Using remote sensing and machine learning to identify biodiversity offsets

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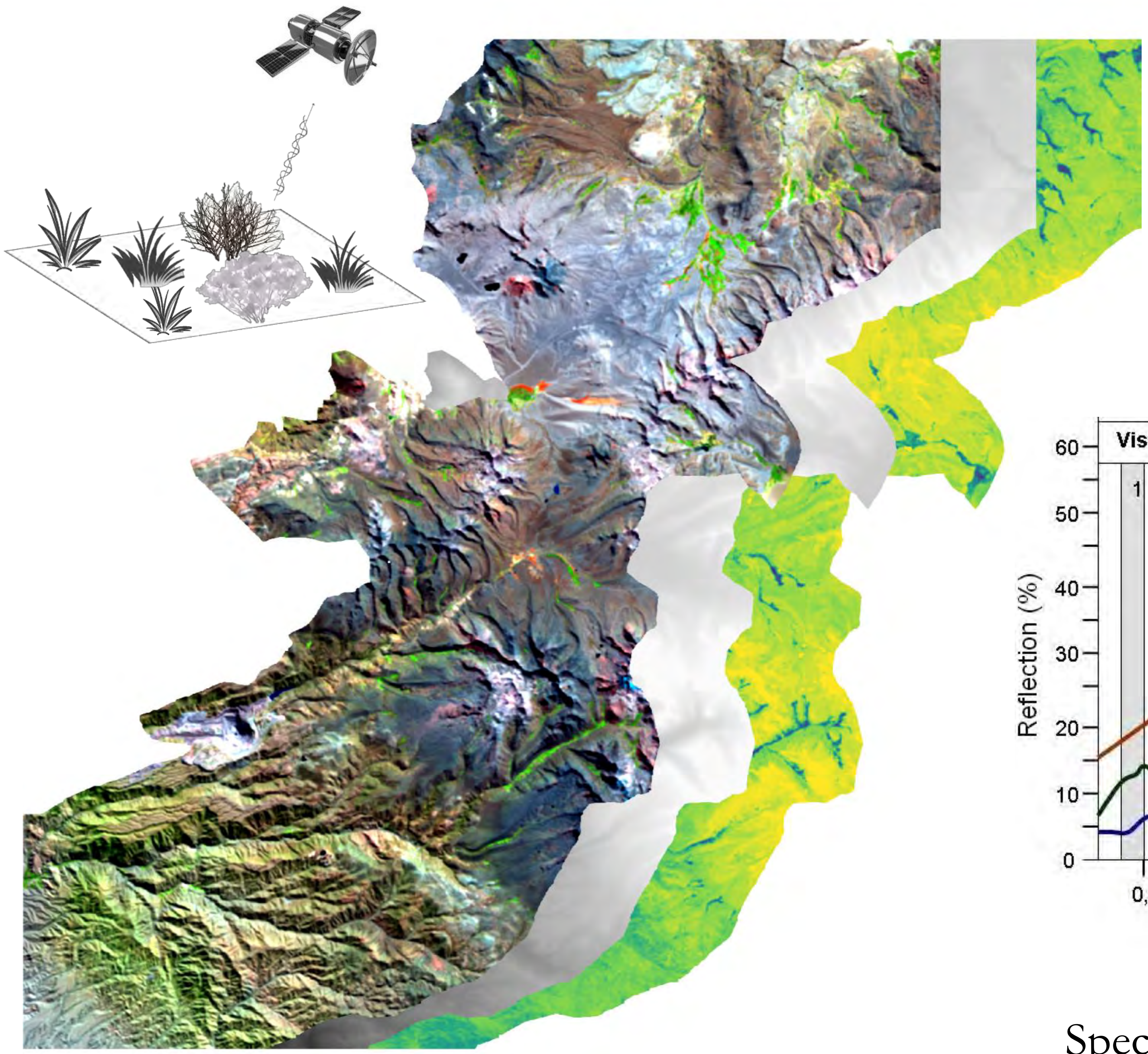
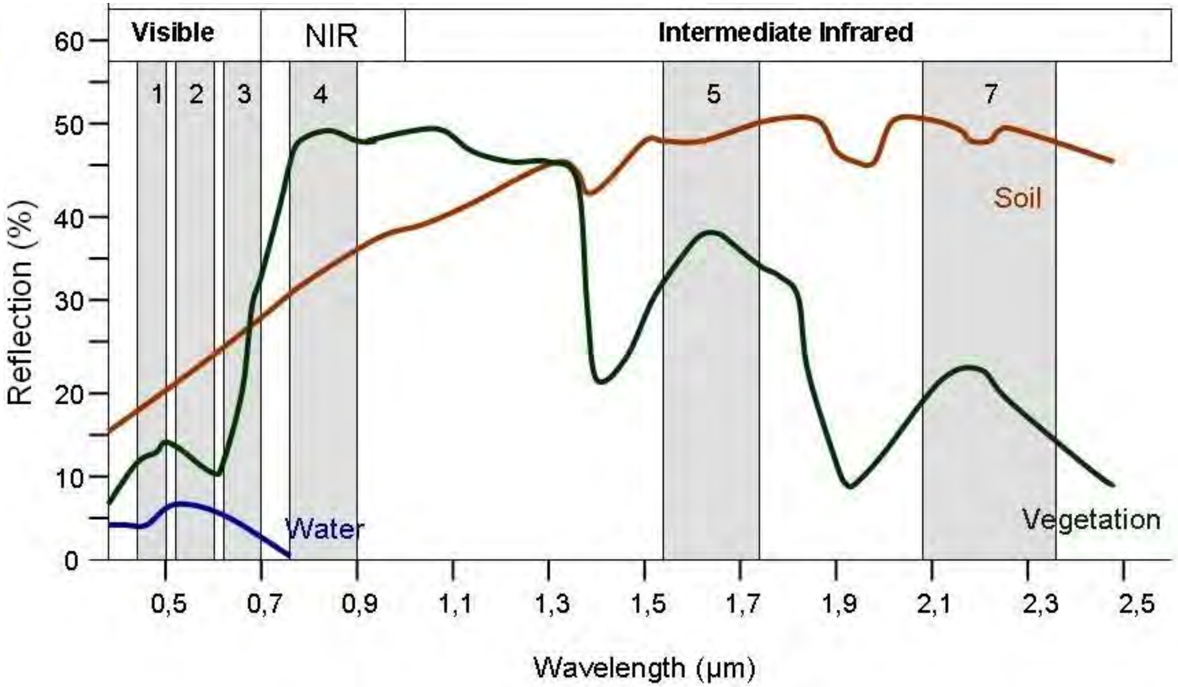
- Usefulness of remote sensing in mapping biodiversity
- How to improve biodiversity impact assessments?: A proposed framework
- Practicalities of the framework in EIAs

Usefulness of remote sensing in mapping biodiversity



Different objects, such as vegetation, rivers, soils or even different plant species reflect the sun's radiation in a different way. These spectral values are ecologically informative layers and hence, are very useful for biodiversity studies at local scales. Satellite imagery cover large extensions, can be freely available and provide continuous spectral information.



