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Conservation priorities in Central Asia: the Shorsuv Massif IPA and its role in the Fergana Valley's biodiversity

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Introduction: The Fergana Valley (FV), a hotspot of endemicity and one of the most densely populated regions in Central Asia, faces increasing anthropogenic pressure.

Methods: In this study, geospatial conservation assessment and grid-based mapping of wild flora were integrated with traditional IPA identification methods recommended by Plantlife, resulting in a significant enhancement of the standard IPA approach.

Results: The Shorsuv Massif and its surrounding areas were identified as an IPA, meeting Criteria A and C of the IPA criterion developed by Plantlife. Given the unique biodiversity of the FV, the lack of IUCN Category I protected areas in the Uzbek part, and the increasing pressure of human activities, documentation and conservation of the plant diversity according to Plantlife criteria is of global importance. As a continuation of research in this direction, this paper details the identification of a third IPA in FV, located in the variegated outcrops of the Turkestan Range in the southwest of FV. Detailed field surveys and grid mapping documented 349 vascular plant species, including 42 threatened species under Criterion A of Plantlife International. However, the site and its surroundings are critically threatened by large-scale mining activities (Criterion C).

Conclusions: The first results of this study and their discussion with authorized representatives provides crucial data for informing the government's decision to establish a new protected area in the FV. According to Decree No. PP-171 of the President of the Republic of Uzbekistan, dated 31 May 2023, a national park will be created, encompassing 100,000 hectares, including the Shorsuv IPA site and adjacent areas. This initiative also supports global conservation targets outlined in the Kunming-Montreal Global Biodiversity Framework (GBF) and the Global Strategy for Plant Conservation (GSPC).

KEYWORDS

Central Asia, threatened species, critical habitats, variegated outcrops, Fergana Valley, important plant areas

1 Introduction

Biodiversity is declining at an accelerated rate, with approximately 25% of assessed animal and plant species worldwide at risk of extinction (Antonelli et al., 2020; Nic Lughadha et al., 2020). Habitat loss and fragmentation are leading causes of this crisis (Damschen, 2013). In this context, area-based protection measures, including statutory protected areas (PAs) and other effective area-based conservation measures are important tools for conservation (Harris et al., 2024).

Plant conservation initiatives often receive less support compared to animal conservation (Darbyshire et al., 2017; Westwood et al., 2020). However, recent publications have increasingly highlighted the results of plant conservation efforts (Kor et al., 2025), recognizing plants as essential primary producers. Important plant areas (IPAs) are critical sites for exceptional botanical richness, including rare, threatened, and socio-economically valuable plant species, as well as rare and threatened habitats (Plantlife, 2018). Established in 2001, global criteria for IPA identification have been applied in over 70 countries (Anderson, 2003; Darbyshire et al., 2017; Plantlife, 2018; Kor et al., 2025). The IPA approach is a leading framework for the spatial conservation prioritisation of plants and fungi. However, over 20 years since its launch, its application and conservation outcomes remained unevaluated (Kor et al., 2025). Recent IPA research has largely focused on tropical countries (Sanchez et al., 2021), with previous emphasis on the Mediterranean region (Blasi et al., 2009; Radford and Odé, 2009; Blasi et al., 2011; Marignani and Blasi, 2012; Sparrius et al., 2019) and the Caucasus (Fayvush et al., 2013). Successful IPA implementations have also been reported in arid regions such as the Arabian Peninsula (Al-Abbasi et al., 2010; Hall et al., 2011; Llewellyn et al., 2011), Egypt (Shaltout and Eid, 2016), and Lebanon (Talhouk et al., 2017).

Central Asia, with its deserts and mountainous regions, is significant for global conservation due to its exceptional biodiversity and high endemism rates (Myers et al., 2000; Li et al., 2020; Nowak et al., 2022; Tojibaev et al., 2022c). Natural habitats in the region are increasingly pressured by human activities (Volis, 2024). Essential ecosystem services are provided by Central Asian deserts and mountains, which support nearly 80 million people. The Mountains of Central Asia are home to more than 64 million people (CEPF, 2017), and the population in the region may reach 90 million by 2050 (UNDESA, 2015). The Pamir-Alay and Tian-Shan Mountain ranges support approximately 55% of the flora in the Iran-Turan region (Kamelin, 1965, 1973; Takhtadzhian, 1986; Manafzadeh et al., 2017). This underscores the region's importance for conservation planning and research (Eastwood et al., 2009; Mittermeier et al., 2011). However, critical habitats in both wet (forests and shrublands) and dry (deserts and variegated outcrops) ecosystems are threatened by habitat loss and fragmentation due to economic growth, agricultural expansion, urbanization, and mining, especially in areas with high endemicity (Wilson et al., 2021; Tojibaev et al., 2023; Volis and Beshko, 2023; Volis, 2024).

Conserving regional biodiversity is a key objective for the five Central Asian countries, all of which are members of the Convention on Biological Diversity and the UNESCO World Heritage Convention (Volis, 2024). However, conservation methods originally established during the Soviet era still prevail, remaining primarily codified in state legislation. Although these approaches have undergone significant changes since that time, they have generally been weakened in scope and effectiveness.

The IPA program represents a new avenue of botanical research in Central Asia. Initial efforts began in 2010 and 2015 (Dimeyeva and Vesselova, 2014), but these were limited to small areas or did not adhere to global site identification methodologies (Darbyshire et al., 2017).

1.1 Fergana Valley – the first IPA research region in Central Asia

The Fergana Valley (FV) is an intermountain depression situated between the Tian-Shan mountains to the north and the Pamir-Alay mountains to the south. The valley features central deserts and high-salinity sites (solonchaks), and its geographical positioning makes it a distinct area (Nazarov et al., 2023). Stretching approximately 300 km in length and up to 70 km in width, the FV covers up to 80,000 km^2 and is shared by Kyrgyzstan, Tajikistan, and Uzbekistan.

The FV is the most densely populated region in Central Asia, with around 15 million inhabitants, and represents an ancient, isolated ecoregion with unique flora and fauna, much of which is endemic to the valley (Tojibaev et al., 2018; Bykova et al., 2022; Nazarov et al., 2023). Despite its relatively small size, the FV hosts approximately 3,000 vascular plant species. Notable genera include *Allium* L. (Amaryllidaceae), with approximately 137 species in Mountainous Central Asia, more than 85 of which are found in the FV (Tojibaev et al., 2018). Additionally, the genus *Tulipa* L. (Liliaceae) comprises 76 species in Central Asia, with the FV providing a favorable habitat for 25 of these species (Asatulloev et al., 2022; Dekhkonov et al., 2022; Tojibaev et al., 2022a; Asatulloev et al., 2023).

A significant issue in the FV is the conservation of natural landscapes. The valley's ecosystems have been under anthropogenic pressure for centuries (Tojibaev et al., 2018). High population growth, a rapidly expanding economy, and agricultural expansion are placing competing demands on the natural landscape, hindering the expansion of the PA network. This challenge is particularly acute in Uzbekistan, which is situated in the central, densely populated part of the FV.

