Landscape history and land use in SW Norway – comparative insights from a parallel universe

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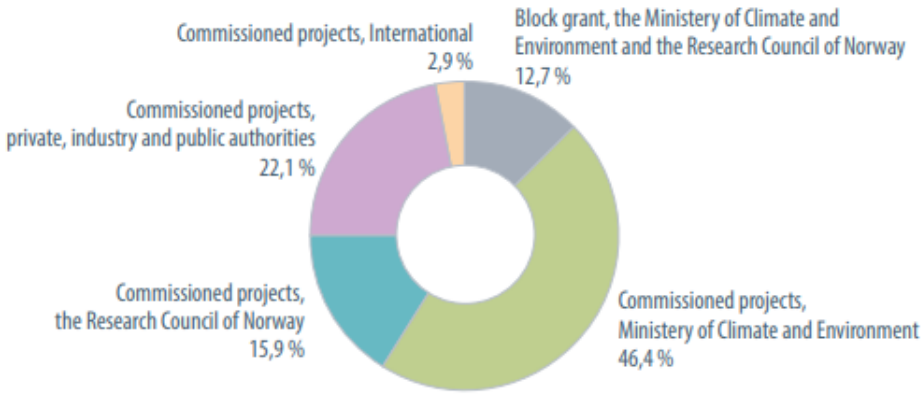
NINA´s turnover 2019



Total turnover: 43,6 mill. EUR

NINA's key statistics for 2019

Number of employees	2019	2018
Total	278	265
- scientific staff	192	171
- women	37,8 %	34,9 %
- women in scientific positions	34,0 %	31,9 %
- women on doctoral programs	44,4 %	44,4 %

Number of employees (full-time equiv.)	2019	2018
Total	272	256

Number of publications	2019	2018
Scientific papers	273	244
NINA Reports	136	156
External lectures and presentations	471	518
Media coverage	2671	2570
News stories published at nina.no	116	117
Unique visitors to nina.no website	222 000	200 000

The Norwegian Institute for Nature Research, NINA, is an independent research foundation focusing on nature, and the interaction between nature and human society.

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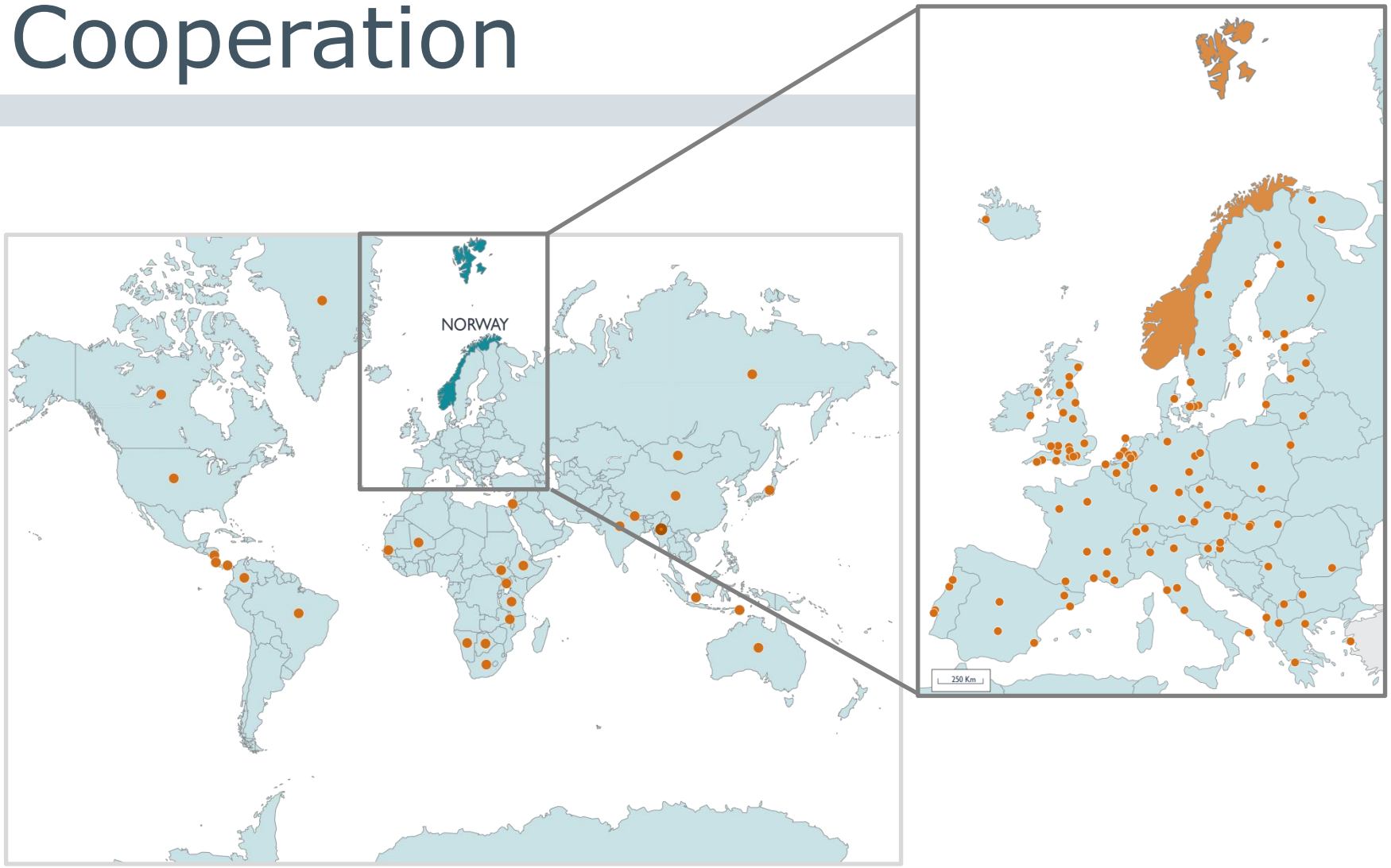
Cooperation



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Hjortevilt

Om Hjorteviltportalen Kontakt Høykontrast a A Sidekart Søk

Portalen for alt om elg, hjort, villrein og rådyr

Hjem | Elg | Hjort | Rådyr | Villrein | Jakt | Forvaltning | Forskning | Vilt og trafikk | Arealbrukskonflikter | Hjorteviltregisteret

Nyhet Villrein 10. november 2015

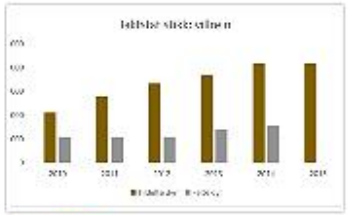
Ønsker velkommen til boklansering

I 50 000 år har mennesker og villrein levd i tett relasjon med hverandre. Nå har vi for første gang anledning til å ta en titt inn i villreinens personlige fotoalbum. Les saken...

Nyhet 09. november 2015

Hvilke etapper hadde en hjort vunnet i triatlon?

I forrige uke gikk Naturdatas viltkonferanse av stabelen. Der fikk tilhørerne nyte et variert program som tok for seg både utvidet jaktid på elg og hjortens ferdigheter i triatlon. Les saken...



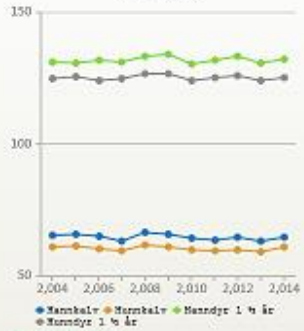
Nyhet Villrein 27. oktober 2015

Dobling i fellingstillatelser på villrein på fem år

I 2015 ble det totalt tildelt en kvote 20 912 villrein fordelt på de 23 villreinområdene. Det er en dobling fra 2010, da tildelingen var på 10 521 dyr. Les saken...

http://hjortevilt.no/

Gå til HJORTEVILTREGISTERET



Vis større diagram

Slaktevektene for elgen på landsbasis har hatt en nedadgående trend fra starten av perioden (2004) og frem til 2013. I
fylker og på landsb
vektene fra 2013 t
kommune, besøk H

Kontakt oss

Har du tips til saker
Hjorteviltportalen?
Send en e-post til

Årshjul

Frister og perioder

Journal of Animal Ecology

British Ecological Society

Journal of Animal Ecology 2008, 77, 958–965 doi: 10.1111/j.1365-2656.2008.01427.x

An efficient multivariate approach for estimating preference when individual observations are dependent

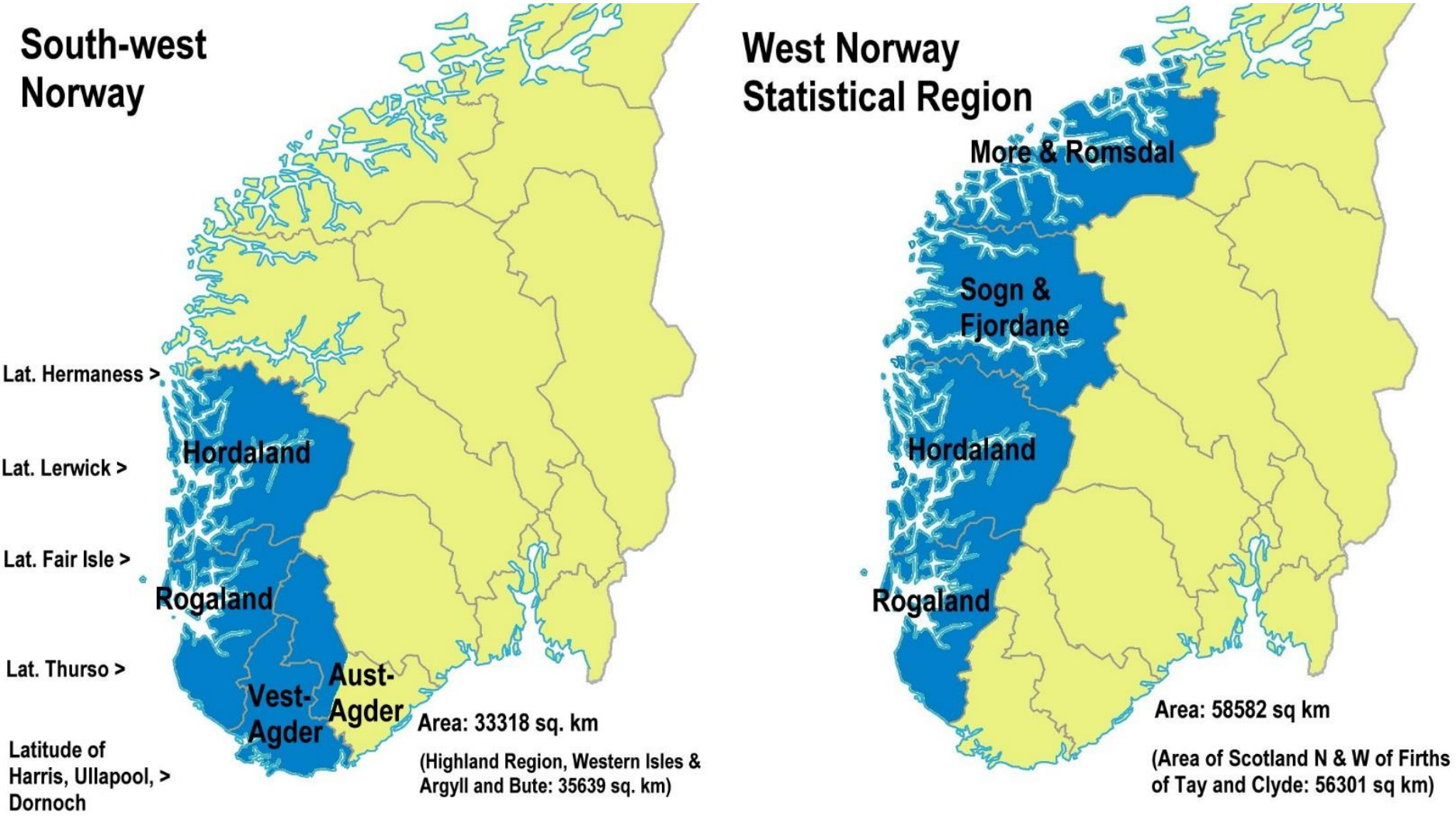
Steinar Engen[1]*, Vidar Grøtan[2], Duncan Halley[3] and Torgeir Nygård[3]

[1]*Centre for Conservation Biology, Department of Mathematical Sciences, Norwegian University for Science and Technology, N-7491 Trondheim, Norway;* [2]*Centre for Conservation Biology, Department of Biology, Norwegian University for Science and Technology, N-7491 Trondheim, Norway; and* [3]*Norwegian Institute for Nature Research, NINA, N-7485 Trondheim, Norway*

Summary

1. We discuss aspects of resource selection based on observing a given vector of resource variables for different individuals at discrete time steps. A new technique for estimating preference of habitat characteristics, applicable when there are multiple individual observations, is proposed.
2. We first show how to estimate preference on the population and individual level when only a

Geographical Definitions



Oslibakken near Stavanger, 1911

West Norway, 1944

Old peat digging with bog pine roots, west Norway, 1917

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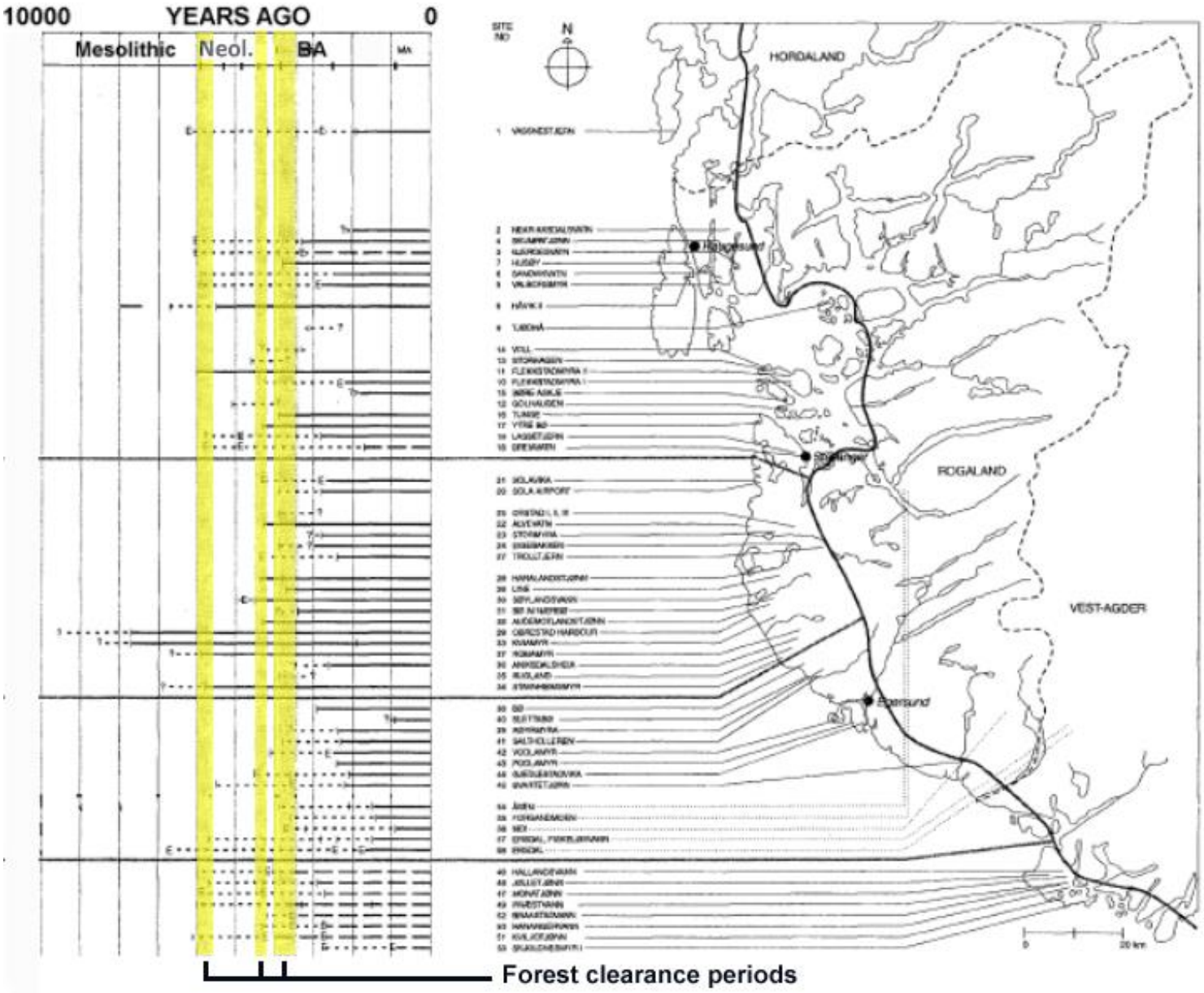
Industrial scale peat production on Fedje island near Bergen, 1903. The peat was transported to the quayside by train. This was the main source of domestic and industrial fuel in Bergen in the later 19th and early 20th centuries.

Peat cuttings and drying stacks in Jæren (coastal plain near Stavanger). Kitty Kielland, oil on canvas, 1900

Peat was the main source of domestic fuel in coastal Norway for many centuries.

This was due to the lack of wood in the region, **conversion to open heathland being «substantially complete by the Bronze Age»**.

This open landscape was **«anthropogenic in origin»**, due primarily to the effects of grazing and associated activities such as muirburn and use for firewood (Prøsch-Danielsen & Simonsen 2000).



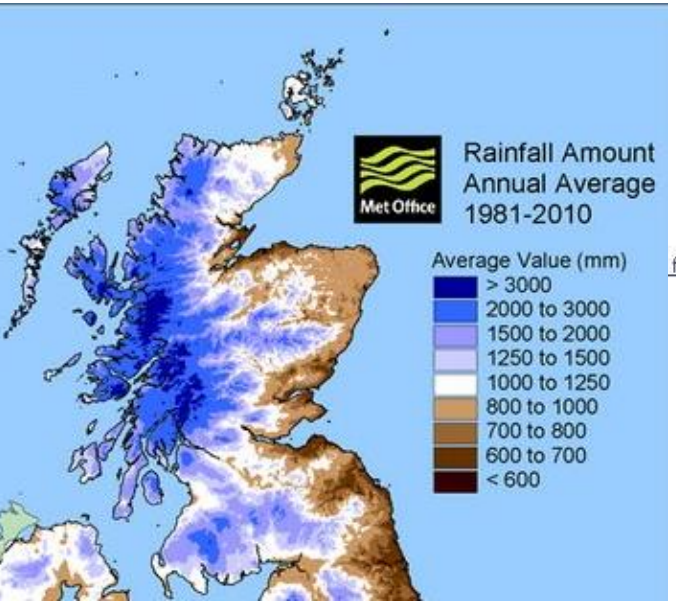
Age of final establishment of heathland, or grassland/ permanent infields, in coastal SW Norway

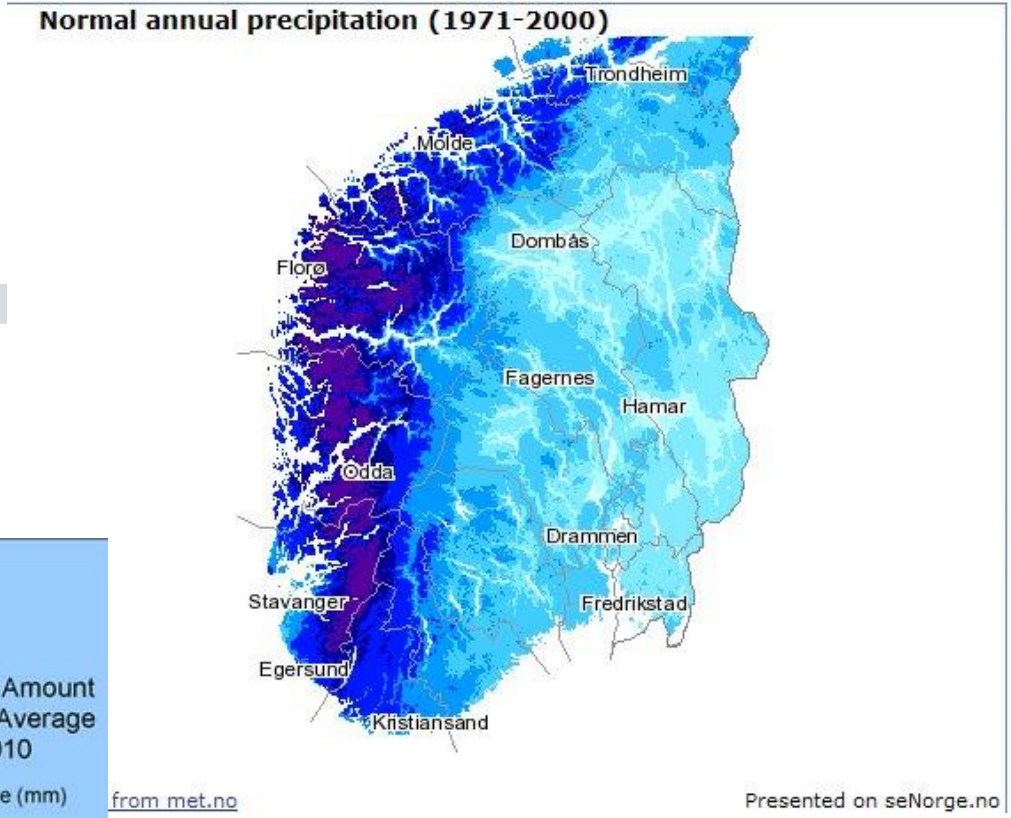
Yellow: Forest clearance periods. ***Dotted line,*** deforestation in progress; ***solid line,*** final heath establishment; ***dashed line,*** grassland and permanent infields. Prøsch-Danielsen & Simonsen 2000. Veget. Hist. Archaeobot. 9:189-204.

A note on terminology

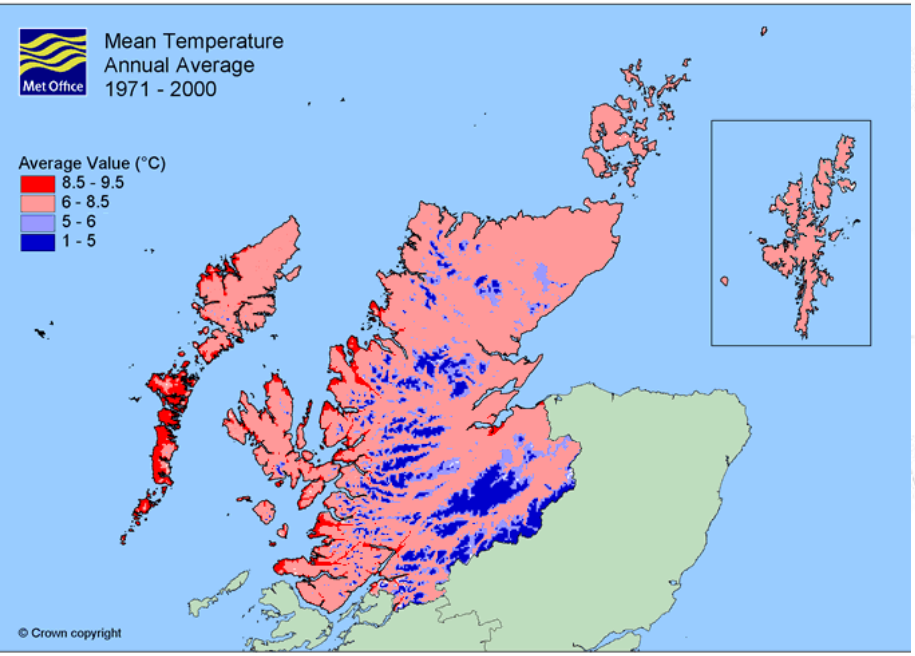
- Norwegians and Scots do not classify the landscape in the same way, either in colloquial speech or in formal (e.g.) habitat classifications
- For example, the two Norwegian words commonly translated as 'moor' ('myr' and 'hei') are not the same things as Scottish moors, except in that they are mainly open habitats
- Treating them as synonyms can and does lead to much confusion and to false inferences (for example in comparisons between Norwegian coastal heaths, and Scottish moors, historically managed very differently, and for different purposes, since the 18th century at least)
- Another example is 'landbruk', usually translated as 'farming'
- It is however a wider term - *landbruk* 'historically always devoted itself to value creation from all available natural resources' (Per Skorge, Secretary General Norwegian Farmer's Association, 2017).
- Land uses traditionally considered quite separate in Scotland, for example timber extraction, hunting, fuelwood, etc. are all included in the term 'landbruk'. Multiple economic uses from the same piece of land are the norm in Norway; in Highland Scotland one overwhelmingly dominant use is currently the norm.
- Care is needed when discussing with Norwegians that you are really discussing the same thing!

