Modeling potential natural vegetation

Bringing to light an old concept to guide nature conservation in fragmented and degraded landscapes

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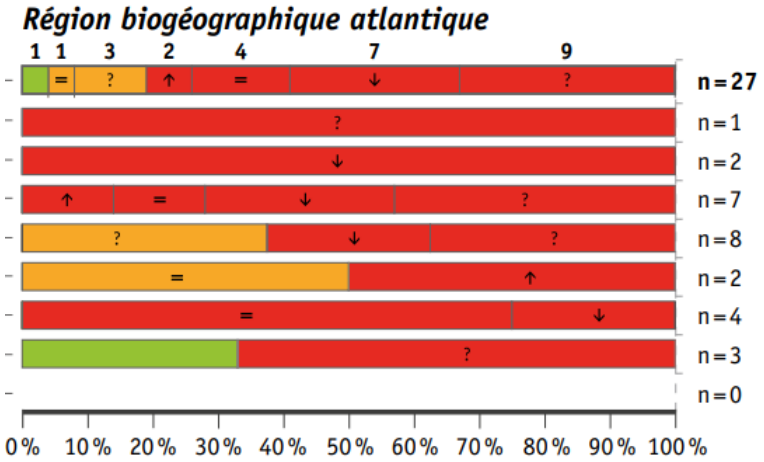
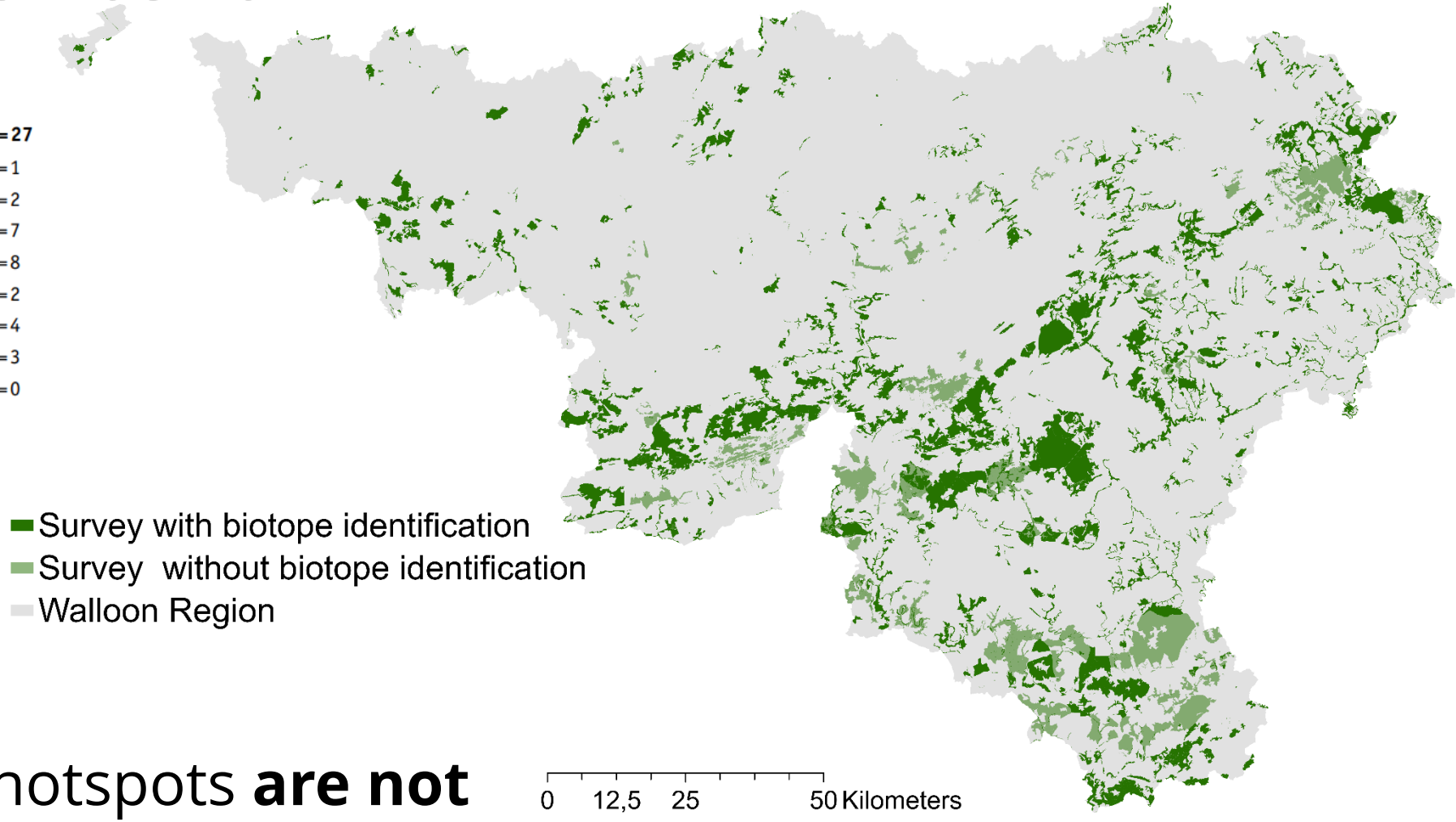
A dramatic context





