

Electronic Supplementary Materials

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Potential Risks of Plant Invasions in Protected Areas of Sri Lanka under Climate Change with Special Reference to Threatened Vertebrates

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Table S1. Fourteen priority IAPS used for MaxEnt model run (adapted from MMD&E [1]). NP = national park; SNR = strict nature reserve.

Species (Family)	Common name	Life form (Year of introduction)	Mechanism	Impact	Affected climatic zones (Protected areas)	Reference
<i>Alstonia macrophylla</i> (Apocynaceae)	Hard milkwood	Tree (unknown)	Compete for resources	Reduce native species regeneration	Wet zone (Peak Wilderness sanctuary, Sinharaja and Hantana forests)	[2]
<i>Annona glabra</i> (Annonaceae)	Pond apple	Tree (unknown)	Grow rapidly and produce high biomass	Convert wetlands into terrestrial ecosystems	Wet zone (Muthurajawela wetland sanctuary)	[3-4]
<i>Austroeupatorium inulifolium</i> (Asteraceae)	Austroeupatorium	Shrub (unknown)	Inhibit natural succession by native species	Exclude native woody species	Montane zone (Knuckles forest, Horton Plains NP, Peak wilderness sanctuary, Hakgala SNR)	[5]
<i>Clidemia hirta</i> (Melastomataceae)	Soapbush, Koster's curse	Herb (1894)	Compete with native species in gaps	Alter forest regeneration	Wet zone (Sinharaja forest)	[6]
<i>Dillenia suffruticosa</i> (Dilleniaceae)	Shrubby Dillenia	Tree (1882)	Alter soil physical and chemical properties	Impact nutrient absorption of native plants	Lowland wet zone (Sinharaja forest)	[7]
<i>Lantana camara</i> (Verbenaceae)	Lantana	Shrub (1826)	Shade out native plants	Suppress undergrowth plant species richness/composition	Intermediate zone (Udawalawe NP; Sinharaja forest, Victoria-Randenigala-Rantambe sanctuary)	[3, 8-11]
			Allelopathic effects /toxic effects	Pronounced health problems for animals/ Soil unsuitable for native species (deplete fodder for animals)		
			Form impenetrable	Disturb		

			thickets/shade out native species	movements of animals		
			Compete for resources	Reduce native species regeneration		
			Adverse environmental impacts (i.e., forest fire)	Destruction of natural habitats		
<i>Leucaena leucocephala</i> (Fabaceae)	White lead tree	Shrub/ Tree (1980)	Form dense monospecific thickets	Replace native forest and threaten endemic species Disturb movements of animals limiting access to food and water resources	Dry and intermediate zones (Mihintale sanctuary)	[6, 12]
<i>Mimosa pigra</i> (Fabaceae)	Giant Mimosa	Shrub (1980)	Reduce area of grazing land and the carrying capacity of the land Form impenetrable thickets	Impact the health of pastoral industries Disturb movements of animals	Intermediate zone (Victoria Randenigala Rantembe sanctuary)	[6]
<i>Opuntia dillenii</i> (Cactaceae)	Prickly pear cactus	Cactus (unknown)	Displace native species Degradation of habitats and habitat alterations	Modify structure and functions of ecosystem Reduce habitats for elephants and wading birds Reduce nesting habitats for turtles	Dry zone (Bundala and Yala NPs)	[3, 13]
<i>Panicum maximum</i> (Poaceae)	Guinea grass	Grass (1801–1802)	Form dense stands	Suppresses or displace local plants	All zones (Udawalawe NP; <i>P. maximum</i> is a good fodder for elephants in the park)	[3, 6]
<i>Parthenium hysterophorus</i> (Asteraceae)	Parthenium	Herb (1980)	Allelopathic effects Destroy habitats	Toxic effects cause pronounced health problems to humans and animals Limited foraging grounds and fodder contents	Dry zone	[9, 14]
<i>Prosopis juliflora</i> (Fabaceae)	Mesquite	Tree (1880)	Form impenetrable thickets Superior competitors for resources/ replace native vegetation	Disturb movements of animal species limiting access to food resources Loss of pasture and habitats for ruminants. Health issues for herbivores	Dry Zone (Bundala NP)	[10]
<i>Sphagneticola</i>	Creeping	Herb	Form dense ground	Prevent	Wet zone (Sinharaja)	[6]

<i>trilobata</i> (Asteraceae)	ox-eye	(unknown)	cover	regeneration of other species	Forest)	
			Compete for resources	Reduce crop yields		
<i>Ulex europaeus</i> (Fabaceae)	Gorse	Shrub (1888)	Alters soil conditions and replace grasses	Increase soil erosion Reduce pasture quality (i.e., thorny and unpalatable)	Montane zone (Horton Plains NP; <i>U. europaeus</i> stands provide habitat for the Black-lipped Lizard, <i>Calotes</i> <i>nigrilabris</i> , (E, EN) and several amphibians)	[6] [3]

Table S2. The environmental variables used in the MaxEnt models (Source: Kariyawasam et al. [15]).