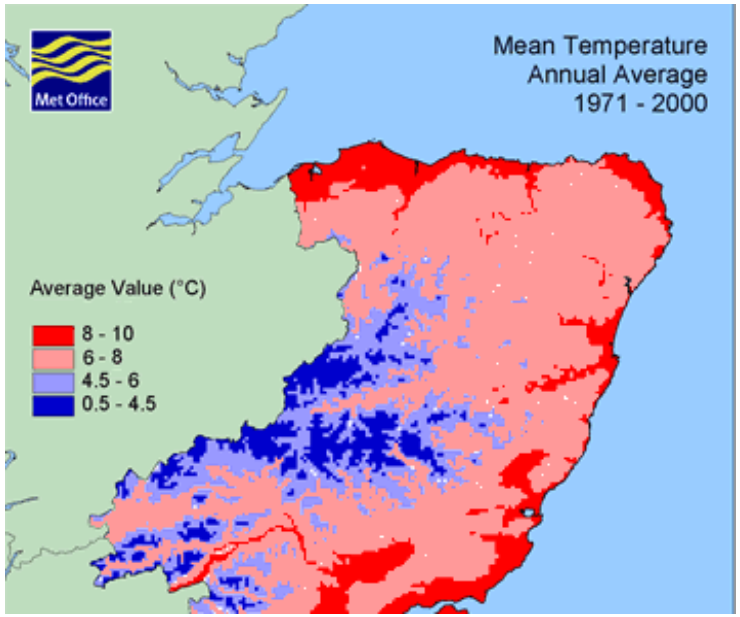
Climate comparisons

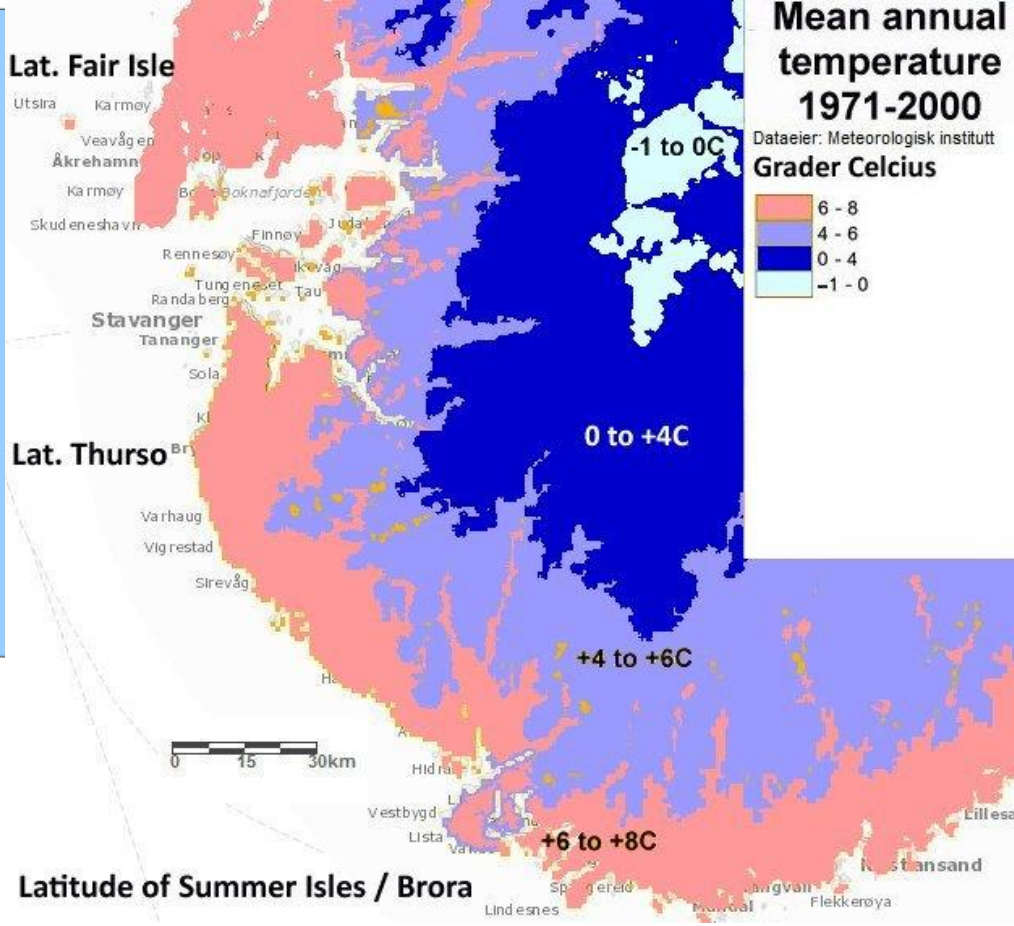


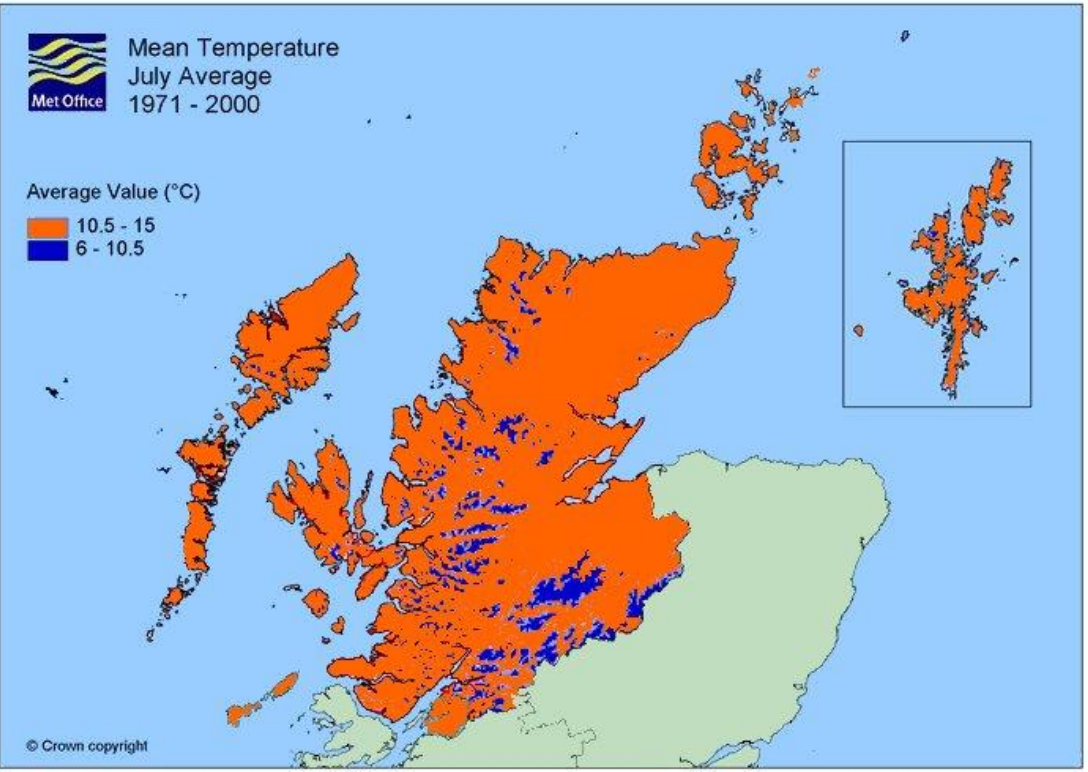


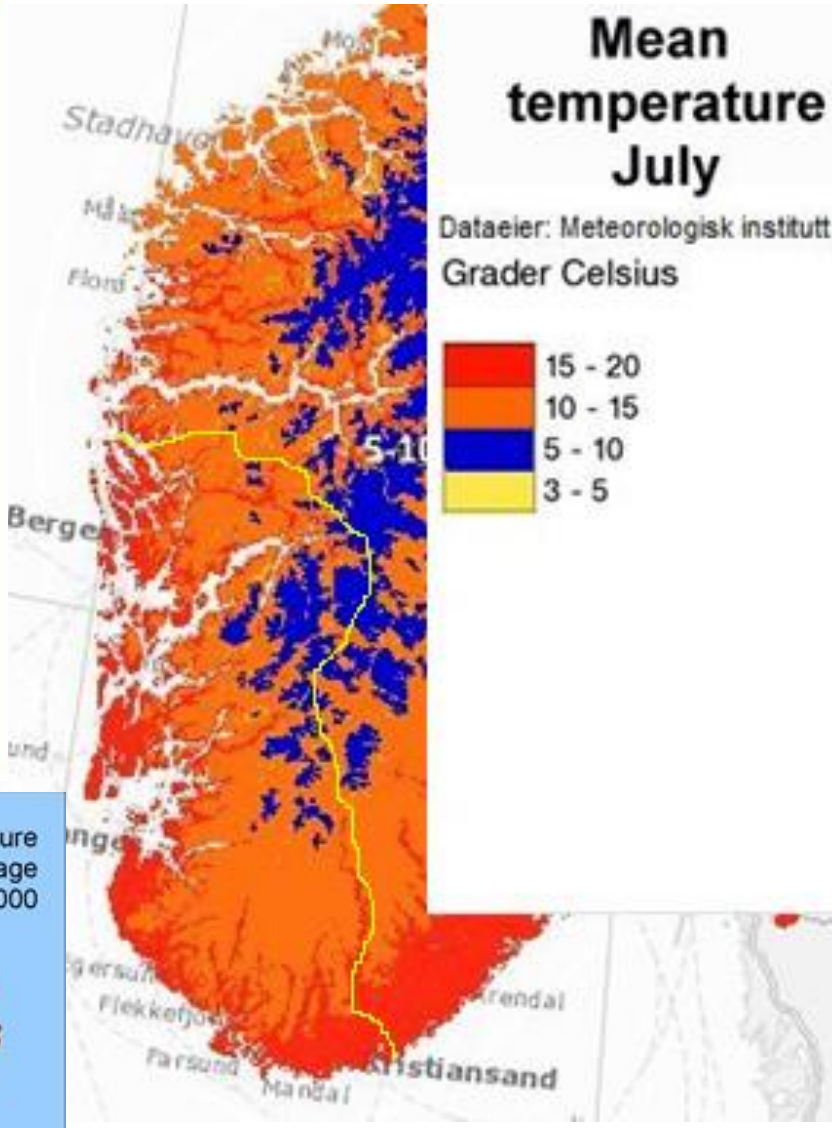
(maps to scale and in correct relative positions)

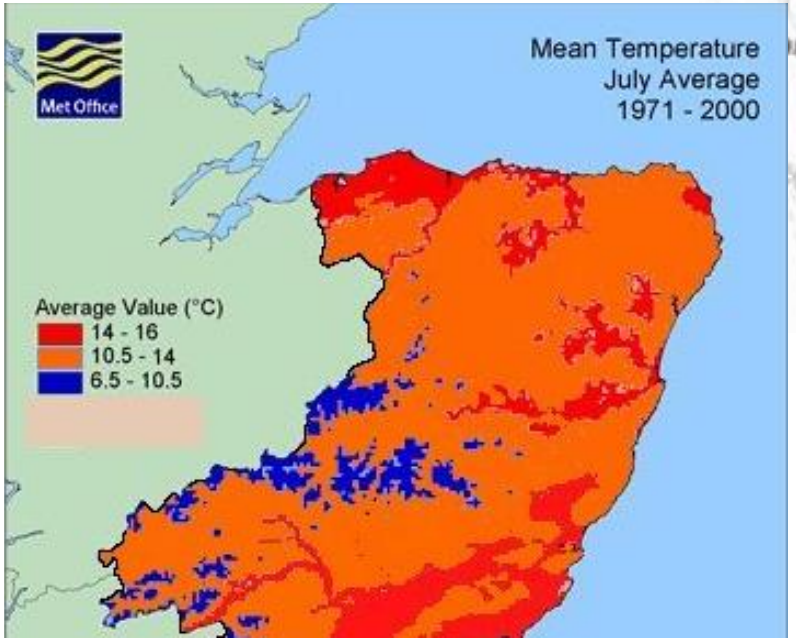

Mean Temperature
Annual Average
1971 - 2000
Average Value (°C)
8.5 - 9.5
6 - 8.5
5 - 6
1 - 5
© Crown copyright


Mean Temperature
Annual Average
1971 - 2000
Average Value (°C)
8 - 10
6 - 8
4.5 - 6
0.5 - 4.5


Lat. Fair Isle
Lat. Thurso
Latitude of Summer Isles / Brora
Mean annual temperature 1971-2000
Dataeier: Meteorologisk institutt
Grader Celcius
6 - 8
4 - 6
0 - 4
-1 - 0
-1 to 0C
0 to +4C
+4 to +6C
+6 to +8C
Stavanger
Tananger
0 15 30km







www.nina.no

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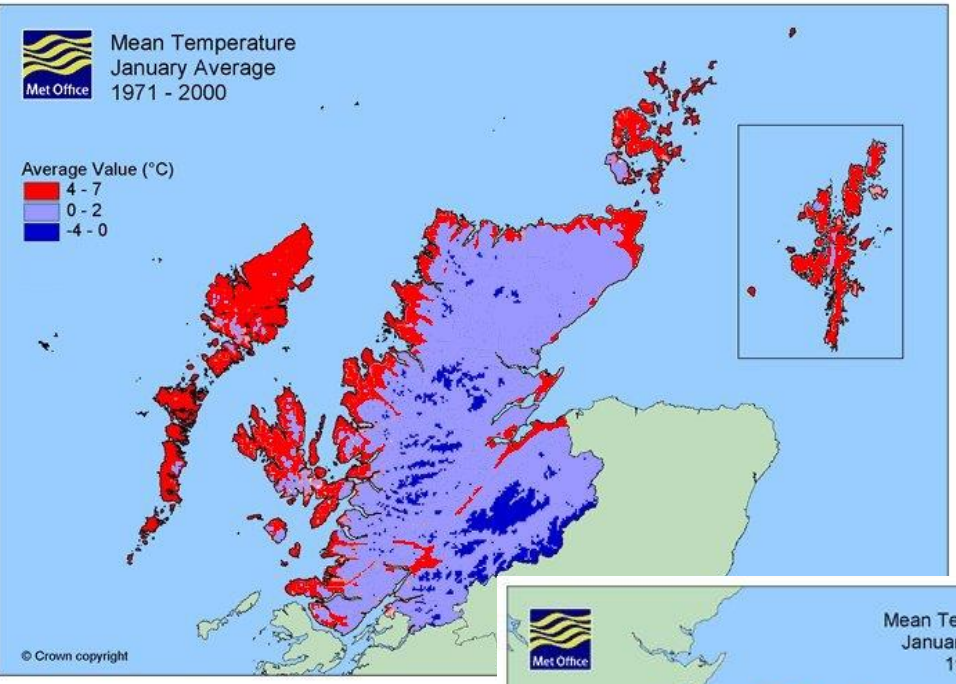
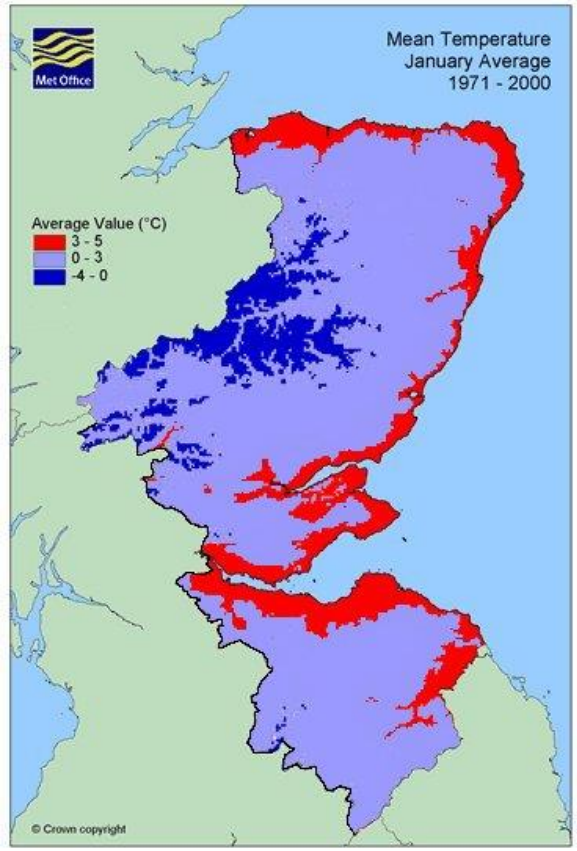
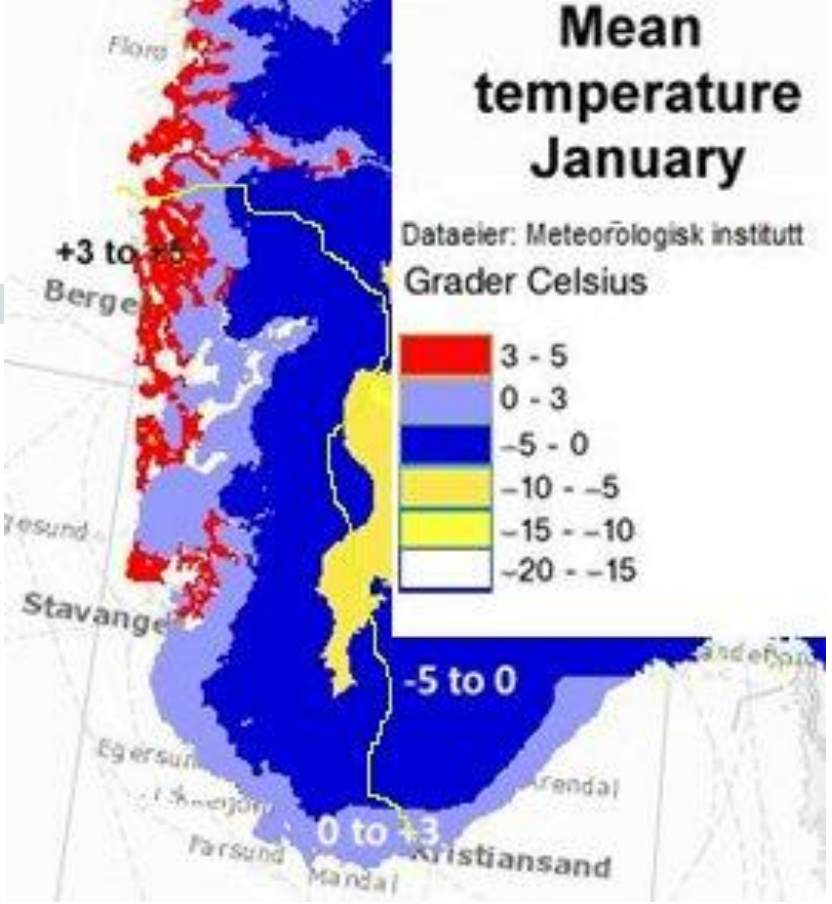

Mean Temperature
January Average
1971 - 2000
Average Value (°C)
4 - 7
0 - 2
-4 - 0
© Crown copyright


Mean Temperature
January Average
1971 - 2000
Average Value (°C)
3 - 5
0 - 3
-4 - 0
© Crown copyright


Mean temperature January
Dataeier: Meteorologisk institutt
Grader Celsius
3 - 5
0 - 3
–5 - 0
–10 - –5
–15 - –10
–20 - –15
+3 to +5
Stavanger
-5 to 0
0 to +3
Kristiansand

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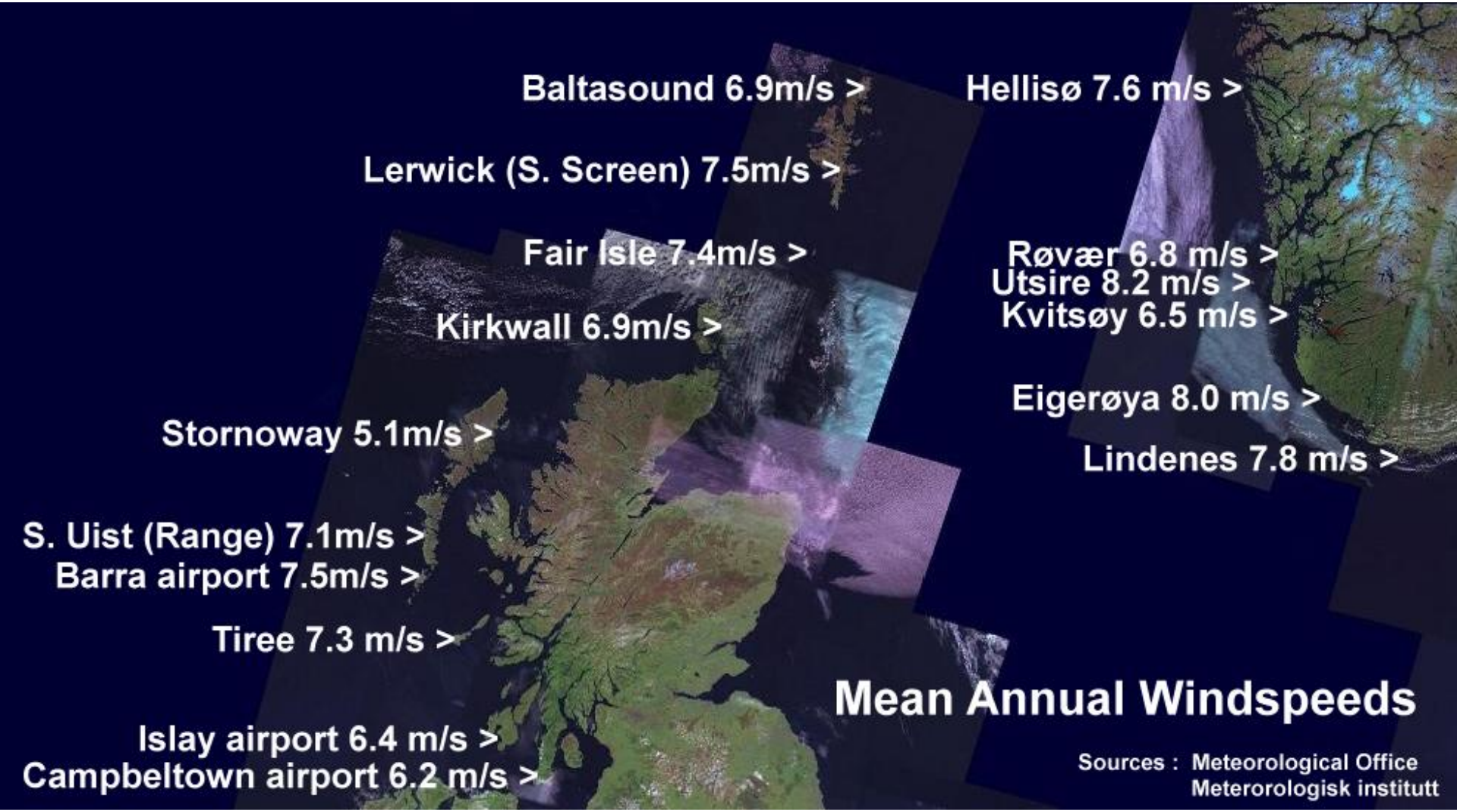
Baltasound 6.9m/s >
Hellisø 7.6 m/s >
Lerwick (S. Screen) 7.5m/s >
Fair Isle 7.4m/s >
Røvær 6.8 m/s >
Utsire 8.2 m/s >
Kvitsøy 6.5 m/s >
Kirkwall 6.9m/s >
Eigerøya 8.0 m/s >
Stornoway 5.1m/s >
Lindenes 7.8 m/s >
S. Uist (Range) 7.1m/s >
Barra airport 7.5m/s >
Tiree 7.3 m/s >
Mean Annual Windspeeds
Islay airport 6.4 m/s >
Campbeltown airport 6.2 m/s >
Sources : Meteorological Office
Meterorologisk institutt

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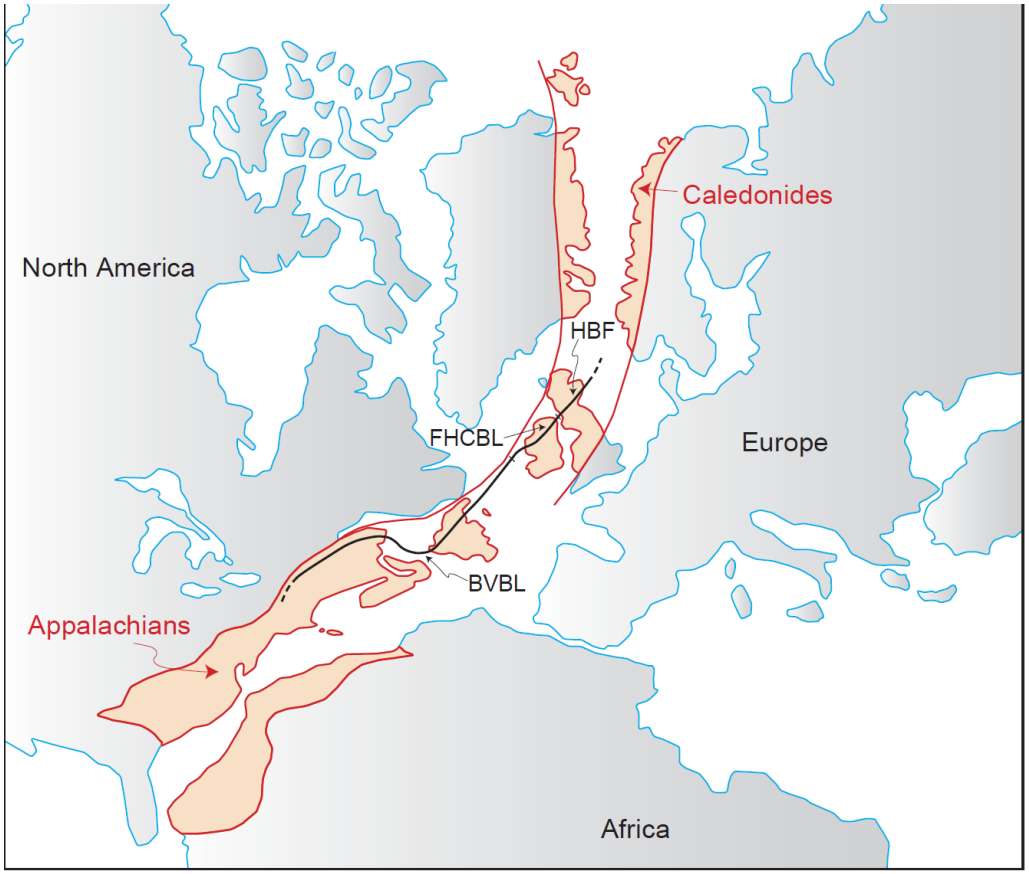
Geology



Caledonian orogeny

Figure 1. Schematic plate reconstruction at the end of the Caledonian orogeny, c. 390myBP (Chew 2005)

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Land cover history, climate, and geology: Summary

- SW Norway has (as Highland Scotland) been largely deforested for centuries; in coastal districts (as Highland Scotland), for millennia.
- Research indicates this was caused by the cumulative effects of livestock grazing and associated land uses, such as muirburn and felling for timber and fuel.
- Data on climate is comprehensive, standardised, publically available, and consists of precisely quantifiable physical measurements collected by the respective Met Offices.
- It indicates that climates of SW Norway and Highland Scotland are very similar: highly oceanic, mild, and wet; precipitation varying strongly depending on topography and rain shadow effects.
- Winds as measured at the west coast are overall slightly stronger in SW Norway. Some parts of SW Norway are wetter than anywhere in Scotland.
- The geology of the two areas is also very similar. Hard, volcanic or metamorphic rocks, largely from the same mountain building episodes, predominate. Soils are generally infertile.