29% of biodiversity hotspots **are not** identified at biotope scale

Biotope distribution model

Model potential biotope distribution to

1. guide further biotope surveys
2. guide restauration of biotopes to increase their conservation state and species habitats availability

Biotope distribution models

Vegetation communities evolve through time

Sub-Atlantic semi-dry calcareous grassland

Climax

Sub-Atlantic calciphile *Quercus* forests

Open biotope are mainly maintained by human activities

Overlapping ecological niches

Potential Natural Vegetation (PNV)

Sub-Atlantic calciphile *Quercus* - *Carpinus betulus* forests

Calcareous thermophile thickets

Sub-Atlantic dry calcareous grassland

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Atlantic *Quercus robur* - *Betula* woods

Peaty heathland with *Vaccinium* and *Erica tetralix*

Moist or wet oligotrophic grassland

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Sphagnum Betula woods

Northern wet heaths

Raised bogs

...

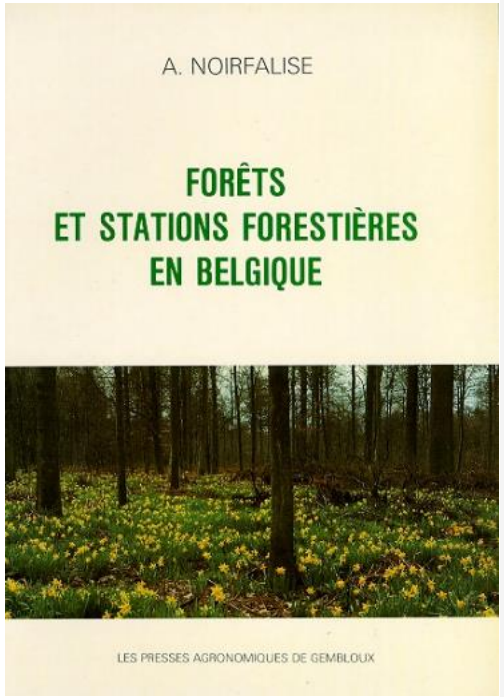
>< opposing ecological contexts in modeling

