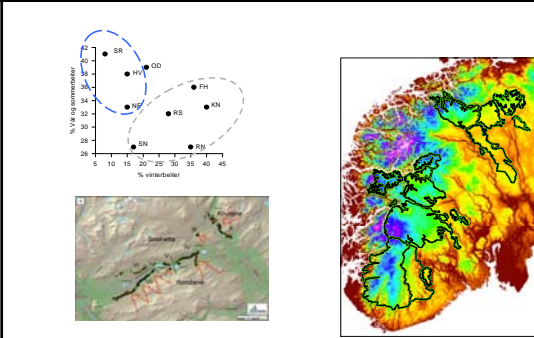


Using remote sensing for land cover mapping and change detection of lichen biomass in Hardangervidda

Olav Strand and Tobias Falldorf

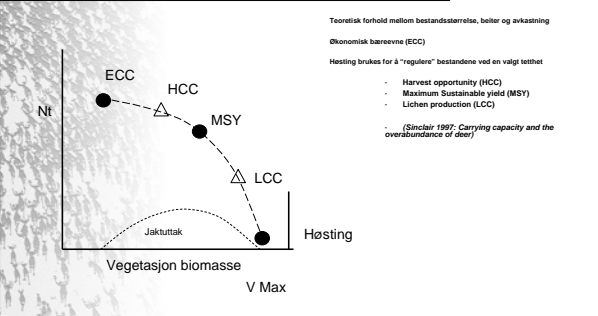


Fordeling av ulike sesongbeiter i villreinområdene



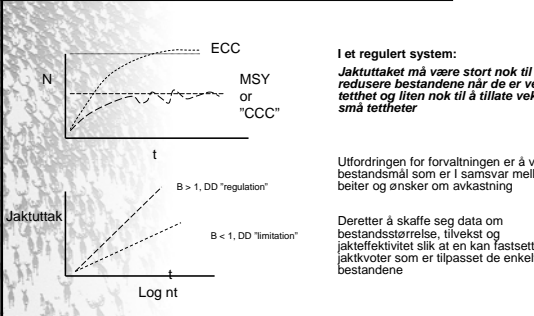
- 1 -

Bærekraft og høsting



- 2 -

Jaktuttak og regulering av bestandene



I et regulert system:
Jaktuttaket må være stort nok til å redusere bestandene når de er ved stor tetthet og liten nok til å tillate vekst ved små tettheter

Utfordringen for forvaltningen er å velge bestandsmål som er i samsvar mellom beiter og ønsker om avkastning

Deretter å skaffe seg data om bestandsstørrelse, tilvekst og jakteffektivitet slik at en kan fastsette jaktkvoter som er tilpasset de enkelte bestandene

- 3 -

Målvalg i bestandsforvaltningen

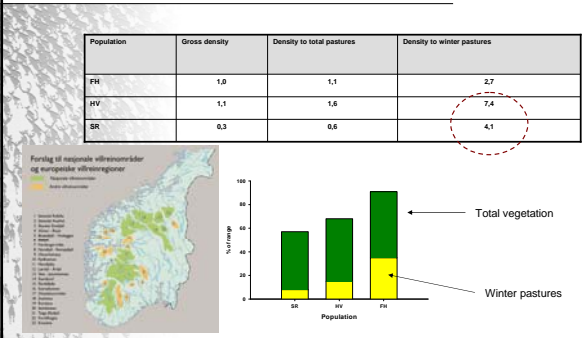
Population	Range size	Population goat	App. Density
FH	1769 km ²	1700	1,0 reindeer / km ²
HV	8136 km ²	9000	1,1 reindeer / km ²
SR	6300 km ²	1800	0,3 reindeer / km ²



- 4 -

Målvalg og beiteressurser

Population	Gross density	Density to total pastures	Density to winter pastures
FH	1,0	1,1	2,7
HV	1,1	1,6	7,4
SR	0,3	0,6	4,1



- 5 -

Bestandsforvaltningen; kulturtradisjon med ambisjoner

Hensyn til dyr og beiter før økonomi, dvs at en stort sett har satt beskjedne bestandsmål

Presis måldefinisjon mht antall dyr, kjønns og alderssammensetning

Øke beitekapasitet og kondisjon er et mål i mange (alle?) områder

Dette er "avanserte" forvaltningsmål- innebærer f. eks stabilisering av bestandene

Har en nådd måla med bestandsforvaltningen?

