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Ecological Impacts of Invasive Alien Flora in Devarayanadurga Reserve Forest, Tumakuru District, Karnataka

Research Article

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Abstract

An alien plant also referred to as exotic, introduced, foreign, non-indigenous or non-native, is one that has been introduced by humans intentionally or otherwise through human agency or accidentally from one region to another. Those naturalized aliens that become so successful as to spread in the flora and displace native biota or threatens valued environmental, agricultural, or personal resources by the damage it causes are considered invasive. Devarayanadurga Reserve Forest (DRF) in Tumakuru District is a tropical dry deciduous type, comparatively dense forest with predominant tree species. It is known for harboring varieties of medicinal plants. During the present study a total of 144 Invasive Alien Species (IAS) belonging to 130 genera of 51 families were recorded. Fabaceae is the dominating invasive family with 27 species followed by Asteraceae and Malvaceae with 11 and 8 species respectively. 105 IAS were reported to be affecting ecosystem functions and services, 56 IAS to be causing biodiversity loss and 81 IAS to be causing economic loss and health hazards of either human or wildlife or both. 111 IAS shows continuous spread in DRF with range extension. IAS affects the ecosystem of the region, the economy of the surroundings, habitat destruction, biodiversity loss, human health, and livelihood. Hence timely monitoring of the phenology and distribution pattern studies of IAS should be undertaken to successfully eradicate them and re-establish native species.

Keywords: Alien species; Biodiversity; Invasive flora, Ecological impact, Tumakuru

Introduction

Invasive Alien Species (IAS) is one of the major threats to global and local biodiversity. In forest ecosystems, the threats caused by IAS include hybridization, transmission of diseases and species competition [1]. An alien plant also referred to as exotic, introduced, foreign, non-indigenous or nonnative, is one that has been introduced by humans intentionally or otherwise through human agency or accidentally from one region to another. An alien plant that has escaped from its original ecosystem and is reproducing on its own in the regional flora is considered a naturalized species. Those naturalized aliens that become so successful as to spread in the flora and displace native biota or threaten valued environmental, agricultural, or personal resources by the damage it causes are considered invasive. Monitoring is required in invasive species management to determine the location and early detection of problematic species, whether a species is likely to become a problem in an area, whether a species is responding to management efforts and the impact of alien plant control methods on native species. Monitoring of invasion can be done through qualitative approach like species inventory (seasonally) and quantitative approach using phytosociological methods and mapping by ground-based methods (Via map overlays or GPS), remotely sensed images (aerial photos, high-resolution multispectral digital data). General methods practiced for the eradication of IAS

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include chemical methods, biological methods, and physical methods. Native plants can act as a sink for air pollutants and contribute significantly to carbon sequestration. Therefore, the loss of native plant diversity through invasive plant pathogens may indirectly affect human healththrough perturbations in environmental quality [2].

Material & Methods

Study area

Tumakuru is located at 13°.34" N, 77°. 1" E., situated 70 km northwest of Bengaluru [3]. Devarayanadurga Reserve Forest (DRF) in Tumakuru District spread over 6194.57ha. is a tropical dry deciduous type, comparatively dense forest with predominant tree species. It is known for harboring varieties of medicinal plants and economically important plants. It is elevated at a height of 1188m above mean sea level.

Soil and Climatic conditions

The average annual rainfall in the district is about 680 mm. The soil type here is red loamy with neutral pH of 7.2, with electrical conductivity being normal at 0.22. Available nitrogen is 156.6 kg per acre, P_2O_5 is 26.3 kg per acre and K_2O is 44.83 kg per acre which is moderate.

Vegetation

The forests in the district are confined mostly to the lower slopes of the hill ranges and are spread over the entire district in small blocks. The forests are mostly open and consist of mixed species varying from dry deciduous to thorny bushes [4]. The dominant tree species found in Devarayanadurga Reserve Forest includes, *Anogeissus latifolia*, *Pterocarpus marsupium*, *Terminalia tomentosa*, *Terminalia chebula*, *Terminalia arjuna*, *Tamarindus indica*, *Tectona grandis*, *Santalum album*, *Albizzia lebbeck*, *Boswellia serrata*, *Hardwickia binata*, *Buchnania angustifolia* and *Terminalia bellerica*. In addition to the higher order species, lower order species such as *Acacia catechu*, *Wrightia tinctoria*, *Canthium parviflorum*, *Dodonaea viscosa*, *Cassia auriculata*, *Cassia fistula,* and *Albizia amara* are also found.

Field survey and Identification

Subsequent field visits were conducted to DRF, and plants were surveyed in the following spots i.e., *Urdigere* entry spot, University sanctioned land spot, lower slopes, and around Bhoga Narasimha Swamy temple and Yoga Narasimha Swamy temple, upper slopes and aroundVidyashankara temple, and in and around Namada chilume. The species were identified using Flora of Presidency of Madras Vol. I to III and Flora of Tumkur District [5,6].