And 60 other biotopes of interest

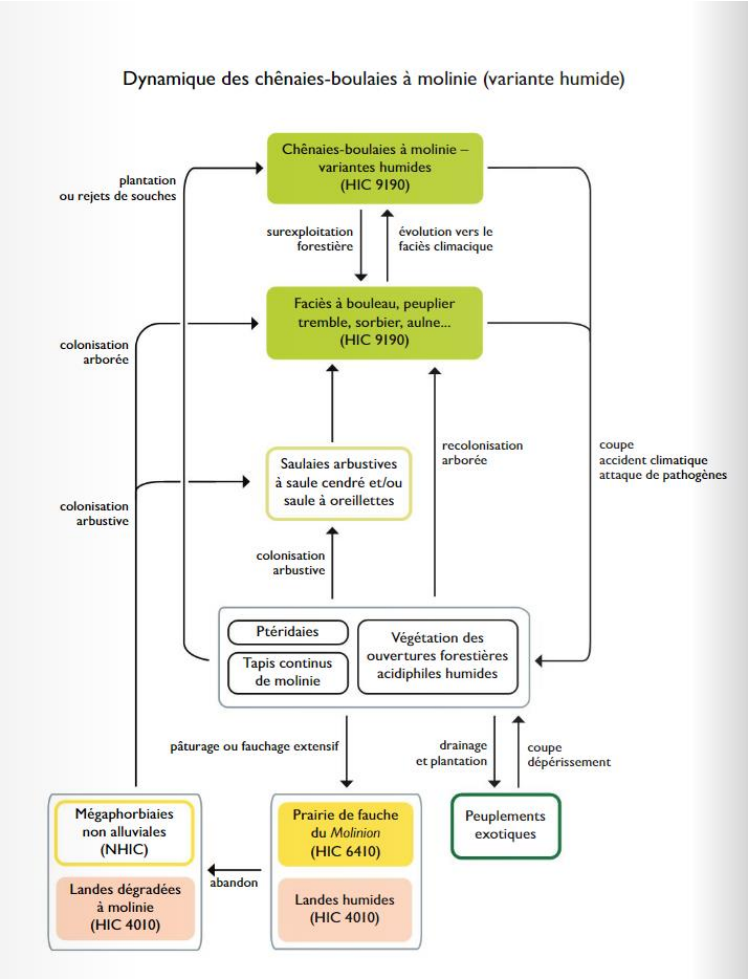
PNV prerequisites

Need of validated PNV typology

A long history of studying local vegetation communities and their dynamics…



Noirfalise A. (1984). *Forêts et stations forestières en Belgique* (Les Presses Agronomiques, Vol. 1). Persée - Portail des revues scientifiques en SHS.



Delescaille L.-M., Wibail L., Claessens H., Dufrêne M., Mahy G., Peeters A., & Sérusiaux E. (2021). *Les Habitats d'Intérêt Communautaire de Wallonie*.