Spectral signatures of surfaces

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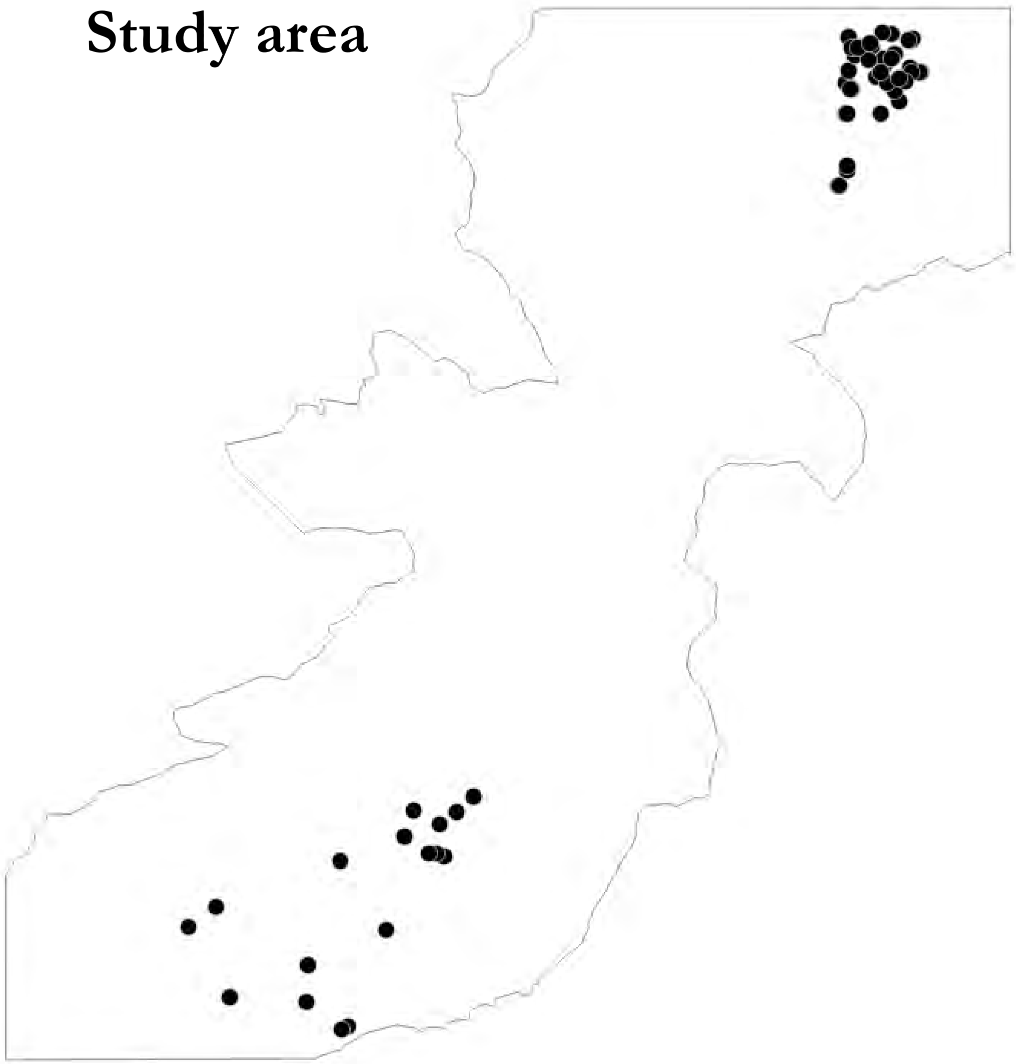
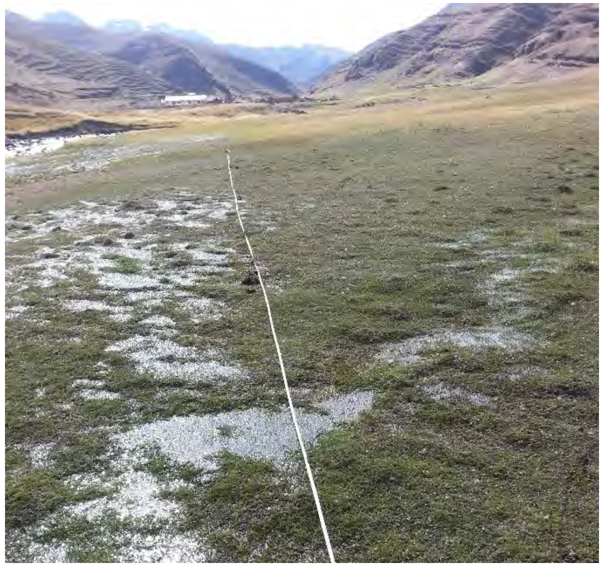
How to improve biodiversity impact assessment?: A proposed framework

Baseline studies

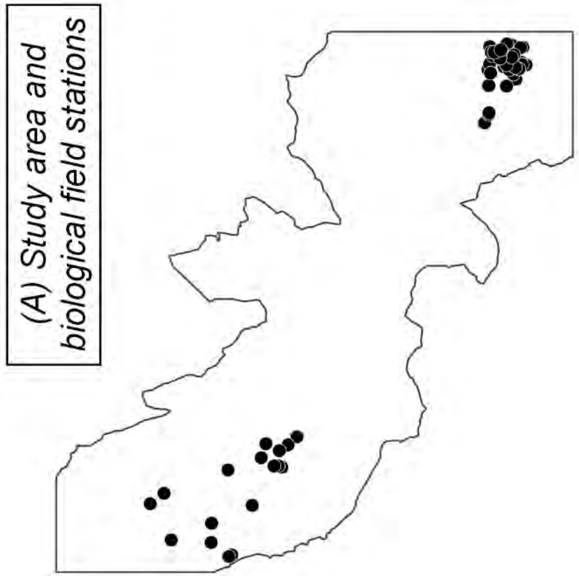
Study area





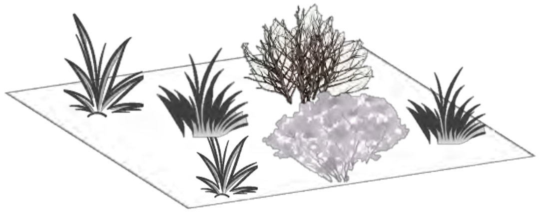
Sampling units (~60 50-m transects) from field-data were used to characterize the vegetation cover (%) of shrubs and herbaceous plants in the study area