Ecological impact studies

Ecological impact studies were done using 'Invasive Attributes' (Sandilyan *et al.*, 2019). The spread and invasiveness, range extension studies of IAS in DRF were studied using the data provided in different regions of the country [8-13].

Results & Discussion

In DRF a total of 144 Invasive Alien Species belonging to 130genera of 51 families were recorded. Out of these 3 are Pteridophytes and the remaining 141 species are Angiosperms. Among these, 59 herbs (41%), 23 shrubs (16%), 38 trees (28%), 12 climbers (8%), 5 Lianas (4%), 6 Climbing Shrubs (4%) and one species (1%) is a parasite (Figure 1)(Table 1). The species are distributed throughout the forest from lower elevations of 300 m to higher elevations of up to 1500 m. In the documented alien flora Fabaceae members are the dominant invasive species with 27 species, followed by Asteraceae with 11 species,Malvaceae with 8 species, Apocynaceae and Lamiaceae with 6 species each which is then followed by Asparagaceae and Convolvulaceae with 5 species each.

Of the documented IAS, 53species show different medicinal uses (28%), 32 tree species are harvested for timber (17%), 18 species are edible with fruits or leaves used in local culinary (10%), 15 species were introduced for ornamental purposes (8%), 12 species hold regional cultural values and are used in local festivities (6%), 8 species show high economical value by providing raw materials such as resins, and plant parts for pharmacy and biofuel (4%). Another 51 species have miscellaneous uses (27%) (Figure 2) (Table 1).

Three main attributes of 'ecological impacts' are given, namely, Invasiveness including IE - Invasive Elsewhere, RMS - Rapid Multiplication and Spread in Different Ecosystems, MMR - Multiple Modes of Reproduction, and MMD - Multiple Modes of Dispersion, Impacts including B1 - affecting ecosystem functions and services, B2 - biodiversity loss, and B3 - economic loss and health hazard (human and wildlife), and Invasion areas (Continues spread) including RE -

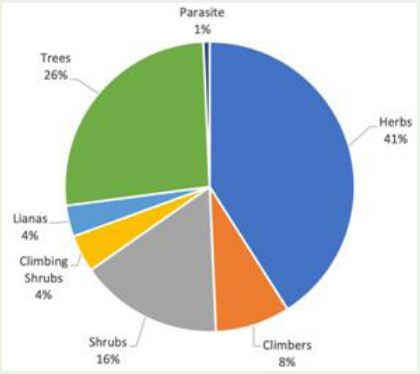

Figure 1: Habit distribution of Invasive Alien Flora in Devarayanadurga Reserve Forest.

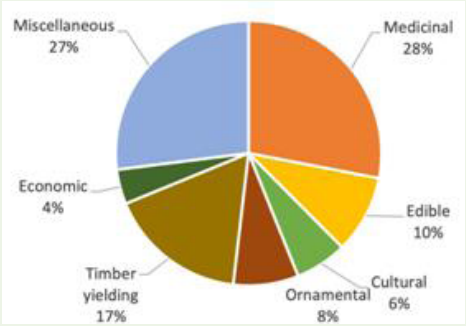

Figure 2: Usage of Invasive Alien Flora in Devarayanadurga Reserve Forest.

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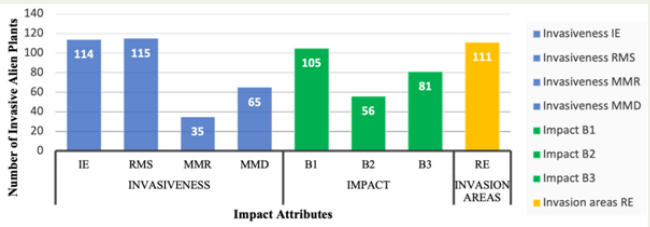

Figure 3: Ecological Impact Attributes of Invasive Alien Flora in Devarayana durga Reserve Forest.

Range Extension. The IAS was assigned respective attributes based on field observations and relevant literature. Among the documented IAS 114 species are invasive elsewhere, 115 species show rapid multiplication and spread in different ecosystems, 35 species show multiple modes of reproduction, and 65 species show multiple modes of dispersion. 105 IAS were reported to be affecting ecosystem functions and services, 56 IAS to be causing biodiversity loss and 81 species to be causing economic loss and health hazards to either humans or wildlife or both. 111 IAS shows continuous spread in DRF with range extension (Figure 3) (Table 2).

Table 1: List of Invasive Alien Species recorded in Devarayanadurga Reserve Forest, Tumakuru District, Karnataka.