Resultatene viser at en har nådd mange av måla som har er definert for bestandsforvaltningen

Problemer med å "regulere" enkelte bestander og det er større svingninger enn ønskelig fra et hestings eller økonomisk synspunkt (størst utfordringer i region 1, og i de største villreinområdene)

Kan oppnå større presisjon med andre metoder eg. radiomarkering, samtidig som at en lærer mer om inn/ utvandring mellom bestandene

Tilgjengelige data indikerer at en har nådd langsiktige mål som;

- Kondisjonøkning (HV + SR)
- Forbedring av beiter (HV)
- Ønska kjønns og aldersstruktur

Fortsatt et kunnskapsbehov knyttet til dynamikken i bestandene og mulighetene som forvaltningen har til å drive en presis bestandsforvaltning

Vi mangler kunnskap om effekter av jakt eks. jegerseleksjon og virkningen av tiltak som tar sikte på å redusere slike effekter

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Hardangervidda og tetthetsavhengige effekter

Vi har dokumentert,

- Endring i fostervekst
- Vinterkondisjon
- Kalvrekuttering

Som indikerer at tetthetsavhengigheten i villreinbestanden er redusert

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AGENDA

Land cover mapping to be used with GPS data; how many classes and at which quality?? – (Good enough to give explanatory power in habitat selection models)

Estimation of lichen biomass also to be used with GPS data

Change detection; - has lichen biomass changed at Hardangervidda and has managers succeeded in increasing reindeer winter forage quality?

LAND COVER AND LICHEN BIOMASS MAPS ARE PREREQUISITES FOR HABITAT MODEL

Klassifisering

1

Reindeer specific land cover classification/ vegetation map with high resolution needed for a complete model definition

Regresjon

2

Lichen biomass believed to influence habitat selection especially during winter

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EXTENSIVE PREPROCESSING REQUIRED

Images	Training points
<p>Image acquisition (resembling method)</p> <ul style="list-style-type: none"> • NN (nearest neighbour) – best for heterogeneous habitats – prioritizes reflectance • CC (cubic convolution 3*3 pixels) <p>Ortho rectification</p> <p>Topography Correction</p> <ul style="list-style-type: none"> • C-correction • Minnaert correction • Cosine correction <p>Radiometric correction</p> <ul style="list-style-type: none"> • Destriping • Dehazing • Cloud-masking 	<p>GPS accuracy</p> <p>Outliers</p> <p>Weighting of sample points</p> <p>Split in Test-/Training Data</p> <p>Defining apriori probabilities</p>

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Sample data

5700 SAMPLE POINTS FROM FIELDWORK AND AERIAL PHOTOS

Pre-processing of sample points

Estimation of apriori probabilities:

- Apriori probability describes the expected class distribution before classification
- Additional decision support for classifiers, when the spectral characteristics of a pixel don't allow for a clear allocation to a unique class
- Apriori probabilities for the landcover classes in Hardangervidda derived from airborne vegetation classification along transects during summer 2004 based on visual interpretation (Caare et al. 2005)
- Adjustments necessary due to partially differences in class definitions classes used

Filtering of sample points collected in the field through excluding those with a GPS accuracy less than 15m RMS to ensure congruence of field data and Landsat pixel

Exclusion of sample points classified as obvious outliers as measured by their summed absolute differences between recorded reflectance values compared to class means within all single bands

We opted against cross-validation for accuracy assessment hence the remaining sample points were split in training and testing data

- Stratified random sample of 100 training points per class with subclasses as covariate resulting in 800 training points (excluding shadow)
- Necessary sample size ranging between 575 (Congalton and Green 1999) and -9600 derived from proxy (Mather 1999a) for statistically valid testing
- Minimum number of 250 training points per class with the exception of snowbed vegetation with only 175 training points with overall 4.900 training points satisfying both estimates for minimum sample size for statistically valid training

Weighting of sample points for training and testing by apriori probabilities to compensate for skewed field sample and thereby get a more proportionally distributed sample as expected using random sampling