Framework

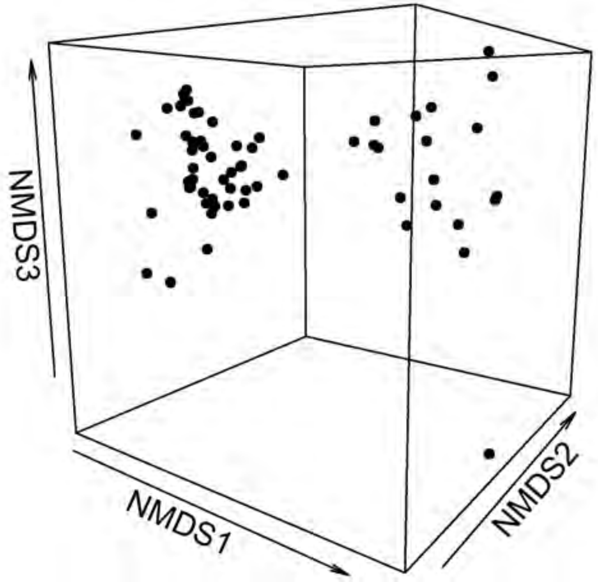


Community matrix

Species / Plot	Species A	Species B	Species C	Species D	Species E	...	Species "n"
Plot 1	0	1	1	1	1	...	1
Plot 2	0	0	0	0	1	...	0
Plot 3	1	1	1	1	0	...	0
Plot 4	0	1	0	0	0	...	1
...	...	...	...	...	...	...	...
Plot "m"	1	1	0	0	0	...	1



If two dots (representing the sampling plots) are closer to each other it means they share more species in common, or that they are floristically more similar.



Each of this axes are indicators or metrics of the species composition

Floristic ordination (NMDS)

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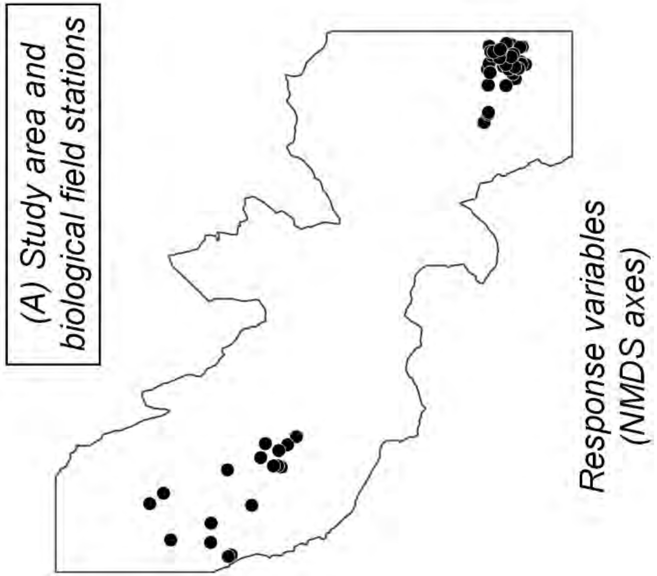
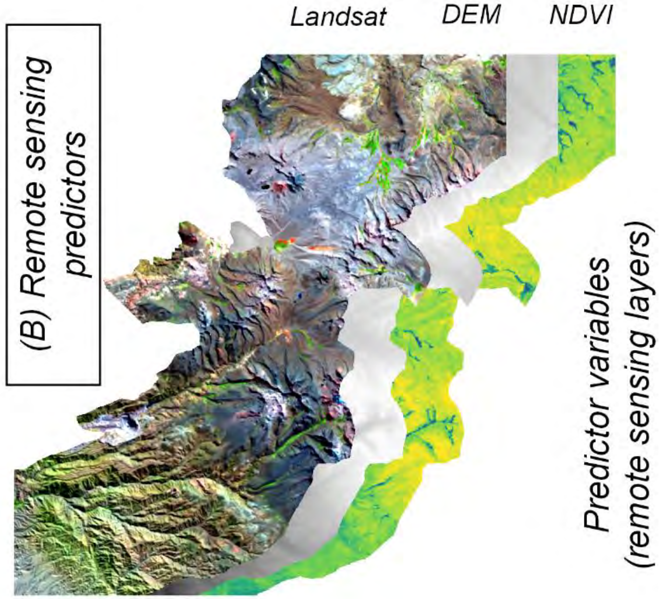
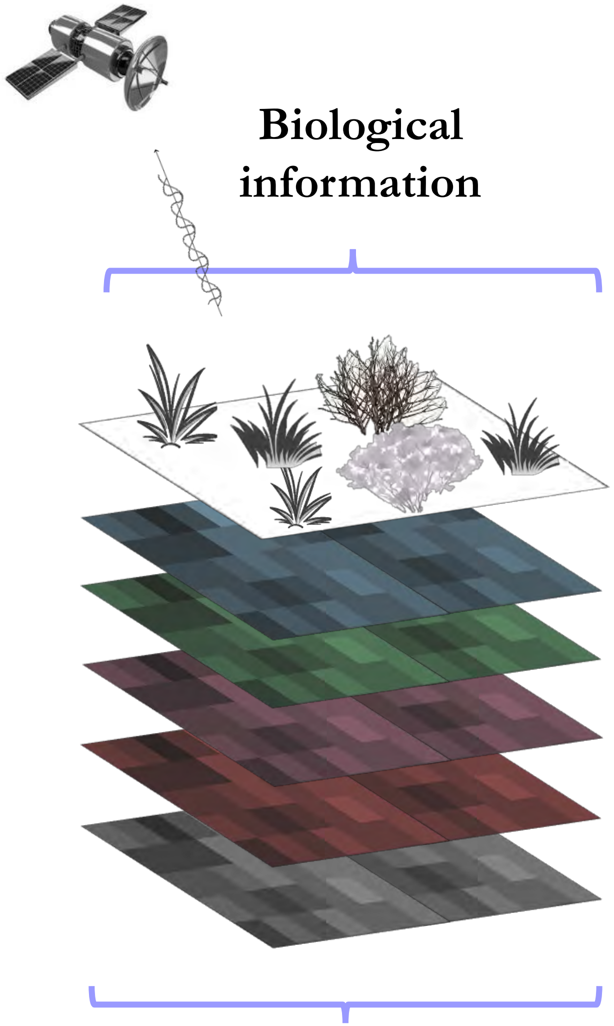