These circumstances necessitate new approaches to biodiversity conservation in Central Asia (Tojibaev et al., 2022b; Nazarov et al., 2023; Tojibaev et al., 2023). Unlike traditional protected areas, IPAs do not confer national legal protection but can support various conservation strategies, such as informing strategic planning, driving community-led sustainable management, and mitigating infrastructure impacts (Darbyshire et al., 2017). To date, the IPA program in Central Asia, launched by the Central Asian Green Road project, has been supported by the Korea National Arboretum and has identified two IPAs in FV (Tojibaev et al., 2022b, 2023): the Chust-Pap badlands, which support a high concentration of endemic species from the southwest Tian-Shan, and the Bozbu-Too-Ungortepa Massif, a transboundary area meeting IPA Criterion A (threatened species). The recognition of IPA sites in the FV presents an opportunity to introduce new conservation methods for local plant diversity, which includes many endemic species in Central Asia (Tojibaev et al., 2022b, 2023).

Given the FV's unique biodiversity and the pressures from anthropogenic activities, documenting and conserving the valley's flora is of global importance. This paper details the identification of a third IPA in the FV, located in the variegated outcrops of the Turkestan Range in the southwest FV, qualifying under Criteria A (threatened species) and C (threatened habitat).

2 Materials and methods

2.1 Study area

The border region between Tajikistan and Uzbekistan in the southwestern part of the Turkestan Range was selected for the third stage of IPA identification in the FV (Figure 1). This area falls within the Fergana region of Uzbekistan and the Sogd region of Tajikistan. Phytogeographically, the IPA site belongs to the West Alay district of the Fergana-Alay region, a province within Mountainous Central Asia (Tojibaev et al., 2016).

The climate of the IFA area and its environs is dry and warm. The annual precipitation is 130–170 mm. The average annual temperature is 13.2°C, and the lowest is 4°C. The absolute minimum fluctuates around -20°C, and the absolute maximum rises to 45°C. Precipitation occurs in spring and autumn-winter. Two contrasting periods are distinguished: spring (until mid-May). Variegated soils of various shades predominate throughout the territory. Agricultural lands and small settlements of farmers are found in places.

The altitude ranges from 510 to 1200 m above sea level, which falls to the foothills of Central Asia called "adyr" (Zakirov, 1947). Adyr zone is characterized by the ephemeroid vegetation (*Poa bulbosa* L., *Carex pachystylis* J.Gay), perennial xerophytic herbs (*Ferula* spp, *Arnebia* spp., *Allium* spp., *Haplophyllum* spp.), shrub communities (*Prunus* spp., *Perovskia* spp., *Zygophyllum ferganense* (Drobow) Boriss.).

The Shorsuv area in the southwestern FV has long been noted for its unique and diverse flora (Tojibaev et al., 2016) and a high proportion of micro-endemics with very restricted distributions (Kamelin, 2017). The area has attracted phytogeographers interested in species diversity (Korovin, 1962), as well as the origin, evolution, and distribution patterns of species in variegated outcrops (Popov, 1923, 1927; Kamelin, 2017). This vegetation is characteristic of Central Asian flora (Oreogypsophyta), which is mountainous in origin (Kamelin, 2017) (Figure 2).

2.2 IPA site selection

The IPA concept followed in this study is based on Anderson (2003) and the revised global assessment by Darbyshire et al. (2017). In contrast to previous studies (2020–2021), the identification of the third FV IPA site was evaluated not only according to Criterion A (threatened species) but also Criterion C, which aims to "capture the largest, most intact areas of threatened and/or extremely restricted natural or semi-natural habitats, and severely declining habitats" (Darbyshire et al., 2017). According to authoritative sources (Anderson, 2003; Al-Abbasi et al., 2010; Blasi et al., 2011; Darbyshire et al., 2017), botanical sites meeting Criterion C are subject to directed anthropogenic impacts that lead to habitat reduction. The criteria for IPAs in the FV are similar to those previously used in Europe, the Middle East, and southern Africa, but IPA Criterion A was applied with modifications consistent with previous FV IPA identification stages (Tojibaev et al., 2022b, 2023).

2.3 IPA methodology modifications

We based our analyses on all the native species listed in the national checklists of all three Fergana Valley countries, with much attention to the nationally red-listed species. Following the previously proposed interpretation (Tojibaev et al., 2022b, 2023) the list of species that satisfy criterion A (threatened species) was identified by their presence in the IUCN Red list (2025) (*Ai*), threatened species or infraspecific taxa (*Aii*) included in the Red

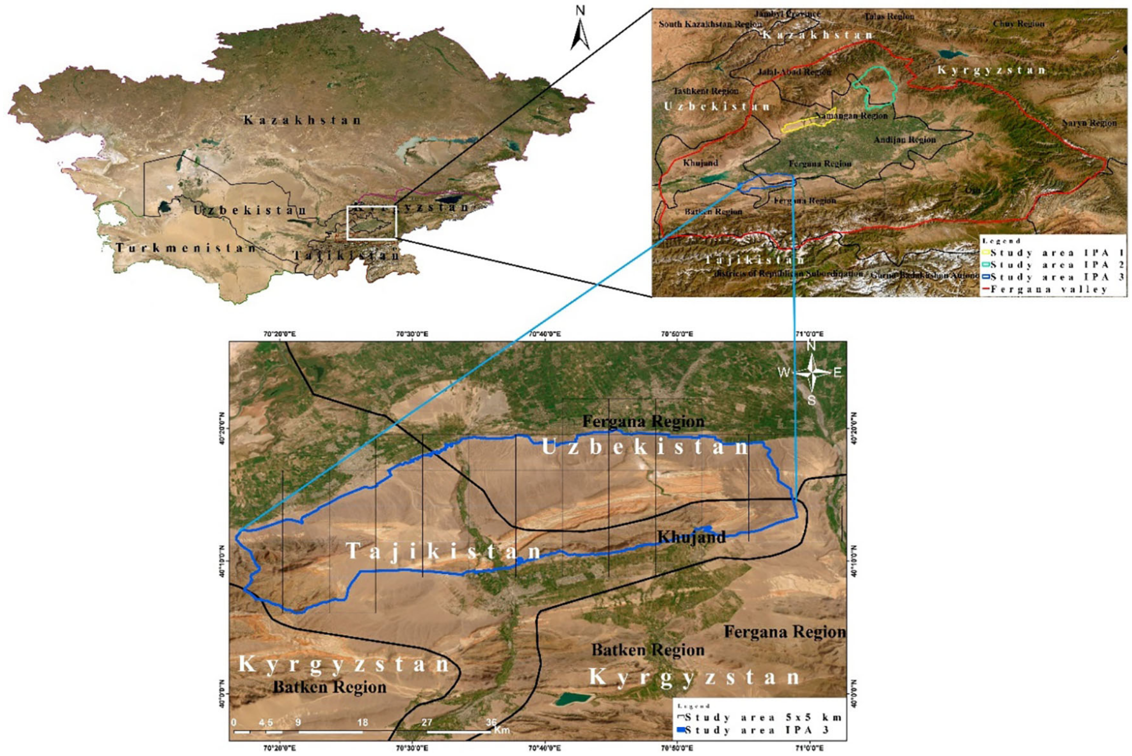

FIGURE 1
Geographic location of the Shorsuv Important plant areas (IPA) site.