Species Name	Habit	Vernacular Name (Kannada)	Nativity	Usage Type
Acanthaceae				
Barleria prionitis L.	H		Tropical Africa, Madagascar, Tropical & Subtropical Asia	MED
Rostellularia procumbens (L.) Nees	H	Hucchunelabevu	Tropical & Subtropical Asia to Central China	MISC
Amaranthaceae				
Alternanthera sessilis (L.) R.Br. ex DC.	H	Honagonesoppu	Tropical & Subtropical Asia to N. & E. Australia, S. Mexico to Tropical America	EDB, MED
Amaranthus spinosus L.	H	Mulluharivi, Mulludantu	Mexico to Tropical America	EDB, MED
Celosia argentea L.	H	Anne soppu	Tropical Africa	EDB, MED
Achyranthes aspera L.	H	Uttaranigida	Tropical & Subtropical Old World (Europe, Asia, Africa)	CUL, MED
Amaryllidaceae				
Crinum asiaticum L.	H	Nagadali, Vishamunguli	Indian Ocean, Tropical & Subtropical Asia to SW. Pacific	ORN
Anacardiaceae				
Annona squamosa L.	T	Seetha phala	Mexico to Colombia	EDB, MED
Apocynaceae				
Gymnema sylvestre (Retz.) R.Br. ex Sm.	L	Madhu nashini	Tropical & Subtropical Old World	MED
Plumeria alba L.	T		Puerto Rico to Windward Islands	CUL, ORN
Cascabela thevetia (L.) Lippold	S	Gantehoo, Haladikanagile	Mexico to S. Tropical America	CUL, ORN
Calotropis gigantea (L.) W.T.Aiton	S	Ekkadagida	S. China to Tropical Asia	CUL, ORN, MED
Wattakaka volubilis (L.f.) Stapf	L	Hegalaballi	NE. Pakistan to S. China and W. Malesia	MED
Ichnocarpus frutescens (L.) W.T.Aiton	L	Gouriballi	Tropical & Subtropical Asia to N. Australia	MED
Asparagaceae				
Asparagus racemosus Willd.	CS	Shatavari	Tropical Africa to N. Australia	MED
Furcraea foetida (L.) Haw.	S	Seemekatthale	Costa Rica to N. South America and S. Caribbean	MISC
Agave americana L.	S	Aanekatthale	S. U.S.A. to Mexico	ECON, MED
Agave angustifolia Haw.	S	Katthale	Mexico to Central America	ECON, MED
Chlorophytum tuberosum (Roxb.) Baker	H		Africa	MED, ORN
Asteraceae				
Ageratum conyzoides L.	H	Nayitulsi	Mexico	MED
Synedrella nodiflora (L.) Gaertn.	H		Tropical & Subtropical America	ORN
Bidens biternata (Lour.) Merr. & Sherff	H		Tropical & Subtropical Old World	MISC
Galinsoga parviflora Cav.	H		Mexico to Tropical America	MISC
Sonchus arvensis L.	H		Europe to Siberia and Caucasus	MISC
Tridax procumbens L.	H	Tikkegida	Mexico to Tropical America	MED
Vicoa indica (L.) DC.	H		Tropical & Subtropical Old World	MED
Chromolaena odorata (L.) R.M.King&H.Rob.	S	Dodda congress gida	Tropical & Subtropical America	MISC
Cyanthillium cinereum (L.) H.Rob.	H	Karehindi	Tropical & Subtropical Old World to Pacific	MED
Parthenium hysterophorus L.	H	Congress gida, Parthenium gida	Tropical & Subtropical America	MISC
Acanthospermum hispidum DC.	H	Kadlemullu	Tropical America	MISC
Bignoniaceae				
Tecoma stans (L.) Juss. ex Kunth	S	Gaudichaudi	Tropical & Subtropical America	MISC, TMB
Jacaranda mimosifolia D.Don	T	Swarna sundari	Bolivia to NW Argentina	ORN, TMB

