Reconciling nature and the electricity grid: the need for sensitivity mapping

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BirdLife INTERNATIONAL

Partnership for nature and people

We require a lot more powerlines

- There are already over 65 million kilometres of powerlines globally – enough to stretch to the moon and back 169 times – and this will need to more than double to accommodate the transition to renewables.

…and we are a long way from achieving this goal

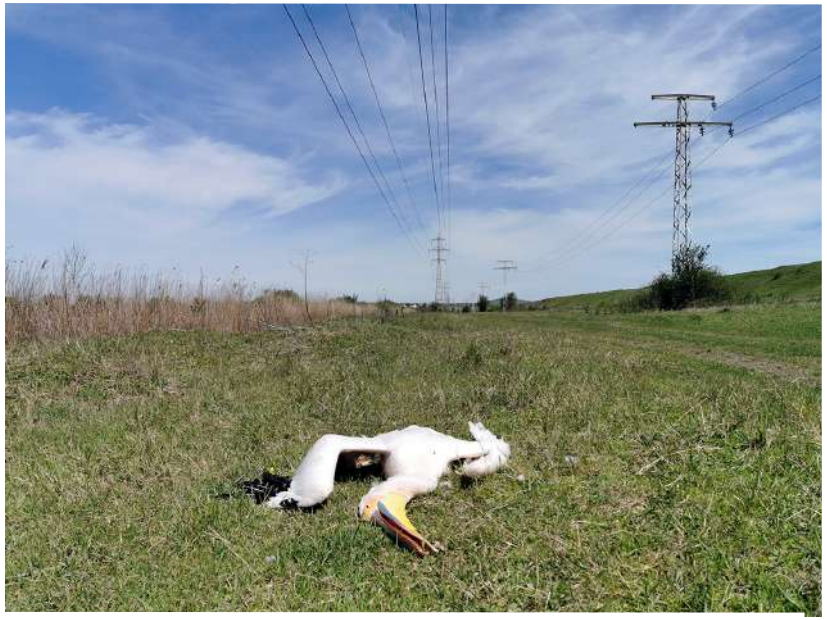
- To achieve Net Zero by 2050 a quadrupling of wind and solar expansion is needed this decade. This is equivalent to installing the world's current largest solar park roughly every day.

The problem









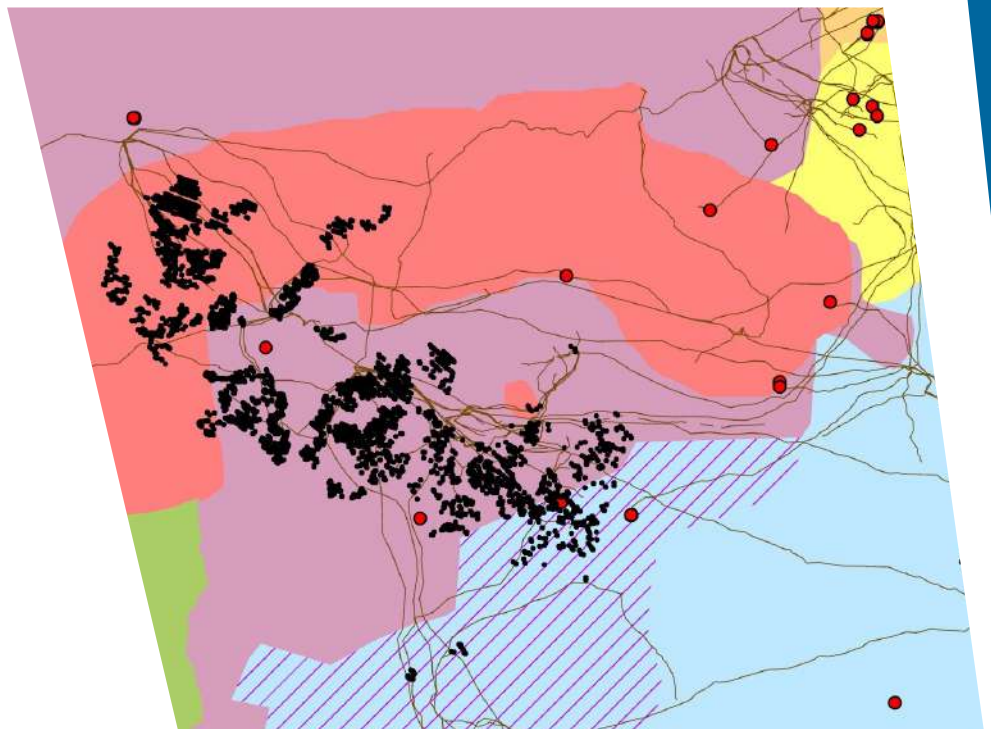
In Mongolia, badly designed powerlines are responsible for the electrocution of 4,000 – 5,000 Endangered **Saker Falcon** each year.

The **Great Indian Bustard** is on course to go extinct due to badly planned renewable energy

The solution

Plan electricity grids strategically with nature in mind

- Grids require centralised planning.
- Much growth in powerline infrastructure is driven by renewable energy – wind and solar resources are often widespread, providing opportunities for different deployment scenarios to be considered.
- By identifying high-risk areas early in the planning process, they can more easily be avoided outright, or alternatively, suitable mitigation (such as undergrounding) can be factored into a projects design from the outset.