Data Book of all three countries of FV, nationally endemic and/or regionally endemic to the FV within three countries (*Aiii*) and endemics to the Afghan-Turkestan Province in sense Kamelin (1990) (Table 1; Supplementary Material).

In applying criterion C, the IPA methodology states that the sub-criteria (*Ci* - site contains globally threatened or restricted habitat/vegetation type; *Cii* - site contains regionally threatened or restricted habitat/vegetation type; *Ciii* - site contains nationally threatened or restricted habitat/vegetation type, or habitats that have severely declined in extent nationally) do not differentiate between threatened and limited habitat. This is a pragmatic decision, since many countries outside Europe do not have official lists of threatened habitats. Furthermore, a habitat can be classified under criterion C because it is limited and/or declining (Darbyshire et al., 2017). This also applies to Central Asia, where the classification of ecosystems has not yet been completed, especially according to the IUCN methodology.

2.4 Field surveys and data collection

Extensive field surveys were conducted during the growing season from mid-March to August, from 2021 to 2024. Four expeditions, lasting between seven and thirteen days, were organized. Fieldwork involved scientists from Namangan State University (Uzbekistan) and Altai State University (Russia).

Distribution data were obtained from over 7,000 occurrence points and 845 herbarium specimens deposited at TASH, MW, and LE, as well as electronic resources such as Plantarium (www.plantarium.ru) and GBIF (www.gbif.org). Relevant floristic and taxonomic literature was reviewed, including works by Arifkhanova (1967); Pratov (1970), and Vernik and Rakhimova (1982). A total of over 3,500 herbarium specimens representing 298 vascular plant species were collected and stored at the National Herbarium of Uzbekistan (TASH).

2.5 Taxonomy and Jaccard similarity

The taxonomic identification was based on several sources, primarily the Conspectus Florae Asiae Media (1969–1993), which is the main taxonomic source for Central Asia (8096 species). Subsequent updated versions of this conspectus were also used (Khassanov, 2015; Li and Tojibaev, 2024), in which the species diversity of the Central Asian flora was significantly expanded (9310 and 9460, respectively). From this point of view, the first edition of *Flora of Uzbekistan* (Kudryashev, 1941; Vvedensky, 1953–1962) and *Flora of Kyrgyzstan* (Shishkin and Vvedensky, 1950–1962a) are still the most important sources of floristic information. Additional references include taxonomic revisions of some families of the flora of Kyrgyzstan (Pimenov and Kljuykov, 2002; Lazkov, 2006), recent volumes of *Flora of Uzbekistan* (Sennikov, 2023), the checklist of the

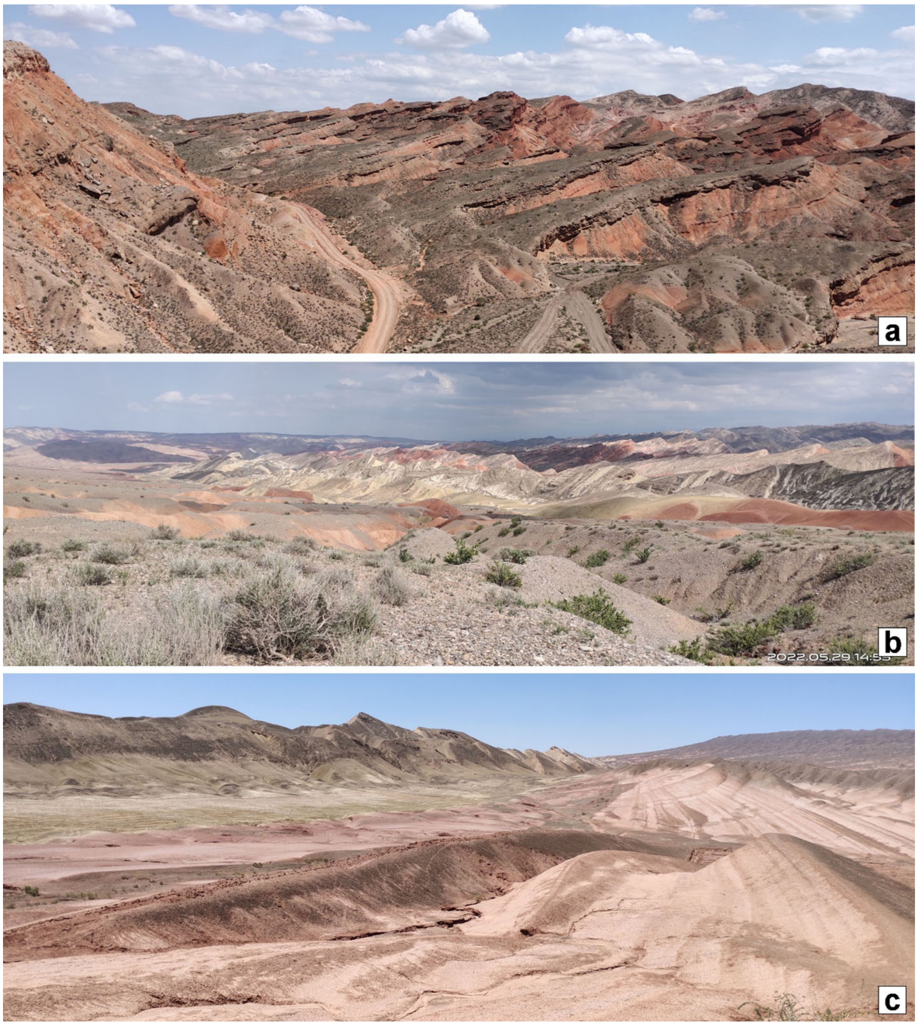

FIGURE 2
General view of the variegated outcrops in the study area. **(a)** Rugged reddish rock formations with a dirt road winding through them under a partly cloudy sky. **(b)** Undulating multicolored hills in white, red, and beige hues, with sparse vegetation in the foreground. **(c)** Expansive barren terrain with brown and beige ridges extending into the distance under clear skies.

Flora of Tian Shan mountains (Tojibaev et al., 2020b), and recent publications on Apiaceae (Tojibaev et al., 2020a), *Tulipa* (Tojibaev et al., 2022a), and *Iris* Tourn. ex L (Sennikov et al., 2023). Standardized scientific names of plants and authorship of species, genera, and families correspond to the International Plant Names Index (IPNI, 2025) and Plants of the World Online (POWO, 2025).

The degree of floristic similarity between the studied area and reference floras was assessed using the Jaccard similarity coefficient (Jaccard, 1901). According to the primacy of the geographical principle, the floras being compared must be geographically related and also show a certain degree of phylogenetic relationship (Serebryakov, 1962; Sergienko and Moseev, 2015). All three identified IPAs in the FV were selected for comparison: the Shorsuv Massif IPA - A, the Badlands of the Northern Foothills – B (Tojibaev et al., 2022b) and the Bozbu-Too-Ungortepa Massif – C (Tojibaev et al., 2023).