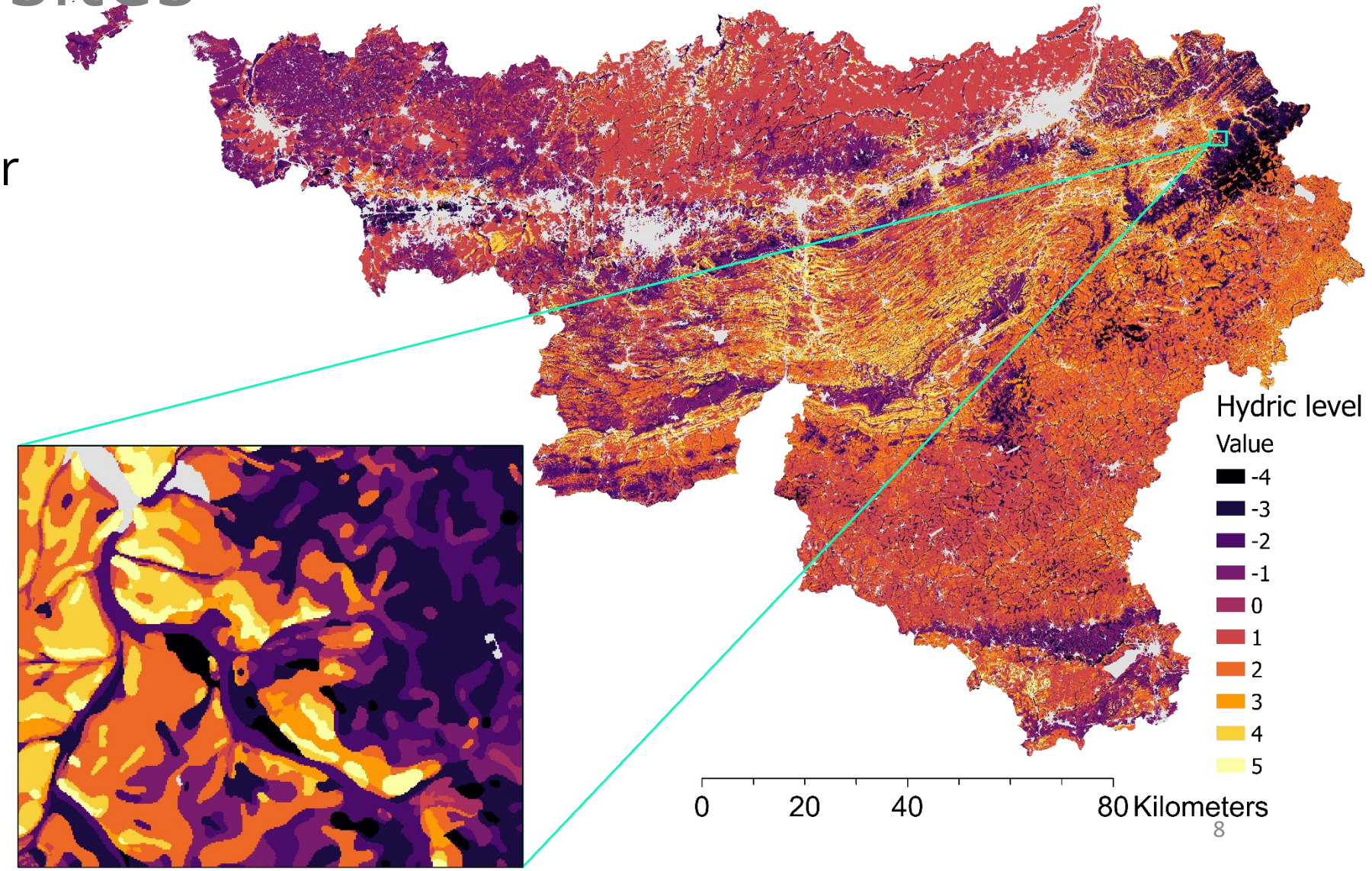
PNV prerequisites

Need of validated mapping of biotopes belonging to PNV

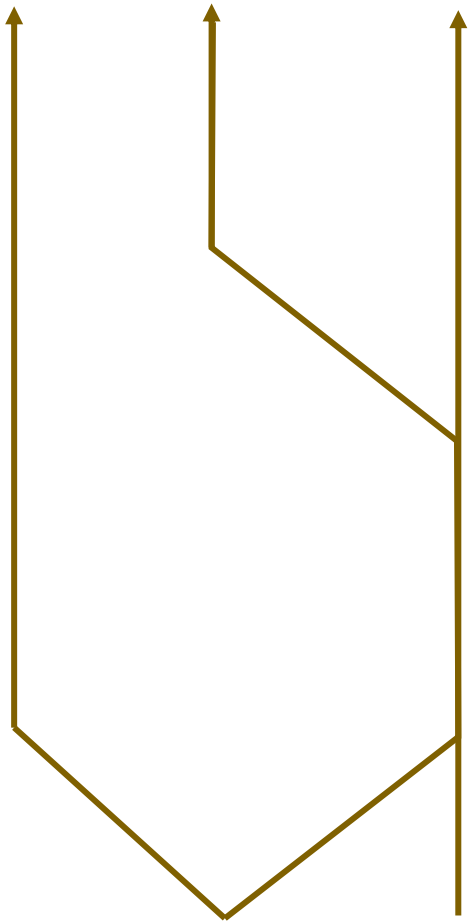
PNV prerequisites

Need of precise environmental predictor mapping

A small region with fine scale environmental data



PNV definitions



Atlantic *Quercus robur* - *Betula* woods

Sphagnum Betula woods

Northern wet heaths

PNV definition made using literature and expert knowledge

Keep biotopes that can be linked to only one PNV

EUNIS Code	Habitat directive code	Biotopes names	Potential Natural Vegetation	Code
D1.1	7110	Raised bogs	***Sphagnum Betula* woods**	**SB**
D2.3	7140	Transition mires and quaking bogs		
F4.11	4010	Northern wet heaths		
G1.51	91D0	*Sphagnum Betula* woods		
D5.21e		Beds of large *Carex spp.*	***Alnus* swamp woods**	**AS**
G1.4		Broad-leaved swamp woodland not on acid peat		
E3.5	6410	Moist or wet oligotrophic grassland	***Quercus* and *Betula* forests with *Molinia***	**QBM**
F4.11	4010	Northern wet heaths		
F4.11b	4010	Peaty heathland with *Vaccinium* and *Erica tetralix*		
F4.13		*Molinia caerulea* wet heath		
G1.81	9190	Atlantic *Quercus robur* - *Betula* woods		
G1.911a	9190	*Betula* facies of *Quercus robur* forests		
E2.2	6510	Low and medium altitude hay meadows	**Riparian and gallery woodland**	**RG**
E5.4	6430	Moist or wet tall-herb and fern fringes and meadows		
F9.12	91E0	Lowland and collinar riverine *Salix* scrub		
G1.1	91E0	Riparian and gallery woodland, with dominant *Alnus, Betula, Populus* or *Salix*		
G1.2	91F0	Mixed riparian floodplain and gallery woodland		