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Crescentia cujete L.	T		Mexico to Venezuela, Caribbean	MISC
Boraginaceae				
Ehretia aspera Willd.	T		Pakistan to Hainan and Peninsula Malaysia	TMB
Trichodesma indicum (L.) Sm.	H	Atumoolisoppu	Afganistan to Thailand, Philippines	MED
Capparaceae				
Capparis zeylanica L.	CS	Thottaluballi, Govindaphala	SE. China to Tropical Asia	MED
Celastraceae				
Elaeodendron glaucum (Rottb.) Pers.	T	Mookrike mara	Sri Lanka	TMB
Gymnosporia senegalensis (Lam.) Loes.	S	Thondarasi	Tropical & S. Africa, Arabian Peninsula	MISC
Colchicaceae				
Gloriosa superba L.	C	Gourihoovu	Tropical and southern Africa and in tropical Asia	CUL, MED
Convolvulaceae				
Evolvulus alsinoides (L.) L.	H	Vishnu kanthi	Tropics & Subtropics	MISC
Ipomoea obscura (L.) Ker Gawl.	C	Muguthiballi	Tropical & Subtropical Old World	MISC
Ipomoea hederacea Jacq.	H		Mexico	MISC
Ipomoea hederifolia L.	H	Nakshatra hoovu	Tropical & Subtropical America	MISC
Xenostegia tridentata (L.) D.F.Austin& Staples	H		Tropical & Subtropical Old World	MISC
Cucurbitaceae				
Kedrostis foetidissima (Jacq.) Cogn.	C		Tropical & S. Africa, SW. Arabian Peninsula	MISC
Coccinia grandis (L.) Voigt	C	Thondeballi	Tropical Africa, W. Arabian Peninsula, Tropical & Subtropical Asia	EDB, MED
Cucumis maderaspatanus L.	C	Gubbi southekai	Tropical & Subtropical Old World	EDB, MED
Cyperaceae				
Bulbostylis barbata (Rottb.) C.B.Clarke	H		Tropical & Subtropical Old World	MISC
Cyperus mindorensis (Steud.) Huygh	H		Tropical & Subtropical Old World to Caucasus	MISC
Dioscoreaceae				
Dioscorea bulbifera L.	C	Heggenasu	Tropical & Subtropical Old World	EDB, MED
Dioscorea laurifolia Wall. ex Hook.f.	C		Peninsula Thailand to Malaya, Borneo	MISC
Dioscorea pentaphylla L.	C	Kaadugumbala	Tropical & Subtropical Asia to N. Australia	EDB
Ebenaceae				
Diospyros montana Roxb.	T	Jagalaganti mara	Tropical Asia	TMB
Euphorbiaceae				
Mallotus philippensis (Lam.) Mull.Arg	T	Kumkumada mara	Tropical & Subtropical Asia to N. & E. Australia	CUL, ECON, MED, TMB
Euphorbia hirta L.	H	Taddigida	Tropical & Subtropical America	MISC
Jatropha curcas L.	T	Bettadaharalu	Mexico to Tropical America	ECON, TMB
Croton bonplandianus Baill.	H	Uttigida	S. Bolivia to Uruguay	MISC
Fabaceae				
Abrus precatorius L.	S	Gulaganji	Tropical & Subtropical Old World to N. & E. Australia	CUL, MED
Clitoria ternatea L.	C	Shankapushpi	Cape Verde, Tropical & S. Africa, Arabian Peninsula	ORN
Cassia grandis L.f.	T		Central Mexico to Tropical America	MISC
Chamaecrista absus (L.) H.S.Irwin& Barneby	H	Kadu huliga, Halubija	Tropics & Subtropics	MISC
Dalbergia sissoo Roxb. ex DC.	T	Biradi mara, sisam mara	S. Arabian Peninsula to Myanmar	TMB
Delonix regia (Bojer ex Hook.) Raf.	T	Kemputurai, Kattikayi mara, Gulmohar	Tropics and subtropics, including Madagascar	ORN, TMB
Enterolobiumcontortisiliquum (Vell.) Morong	T		Bolivia to Brazil and N. Argentina	TMB
Parkia biglandulosa Wight & Arn.	T		Bangladesh to Myanmar	TMB
Pongamia pinnata (L.) Pierre	T	Honge mara	Tropical & Subtropical Asia to W. Pacific	MED, TMB
Prosopis juliflora (Sw.) DC.	T	Ballari jali	Mexico to Venezuela, Peru, Caribbean	MISC
Senna pallida (Vahl) H. S. Irwin & Barneby	S		Mexico to Tropical America	MISC
Tamarindus indica L.	T	Hunase mara	Tropical Africa	CUL, EDB, MED, TMB
Calobota cytisoides (P.J.Bergius) Eckl. &Zeyh.	H		SW. Cape Prov.	MISC
Indigofera linifolia (L.f.) Retz.	H		NE. Tropical Africa, SW. Arabian Peninsula, Afghanistan to China (S. Sichuan, Yunnan) and Tropical Asia, Australia	MISC