Main Class	Sample -points	Apriori prob. ⁽²⁾
Shadow	570	0,5
Snowbed	359	1,2
Water	1395	9,1
Rock	489	9,5
Ridge	1345	26,5
Leeside	360	21,5
Snowbed	275	18,0
Mire	554	9,0
Forest	443	4,7

(1) With average feature number of 4 within subgroups created from auxiliary data
 (2) Estimation based on (Caare et al. 2005)

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CALIBRATION OF CLASSIFIER PARAMETERS WITH SIGNIFICANT IMPACT ON ACCURACIES

Example: kNN-Classifier

First Step: FSS (forward/backward selection)

Best 10 kNN-parameters:

- cb321 gained 0.713
- cb322 gained 0.703
- cb323 gained 0.700
- cb324 gained 0.699
- cb325 gained 0.698
- cb326 gained 0.697
- cb327 gained 0.696
- cb328 gained 0.695
- cb329 gained 0.694
- cb330 gained 0.693

Second step: Determine k

- 19 -

SAMPLING SCHEME, SIZE AND WEIGHTING WITH SIGNIFICANT IMPACT ON ACCURACY

Example: Confusion matrix kNN before auxiliary data

Unweighted

M_Cl_Nr	3	4	5	6	7	8	9	10	Total	B_Acc
3	94	2							100	96
4	100								100	100
5	88	11	16	1	1	2		100	89	
6	7	87	4					100	87	
7	22	4	63					100	83	
8	18	19	3	55	3			100	55	
9		35	4	41				100	61	
10			2		4	1	95	100	93	
Total	98	102	118	160	80	61	67	104	800	79,1
U_Acc	100	98	58	54	68	90	91	89	70,1	70,6
Average	58	99	64	71	56	73	78	91	73,2	

Weighted with apriori probabilities

M_Cl_Nr	3	4	5	6	7	8	9	10	Total	B_Acc
3	9	0							10	96
4	72								73	100
5	148	23	34	2	2	4			212	89
6	12	158	2						176	87
7	32	12	31						104	83
8	13	14	4	40	2				72	55
9		13	2	23					38	61
10			2	3	1	71			76	93
Total	9	73	205	215	118	44	31	63	800	71,1
U_Acc	100	100	71	71	66	90	75	83	70,2	70,6
Average	56	100	70	70	64	75	88	91	71,9	

Testing Sample: 100 random points per class; necessary sample size dependent on dimension of FSS

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kNN WITH OVERALL ACCURACY OF ~80%

Auxiliary Data with a gain of ~5%-pt.

Unweighted

Weighted

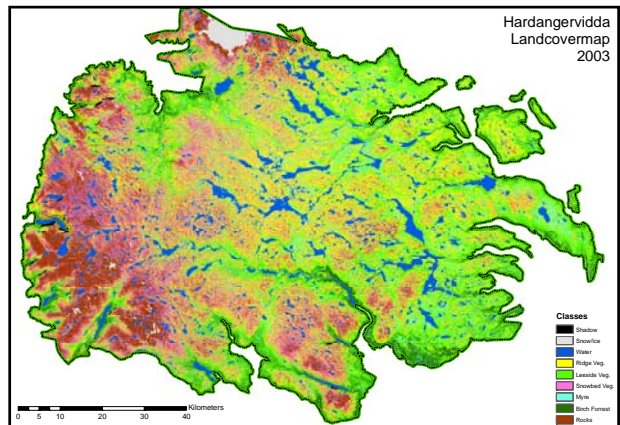
Auxiliary data used through definition of homogeneous sub areas (relative elevation and snow coverage in June) with specific apriori probabilities- Hig- low terrain, with snow and no snow