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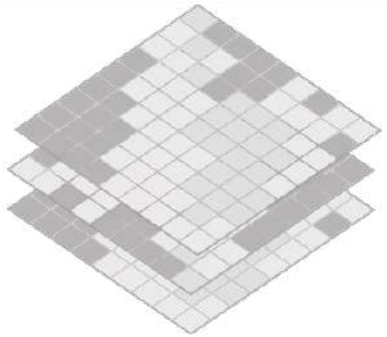
1) Identifying top-priority species

2) Map the distribution of priority species

creating a surface to represent the species occurrence probability



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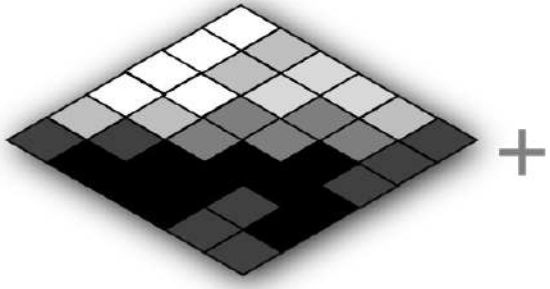

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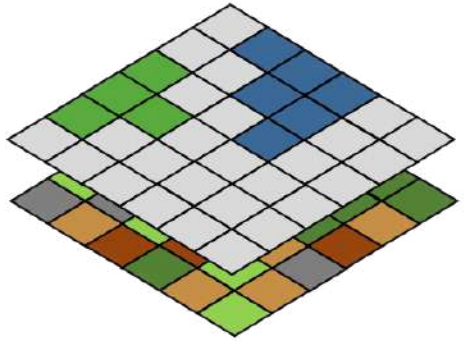
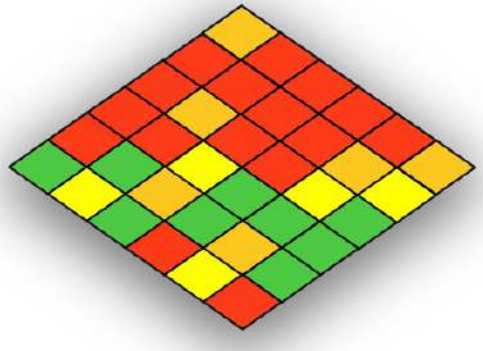


5) Categorize sensitivity to produce final map



Create Sensitivity Index ranking species of highest concern

$$\text{PW collision sensitivity index} = \text{PwCo} \times \text{CnS}^{(1-(\frac{Su+En}{2})/((\frac{Su+En}{2})+0.5)}$$

$$\text{PW electrocution sensitivity index} = \text{PwEc} \times \text{CnS}^{(1-(\frac{Su+En}{2})/((\frac{Su+En}{2})+0.5)}$$

Primary factors

- Powerline Collision Sensitivity (**PwCo**)
- Powerline Electrocution Sensitivity (**RwEc**)
- Conservation Status – Global Red List (**CnS**)

Aggravating factors

- Survivorship – Annual Adult Survival (**Su**)
- Endemicity – % global population (**En**)

Create Sensitivity Index ranking species of highest concern

- Conduct a global analysis of collision and electrocution records enabling modelling based on morphological, ecological and phylogenetic traits (e.g. Thaxter *et al*. 2017 for onshore wind energy).

- Score traits such as bird size, wing morphology, flight height, use of poles and lines for perching etc. using expert knowledge (e.g. Biasotto *et al*. 2021).

- Consult published reviews on impacted species and extrapolate to related taxa (Serratosa & Allinson 2022).

- Applied a scoring system to the species reported in three published reviews from Africa and Eurasia (Haas *et al*. 2003; Martín-Martín *et al*. 2019; Prinsen *et al*. 2011) and then extrapolated to related taxa. So species in the family Anhingidae were scored as Phalacrocoracidae.

Create Sensitivity Index ranking species of highest concern

INDIA collision

Family	Scientific name	Common name	CnS	CnS (s)	Su	Su (s)	En	En (s)	Co	Co (s)	PwCo SI	PwCo SI (norm)
Otididae	*Ardeotis nigriceps*	Great Indian Bustard	5	1	5	1	5	1	6	1	1	1
Otididae	*Houbaropsis bengalensis*	Bengal Florican	5	1	5	1	4	0.8	6	1	1	1
Otididae	*Sypheotides indicus*	Lesser Florican	4	0.8	4	0.8	5	1	6	1	0.9234	0.8869
Ciconiidae	*Leptoptilos dubius*	Greater Adjutant	4	0.8	5	1	3	0.6	6	1	0.9178	0.8785
Charadriidae	*Vanellus gregarius*	Sociable Lapwing	5	1	4	0.8	1	0.2	5	0.8333	0.8333	0.7539
Gruidae	*Grus antigone*	Sarus Crane	3	0.6	5	1	4	0.8	6	1	0.8332	0.7537
Ciconiidae	*Leptoptilos javanicus*	Lesser Adjutant	3	0.6	5	1	3	0.6	6	1	0.8216	0.7366
Otididae	*Chlamydotis macqueenii*	Asian Houbara	3	0.6	5	1	1	0.2	6	1	0.7928	0.6940
Phasianidae	*Perdicula manipurensis*	Manipur Bush-quail	4	0.8	3	0.6	5	1	5	0.8333	0.7648	0.6526
Scolopacidae	*Tringa guttifer*	Spotted Greenshank	4	0.8	5	1	1	0.2	5	0.8333	0.7530	0.6351
Scolopacidae	*Calidris tenuirostris*	Great Knot	4	0.8	5	1	1	0.2	5	0.8333	0.7530	0.6351
Ciconiidae	*Mycteria leucocephala*	Painted Stork	2	0.4	5	1	4	0.8	6	1	0.7209	0.5878
Ciconiidae	*Ciconia episcopus*	Asian Woollyneck	2	0.4	5	1	4	0.8	6	1	0.7209	0.5878
Phasianidae	*Francolinus gularis*	Swamp Francolin	3	0.6	4	0.8	4	0.8	5	0.8333	0.6847	0.5343
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	2	0.4	5	1	2	0.4	6	1	0.6826	0.5313
Anatidae	*Aythya baeri*	Baer's Pochard	5	1	3	0.6	1	0.2	4	0.6667	0.6667	0.5077
Ardeidae	*Ardea insignis*	White-bellied Heron	5	1	4	0.8	3	0.6	4	0.6667	0.6667	0.5077
Scolopacidae	*Gallinago nemoricola*	Wood Snipe	3	0.6	4	0.8	2	0.4	5	0.8333	0.6607	0.4988
Phasianidae	*Lophophorus sclateri*	Sclater's Monal	3	0.6	4	0.8	2	0.4	5	0.8333	0.6607	0.4988

