudi Arabia's high conservation priority terrestrial vertebrates. *Asian Journal of Conservation Biology* 10, 197-210.
- Child, G. & Grainger, J. 1990. A System Plan for Protected Areas for Wildlife Conservation and Sustainable Rural Development in Saudi Arabia. 2 vols. 335 pp. Report to the National Commission for Wildlife Conservation and Development, Riyadh and IUCN, Gland.
- Clarke, C. & Crute, S. 2023. Soudah Development. Baseline Assessment Terrestrial Biodiversity. Al Soudah Vegetation Survey. KAUST.
- Egan, D. 2023. Soudah Development. Baseline Assessment Terrestrial Biodiversity. Reptile, Amphibian, and Freshwater Surveys. KAUST.
- El-Juhany, L. 2015. The magnitude of dieback on *Juniperus procera* trees in the natural forests in the southwestern region of Saudi arabia. *Biosciences Biotechnology Research* 12, 219-230.
- Feulner, G. 2023. Soudah Development. Baseline Assessment Terrestrial Biodiversity. Flora Surveys. KAUST.
- Freyhof, J., Els, J., Feulner, G.R., Hamidan, N.A. & Krupp, F. 2020. Freshwater fishes of the Arabian Peninsula. Motivate Media group, Dubai.
- Freyhof, J., Hamidan, N.A., Feulner, G.R. & Harrison, I. 2015. The status and distribution of freshwater fishes of the Arabian Peninsula. In: Garcia, N., Harrison, I., Cox, N. & Tognelli, M.F. (eds.) *Status and distribution of freshwater biodiversity in the Arabian Peninsula*. IUCN, Gland, Cambridge, and Arlington.

- Gvoždik, V., Moravec, J., Klütsch, C. & Kotlík, P. 2010. Phylogeography of the Middle Eastern tree frogs (*Hyla*, Hylidae, Amphibia) as inferred from nuclear and mitochondrial DNA variation, with a description of a new species. *Molecular Phylogenetics and Evolution* 55, 1146-1166.
- Harrison, I.J. 2015. *Garra buettikeri*. The IUCN Red List of Threatened Species 2015: eT203416A2765000 <https://www.iucnredlist.org/species/203416/2765000>
- Harrison, I., Cox, N. & Tognelli, M.F. 2015. The status and distribution of freshwater biodiversity in the Arabian Peninsula. IUCN, Gland, Cambridge & Arlington.
- Jennings, M.C. 2010. Atlas of the breeding birds of Arabia. Fauna of Arabia, Vol. 25. Karger Libri, Basle.
- KBD 2024. Soudah Cloud Forest Reserve. The Mountain Path to 2030. Management Plan 2024-2034.
- Krupp, F. 1983. Fishes of Saudi Arabia. Freshwater fishes of Saudi Arabia and adjacent regions of the Arabian Peninsula. Fauna of Saudi Arabia 5, 568-636.
- Schneider, W. & Samraoui, B. 2015. The status and distribution of dragonflies and damselflies (Odonata) in the Arabian Peninsula. In: García, N., Harrison, I., Cox, N. and Tognelli, M.F. (eds.). The Status and Distribution of Freshwater Biodiversity in the Arabian Peninsula. Gland, Switzerland, Cambridge, UK and Arlington, USA: IUCN.
- Thomas, J., El-Sheikh, M.A., Alfarhan, A.H., Alatar, A.A., Sivadasan, M., Basahi, M., Al-Obaid, S. & Rajakrishan, R. (2016). Impact of alien invasive species on habitats and species richness in Saudi Arabia. *Journal of Arid Environments* 127, 53-65.
- Waldhauser, M., Müller, O., Vierstraete, A. & Schneider, T. 2023a. *Pinheyschna yemenensis*, a new species for Saudi Arabia, with description of the final instar larva and exuvia (Odonata: Aeshnidae). *Odonatologica* 52, 79-87.
- Waldhauser, M., Vierstraete, A. & Schneider, T. 2023b. records of little-known Odonata from southwestern Saudi Arabia. *Notulae Odonatologicae* 10, 17-29.
- Warrag, E., Mallick, J., Singh, R.K. & Khan, R.A. 2019. Status of dieback of *Juniperus procera* (African pencil cedar) in natural stands and plantation in Alsouda Highlands, Saudi Arabia. *Applied Ecology and Environmental Research* 17, 2325-2338.
- Whelan, R. 2023a. Soudah Development. Baseline Assessment Terrestrial Biodiversity. Small Mammals Surveys. KAUST.
- Whelan, R. 2023b. Soudah Development. Environmental Baseline Survey. Terrestrial Fauna. KAUST.
- Whelan, R. & Alkaboor, A. 2023. Soudah Development. Baseline Assessment Terrestrial Biodiversity. Invertebrate Surveys. KAUST
- White, D. & Hagggar, H. 2023. Soudah Development. Baseline Assessment Terrestrial Biodiversity. Bat Surveys. KAUST.