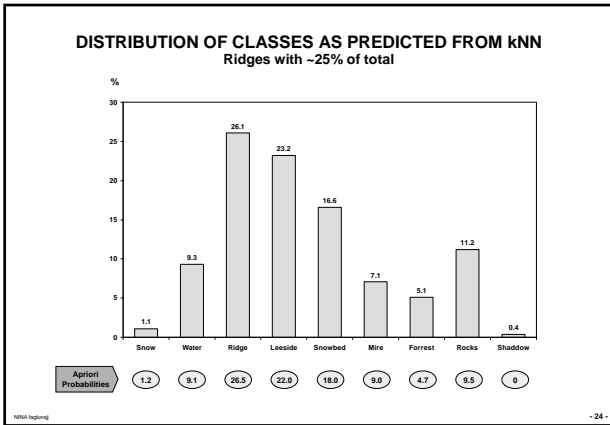
- 21 -

SNOWBED VEGETATION WITH HIGHEST GAIN THROUGH AUXILIARY DATA

Class	Gain in %pt.
Snow	0
Water	0
Ridge	0
Leeside	-1
Snowbed	3
Myr	-6
Forrest	18
Rocks	-1

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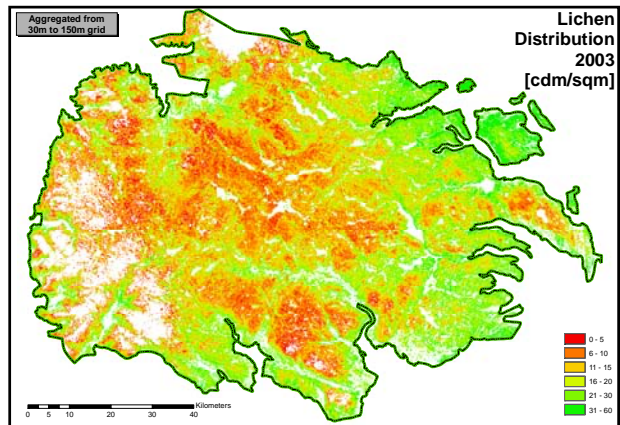
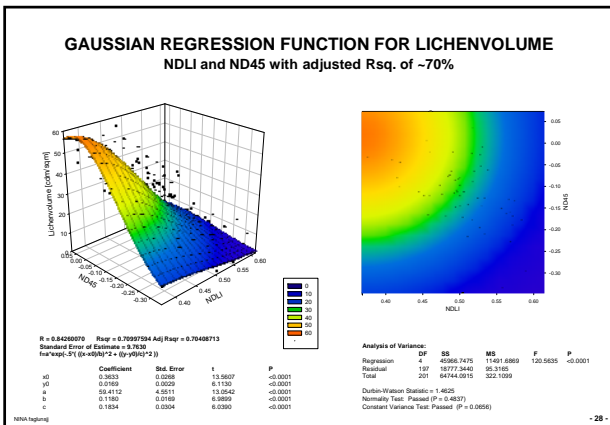
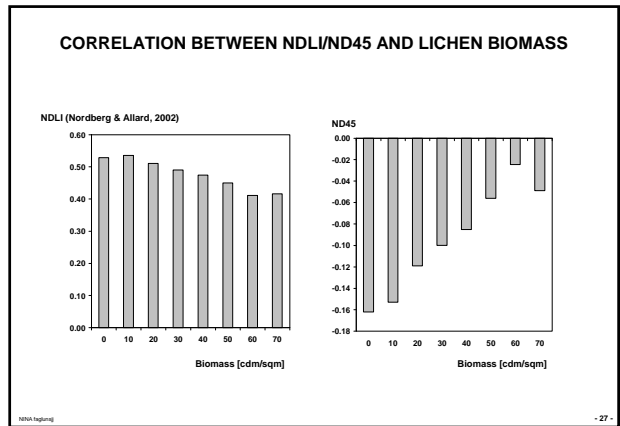