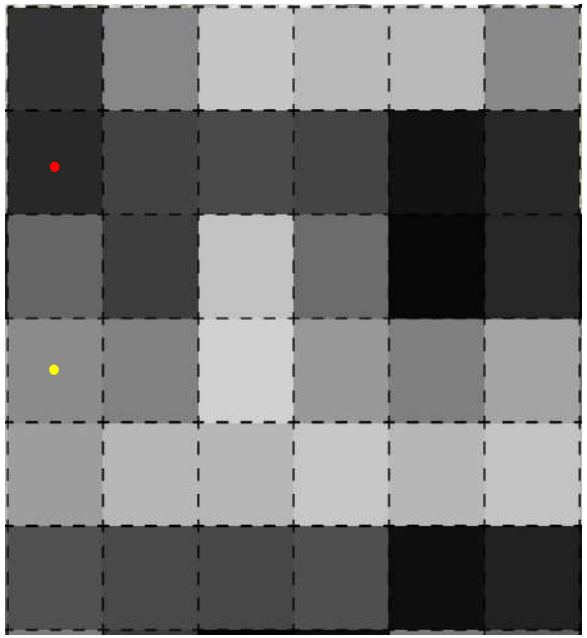
Create Sensitivity Index ranking species of highest concern

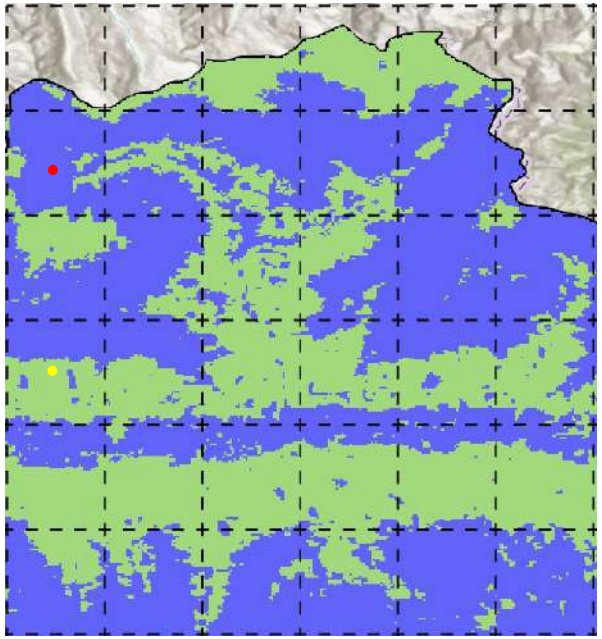
INDIA electrocution

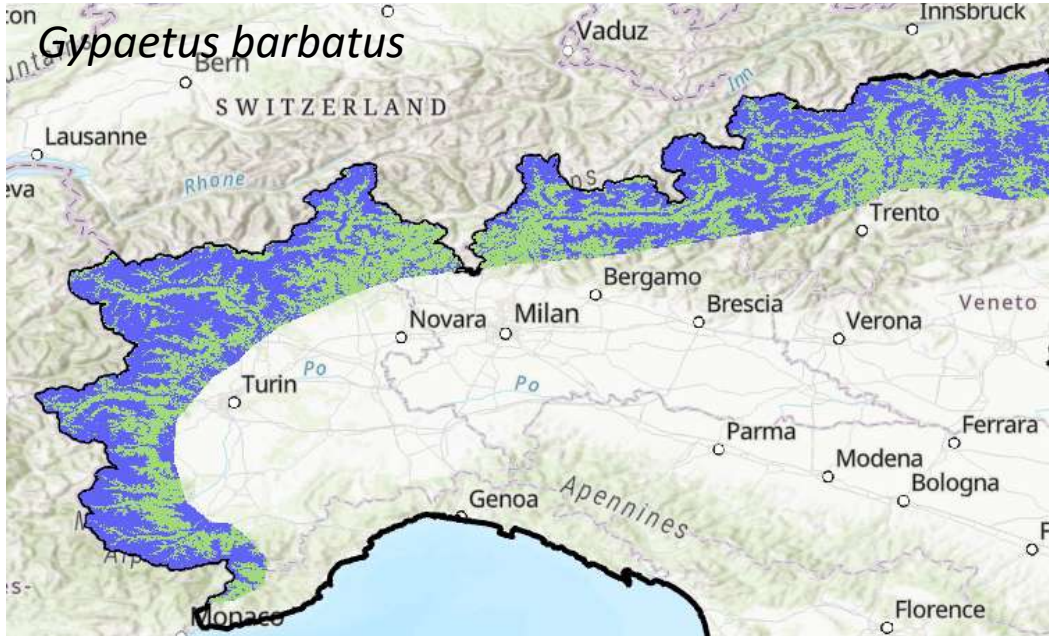
Family	Scientific name	Common name	CnS	CnS (s)	Su	Su (s)	En	En (s)	PwEc	PwEc (s)	PwEc SI	PwEc SI (norm)
Ciconiidae	*Leptoptilos dubius*	Greater Adjutant	4	0.8	5	1	3	0.6	6	1	0.9178	1
Accipitridae	*Gyps bengalensis*	White-rumped Vulture	5	1	5	1	4	0.8	5	0.8333	0.8333	0.8747
Accipitridae	*Sarcogyps calvus*	Red-headed Vulture	5	1	5	1	4	0.8	5	0.8333	0.8333	0.8747
Accipitridae	*Gyps tenuirostris*	Slender-billed Vulture	5	1	5	1	3	0.6	5	0.8333	0.8333	0.8747
Accipitridae	*Gyps indicus*	Indian Vulture	5	1	5	1	5	1	5	0.8333	0.8333	0.8747
Ciconiidae	*Leptoptilos javanicus*	Lesser Adjutant	3	0.6	5	1	3	0.6	6	1	0.8216	0.8573
Strigidae	*Athene blewitti*	Forest Owlet	4	0.8	4	0.8	5	1	5	0.8333	0.7695	0.7799
Accipitridae	*Haliaeetus leucoryphus*	Pallas's Fish-eagle	4	0.8	5	1	1	0.2	5	0.8333	0.7530	0.7553
Accipitridae	*Neophron percnopterus*	Egyptian Vulture	4	0.8	5	1	1	0.2	5	0.8333	0.7530	0.7553
Accipitridae	*Aquila nipalensis*	Steppe Eagle	4	0.8	5	1	1	0.2	5	0.8333	0.7530	0.7553
Falconidae	*Falco cherrug*	Saker Falcon	4	0.8	4	0.8	1	0.2	5	0.8333	0.7454	0.7440
Ciconiidae	*Mycteria leucocephala*	Painted Stork	2	0.4	5	1	4	0.8	6	1	0.7209	0.7077
Ciconiidae	*Ciconia episcopus*	Asian Woollyneck	2	0.4	5	1	4	0.8	6	1	0.7209	0.7077
Accipitridae	*Clanga hastata*	Indian Spotted Eagle	3	0.6	5	1	5	1	5	0.8333	0.7029	0.6809
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	2	0.4	5	1	2	0.4	6	1	0.6826	0.6509
Accipitridae	*Clanga clanga*	Greater Spotted Eagle	3	0.6	5	1	1	0.2	5	0.8333	0.6607	0.6183
Accipitridae	*Aquila rapax*	Tawny Eagle	3	0.6	5	1	1	0.2	5	0.8333	0.6607	0.6183
Accipitridae	*Aquila heliaca*	Eastern Imperial Eagle	3	0.6	5	1	1	0.2	5	0.8333	0.6607	0.6183