2.6 IUCN assessment and spatial analysis

Species status was assessed using the IUCN Red List Criteria (www.iucnredlist.org), the most widely accepted system for measuring extinction risk (Mace et al., 2008). All assessments adhered to the Guidelines for the Application of the IUCN Red List Criteria at the Regional Levels and were peer-reviewed through workshops and correspondence with experts.

A distinguishing feature of this IPA research in the FV is the use of geospatial analysis. The global conservation status of selected species was assessed using GeoCAT (Bachman et al., 2011), an open-source, browser-based tool that facilitates rapid geospatial analysis for Red Listing taxa. The analysis included temporal elements of herbarium specimen data, focusing on two aspects of the geographic range of taxa: the extent of occurrence (EOO) and the area of occupancy (AOO) (Bachman et al., 2011).

TABLE 1 Adaptation of IPA sub-criterion A to the specific conditions of the Mountainous Central Asia.

Sub-criterion	Relevant global thresholds	Interpretation for IPA in the Mountainous Central Asia
Ai	The site contains globally threatened species	The site contains globally threatened species
Aii	The site contains one or more regionally threatened species	Threatened species (or infraspecific taxa) included in the National Red Data Book
Aiii	The site contains one or more highly restricted endemic species that are potentially threatened	Nationally endemic and/or regionally endemic to the FV (within three countries)
Aiv	The site contains one or more range-restricted endemic species that are potentially threatened	Endemics to the Afghan-Turkestan Province

3 Results

The rich species diversity and endemism in the FV can be explained by many reasons. The main ones include the fact that the valley is located at the junction of two of the greatest mountain systems of Central Asia – Tian-Shan (in the north) and Pamir-Alai (in the south). Peripheral zones of certain ridge systems and mountain spurs are notable for a high proportion of micro-endemics, many of which exhibit exceptionally narrow distribution ranges (Kamelin, 2017). Moreover, this can be clarified using the mountain-geobiodiversity hypothesis, which includes three conditions: (a) the presence of lowland, montane, and alpine zones; (b) climatic fluctuations creating a «species pump» effect; and (c) high-relief terrain with complete elevational zonation (Muellner Riehl et al., 2019). All these conditions are present in the FV, which is situated at the junction of the largest mountain ranges in Central Asia—the Tian-Shan and Pamir-Alay.

The IPA work being conducted can be used in national biodiversity strategies and action plans and could help with designing a more effective protected and conserved area network rather than it complementing it can directly improve these conservation efforts. The main goal of this study was to integrate regional data from Central Asia into the global IPA network (Tojibaev et al., 2023). Thus, the basic principles of IPA identification were strictly adhered to throughout the assessment and site-selection procedures.

The study area met the thresholds for IPA identification, and the third IPA site in the FV was identified. Named "Shorsuv," meaning "salty water area" the IPA site is located between 40° 15'56.95" N, 70°57'3.31" E and 40°10'18.96" N, 70°19'3.91" E, with an altitude range from 530 to 1850 meters above sea level. The site is 42–58 km long and 8–20 km wide. Criterion C (threatened habitats) was the primary basis for identifying this IPA site. Additionally, rare and threatened species were detailed according to Criterion A, and a complete flora inventory was conducted to assess botanical richness (Criterion B).

3.1 Criterion A (threatened species)

Forty-two vascular plant species recorded in the IPA site fall under Criterion A for their threat status (Table 2; Supplementary Material). Over three years of research, a list of rare and threatened species was compiled, highlighting the conservation significance of the area. Compared to the Bozbu-Too-Ungortepa Massif (Tojibaev et al., 2023), which has 62 threatened species, this site has fewer but still significant numbers (42 compared to 29 in the Badlands of the northern foothills) (Tojibaev et al., 2022b). The difference is partly due to the smaller spatial area and less species-rich environment of the Badlands.

Determining a predominant taxonomic group among the species under Criterion A proved challenging. A significant number belonged to the genus *Astragalus* L. (three species; Fabaceae), distributed across subcategories *Aiii* and *Aiv*. Other genera were represented by one or two species. Two species of shrubs, *Calligonum* × *calcareum* Pavlov (Polygonaceae) and *Zygophyllum xanthoxylum* (Bunge) Maxim. (Zygophyllaceae), were noted. The latter species' taxonomic status is questionable and may be mistakenly identified as *Zygophyllum xanthoxylum*. It is more likely to be *Zygophyllum ferganense* (Drobow) Boriss., endemic to the saline foothills of the FV (Adylov and Zuckerwanik, 1983).

The classification results revealed one globally threatened species (*Ai*), nine species listed in the Red Data Books of Tajikistan and Uzbekistan (*Aii*), and 20 species identified as national or regional endemics of the Fergana Valley under subcategory *Aiii*, including 12 classified as Highly Restricted Endemics (HRE) and eight as Range Restricted Endemics (RRE). Additionally, 12 species were confirmed as endemic to the Afghan-Turkestan Province under subcategory *Aiv* (Supplementary Material).

3.2 Criterion B

Based on consideration of the data collected and IPA thresholds, it is not considered that the study area corresponds to the requirements for criterion B (Anderson, 2003; Blasi et al., 2011; Darbyshire et al., 2017). This site is not distinguished by its exceptional botanical richness. Nevertheless, the so-called «contrasting features of the flora» are observed here (Kamelin, 1990). This is manifested in the high diversity of some taxonomic groups (including high endemism), whereas in others there is a complete absence or poor taxonomic composition in the same geographical areas with almost the same environmental

TABLE 2 List of species recorded in the badlands of the Shorsuv Massif that fall under Important plant areas (IPA) criterion A or are restricted range endemics.

