International Journal of Botany Studies
www.botanyjournals.com
ISSN: 2455-541X
Received: 27-09-2025, Accepted: 27-10-2025, Published: 11-11-2025
Volume 10, Issue 11, 2025, Page No. 20-31

A descriptive study of diversity of native flora in the Aravali Hills of Gurugram region

Jyoti Singh[1*], Manisha Saini[2], Mohd Mubashshir[1]
[1] Department of Botany, Vivekananda Global University, Jaipur, Rajasthan, India
[2] Department of Zoology, Dronacharya Government College, Gurugram, Haryana India

Abstract
One of the oldest mountain ranges in the world, the Aravali Hills, is essential to maintaining biodiversity and ecological balance in the Gurugram area. The natural flora of the Aravali Hills is thoroughly described in this paper, with a focus on its ecological relevance and botanical diversity. In order to identify and categorize the native plant species, the study looks at their ecological roles, distribution patterns, and state of conservation. The study also emphasizes how local environmental elements, such as soil type, climate, and human activity, interact with the native flora. The results show a wide variety of native plant species, many of which support the delicate environment in the region. However, the area's botanical wealth is under jeopardy due to escalating issues including urbanization, habitat degradation, and climate change. In order to safeguard and conserve this priceless natural resource, the study emphasizes the necessity of focused conservation measures, such as habitat restoration and community involvement. The project is to support sustainable management methods in the Aravali Hills and inform policy formation by recording the botanical diversity and evaluating the challenges.

Keywords: Native species, ecological sustainability, conservation, habitat restoration, urbanization, climate change, deforestation

Introduction

The Aravali Hills, one of the world's oldest mountain ranges, are a critical ecological feature in northwestern India, including the Gurugram region. These hills play a vital role in maintaining the region's environmental stability by acting as a green barrier against desertification, conserving groundwater resources, and supporting a diverse array of plant species [1]. The botanical diversity of the Aravalis is not only significant for its ecological value but also for its cultural and economic importance to the local communities and wildlife. However, rapid urbanization, deforestation, and climate change have increasingly threatened this biodiversity, leading to concerns about the sustainability of these natural resources [2]. The Aravali Hills, among the oldest mountain ranges in India, extend over 800 kilometers through the northwestern region, crossing the states of Rajasthan, Haryana, and Delhi. The Gurugram region in Haryana exemplifies a distinct ecological niche, marked by its varied flora and fauna, complex geological structures, and notable weather fluctuations. The hills are crucial to the region's environment, serving as a natural barrier and affecting local weather patterns, water supplies, and biodiversity. Botanical diversity denotes the assortment of plant species within a specific region and is essential for ecosystem health and resilience. The plant diversity of the Aravali Hills is significant for both its ecological importance and its socio-economic ramifications [12]. The region sustains various species with medicinal, agricultural, and economic significance. The abundance of flora supports local economies and is integral to traditional practices and biodiversity preservation.

The Aravali Hills, especially in the Gurugram area, are under considerable threat from accelerated urbanization, industrialization, and population expansion [13]. Gurugram, one of India's swiftly advancing metropolitan hubs, has experienced significant alterations in land use, resulting in habitat degradation and fragmentation. Anthropogenic forces present substantial threats to local plant species, many of which are indigenous to the region or play crucial ecological roles. Previous research has recorded the botanical variety of the Aravali Hills, emphasizing significant species and their ecological functions. Studies reveal that the area hosts more than 700 blooming plant species [3], including a significant number of indigenous and unusual varieties. Prominent groups include Fabaceae, Poaceae, and Euphorbiaceae prevail in the environment, offering vital ecosystem services such as soil stabilization, carbon sequestration, and habitat for many wildlife species [12].

The Aravali Hills serve multiple essential ecological functions. They serve as a natural barrier, affecting local climate patterns and contributing to regional hydrology by functioning as a watershed. The hills are crucial for groundwater replenishment, sustaining the adjacent agricultural regions and metropolitan locales, like Gurugram. These hills act as a watershed that supplies neighboring rivers and enhances regional hydrology. The varied plant life contributes to soil preservation and erosion management, alleviating the effects of seasonal precipitation. Prevalent plant families like Fabaceae and Poaceae in the region, not only bolster the biological integrity of the area but also deliver vital ecosystem services, including carbon sequestration and habitat for diverse fauna. Additionally, the Aravali Hills enhance cultural and economic aspects by sustaining traditional practices and local livelihoods through the use of medicinal plants and other natural resources. Nonetheless, the ecological equilibrium is progressively jeopardized by urbanization, deforestation, and pollution, rendering it

imperative to acknowledge and safeguard the inherent worth of this biodiversity [12]. The Aravali Hills, especially within the Gurugram region, represent a complex and rich ecological system essential for environmental sustainability. Comprehending their ecological significance is crucial for guiding conservation initiatives and safeguarding their botanical diversity in the face of increasing human-induced stressors.

Notwithstanding the recognized significance of the plant diversity of the Aravali Hills, a substantial deficiency persists in detailed and systematic literature that consolidates current knowledge. Despite various research examining the topic from diverse perspectives, a comprehensive review article that consolidates findings, analyzes trends, and bridges knowledge gaps is absent. This systematic literature analysis seeks to address this gap by analyzing the existing studies on the flora variety of the Aravali Hills in the Gurugram region. This review article enumerates the plant species in the Aravali Hills, to evaluate the ecological importance of this diversity, to identify the principal threats to plant life in the region, and to analyze the current conservation initiatives and their efficacy. This article synthesizes current material to deliver a detailed assessment of botanical variety in the region, providing insights to drive future research, conservation strategies, and policy-making efforts for the preservation of this crucial ecological asset. The Aravali Hills in the Gurugram region epitomize a complex interaction between natural beauty and human activity. Comprehending and preserving the botanical diversity of this region is essential for ecological sustainability as well as for the cultural and economic welfare of the local inhabitants [17]. With escalating urban pressures, the significance of knowledgeable conservation measures is paramount, rendering this systematic review a pertinent addition to the domains of botany and ecology.

Geographic and Ecological Context

1. Overview of the Aravali Hills in Gurugram

The Aravali Hills, acknowledged as one of the oldest mountain ranges in the Indian subcontinent, spanning multiple states, including Rajasthan, Haryana, and Delhi. The Gurugram district of Haryana presents a distinctive ecological and geological setting, characterized by diverse biodiversity and intricate landscapes. The Aravalis in Gurugram have a succession of hills, valleys, and harsh landscapes, which enhance the region's aesthetic appeal and fulfill critical ecological roles [4].