Map the distribution of priority species

- Used Area of Habitat (AoH) maps showing the habitat available to a species within its range. These maps were creating by matching habitat preference (as listed by IUCN) with land cover data (Brooks *et al*. 2019; Lumbierres *et al*. 2022). AoH maps at a resolution of 100m resolution converted to a 5km x 5km grid cell to give occurrence probability.



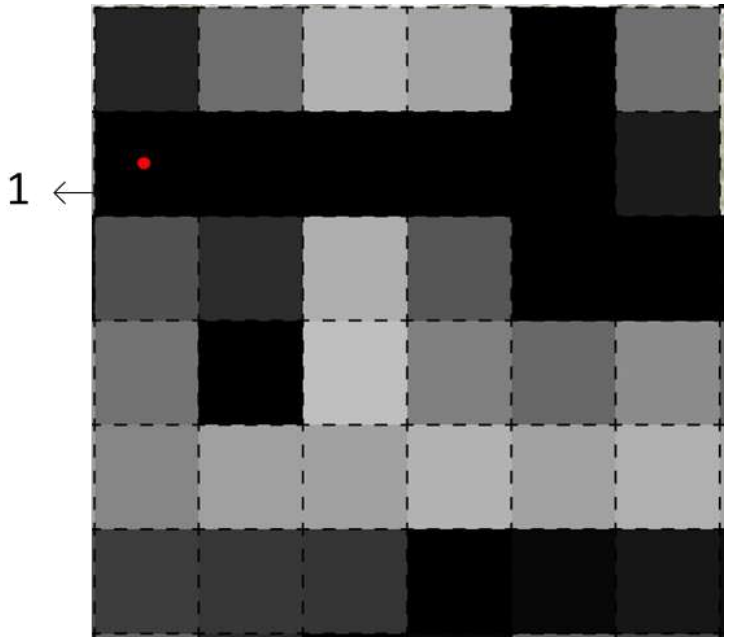


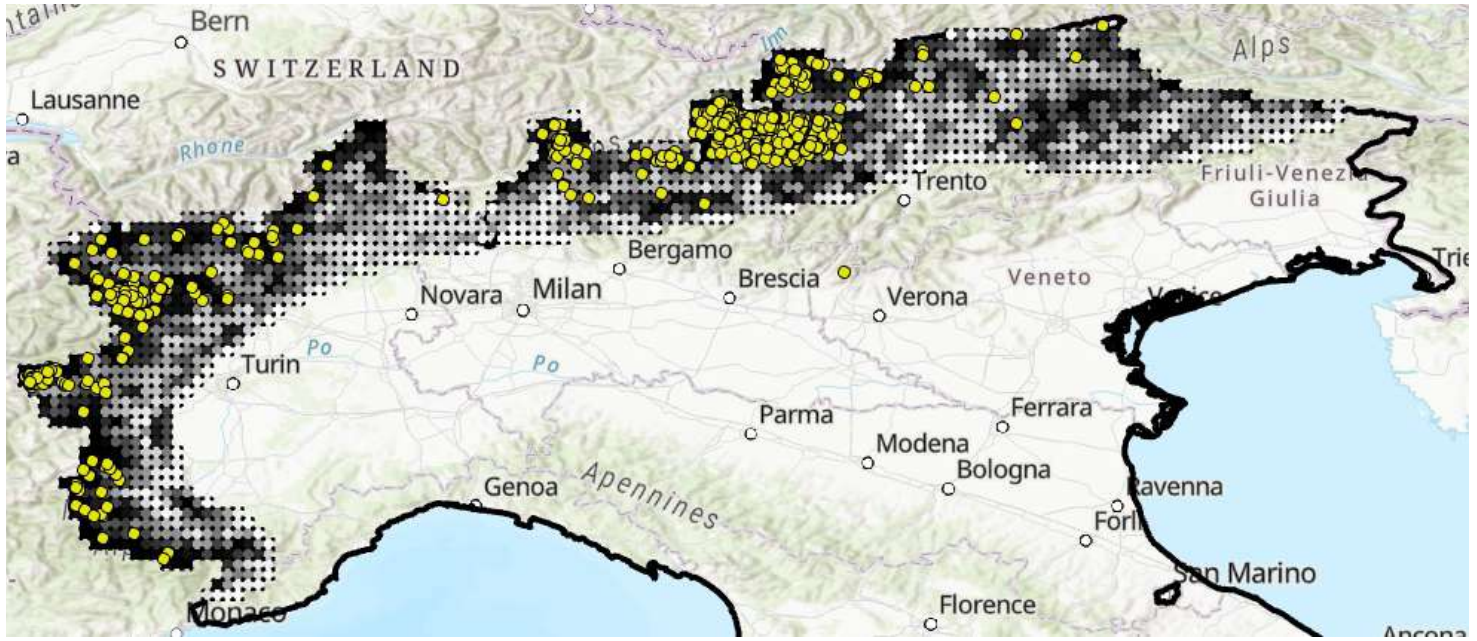


Map the distribution of priority species

- Used observational records from multiple sources (ebirds, scientific literature, surveys etc) to refine the maps. Used Bradbury formula to link probability to sensitivity value.

