



Landscape-scale change and ecosystem services in Norway

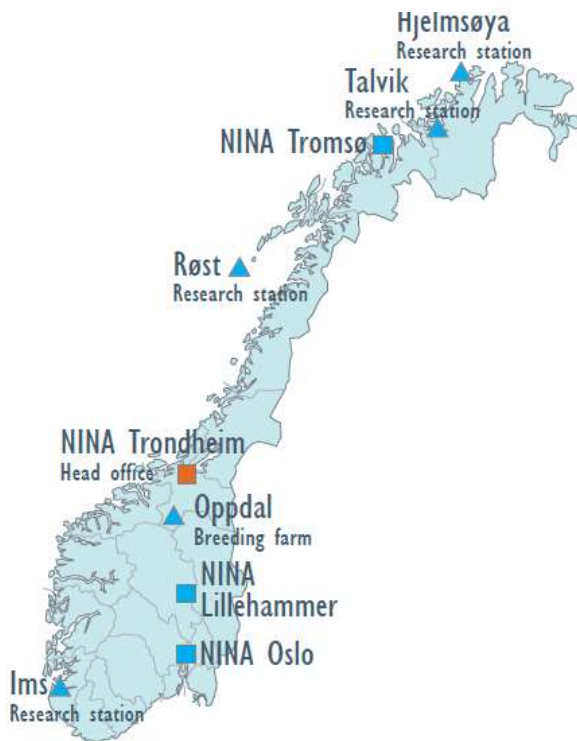
Duncan Halley

duncan.halley@nina.no



[NINA webside
\(English\)](#)

[NINA brochure
\(English\)](#)



- The Norwegian Institute for Nature Research (NINA) is Norway's leading institution in the areas of nature management, monitoring, biodiversity, ecosystems services, sustainability, and community development of natural resource management.
- It is a non-profit making, nongovernmental foundation.

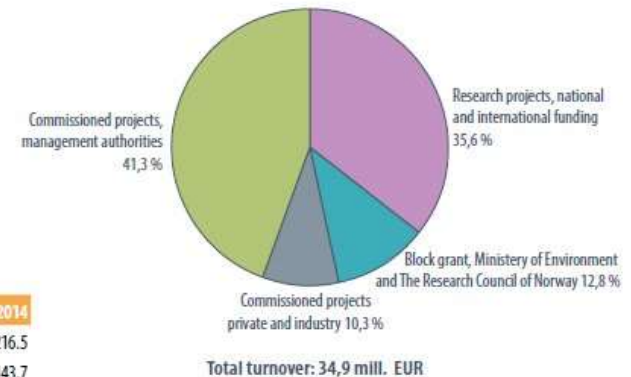
NINA's key statistics for 2015

Number of publications	2015	2014
Scientific papers	189	201
NINA reports	146	124
External lectures and presentations	721	600
Media coverage	2482	2548
News stories published at nina.no	101	79
Unique visitors to nina.no website	105 454	90 902

Number of employees	2015	2014
Total	231	222
- women	33.8 %	34.2 %
- women in scientific positions	26.3 %	25.5 %
- female PhD students	50.0 %	66.7 %

Number of employees (full-time equivalents)	2015	2014
Total	222.4	216.5
- scientific staff	145.4	143.7