See also presentations in
https://www.nina.no/english/Fields-of-research/Projects/Land-use-in-Norway-and-Scotland

(In the 1920s-30s) **"it was commonly believed that our forests would soon no longer exist, and initiatives were implemented to counteract the deforestation" (Statistics Norway, introduction to forestry statistics).**

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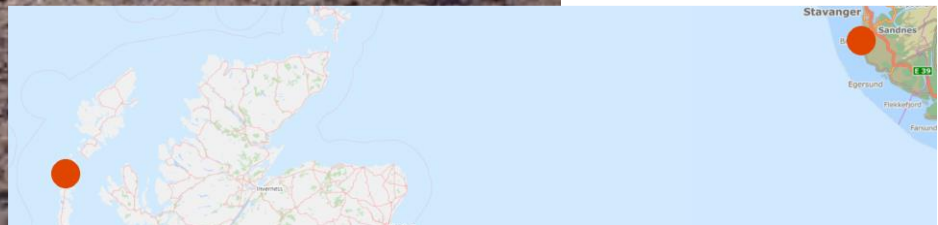
Norsk institutt for naturforskning

(NB the claim occasionally advanced in Scotland that N&W Scotland are of 'comparatively subdued relief' compared to *all* of S&W Norway, and this relief is why N&W Scotland does not currently have regeneration of woodland while S&W Norway does, is clearly untrue- see this and many other photos in this presentation; or any medium scale + map, e.g www.norgeskart.no)

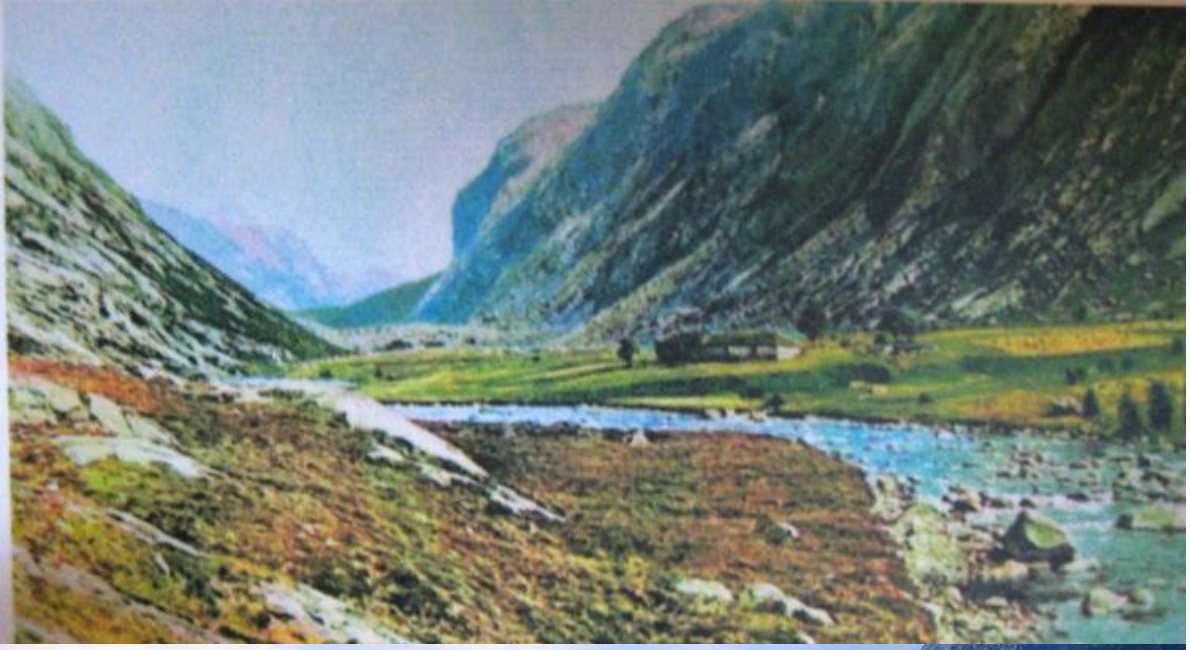
N. Uist

Jæren

(both early 20th Century)



Peat cutting in the mid 20th Century



Fidjadalen

Fidjadalen 2015

http://jarenfri.no/no/steder/friluftsgarden-man/

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Geiranger
(west Norway)

www.tilbakeblikk.no

On high mountain treeline sites in central Norway (>1000m asl), where growth is relatively slow, birch grows out of the range of sheep browsing within 8 years if browsing pressure is low (Speed et al 2011)

Oslibakken near Stavanger, 1911

Oslibakken near Stavanger, 2015

X=approximate point of shot 1911 photograph

1913

2004

Photos: Anders Beer Wilse (1913)
& Oskar Puschmann (2004)

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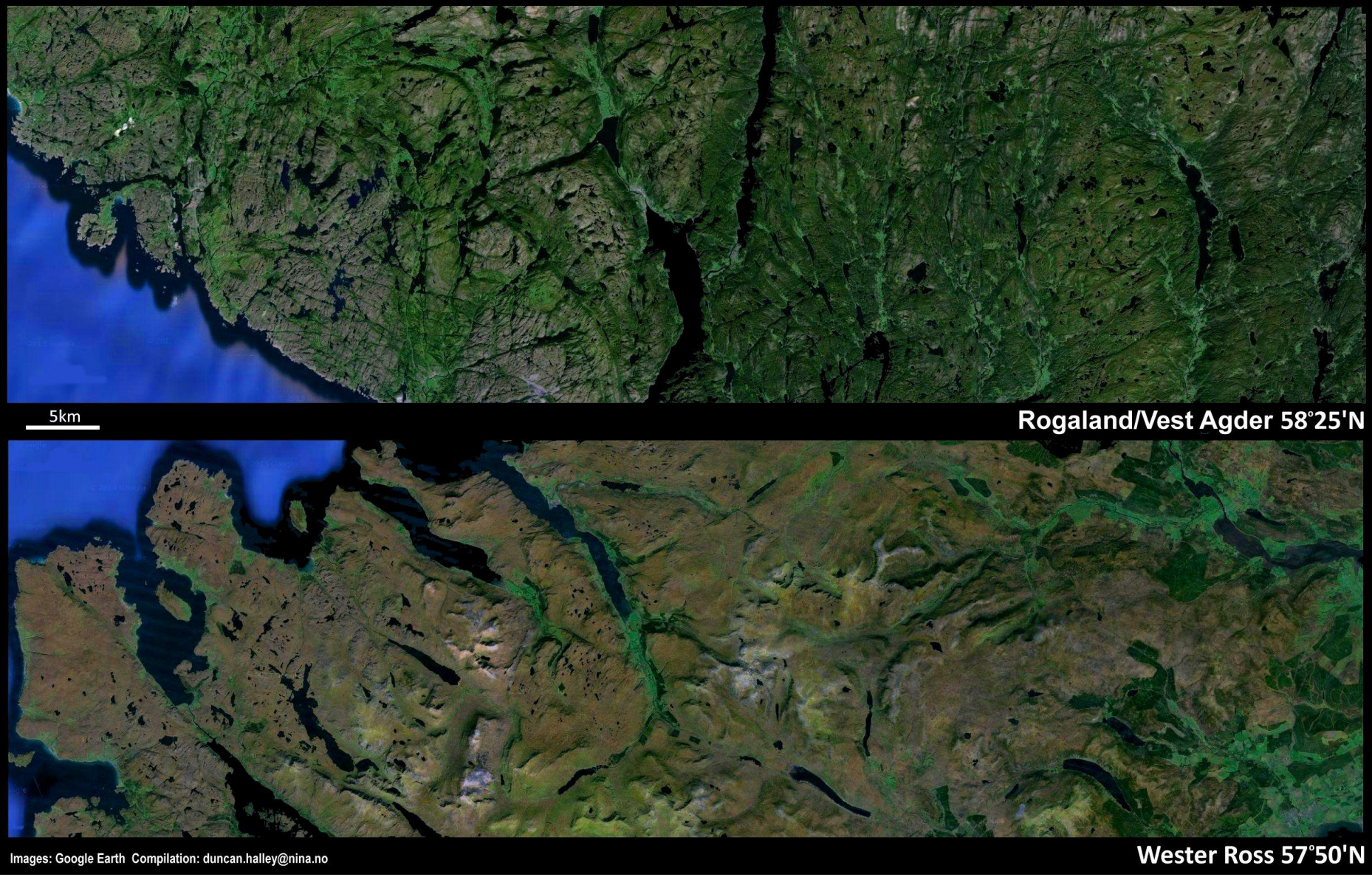
5km
Rogaland/Vest Agder 58°25'N
Images: Google Earth Compilation: duncan.halley@nina.no
Wester Ross 57°50'N

Trends in land cover

Adapted from: *

Anders Bryn , Pablo Dourojeanni , Lars Østbye Hemsing & Sejal O'Donnell (2013) A high-resolution GIStnull model of potential forest expansion following land use changes in Norway, Scandinavian Journal of Forest Research,28:1, 81-98

Forest defined as trees >2.5m high. "Other land cover types" mainly infield farmland and urban.

Input baseline maps: cover as mapped in 2007.

Potential natural forest regeneration

Actual forest cover

Jæren (arable on marine sediments)

Montane scrub and alpine

Other land cover types

0 100km

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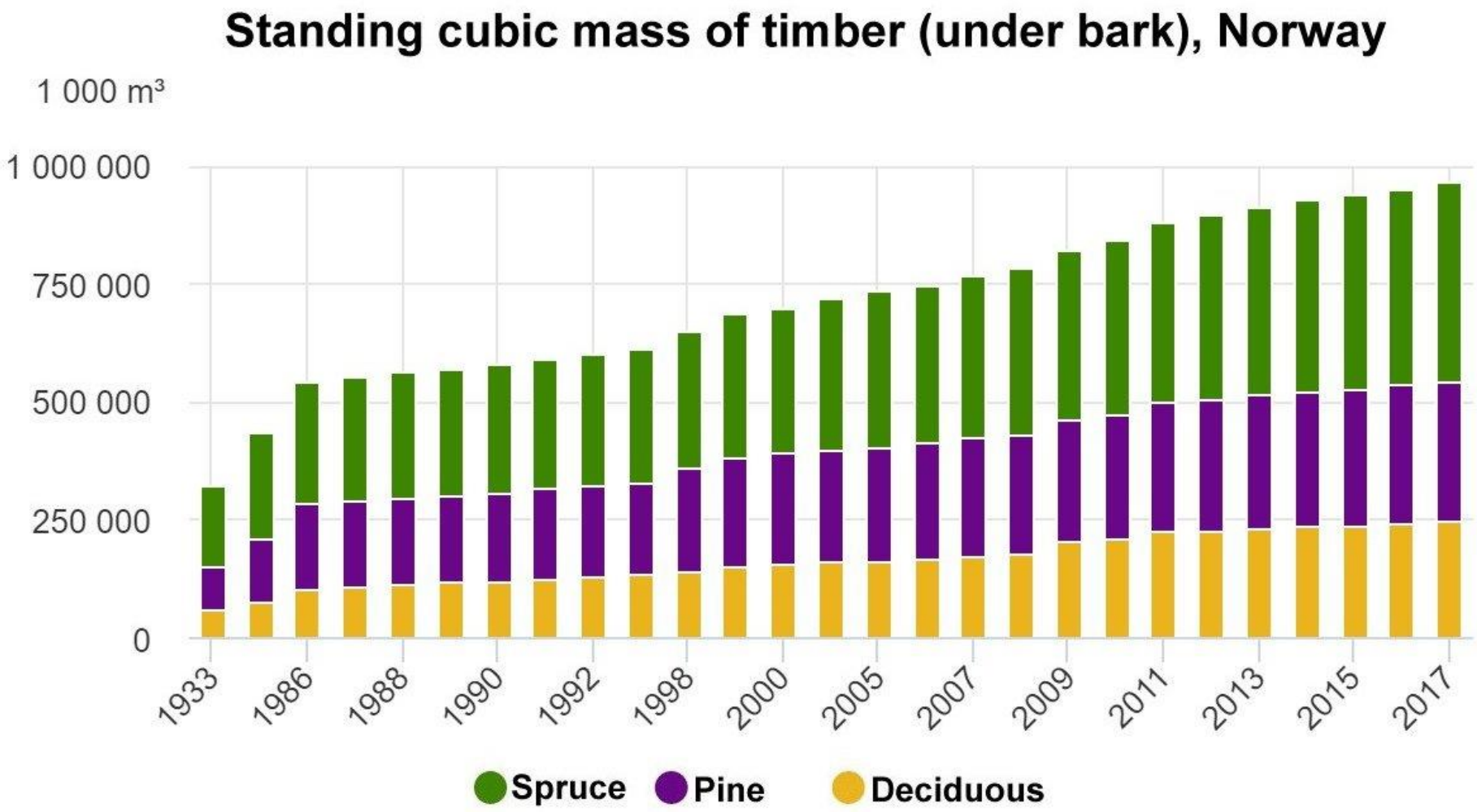
* Montane scrub/alpine and Jæren arable split from "other land cover" category

NB Much of the 'potential natural forest regeneration' mapped is occurring now, but has not reached the >2.5m height threshold. Unless current land use patterns change, almost all of it is predicted to in fact occur in coming decades. Regeneration is due to reductions in grazing pressure and associated land uses (muirburn, firewood collection). In recent years climate change may be marginally affecting the altitude limits of zones, but if so is subordinate to browsing effects (Bryn 2008; Hofgard et al 2010).



Kilde: Norsk institutt for bioøkonomi. Statistisk sentralbyrå, Landsskogtakseringen.

Index values over period(1933=100): spruce 242; pine 329; deciduous 296; overall 299
Spruce & pine increases mainly natural regeneration, partly planting. Deciduous almost entirely natural regeneration.

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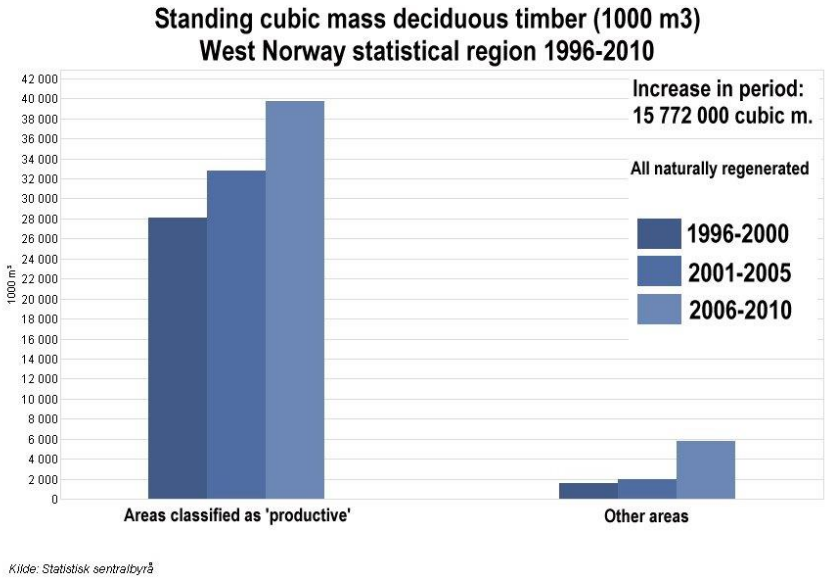
- **The *area* of woodland in West Norway statistical region* increased by >1000km^2 between 2005 and 2012.**
- **This was entirely due to natural regeneration.**
- **The *volume* of deciduous timber in West Norway, all naturally regenerated, has more than doubled over the last 20 years.**

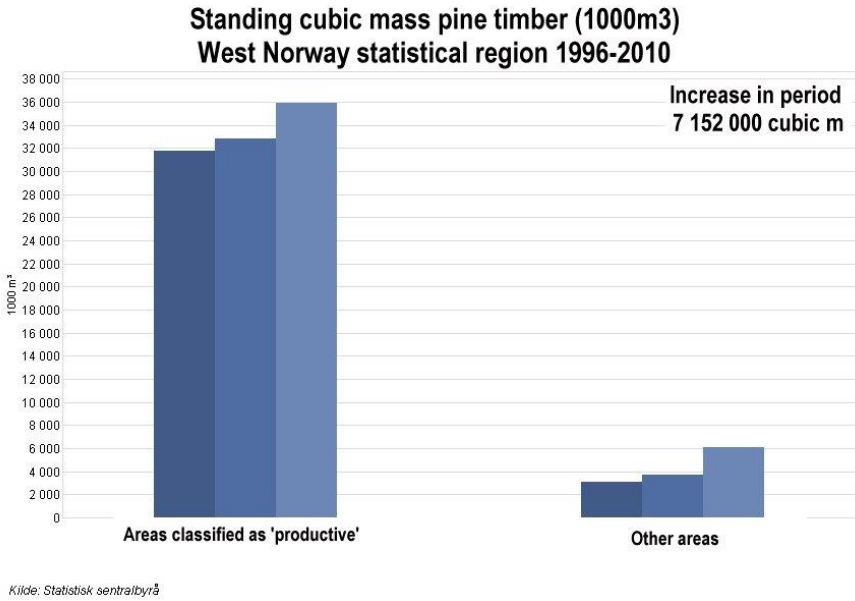
Source: Statistics Norway

*** 62043 km^2; Scotland is 78772km^2**

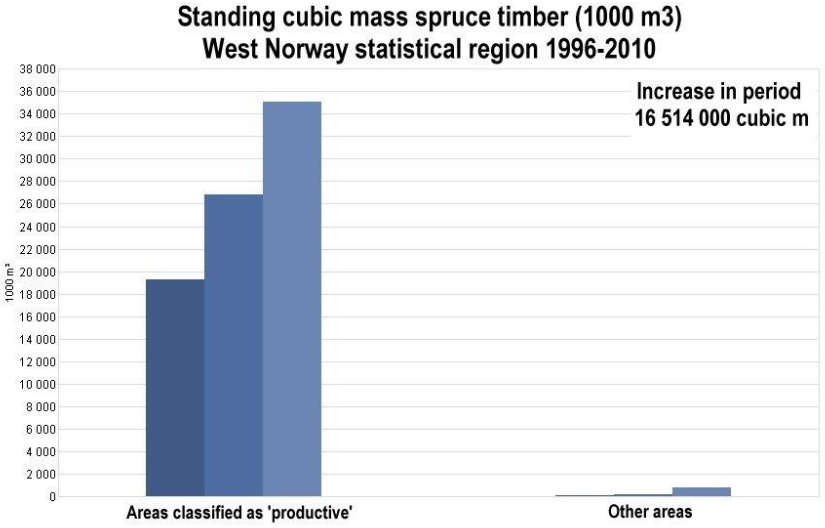
Woodland expansion: standing mass of timber and carbon sequestration in West Norway



Kilde: Statistisk sentralbyrå

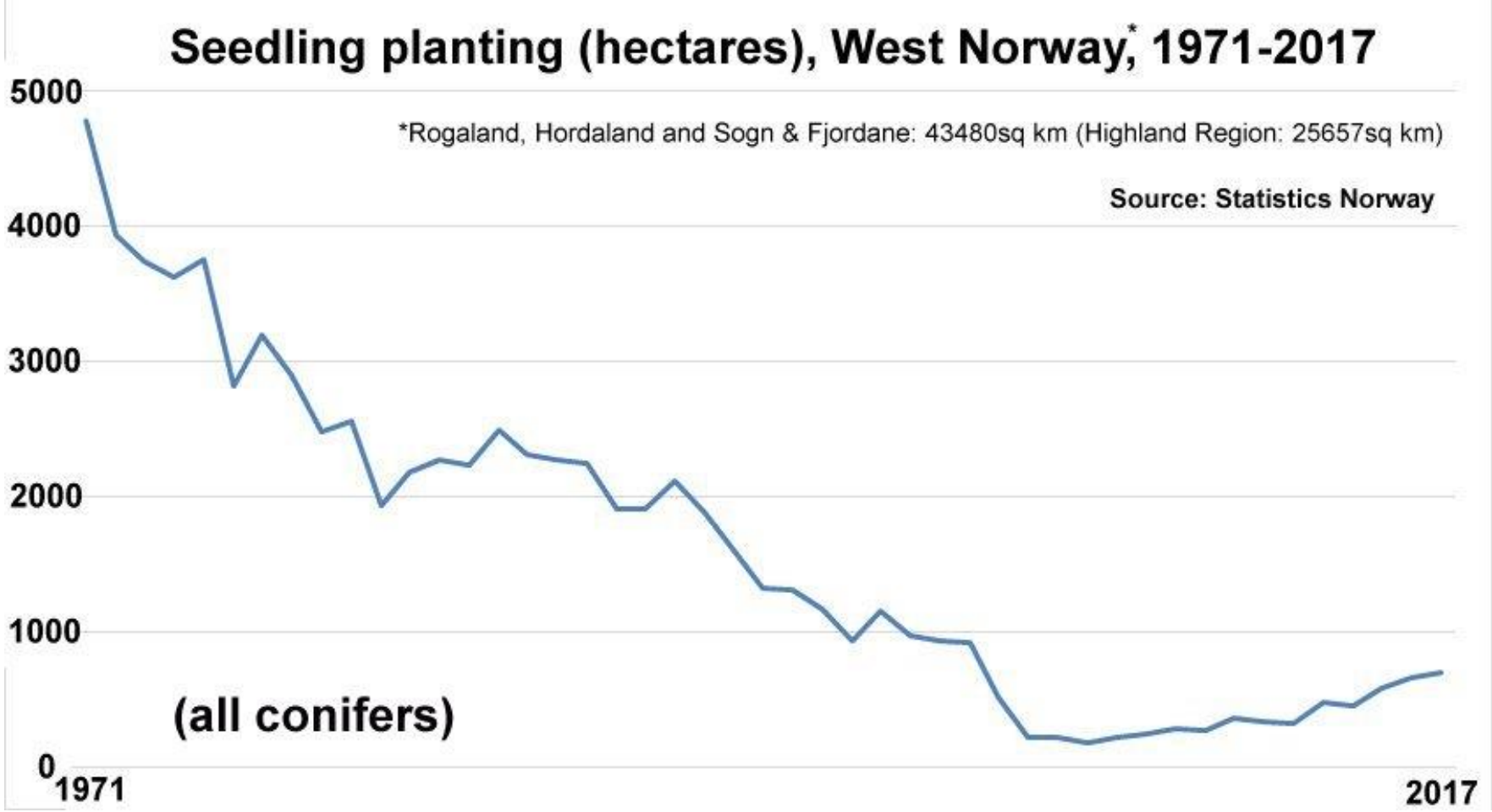


Kilde: Statistisk sentralbyrå



Kilde: Statistisk sentralbyrå

- Annualised increase in standing timber volume 1996-2010: **3 943 800 cubic metres / year**
- Using volume increase ratio 1996-2010 spruce:pine:deciduous (mainly birch) and UK Forestry Commission conversion factors this represents an **annual sequestration of 0.99MtC**
- Notional value, EU CO2 emissions auction price 17/04/23 (€93/tonne CO^2): **€338 million/year**
- Does not include bark, branches, leaves, root system, or soil carbon.
- Scottish Forest Strategy sequestration target:sequester 1.0MtC annually by 2020 through woodland expansion.



- Planting (of commercial conifers) was relatively common in the period of woodland restoration
- Natural regeneration now dominates, even in pure commercial foresty stands
- Farmer-owned woodland is now almost all regenerated naturally
- The Norwegian Forest Law of 2010 requires all owners to ensure adequate regeneration of woodland following any harvest.
- Deer fencing is never used (except on deer farms and along a few busy periurban roads).

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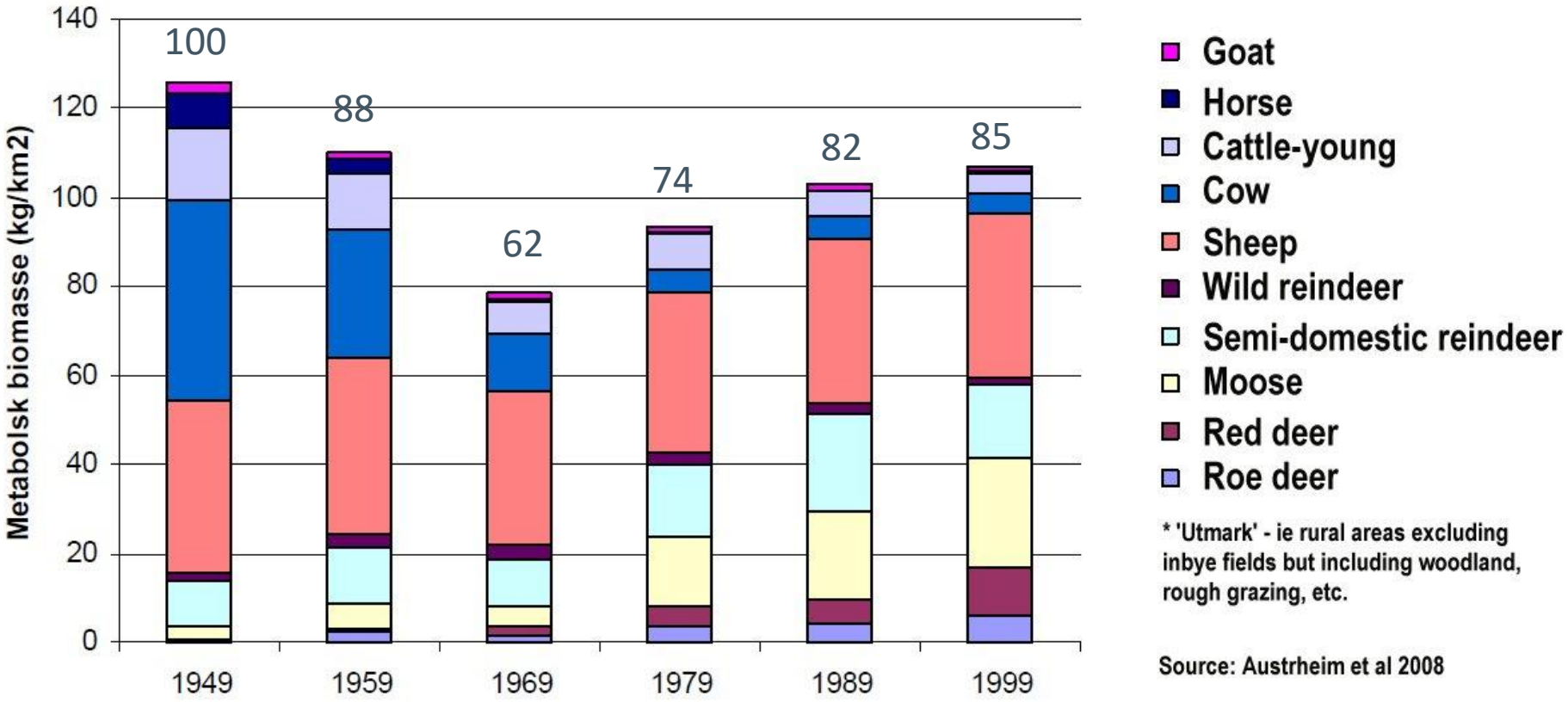
Grazing/browsing pressure, all large herbivores in Norway, 1949-1999. Metabolic biomass per square kilometre (kg/km^2)*



* 'Utmark' - ie rural areas excluding inbye fields but including woodland, rough grazing, etc.

