

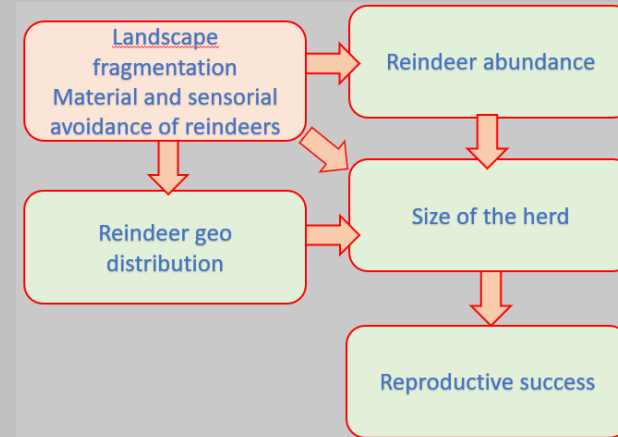
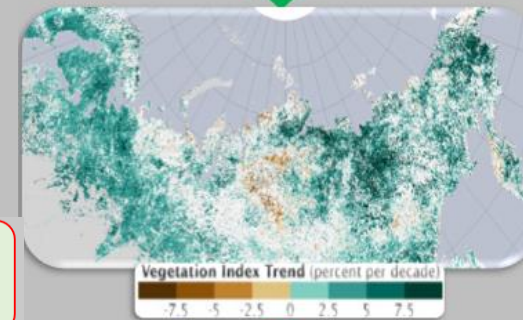
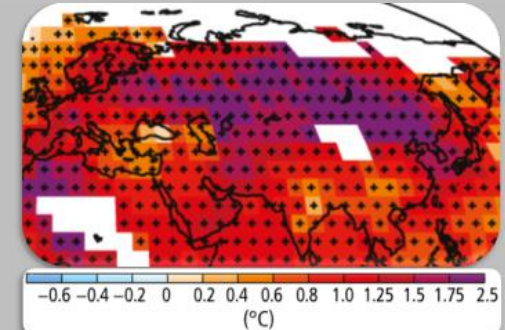
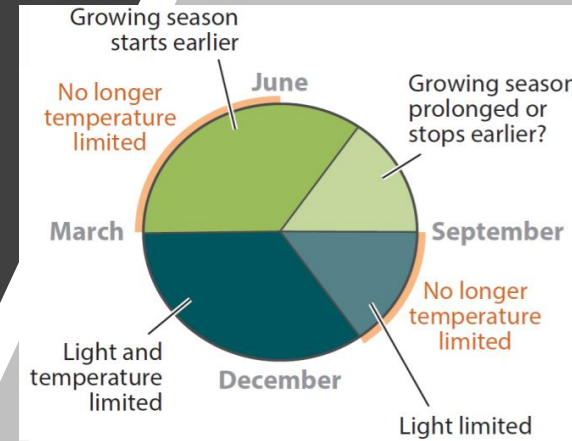
Evolution of ecosystem services in the frame of pastoral functional categories

A study case in Swedish Lapland

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1.1. Global change and its effects on subarctic (socio-) ecosystems

- Arctic and subarctic socio – ecosystems: sentinels of climate change and its impacts at various geo/temporal scales
- In particular studying reindeer *Rangifer tarandus* and associated pastoralism is meaningful
- Plant distribution modification (e.g. « borealization of ecosystems »; « shrubification ») : loss of pastures?
- Economical activities increasing, landscape fragmentation and reindeer avoiding strategies