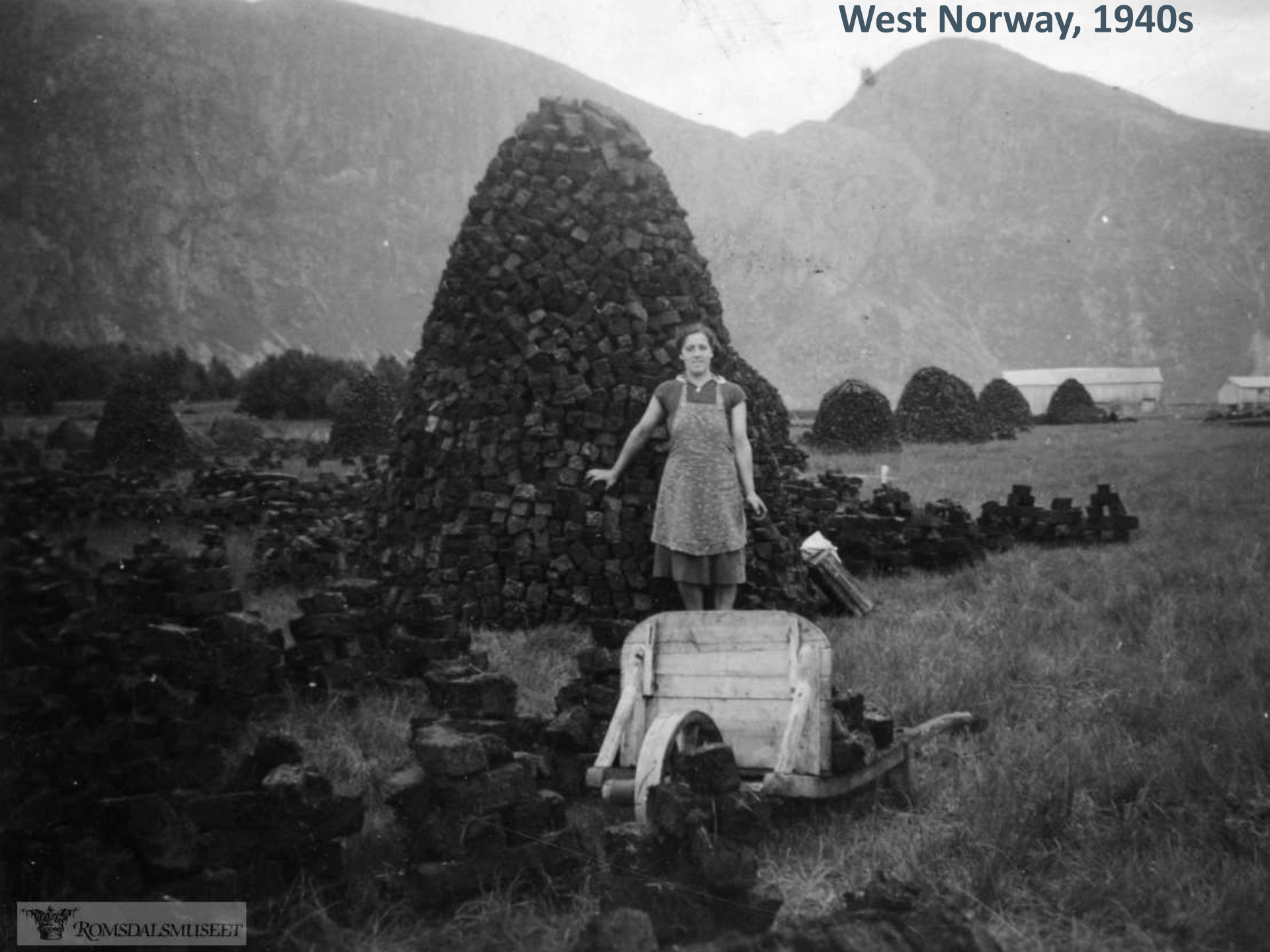
NINA's turnover 2015







West Norway, 1940s



Oslibakken, Rogaland 1911



DSS 2075



Old peat digging with pine roots, west Norway, 1917



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.



Fidjadalen



Fidjadalen 2007

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



c. 1885



1960



2004



Note woodland regrowth (1960, 2004)
on bare rock slope, upper right of 1885
image

Geiranger
(west Norway)

www.tilbakeblikk.no

Kvenadhøla sawmill, inland Rogaland

Ca. 1890

Kvenadhøla was one of many sawmills in inland SW Norway that sawed lumber using water power for export - in the later 17th to 19th centuries.

The dominant destination for the timber was Scotland and Ireland, and it led to further substantial declines in the remaining forests of inland SW Norway