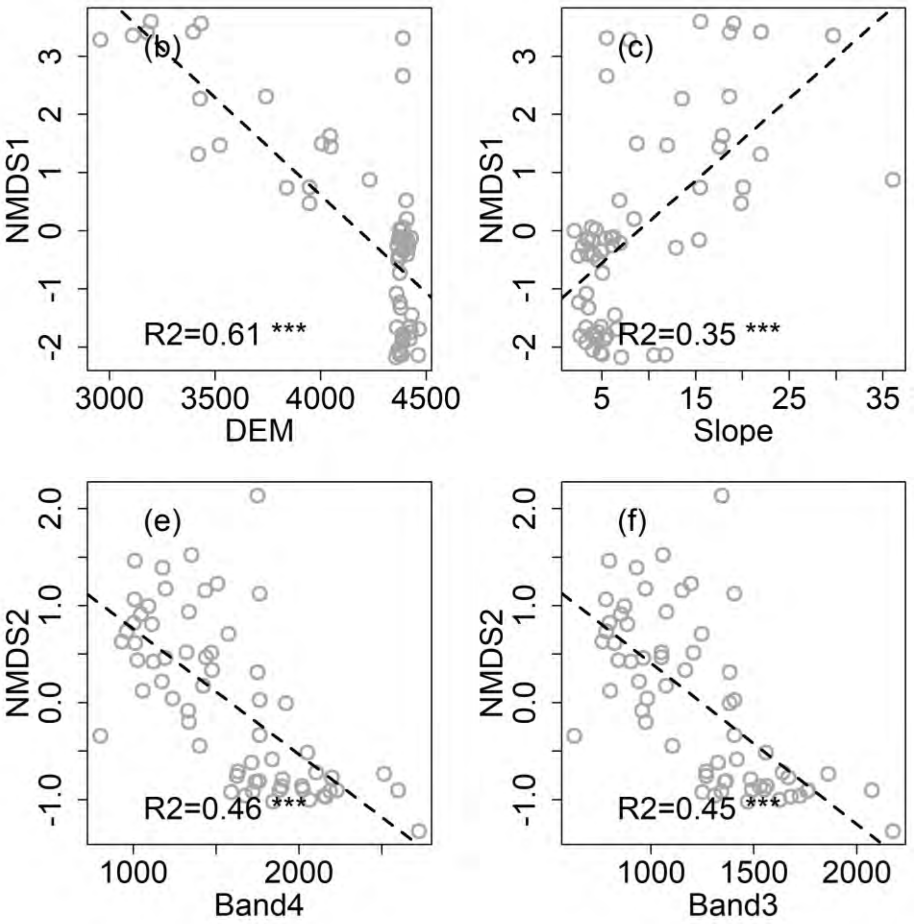




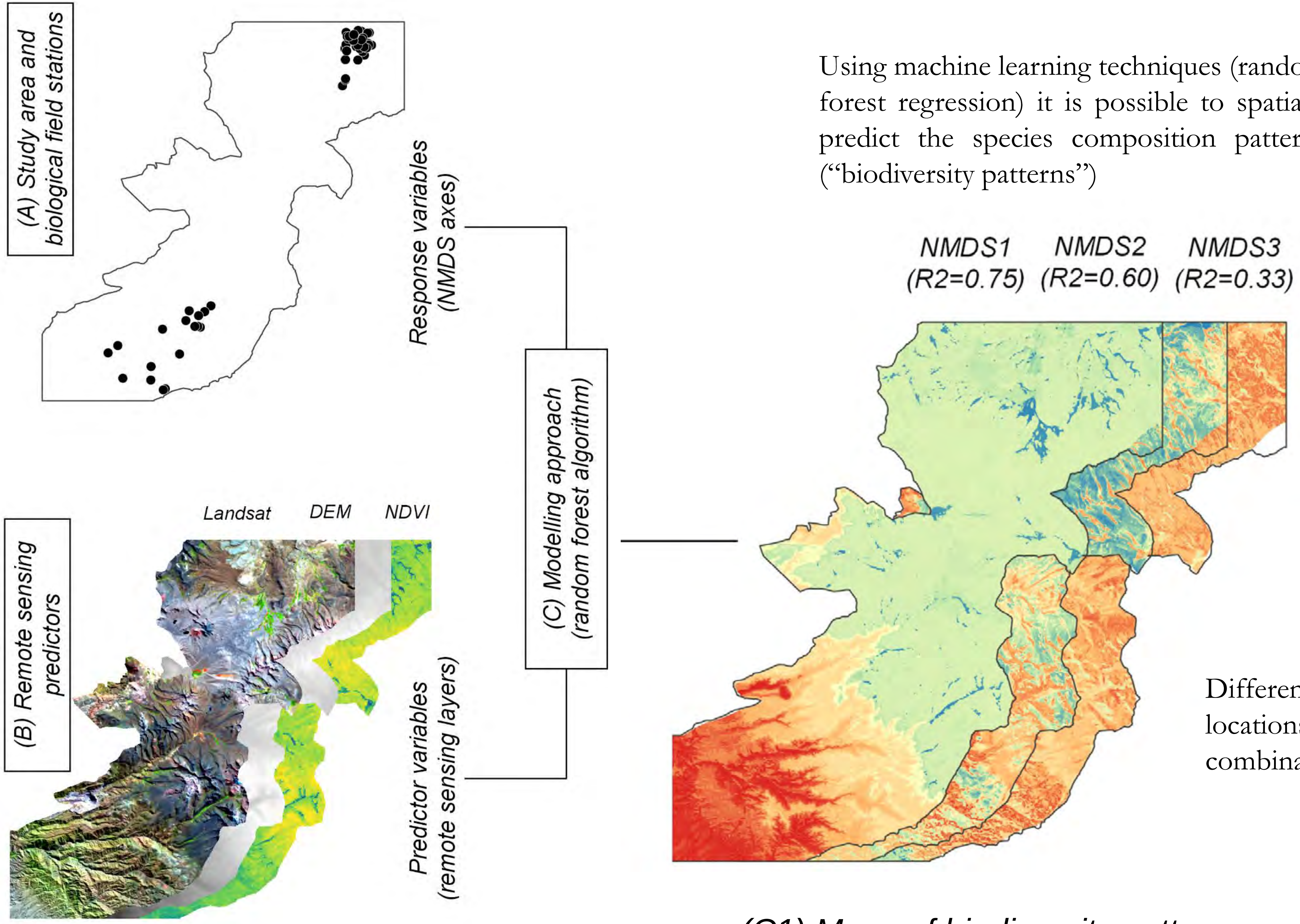
RS information

“band1“,"band2“,"band3",
"band4","band5","band6",
"band7","ndvi","dem",
"slope“

Just through simple linear regressions, remote sensing predictors explain a great percentage of the species composition



Framework



Using machine learning techniques (random forest regression) it is possible to spatially predict the species composition patterns ("biodiversity patterns")