PNV definitions

13 PNV defined from very wet to xeric conditions

Sphagnum Betula woods

Alnus swamp woods

Quercus and *Betula* forests with *Molinia*

*R*iparian and gallery woodland

Fammenian *Quercus* and *Carpinus* forests

Neutrophile *Quercus* and *Fraxinus* forests

Acidophilous *Quercus* and *Carpinus* forests

Neutrophile *Fagus* forests

Wet and shady ravine forests

Acidophilous *Fagus* forests

Calcareous *Fagus* and *Quercus* forests

Thermophile acidophilous *Quercus* forests

Xerophile Fammenian *Quercus* and *Carpinus* forests

Sphagnum Betula woods

Calcareous *Fagus* and *Quercus* forests

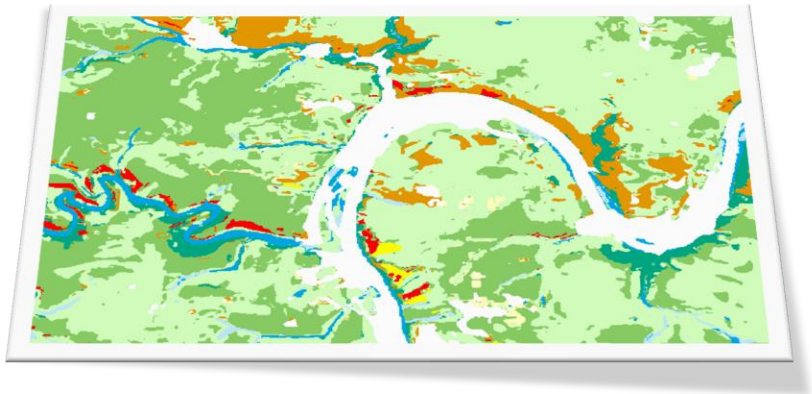
PNV modeling

Presence/absence calibration dataset

19 uncorraleted predictors (topography, soil and climate)

Individual PNV Modeling

Dominant PNV Classification



Quality assessment

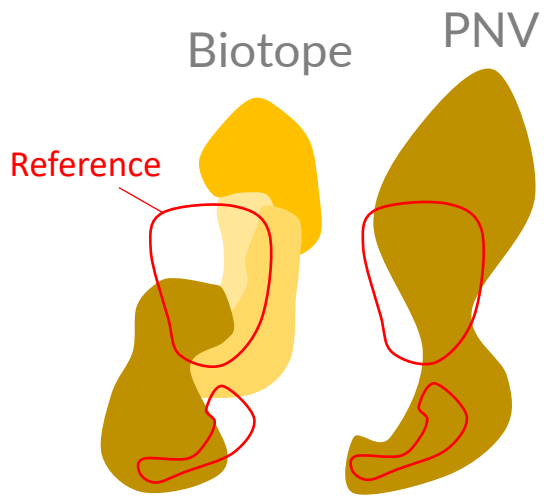
Biotope approach vs. PNV

EUNIS Code	Habitats Directive code	Biotopes names
E1.26	**6210***	Sub-Atlantic semi-dry calcareous grassland
F3.1b		Calcareous thermophilic thickets and scrub
G1.66	**9150**	Medio-European limestone *Fagus* forests
G1.71		Western *Quercus pubescens* woods and related communities
G1.A17	**9150**	Sub-Atlantic calciphile *Quercus* - *Carpinus betulus* forests

Presence = biotope modeled

Absence = all other biotopes

Comparison of additive presence based on producer accuracy



Sub-Atlantic semi-dry calcareous grassland

Calcareous thermophilic thickets and scrub

Sub-Atlantic calciphile *Quercus* and *Carpinus betulus* forests

Quality assesment

Floristic data dependance to PNV

Independent assessment based on naturalist observation platforms data sets

Using Chi² test to evaluate dependence between species observations and PNV classification results

Equation 1.

$$T = \sum_{ij} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

where O_{ij} is the number of observations of a taxon i in a PNV j

Equation 2.

$$E_{ij} = \frac{O_{i+} \times O_{+j}}{N}$$

where O_{i+} is the total number of observations for a taxon, O_{+j} is the total number of observations in a PNV j and N is the total number of observations in all PNV.