2004

<Våskeland: Old hill farm

Røynes: Old hill farm

Tjellås: Old hill farm

<http://www.kvinesdal.no/farmregister>

Elevation 352m asl



Oslibakken near Stavanger, 1911



Oslibakken near Stavanger, 2015



X=approximate point of
shot 1911 photograph

Photo: Erlend Tøssebro

Fonnes, Hordaland 1971



Pines planted 1907 >

Fonnes >

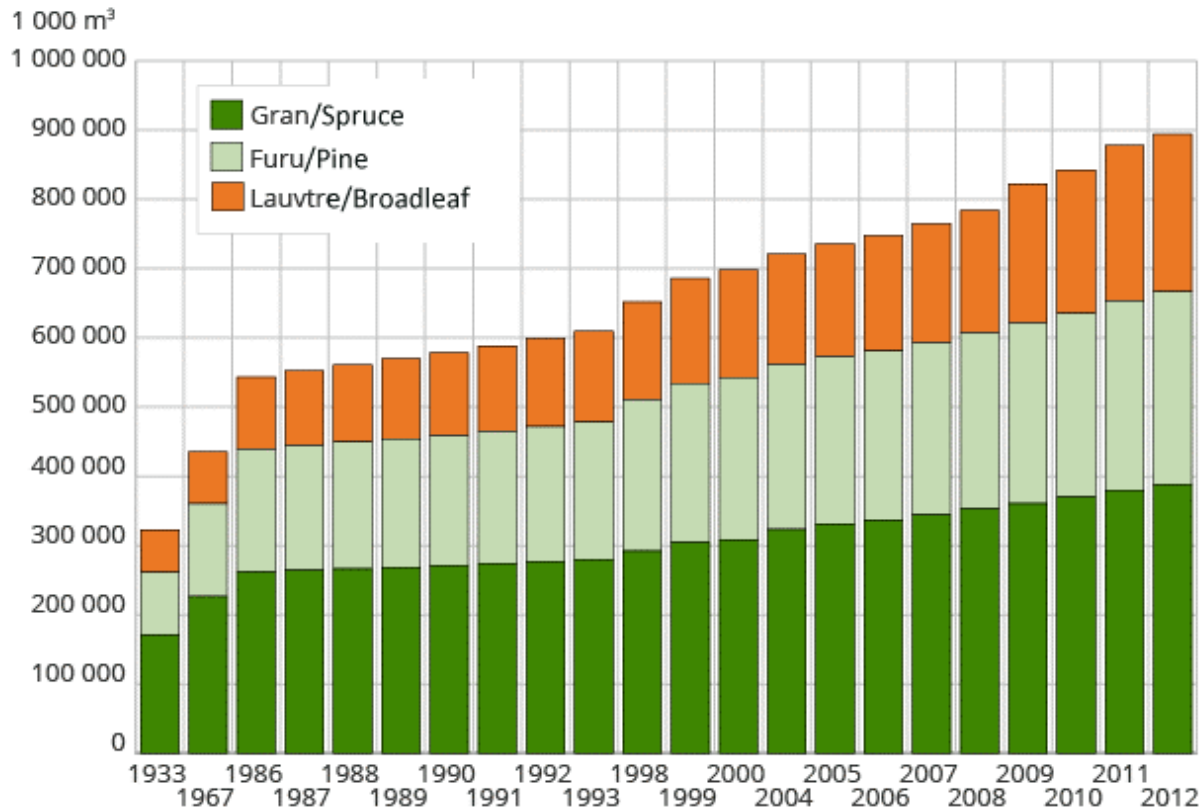


Fonnes, Hordaland 2005



Grazing pressure reduced from 1975

Stående kubikkmasse¹ under bark, etter treslag. 1933-2012.
Standing timber (excl. bark) by tree type, Norway, 1933-2012



% increase over period:

Spruce 127%

Pine 209%

Broadleaf 269%

Spruce and pine increases in part due to natural regeneration and in part due to forestry practices.