Different colours show locations that have different combination of species

(C1) Maps of biodiversity patterns

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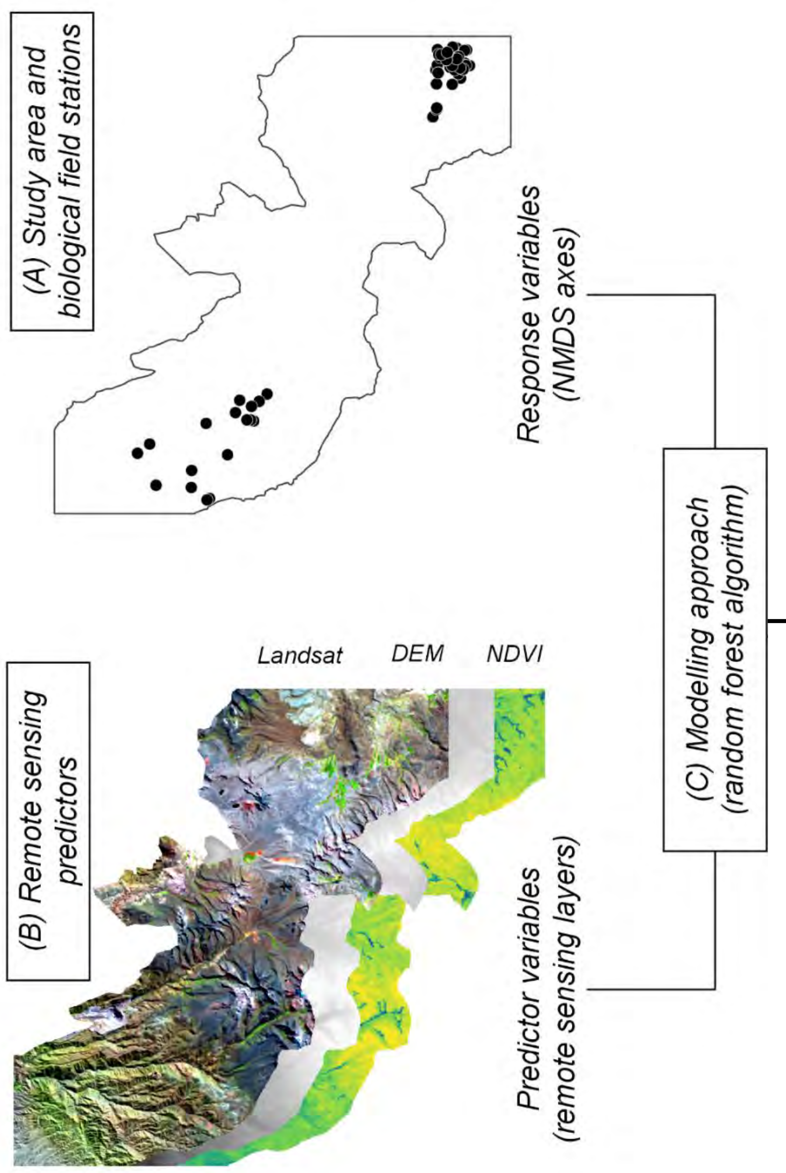
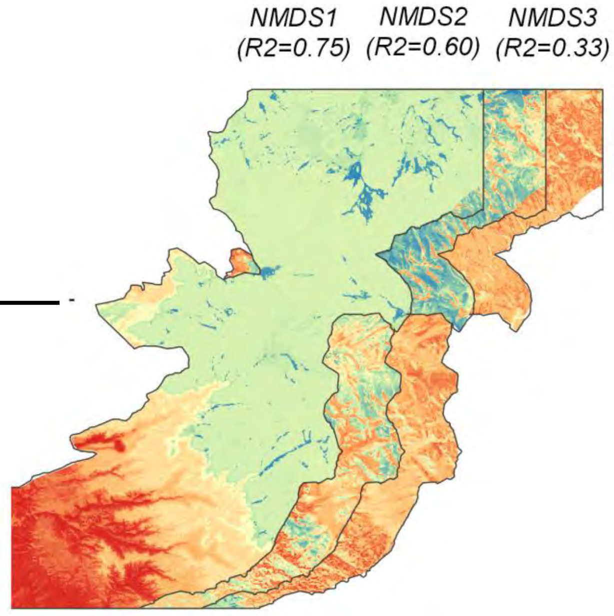
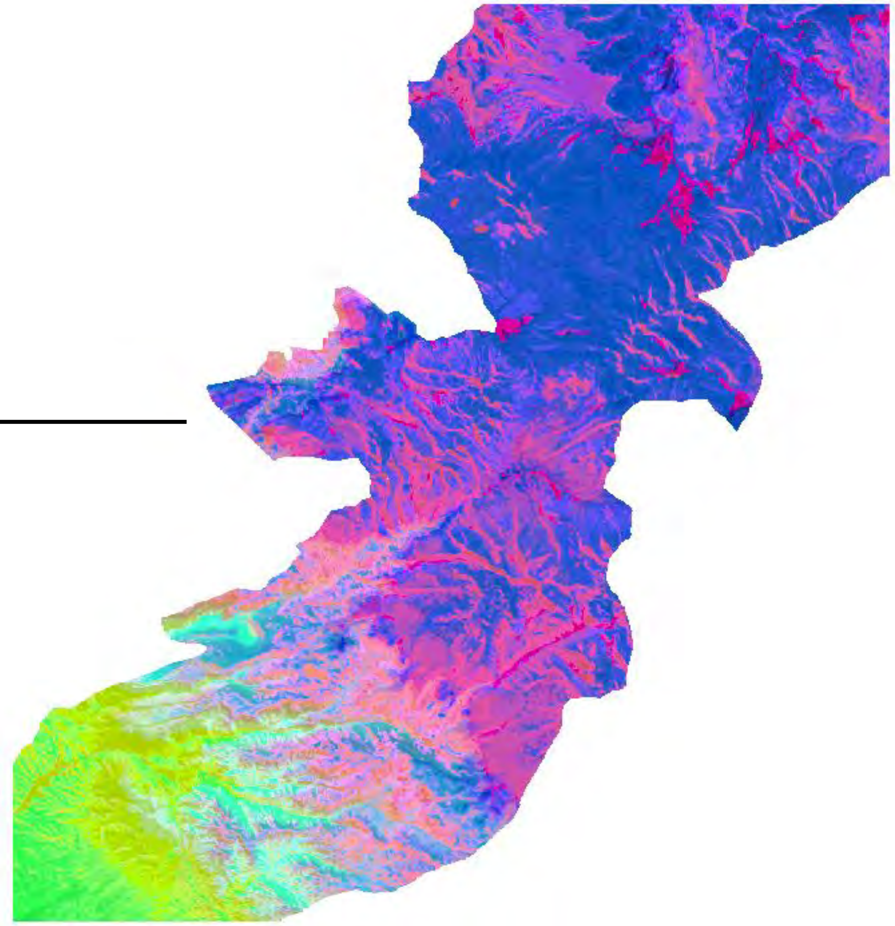
Framework



By combining these three maps (representing the species composition axes) in one RGB (red-gree-blue) colour composite, we can visualize better the species composition in a single map