$$\sum_{species}^{n} \ln(sps\ occur.probab + 1) * SSI$$





Incorporate information on habitat and sites of conservation value

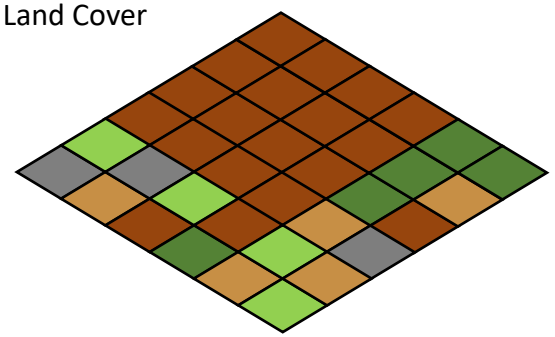
- Used 100m resolution Copernicus Global Land Cover (2019).

Human modification landscapes = 0

Natural landscapes = 1

- % in each grid cell (5x5km) : ↑ values = ↑ sensitivity.
- World Database on Protected Areas (WDPA).
- Important Birds and Biodiversity Areas (IBAs).

Land Cover



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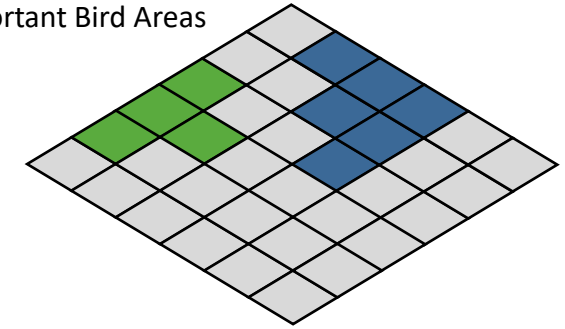
Protected Areas &
Important Bird Areas



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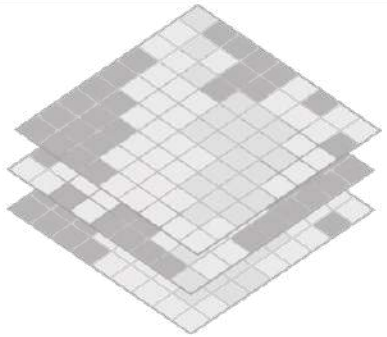

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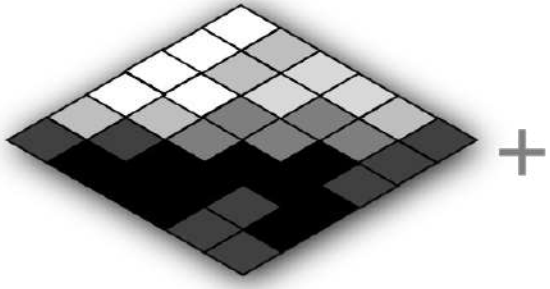

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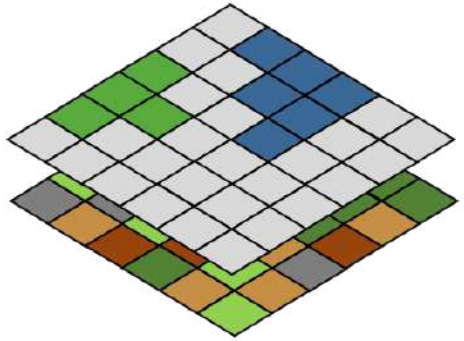