No	Variable	Abbreviation	Unit
1	Annual mean diurnal temperature range	bio2	°C
2	Maximum temperature of warmest month	bio5	°C
3	Minimum temperature of coldest month	bio6	°C
4	Annual precipitation	bio12	mm
5	Precipitation of driest month	bio14	mm
6	Precipitation seasonality	bio15	%
7	Precipitation of coldest quarter	bio19	mm

Table S3. Model performances of 14 priority IAPS in Sri Lanka, Modified from Kariyawasam et al. [15]. AUC: area under the receiver operating characteristic curve, TSS: true skill statistic.

	Species	Number of Occurrences	Mean AUC	Average TSS	Overall model performance
1	<i>Alstonia macrophylla</i>	116	0.941	0.758	Moderate
2	<i>Annona glabra</i>	69	0.967	0.845	Good
3	<i>Austroeupeatorium inulifolium</i>	60	0.984	0.896	Good
4	<i>Clidemia hirta</i>	80	0.948	0.739	Moderate
5	<i>Dillenia suffruticosa</i>	68	0.958	0.776	Moderate
6	<i>Lantana camara</i>	253	0.788	0.462	Moderate
7	<i>Leucaena leucocephala</i>	151	0.856	0.551	Moderate
8	<i>Mimosa pigra</i>	36	0.911	0.663	Moderate
9	<i>Opuntia dillenii</i>	25	0.934	0.618	Moderate
10	<i>Panicum maximum</i>	323	0.796	0.456	Moderate
11	<i>Parthenium hysterophorus</i>	169	0.946	0.820	Good
12	<i>Prosopis juliflora</i>	48	0.973	0.730	Moderate
13	<i>Sphagneticola trilobata</i>	47	0.910	0.659	Moderate
14	<i>Ulex europaeus</i>	15	0.995	0.892	Good

AUC is Area under the ROC (Receiver Operating Characteristic) Curve; TSS is True Skill Statistic. Overall model performance was evaluated considering both AUC and TSS values. Overall model performance was considered as ‘good’ if both AUC and TSS show good performance (AUC >0.9 and TSS > 0.8). Overall model performance was considered as ‘moderate’ if one measure shows moderate performance (AUC > 0.7–0.9 or TSS 0.4–0.8) although the other measure performs well.

Table S4. List of ‘Critically Endangered’ amphibian, reptile, bird, and mammal species for which occurrences were downloaded from GBIF (E = Endemic).

Taxonomic Group	Species
Amphibians	<i>Adenomus kandianus</i> (Bufonidae), E <i>Microhyla zeylanica</i> (Microhylidae), E <i>Ramanella palmata</i> (Microhylidae), E
Reptiles	<i>Calotes desilvai</i> , (Agamidae), E <i>Ceratophora erdeleni</i> , (Agamidae), E <i>Ceratophora karu</i> , (Agamidae), E <i>Ceratophora tennentii</i> , (Agamidae), E <i>Cnemaspis upendrai</i> , (Gekkonidae), E <i>Cophotis dumbara</i> , (Agamidae), E <i>Cyrtodactylus fraenatus</i> , (Gekkonidae), E <i>Rhinophis lineatus</i> , (Uropeltidae), E <i>Rhinophis zigzag</i> , (Uropeltidae), E <i>Typhlops mirus</i> , (Typhlopidae), E <i>Cnemaspis kallima</i> , (Gekkonidae), E <i>Cyrtodactylus soba</i> , (Gekkonidae), E <i>Cyrtodactylus subsolanus</i> , (Gekkonidae), E <i>Lankascincus sripadensis</i> , (Scincidae), E <i>Ophisops leschenaultia</i> , (Lacertidae) <i>Rhinophis erangaviraji</i> , (Uropeltidae), E
Birds	<i>Anas poecilorhyncha</i> (Anatidae) <i>Columba livia</i> (Columbidae) <i>Cursorius coromandelicus</i> (Glareolidae) <i>Dromas ardeola</i> (Dromadidae) <i>Ephippiorhynchus asiaticus</i> (Ciconiidae) <i>Francolinus pictus</i> (Phasianidae) <i>Merops philippinus</i> (Meropidae) <i>Perdica asiatica</i> (Phasianidae) <i>Rallina eurizonoides</i> (Rallidae) <i>Sterna dougallii</i> (Laridae) <i>Sterna hirundo</i> (Laridae)
Mammals	<i>Crocidura horsfieldii</i> (Soricidae) <i>Crocidura miya</i> (Soricidae), E <i>Kerivoula hardwickii</i> (Vespertilionidae) <i>Saccolaimus saccolaimus</i> (Emballonuridae) <i>Solisorex pearsoni</i> (Soricidae), E