The hills offer essential habitat for numerous plant species, many of which are indigenous to the area. It is estimated that more than 700 species of flowering plants flourish in this region, including notable representatives from the families Fabaceae, Poaceae, and Euphorbiaceae [3]. This plant diversity is not merely a natural asset; it is essential for supporting local ecosystems and sustaining wildlife populations. The diverse geography of the Aravalis facilitates a variety of microhabitats, enhancing the ecological richness of the region. Species including Acacia nilotica, Ziziphus jujuba, and Butea monosperma are prevalent, each offering vital resources for various insects, birds, and mammals [14-16].

Additionally, the Aravali Hills function as a crucial watershed for the Gurugram region, impacting both surface and groundwater resources. The hills facilitate the replenishment of aquifers and the regulation of water flow in nearby rivers and streams, a function that is becoming increasingly vital amid urban growth and water scarcity. With Gurugram's swift urbanization, the ecological roles of these hills are increasingly vital, as they alleviate flooding and soil erosion while offering green spaces that improve inhabitants' quality of life [12].

2. Climatic, Edaphic, and Topographical Characteristics

The climate of the Gurugram region, home to the Aravali Hills, is categorized as semi-arid, marked by pronounced seasonal fluctuations. The summer months, especially from April to June, can be exceedingly hot, with temperatures often above 40°C. Conversely, the winter months from November to February may experience temperatures declining to approximately 5°C [5]. The monsoon season, spanning from June to September, delivers the most of the region's yearly precipitation, averaging between 600 and 800 mm. This precipitation is essential for sustaining ecological equilibrium and fostering the rich flora that defines the hills [3]. The soil in the Aravali Hills exhibits considerable variation depending on elevation and land utilization. The primary soil types are sandy loam and clayey loam, typically well-drained but potentially low in fertility due to the underlying geological substrate [6]. The rocky outcrops of the hills, especially at elevated altitudes, sustain a distinct species of plant adapted to the less fertile soil conditions. This adaptability is essential for preserving the ecological diversity of the region, as numerous plant species flourish in nutrient-deficient soils, enhancing overall biodiversity [17-18]. The Aravali Hills exhibit a rough topography with altitudes varying from 300 to 600 meters above sea level. This height gradient generates diverse microclimates and habitats, facilitating the presence of varied plant groups [7]. Valleys, inclines, and geological formations significantly impact local ecosystems. Seasonal streams originating from the hills supply vital water supplies for flora and animals while enhancing soil moisture levels that support diverse plant species.

The intricate interaction among the hills' climatic conditions, soil properties, and topographical attributes cultivates a variety of ecosystems that sustain numerous wildlife species. This encompasses many avian species, like the Indian Peafowl and the Lesser Short-toed Lark, alongside mammals such as the Indian Fox and several reptilian species [3]. Diverse flora provides sustenance and habitat for these creatures while also playing a vital role in preserving ecological equilibrium. The physical and ecological setting of the Aravali Hills in Gurugram underscores its importance as a natural heritage site and a vital ecological area. The interplay of distinctive geological characteristics, variable weather conditions, and varied soil types fosters a rich flora diversity essential for the region's ecological integrity [12]. Comprehending these relationships is crucial for formulating effective conservation policies that will alleviate the effects of urbanization and save this unique natural resource for future generations.

Research Methodology

A search across multiple academic and scientific databases was made to ensure an extensive collection of pertinent literature.

1. Utilized Databases

The principal databases employed Google Scholar for an extensive array of scholarly articles and citations. Indexed journals were accessed for assessing research articles pertaining to botany, ecology, and environmental science. Articles that have undergone peer review were used to discern significant research and transdisciplinary investigations.

2. Terms and keywords used for literature search

A combination of keywords and phrases was utilized to encompass the extensive literature pertaining to the plant diversity in the Aravali Hills. The primary search phrases comprised: "Aravali Hills botanical diversity"
"Gurugram flora"
"Plant species in Aravali"
"Biodiversity Aravali Hills"
"Ecological Importance of the Aravali Range"
"Conservation initiatives for Aravali flora"
were employed (And/or) to enhance search precision, for instance:
"Aravali Hills and biodiversity"
"Gurugram, flora, and conservation"

3. Inclusion/Exclusion Criteria

Articles published in peer-reviewed journals from 2003 to 2023 to guarantee contemporary and pertinent information. Research concentrated on the botanical diversity, ecological importance, or protection of plant species in the Aravali Hills, especially in the Gurugram area. Investigations that encompass quantitative data, species inventories, or ecological evaluations were included.
Publications not published in English were excluded as the review seeks to be accessible to a wider readership. Articles that fail to specifically discuss the botanical characteristics of the Aravali Hills or are very generic in nature were also excluded.

4. Techniques for Data Extraction and Analysis

Data Extraction - A standardized form for data extraction was created to maintain consistency throughout the literature. Essential data points comprised:

- **a. Citation details:** Authors, year of publication, title, and source.
- **b. Methods Employed:** The techniques utilized for data collecting and analysis.
- **c. Findings:** Principal outcomes include plant species, ecological functions, threats, and conservation methodologies.
- **d. Geographic focus:** Designated regions examined inside the Aravali Hills, particularly highlighting the Gurugram area.
- **e. Biodiversity metrics:** Species richness, endemism, and conservation status when applicable.

5. Data Analysis

The extracted data was categorized to enhance analysis. The categories encompassed flora composition overview of plant species and families, encompassing indigenous and medicinal varieties. Ecological roles elucidate of the ecological functions rendered by the flora and recognition of anthropogenic pressures impacting biodiversity. Conservation Strategies depicts projects and their efficacy. Quantitative analysis was conducted where relevant, including the calculation of species richness and diversity indices. Qualitative analysis entailed integrating information to discern trends, research deficiencies, and emergent themes.

6. Synthesis of Findings

A narrative synthesis was created to amalgamate information from multiple investigations, emphasizing significant ideas and trends. This encompassed comparisons of floral composition across various research and regions within the Aravali Hills, alongside an evaluation of the cumulative knowledge regarding conservation initiatives.

7. Critical Evaluation

The reliability and validity of each study were evaluated based on methodology, sample size, and data integrity. This assessment facilitated the contextualization of the findings and the evaluation of the robustness of the evidence underpinning various assertions about botanical variety and ecological significance. This systematic methodology seeks to deliver a thorough and nuanced comprehension of the plant diversity in the Aravali Hills, specifically within the Gurugram region, hence offering useful insights for future study and conservation initiatives.