Source: Austrheim et al 2008

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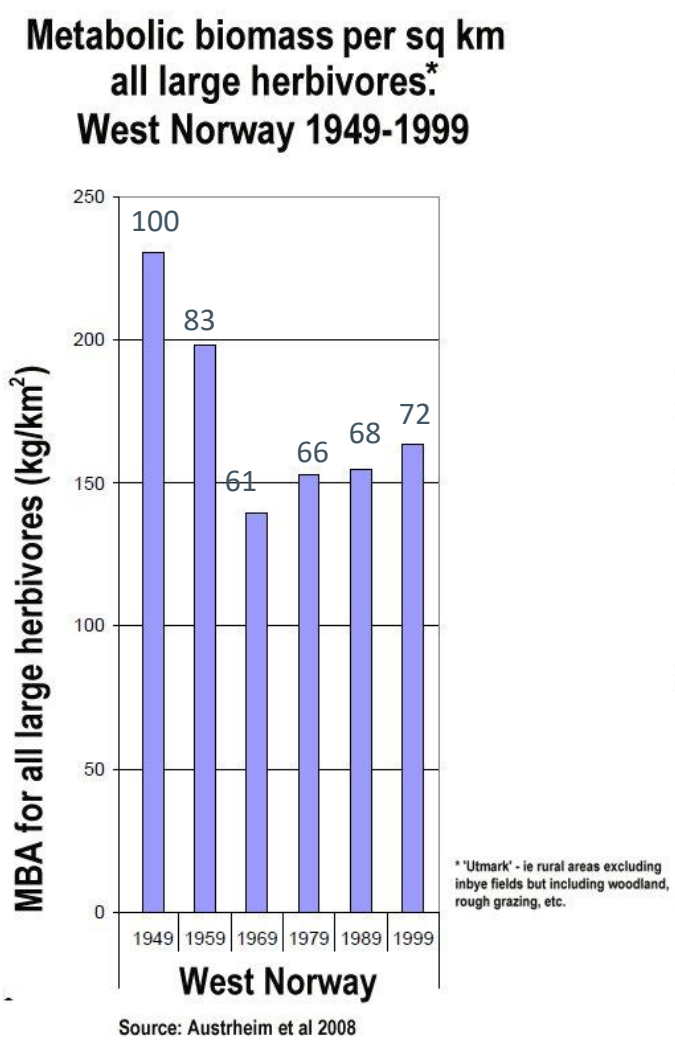
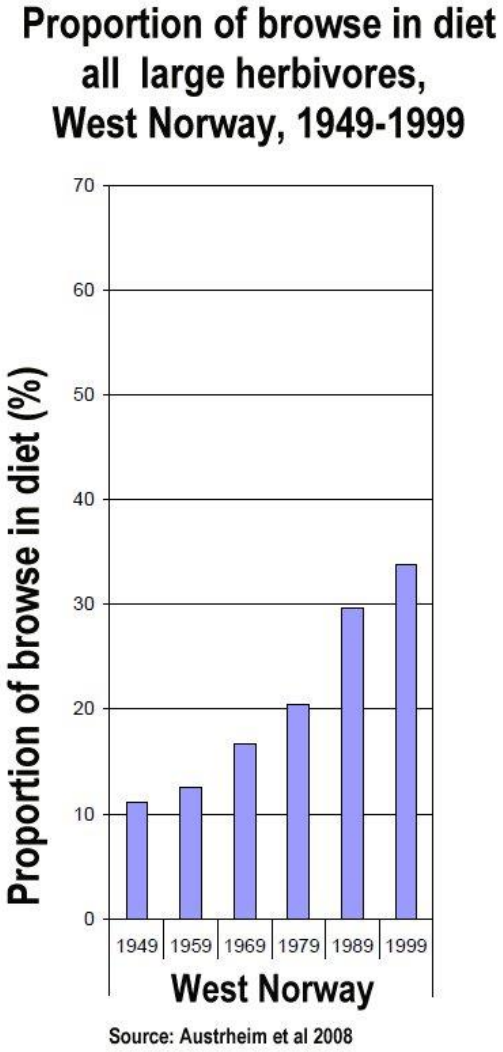
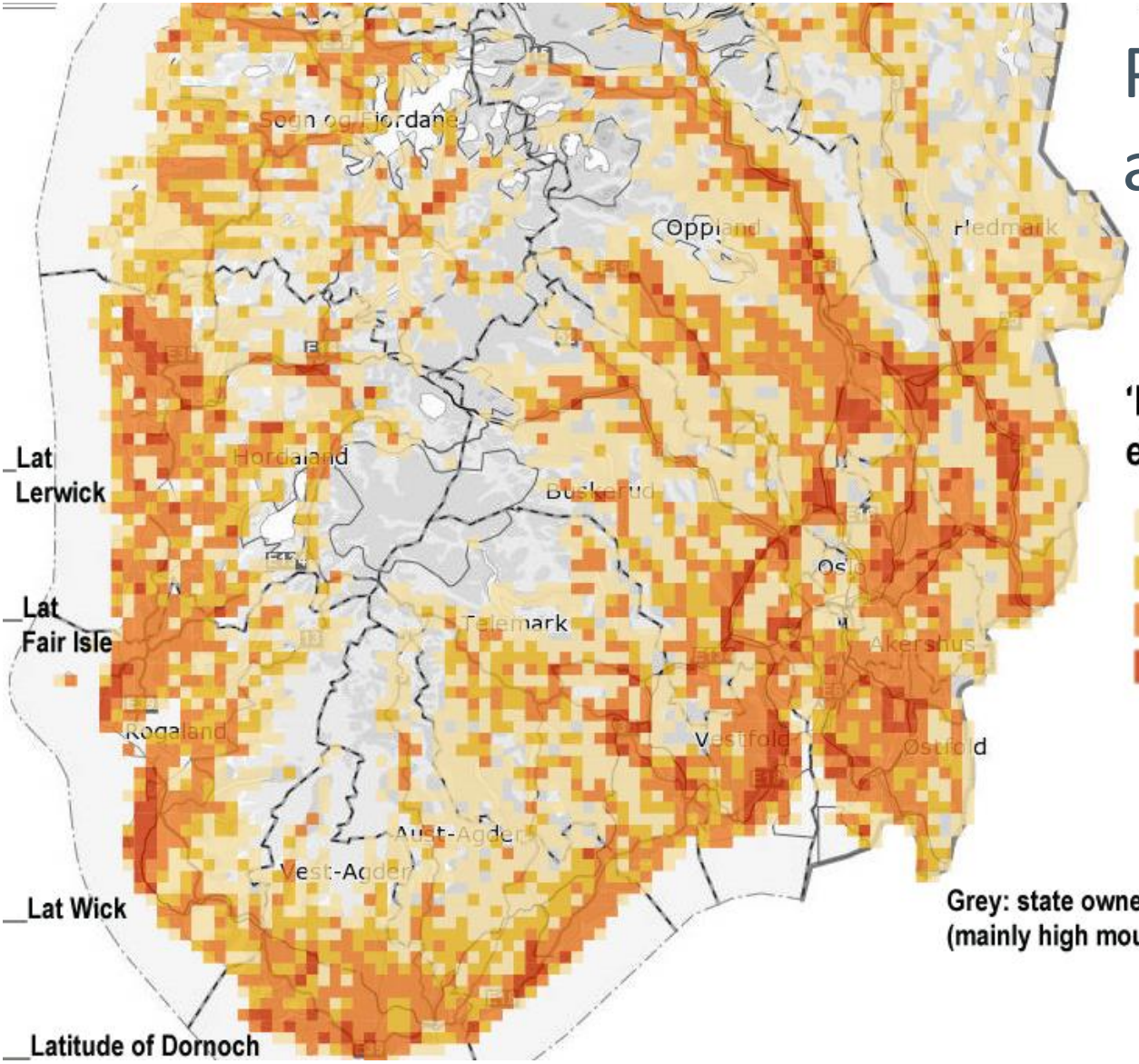




- 1949 levels sufficient to inhibit woodland regeneration
  1969 levels allowed woodland to regenerate from an unwooded state
  Later increases in metabolic biomass of herbivores were not sufficient to inhibit woodland regeneration over time
  Even though proportion of browse in overall herbivore diet increased
  This appears to have been due to increased levels of regeneration (ie, more seedlings), plus soil development (ground more fertile)
  NB minimum pressures 1969, but rate of woodland spread apparently peaking 2000-2010s.
  Lag probably related to availability of seed source, plus soil development effects .
  However, detailed research would be useful.

Patterns of landuse and habitation



'Land Use' (farming, forestry, hunting etc) properties per 5km grid square

- 12 or fewer (<0.5/sq km)
- 13-25 (0.5-1/sq km)
- 26-75 (2-3/sq km)
- 76 or more (>3/sq km)

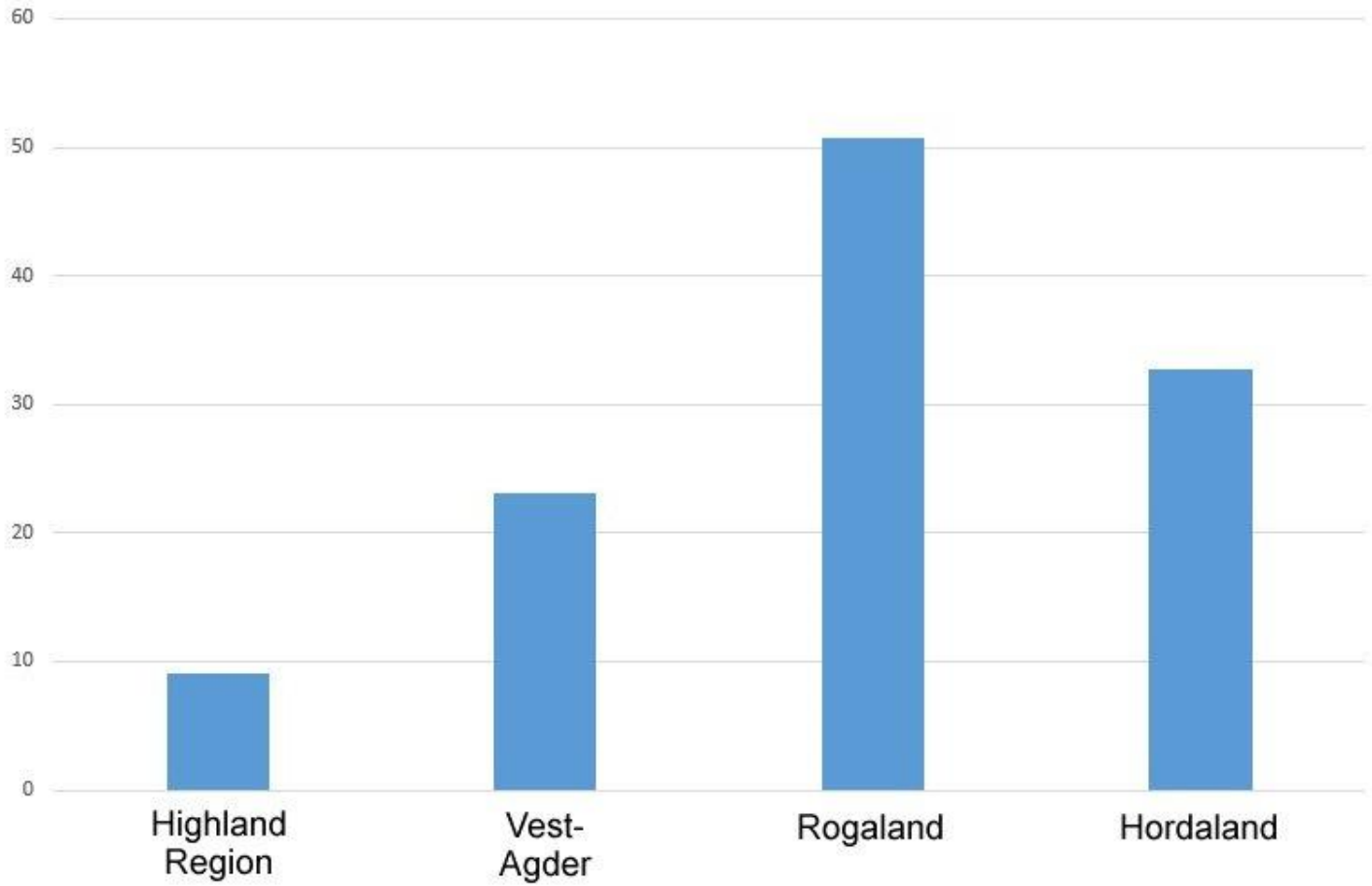
Grey: state owned, state common lands ('Statsallmenning'), etc. (mainly high mountain plateaus above the natural treeline)

Source: Statistics Norway (www.ssb.no)

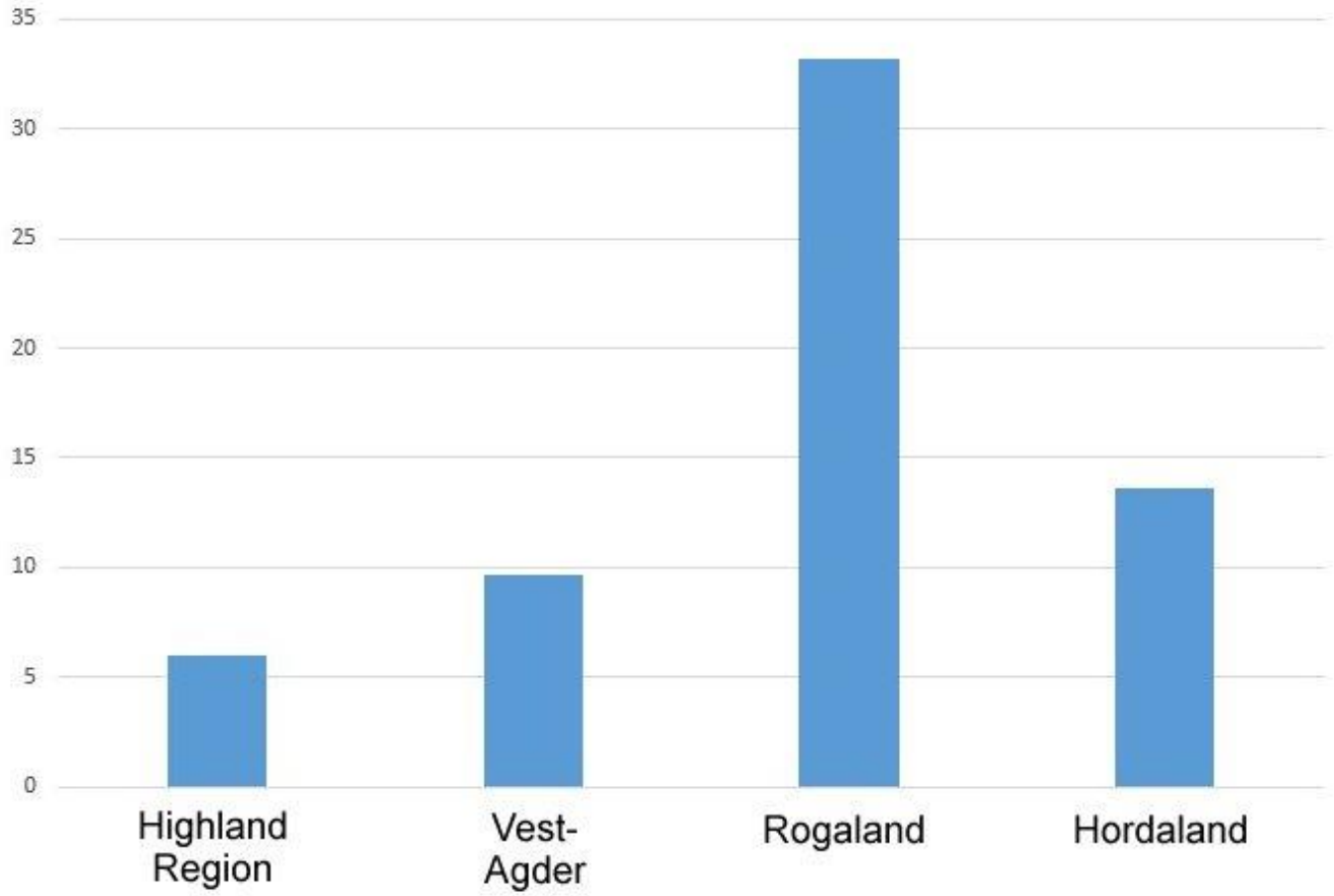
Detailed mapping information on property boundaries is publically available at www.seeiendom.no

NINA

Population densities (residents/km^2), Highland Region and SW Norway



Population densities (residents/km^2) Highland Region and SW Norway, excluding main urban settlements



Inverness, Kristiansand, Stavanger (including Sola kommune), Bergen excluded

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View from Hovdenuten (1119m)

- SW Norway is closely similar in the basic conditions of life (climate, landforms, geology) to Highland Scotland, as comprehensive data demonstrates.
- Landscape history, including the pattern of landscape use and of deforestation, was closely similar from the Mesolithic until the mid 18th century.
- SW Norway has reforested, largely through natural regeneration, since the late 19th century, and especially since the 1950s.
- Research demonstrates that this been a result of reductions in grazing intensities and associated land uses (e.g. muirburn, fuelwood).
- Natural reforestation is continuing at a rapid rate.
- Much of this regeneration is occurring on wet peat soils formed during the deforested period.
- Including on hard, infertile rock types in very wet, mild, and windy ocean-edge locations.
- It was and is a working cultural landscape.
- Land use is diversified, typically with multiple income streams from the same property; including agriculture, grazing, forestry, hunting and fishing sales, fuelwood production, cabin sales and rental.
- The human population density in rural SW Norway is much higher than in Highland Scotland

Some comparative approach insights

i – the ‘Refugee Habitat’ problem in Scottish conservation

NINA

- Alpine blue sow-thistle *Cicerbita alpina* is critically endangered in Britain. It is confined to four rock ledges in the extreme SE of CNP (Angus glens & Lochnagar). A fifth patch went extinct in 1977.

- The plants are highly impoverished genetically.They very rarely produce any seeds.

- Management publications on the species in Britain correctly identify that it is highly palatable to grazing animals, and this is the major factor in its rarity.

- But they also include statements like:

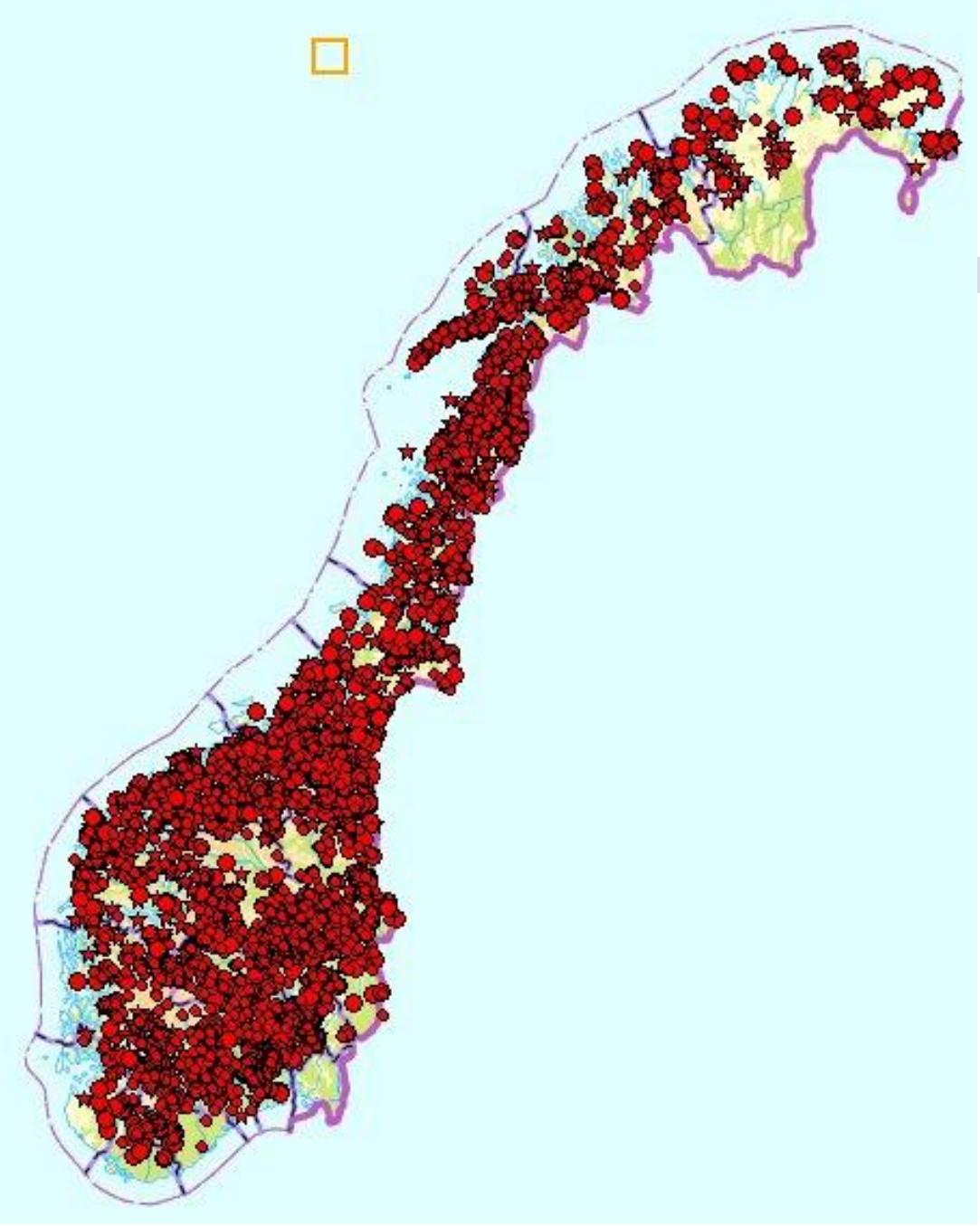
"As the species has a continental distribution, this would suggest optimum conditions of hot summers and cold winters."

"In western Norway, *Cicerbita alpina* seems to avoid the extreme oceanic areas and tends to be found in the more continental inner fjord areas. It avoids the west coast; like many boreal species, it tolerates or even needs high summer temperatures, occurs in areas of cold winters and tends to be absent from areas with mild winters"

"As a consistent feature of its European habitats, winter snow cover protects plants from winter frosts and provides additional moisture in early summer"

- All of the three statements above are false, but lead to the first of the 'key factors' identified as "limiting the current and future distribution of *C. alpina"* as being:

"***C. alpina*** **appears to be at the western limit of its climatic tolerance in Scotland**…."



Cicerbita alpina distribution, Norway

Source: www.artsdatabanken.no

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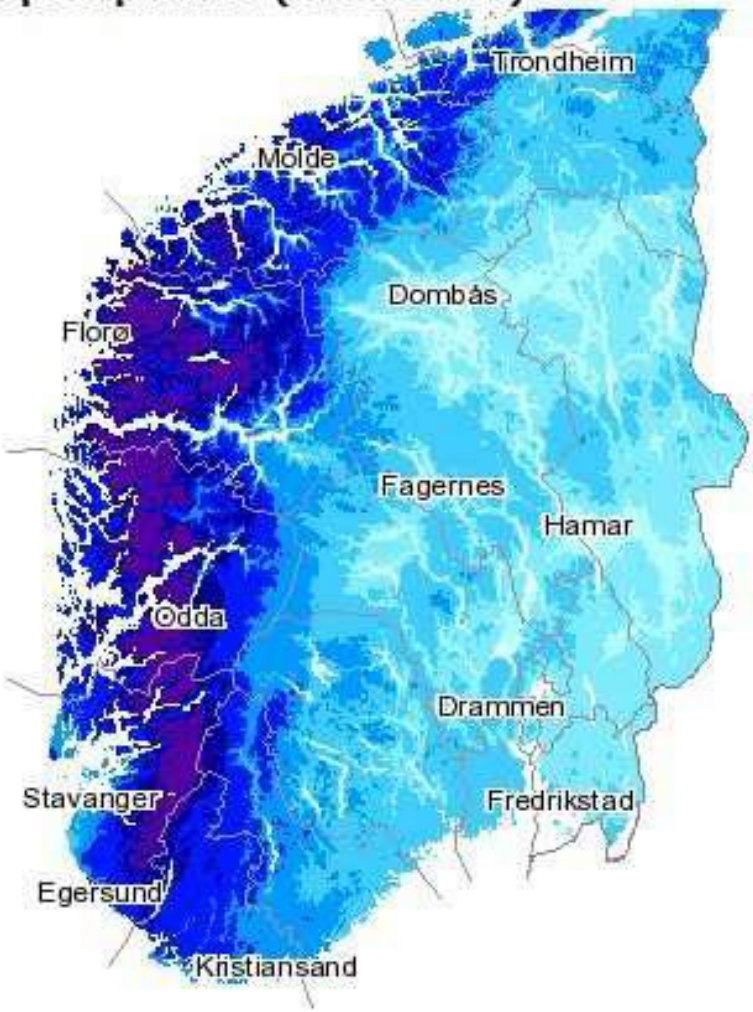
Normal annual precipitation (1971-2000)



Theme information

Map shows normal annual precipitation (in mm) for normal period 1971-2000.

Colour legend

mm

- Above 4000
- 3000 - 4000
- 2000 - 3000
- 1500 - 2000
- 1000 - 1500
- 750 - 1000
- 500 - 750
- Below 500

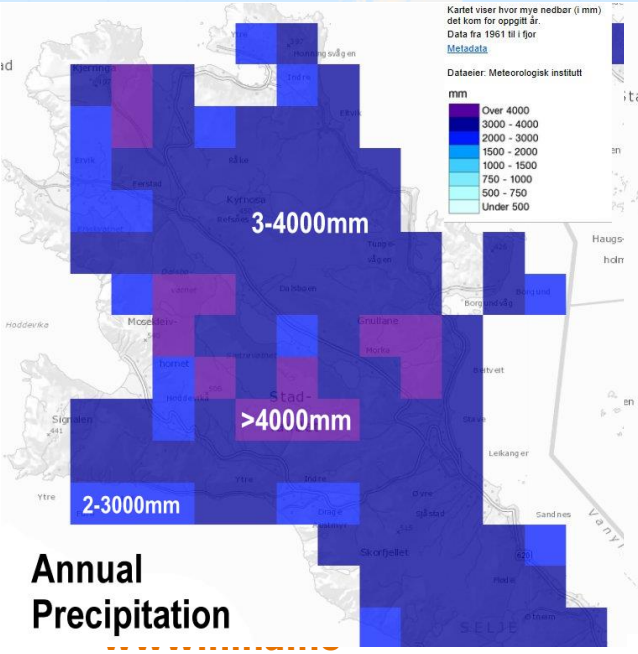
Comparisons:annual precipitation

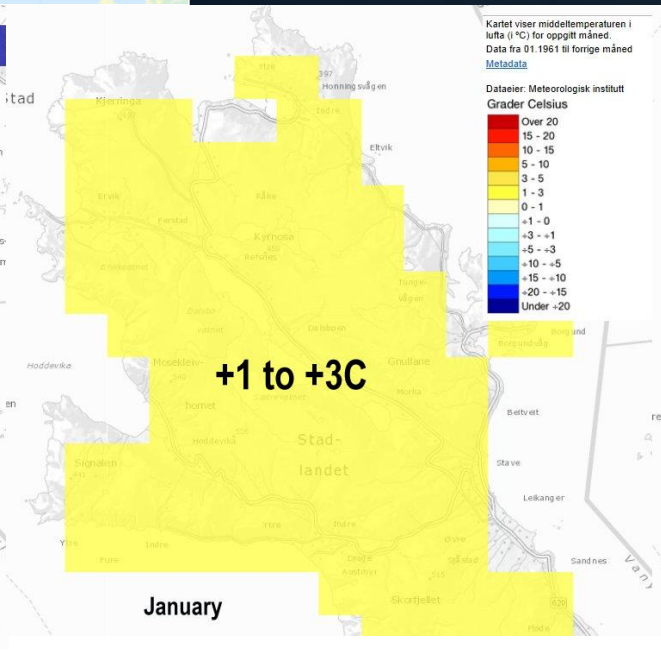
Ben Nevis (summit) 4350mm
Ben Cruachan (summit) 3600mm
Ben Lawers 1430mm
Creag Meagaidh (plateau) 1250mm
Cairngorm (plateau) 1100mm

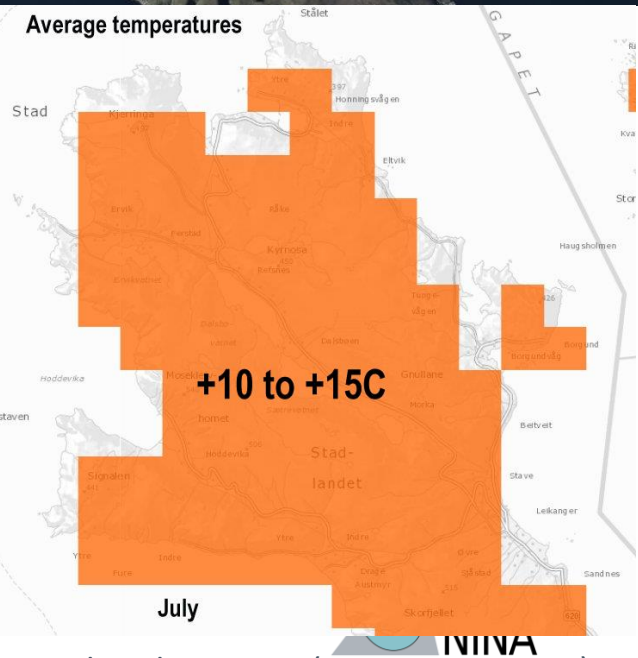
Theme from met.no

Presented on seNorge.no

C. alpina recorded in every decade since the 1950s on Stad by university botanists (UiO, NTNU, NMB)







Meteorological information: Meteorologisk institutt (www.senorge.no)

‘Highly prized browse for many animals... In our (*i.e., coastal SW Norway*) mountains it (*C. alpina*) must seek refuge in inaccessible places to avoid being eaten by sheep’

Bakkeveig, S. (1983). Botany for mountain lovers. Stavanger Hiker’s Association, Stavanger

- Rogaland (‘Stavanger county’) sheep population, summer 2014: ~510 000 sheep or 59.4/km^2; ca. 20% of all sheep in Norway (data: Statistics Norway)
- Rogaland is 2.8% of Norway’s land area; sheep grazing intensity for the county taken as a whole is thus c. 14x the Norwegian average. Most sheep graze on the coast and on the foothills behind the coast

NINA

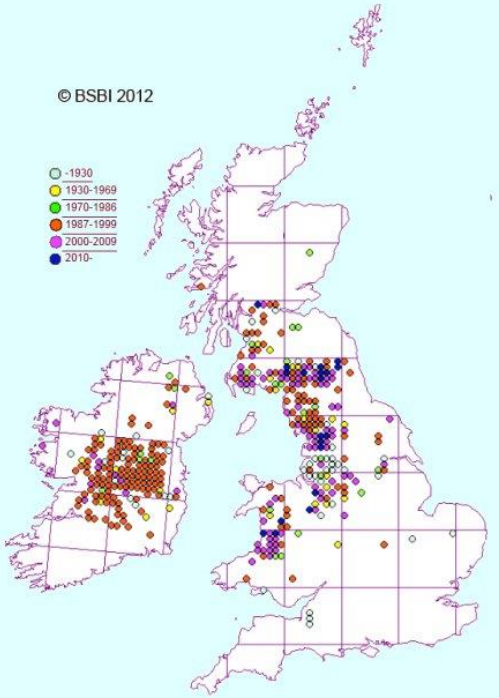
Large areas of the Cairngorms, from Abernethy to Glen Feshie; and the eastern part of Mar Lodge estate, have potential habitat for *C. alpina*.