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Mimosa pudica L.	H	Muttidaremuni, Nachikemullu	South America	MED
Tephrosia purpurea (L.) Pers.	H	Koggigida	Africa to Arabian Peninsula, Tropical & Subtropical Asia to S. Pacific	MISC
Senna timoriensis (DC.) H.S.Irwin & Barneby	S		Tropical Asia to N. Australia	MISC
Senna hirsuta (L.) H.S.Irwin & Barneby	H		Tropical & Subtropical America	MISC
Gliricidia sepium (Jacq.) Kunth	T	Gobbaradagida	Mexico to Colombia	ECON, TMB
Leucaena leucocephala (Lam.) de Wit	T	Bili jali mara	Mexico to Central America	TMB
Acacia auriculiformis A.Cunn. ex Benth.	T		SE. Maluku to New Guinea and N. Australia	ORN, TMB
Uraria rufescens (DC.) Schindl.	H		Tropical & Subtropical Asia	MISC
Mucuna pruriens (L.) DC.	L		Tropical & Subtropical Old World	MED
Senegalia rugata (Lam.) Britton & Rose	CS	Seege kai	China (W. & SW. Yunnan, S. Guangdong) to Tropical Asia	ECON, TMB
Erythrina variegata L.	T	Harivana mara	Tanzania to Pacific	TMB
Baptisia alba (L.) R.Br.	H		SE. Canada to Central & E. U.S.A.	MISC
Polhillides velutina (Willd.) H.Ohashi&K. Ohashi	H		Tropical & Subtropical Old World	MISC
Gentianaceae				
Exacum tetragonum Roxb.	H		S. China to Tropical Asia and N. Australia	MISC
Hernandiaceae				
Gyrocarpus americanus Jacq.	T	Kaadubende	E. Tropical Africa to Pacific, Central Mexico to Venezuela	TMB
Hydrocharitaceae				
Hydrilla verticillata (L.f.) Royle	H		E. Europe to Asia, Australia, Uganda to N. Zambia	MISC
Hypoxidaceae				
Curculigo orchioides Gaertn.	H	Nelataale gaddi	Tropical & Subtropical Asia to W. Pacific	MISC
Lamiaceae				
Tectona grandis L.f.	T	Tegada mara	Southeast Asia	TMB
Vitex altissima L.f.	T	Navilaadi	Tropical Asia	TMB
Mesosphaerum suaveolens (L.) Kuntze	H	Natitulsi	Mexico to Tropical America	MED
Premna tomentosa Willd.	T	Naaruvalu	China (Guangdong) to Tropical Asia and N. Queensland	MISC
Leucas lavandulifolia Sm.	H	Kaadu tumbe	Tropical & Subtropical Asia	MED
Leucas aspera (Willd.) Link	H	Tumbe gida	Mauritius, Tropical & Subtropical Asia	CUL, MED
Lecythidaceae				
Couroupita guianensis Aubl.	T	Nagalingapushpa	Panama to S. Tropical America	CUL, MED, ORN
Careya arborea Roxb.	T	Kavale mara	Afghanistan to NW. Peninsula Malaysia	MED, TMB
Malpighiaceae				
Hiptage benghalensis (L.) Kurz	L	Madhavi gida	Tropical & Subtropical Asia	MISC
Malvaceae				
Urena lobata L.	S	Kaaduthutti	Tropics & Subtropics	MISC
Grewia asiatica L.	T		Mascarenes, S. Iran to Queensland	TMB
Hibiscus panduriformis Burm.f.	S		Tropical Old Wold	ORN
Sida acuta Burm.f.	H	Bheemanakaddi	Tropics & Subtropics	MISC
Abutilon indicum (L.) Sweet	S	Sri mudregida	NW. Africa, Mascarenes, Tropical & Subtropical Asia to W. Pacific	MISC
Abutilon hirtum (Lam.) Sweet	S	Hetutti	Tropical & Subtropical Old World	MISC
Bombax ceiba L.	T	Kempuburugada mara	Tropical & Subtropical Asia to N. Australia	ORN, TMB
Sida mysorensis Wight & Arn.	H	Antutti	Tropical & Subtropical Asia	MISC
Meliaceae				
Cipadessa baccifera (Roth) Miq.	S	Sidigolli	Nepal to S. China and W. & Central Malesia	MED
Menispermaceae				
Cocculus hirsutus (L.) W.Theob.	CS	Dhagadiballi	Eritrea to S. Africa, Arabian Peninsula, SE. Pakistan to S. China	MED
Moraceae				
Ficus religiosa L.	T	Arali mara	SE. Pakistan to Myanmar	CUL, TMB
Streblus asper Lour.	T	Akhor mara, Mitale mara	S. China to Tropical Asia	TMB
Myrtaceae				
Corymbia intermedia (R.T.Baker) K.D.Hill&L.A.S.Johnson	T	Neelagiri mara	E. Queensland to E. New South Wales	ECON, TMB
Syzygium cumini (L.) Skeels	T	Nerale mara	Tropical & Subtropical Asia to N. Queensland	EDB, TMB
Olacaceae				
Ximenia americana L.	CS	Nagari gida	Tropics & Subtropics, Queensland	EDB