Floral Composition

The Aravali Hills, especially in the Gurugram area, have significant floristic richness, with more than 700 kinds of blooming plants recorded [15-16]. The region's unique climatic and geological circumstances significantly account for this richness, facilitating numerous ecosystems, including dry deciduous forests, scrublands, and grasslands [3]. Numerous plant groups and genera are prevalent in the flora of the Aravalis, enhancing the ecological diversity of the region.

1. Fabaceae (Leguminosae)

The Fabaceae family is a major contribution to the biodiversity of the Aravali Hills. This family comprises several genera, including *Acacia, Mimosa, and Dalbergia, Cassia fistula* (Table 1). Prominent species comprise: [10] [15-16]

- **a. *Acacia nilotica* (Indian Gum Arabic Tree):** This species is essential for nitrogen fixation and provides habitat for diverse creatures, including avifauna and insects.
- **b. *Mimosa pudica* (Sensitive Plant):** Recognized for its distinctive leaf movement upon tactile stimulation, this plant contributes to soil conservation through its large root system.

2. Poaceae (Family of Grasses)

The Poaceae family is prominently found in the Aravalis, offering essential ecological services. Notable species comprise:

a. ***Cenchrus ciliaris*** **(Buffel Grass):** This grass is highly suited to arid environments and aids in mitigating soil erosion.

b. ***Pennisetum glaucum:*** **(**Pearl Millet) serves not just an ecological function but also plays a crucial role as a crop in the region, enhancing local food security (Table 1).

3. Euphorbiaceae (Spurge Family)

The Euphorbiaceae family comprises various species that are suited to the arid environment of the Aravalis. Principal species comprise:

a. ***Euphorbia hirta:*** Frequently used in traditional medicine, this plant is esteemed for its therapeutic attributes and capacity to flourish in suboptimal soil circumstances.

b. ***Euphorbia royleana:*** This species is essential for preserving soil stability and mitigating erosion. Other significant families that enhance the floristic variety of the region comprise *Asteraceae, Lamiaceae, and Rubiaceae*. [4].

4. Endemic, Rare, and Threatened Species

The Aravali Hills host numerous indigenous and uncommon plant species that are crucial for conservation initiatives. The region's endemism illustrates its distinctive ecological conditions and geological history. Among the distinguished endemic species are given below.

a. ***Hymenocallis littoralis:*** This bulbous species, recognized for its prominent white blossoms, is predominantly located in particular environments within the Aravalis. Its existence signifies the vitality of the local ecology.

b. ***Murraya koenigii*** **(Curry Leaf Tree):** Esteemed for its culinary and medicinal applications, this species is regarded as rare and is endangered by habitat destruction resulting from urban expansion.

c. ***Vachellia leucophloea*** **(White Bark Acacia):** This species is ecologically significant for offering shade and habitat. however, it faces threats from urban development and alterations in land use.

d. ***Dendrocalamus strictus*** **(Bamboo):** This species is economically significant for construction and crafts. The preservation of these endemic and endangered species is essential for sustaining the ecological integrity of the Aravali Hills. These plants frequently fulfill distinct functions within their ecosystems and act as markers of environmental health [7].

5. Medicinal and Economically Significant Flora

The botanical richness of the Aravali Hills includes numerous medicinal and commercially significant species, which hold considerable cultural and commercial importance for local populations. The utilization of these species underscores the convergence of biodiversity and traditional behaviors [9-11].

5.1 Pharmaceutical Flora

The area is abundant in medicinal plants, with numerous species employed in traditional Ayurvedic and herbal therapies. Notable instances encompass:

a. ***Withania somnifera*** **(Ashwagandha):** This herb is esteemed for its adaptogenic qualities, facilitating stress alleviation and promoting general well-being. It is essential in traditional medicine and has become increasingly popular in contemporary health practices [5].

b. ***Ocimum sanctum*** **(Holy Basil), also known as Tulsi:** Tulsi, recognized for its spiritual importance and therapeutic attributes, is a fundamental component in herbal treatments and is said to offer several health advantages, such as anti-inflammatory and antibacterial capabilities (Table 1).

5.2 Plants of Economic Significance

Numerous species in the Aravali Hills furnish supplies that bolster local economies and livelihoods. Prominent instances comprise:

a. ***Butea monosperma*** **(Flame of the Forest):** This species possesses ecological importance and cultural relevance, as its vivid blossoms are utilized in traditional dyeing methods and celebrations. Moreover, the timber is in demand for construction and craftsmanship [3].

b. ***Ziziphus jujuba*** **(Jujube):** This fruit-bearing tree enhances local food security and possesses potential commercial worth in the fruit market. Their fruits are healthy and are conventionally utilized in diverse culinary applications.

The floristic makeup of the Aravali Hills in the Gurugram region is marked by a varied range of plant groups, genera, and species. Ongoing research and conservation initiatives are crucial to protect this richness and guarantee the sustainability of the region's ecosystems for future generations.

Types of Vegetation

The Aravali Hills in the Gurugram region have a varied assortment of flora varieties, influenced by the area's distinct meteorological, topographical, and soil characteristics. This diversity is crucial for sustaining ecological equilibrium and facilitating numerous wildlife species. Comprehending the primary plant communities and their distributions offers insight into the ecological dynamics of this region.

1. Principal Plant Communities and Their Distribution

1.1 Arid Deciduous Forests

Dry deciduous forests dominate the lower elevations of the Aravali Hills, distinguished by a seasonal leaf abscission during the arid months. These forests generally flourish in

regions with moderate precipitation (about 600-800 mm yearly) and are predominantly located on the southern and eastern inclines of the hills [3]. These woods are extensively located in the slopes and valleys, characterized by relatively fertile soil and enhanced moisture retention. The heterogeneous canopy generates varied microhabitats that sustain a multitude of wildlife and flora.

1.2 Scrublands

Scrub lands prevail in the arid and harsh regions of the Aravali Hills, especially at elevated altitudes where soil is poor and precipitation is scarce. This community is defined by short, dense vegetation and is frequently located on rocky outcrops and steep inclines [7]. Scrublands are abundant on the western and northwestern slopes of the hills, characterized by reduced rainfall and more sunshine exposure. These regions are essential for preserving soil stability and averting erosion.

1.3 Prairies

Grasslands represent another important vegetation type in the Aravalis, frequently interspersed with wooded regions and scrublands. These environments are predominantly composed of diverse grass species and are distinguished by the absence of tall woody vegetation [5]. Grasslands predominantly occur in open regions and disturbed locations, including roadsides and abandoned agricultural fields. They function as vital grazing areas for herbivores and enhance local biodiversity.