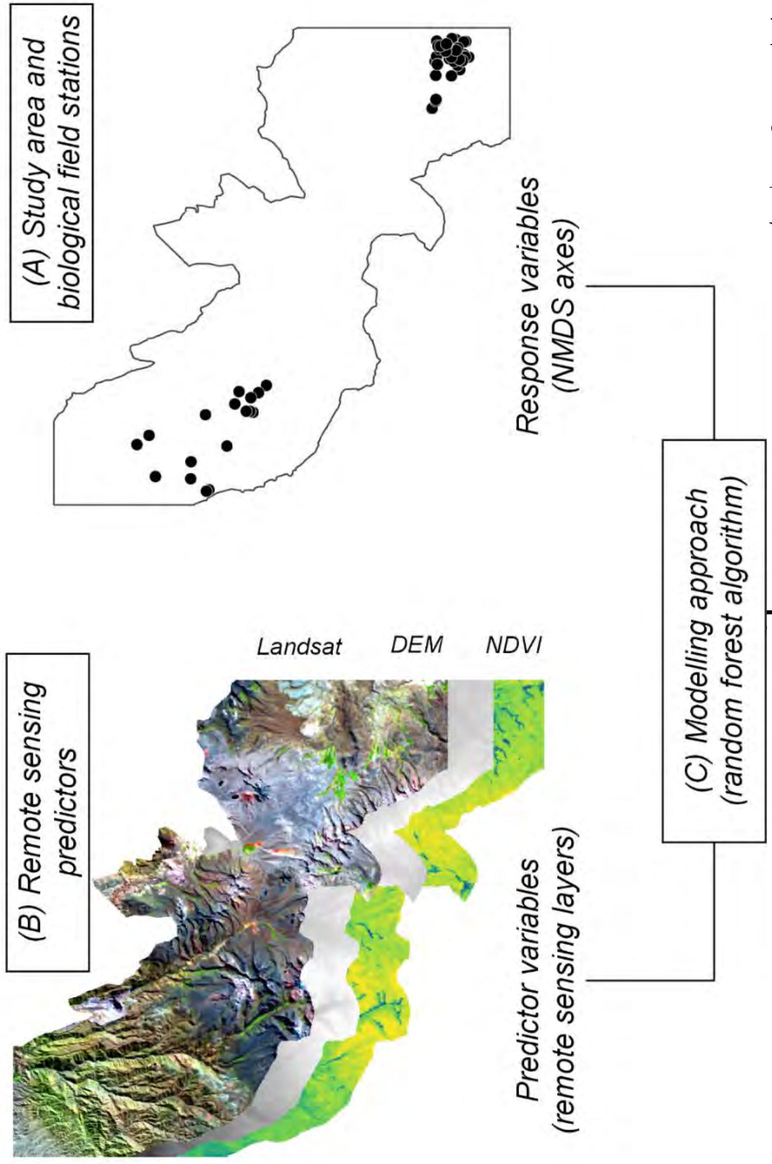


Each colour represents an area that has a unique or "singular" combination of species

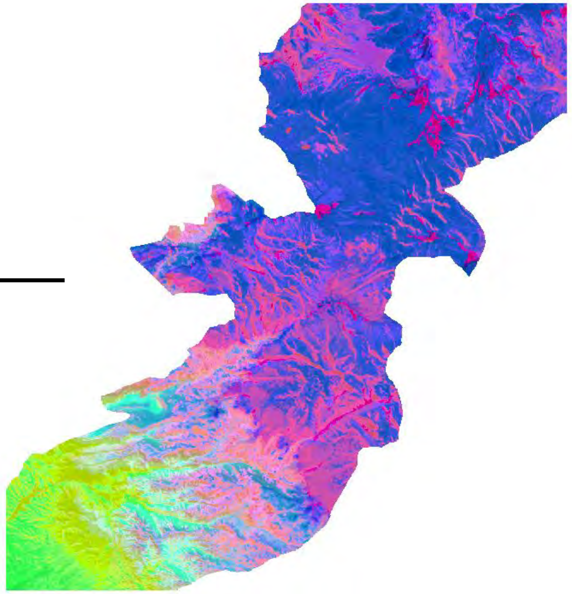


(C2) Beta-diversity / Singularity map

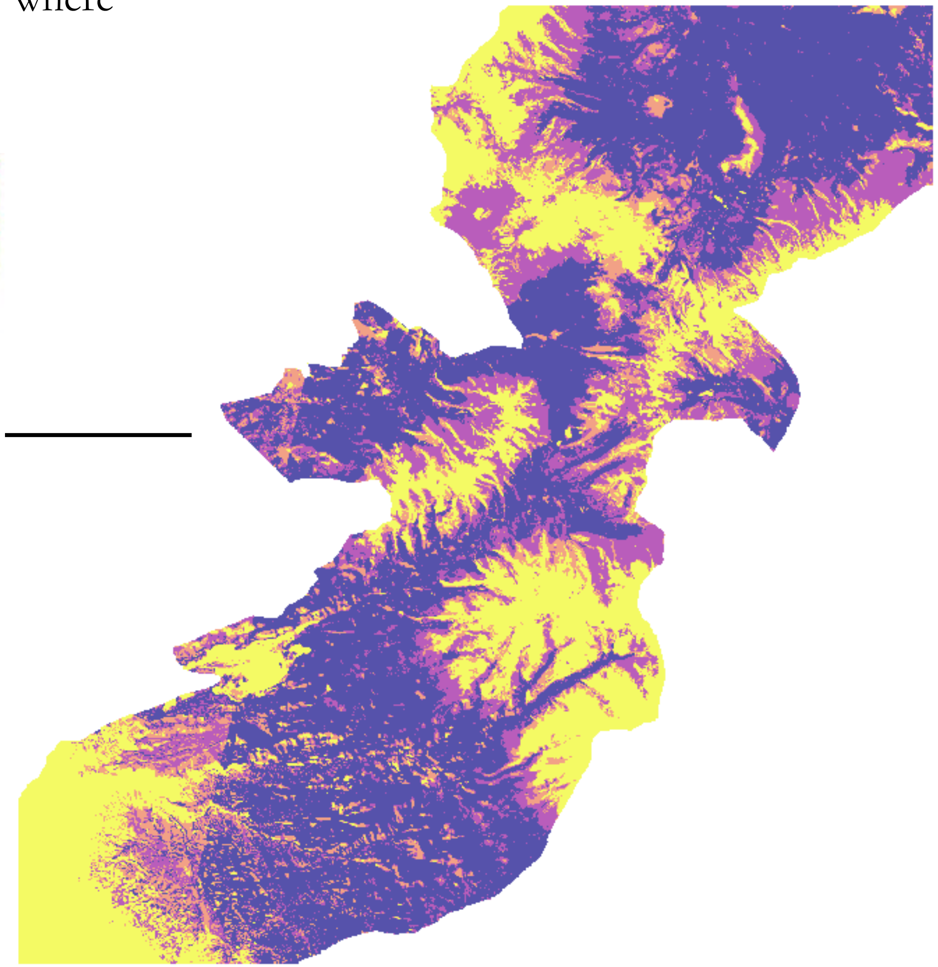
Framework



Since we are dealing with spatial predictions and machine learning, we should avoid extrapolation and overprediction. Therefore, we suggest the AOA approach to identify locations where we can actually trust the predictions