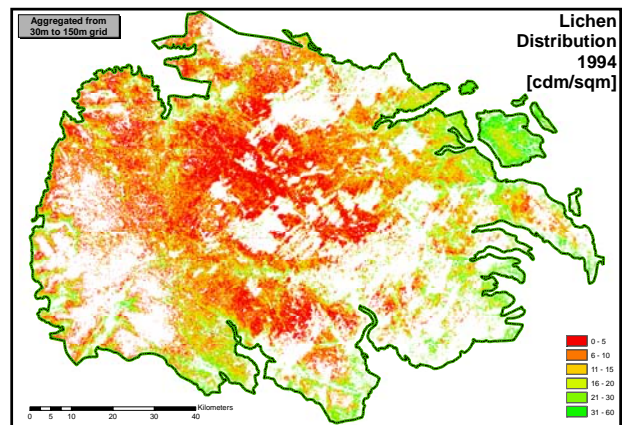
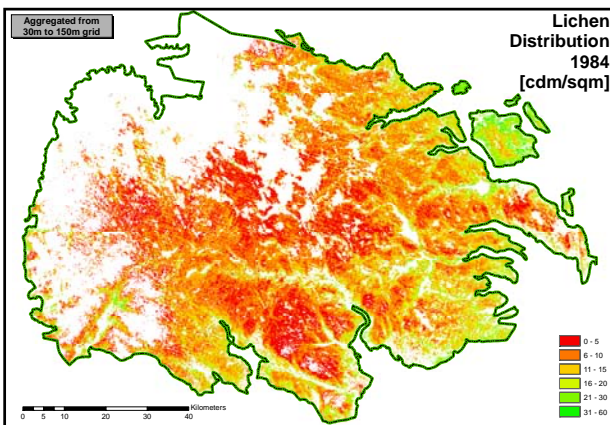
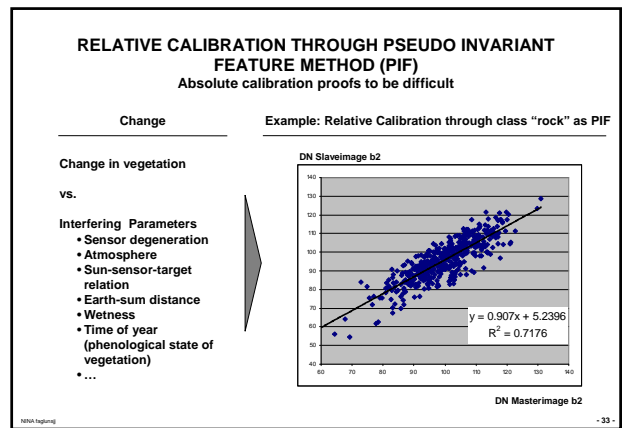
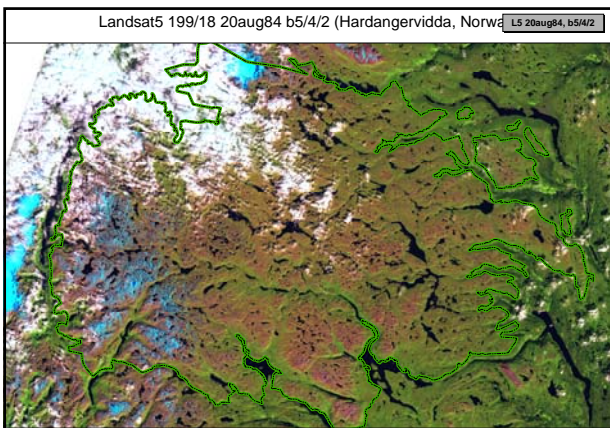
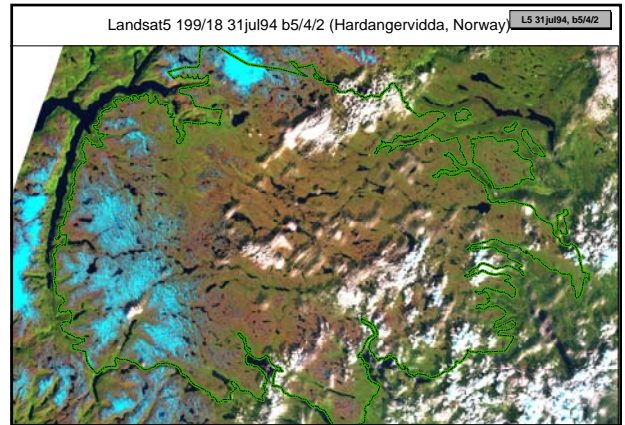
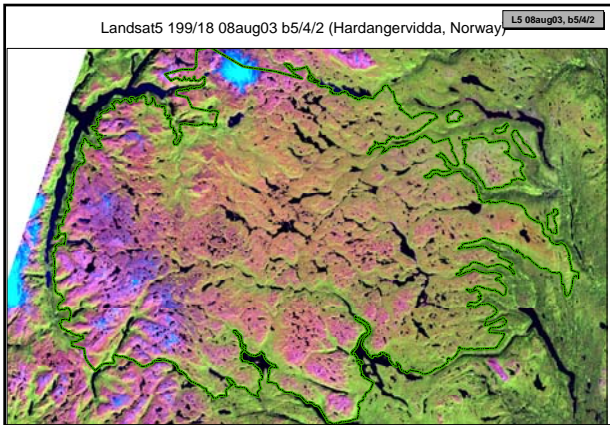
- ### OUR LEARNINGS: KEY SUCCESS FACTORS FOR VEGETATIONMAP
- Reduction of Classes: how many classes are really necessary?
 - Efficient sampling scheme in fieldwork: the more points the better
 - Number of sampling training points should be somewhat proportional to a priori probabilities
 - Educated preprocessing is critical: images and sample points
 - Non-parametric Classifiers superior to parametric
 - kNN with advantage when dealing with heterogeneous classes
 - Auxiliary data especially helpful for snowed Vegetation
- NMA (upgms) - 25 -