Comparison of Chi² test results with existing lists of biotope indicative species

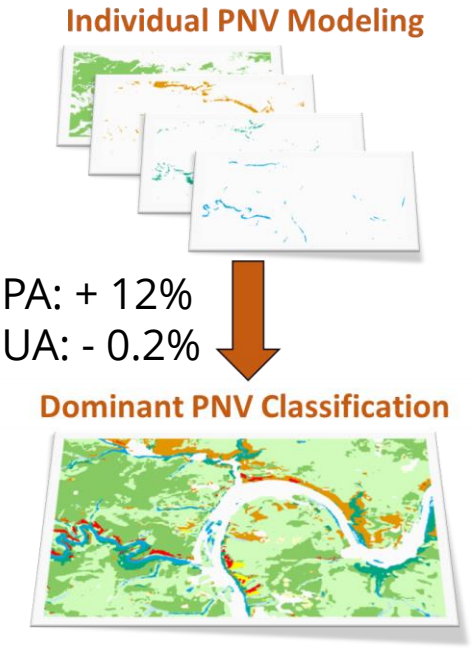
Asplenium scolopendrium

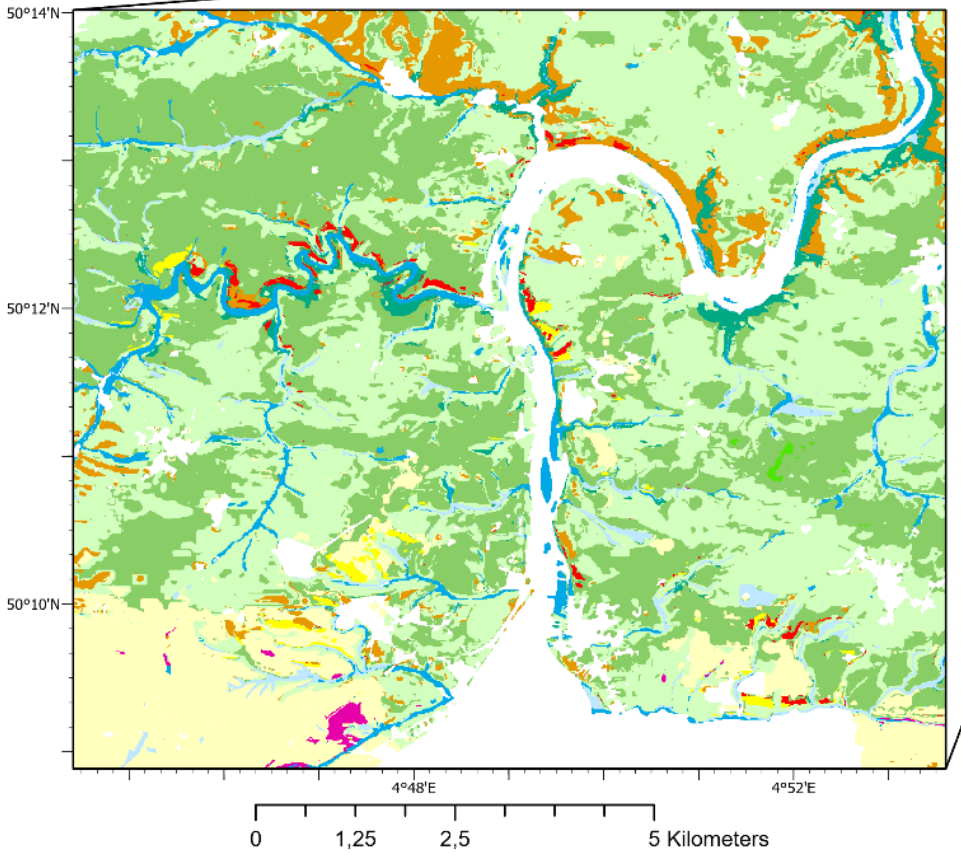
Vaccinium myrtillus

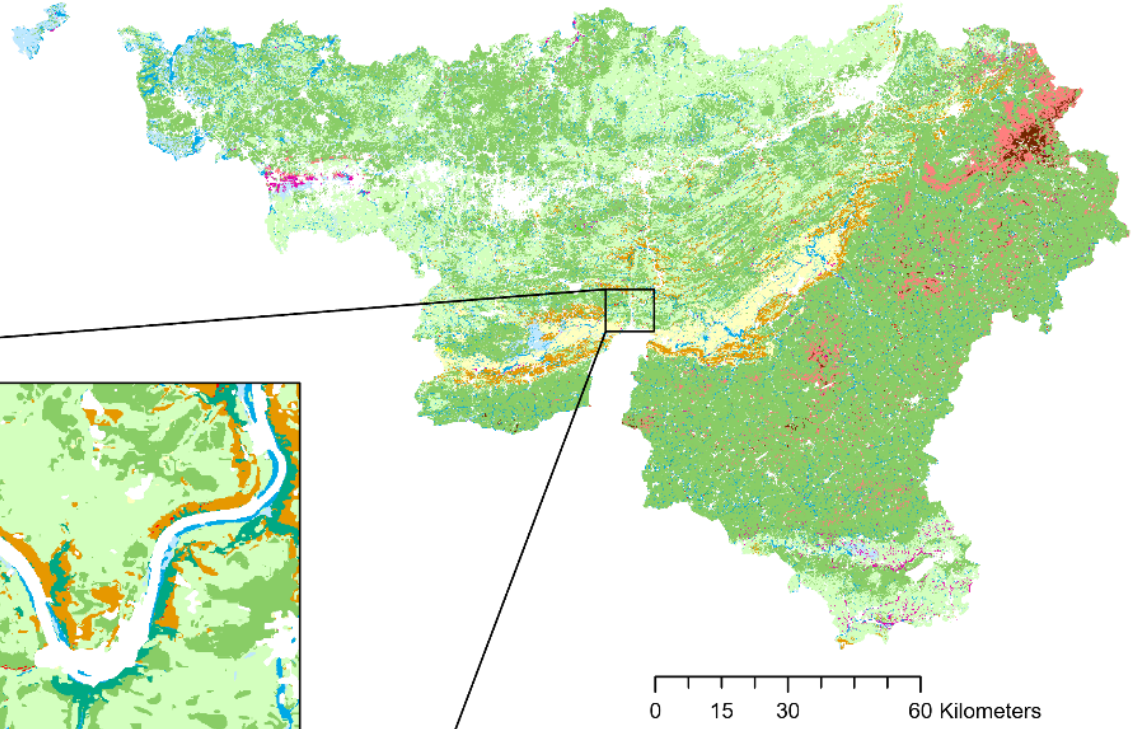
Helianthemum nummularium

PNV modeling

Kappa: 0.92
Mean PA: 0.79
Mean UA: 0.81







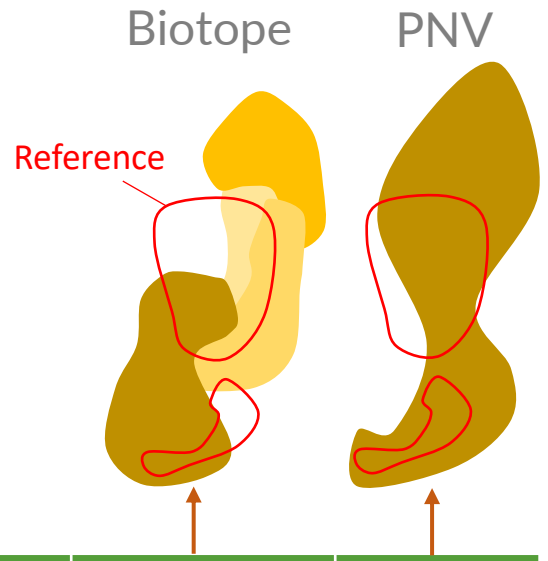
Potential Natural Vegetations

Codes

- SB
- AS
- QBM
- RG
- FQC*
- NFQ*
- AQC*
- NF*
- WSR*
- AF*
- CFQ
- TAQ*
- XFQC*

Quality assessment

Biotope approach vs. PNV



Biotopes	Biotopes (EUNIS code)	PA of individual biotopes predictions	PA of individual biotopes predictions inside grouped area	PA individual biotopes predictions inside PNV
Sub-Atlantic semi-dry calcareous grassland	E1.26	**0.609**	**0.843**	**0.905**
Calcareous thermophilic thickets and scrub	F3.1b	**0.488**	**0.710**	**0.861**
Medio-European limestone Fagus forests	G1.66	**0.615**	**0.720**	**0.817**
Western Quercus pubescens woods and related communities	G1.71	**0.304**	**0.781**	**0.871**
Sub-Atlantic calciphile Quercus and Carpinus betulus forests	G1.A17	**0.857**	**0.863**	**0.859**