№	Accepted species name	IPA category	Conservation status (IUCN)			Red data book	Preserved Herbaria
			EOO km^2	AOO km^2	Category		
1	*Calligonum × calcareum* Pavlo	*Ai*	693.037	52	EN	UZ	TASH, MW
2	*Acanthophyllum pungens* (Bunge) Boiss	*Aii*	11,156.258	156	VU+EN	UZ	TASH, TAD, MW
3	*Allium isakulii* R.M.Fritsch & F.O.Khass.	*Aii*	15,206.571	52	VU+EN	UZ	TASH
4	*Fergania polyantha* (Korovin) Pimenov	*Aii*	14,922.331	308	VU+EN	UZ	TASH, MW, FRU, TAD
5	*Halimocnemis ferganica* (Iljin) Akhani ex Sennikov	*Aii*	16,474.330	184	VU+EN	UZ	TASH, FRU, MW
6	*Halimocnemis lasiantha* Iljin	*Aii*	12,983.230	84	VU+EN	KG, UZ	TASH, MW
7	*Jurinea pteroclada* Iljin	*Aii*	161.544	16	EN	TJ	TAD
8	*Miltianthus portulacoides* Bunge	*Aii*	57,681.818	72	LC+EN	TJ	TASH, TAD
9	*Pseudosedum campanuliflorum* Boriss.	*Aii*	49,019.844	48	LC+EN	UZ	TASH, AA, MW, TAD
10	*Tulipa korolkowii* f. *rosea* (Vved.) Zonn.	*Aii*	1,138.425	44	EN	TJ	TASH, MW, TAD
11	*Acantholimon nabievii* Lincz.	*Aiii*	6,597.929	72	VU+EN	–	TASH, FRU, MW, LE
12	*Allium michaelis* F.O. Khass. & Tojibaev	*Aiii*	11,377.065	168	VU+EN	–	TASH, FRU
13	*Anabasis ferganica* Drobow	*Aiii*	8,613.662	80	VU+EN	–	TASH
14	*Asparagus ferganensis*	*Aiii*	17,690.212	80	VU+EN	–	TASH, FRU, MW
15	*Astragalus brachyrhachis* Popov	*Aiii*	1,060.720	100	EN	–	TASH, FRU, MW
16	*Astragalus ferganensis* (Popov) B.Fedtsch. ex Korol.	*Aiii*	19,713.564	200	VU+EN	–	MW, TASH, FRU
17	*Calligonum santoanum* Korovin	*Aiii*	182.973	20	EN	–	TASH, MW
18	*Cousinia ferghanensis* Bornm	*Aiii*	235.211	40	EN	–	TASH, MW, TAD
19	*Ferula lipskyi* Korovin	*Aiii*	21,983.465	64	NT+EN		TASH, MW
20	*Lagochilus pubescens* Vved.	*Aiii*	11,254.753	84	VU+EN	–	TASH, FRU, MW
21	*Linaria kokanica* Regel	*Aiii*	7,817.072	128	VU+EN	–	TASH, FRU, MW
22	*Stipa magnifica* Junge	*Aiii*	17,187.456	32	VU+EN	–	TASH, MW
23	*Echinops knorringianus* Iljin	*Aiii*	15,256.662	144	VU+EN	–	TASH, MW
24	*Jurinea winkleri* Iljin	*Aiii*	11,344.827	132	VU+EN	–	TASH, MW
25	*Limonium ferganense* Ikonn.-Gal.	*Aiii*	30,132.947	60	NT+EN	–	TASH, FRU, MW, TAD
26	*Mogoltavia sewerzowii* (Regel) Korovin	*Aiii*	18,196.776	204	VU+EN	–	TASH, FRU, TAD, MW
27	*Nepeta santoana* Popov	*Aiii*	5,564.418	84	VU+EN	–	TASH, MW
28	*Plocama vassilczenkoi* (Lincz.) Md.Backlun & Thulin	*Aiii*	10,923.530	96	VU+EN	–	TASH, FRU, TAD
29	*Sisymbrium isfarense* Vassilcz.	*Aiii*	1,158.303	88	EN	–	TASH, MW
30	*Tanacetopsis santoana* (Krasch., Popov & Vved.) Kovalevsk.	*Aiii*	23,088.639	104	NT+EN	–	TASH, FRU, MW, TAD
31	*Arnebia obovata* Bunge	*Aiv*	387,211.939	320	LC+EN	–	TASH, FRU, AA, MW, TAD
32	*Astragalus intarrensis* Franch.	*Aiv*	25,203.558	56	NT+EN	–	LE, TASH, TAD
33	*Crambe schugnana* Korsh.	*Aiv*	130,193.432	80	LC+EN	–	TASH, FRU, AA, MW, TAD
34	*Cryptospora inconspicua* (Kom.) O.E.Schulz	*Aiv*	55,079.726	60	LC+EN	–	TASH, FRU, MW

(Continued)

TABLE 2 Continued

№	Accepted species name	IPA category	Conservation status (IUCN)			Red data book	Preserved Herbaria
			EOO km^2	AOO km^2	Category		
35	*Fritillaria karelinii* (Fisch. ex D.Don) Baker	*Aiv*	2,141,367.606	476	LC+EN	–	TASH, FRU, AA, MW, TAD other
36	*Gypsophila intricata* Franch.	*Aiv*	65,468.799	104	LC+EN	–	TASH, FRU, MW
37	*Pseudopodospermum ferganicum* (Krasch.) E.Hatami, N.Kilian & K.E.Jones	*Aiv*	203,413.933	84	LC+EN	–	TASH, FRU, AA, MW, TAD other
38	*Rheum macrocarpum* Losinsk.	*Aiv*	41,807.490	44	NT+EN	–	TASH, MW
39	*Seseli tenuisectum* Regel & Schmalh.	*Aiv*	70,978.305	156	LC+EN	–	TASH, FRU, MW, TAD
40	*Tragopogon malikus* S.A.Nikitin	*Aiv*	161,559.996	260	LC+EN	–	TASH, FRU, AA, MW, TAD
41	*Tulipa turkestanica* (Regel) Regel	*Aiv*	133,006.723	376	LC+EN	–	TASH, FRU, AA, MW, TAD
42	*Zygophyllum xanthoxylum* (Bunge) Maxim.	*Aiv*	4,164,738.030	428	LC+EN	–	TASH, FRU, AA, MW, TAD other

Each species is presented with information including IPA sub-criteria, IUCN red list status, general distribution, and threats.

conditions. This is clearly visible in both the composition of the leading genera in Central Asia and Uzbekistan and the spectrum of leading monocotyledonous geophytes, which are rich in FV flora (Tojibaev et al., 2018) (Table 3). Nearness to large human settlements and anthropogenic influences cause the abundance of many ruderal species, mainly from the families Brassicaceae, Poaceae, and Boraginaceae (Table 4).

The flora inventory was based on grid mapping (Seregin, 2014). Using 5 × 5 km grid cells, the vascular plant species diversity and distribution of 42 IPA species (*Ai–Aiv*) were analyzed. Species richness (SP) and collection density (CD) were defined as the number of vascular species and occurrence records per grid cell, respectively (Tojibaev et al., 2022c). Forty-nine grids constituted the Shorsuv IPA. The grid mapping results showed that the species diversity of the study area consisted of 349 species belonging to 193 genera and 43 families. A total of 11270 occurrence records were used (Figure 3). According to the SR, the highest species diversity was recorded in E5, with 139 species, whereas the highest level of CD was determined by 512 collections (D8).

High and predictable similarity values were obtained using the Jaccard coefficient for the floristic composition of all three IPAs in the FV. The species richness and comparative characteristics of the study area and the reference floras are summarized in the Table 5.

The UPGMA-based cluster analysis, using Jaccard similarity coefficients, revealed two primary floristic groupings among the three IPAs of the FV (Figure 4). B and C sites have the highest degree of floristic affinity (J=0.360), forming a close cluster. In contrast, A site (the Sursuv Massive) showed lower similarity to both, clustering with the B–C group at a greater distance. These results suggest that the Sursuv Massive IPA possesses a relatively distinct plant assemblage, potentially influenced by differing environmental conditions, microhabitats, and/or biogeographic history.