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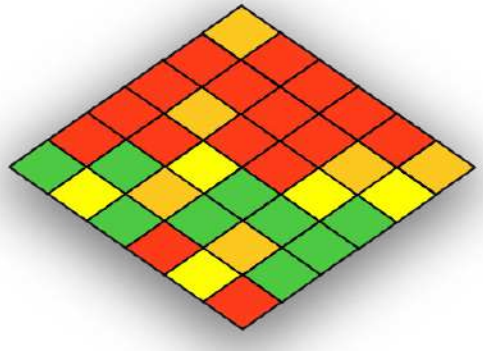
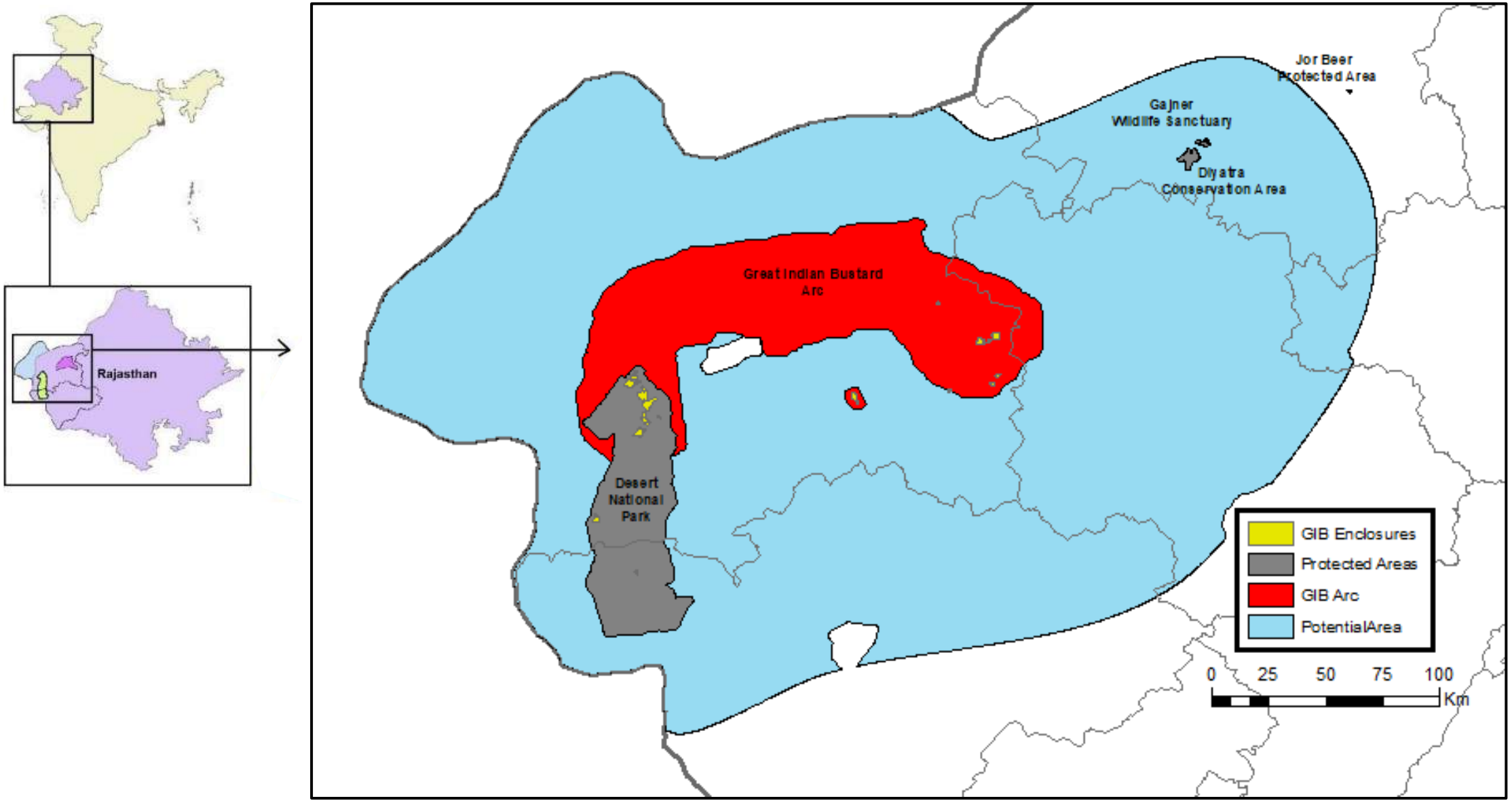
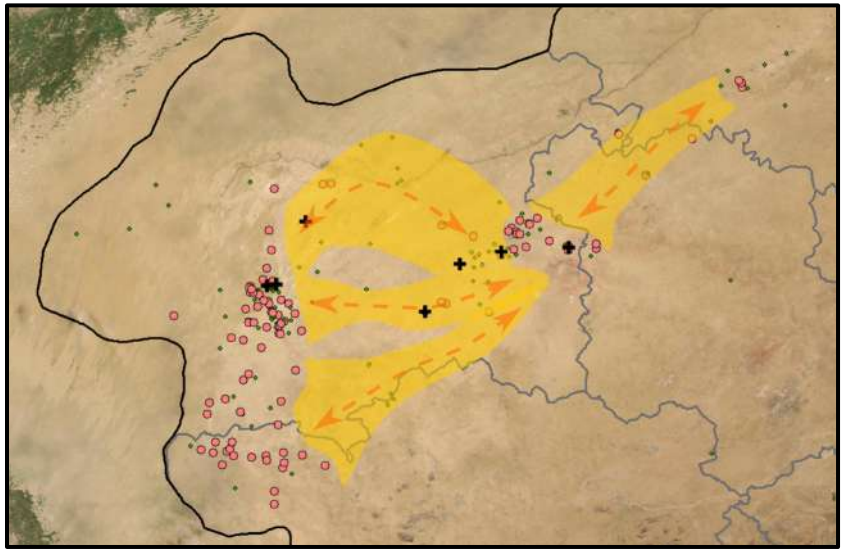
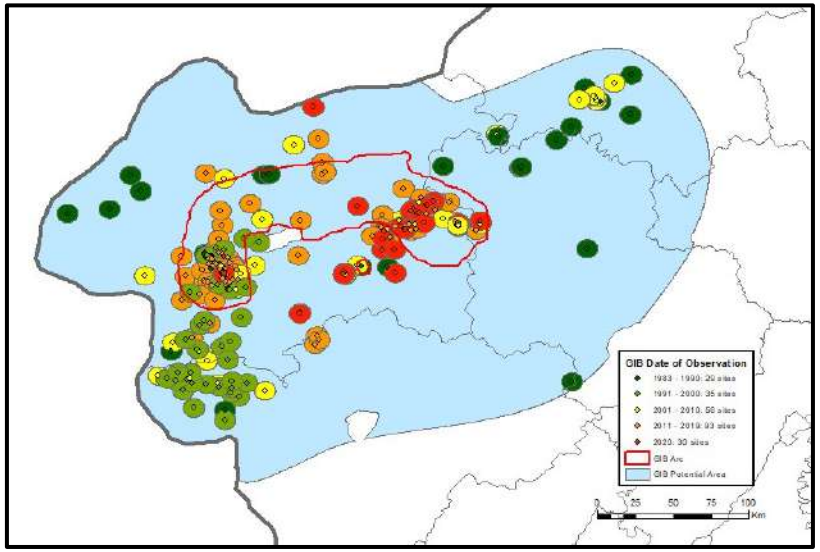
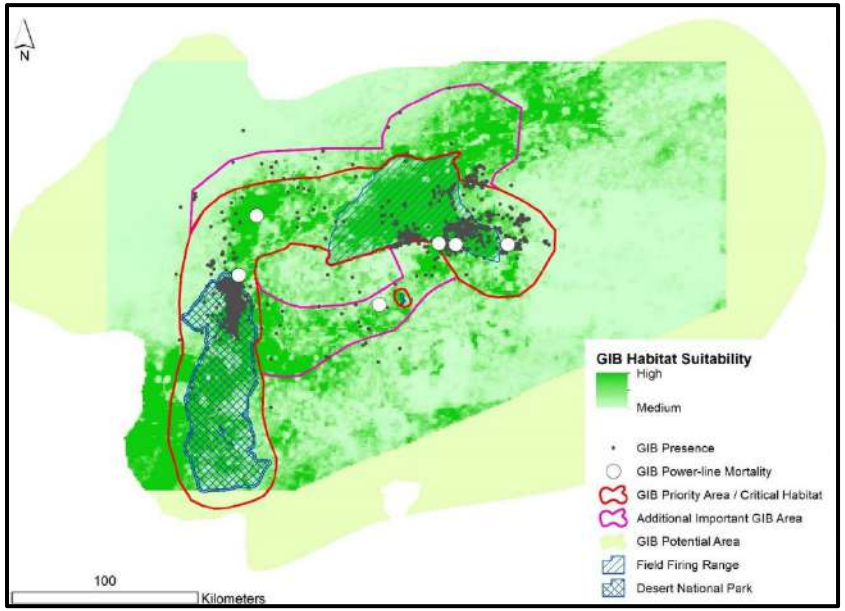
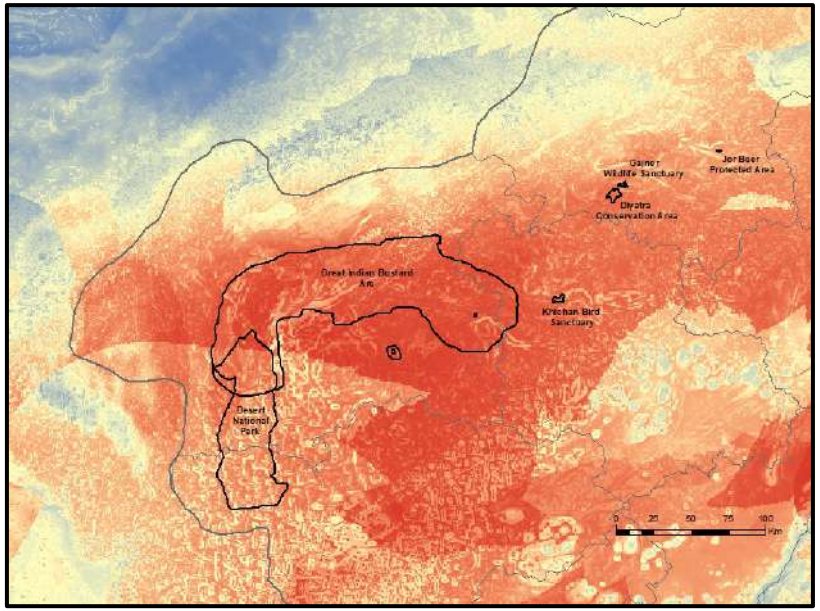