+21% **+8%**

Sub-Atlantic semi-dry calcareous grassland

Calcareous thermophilic thickets and scrub

Sub-Atlantic calciphile *Quercus* and *Carpinus betulus* forests

Quality assesment

Floristic data dependance to PNV

Potential Natural Vegetation	Five most dependent species
Wet and shady ravine forests	***Asplenium scolopendrium*[F], *Polystichum aculeatum*[F], *Asplenium trichomanes*[M], *Mercurialis perennis*[F], ~~*Biscutella laevigata*~~[O]**
Acidophilous Fagus forests	***Pteridium aquilinum*[M], *Teucrium scorodonia*[F], *Cytisus scoparius*[O], *Vaccinium myrtillus*[M], *Luzula luzuloides*[F]**
Neutrophile Quercus and Fraxinus forests	~~*Lythrum salicaria*~~[M], ***Alnus glutinosa*[M], *Filipendula ulmaria*[M], *Glechoma hederacea*[M]**, ~~*Phragmites australis*~~[M]

Asplenium scolopendrium

Vaccinium myrtillus

Filipendula ulmaria

Discussion

Case of acidophilous beech forest

		Prediction												
		SB	AS	QBM	RG	FQC	NQF	AQC	NF	WSR	AF	CFQ	TAQ	XFQC
Reference	SB	83%	2%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	AS	0%	68%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	QBM	14%	2%	83%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	RG	0%	1%	0%	69%	0%	0%	0%	0%	1%	0%	0%	0%	0%
	FQC	0%	4%	0%	5%	93%	1%	0%	1%	0%	0%	2%	2%	9%
	NQF	0%	1%	0%	5%	0%	89%	2%	0%	0%	0%	1%	0%	0%
	AQC	0%	0%	0%	0%	0%	0%	73%	0%	0%	0%	0%	0%	0%
	NF	0%	2%	0%	4%	0%	2%	1%	91%	8%	0%	5%	3%	1%
	WSR	0%	0%	0%	1%	0%	0%	0%	0%	69%	0%	2%	2%	0%
	AF	3%	21%	15%	15%	6%	8%	24%	5%	11%	99%	2%	33%	3%
	CFQ	0%	0%	0%	0%	0%	0%	0%	1%	11%	0%	88%	2%	2%
	TAQ	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	58%	0%
	XFQC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	84%
	Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

High confusion of other predicted PNV with acidophilous beech forest reference polygons

Hypotheses:

1. Most dominant PNV with coarser mapping
2. Long-term management of beech forest

Discussion

Biotope ecological niches in human dominated landscapes

PNV better represent original ecological niches ?

Can we tend to the original ecological niches in a landscape dominated by human activities?

Thank you for your attention

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FÉDÉRATION WALLONIE-BRUXELLES

Context

Walloon region = **16 900km²** (5% of Poland)

Potential natural vegetation

Model ~~potential biotope~~ distribution to

1. guide further biotope surveys
2. guide restauration of biotopes to increase their conservation state and species habitats availability
3. model numerous biotopes on a whole region
4. consider natural disturbance to perform a dynamic ecosystem management

PNV modeling

Individual PNV prediction

Model : Random forest

Calibration data: Eunis polygon map , presence/ absence (PNV modeled/other PNV)

Predictors: uncorrelated environmental predictors (climate, topography, soil)

Balancing dataset: SMOTE algorithm

Accuracy metrics: AUC, overall accuracy, producer accuracy, user accuracy

Dominant PNV classification

Model : Random forest

Calibration data: Eunis polygon map , classes : different PNV

Predictors: individual PNV predictions

Balancing dataset: weighted class importance

Accuracy metrics: AUC, overall accuracy, producer accuracy, user accuracy