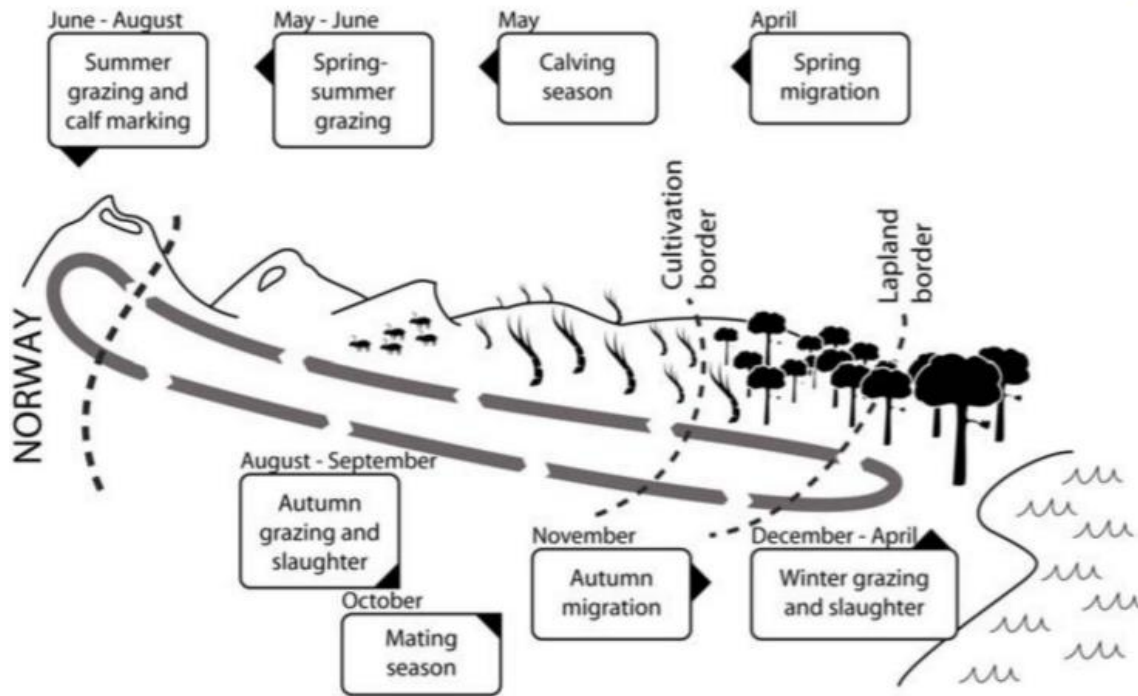


1.2. The Saami people and reindeer herding

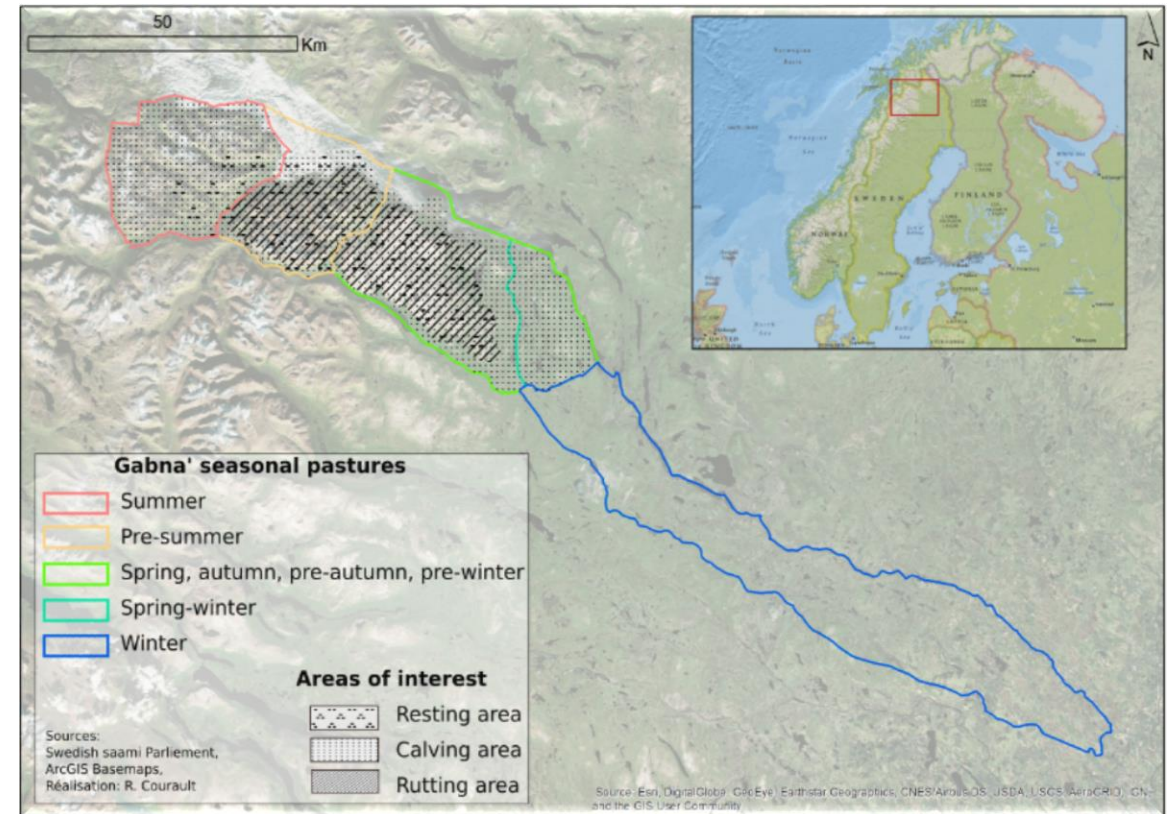
- Last indigenous people of Europe
- 6 500 herders across 4 nations
- 650 000 reindeers
- Lapland/Sapmi: 146 000 km²
- Meat, cheese and production