Table 1: List of native plants in Gurugram region [6, 15-18]

S. No.	Common Name	Scientific Name	Family
1	Ultakanta	*Achyranthes aspera*	Amaranthaceae
2	Pila bansa	*Barleria prionitis*	Acanthaceae
3	Gandhi	*Blumea lacera*	Asteraceae
4	Santi/punarnava	*Boerhavia diffusa*	Nyctaginaceae
5	Kair	*Capparris decidua*	Capparaceae
6	Buffalo grass	*Cenchrus ciliaris*	Poaceae
7	Vativeria	*Chrysopogon zizanioides*	Poaceae
8	Hadjod	*Cissus quadrangularis*	Vitaceae.
9	Kukar Bhangra	*Cloeme gynandra*	Caparaceae
10	Hulhul	*Cloeme viscosa*	Cleomaceae
11	Arno	*Clerodendrum phlomidis*	Lamiaceae
12	Indigo	*Indigofera linifolia*	Fabaceae
13	Kharsana	*Crotolaria burhia*	Fabaceae
14	Sticky snoutbean	*Rhynchosia viscosa*	Fabaceae
15	Rati	*Abrus precatorius*	Fabaceae
16	Fevernut	*Caesalpinia bonduc*	Caesalpiniaceae
17	Badberi	*Ziziphus*	Rhamnaceae
18	Gwar	*Cyamopsis*	Fabaceae
20	Arhar	*Cajanus*	Fabaceae
21	Babul	*Acacia*	Fabaceae
22	Sahjan	*Moringa oleifera*	Moringaceae
23	Khair	*Senegalia catechu*	Fabaceae
24	Amla	*Phyllanthus emblica*	Phyllanthaceae
25	Keekar	*Prosopis juliflora*	Fabaceae
26	Babool	*Acacia nilotica*	Fabaceae
27	Jhinjheri	*Bauhinia racemos*	Caesalpiniaceae
28	Bistendu	*Diospyros cordifolia*	Ebenaceae
29	Maulasari	*Minusopus elengi*	Sapotaceae
30	Fig	*Ficus ebupacea*	Moraceae
31	Fig	*Ficus benghalensis*	Moraceae
32	Rubber tree	*Ficus elastica*	Moraceae
33	Mahua	*Madhua longifolia*	Sapotaceae
34	Goolar	*Ficus racemose*	Moraceae
35	Pilkhan	*Ficus virens*	Moraceae
36	Peepal	*Ficus religiosa*	Moraceae
37	Papri	*Haloptelea integrifolia*	Ulmaceae
38	Ber	*Zizipus mauritiana*	Rhamnaceae
39	Harshingar	*Nyctanthes arbor tristis*	Oleaceae
40	Arjun plant	*Terminalia arjuna*	Combretaceae
41	Lasora	*Cordia dichotoma*	Boraginaceae
42	Kadam	*Neolanarckia cadamba*	Rubiaceae
43	Dhau	*Anogeissus pendula*	Combretaceae
44	Weeping fig	*Ficus benjamina*	Moraceae
45	Shahtot	*Morus alba*	Moraceae
46	Peelu	*Salvadora persica*	Salvadoraceae
47	Mango	*Mangifera indica*	Anacardiaceae
48	Gamhar	*Gmelina arbora*	Lamiaceae
49	Champa	*Plumeria rubra*	Apocynaceae

50	Thor Indian spurge	*Euphorbia neriifolia*	Euphorbiaceae
51	Doodhi	*Wrightia tinctoria*	Apocynaceae
52	Khirni	*Manilkara hexandra*	Sapotaceae
53	Gondi	*Cordia gharaf*	Boraginaceae
54	Kaim	*Mitragyna parviflora*	Rubiaceae
55	Baheda	*Terminalia bllirica*	Combretaceae
56	Jangli arand	*Jatropha curcus*	Euphorbiaceae
57	Bottle brush	*Callistemon viminalis*	Myrtaceae
58	Kaner	*Thevetia peruviana*	Apocynaceae
59	Roheda	*Tecomella undulata*	Bignoniaceae
60	Hingot	*Balanites roxburghii*	Zygophyllaceae
61	Kachnar	*Bauhinia variegata*	Fabaceae
62	Bael	*Aegle marmelos*	Rutaceae
63	Dhak	*Butea monosperma*	Fabaceae
64	Imli	*Tamarindus indica*	Fabaceae
65	Neem	*Azadiracta indica*	Meliaceae
66	Kadi patta	*Bergera koengii*	Rutaceae
67	sausage tree	*Kigelia africana*	Bignoniaceae
68	silky oak	*Grevillea robusta*	Proteaceae
69	Shisham	*Dalbergia sisso*	Papilionaceae (Fabaceae)
70	kamini	*Murraya paniculata*	Rutaceae
71	marodfali	*Fernandoa adenophyllum*	Bignoniaceae
72	Ronjh	*Acacia leucophloea*	Fabaceae
73	Goya khair	*Dichrostachys cinerea*	Fabaceae
74	Khejdi	*Prosopis cineraria*	Fabaceae
75	Jungle jalebi	*Pithecellobium elulce*	Fabaceae
76	Siris	*Albizia lebbeck*	Fabaceae
77	Krishna siris	*Albizia amara*	Fabaceae
78	Doon siris	*Albizia procera*	Fabaceae
79	Gulmohur	*Peltophorum africanum*	Fabaceae
80	Bakain	*Melia azedaracta*	Meliaceae
81	Gokhru	*Tribulus terrestris*	Zygophyllaceae
82	Chulai	*Amaranthus*	Amaranthaceae
83	Makoi	*Solanum nigrum*	Solanaceae
84	Googal	*Commiphora wightii*	Burseraceae
85	Adoosa	*Adhatoda vasica*	Acanthaceae
86	kair	*Capparis desidua*	Capparaceae
87	Date	*Phoenix dactylifera*	Arecaceae
88	Moonj	*Saccharum raveneae*	Poaceae
89	Kendu	*Diospyros cordifolia*	Ebenaceae
90	Ashwagandha	*Withania somnifera*	Solanaceae
91	Tulsi	*Ocimum sanctum*	Lamiaceae

Bamboo groves, especially of *Dendrocalamus strictus*, are a notable characteristic of the Aravali Hills, typically located in damp, protected regions inside the forests. These groves furnish essential resources for local communities, encompassing construction materials and fuelwood [4]. Bamboo is generally found in valleys and adjacent to water bodies, where soil moisture levels are elevated. These groves are essential for providing habitat for numerous bird species and other wildlife.

2. Predominant Species in Each Vegetation Type

Table 1 and Figure 1 show some of the prominent native plant species of Aravali region of Gurugram. Some of the important species in each vegetation type are given below.