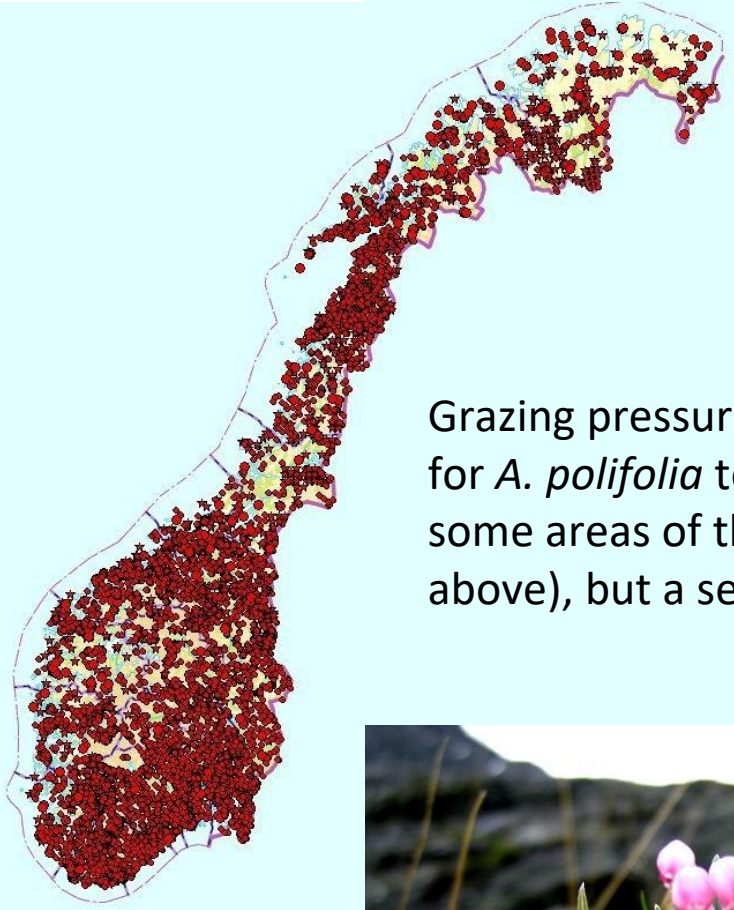
They also now have low grazing pressures.

However, they lack a seed source.

Andromeda polifolia (Bog rosemary)

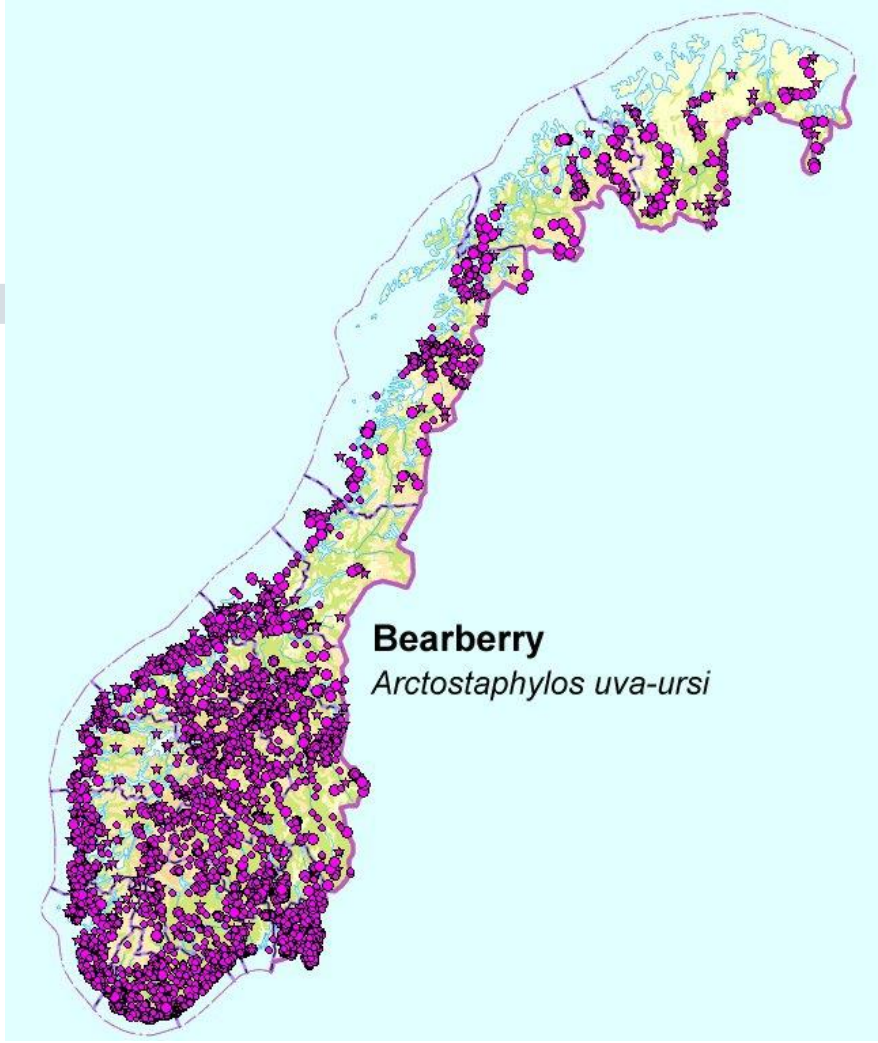
www.artsdatabanken.no
www.bsbimaps.org.uk/atlas/main.php





Grazing pressure is now low enough for *A. polifolia* to reestablish in some areas of the Highlands (see above), but a seed source is lacking.

- In Scotland (including CNP), SACs with ‘bearberry heath’ are being cleared of naturally regenerating pine to ‘protect’ the ‘bearberry heath’.
- In Norway, the species is LC status and abundant from sea level to the low alpine zone, largely as a woodland understory plant.
- Its usual habitat is described as "Bearberry grows in drier woodlands, most usually Scots pine woods, and drier heaths. It is common in the whole country up to the firn snow level. Bearberry can grow both on acidic and alkaline soils.” Source
- It is certain that open habitats are not a requirement for *Arctostaphylos* (among others)
- Especially not a 19th century and later ‘survivor assemblage’ dependent on frequent rotational burning by humans
- Comparison with SW Norway can help avoid the ‘refugee habitat’ error in species conservation



www.artsdatabanken.no

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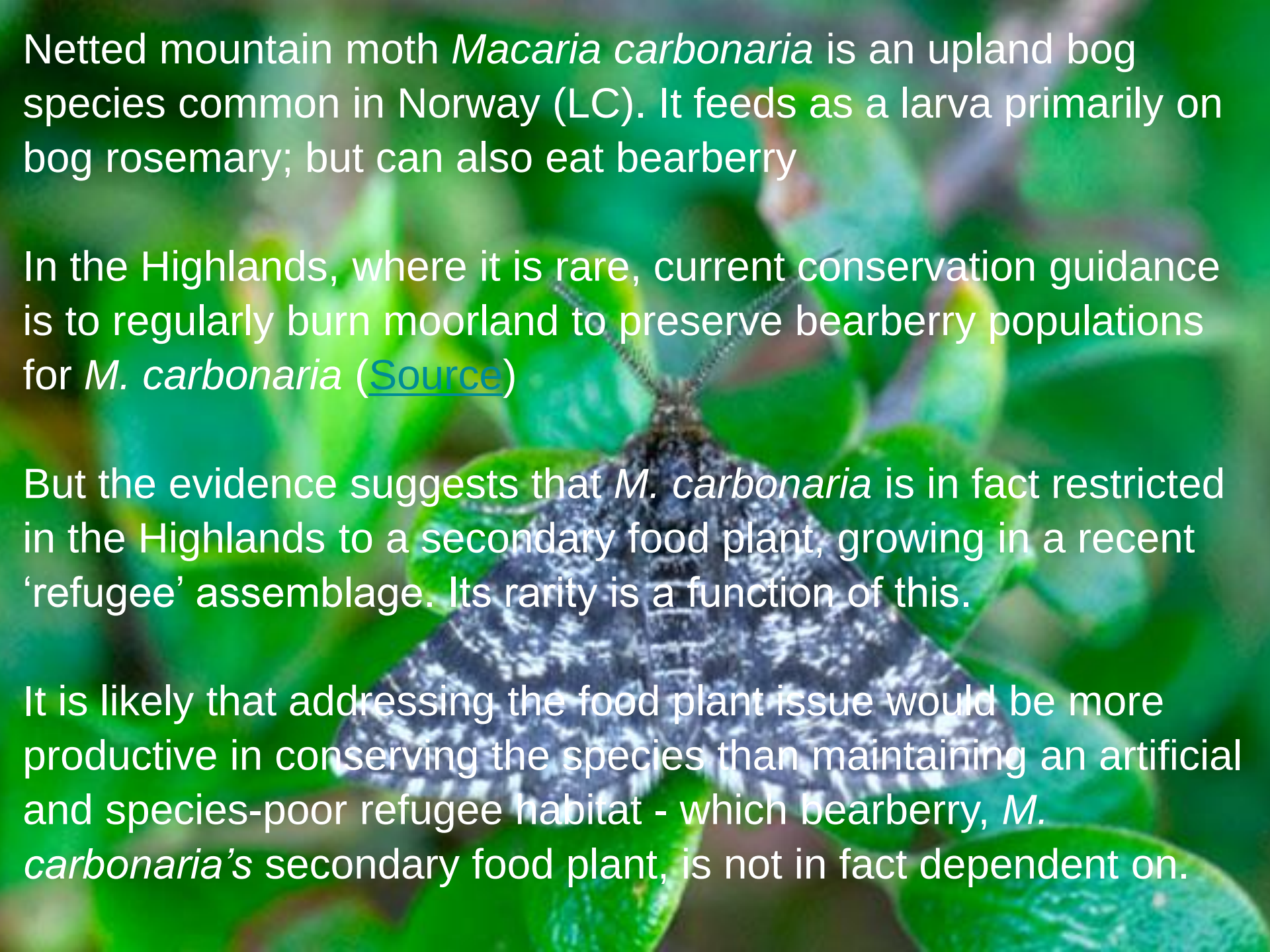
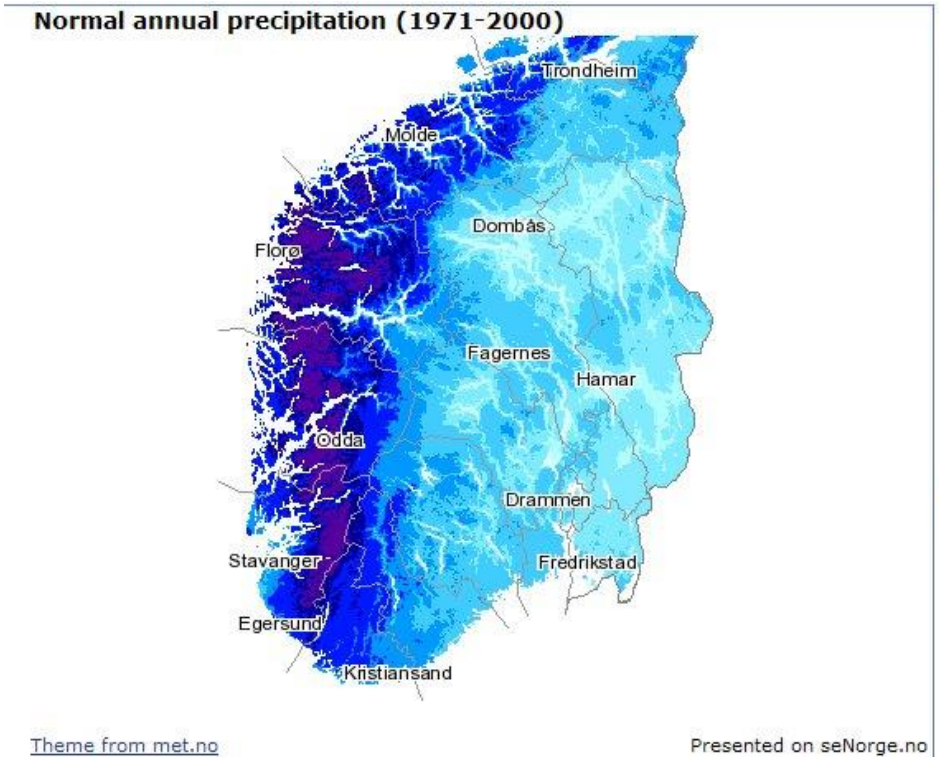


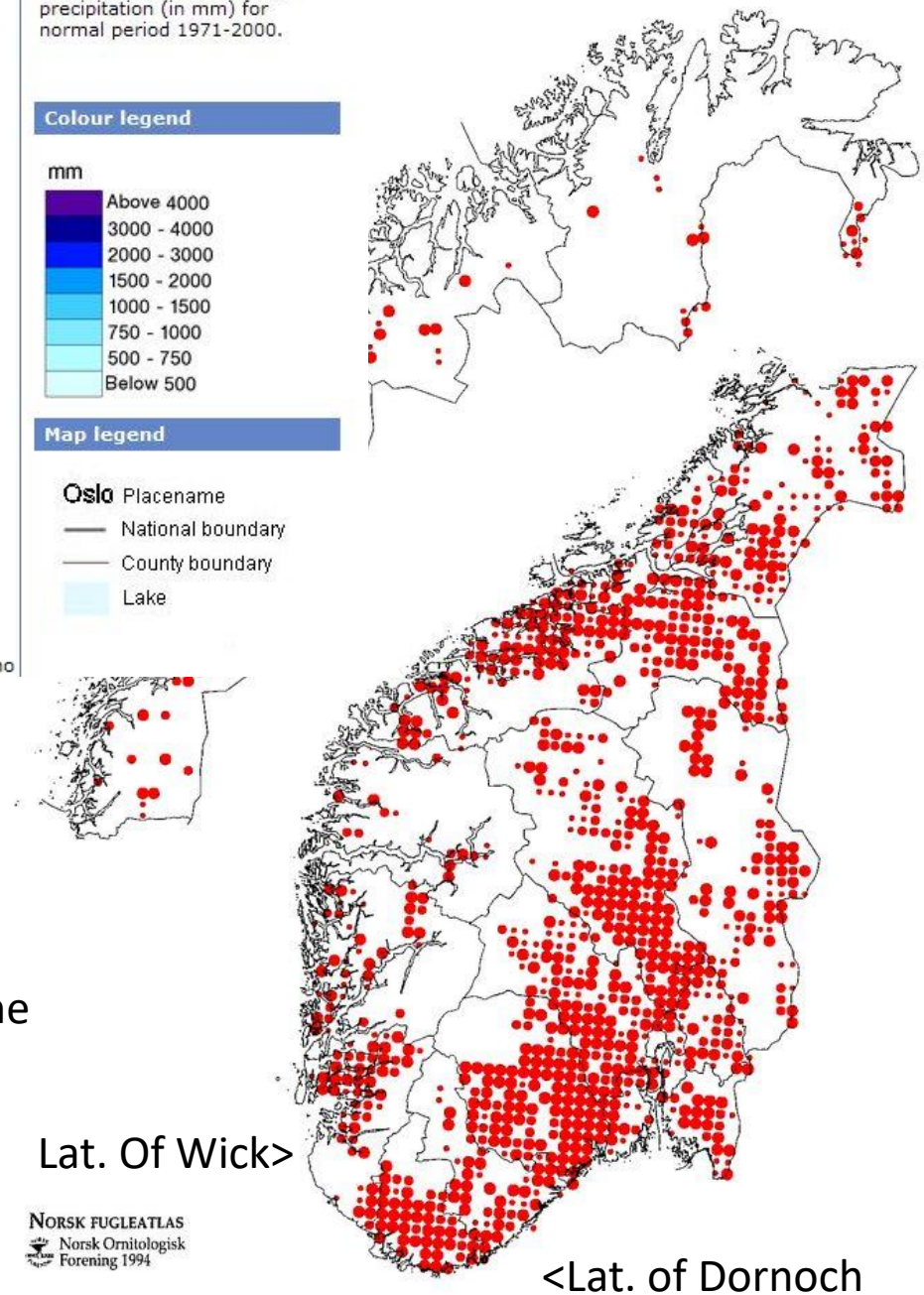
Netted mountain moth *Macaria carbonaria* is an upland bog species common in Norway (LC). It feeds as a larva primarily on bog rosemary; but can also eat bearberry

In the Highlands, where it is rare, current conservation guidance is to regularly burn moorland to preserve bearberry populations for *M. carbonaria* (Source)

But the evidence suggests that *M. carbonaria* is in fact restricted in the Highlands to a secondary food plant, growing in a recent 'refugee' assemblage. Its rarity is a function of this.

It is likely that addressing the food plant issue would be more productive in conserving the species than maintaining an artificial and species-poor refugee habitat - which bearberry, *M. carbonaria's* secondary food plant, is not in fact dependent on.





- Capercaillie are declining and red listed in Scotland
- They are stable, 'LC' status, in Norway
- A hypothesis in Scotland is that they dislike oceanic climates and this is a factor in decline
- However, in SW Norway they occur in mild, 'hyperoceanic' areas of very high rainfall
- Suggesting comparative research might be illuminating

www.nina.no

“In Norway the golden eagle breeds in hill forest and mountain tracts over most of the country….The golden eagle is first and foremost associated with open mountain woodland (*fjellskog*) (Dahl et al. 1986)…it can also breed in open coniferous forests a long way from the open fell”

Gjershaug et al. (eds.) (1994). Norwegian Bird Atlas.

Ring ouzel

Turdus torquatus torquatus

Scotland: ring ouzel habitat stated to be "*open* heather clad moorland and mountains with only very sparse or stunted tree cover" (Rollie 2007).

SPA review for the species stated: "Key conservation requirements: Maintain good moorland management and *open* moorland/ pasture interface" (my italics).

Norway: "Prefers hilly areas with rocky terrain and mixed grass and shrub vegetation... It especially likes steep slopes with lots of rocks and plenty of juniper bushes, where at the same time there are mixed in more open areas with grass. It does not like barren areas with little vegetation, either on the coast or in the mountains" (Pedersen 1994).

Montane shrub mosaic associations as described above, the core habitat for the species, are functionally extinct as habitats in Scotland. *The 'key conservation requirement', if implemented as SPAs, would have prevented reestablishment of these associations*.

Scotland: over 50% decline in the last 25 years, and a very marked contraction in range (Rollie 2007). Red listed and a priority species in the UK biodiversity action plan.

Norway: appears to be slowly increasing (Pedersen 1994). Red list status 'LC'.

The same subspecies breeds in both countries and they appear to winter in the same regions of Morocco.

SPA status considered for current Scottish habitat (rejected only for technical reasons).

2010 UK BAP revision: "Encourage comparative breeding-season studies in Norway/Sweden, where the population is apparently stable".

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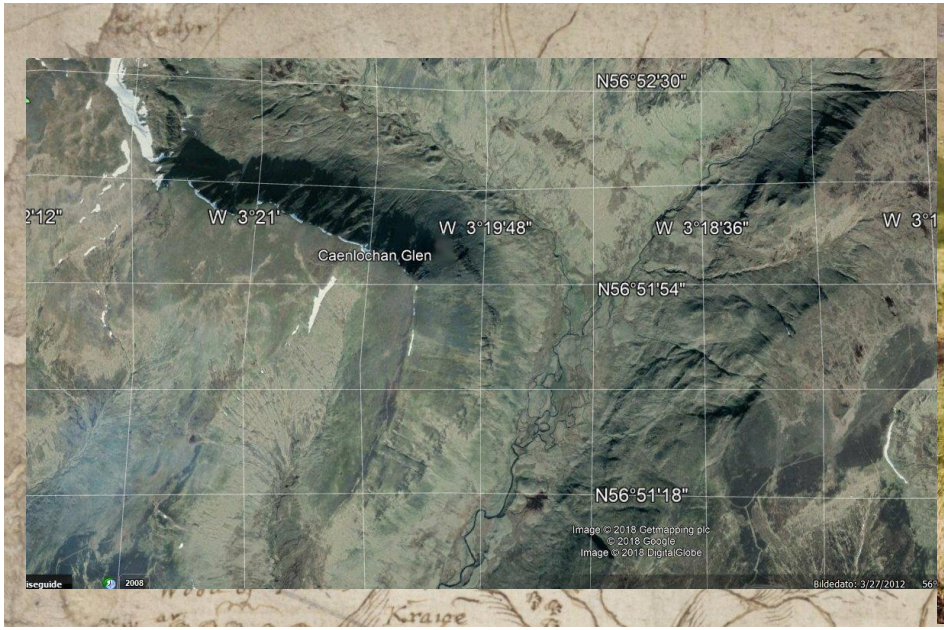
SACs and restoration: an example

Caenlochan SAC



Pont map, 1590

- Caenlochan SAC is designated for various types of open ground associations, all below c800m anthropogenic
- This prevents any woodland being regenerated there as it would 'damage the SAC feature'
- Despite map data showing woodland quite recently present which itself would be SAC designated if it still existed
- And pollen and other data indicating that the natural vegetation was, and absent human influences would be, a much more biodiverse woodland sequence to c. 900m asl, including montane scrub associations.

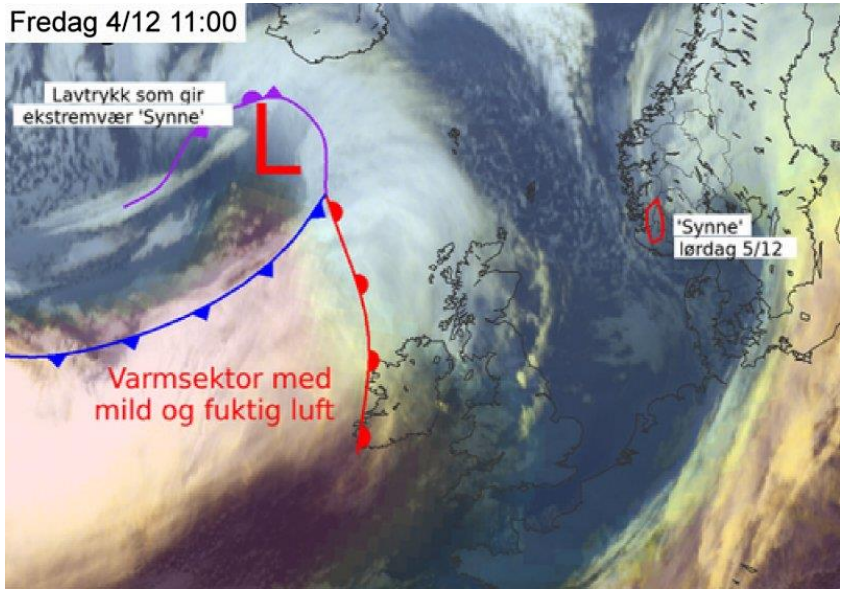
In Cairngorms SAC, restoration of birch is currently being forbidden by NatureScot because montane birch is absent from the SAC description dating from the 1980s. It is absent because it is extinct as a habitat. Montane birch woodland would naturally be a large proportion of the SAC area, and is much more species rich and biologically productive than current impoverished assemblages (and sequesters much more carbon in the higher biomass of organisms and the richer, deeper soils the habitat supports)

Norwegian Nature Diversity Act 2009

Section 1 States: "The purpose of this Act is to protect biological, geological and landscape diversity *and ecological processes* through conservation and sustainable use, and in such a way that the environment provides a basis for human activity, culture, health and well-being, now and in the future"

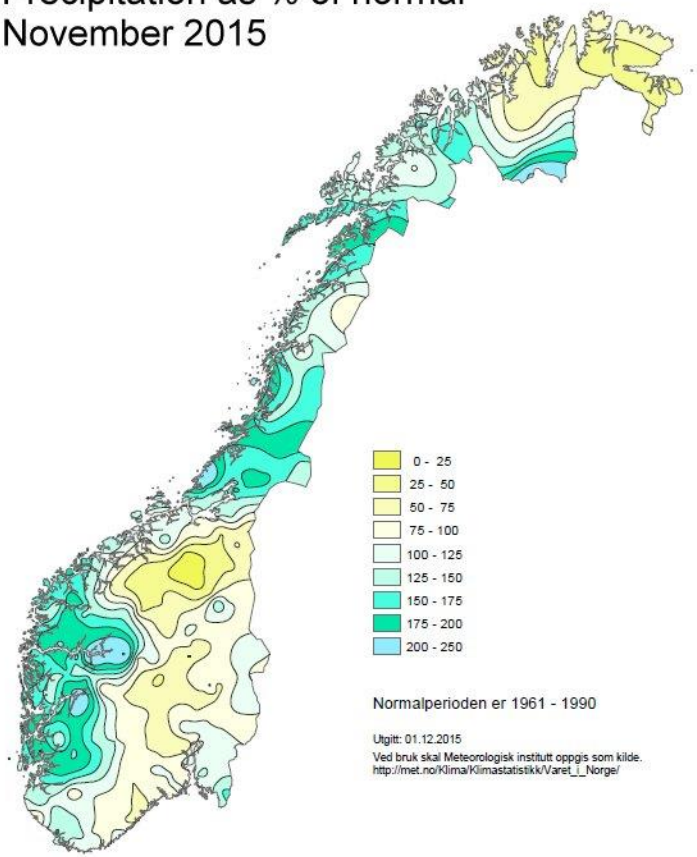
Comparison of Storm Desmond (Synne) Economic Damage in SW Norway and N England/S Scotland

- Storm Desmond affected N England/S Scotland in the period 4-6 December 2015.
- Known as Storm Synne, the same system arrived in Norway about 18 hours after its onset in Britain.
- Temperatures were above zero in all areas throughout, except a few mountain peaks. Almost all precipitation fell as rain on ground already wet from a wet November, in both Britain and SW Norway.