1.3. Study area: Gabna community (Northern Sweden)



Inga, B. (2008). *Traditional ecological knowledge among reindeer herders in northern Sweden*.



Credits: R. Courault (2018)

1.4. Ecosystem services applied to reindeer pastoralism

Ecosystem services :

« *the benefits human populations derive, directly or indirectly, from ecosystem functions* » (Constanza et al. 1997 in Fisher et al., 2007)

Vihervaara, Kumpula et al. (2010):

- a. Supporting
- b. Provisioning
- c. Regulating
- d. Cultural services

⇒ How apply it in the Swedish context?

⇒ How it might evolve during time?

		Industries/cities	Coniferous forests
Provisioning values	Reindeer	0	20
	Game	0	20
	Fish	0	10
	Berries, mushroom	0	20
	Fodder	0	20
	Medecine	0	20
	Wood	0	20
	Water	0	10
	Energy	0	20
	Genetic resources	0	20
Regulating values	Local and regional climate	0	20
	Carbon sequestration	0	20
	Pollination	10	10
	Flood prevention	20	10
	Erosion prevention	10	20
	Nutrient sequestration	20	0
Cultural values	Local and Sami culture	10	20
	Esthetic landscapes	0	20
	Intrinsic value of nature	0	20
	Recreation	0	20
Supporting values	Phtosynthesis	0	20
	Nutrient cycling	0	20
	Soil formation	0	20

Source: Vihervaara, Kumpula et al., Ecosystem services: - A tool for sustainable management of human-environment systems. Case study Finnish Forest Lapland, *Ecological Complexity* 7 (2010) 410-420

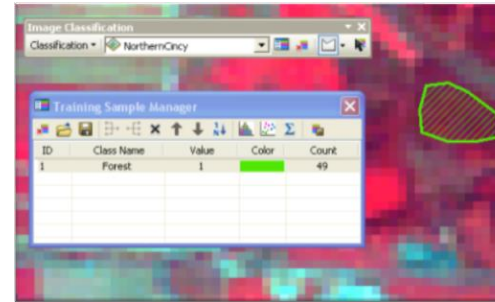
3.1. Results: Linguistic categories ≠ ecological categories!

Saami terminology	English translation	Biogeographical scale	Interpretation (CLC and SW maps)
<i>Beahcevuovdi</i>	Pine forest	Landscape + specie	Coniferous forest
<i>Duottar</i>	Tundra, hill, treeless mountain	Landscape	Sparsely vegetated areas; bare rocks
<i>Lageš</i>	Montane birch	Specie	Broadleaved forest
<i>Hàika</i>	Old pine	Specie + dynamics	Cold and humid conifer forests
<i>Meahcci</i>	Open country, pasture land, wilderness	Landscape	Moors and heathlands
<i>Sitnu</i>	Grasses	Familia / genera	Grasslands

2.1. Material and methods:

- 1) Acquiring and preprocessing Landsat imagery
- 2) Training samples for the supervised classification
- 3) Classification and computation of the confusion matrix/validation
- 4) Land cover maps, mixing « occidental » categories and traditional categories
- 5) Reclassing land cover maps to ecosystem services ones
- 6) Areas calculation for the two scales of analysis (Gabna' community and seasonal pastures)