2.1 Arid Deciduous Forests

The principal species in the dry deciduous woods of the Aravali Hills comprise:

a. ***Acacia nilotica*** **(Indian Gum Arabic Tree):** This tree is vital for its nitrogen-fixing properties and offers habitat and sustenance for several avian and insect species.

b. ***Ziziphus jujuba*** **(Jujube):** Recognized for its consumable fruits, this tree enhances biodiversity and supports local agriculture.

c. ***Butea monosperma*** **(Flame of the Forest):** Esteemed for its vivid blossoms and lumber, this species significantly contributes to the local economy.

2.2 Scrublands

In scrubland ecosystems, the predominant species are adapted to arid environments.

a. ***Mimosa pudica*** **(Sensitive Plant):** Its capacity to flourish in disturbed and arid environments renders it a prevalent species in this society.

b. ***Euphorbia royleana:*** This succulent thrives in the arid, rocky environments of scrublands and is frequently utilized in traditional medicine.

c. ***Capparis decidua*** **(Caper Bush):** This plant is recognized for its robustness in extreme conditions and provides sustenance for indigenous wildlife

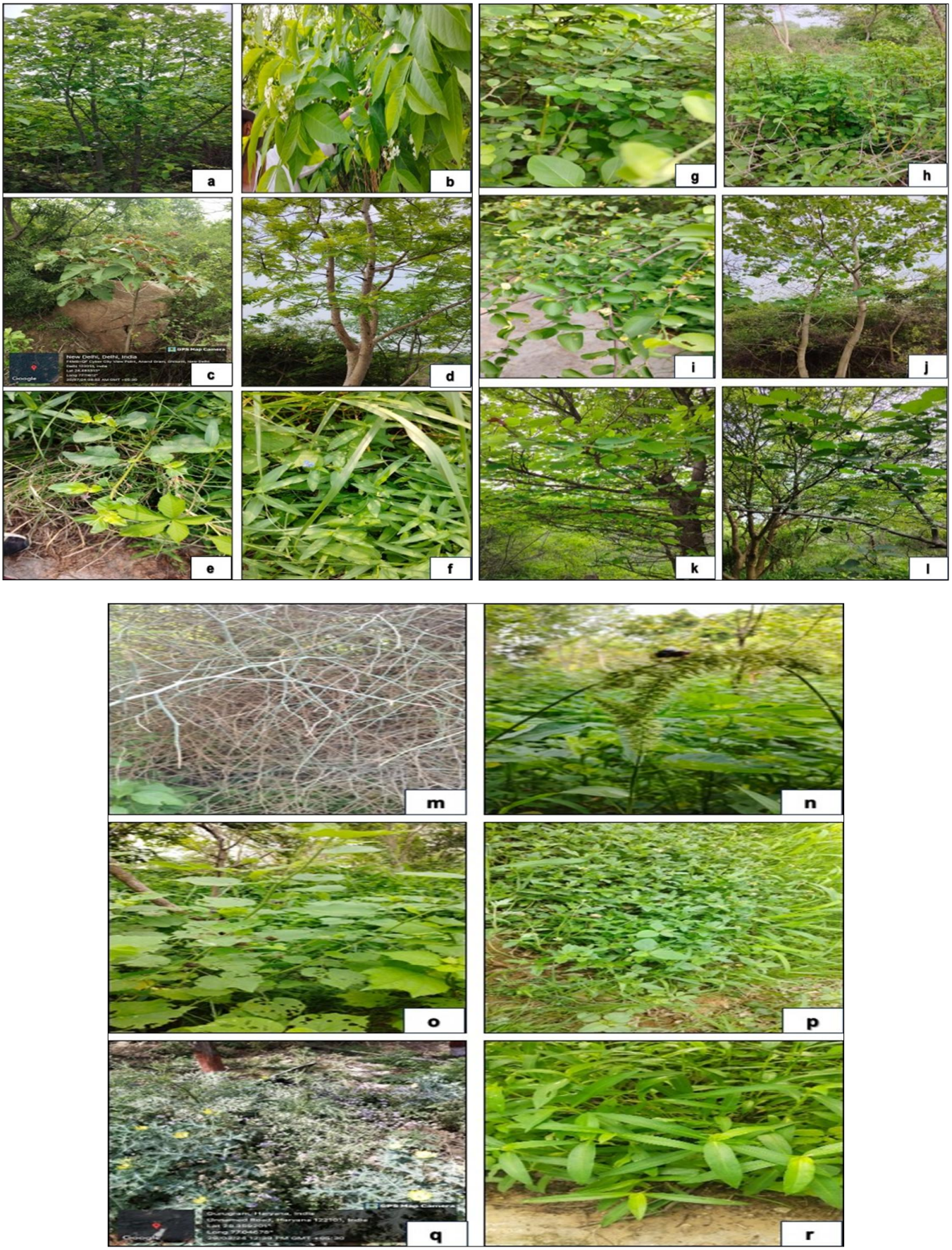

Fig 1: Some important native flora of Aravali: a) *Kadam;* b) *Holarrhena antidysentrica;* c) *Hymenodictyon;* d) *Boswellia serrata* (salai); e) *Boerrahavia;* f) *Commelina;* g) *Capparis sepiria;* h) *Barleria* (vajardanti); i) *Grewia tenax;* j) *Gmelina arborea* (gamhar); k) *Bauhinia*; l) *Ficus carica* (jungle anjeer); m) *Capparis decidua;* n) *Setaria;* o) *Abutilon indicum* (Indian mallow); p) *Tridex*; q) *Argemone maxicana;* r) *Commelina*

2.3 Grasslands

Prominent species in the grasslands comprise

a. ***Cenchrus ciliaris* (Buffel Grass):** This grass is crucial for soil stabilization and is favored for grazing by animals.
b. ***Pennisetum glaucum* (Pearl Millet):** Although mostly grown for consumption, it also holds importance in the region's natural grasslands.

2.4 Bamboo groves

In bamboo groves, *Dendrocalamus strictus* is the predominant species. This bamboo is distinguished for its swift growth and adaptability in supplying resources, including construction materials for local dwellings and crafts, fuelwood utilized for culinary and heating purposes and a habitat for diverse avian species, rendering it an essential component of the ecosystem. The vegetation types of the Aravali Hills in the Gurugram region exemplify the complexity and richness of the indigenous flora. Every plant community, characterized by its predominant species, is essential for maintaining the ecosystem's health and diversity. Safeguarding these varied habitats is crucial for preserving ecological equilibrium and supporting the multitude of species that depend on them.