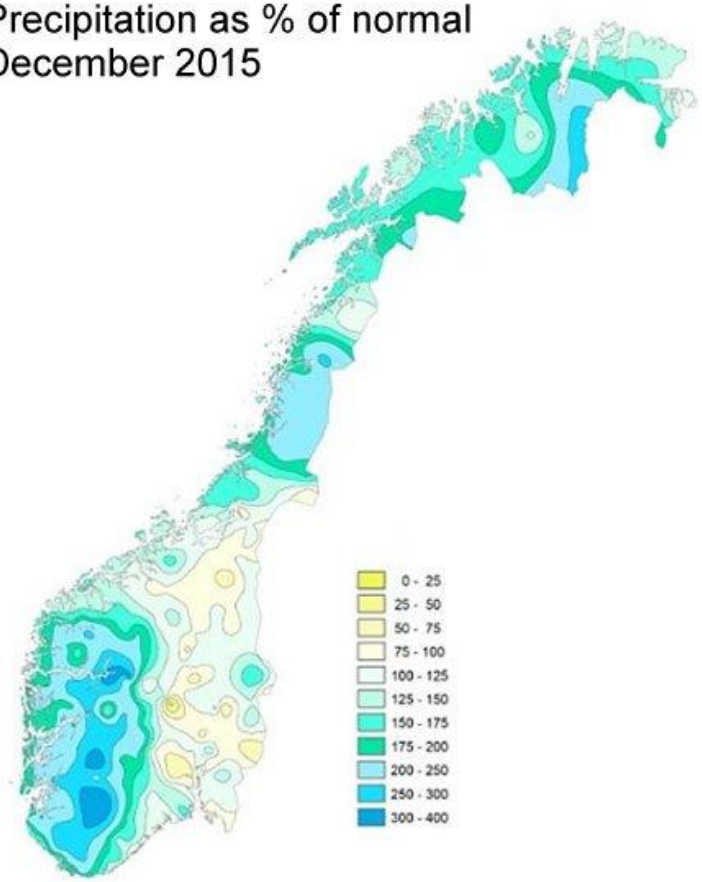


Meteorologisk institutt

Precipitation as % of normal November 2015



Precipitation as % of normal December 2015



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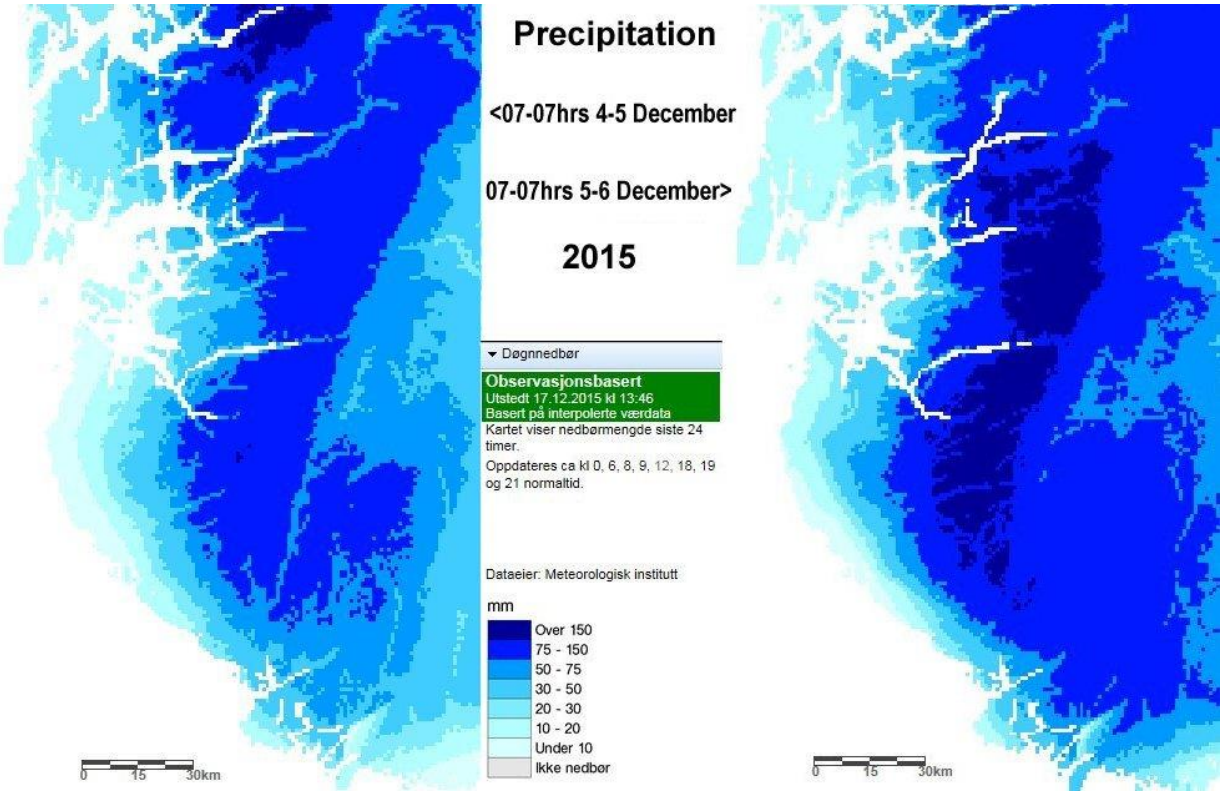
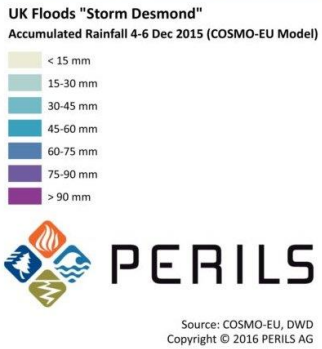
Storm Desmond(aka Synne)





- Heaviest accumulated rainfall band N England/S Scotland (PERILS map): >90mm
- Large areas of SW Norway at least 225mm

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Storm Desmond (Synne) Economic Damage

	Lancashire, Cumbria, Co. Durham, Northumberland, Scottish Borders	Vest Agder, Rogaland, Hordaland
Area (km^2)	22309	29818
Population	2 887 570	1 067 588
Population density (km^2)	129	36

	UK	Norway
Storm Desmond/Synne Insurance claims estimates	€833.6 million	€31.8 million
Inurance claim/person main affected area, defined above	€289	€30

'severe flooding …. mainly affected the counties of Cumbria and Lancashire' (PERILS AG catastrophe insurance market news, 4th March 2016) (Population Cumbria & Lancashire: 1.9 million)

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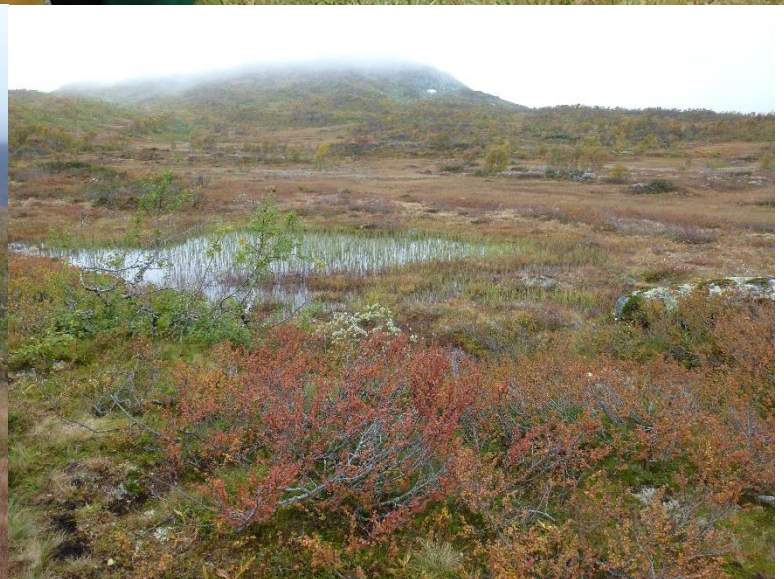
Conclusion

- Detailed comparative research would be useful to compare river flood profiles* and damage levels, to explain the apparent very large differences in economic damage levels (> nine times greater per head in affected region of Britain) from an event of similar or greater magnitude in SW Norway.

- These will likely have complex causes. However, the main land cover difference between the areas, a factor known to strongly affect runoff rates, is the difference in **extent and character of woodland cover**. SW Norway is largely wooded, mostly by natural regeneration, and mostly in recent decades; and almost entirely without artificial drainage. There is comparatively little woodland in N England & S Scotland, with large areas of open hill; woodland mainly artificially drained commercial plantations.

- data for Norwegian hydrological stations is publically available at www.xgeo.no


Peat erosion (Scotland)



Blanket peat in Norway.

Better developed & biodiverse ground layer with trees on drier patches and by watercourses; peat hagging absent

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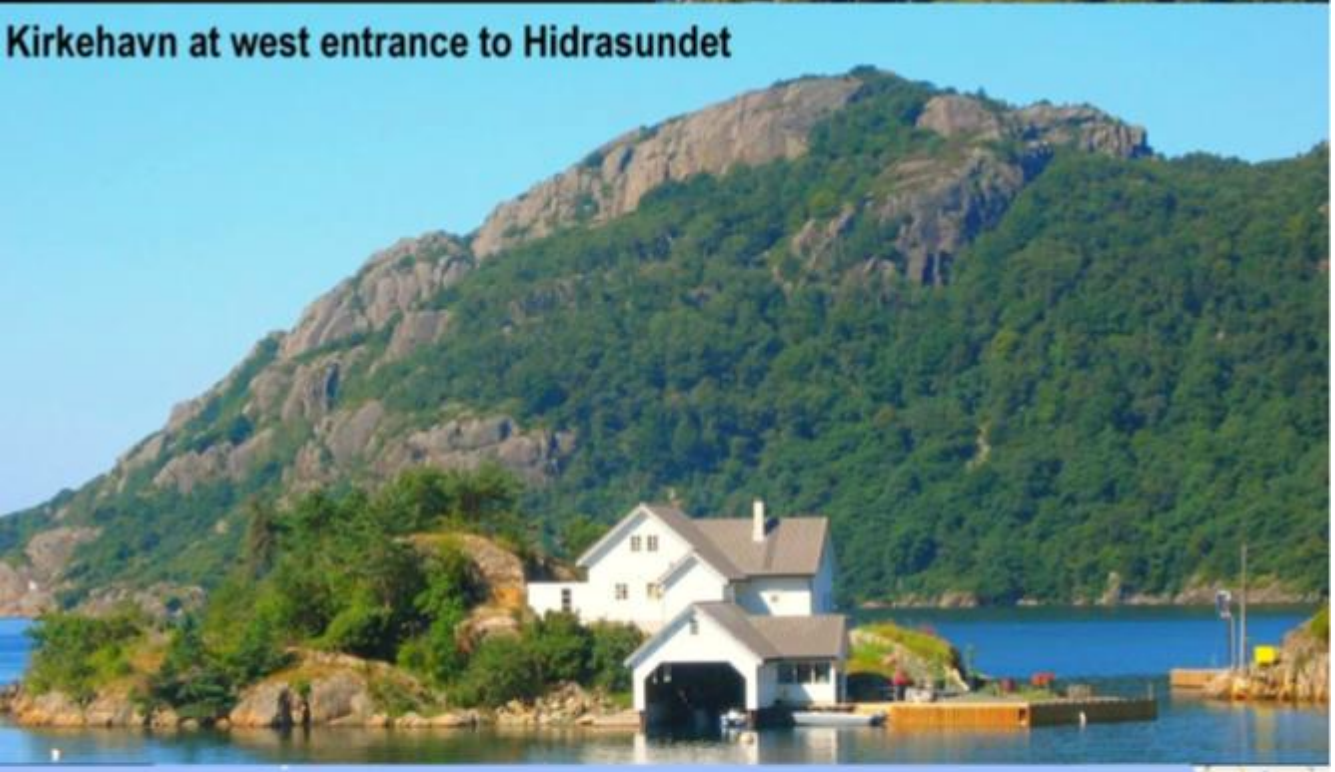
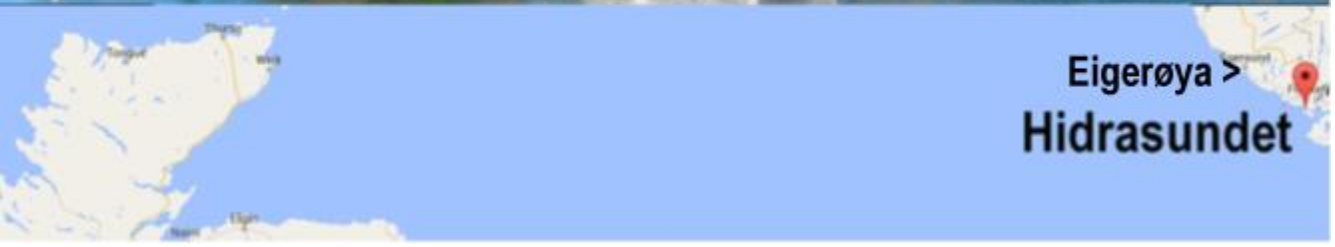
Effects of mutual shelter: wind-bent ‘granny pines’ scattered among straight young-adult pines, naturally regenerated since the 1930s following reduction in grazing pressures. (Songli, coastal Trøndelag, 300m asl).

1. Gården Li & Hidrasundet

Gården Li, Hidrasundet >

See also blog entry for 17 June 2017 here:
https://wherehaveallthеflowersgonesite.wordpress.com/2017/06/





See also:http://ut.no/hytte/3.1491/

Extreme annual wind events at Eigerøya weather station 1994-2017 (Force 10, 25-28m/s, is annual)

08.12.1994 Force 11 (29-32m/s)

19.01.1995 Force 11

30.01.1995 Force 11

17.02.1997 Force 11

28.11.1999 Force 11

11.01.2005 Force 12 (>33m/s)

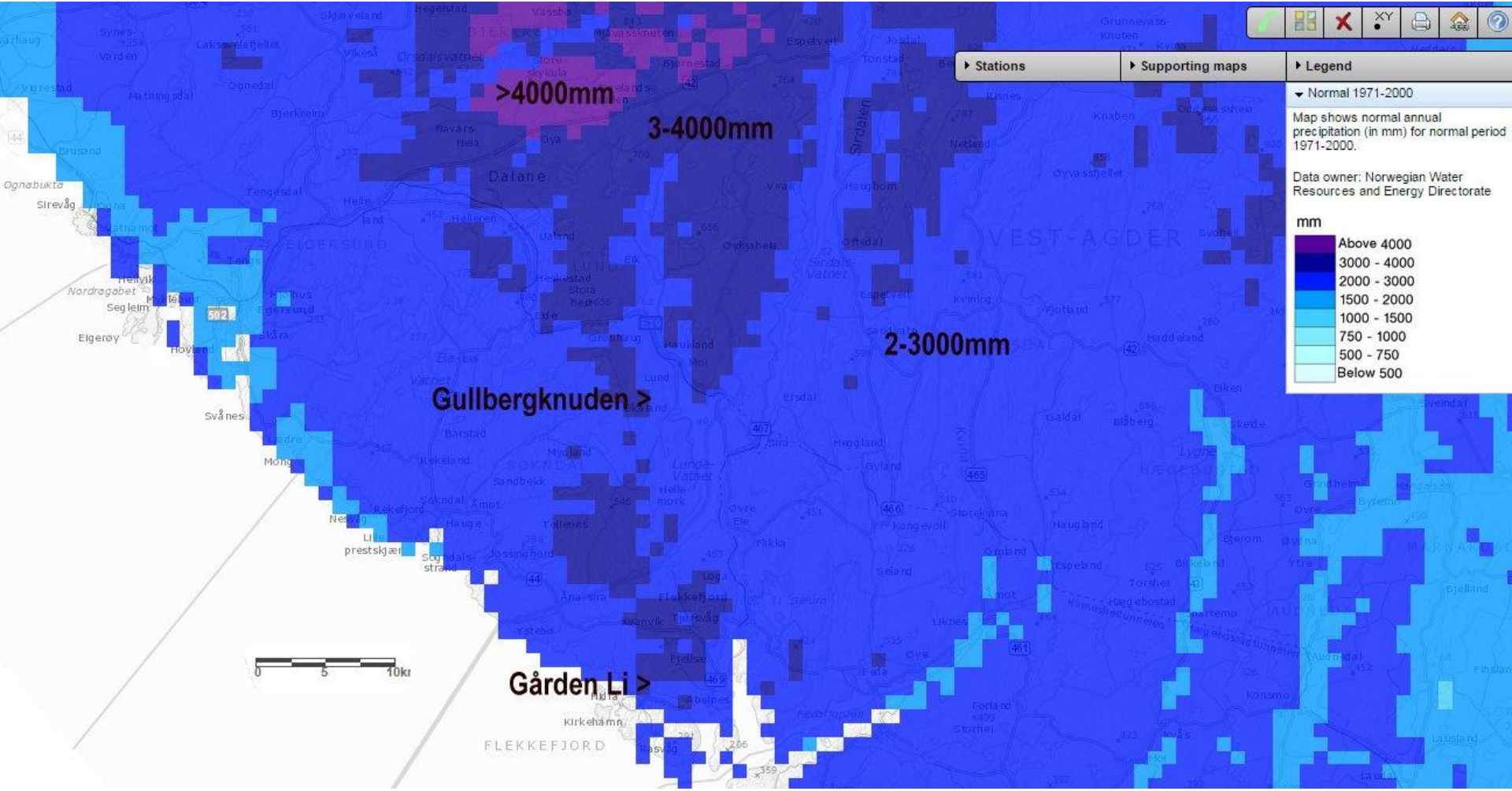
13.01.2007 Force 11

10.08.2014 Force 11

10.01.2015 Force 12 (max sustained wind 45.6m/s)

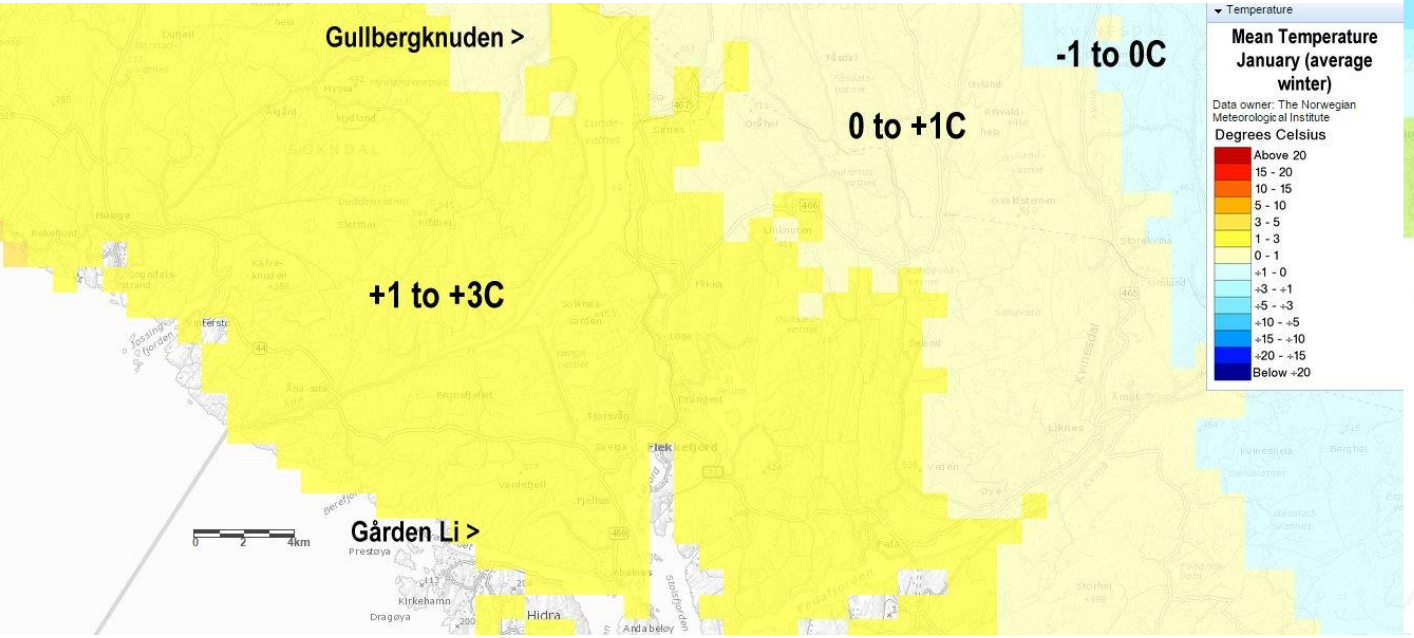
26.12.2016 Force 12

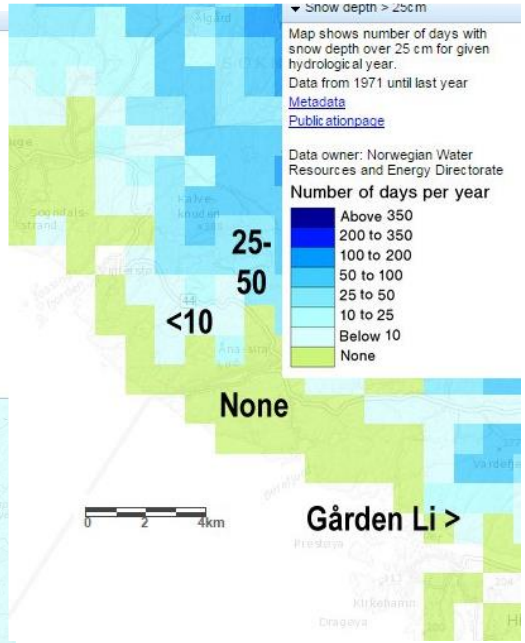
11.01.2017 Force 11

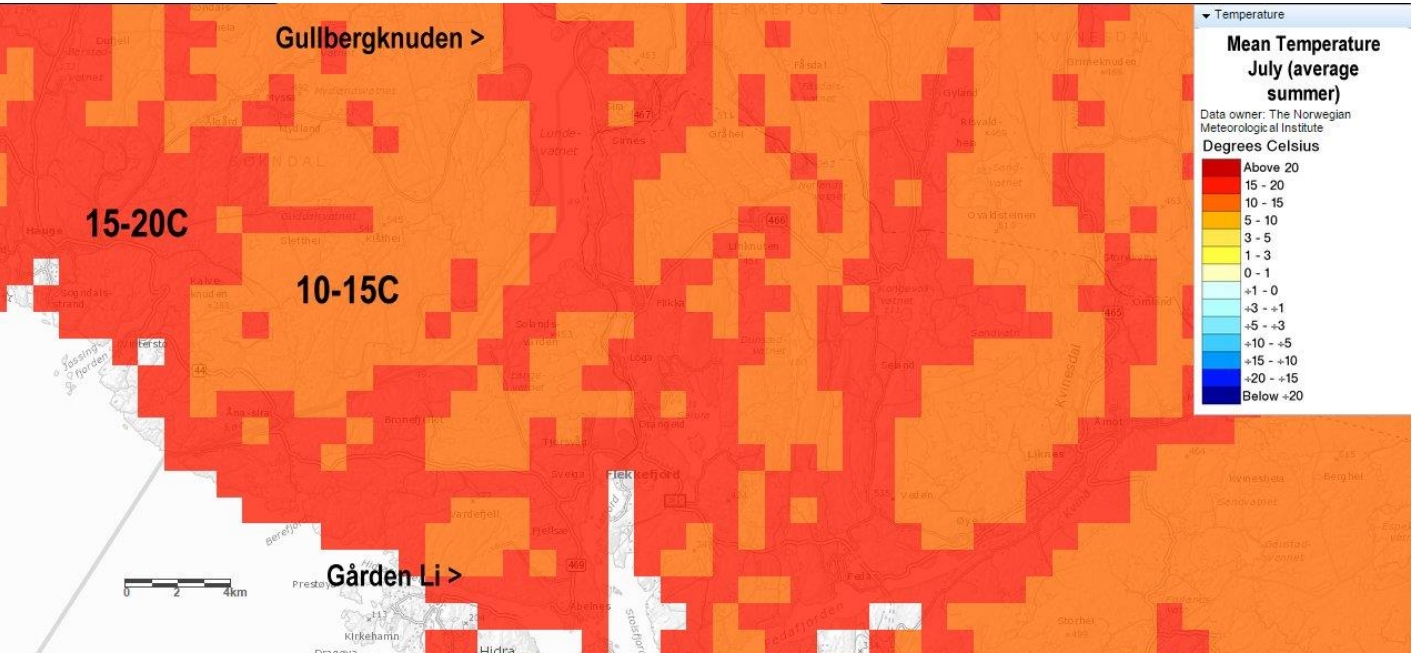


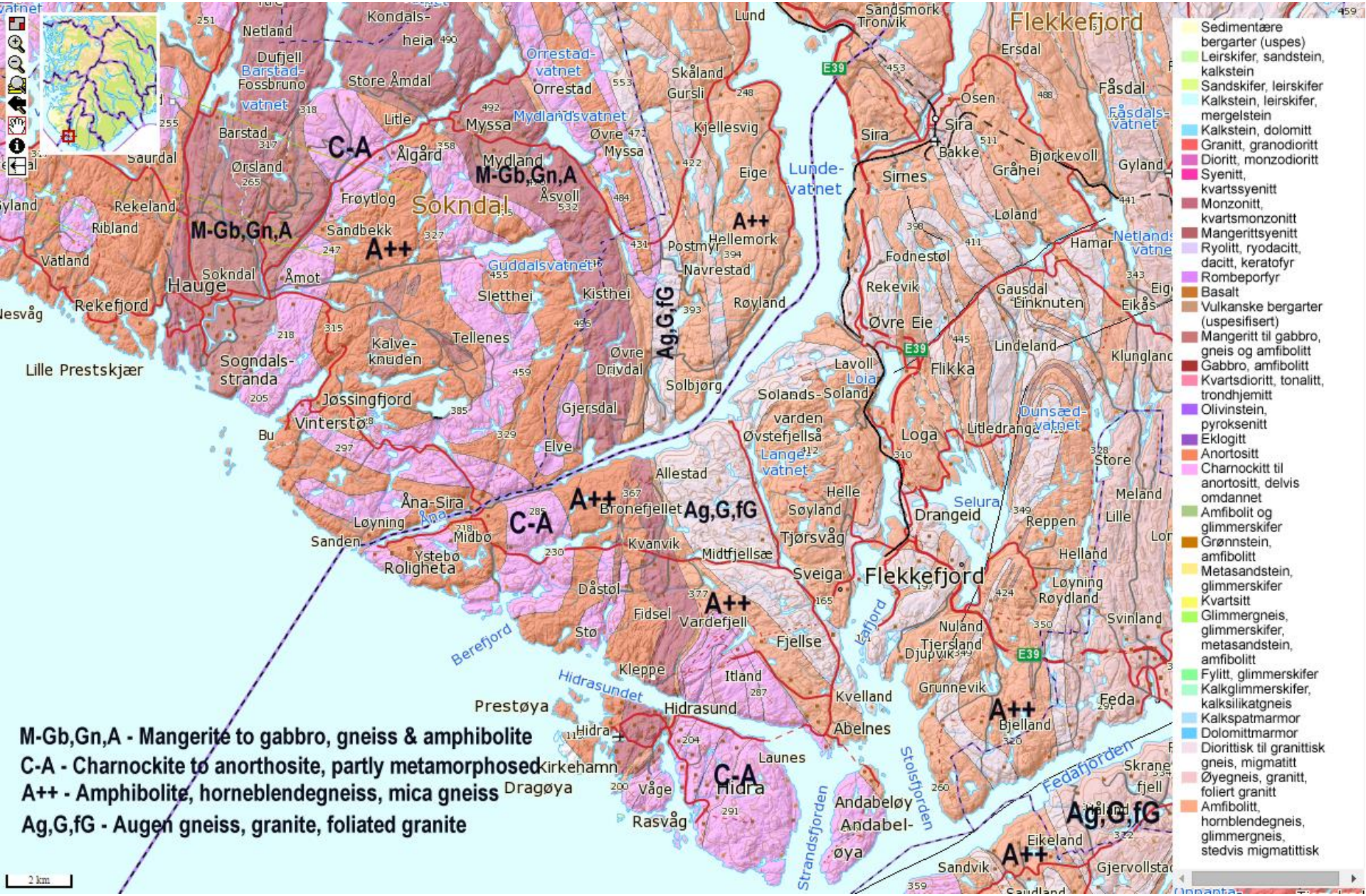
Annual precipitation

Weather data from www.senorge.no


Gullbergknuden >
-1 to 0C
0 to +1C
+1 to +3C
Gården Li >
Temperature
Mean Temperature January (average winter)
Data owner: The Norwegian Meteorological Institute
Degrees Celsius
Above 20
15 - 20
10 - 15
5 - 10
3 - 5
1 - 3
0 - 1
+1 - 0
+3 - +1
+5 - +3
+10 - +5
+15 - +10
+20 - +15
Below +20