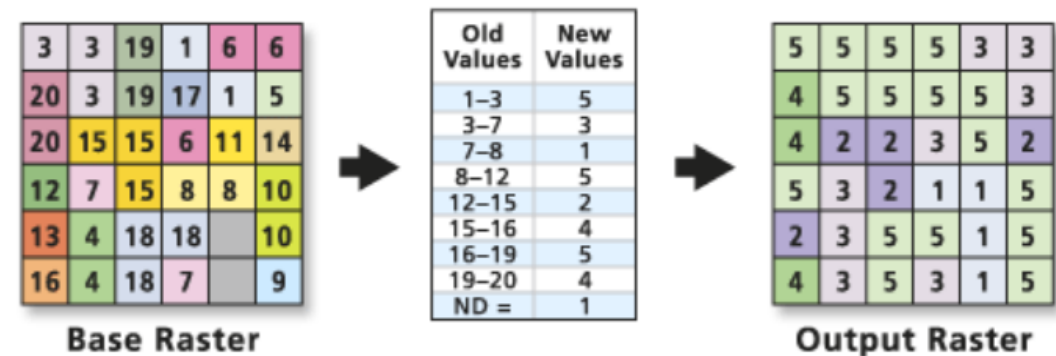
Training samples



Confusion matrix / Kappa accuracy