3.3 Criterion C

Variegated outcrops vegetation is unique for Central Asian flora (Korovin, 1962) and is characterized by high species endemism. Majority of vascular plant species of variegated outcrops in Mountainous Central Asia, including IPA site, settled over the Cretaceous and partly Paleogene age (Kamelin, 2017; Tojibaev et al., 2022c). The study area is one of the largest areas in the FV for the industrial mining of lime and gypsum. In particular, the variegated slopes of Shorsuv village and its surroundings are rich in these minerals, providing a basis for the development of industrial mining. These activities were carried out during Soviet times, but after the collapse of the Soviet Union, mining stopped. However, in the last decade, activity has reactivated, and natural landscapes with unique variegated vegetation have come under threat. Mining was performed using the open-pit method with gypsum crushed *in situ*, resulting in an abundance of gypsum being sprayed over the surrounding area. The area has been allocated to private companies that are increasing their annual production. The entire area has numerous roads for trucks; therefore, any point is accessible for mining. This situation poses a great threat to the conservation of variegated outcrops unique to Central Asia, with numerous endemics and relics of the Central Asian Tertiary flora. Accordingly, the site qualified as an IPA under criterion C (threatened habitat) (Figure 5).

4 Discussion

The Shorsuv Massif IPA within the FV is crucial for the conservation of relict plant species in variegated outcrops, meeting IPA Criteria A and C. The site includes forty-two vascular plant species categorized under Criterion A (*Ai*–1 species; *Aii*–9 species; *Aiii*–20 species; *Aiv*–12 species). Compared to other IPA sites in the FV, the number of species here is lower than in the Bozbu-Too-Ungortepa Massif IPA (62 species; Tojibaev et al. (2023)) but slightly higher than in the Badlands of the northern foothills IPA (29 species; Tojibaev et al. (2022b)). Criterion A species make up more than 12% of the total vascular species (349 species) recorded in the Shorsuv Massif, highlighting the site's significance. Among these, *Calligonum* × *calcareum*, a Critically Endangered species on the IUCN Red List (last assessed in 2007 under criterion B2ab), is particularly notable. Additionally, six species from sub-Criteria *Ai*–*Aii* are included in the Red Data Book of Uzbekistan (Khassanov et al., 2019), and one species, *Halimocnemis lasiantha* Iljin (Amaranthaceae), appears in both Uzbekistan and Kyrgyzstan's Red Data Books (Davletkeldiev, 2006; Khassanov et al., 2019). Five other species assessed under IUCN guidelines are candidates for inclusion in the National Red Lists of Tajikistan and Uzbekistan, emphasizing the importance of IPA studies in documenting species rarity, particularly in the underexplored transboundary regions of Central Asia.

The northwestern slopes of the Turkestan Range, including Shorsuv, Kim, and Santo, are renowned for their unique and diverse flora, including numerous micro-endemics with very limited distribution areas (Popov, 1923, 1927; Arifkhanova, 1967; Kamelin, 2017). This study continues the IPA identification process by focusing on these variegated outcrop areas, which are both unique and highly threatened. These habitats are regarded as museums of tertiary relict plant species (Nabiev, 1959) and sources of new evolutionary lineages (Kamelin, 2017). The characteristic landscapes of variegated outcrops, composed of sedimentary rocks from the Cretaceous and partly Paleogene periods, support globally unique vegetation, with over 1,400 plant species, at least 540 of which are endemic (Kamelin, 2017). However, these ecosystems are increasingly threatened by land-use changes (Nabiev, 1959; Tojibaev et al., 2022c) and are under significant anthropogenic pressure (Tojibaev et al., 2019a; Orsenigo et al., 2022; Shomurodov and Khabibullaev, 2022). For instance, the plant community containing *Moluccella bucharica* (B.Fedtsch.) Ryding (Lamiaceae) has decreased from 90 to 53 species over the last 50 years, with 37 species no longer present (Shomurodov and Khabibullaev, 2022). The number of individuals of some endemic species, such as *Moluccella bucharica*, has sharply declined from 1800 (Tojibaev, 2009) to 400 individuals (Shomurodov and Khabibullaev, 2022). As the scale of anthropogenic impacts expands, the crisis facing relict ecosystems, including variegated outcrops, grows increasingly severe. Over the last half-century, an increasing proportion of the total biomass in the studied plant community has been formed by annual plants, driven by the expansion of anthropogenic species (Khabibullaev et al., 2022; Shomurodov and Khabibullaev, 2022). Meanwhile, rapid population growth in Uzbekistan and FV (Bondarenko, 2020) has also affected massifs with variegated slopes that are rich in minerals through the industrial extraction of lime and gypsum for cement production. In Central Asia, almost all variegated outcrop slopes experience strong anthropogenic pressure. The natural reproduction of many endemic plants is very low, and the number of individuals is steadily decreasing. Many species require urgent efforts to prevent extinction; however, the available options are limited (Tojibaev et al., 2019a). The situation is similar at the Shorsuv IPA site. This is one of the largest areas in the FV for the industrial mining of limestone and gypsum. The current scale of Industrial mining threatens to eliminate tertiary habitats. The current scale of Industrial mining threatens to eliminate tertiary habitats. All of the above facts allow us to identify Shorsuv and its adjacent areas as an IPA under criterion C.

Conservation efforts in the FV are further complicated by its socio-economic context. The region, with a population density of 1,600 people per square mile—far exceeding the Central Asian average of 40.8—has experienced a 32% population increase over the past decade, exacerbating pressures on its ecosystems (CGIAR, 2022). Historically, valley ecosystems have been subjected to significant anthropogenic pressures (Tojibaev et al., 2018). The lack of recent botanical research, following major studies from 1950–1980 (Arifkhanova, 1967; Pratov, 1970; Vernik and Rakhimova, 1982), has led to insufficient documentation of plant diversity. The expansion of settlements and agricultural lands has made new research efforts less likely, leaving the local population and authorities with insufficient information about the plant diversity in many subregions of the FV. As a result, numerous projects to develop settlements and establish industrial facilities were implemented without adequate scientific data. This lack of consideration has intensified human impacts on the environment, exacerbating the threatened status of numerous plant species and habitats. In the Uzbekistan part of the Valley, the situation is further aggravated by the absence of protected areas dedicated to preserving biodiversity (Tojibaev et al., 2022a).

Global evaluations of Important Plant Areas (IPAs) highlight a persistent research-implementation gap (Kor et al., 2025), where many IPAs are identified but lack sufficient evidence of effective conservation outcomes. Nevertheless, a significant number of IPAs have been integrated into formal conservation designations and national conservation strategies, contributing to broader preservation efforts. Our IPA research in the FV has directly influenced conservation planning. Since 2020, several projects have been initiated to support research on flora and fauna and to preserve natural (tertiary) ecosystems. Notable initiatives include the "Preservation of Key Natural Complexes in the FV" project (led by the Michael Succow Foundation, with support from the World Wildlife Fund (WWF) and Critical Ecosystem Partnership Fund (CEPF), the Central Asian Desert Initiative (CADI) project, the Central Asia Green Road Project II, and scientific programs by the National Herbarium of Uzbekistan (TASH). These efforts have contributed to practical advancements in protected area designation. The achievements of these projects have positively impacted the FV. Research findings on flora and fauna were presented to the Uzbekistan government, leading to decisions on conserving rare and endangered species and establishing new protected areas. Presidential Decree No. PP-171, issued on 31 May 2023, established a national park encompassing 100,000 hectares, including the Shorsuv IPA site and its surrounding areas

TABLE 3 Contrast in taxonomic diversity of leading genera and monocot geophytes of Central Asia and the study area.