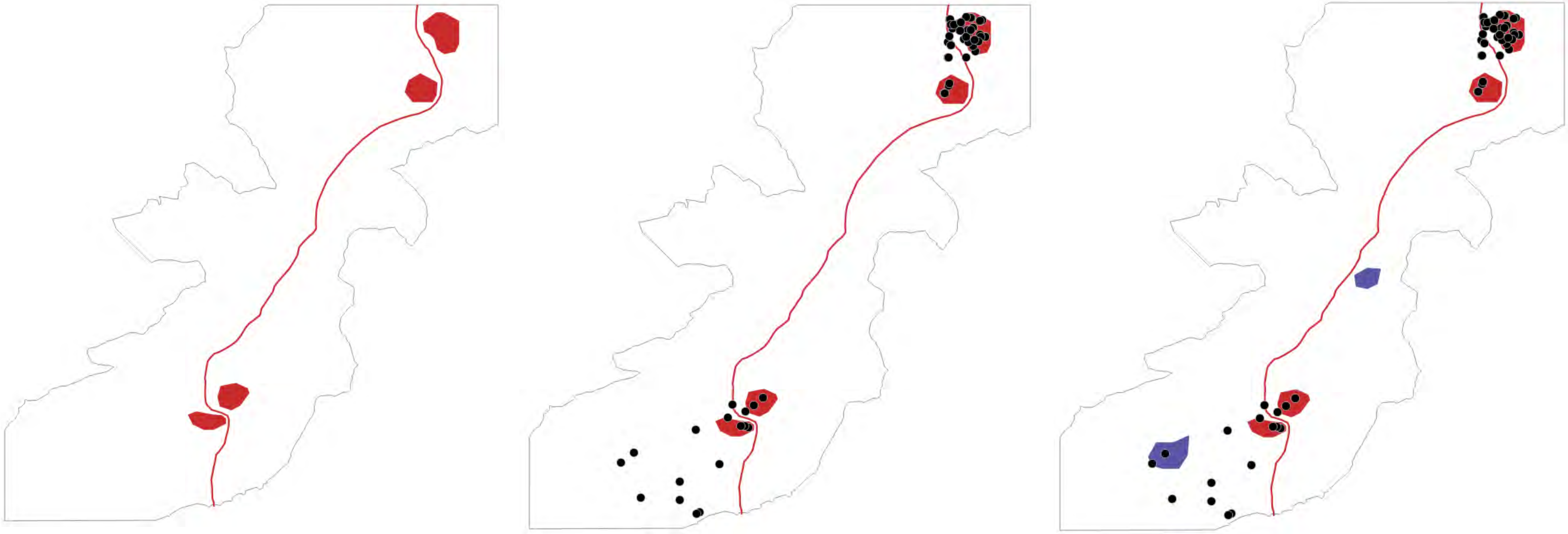
Purple colours show areas where the predictions are reliable, and yellow colours, locations where predictions should be interpreted with caution.



(C3) Area of Applicability (AOA) / Uncertainty map

Practicality

Impact Assessment



Planned infrastructure
New infrastructure
Transects

Projects are not static, on the contrary there will always be changes in the alignment of components or new infrastructure.

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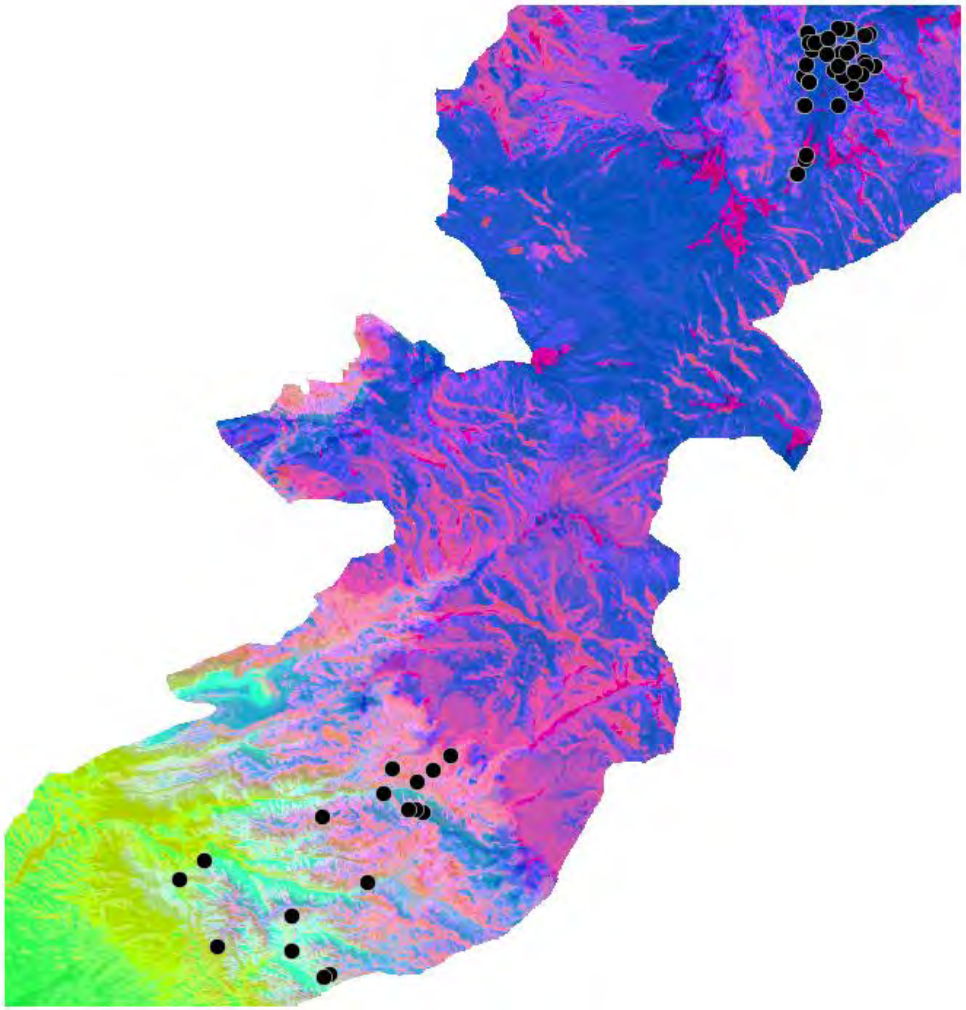
Practicality

- Available biological information it is often scattered and only cover focalized locations. By combining field-data with freely available remote sensing predictors, it is possible to map biodiversity patterns in areas where field-data is yet missing.
- We should still account for uncertainty in the spatial predictions.