Snow depth > 25cm
Map shows number of days with snow depth over 25 cm for given hydrological year.
Data from 1971 until last year
Metadata
Publicationpage
Data owner: Norwegian Water Resources and Energy Directorate
Number of days per year
Above 350
200 to 350
100 to 200
50 to 100
25 to 50
10 to 25
Below 10
None
25-50
<10
None
Gården Li >


Gullbergknuden >
15-20C
10-15C
Gården Li >
Temperature
Mean Temperature July (average summer)
Data owner: The Norwegian Meteorological Institute
Degrees Celsius
Above 20
15 - 20
10 - 15
5 - 10
3 - 5
1 - 3
0 - 1
+1 - 0
+3 - +1
+5 - +3
+10 - +5
+15 - +10
+20 - +15
Below +20


M-Gb,Gn,A - Mangerite to gabbro, gneiss & amphibolite
C-A - Charnockite to anorthosite, partly metamorphosed
A++ - Amphibolite, horneblendegneiss, mica gneiss
Ag,G,fG - Augen gneiss, granite, foliated granite
Sedimentære bergarter (uspes)
Leirskifer, sandstein, kalkstein
Sandskifer, leirskifer
Kalkstein, leirskifer, mergelstein
Kalkstein, dolomitt
Granitt, granodioritt
Dioritt, monzodioritt
Syenitt, kvartssyenitt
Monzonitt, kvartsmonzonitt
Mangerittsyenitt
Ryolitt, ryodacitt, dacitt, keratofyr
Rombeporfyr
Basalt
Vulkanske bergarter (uspesifisert)
Mangeritt til gabbro, gneis og amfibolitt
Gabbro, amfibolitt
Kvartsdioritt, tonalitt, trondhjemitt
Olivinstein, pyroksenitt
Eklogitt
Anortositt
Charnockitt til anortositt, delvis omdannet
Amfibolit og glimmerskifer
Grønnstein, amfibolitt
Metasandstein, glimmerskifer
Kvartsitt
Glimmergneis, glimmerskifer, metasandstein, amfibolitt
Fylitt, glimmerskifer
Kalkglimmerskifer, kalksilikatgneis
Kalkspatmarmor
Dolomittmarmor
Diorittisk til granittisk gneis, migmatitt
Øyegneis, granitt, foliert granitt
Amfibolitt, hornblendegneis, glimmergneis, stedvis migmatittisk
2 km

Geology

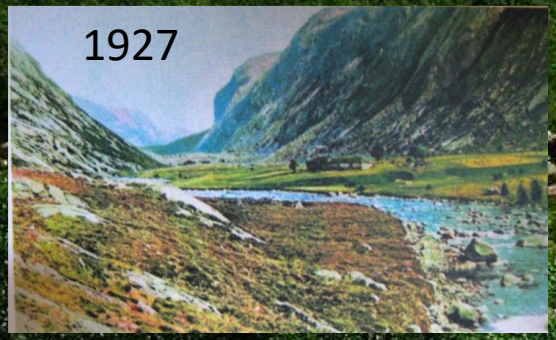
Drystane farm ruin, Hidrasundet

Photo: Thomas MacDonell

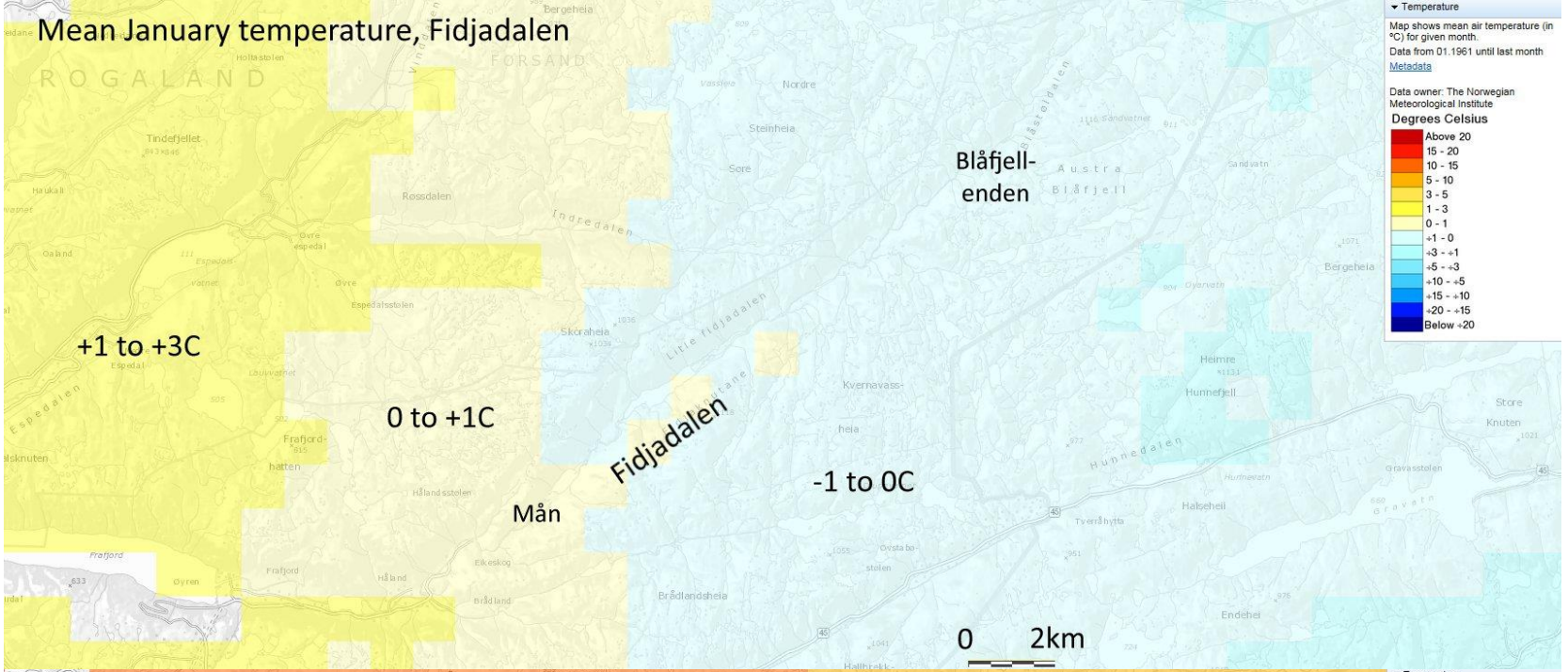
Kirkehavn, west entrance to Hidrasund

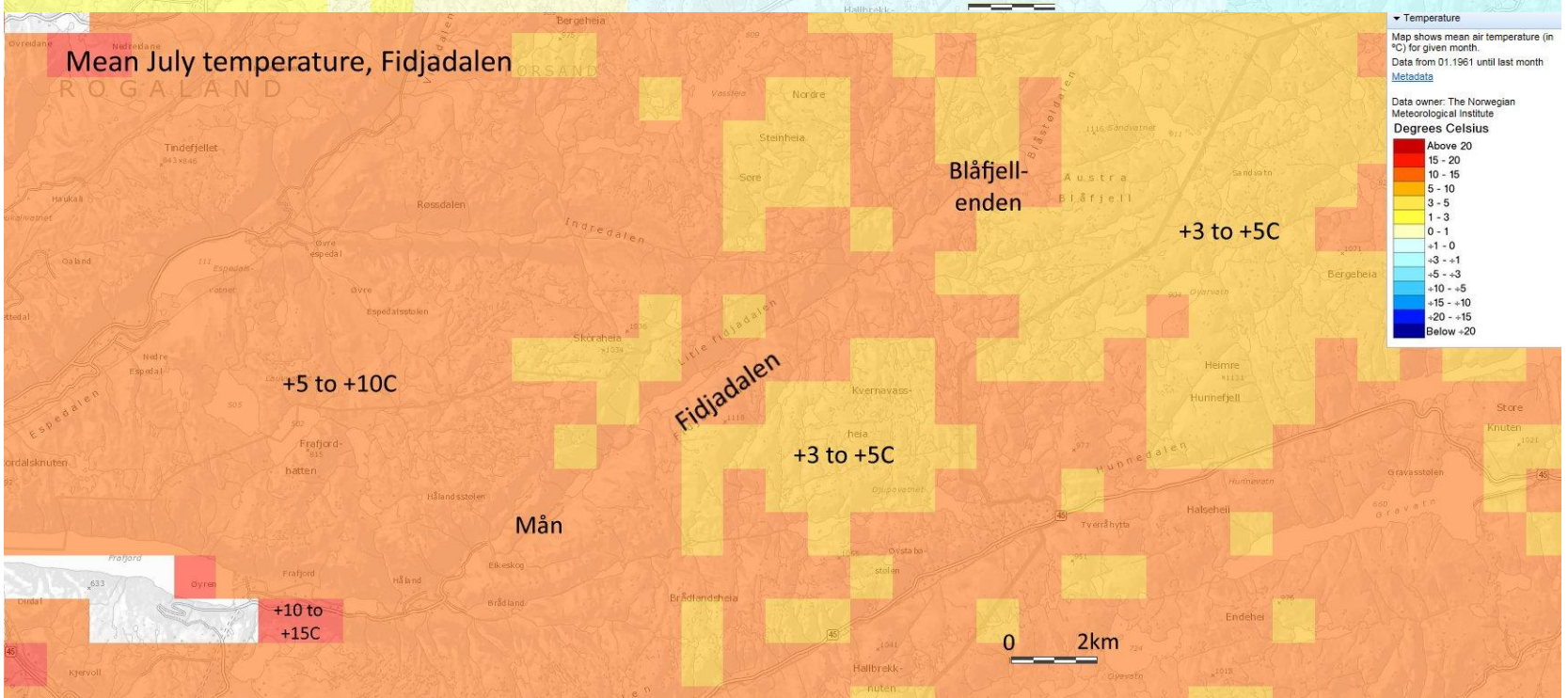

Old hill farm
inbye fields
Old hill farm
inbye fields
Old hill farm inbye fields
(out of use 1935)
Elevation 352m asl
Thurso
Wick
Lewis
Ullapool
Moray
Firth
Elgin
Uig
Egersund
Flekkefjord
Tjellås
Farsund
Mandal

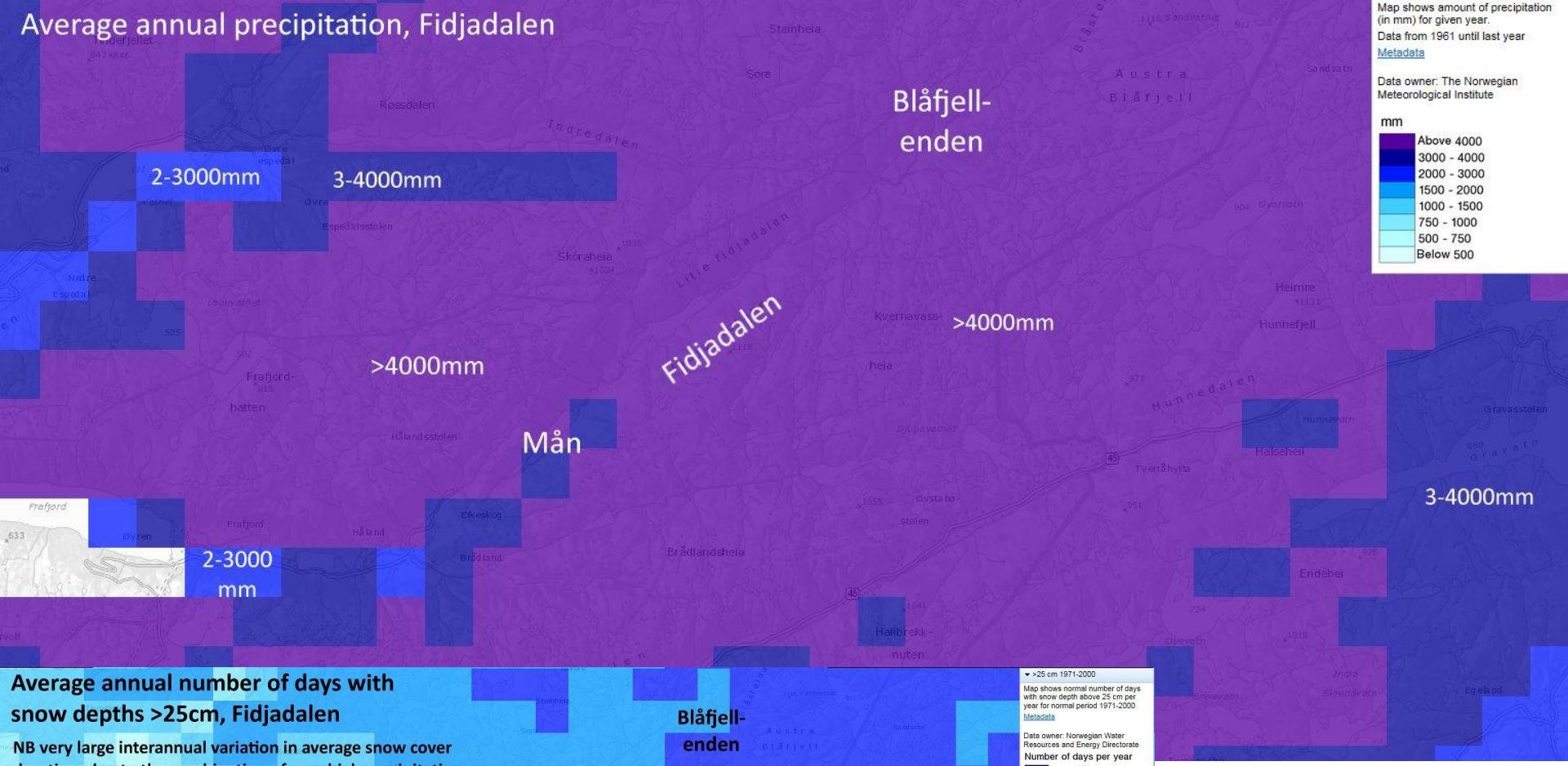
2. Mån & Fidjadalen

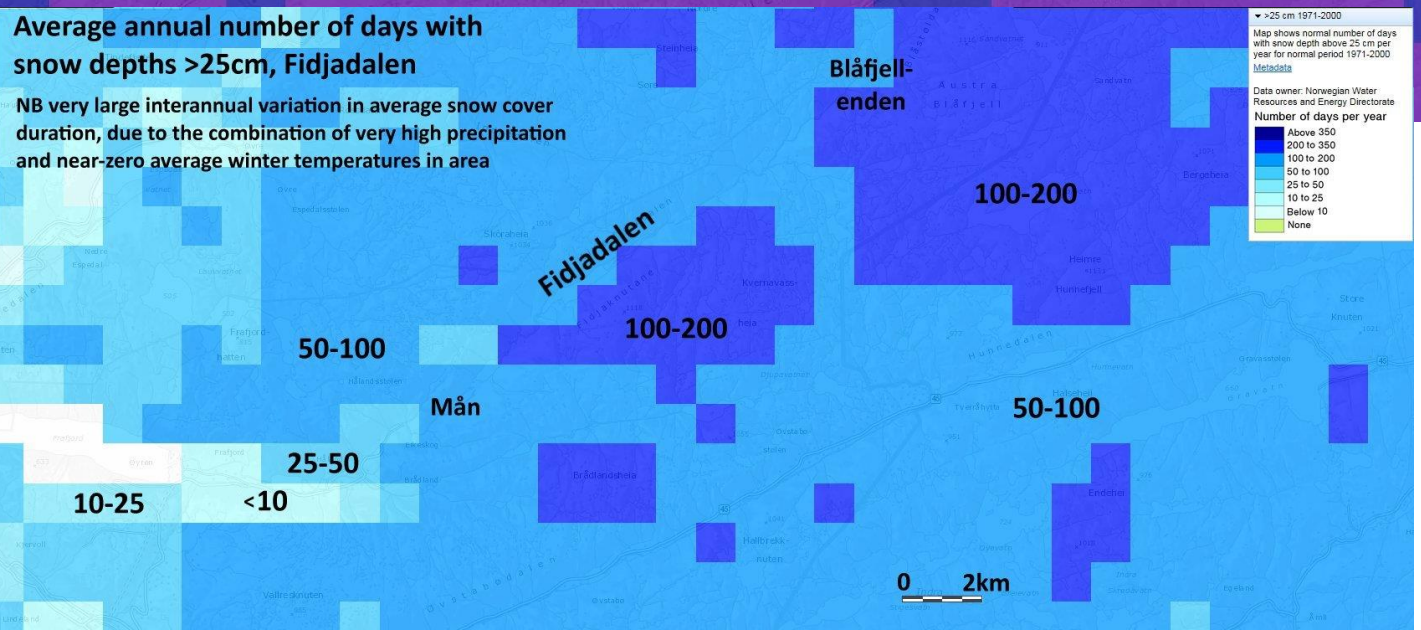


Jens Leitan- 07

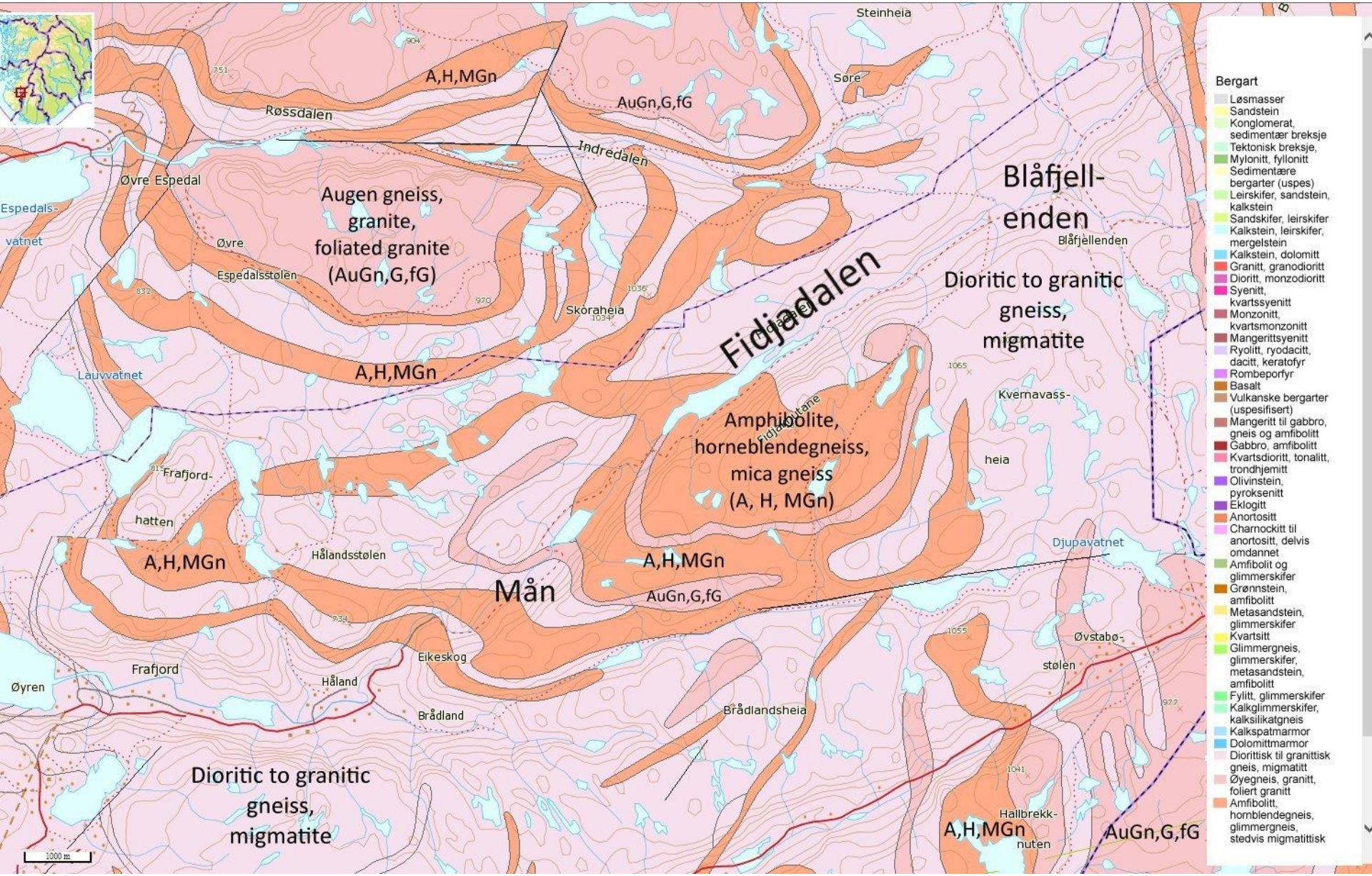

Mean January temperature, Fidjadalen
Blåfjell-
enden
+1 to +3C
0 to +1C
Fidjadalen
-1 to 0C
Mån
0 2km
Temperature
Map shows mean air temperature (in °C) for given month.
Data from 01.1961 until last month
Metadata
Data owner: The Norwegian Meteorological Institute
Degrees Celsius
Above 20
15 - 20
10 - 15
5 - 10
3 - 5
1 - 3
0 - 1
+1 - 0
+3 - +1
+5 - +3
+10 - +5
+15 - +10
+20 - +15
Below +20


Mean July temperature, Fidjadalen
Blåfjell-
enden
+3 to +5C
+5 to +10C
Fidjadalen
+3 to +5C
Mån
+10 to
+15C
0 2km
Temperature
Map shows mean air temperature (in °C) for given month.
Data from 01.1961 until last month
Metadata
Data owner: The Norwegian Meteorological Institute
Degrees Celsius
Above 20
15 - 20
10 - 15
5 - 10
3 - 5
1 - 3
0 - 1
+1 - 0
+3 - +1
+5 - +3
+10 - +5
+15 - +10
+20 - +15
Below +20


Average annual precipitation, Fidjadalen
Map shows amount of precipitation (in mm) for given year.
Data from 1961 until last year
Metadata
Data owner: The Norwegian Meteorological Institute
mm
Above 4000
3000 - 4000
2000 - 3000
1500 - 2000
1000 - 1500
750 - 1000
500 - 750
Below 500
Blåfjell-enden
2-3000mm
3-4000mm
>4000mm
Fidjadalen
>4000mm
Mån
2-3000 mm
3-4000mm


Average annual number of days with snow depths >25cm, Fidjadalen
NB very large interannual variation in average snow cover duration, due to the combination of very high precipitation and near-zero average winter temperatures in area
>25 cm 1971-2000
Map shows normal number of days with snow depth above 25 cm per year for normal period 1971-2000
Metadata
Data owner: Norwegian Water Resources and Energy Directorate
Number of days per year
Above 350
200 to 350
100 to 200
50 to 100
25 to 50
10 to 25
Below 10
None
Blåfjell-enden
100-200
Fidjadalen
100-200
50-100
Mån
50-100
25-50
10-25
<10
0
2km

NINA


Steinheia
A,H,MGn
AuGn,G,fG
Søre
Røssdalen
Indredalen
Øvre Espedal
Augen gneiss,
granite,
foliated granite
(AuGn,G,fG)
Espedals-
vatnet
Øvre
Espedalsstølen
Skoraheia
Fidjadalen
Blåfjell-
enden
Blåfjellenden
Dioritic to granitic
gneiss,
migmatite
A,H,MGn
Lauvvatnet
Kvernavass-
heia
Amphibolite,
hornblendegneiss,
mica gneiss
(A, H, MGn)
Frafjord-
hatten
A,H,MGn
Hålandsstølen
Djupavatnet
A,H,MGn
Mån
AuGn,G,fG
Øvstabø-
stølen
Eikeskog
Frafjord
Øyren
Håland
Brådland
Brådlandsheia
Dioritic to granitic
gneiss,
migmatite
Hallbrekk-
nuten
A,H,MGn
AuGn,G,fG
1000 m
Bergart
Løsmasser
Sandstein
Konglomerat, sedimentær breksje
Tektonisk breksje,
Mylonitt, fyllonitt
Sedimentære bergarter (uspes)
Leirskifer, sandstein, kalkstein
Sandskifer, leirskifer
Kalkstein, leirskifer, mergelstein
Kalkstein, dolomitt
Granitt, granodioritt
Dioritt, monzodioritt
Syenitt, kvartssyenitt
Monzonitt, kvartsmonzonitt
Mangerittsyenitt
Ryolitt, ryodacitt, dacitt, keratofyr
Rombeporfyr
Basalt
Vulkanske bergarter (uspesifisert)
Mangeritt til gabbro, gneis og amfibolitt
Gabbro, amfibolitt
Kvartsdioritt, tonalitt, trondhjemitt
Olivinstein, pyroksenitt
Eklogitt
Anortositt
Charnockitt til anortositt, delvis omdannet
Amfibolit og glimmerskifer
Grønnstein, amfibolitt
Metasandstein, glimmerskifer
Kvartsitt
Glimmergneis, glimmerskifer, metasandstein, amfibolitt
Fylitt, glimmerskifer
Kalkglimmerskifer, kalksilikatgneis
Kalkspatmarmor
Dolomittmarmor
Diorittisk til granittisk gneis, migmatitt
Øyegneis, granitt, foliert granitt
Amfibolitt, hornblendegneis, glimmergneis, stedvis migmatittisk

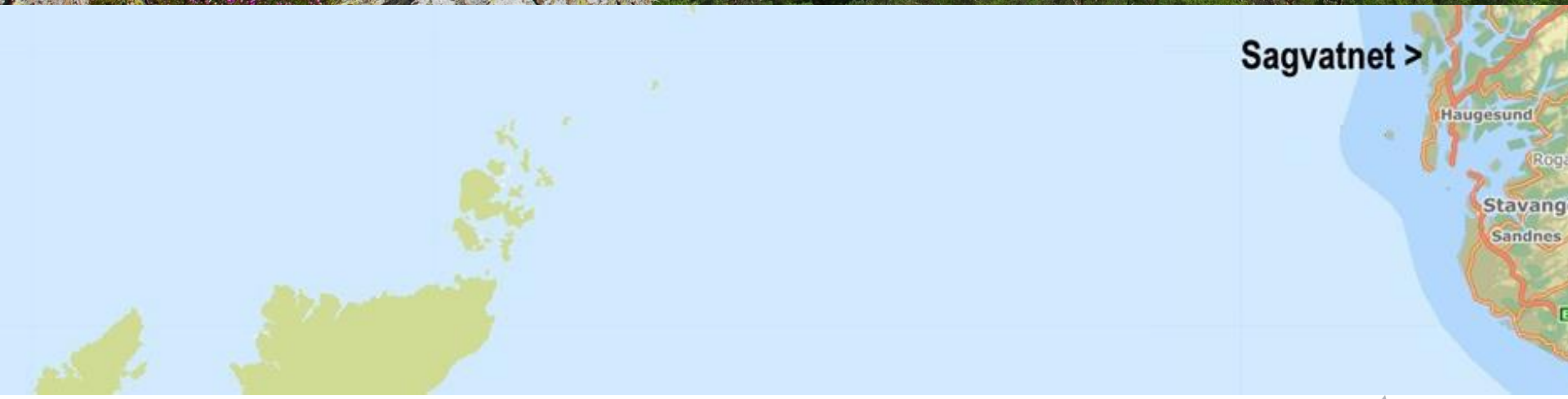
Mån
300m

Månemyra
(Mån's bog)
580m

"Peat they took among other places from Månemyra. Peder relates that they found the roots of large trees up there"
-1987 oral history account by Peder Østebø, who lived at Mån until 1914.