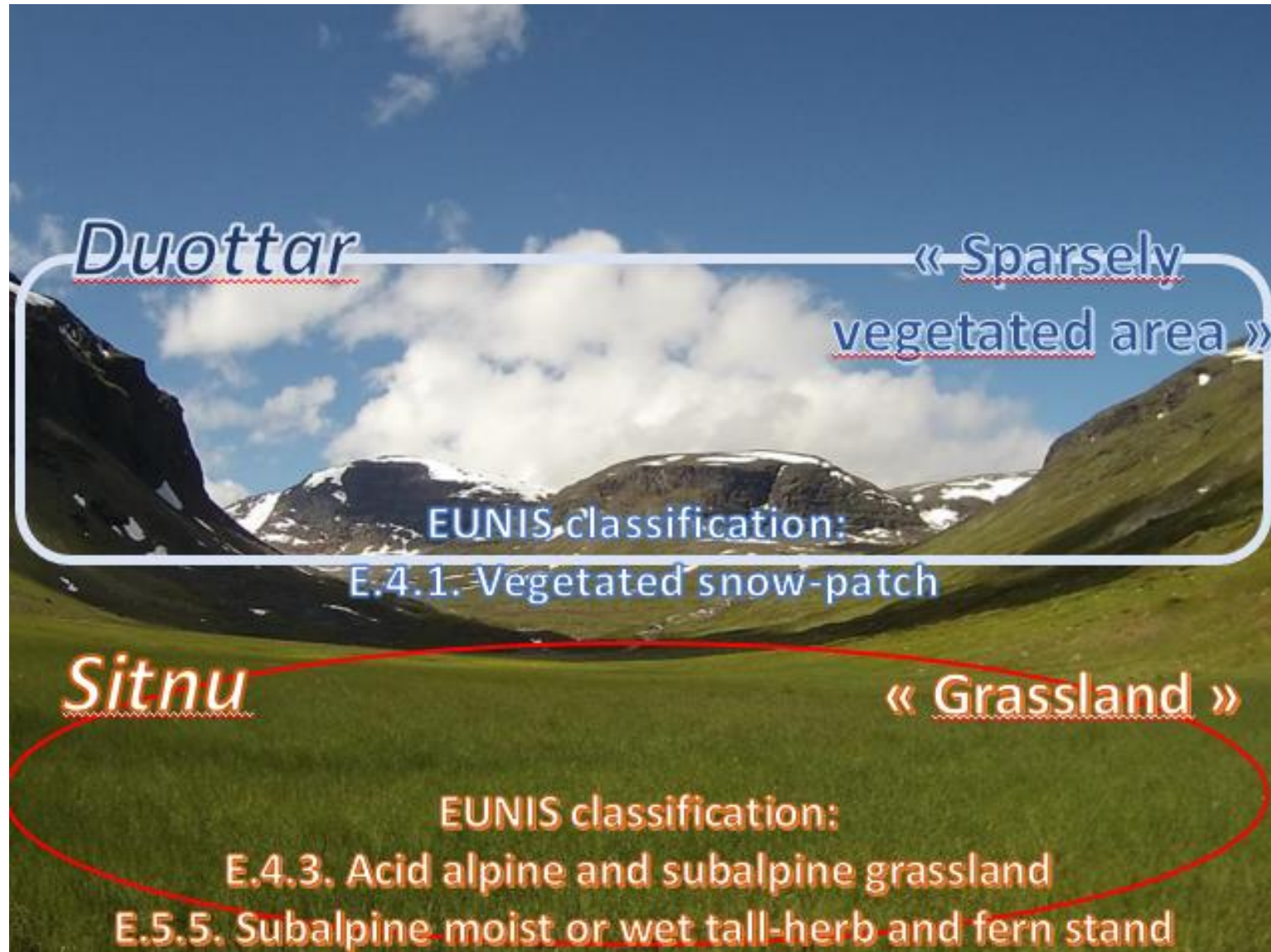
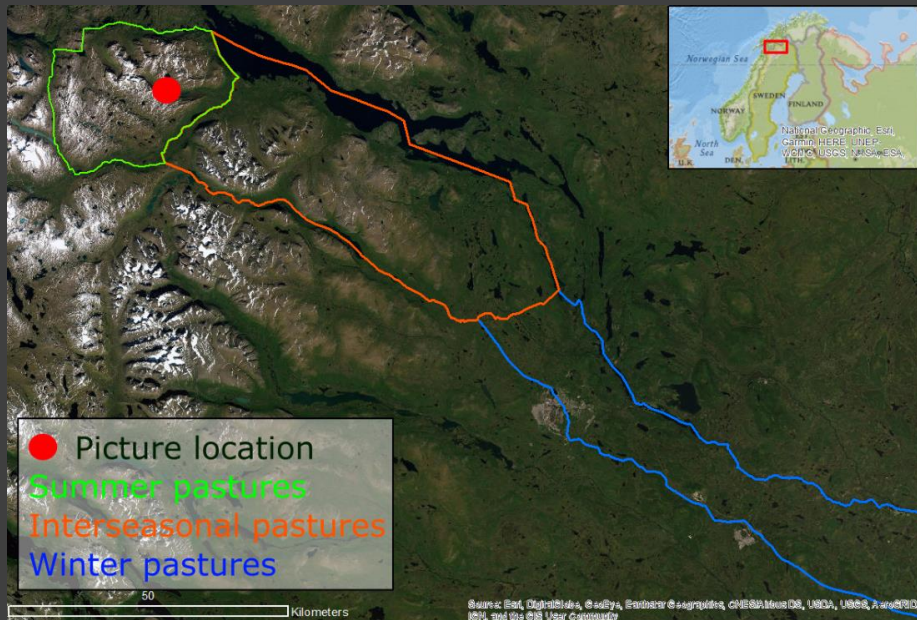
$$k = \frac{p_o - p_e}{1 - p_e}$$