Beta-diversity / Singularity map

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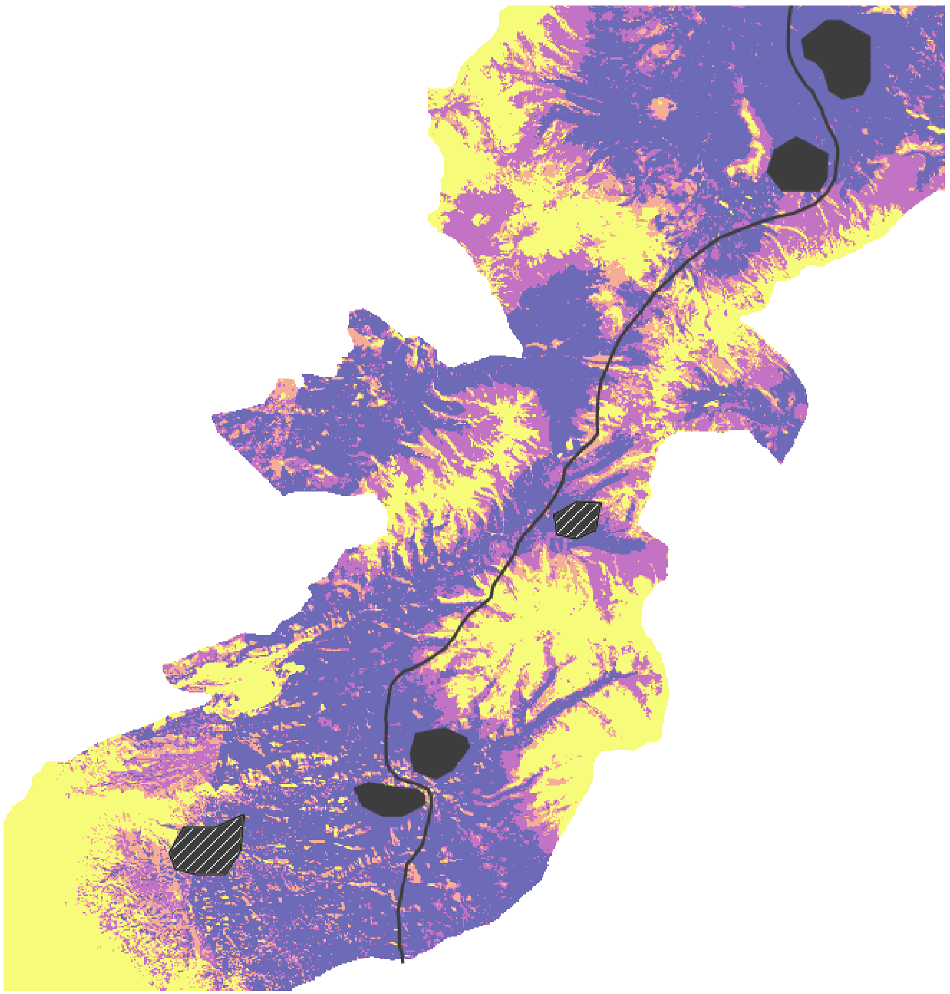
Practicality

- Through the area of applicability (AOA) method / uncertainty maps it is possible to know if changes in the project alignment or design will require more field work.
- It is also possible to determine areas that require higher sampling effort for complementing the EIA baseline studies.



Area of Applicability (AOA) / Uncertainty map

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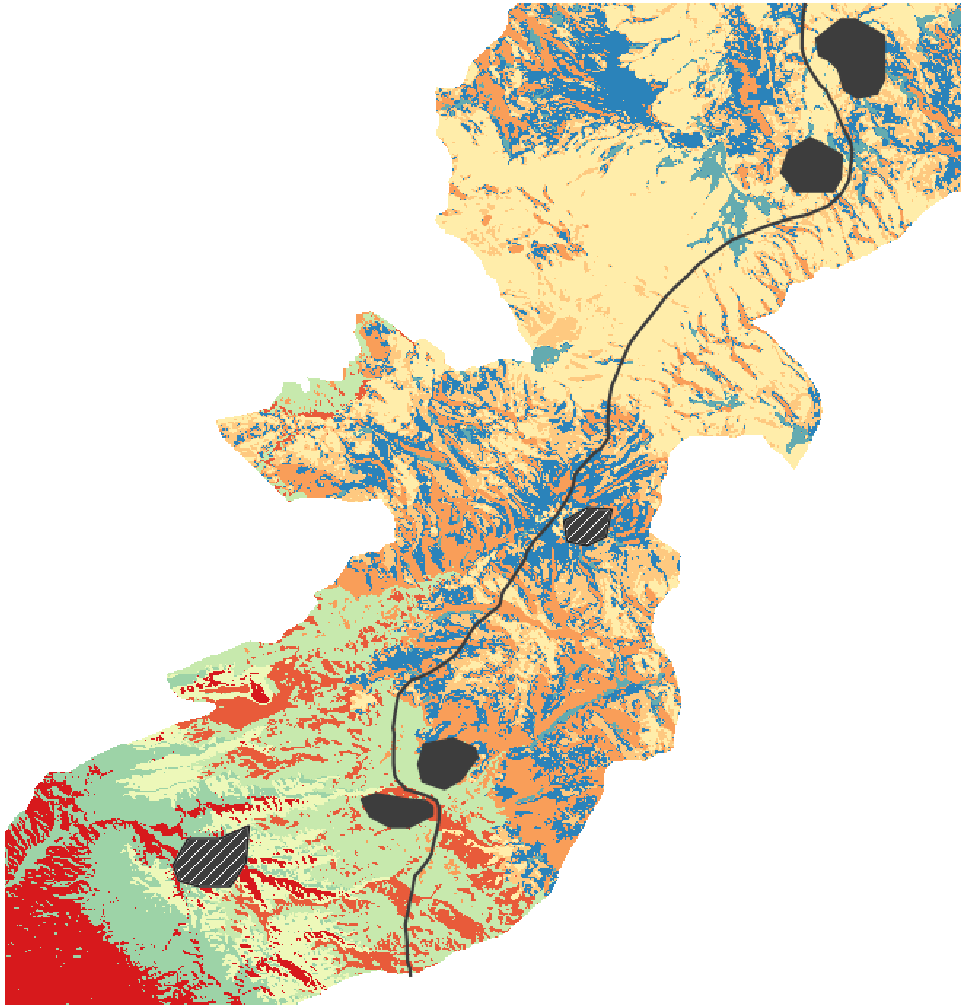
Practicality

- Having maps of biodiversity patterns throughout a project's study area allow:
  (i) avoiding species communities with key species / endangered species.
  (ii) properly quantifying a project footprint's impact on biodiversity
  (iii) identifying suitable areas for "like-for-like" compensation schemes.



K-means classification (10 classes)
Beta-diversity / Singularity map

Let’s continue the conversation!

Post questions and comments in the IAIA23 app.

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