Scree formed in the period of deforestation in Fidjadalen, and throughout SW Norway, is being directly colonised by birch and aspen, forming new soils, sequestering carbon, and reducing erosion

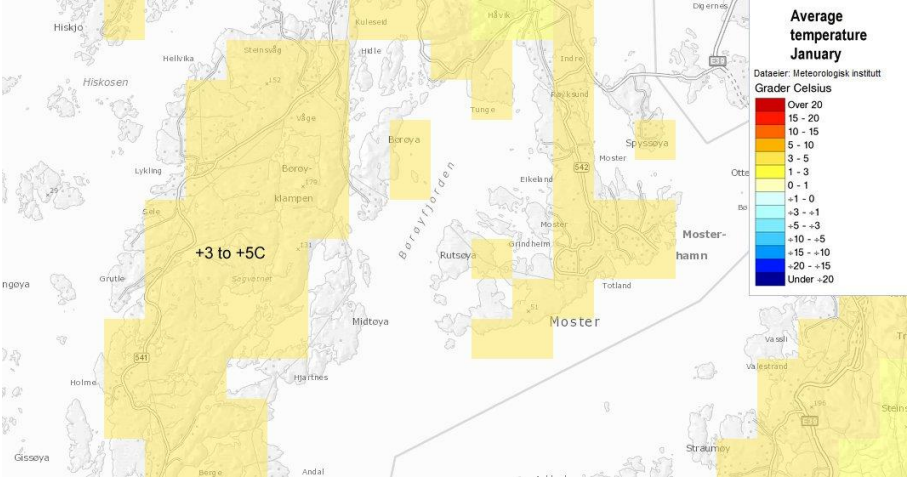
3. Sagvatnet, Bømlo

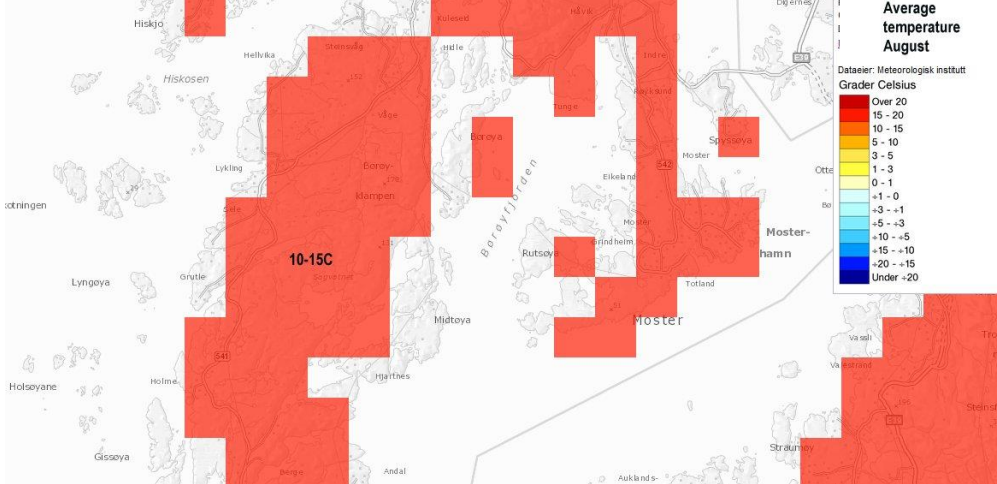


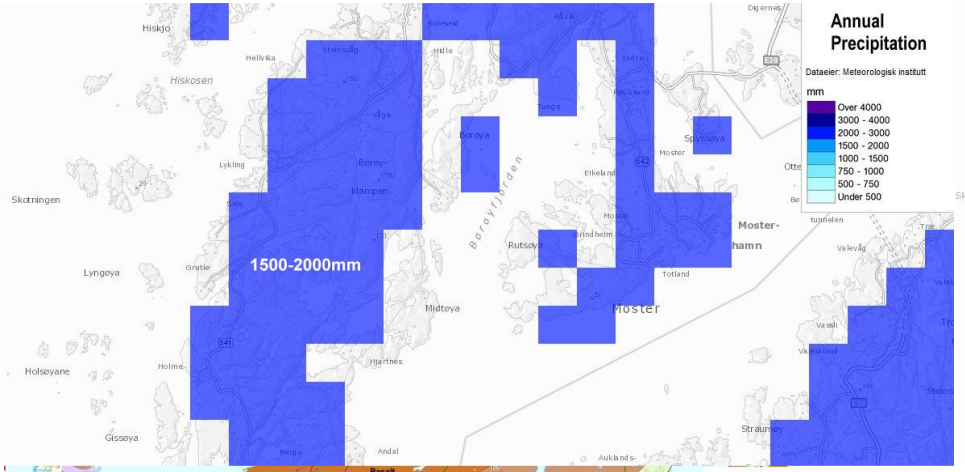
Sagvatnet

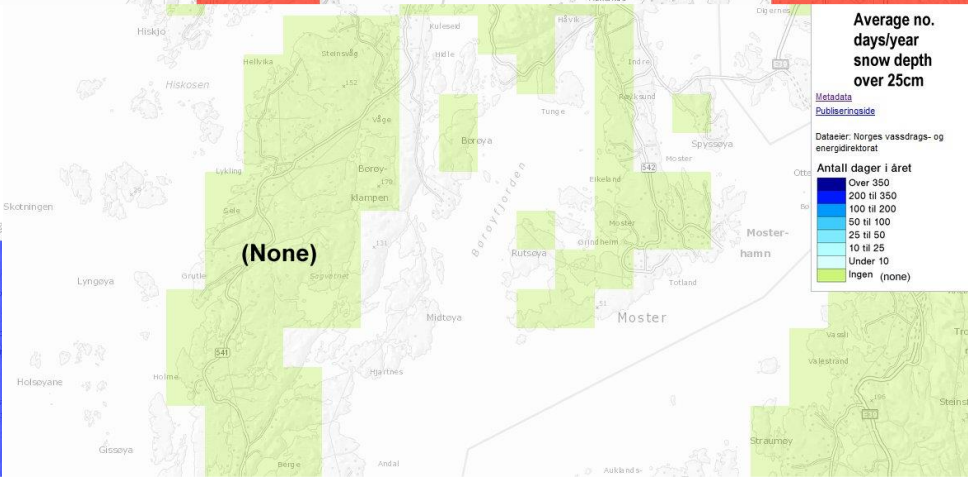
500 m

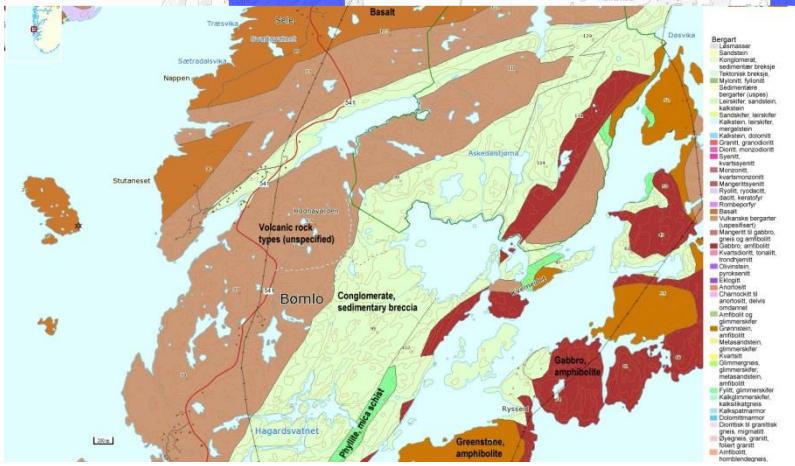
- Woodland is predominantly Scots Pine.
- Capercaillie breed.







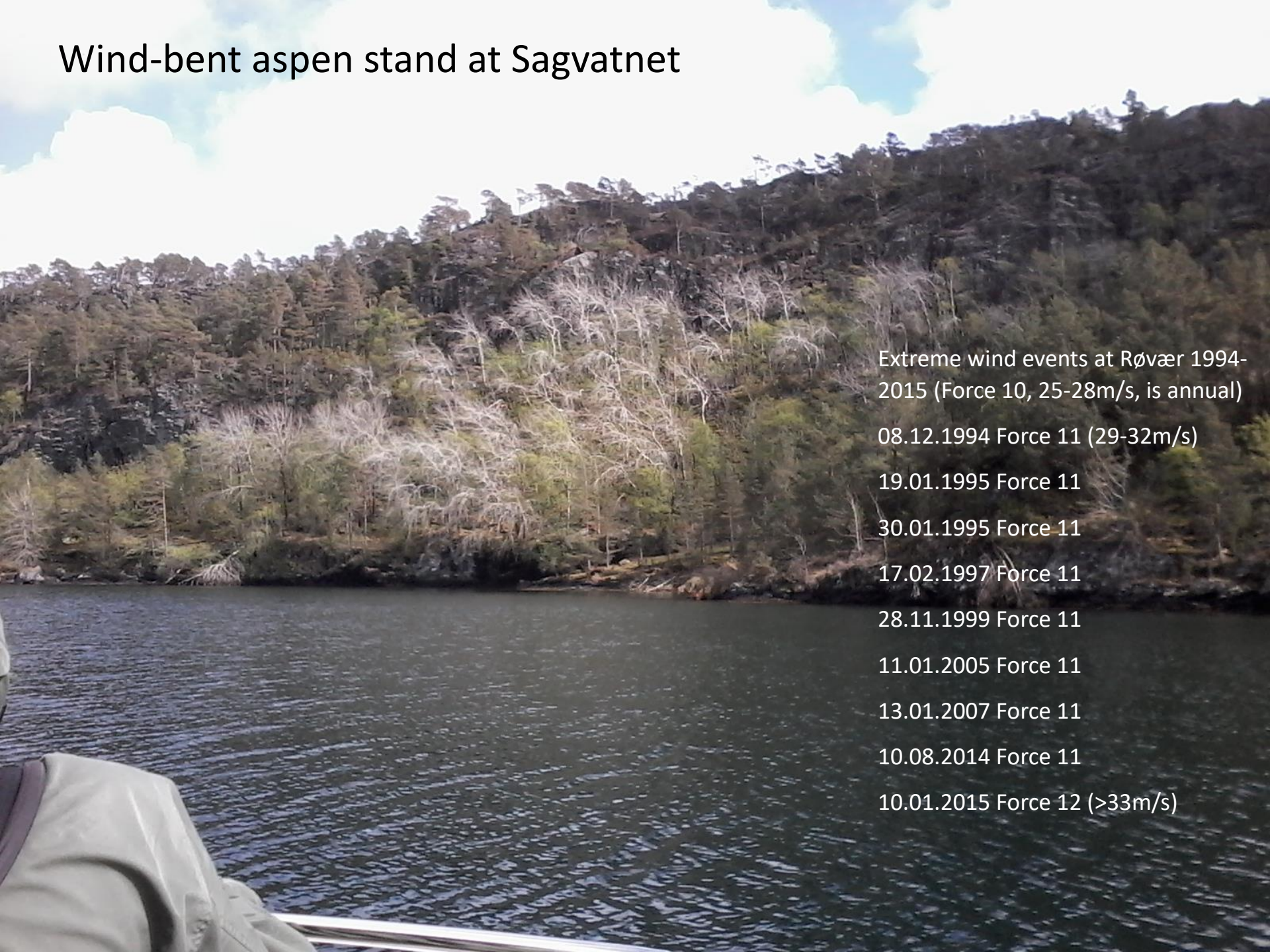




All trees at Sagvatnet are less than 150 years old. Most are under 100 years old. All are naturally regenerated. Previously coastal moor from Bronze Age until decline in grazing pressure associated with mass (voluntary) emigration in the later 19th and early 20th centuries.

(Steinsvåg, M.J. 2013. Forvaltingsplan for Sagvatnet naturreservat: Naturkvalitetar, bevaringsmål og forvaltingstiltak – Fylkesmannen i Hordaland, Mva-rapport 8/2013.)

Wind-bent aspen stand at Sagvatnet



Extreme wind events at Røvær 1994-2015 (Force 10, 25-28m/s, is annual)

08.12.1994 Force 11 (29-32m/s)

19.01.1995 Force 11

30.01.1995 Force 11

17.02.1997 Force 11

28.11.1999 Force 11

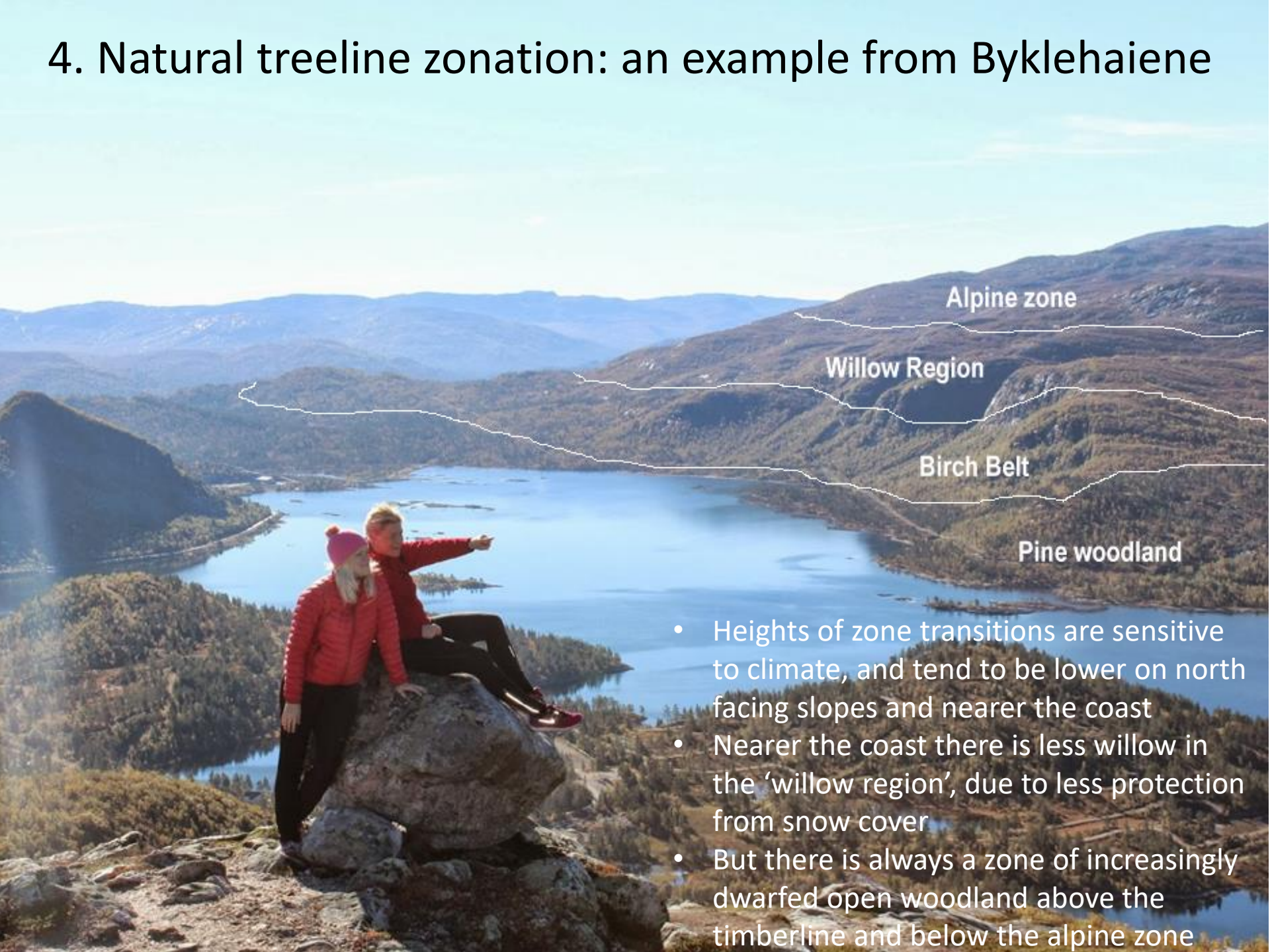
11.01.2005 Force 11

13.01.2007 Force 11

10.08.2014 Force 11

10.01.2015 Force 12 (>33m/s)

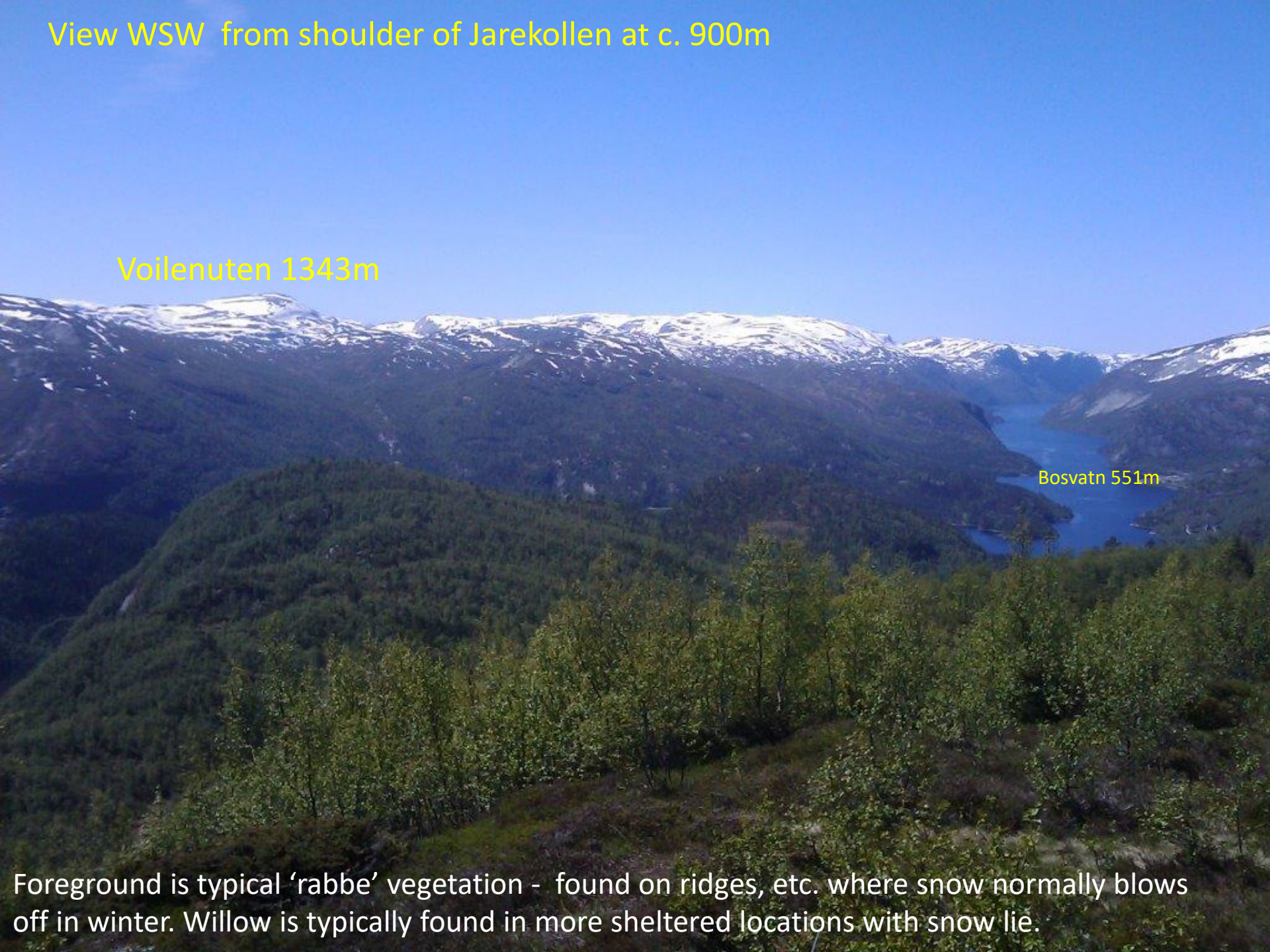
4. Natural treeline zonation: an example from Byklehaiene



- Heights of zone transitions are sensitive to climate, and tend to be lower on north facing slopes and nearer the coast
- Nearer the coast there is less willow in the ‘willow region’, due to less protection from snow cover
- But there is always a zone of increasingly dwarfed open woodland above the timberline and below the alpine zone

Pine-birch belt transition, Bykleheiane


Birch belt on Hovdenut
Hartevatnet 759m



Foreground is typical ‘rabbe’ vegetation - found on ridges, etc. where snow normally blows off in winter. Willow is typically found in more sheltered locations with snow lie.


Bygdeheii 1306m
c. 750m

Seter: summer farm, shieling. Typically cows were grazed (and milked) in the innmark, sheep and goats grazed in the 'utmark', or rough grazing, in summer. Hay harvested from suitable grass-dominated slopes. Animals were driven to lower levels for the winter.

Willow zone c. 950m

(Typical ‘willow zone’ vegetation. The term means the zone where montane willows are common; not that the zone is all willow, or even dominated by willows. Birch, rowan, juniper and aspen are typically common as well; with krummhölz pine in some places.

This area was open moor 50 years ago; regeneration has followed decline in grazing pressures. Cows and sheep are still grazed at this site in summer at moderate densities; wild browsers include moose and reindeer)

NINA

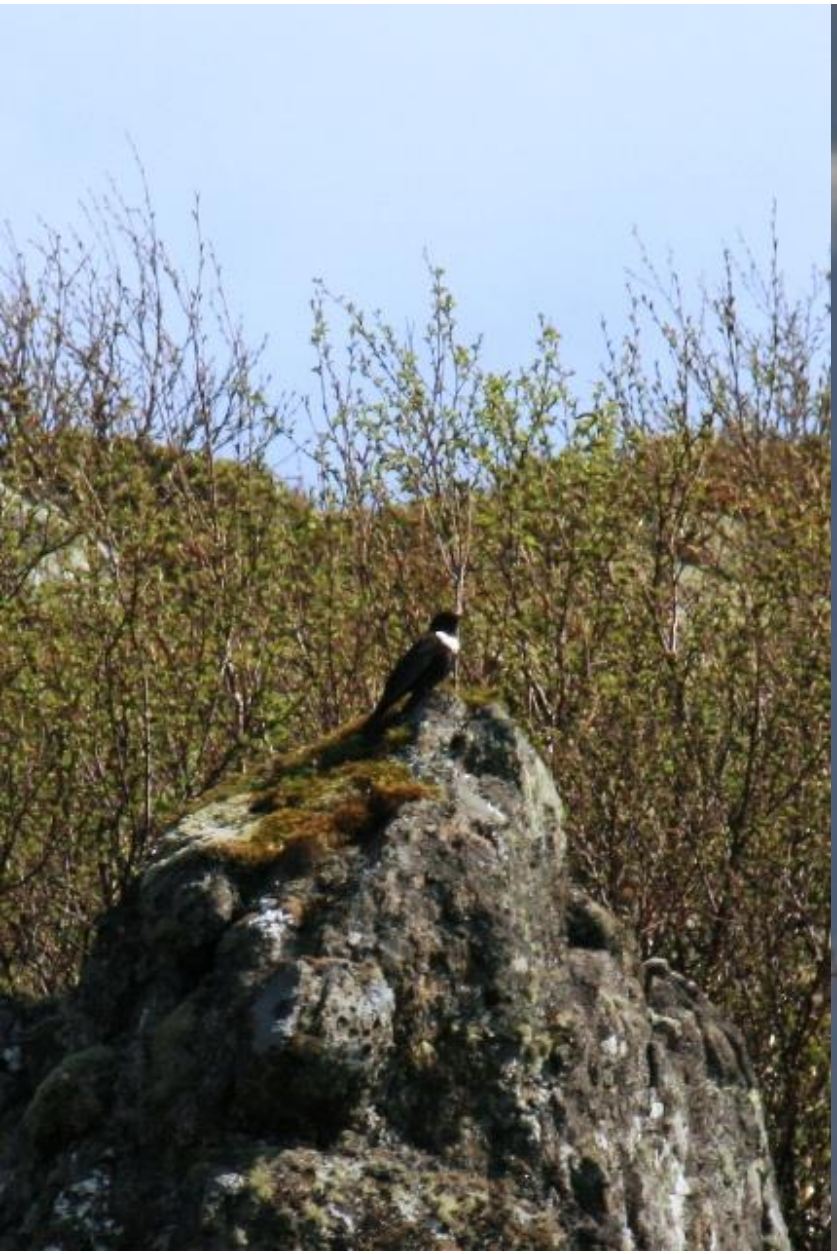

Sloaros 1045m


Breeding
Population, pairs
Norway: 500 000 -
1 000 000
Scotland: 0-1


Breeding population, pairs
Norway: 200 000 – 500 000
Scotland: 0-3


Norway: ’common in montane birch zone’
Scotland: not known to breed



Norway: ’especially common in willow zone’; no evidence of decline. ‘Least Concern’.
Scotland: Severe decline in the UK breeding population size, of more than 50%, over 25 years (Red listed, BDp1)


Hovatn 1100m

Hovden, Bykle

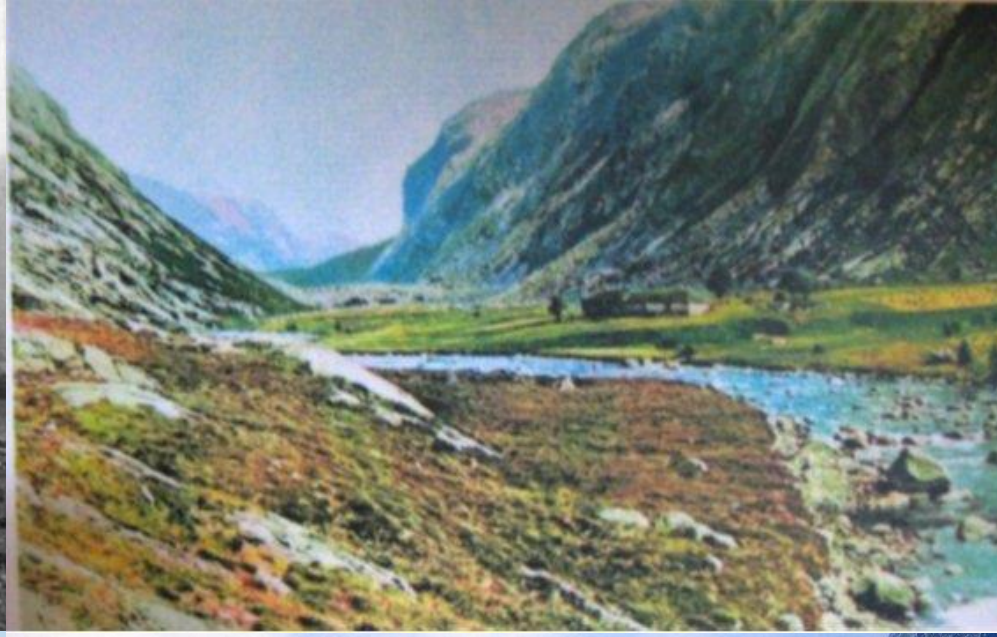


Photo: Erlend Tøssebro