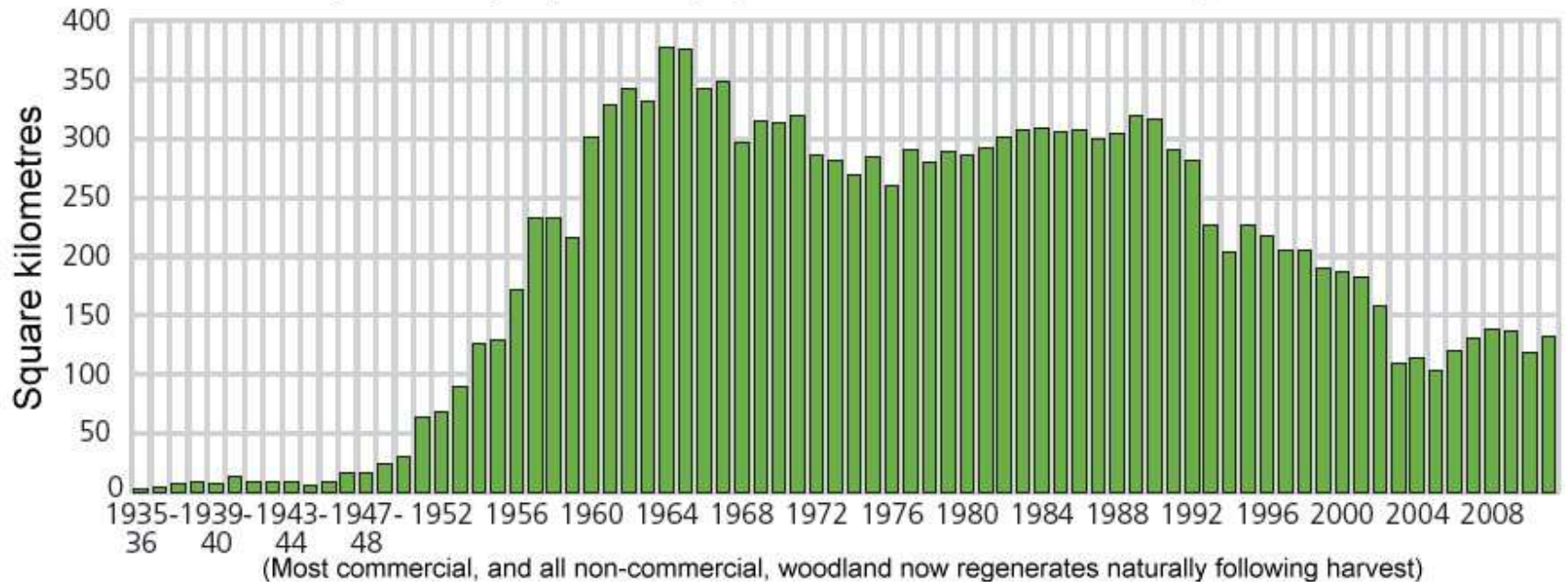
Broadleaf increases almost entirely due to natural regeneration.

NB Figures do not include areas above the commercial timberline, i.e. montane birch and willow woodlands.

¹Fra og med takseringsperioden 2007-2011 er Finnmark inkludert.
 Kilde: Norsk institutt for skog og landskap. Landsskogtakseringen.

(Pine and broadleaf are concentrated in the more oceanic and previously most deforested regions)

Forestry area physically planted with seedlings, 1935-2011



Kjelde: Skogkulturstatistikk, Statistisk sentralbyrå.

Data for all Norway

Future trends in land cover



Adapted from: *

Anders Bryn , Pablo Dourojeanni , Lars Østbye Hemsing & Sejal O'Donnell (2013) A high-resolution GISnull 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.



0 100km

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

NB Assuming current land use patterns and trends do not change significantly. Much of the 'potential natural forest regeneration' mapped is occurring now, but has not reached the >2.5m height threshold. 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) *Norw. J. Geog.* 62:251-270; Hofgaard et al (2010) *Plant Ecol. & Diversity* 3:19-27).