Biodiversity patterns

The Aravali Hills in the Gurugram region exemplify complex biodiversity patterns shaped by various ecological factors, including climate, topography, and human activity. Understanding species richness and diversity indices, as well as altitudinal and spatial distribution patterns, is crucial for effective conservation strategies and ecological management [12].

1. Species richness and diversity indices

Species richness, defined as the number of different species in a given area, is a fundamental aspect of biodiversity. To quantify biodiversity, several diversity indices are employed, with the most common being the Shannon-Wiener index and Simpson's index.

2. Altitudinal and spatial distribution patterns

The altitudinal gradient in the Aravali Hills significantly influences plant distribution and community composition. This variation in elevation—from around 300 meters to over 600 meters—creates distinct microclimates and habitats that foster unique plant communities.

3. Altitudinal distribution

At lower elevations (300-400 meters), dry deciduous forests dominate, characterized by species such as *Acacia nilotica* and *Butea monosperma*. These forests benefit from slightly higher moisture retention due to lower evaporation rates [4]. Mid-elevation zones (400-500 meters) often transition into mixed deciduous forests, where species richness peaks. Here, a combination of dry and moist forest species coexists, reflecting the diverse ecological conditions [3]. Higher elevations (500-600 meters) are primarily characterized by scrubland and rocky outcrops. These areas are home to drought-resistant species such as *Mimosa pudica* and *Capparis decidua*, which have adapted to the harsher conditions [6].

4. Spatial distribution patterns:

The spatial distribution of plant communities within the Aravali Hills is influenced by several factors, including soil type, land use, and human activity. For instance, areas with fertile soil and adequate moisture, such as valleys and lower slopes, typically support more diverse plant communities [7]. Urbanization has significantly impacted spatial distribution patterns, particularly in and around Gurugram. Encroachment on natural habitats has led to habitat fragmentation, reducing the available space for many native species. This has caused shifts in species composition and may threaten local biodiversity [5].

Additionally, roads and agricultural land have altered the natural corridors for wildlife, impacting the distribution of various plant species. Studies have indicated that species such as *Dendrocalamus strictus* have declined in areas heavily affected by human activities [3].

The biodiversity patterns in the Aravali Hills reflect a rich and complex ecological tapestry influenced by altitude, spatial distribution, and human activities. Species richness and diversity indices indicate that while certain habitats, particularly forests, are biodiverse, others, like scrublands and grasslands, exhibit lower diversity. Understanding these patterns is vital for implementing effective conservation measures and promoting sustainable management practices in the region.

Ecological factors affecting diversity

The biodiversity of the Aravali Hills in the Gurugram region is influenced by a complex interaction of ecological elements, such as soil properties, terrain, microclimate, and human activities. Comprehending these aspects is essential for the formulation of effective conservation and management policies intended to preserve the area's abundant plant diversity.

1. Influence of Soil Properties, Terrain, and Microclimate

1.1 Pedological attributes

Soil is crucial in defining the types of vegetation that can flourish in a specific region. The Aravali Hills display a diverse array of soil types, shaped by weathering processes, parent material, and anthropogenic influences.

1.2 Soil Texture and Nutrient Composition

The soils in the region vary from sandy loams to clayey types, influencing water retention and nutrient accessibility. The fertile alluvial soils in valleys sustain verdant dry deciduous woods, which harbor a variety of flora, including species such as *Ziziphus jujuba* and *Butea monosperma* [3]. Conversely, the drier, stony soils at elevated altitudes typically sustain scrublands featuring drought-resistant flora such as *Capparis decidua* and *Mimosa pudica* (Figure 1) [7].

1.3 Soil pH and Organic Matter

Soil pH affects plant diversity, with neutral to slightly acidic soils typically fostering increased biodiversity. Regions rich in organic matter, characteristic of forested areas, generally sustain a more intricate plant community owing to increased nutrient availability and moisture retention [6].

2. Geographical features

The physical characteristics of the Aravali Hills markedly affect microhabitats and, as a result, plant distribution and diversity. Variations in elevation provide distinct

microclimates, influencing temperature, humidity, and solar exposure. Lower slopes with gentle gradients typically retain greater moisture and sustain diverse plant communities, while steep, rocky slopes endure harsher conditions, resulting in the predominance of robust scrub and grassland species [5].

The direction of slopes (north-facing versus south-facing) influences vegetation. North-facing slopes, receiving diminished direct sunlight, generally sustain elevated humidity levels and accommodate a distinct array of plant species in contrast to sunlit south-facing slopes, where xerophytic species predominate [4].

3. Microclimate

Microclimatic changes within the Aravali Hills augment biodiversity. Elements such as vegetation cover, moisture retention, and wind exposure can establish isolated habitats that sustain distinct plant groups.

3.1 Vegetation canopy

Dense Forest canopies generate shaded settings that sustain elevated humidity and colder temperatures, fostering the establishment of shade-tolerant species. Species such as *Ficus carica* (Figure 1) and *Cinnamomum tamala* (Tejpat) flourish in these understory conditions [3].

3.2 Humidity and rainfall patterns

Regions in proximity to aquatic environments or characterized by dense vegetation typically exhibit elevated humidity levels, fostering a diverse array of plant life. In contrast, open areas with no vegetation undergo increased evaporation and heat, hence restricting species diversity [7].

3.3 Climate change

Climate change is altering precipitation patterns and increasing temperatures, which can have profound effects on plant communities. Changes in climate can shift suitable habitats for many species, making it challenging for them to adapt quickly enough to survive.

3.4 Altered growth cycles

Changes in seasonal weather patterns can affect flowering times, pollinator interactions, and overall plant health, potentially leading to mismatches in ecological relationships [5].

Human Impacts on Plant Diversity and threats to botanical diversity in the region

Human activities have significantly influenced the biodiversity of the Aravali Hills, resulting in both beneficial and detrimental effects on plant species.

1. Urbanization and Alterations in Land Utilization

The swift urbanization in and surrounding Gurugram has resulted in considerable habitat loss and fragmentation. Natural environments are progressively being transformed into residential, commercial, and industrial zones, altering local ecosystems and diminishing the space available for indigenous plant species.

1.1 Habitat fragmentation

Fragmented habitats typically sustain a diminished number of species in the surviving regions. Fragmentation restricts gene flow among plant populations and may result in local extinctions, especially for species with unique environmental needs. As urban areas expand, remaining natural habitats are often isolated, which can disrupt the ecological processes essential for species survival. This fragmentation can lead to reduced genetic diversity and increased vulnerability to extinction for certain plant populations [5].