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Oleaceae				
Chionanthus ramiflorus Roxb.	T		Tropical & Subtropical Asia to N. Queensland	TMB
Orchidaceae				
Spathoglottis plicata Blume	H		Tropical & Subtropical Asia to Pacific	ORN
Papavaraceae				
Argemone mexicana L.	H	Daturigida	Central Mexico to Honduras	MED
Passifloraceae				
Passiflora foetida L.	C	Kukkiballi	Tropical & Subtropical America	MED
Phyllanthaceae				
Flueggea leucopyrus Willd.	S		Ethiopia to Somalia, Socotra, Saudi Arabia (Sajid Island), Pakistan to China (Sichuan, Yunnan), Sri Lanka	MED
Phyllanthus amarus Schumach. & Thonn.	H	Kirunelligida	S. Mexico to Tropical America	MED
Phyllanthus emblica L.	T	Bettadanellikai	Tropical & Subtropical Asia	EDB, MED
Poaceae				
Arthraxon hispidus (Thunb.) Makino	H		Tropical Africa, W. Indian Ocean, Asia to E. Australia	MISC
Saccharum spontaneum L.	H		Sicilia, Africa, Asia to N. & NE. Australia	MISC
Dactyloctenium aegyptium (L.) Willd.	H		Tropical & Subtropical Old World	MISC
Cymbopogon schoenanthus (L.) Spreng.	H	Porakehullu	Sahara & Sahel to Iran and Kenya	MISC
Polygalaceae				
Polygala chinensis L.	H		Tropical & Subtropical Asia to Caroline Islands	MED
Pteridaceae				
Actiniopteris radiata (Sw.) Link	H		Africa, Arabian Peninsula, Iran to Myanmar	MISC
Adiantum caudatum L.	H		Tropical & Subtropical Asia to SW. Pacific	ORN
Acrostichum aureum L.	H		Tropics & Subtropics	MISC
Rhamnaceae				
Ziziphus jujuba Mill.	T	Bore	N. & E. China to S. Korea	EDB, TMB
Ziziphus oenopolia (L.) Mill.	T		China (S. Yunnan, Guangxi) to Tropical Asia and N. Australia	TMB
Rubiaceae				
Catunaregam spinosa (Thunb.) Tirveng.	S	Bili hooli	Pakistan to S. China and W. Malesia	MED
Spermacoce ocymoides Burm.f.	H		Tropical Asia to SW. Pacific	MED
Morinda citrifolia L.	T	Noni mara	Tropical & Subtropical Asia to N. Australia	EDB, MED
Rutaceae				
Murraya paniculata (L.) Jack	S	Kaadukaribevu	Tropical & Subtropical Asia to Vanuatu	EDB, MED
Zanthoxylum asiaticum (L.) Appelhans, Groppo &J.Wen	C	Doddakadumenasu	Ethiopia to Eswatini, W. Indian Ocean, Tropical & Subtropical Asia	EDB
Santalaceae				
Viscum articulatum Burm.f.	P		Tropical & Subtropical Asia to S. Pacific	MISC
Sapindaceae				
Dodonaea viscosa Jacq.	S	Bandarikegida	Australia, India, and tropical and subtropical Africa	TMB
Cardiospermum halicacabum L.	C	Bekkinabuddegida	Tropics & Subtropics	MED
Solanaceae				
Solanum torvum Sw.	S	Sundekayi	Mexico to N. South America, Caribbean, E. Brazil	EDB, MED
Verbenaceae				
Lantana camara L.	S	Beligida, Kasoothihoovu	Mexico to Tropical America	MISC
Stachytarpheta indica (L.) Vahl	S		Mexico to Tropical America	MISC
Violaceae				
Afrohybanthus enneaspermus (L.) Flicker	H	Purusha rathna	Tropical Africa, Madagascar, Tropical & Subtropical Asia to Australia	MED
Vitaceae				
Cissus adnata Roxb.	CS	Gudametake	Madagascar, China (S. Yunnan) to Tropical Asia, N. Australia	MED
Zingiberaceae				
Curcuma longa L.	H	Arishinagida	Tropical & Subtropical Asia to N. Australia	CUL, EDB, ECON, MED
Zingiber zerumbet (L.) Roscoe ex Sm.	H	Kadu Shunti, Kallushunti	Tropical & Subtropical Asia	MED

CUL - Cultural, ECON - Economical,EDB- Edible, MED - Medicinal, ORN - Ornamental,TMB - Timber, MISC - Miscellaneous

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Table 2: Invasive status and Impact of the species reported in Devarayanadurga Reserve Forest, Tumakuru District, Karnataka.