Reclass land cover classification to ecosystem services



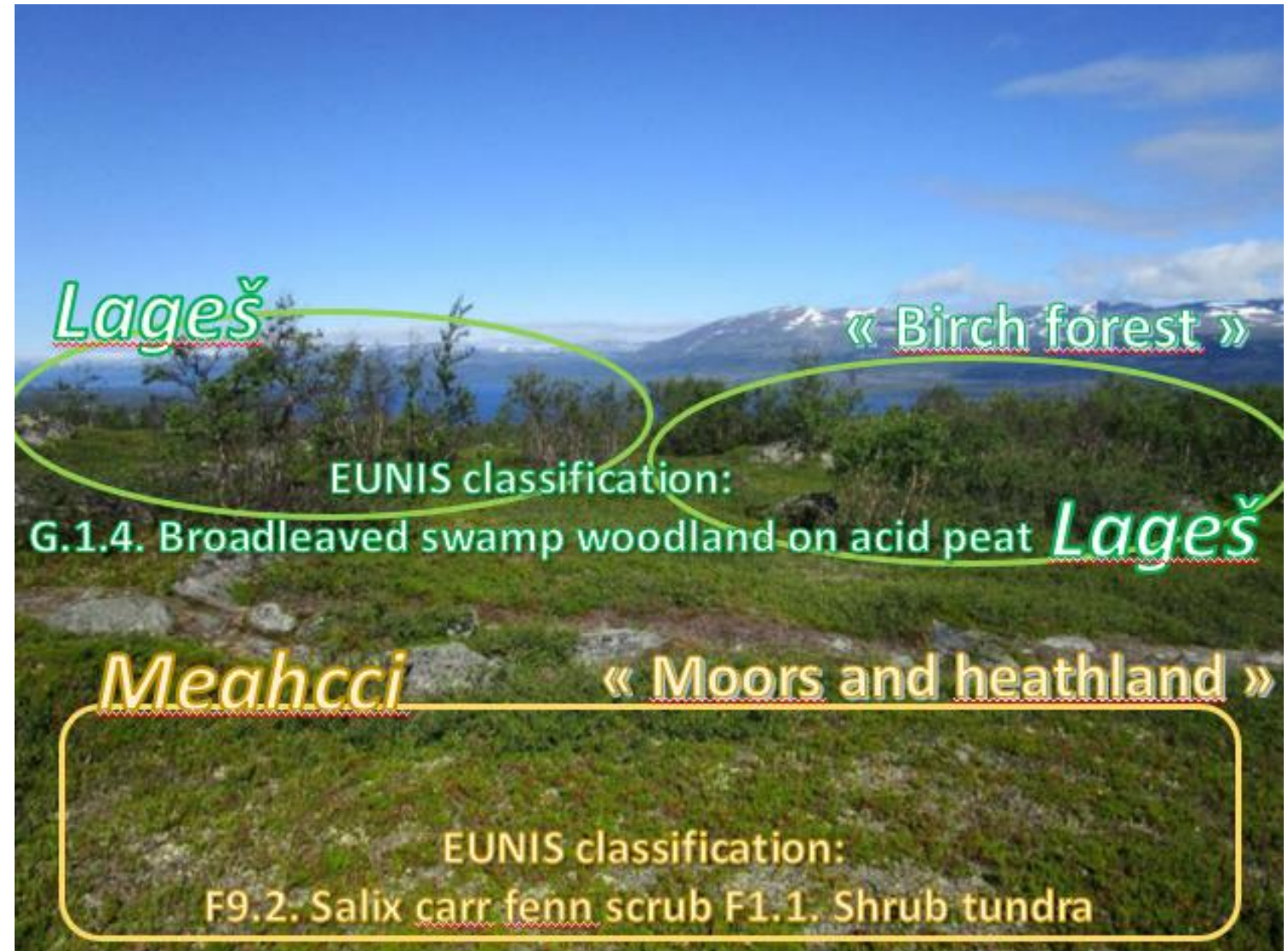
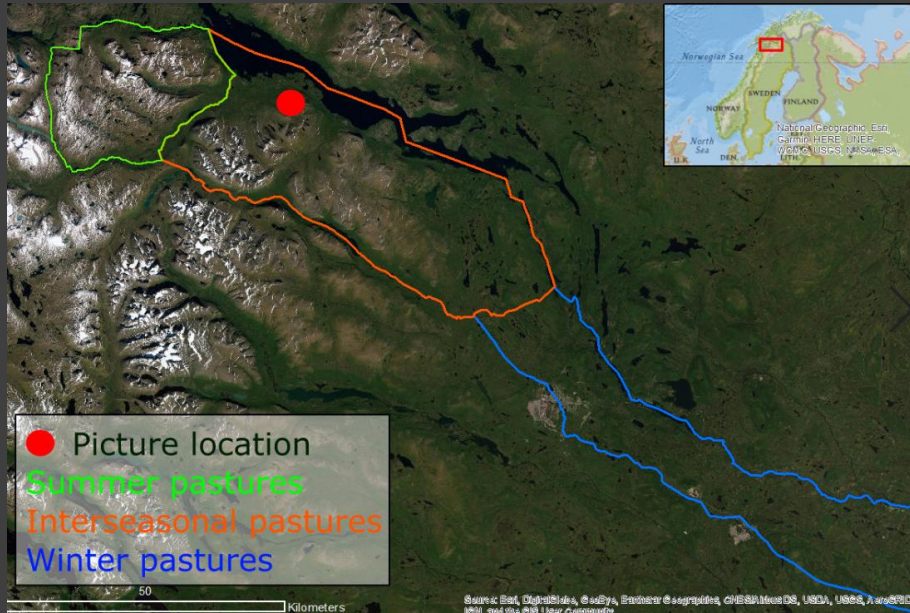
3.2 Quick interpretation of landscape using herders' ecological categories

- Mountainous area: summer pastures
- Glacial valley of Gorsajohka (Abisko valley)