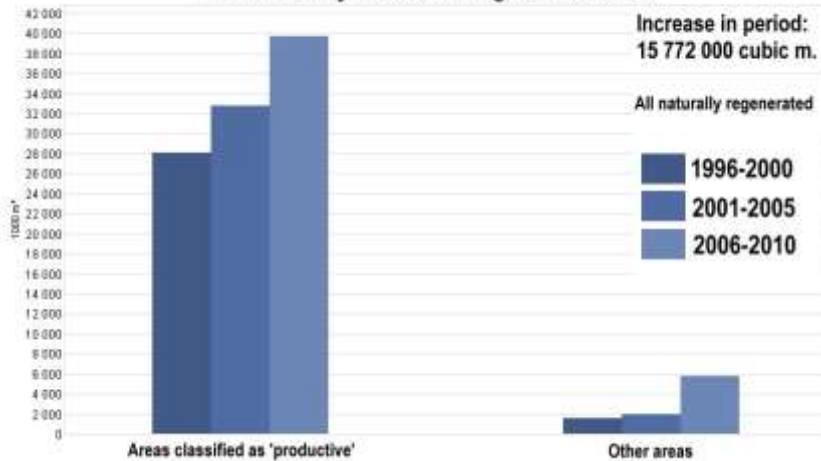
Woodland expansion: area



- **The total area of forest classified as ‘productive’ increased in SW Norway by 55% 1963-93** (Source: [Norwegian Forest & Landscape Institute](#)).
- ‘Productive’ is a forestry statistics term. It means potential increase in harvestable timber volume of $>1\text{m}^3/\text{ha}/\text{year}$, whether or not harvested for timber.
- **Between forest inventory periods 2005-09 and 2010-14 the annualised increase in area of woodland in West Norway was 305 sq. km/year, or 2.6% of the land area over 5 years.** (Data: Statistisk sentralbyrå)
- Almost all of the expansion in area in the period 2005-2014 has been through natural regeneration.

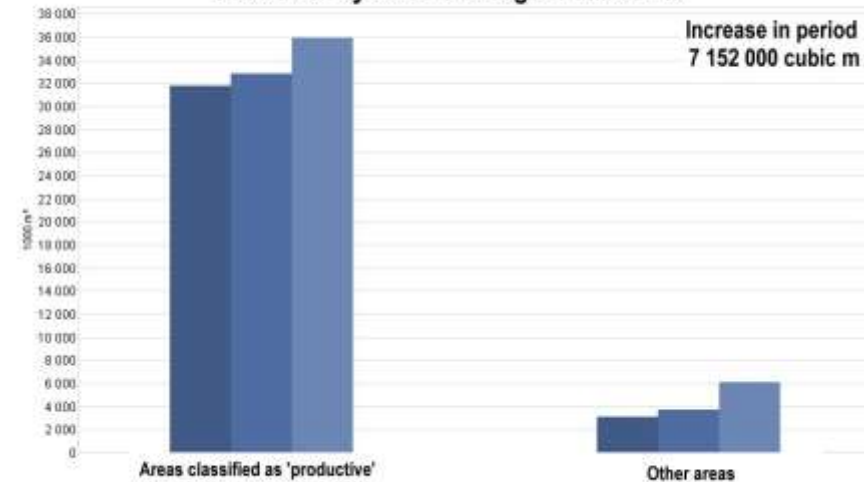
Woodland expansion: standing mass of timber and carbon sequestration in West Norway

Standing cubic mass deciduous timber (1000 m3)
West Norway statistical region 1996-2010



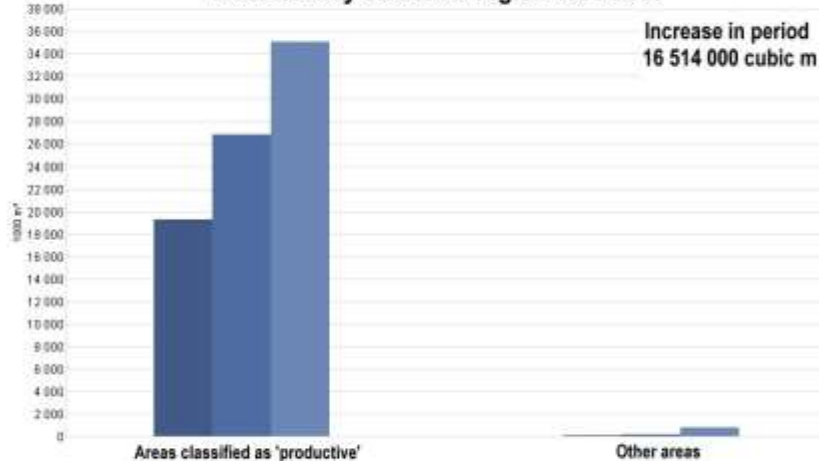
Kilde: Statistisk sentralbyrå

Standing cubic mass pine timber (1000m3)
West Norway statistical region 1996-2010



Kilde: Statistisk sentralbyrå

Standing cubic mass spruce timber (1000 m3)
West Norway statistical region 1996-2010



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 16/11/15 (€8.46/tonne CO²): €26.6 million/year
- Does not include bark, branches, leaves, root system, or soil carbon.