Species	Invasiveness				Impacts			RE
	IE	RMS	MMR	MMD	B1	B2	B3	
Abrus precatorius L.		+			+			
Abutilon hirtum (Lam.) Sweet	+	+	+	+	+		+	+
Abutilon indicum (L.) Sweet	+	+	+	+	+	+	+	+
Acacia auriculiformis A.Cunn. ex Benth.	+	+	+	+	+	+	+	+
Acanthospermum hispidum DC.		+			+			+
Achyranthes aspera L.	+	+	+	+	+	+	+	+
Acrostichum aureum L.		+			+			+
Actiniopteris radiata (Sw.) Link		+			+			+
Adiantum caudatum L.		+			+			+
Afrohybanthus enneaspermus (L.) Flicker	+	+			+			
Agave americana L.	+	+			+	+	+	+
Agave angustifolia Haw.	+	+			+	+	+	+
Ageratum conyzoides L.	+	+			+			
Alternanthera sessilis (L.) R.Br. ex DC.	+	+	+	+	+	+	+	+
Amaranthus spinosus L.	+	+	+	+	+	+	+	+
Annona squamosa L.	+	+			+			+
Argemone mexicana L.	+	+			+	+		+
Arthraxon hispidus (Thunb.) Makino	+	+			+	+		+
Asparagus racemosus Willd.	+	+			+		+	+
Baptisia alba (L.) R.Br.					+			
Barleria prionitis L.	+	+			+		+	+
Bidens biternata (Lour.) Merr. & Sherff	+	+			+		+	+
Bombax ceiba L.	+			+	+		+	
Bulbostylis barbata (Rottb.) C.B.Clarke	+	+		+				+
Calobota cytisoides (P.J.Bergius) Eckl. &Zeyh.		+						+
Calotropis gigantea (L.) W.T.Aiton	+	+		+	+	+	+	+
Capparis zeylanica L.	+				+			
Cardiospermum halicacabum L.	+	+	+		+		+	
Careya arborea Roxb.	+	+					+	+
Cascabela thevetia (L.) Lippold	+		+				+	
Cassia grandis L.f.	+		+				+	+
Catunaregam spinosa (Thunb.) Tirveng.					+	+	+	
Celosia argentea L.	+	+		+	+	+	+	+
Chamaecrista absus (L.) H.S.Irwin & Barneby	+	+				+	+	+
Chionanthus ramiflorus Roxb.					+			
Chlorophytum tuberosum (Roxb.) Baker	+				+	+	+	+
Chromolaena odorata (L.) R.M.King & H.Rob.	+	+	+	+	+	+	+	+
Cipadessa baccifera (Roth) Miq.		+		+	+	+	+	
Cissus adnata Roxb.		+		+	+	+	+	
Clitoria ternatea L.	+	+		+	+	+	+	+
Coccinia grandis (L.) Voigt	+	+		+			+	
Cocculus hirsutus (L.) W.Theob.	+	+		+			+	
Corymbia intermedia (R.T.Baker) K.D.Hill & L.A.S.Johnson	+	+		+	+	+	+	+
Couroupita guianensis Aubl.	+				+			
Crescentia cujete L.	+				+			
Crinum asiaticum L.	+	+			+	+	+	+
Croton bonplandianus Baill.	+	+		+	+	+	+	+
Cucumis maderaspatanus L.	+	+		+			+	
Curculigo orchioides Gaertn.	+							
Curcuma longa L.	+		+					
Cyanthillium cinereum (L.) H.Rob.	+		+					
Cymbopogon schoenanthus (L.) Spreng.	+			+	+	+		+
Cyperus mindorensis (Steud.) Huygh	+			+	+	+		+
Dactyloctenium aegyptium (L.) Willd.	+			+	+	+		+
Dalbergia sissoo Roxb. ex DC.	+		+		+	+		+
Delonix regia (Bojer ex Hook.) Raf.	+		+		+	+	+	+
Dioscorea bulbifera L.	+	+					+	
Dioscorea laurifolia Wall. ex Hook.f.	+	+					+	
Dioscorea pentaphylla L.	+	+					+	+
Diospyros montana Roxb.	+	+	+	+	+	+	+	
Dodonaea viscosa Jacq.	+	+		+	+	+	+	+
Ehretia aspera Willd.	+	+				+		
Elaeodendron glaucum (Rottb.) Pers.	+	+				+		+
Enterolobiumcontortisiliquum (Vell.) Morong	+			+	+		+	
Erythrina variegata L.	+				+	+		
Euphorbia hirta L.	+	+	+	+	+	+	+	+
Evolvulus alsinoides (L.) L.	+	+	+	+	+	+	+	+
Exacum tetragonum Roxb.	+	+	+				+	
Ficus religiosa L.		+	+	+	+			+
Flueggea leucopyrus Willd.		+			+			+
Furcraea foetida (L.) Haw.	+	+	+		+	+	+	+
Galinsoga parviflora Cav.					+			+
Gliricidia sepium (Jacq.) Kunth	+	+	+	+	+	+	+	+
Gloriosa superba L.		+						
Grewia asiatica L.		+		+	+		+	+
Gymnema sylvestre (Retz.) R.Br. ex Sm.		+			+			+
Gymnosporia senegalensis (Lam.) Loes.	+	+		+		+		+
Gyrocarpus americanus Jacq.	+	+		+	+		+	+
Hibiscus panduriformis Burm.f.		+	+		+		+	+
Hiptage benghalensis (L.) Kurz		+			+			+
Hydrilla verticillata (L.f.) Royle	+	+			+	+		+
Ichnocarpus frutescens (L.) W.T.Aiton	+	+			+	+		+
Indigofera linifolia (L.f.) Retz.		+			+	+		+
Ipomoea hederacea Jacq.		+			+	+		+
Ipomoea hederifolia L.	+	+			+	+		+
Ipomoea obscura (L.) Ker Gawl.	+	+			+	+	+	+
Jacaranda mimosifolia D.Don	+	+			+	+		+
Jatropha curcas L.	+	+			+			+