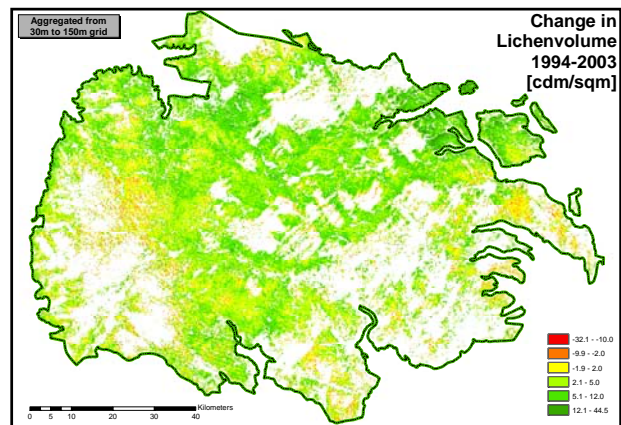
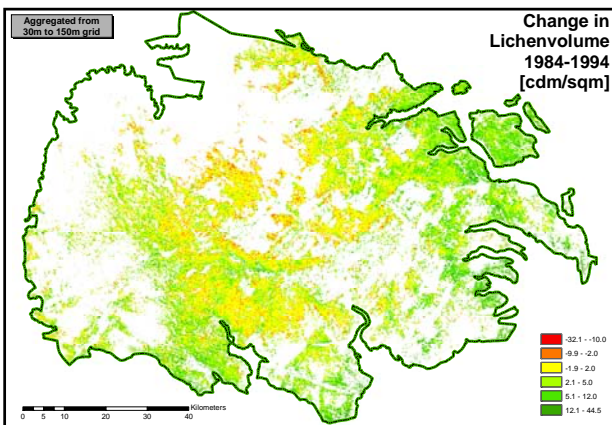
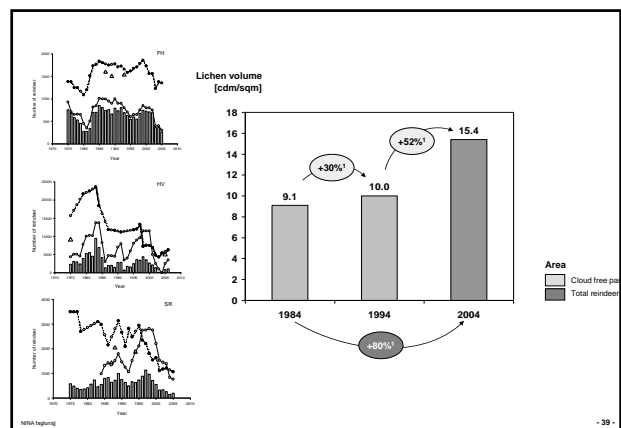
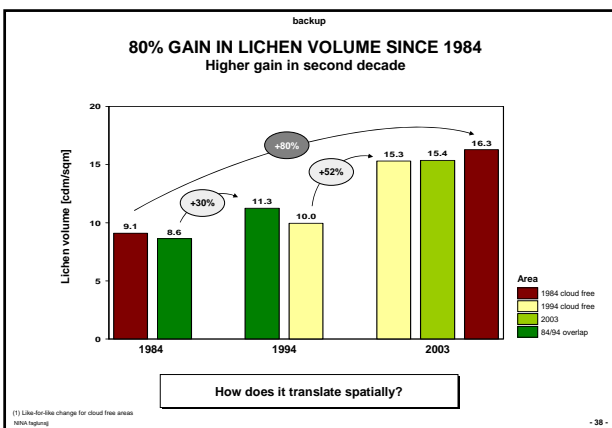
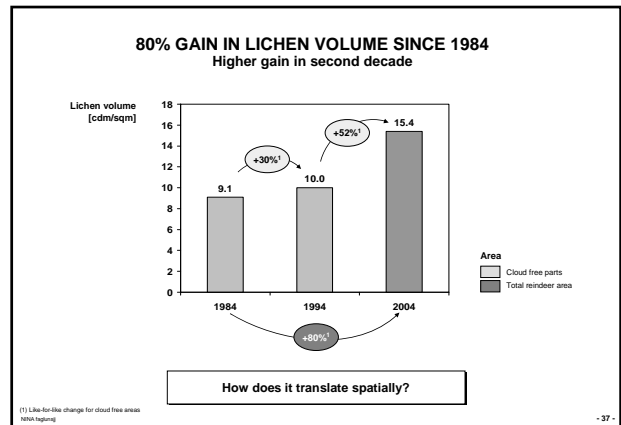
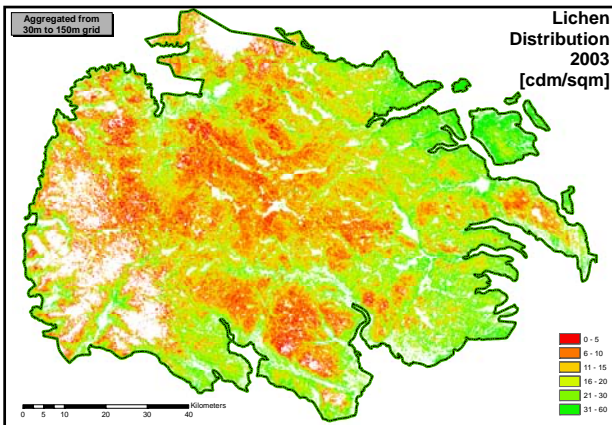
AGENDA