Rajasthan
Jor Beer
Protected Area
Gajner
Wildlife Sanctuary
Diyatra
Conservation Area
Great Indian Bustard
Arc
Desert
National
Park
GIB Enclosures
Protected Areas
GIB Arc
PotentialArea
0
25
50
75
100
Km




GIB Date of Observation
GIB Arc
GIB Potential Area
0 25 50 75 100
Km


N
GIB Habitat Suitability
High
Medium
GIB Presence
GIB Power-line Mortality
GIB Priority Area / Critical Habitat
Additional Important GIB Area
GIB Potential Area
Field Firing Range
Desert National Park
100
Kilometers


Great Indian Bustard Arc
Desert National Park
Khichan Bird Sanctuary
Gainer Wildlife Sanctuary
Jorbeer Protected Area
Dhedra Conservation Area
0 25 50 75 100
Km

	Zone	Sensitivity
	GIB arc	Very High
	Protected Areas	Very High
	GIB core zone	Very High
	GIB dispersal zone	High
	GIB recolonisation zone	High
	GIB post-recolonisation dispersal zone	Medium
	GIB potential area	Low

INVESTOR GUIDANCE BY ZONE

New infrastructure	Existing infrastructure
GIB Arc — de facto Critical Habitat for GIB	
No new energy development (wind and solar facilities, powerlines or associated transformers and substations) should be financed.	No existing energy infrastructure should be refinanced unless there is an agreement to underground all associated powerlines.
Protected Areas — de facto Critical Habitat for GIB	
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GIB recolonisation zone	
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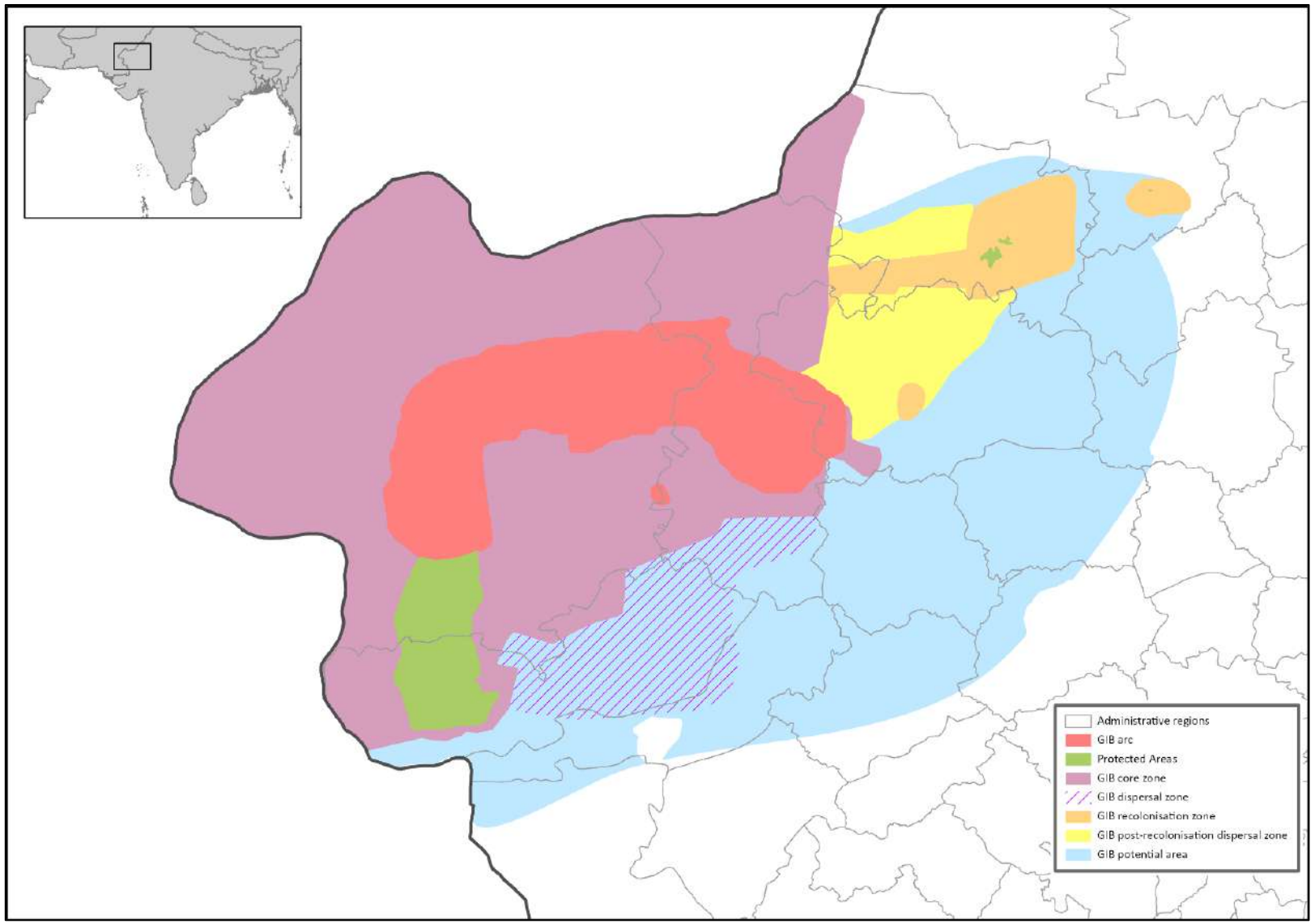