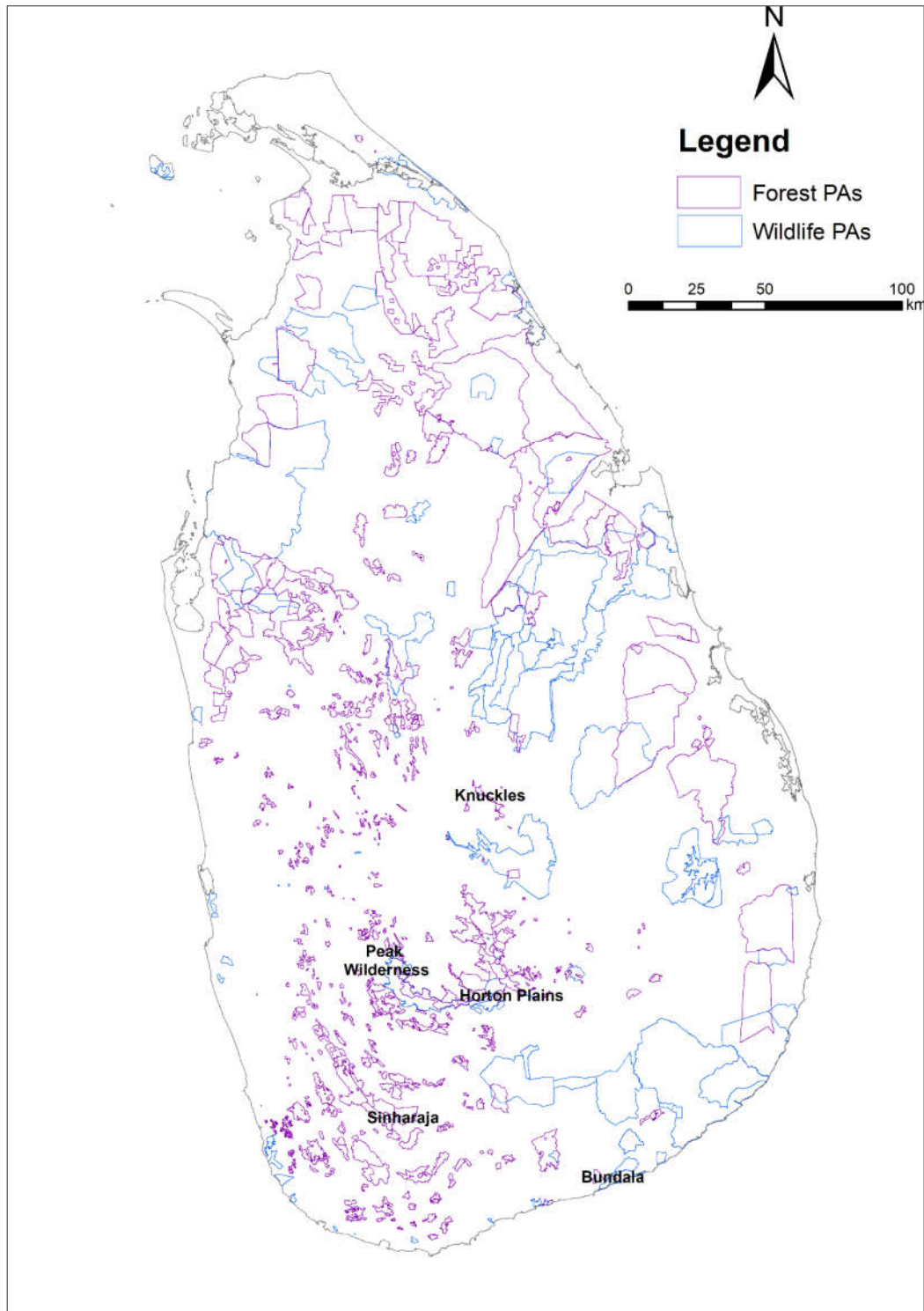


Figure S1. Wildlife and forest protected areas considered by the study.

Table S5. Number of vertebrate species recorded in six wildlife protected areas with endemism and national conservation status, E = endemic; NP = national park; NT = nationally threatened (NT status is given within brackets, and is based on the national red list 2012); SNR = strict nature reserve.

Protected area	Area km ² (Approx.)	Amphibians		Reptiles		Birds		Mammals		Reference
		Total	E (NT)	Total	E (NT)	Total	E (NT)	Total	E (NT)	
Horton Plains NP	31.6	14	13 (13)	06	5 (5)	64	13 (14)	19	5 (9)	[16]
Bundala NP	62.16	13	0 (1)	26	4 (0)	165	2 (13)	69	4 (7)	[17]
Peak Wilderness Sanctuary	223.79	21	18 (16)	27	11 (6)	91	21 (19)	13	5 (5)	[18]
Ritigala SNR	15.28	17	4 (3)	58	19 (8)	137	4 (3)	37	4 (10)	[19]
Minneriya NP	94.11	14	2 (2)	40	12 (2)	135	3 (5)	36	4 (10)	[20]
Wasgomuwa NP	33,649	6	4 (2)	22	6 (2)	148	8 (6)	40	4 (13)	[21]

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