3.2 Quick interpretation of landscape using herders' ecological categories

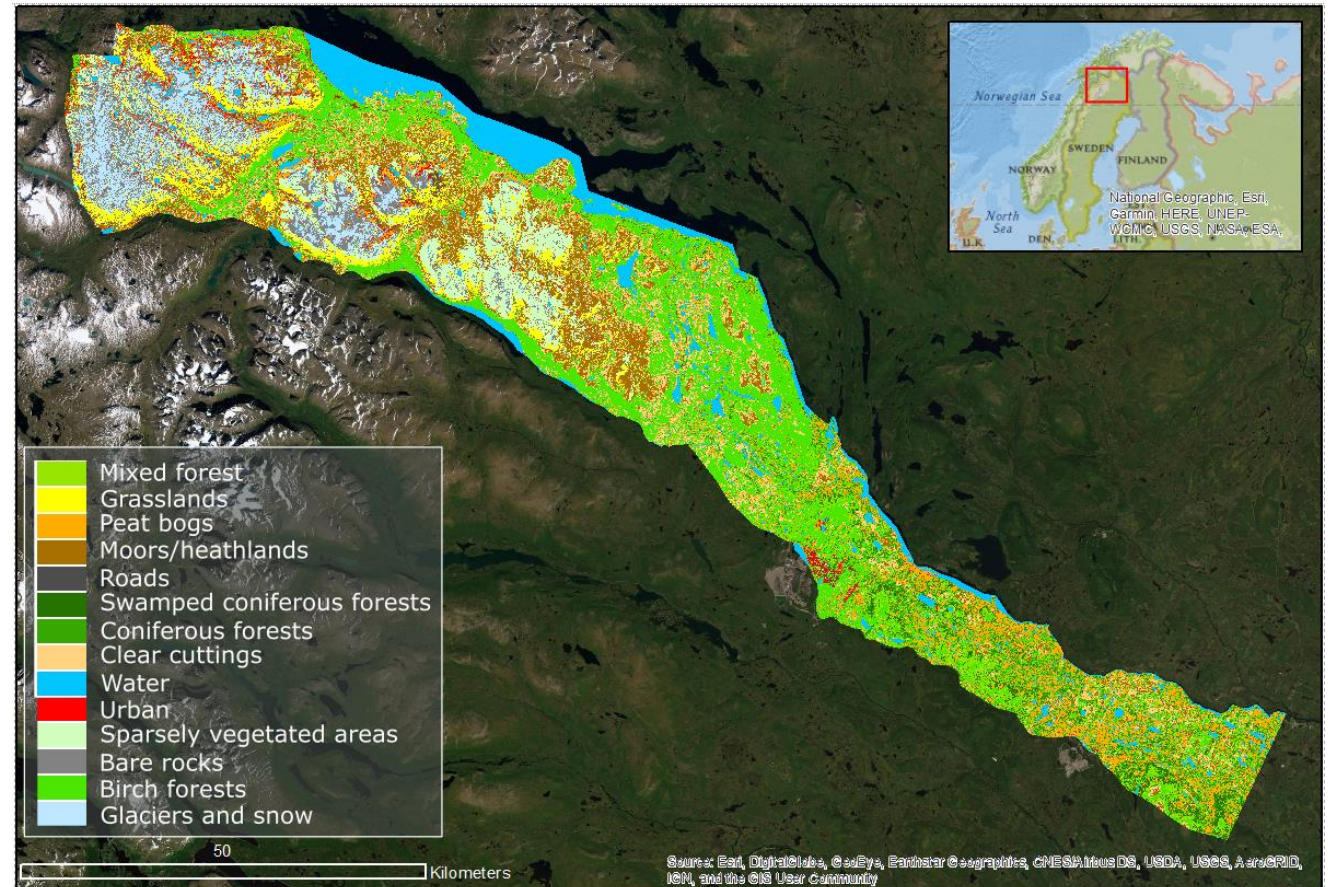
- Above treeline (~600 m)
- Near from the Torneträske lake, Abisko



4.2. Results: Evolution of land cover (1990-2017)

- At Gabna' herders community scale
 - « Clear cuttings » are slightly increasing (+3%), as well as « urban » and « roads » (+1.7% and +0.3%)
 - « Bare rocks/*Duottar* » areas are decreasing (-1.8%) while « Grassland / *Sitnu* » increases (+ 3.2%)
- For seasonal pastures :
 - Winter pastures are the most affected by the infrastructure development (Kiruna..)
 - Summer pastures presents the strongest numbers for natural vegetation shifts