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Kedrostis foetidissima (Jacq.) Cogn.		+					+	+
Lantana camara L.	+	+	+	+	+	+	+	+
Leucaena leucocephala (Lam.) de Wit	+	+		+	+	+		+
Leucas aspera (Willd.) Link	+	+	+	+			+	+
Leucas lavandulifolia Sm.	+	+	+	+			+	+
Mallotus philippensis (Lam.) Mull. Arg	+		+	+	+		+	
Mesosphaerum suaveolens (L.) Kuntze	+	+	+	+	+	+		+
Mimosa pudica L.	+	+		+		+		+
Morinda citrifolia L.	+	+	+		+			
Mucuna pruriens (L.) DC.	+	+			+	+	+	+
Murraya paniculata (L.) Jack		+	+	+			+	+
Parkia biglandulosa Wight & Arn.					+		+	
Parthenium hysterophorus L.	+	+	+	+	+	+	+	+
Passiflora foetida L.	+	+					+	
Phyllanthus amarus Schumach. & Thonn.	+	+					+	+
Phyllanthus emblica L.	+	+					+	+
Plumeria alba L.	+	+	+		+		+	+
Polhillides velutina (Willd.) H.Ohashi & K.Ohashi	+							+
Polygala chinensis L.	+	+						+
Pongamia pinnata (L.) Pierre	+	+		+	+			+
Premna tomentosa Willd.				+	+			+
Prosopis juliflora (Sw.) DC.	+	+	+	+	+	+		+
Rostellularia procumbens (L.) Nees		+						+
Saccharum spontaneum L.	+	+			+			+
Senegalia rugata (Lam.) Britton & Rose	+	+			+	+		+
Senna hirsuta (L.) H.S.Irwin & Barneby	+	+		+			+	+
Senna pallida (Vahl) H. S. Irwin & Barneby	+	+		+			+	+
Senna timoriensis (DC.) H.S.Irwin & Barneby	+	+		+			+	+
Sida acuta Burm.f.	+	+		+	+			+
Sida mysorensis Wight & Arn.	+	+		+	+			+
Solanum torvum Sw.	+	+		+	+	+	+	+
Sonchus arvensis L.	+	+		+			+	+
Spathoglottis plicata Blume	+				+			
Spermacoce ocymoides Burm.f.	+	+		+			+	+
Stachytarpheta indica (L.) Vahl	+	+		+	+		+	+
Streblus asper Lour.	+	+		+	+		+	+
Synedrella nodiflora (L.) Gaertn.	+	+		+	+		+	+
Syzygium cumini (L.) Skeels	+		+	+	+			+
Tamarindus indica L.	+	+		+	+	+	+	+
Tecoma stans (L.) Juss. ex Kunth	+	+	+	+	+	+	+	+
Tectona grandis L.f.	+				+			+
Tephrosia purpurea (L.) Pers.	+	+						+
Trichodesma indicum (L.) Sm.	+	+			+		+	+
Tridax procumbens L.	+	+		+	+		+	+
Uraria rufescens (DC.) Schindl.		+			+			+
Urena lobata L.		+						+
Vicoa indica (L.) DC.	+	+		+	+		+	+
Viscum articulatum Burm.f.	+	+	+		+	+	+	+
Vitex altissima L.f.				+	+		+	+
Wattakaka volubilis (L.f.) Stapf	+	+			+			+
Xenostegia tridentata (L.) D.F.Austin & Staples	+	+		+	+		+	+
Ximenia americana L.	+	+		+	+		+	+
Zanthoxylum asiaticum (L.) Appelhans, Groppo & J.Wen		+				+		+
Zingiber zerumbet (L.) Roscoe ex Sm.	+	+			+		+	+
Ziziphus jujuba Mill.	+	+		+	+		+	+
Ziziphus oenopolia (L.) Mill.	+	+		+	+		+	+

IE - Invasive Elsewhere; RMS - Rapid Multiplication and Spread in different ecosystems; MMR - Multiple Modes of Reproduction, MMD - Multiple Modes of Dispersion; Impacts (B1- affecting ecosystem functions and services;B2 - Biodiversity loss; B3 - Economic loss and health hazard (human and wildlife) RE - Range Extension (Continues spread of the alien species).

Conclusion

The IAS are ought to compete with the native species for nutrition, light, and hence affects the regeneration capacity of native species. Hybridization of alien plant species with native species causes gene mixing leading to reduced disease resistance in native plants. Allelopathic interaction of IAS impacts the fertility of soil and degradation of the native species. Of the documented IAS *Jacaranda mimosifolia* D.Don (Bignoniaceae) is an IUCN Red Listed as Vulnerable (VU) tree species [14]. The tree species was introduced as an ornamental plant which eventually was used for timber by the local villagers around the DRF. Many such species were either introduced for aesthetics or came to the study area by accidental movement through man or wildlife and now are invasive within native species.

Among the documented IAS 79.16% of species are invasive elsewhere, 79.86% of species show rapid multiplication and spread in different ecosystems, 24.30% of species show multiple modes of reproduction, and 45.13%of species show multiple modes of dispersion. 72.91% IAS was reported to be affecting ecosystem functions and services, 38.88% IAS to be causing biodiversity loss and 56.25% of species to be causing economic loss and health hazards to either humans or wildlife or both. 77.08% IAS show continuous spread in DRF with range extension. Hence timely monitoring of the distribution pattern of IAS should be undertaken to successfully eradicate them and reestablish native species.

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