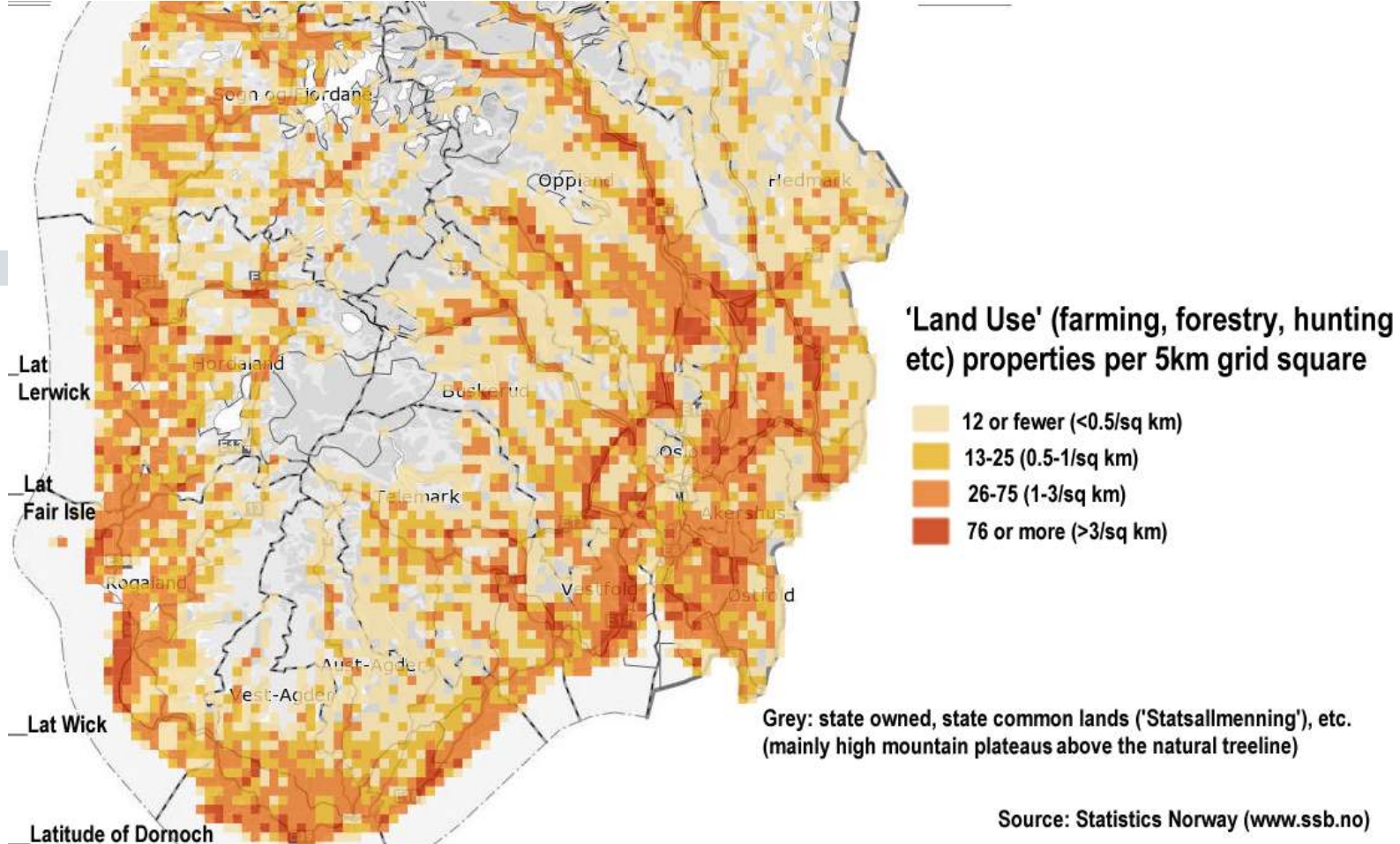
Summary: Recent landscape history

- SW Norway has been wholly to largely deforested for centuries to millennia.
- It has been reforesting, in part through forestry practices but mainly through natural regeneration, from the later 19th century and especially since the 1950s. In recent decades reforestation by natural means has been very rapid.
- Research* has determined that this widespread natural regeneration has been due to reductions in grazing pressures and associated landuses such as muirburn and fuelwood collection.
- This was caused by mass (voluntary) emigration to N. America in the period 1862-1914; and by changes in social and economic conditions from the 1950s.
- 90% of the coastal region moorland of the 19th century is now either reclaimed arable/improved pasture or (mainly) woodland (Source: [Norwegian Environment Agency](#)).
- Most new woodland is of an open structure with an understory remaining suitable for purposes such as livestock grazing at moderate densities. Most is so used.