1.2 Invasive species

Urban settings can promote the proliferation of invasive species that surpass native vegetation in resource acquisition. The introduction and spread of invasive plant species pose a significant threat to native biodiversity in the Aravali Hills. Species such as *Lantana camara* and *Prosopis juliflora* can outcompete native flora for resources, disrupting local ecosystems and reducing overall plant diversity. Invasive species often thrive in disturbed habitats and can rapidly colonize areas, leading to the decline or extinction of native species that cannot compete for sunlight, nutrients, or water [7].

2. Agricultural methods

Agricultural growth and practices, such as monoculture farming and the excessive application of fertilizers and pesticides, have impacted plant diversity. The conversion of natural habitats into agricultural land has also contributed to biodiversity loss. Intensive farming practices often involve monoculture, which reduces habitat complexity and negatively impacts native flora.

2.1 Soil degradation

Intensive agriculture may result in soil degradation, depletion of organic matter, and diminished fertility, negatively impacting plant variety in adjacent regions [6].

2.2 Modified hydrology

Irrigation activities can disrupt natural water flow patterns, affecting local plant ecosystems. Variations in water availability may result in alterations in species composition, privileging those capable of adapting to changed hydrological regimes [7].

3. Conservation initiatives and Reforestation

Despite the challenges posed by urbanization and agriculture, there are beneficial anthropogenic effects, notably through conservation initiatives and reforestation operations designed to rehabilitate degraded ecosystems.

3.1 Protected areas

The creation of protected areas and reserves in the Aravali range has proven essential for biodiversity conservation. These regions serve as sanctuaries for indigenous species and facilitate the preservation of biological processes [4].

3.2 Sultanpur National Park

Located near Gurugram, this park is vital for preserving the region's wetlands and supporting a rich variety of flora and fauna. It serves as a crucial habitat for migratory birds and helps maintain the ecological balance of the area [3].

3.3 Aravalli Biodiversity Park
This park aims to restore the natural ecosystem and enhance biodiversity through habitat restoration efforts. It provides a refuge for native species and offers educational programs to raise awareness about the importance of conservation [7].

3.5 Community initiatives
Local community engagement in conservation efforts, including afforestation and sustainable land management methods, has demonstrated potential in rehabilitating degraded habitats and improving plant variety [3]. Ecological variables affecting biodiversity in the Aravali Hills are complex, with soil properties, terrain, and microclimate significantly influencing plant groups. Furthermore, human-induced factors pose both obstacles and prospects for plant variety. Effective conservation efforts must account for these biological processes and anthropogenic influences to save the region's abundant floral heritage.

The conservation status of botanical diversity in the Aravali Hills of the Gurugram region is a critical issue, given the rich biodiversity and the increasing pressures from urbanization and environmental change. Understanding the threats to this diversity and the existing conservation efforts is essential for formulating effective management strategies.

3.6 Reforestation initiatives
Various non-governmental organizations and community groups are involved in reforestation efforts aimed at restoring degraded habitats. These initiatives focus on planting native species that are well-suited to the local environment.

Local communities are often involved in these reforestation efforts, which not only help restore ecosystems but also promote sustainable livelihoods through eco-tourism and community-based resource management [5].

4. Legislation and policy frameworks
The Indian government has implemented various policies aimed at biodiversity conservation, including the Wildlife Protection Act and the Forest Conservation Act. These laws provide a legal framework for protecting natural habitats and managing resources sustainably.

5. Biodiversity action plans
The development of state-level biodiversity action plans helps to identify priority areas for conservation and outlines strategies for protecting species and habitats at risk [6].

6. Research and monitoring
Ongoing research is essential for understanding the dynamics of biodiversity in the Aravali Hills. Monitoring programs help track changes in plant populations and assess the effectiveness of conservation strategies. Partnerships between academic institutions, government agencies, and conservation organizations facilitate the sharing of knowledge and resources, enhancing the capacity for effective conservation [3].

The conservation status of botanical diversity in the Aravali Hills is under significant threat from urbanization, invasive species, agricultural practices, and climate change. However, existing conservation efforts, including protected areas, reforestation initiatives, and legislative frameworks, provide a foundation for protecting this vital biodiversity. Continued collaboration between stakeholders, community involvement, and adaptive management strategies are essential for ensuring the long-term sustainability of the region's rich botanical heritage.

Areas of insufficient knowledge and prospective research avenues
Notwithstanding the considerable botanical diversity in the Aravali Hills in the Gurugram region and the continuous conservation initiatives, numerous knowledge gaps remain that obstruct effective management and preservation of this biodiversity. Recognizing these deficiencies and proposing future study avenues is essential for improving our comprehension of the region's ecological dynamics.

1. Taxonomic Diversity and Species Cataloging
Although more than 700 plant species have been recorded in the region, rigorous taxonomic research are still required to precisely identify and classify lesser-known species. A significant portion of the local flora may be either unreported or misdiagnosed, especially among cryptic species or those exhibiting morphological similarities [5].

2. Endemism and Rare Species
There has been minimal research on endemic and rare species in the Aravali Hills. Comprehending the distribution, population dynamics, and ecological needs of these species is crucial for focused conservation initiatives [7].

3. Ecological Interactions and Community Dynamics
The complex interactions among various plant species and between flora and animals remain inadequately comprehended. Research on ecological interactions, including pollination dynamics, seed dispersal processes, and interspecies competition, is insufficient.

Microhabitat Studies: Comprehensive investigations of microhabitats and their distinct circumstances may elucidate the impact of local environmental factors on species distribution and community structure [3].

4. Consequences of Climate Change
Although there is considerable recognition of climate change's impact on biodiversity, localized research evaluating the responses of individual plant groups to shifting climatic circumstances are limited.

Phenological Studies: Investigations into phenological alterations—such as variations in flowering periods or fruiting behaviors—can elucidate the impact of climate change on plant species and their relationships with pollinators and other creatures [6].

5. Soil Microbial Diversity and Ecosystem Functionality
The influence of soil microorganisms on plant health, nitrogen cycling, and ecosystem functioning in the Aravali Hills is little researched.

Soil Health Assessments: Investigations that combine soil health evaluations with plant diversity research can improve our comprehension of the essential relationship between soil biodiversity and plant communities [5]. Addressing the information deficiencies in plant variety and ecology of the

Aravali Hills is essential for effective conservation and management methods. Future study can substantially aid in the preservation of the region's diverse plant life and the ecosystems they sustain by emphasizing thorough surveys, interdisciplinary methodologies, and community involvement.