Gabna' reindeer herders community land cover in July 1990

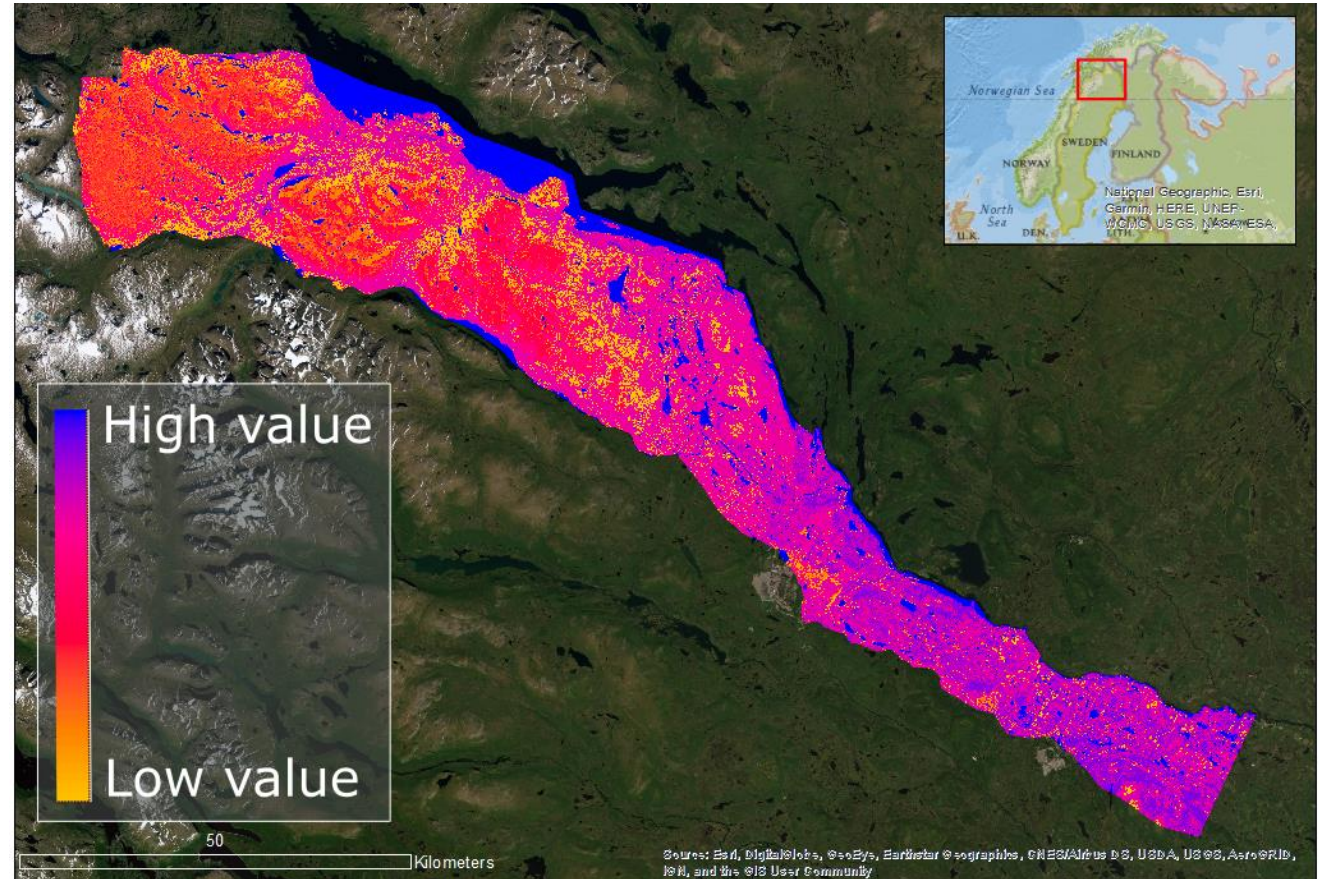


Credits: R. Courault (2019)

Gabna' reindeer herders community ecosystem services in July 2017

4.3. Results: Evolution of ecosystem services (1990-2017)

- Low ranked land cover (e.g. roads, urban...) are mechanically increasing at the Gabna' community scale
- High valued ones (forests...) does not show any specific trend between 1990 and 2017
- High variability between seasons



5. Conclusion and perspectives

Uses of local / indigenous taxonomy: brings ecological informations and allow discussion with stakeholders

But watch for generalization abuses/misinterpretation!

=> Here need for feedbacks fieldwork (talk with native speakers/herders and linguists)

Evolution of Gabnas' landscapes and associated ecosystem services : landscape fragmentation and vegetation shifts

=> Supervised classification: fair performances (for now), to enhance with more accurate imagery

=> Focusing the ranking of ecosystem services specifically on *Rangifer tarandus* ecology (e.g. "Providing" values)



Thank you
for your attention!