Genus	Species number in CA	Species number in Uzbekistan	Species number in this IPA site
Leading genera			
Astragalus L.	600	278	8
Cousinia Cass.	260	141	2
Ranunculus L.	206	102	4
Oxytropis L.	166	62	–
Hedysarum L.	81	26	–
Geophyte genera			
Allium L.	262	141	2
Gagea Salisb.	182	75	4
Tulipa L.	66	34	2
Eremurus M.Bieb.	59	32	–
Iris L. (*Juno* Tratt.)	57	41	1

(https://lex.uz/docs/6479136). Additionally, the project "Maintenance and Conducting Selective Records of Rare and Endangered Species of Vertebrate Animals of the Fergana Valley" is gaining traction for FV conservation (Nazarov et al., 2023).

Efforts to identify Important Plant Areas (IPAs) began with field studies conducted in 2013–2014 but were interrupted due to funding constraints. Research under the IPA program resumed in 2020, significantly advancing the recognition of the Fergana Valley as a biodiversity hotspot and a center of local endemism. This renewed effort updated distribution and population density data for endemic and threatened species (Tojibaev et al., 2020b), identified new species (Tojibaev et al., 2014a, 2014b), and completed a checklist and grid mapping of flora in the northern foothills (Hoshimov et al., 2022). Additionally, over 30 new species, including an invasive one, were recorded for the Flora of Uzbekistan, and two new IPAs (Tojibaev et al., 2022b, 2023) were documented. Remarkably, species previously believed extinct in Uzbekistan, such as *Lamyropappus schakaptaricus* (O.Fedtsch. & B.Fedtsch.) Knorring & Tamamsch. (Asteraceae) and *Hedysarum gypsaceum* Korotkova, were rediscovered (Tojibaev et al., 2019b). The decision to establish a new protected area was significantly influenced by the IPA research, highlighting its importance in shaping conservation strategies. Currently, the identification of two additional IPA sites is underway (Sokh River Basin, northern slopes of the Alay Range, and the sands of Central Fergana). Completing these studies will facilitate the creation of the first transboundary IPA network in Central Asia, representing a successful collaboration between national programs to expand the protected area network. This will be one of the few transboundary IPAs globally (Shuka and Malo, 2010). This research underscores the relevance of IPA studies in this region, a relatively underexplored area of Asia (Manafzadeh et al., 2017; Li et al.,

TABLE 4 Top families and genera of vascular plants.

Flora of IPA site				Flora of Uzbekistan			
Family	Spec. No	Genera	Spec. No	Family	Spec. No	Genera	Spec. No
Asteraceae	55	*Artemisia* L.	8	Asteraceae	649	*Astragalus* L.	278
Amaranthaceae	35	*Astragalus* L.	6	Fabaceae	521	*Artemisia* L.	48
Brassicaceae	42	*Haplophyllum* A.Juss.	6	Poaceae	301	*Calligonum* L.	36
Poaceae	30	*Zygophyllum* L.	6	Lamiaceae	246	*Lappula* Moench	24
Boraginaceae	24	*Strigosella* Boiss.	6	Apiaceae	238	*Bromus* L.	17
Polygonaceae	20	*Anabasis* L.	5	Brassicaceae	235	*Stipa* L.	17
Fabaceae	19	*Arnebia* Forssk.	5	Amaranthaceae	201	*Convolvulus* L.	15
Lamiaceae	14	*Bromus* L.	5	Caryophyllaceae	164	*Haplophyllum* A.Juss.	15
Apiaceae	10	*Calligonum* L.	5	Boraginaceae	127	*Strigosella* Boiss.	13
Caryophyllaceae	10	*Convolvulus* L.	5	Polygonaceae	108	*Anabasis* L.	12

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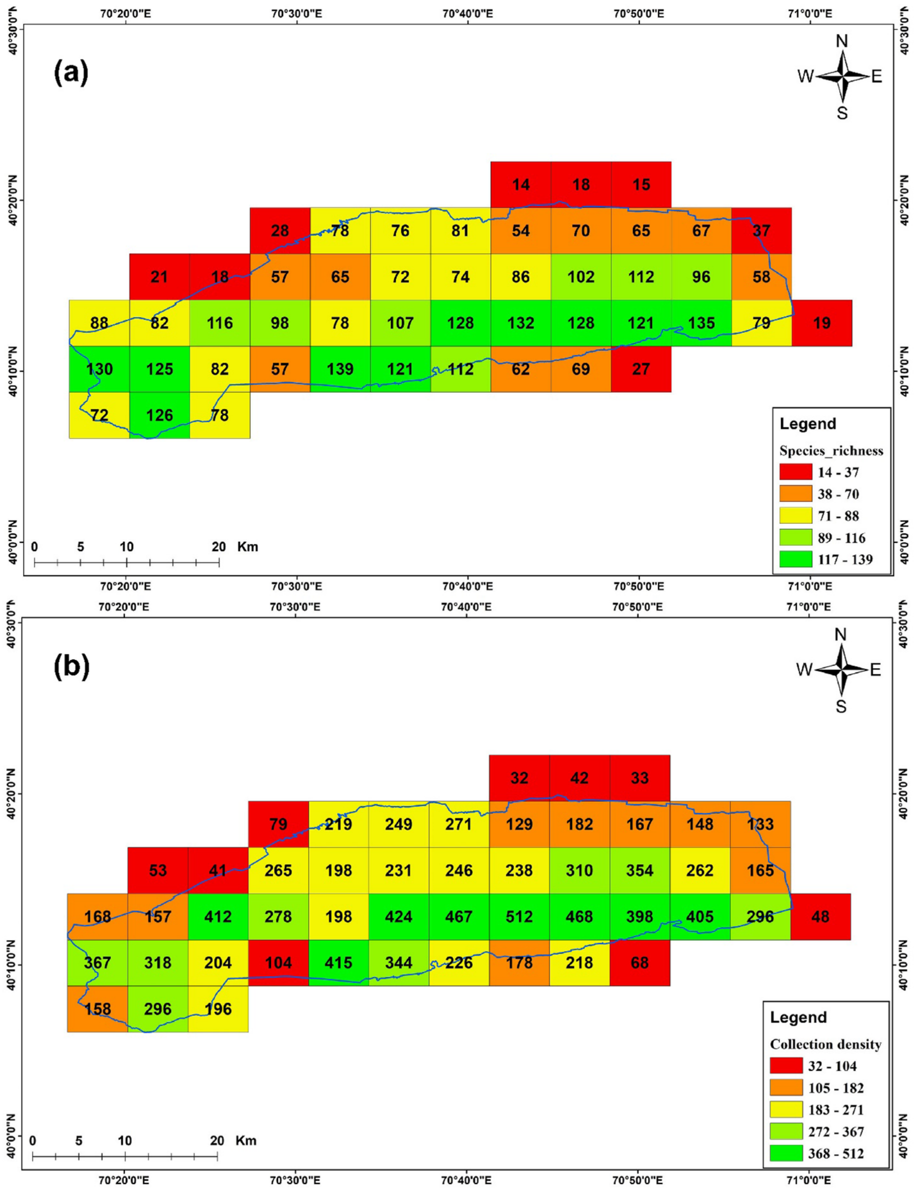

FIGURE 3
(a) Species richness and **(b)** collection density.