Conclusion

The Aravali Hills in the Gurugram region constitute a crucial ecological area characterized by extensive flora diversity, which is essential for both the local ecology and the cultural and economic framework of the region. This diversity results from a unique combination of climatic conditions, varying topography, and diverse soil types, leading to separate plant communities that encompass numerous endemics and commercially significant species. The hills provide as a sanctuary for numerous plant species, offering essential ecosystem services including soil stabilization, water retention, and wildlife habitat. This biodiversity is increasingly jeopardized by several anthropogenic factors, including as growing urbanization, the spread of exotic species, climate change, and unsustainable agricultural methods. The challenges presented by these threats underscore the pressing necessity for effective conservation measures that not only save current habitats but also seek to rehabilitate those that have been compromised.

The fast urbanization of Gurugram has resulted in considerable habitat destruction and fragmentation, disturbing the fragile equilibrium of local ecosystems. Invasive plants, frequently introduced via human activities, outcompete indigenous flora, reducing plant diversity and modifying ecosystem dynamics. Moreover, climate change adds another dimension of complexity, influencing precipitation patterns and temperature variations, which subsequently affect plant growth, reproduction, and interspecies interactions. The convergence of these forces necessitates a holistic conservation strategy that recognizes and tackles these interconnected concerns.

Notwithstanding the acknowledgment of these challenges, much progress has been achieved in conservation initiatives, notably through the creation of protected areas like Sultanpur National Park and the Aravalli Biodiversity Park. These regions function as essential refuges for indigenous species and offer significant prospects for ecological research and education. Furthermore, community-based efforts focused on reforestation and habitat restoration have shown encouraging results, both in improving local biodiversity and in promoting sustainable behaviors among inhabitants. The efficacy of these approaches frequently depends on public knowledge and engagement, highlighting the necessity for educational activities that might enhance understanding of biodiversity's significance and encourage community involvement in conservation efforts.

Looking ahead, it is evident that substantial knowledge gaps persist about the plant richness of the Aravali Hills. Thorough taxonomic investigations are essential to precisely record species diversity, especially for obscure or inadequately researched species that may possess ecological or therapeutic importance. Research on ecological interactions, including pollination dynamics and interspecies competition among plants, is urgently needed to further our understanding of the determinants affecting community composition and ecosystem functionality. The effects of climate change on local plant species and ecosystems necessitate focused longitudinal research to monitor changes over time, yielding critical data for adaptive management options.

Involving local populations in research and conservation is essential for improving the efficacy of biodiversity preservation initiatives. Community engagement enhances data collecting and cultivates a sense of ownership and accountability for local biodiversity. Initiatives that foster citizen science—where the public engages in monitoring and documenting plant species—can significantly enhance knowledge and raise awareness of the region's ecological importance.

In conclusion, the preservation of floral diversity in the Aravali Hills transcends ecological significance; it embodies a dedication to safeguarding our natural legacy amid swift transformation and development. The way forward requires a comprehensive strategy that integrates scientific research, community involvement, and strong conservation policies. By adopting these features, stakeholders may strive for a sustainable future that preserves the diverse biodiversity of the Aravali Hills while respecting the complex ecosystems that characterize this exceptional location. It is our collective duty to guarantee the survival of vital plant species and their habitats for future generations, fostering a legacy of biodiversity that enhances our existence and maintains the planet.

Acknowledgement

The authors are grateful to Haryana Forest department (Gurugram region) and the team members of ‘Iamgurgaon’ for providing additional information about native plants in Aravali region and changing landscape over decades.

Author’s contribution

Design and conceptualization: J.S., M. S. and M. M.; Wrote the manuscript: J.S. and M. S.; Critically reviewed manuscript: M.S. and M.M. All authors have read and agreed to the published version of the manuscript.

References

1. Aravalli biodiversity Park Gurgaon, Making of a city forest (2010-2020) A ten-year report by iamgurgaon
2. Sheeba AMIR, Kelly Shannon the Taking and Making of a Forest —Socio-Ecological Transformations of the Aravalli Hills, India
3. Mohammad Ehsaan Dulloo, Nigel Maxted. Plant Genetic Resources conservation and utilization – crop wild relatives, 2019.
4. Nassary EK, BH Msomba, WE Masele. Exploring urban green packages as a part of nature-based solution for climate change adaptation measure in rapidly growing cities of global south, 2022.
5. Hooker JD. (1872-97). Flora of British India Vol. I-VII.L
6. Duthie JF. (1903-22) Flora of upper Gangetic plains and adjacent Shivalik and sub-Himalayan tracts Vols. 1-3.
7. Maheshwari JK. Flora of Delhi Council of Scientific and Industrial Research, Delhi, 1963.

https://flowersofindia.net,http://www.theplantlist.org/, http://powo.science.kew.org/
8. Hughes KA, P Convey. Determining the native/ non-native status of newly discovered terrestrial and freshwater species in Antarctica current knowledge, 2012.
9. Willis KJ, H J B Birks. What is natural? The need for a long-term perspective in biodiversity conservation, 2006.
10. Narendra Kumar, SM Paul Khurana. Medicinal plant's wealth of Aravalli Hills, Gurgaon district, Haryana, 2020.
11. Mohan Lal, BD Vashistha. Floristic diversity and ethnobotanical study of some part of southern Haryana, Block Narnaul, district Mahendergarh, Haryana, India. International journal of Botany studies 2021.
12. Singh A. An ethnobotanical study of medicinal plants in Bhiwani district of Haryana, India. J. Medicinal Plants Studies,2016:4(2):212-215.
13. Baliyan, R. The Spine of Haryana: Ecological and Historical Significance of Aravalli Hills. International Journal of Innovative Science and Research Technology,2024:9(9):363-366. https://doi.org/10.38124/ijisrt/IJISRT24SEP412.
14. Centre for Science and Environment, CSE. Vanishing Aravallis: Mining, Real Estate, and the Greed Game, 2018. https://www.cseindia.org
15. https://www.researchgate.net/publication/341619367_Floristic_diversity_and_vegetation_analysis_of_the_community_forests_of_South-West_Haryana_India
16. Pradeep Bansal, Amrender Singh Rao, Surender Singh Yadav, MS Bhandoria. Floristic diversity of wild exotic ornamental species from Aravalli hill ranges of Rewari district of Haryana, India, 2022.
17. Pradeep Bansal, Amrender Singh Rao, Surender Singh Yadav, MS Bhandoria, SS Dash. Floristic diversity of native wild ornamental plants of Aravalli hill Range, A case study from district Rewari, Haryana, India, 2023.
18. State Forest Report, Haryana, 2019
19. Plants of the Northern Aravalli Range in Delhi, Department of Forest and Wildlife Gnct Of Delhi.