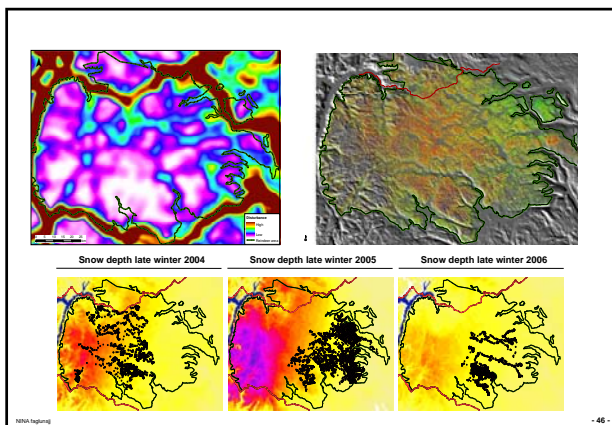
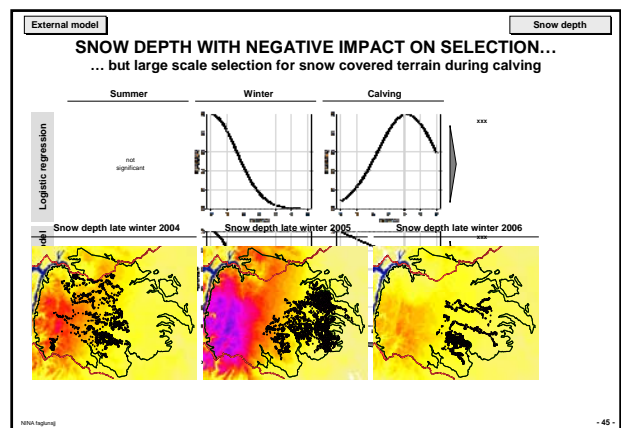
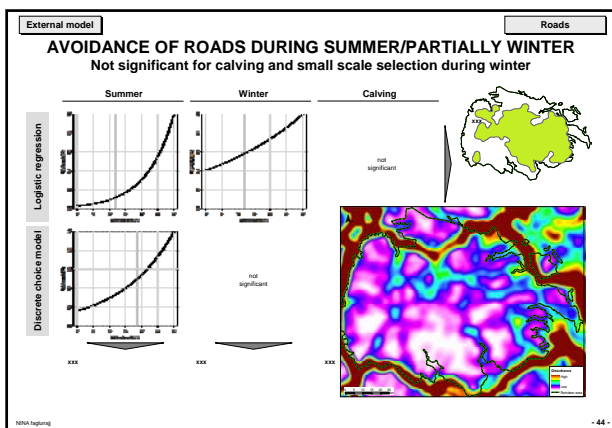
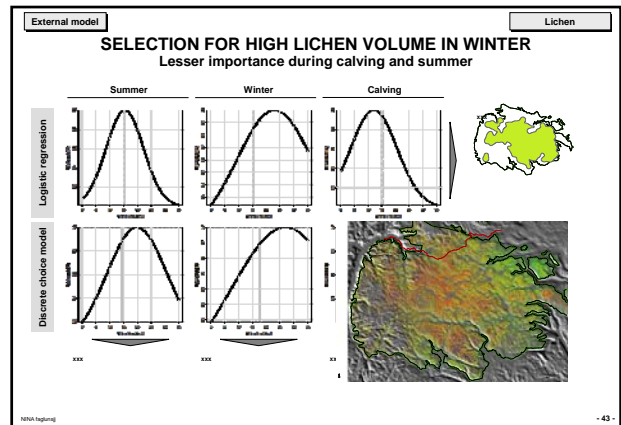
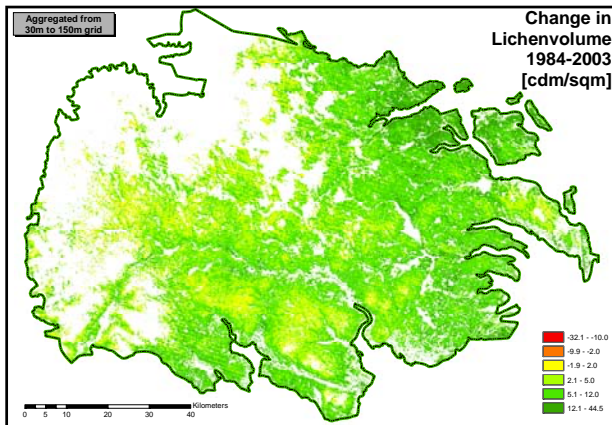
- Land cover mapping
- Estimation of lichen biomass
- Change detection
- Discussion

NMA (upgms) - 26 -









- ### Oppsummering lett blanding av + og -
- Repeterbarheten er stor- produsent uavhengighet
 - Habitatklassene og biomasse målet i lavbeitene hadde betydelig forklaringssevne i habitatassosiasjonsmodeller på HV - (30 meter og de klassene vi har benyttet fungerer på rein)
 - Estimering av biomass er mulig, men en bør ta et utvalg av bakkepunkter for å teste sammenhengen mellom de to indeksene og bakkemålinger dersom en skal ekstrapolere ut i nye områder
 - L5 er billige bilder, dekker store områder, muliggjør retrospektive analyser, men det er en utfordring å finne gode bilder- været er en utfordring, gjelder også andre bilder med høyere oppløsning som må bestilles- dette kan ta tid
 - Vanskelig å finne gode bilder! - kan være lettere i de andre områdene!
 - Må teste lavindeksene på beiter som avviker mye fra reinens beitetilbud på HV, (mye større - vs mye mindre biomasse)
 - Krever en viss mengde bakke data som må hentes inn fra hvert område
 - Av betydelig interesse å teste hvor generelle resultatene er, e.g. lage modell for et område, deretter hente test data.
- NINA Høgskolen
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