	Zone	Sensitivity
	GIB arc	Very High
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	GIB core zone	Very High
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	GIB potential area	Low

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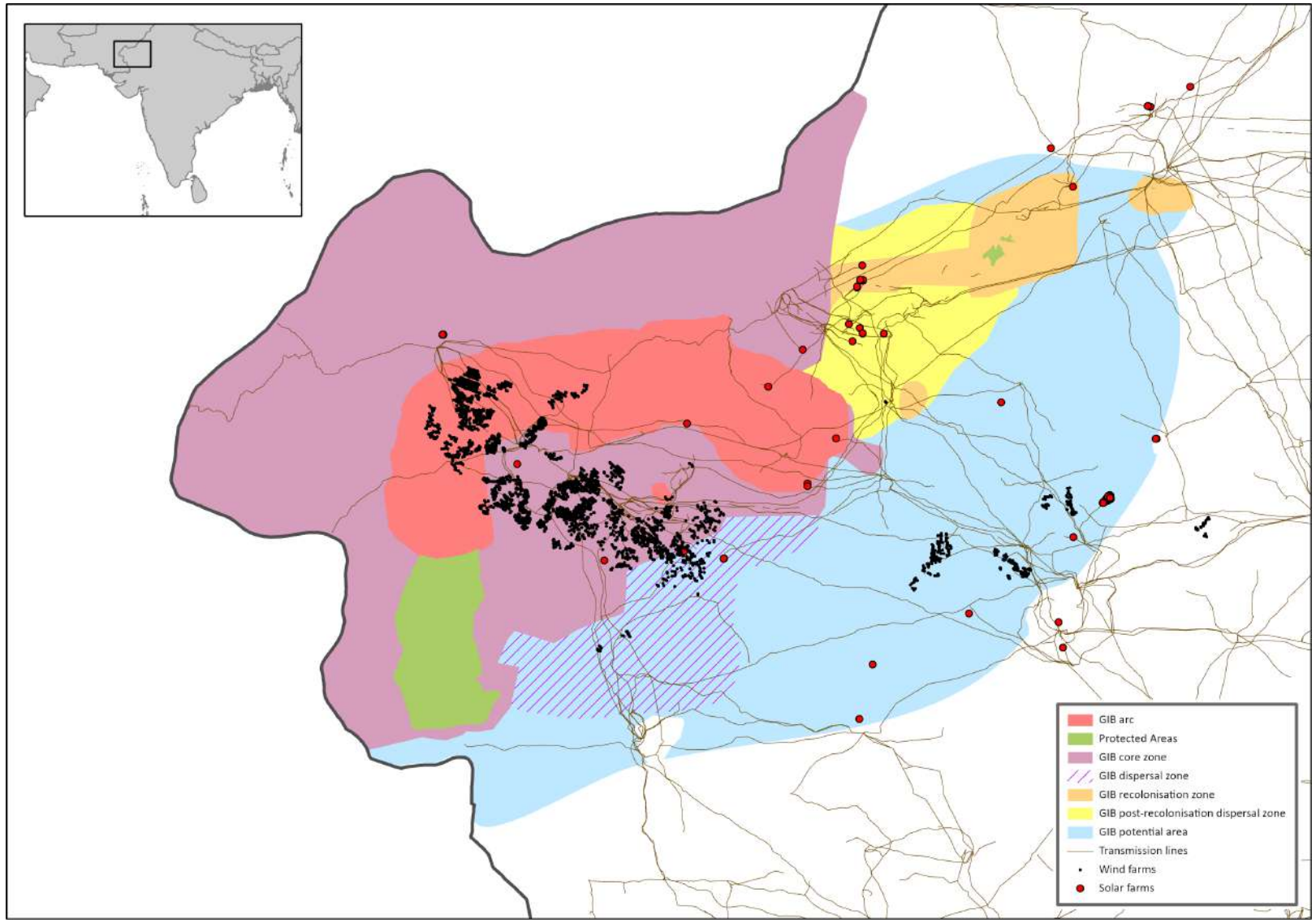

Thank you