TABLE 5 Summary of floristic data by IPAs of Fergana Valley.

Comparable floras	Species number
The Shorsuv Massif IPA (A)	349
The Badlands of the Northern Foothills IPA (B)	428
The Bozbu-Too-Ungortepa Massif IPA (C)	403
Pairwise comparison	**Shared species number**
A and B	163
A and C	131
B and C	220

2020). Additionally, a priority is integrating the FV IPA network into national conservation planning and monitoring schemes (Darbyshire et al., 2017).

4.1 Future research

PA identification continues to grow worldwide, there is a way to go to truly achieve the other important half of its main goal of "identifying and protecting a network of the best plant conservation sites" worldwide (Anderson, 2003) and to achieve the goals of the CBD Global Strategy for Plant Conservation (GSPC) (Kor et al., 2025).

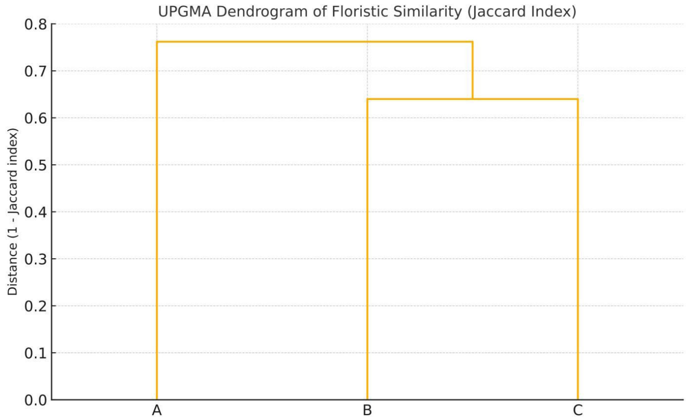

FIGURE 4
UPGMA dendrogram showing floristic similarity among three surveyed FV IPAs **(A, B, C)** based on Jaccard similarity indices. The horizontal axis indicates the clustering distance (1 – Jaccard index).

Lack of financial support is one of the main challenges in the development of IPA identification research and network establishment. For example, in the Fergana Valley, the first IPA identification studies using the methods proposed by Plantlife were started in 2012-2015, but were soon suspended due to lack of financial support. Only thanks to the Central Asia Green Road project, these studies were resumed and three IPA sites were identified, two of which are transboundary. Research to establish an IPA network in the Fergana Valley is ongoing. At least two more IPA sites will be identified (in the Sokh River basin of the Alai Range and the sands of Central Fergana), and then it will be possible to talk about the first IBA network in Central Asia integrated into the global IPA network. However, these results do not allow us to talk about the success of IBA research in Central Asia as a whole, since (a) the Fergana Valley is not a representative territory of Central Asia or even its individual countries; (b) there is a high risk of funding suspension (funding periods for projects are expiring); (c) the gap between identification and conservation actions is a common phenomenon among zonal initiatives. Although in many ways, IPA research in the Fergana Valley (while the results of other vertebrate diversity research projects and area-based conservation initiatives made an invaluable contribution) largely achieved its goal, since out of the three identified IPA sites, two were established as protected areas by government decision. For further development of research and capacity building, it is advisable to adopt the key recommendations developed by Kor et al. (2025) in an evaluation of important plant areas around the world. They consist of the following five points: provide more ambitious and targeted funding, tailor stakeholder communications, time stakeholder engagement properly, clarify the relationship of IPAs

FIGURE 5
Variegated slopes at the Important plants area (IPA) site and industrial mining of minerals. **(a)** Industrial buildings with smoke emissions. **(b)** The factory, with a foreground billboard advertising Albus cement (M500 and M400 products) and contact information.

with KBAs, and provide a single central hub for IPA information. Given the volume and specificity of research funding in Central Asian countries, it is recommended that such initiatives be included in programs with government funding for research (primarily academic research institutes), which minimizes the risks of lack of funding from international organizations or projects.

5 Conclusion

The third IPA site in the FV spans the transboundary region between Uzbekistan and Tajikistan. This site was chosen due to its importance for protecting critical habitats and species endemic to national (Uzbekistan and Tajikistan), regional (FV), and botanical (Afghan-Turkestan province) levels. The current phase of IPA research in Central Asia demonstrates the effectiveness of the IPA methodology in mountainous regions. This advancement is crucial for creating a regional database of rare and endangered species and developing the Central Asia Red List, which will help direct transboundary conservation efforts. Notably, this research marks the first IPA study in Central Asia to meet Criterion C.

The third stage of IPA research in the FV was completed in accordance with the core objectives of the IPA program (Anderson, 2003; Darbyshire et al., 2017, 2019). An international team of scientists from Uzbekistan, Kyrgyzstan, Tajikistan, Russia, Korea, and the United Kingdom utilized the best available data to identify this IPA site. The Shorsuv IPA site and its surrounding areas have been recognized as critical habitats, particularly due to extensive large-scale mining activities. This area is a significant repository of tertiary relics, some of which have not been assessed using IUCN criteria. Consequently, Shorsuv and its adjacent areas have been classified as an IPA under Criteria A and C of Plantlife International.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding authors.

Author contributions

KT: Writing – original draft, Writing – review & editing, Investigation, Methodology. HH: Writing – review & editing, Data curation, Formal Analysis, Investigation, Methodology. RG: Writing – review & editing, Data curation, Formal Analysis, Investigation, Methodology. OS: Writing – review & editing, Data curation, Formal Analysis, Investigation, Methodology. FK: Writing – review & editing, Data curation, Methodology, Formal analysis, Investigation. LK: Writing – review & editing, Data curation, Methodology, Formal analysis, Investigation. AB: Writing – review & editing, Data curation, Formal Analysis, Investigation, Methodology. SB: Writing – review & editing, Data curation, Formal Analysis, Investigation, Methodology. JEJ: Writing – review & editing, Visualization. JJ: Writing – review & editing. H-YG: Writing – review & editing, Conceptualization, Funding acquisition, Project administration. HC: Writing – review & editing, Conceptualization, Funding acquisition, Project administration.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcosc.2025.1629529/full#supplementary-material

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