*e.g. Ålmås et al (2004) *Norwegian agricultural history (Tapir, Trondheim)*; Bryn (2008) *Norw. J. Geog.* 62:251-270; Hofgaard (1997) *Glob. Ecol. and Biogeog. Lett.* 6:419–429; Hofgaard et al (2010) *Plant Ecol. & Diversity* 3:19–27; Olsson et al (2000) *Landscape Ecol.* 15: 155–170; Rössler et al (2008) *Erdkunde* 62:117-128.

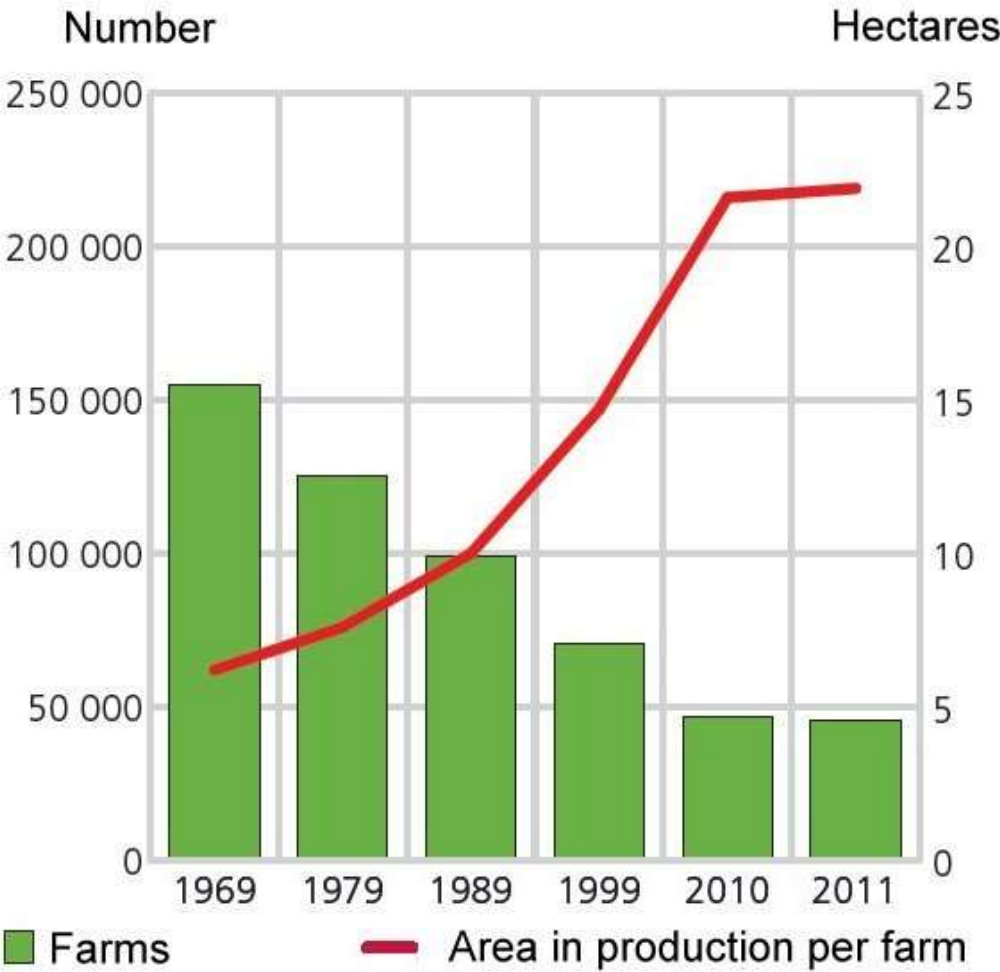
'Landbruk' – Land use

- 'Landbruk' (*pron. 'landbrook'*) is a central concept in understanding how land is used in Norway.
- 'Landbruk' literally translates as 'Land Use'
- But is usually translated into English as 'farming' or 'agriculture'. This can be misleading.
- 'Landbruk' is a wider concept. It means making a living from the land, most usually from diverse sources.
- Usually several income generating activities are carried out on any given piece of land, by the same owner/occupier landowner. Monocultural use is rare, except on arable fields.



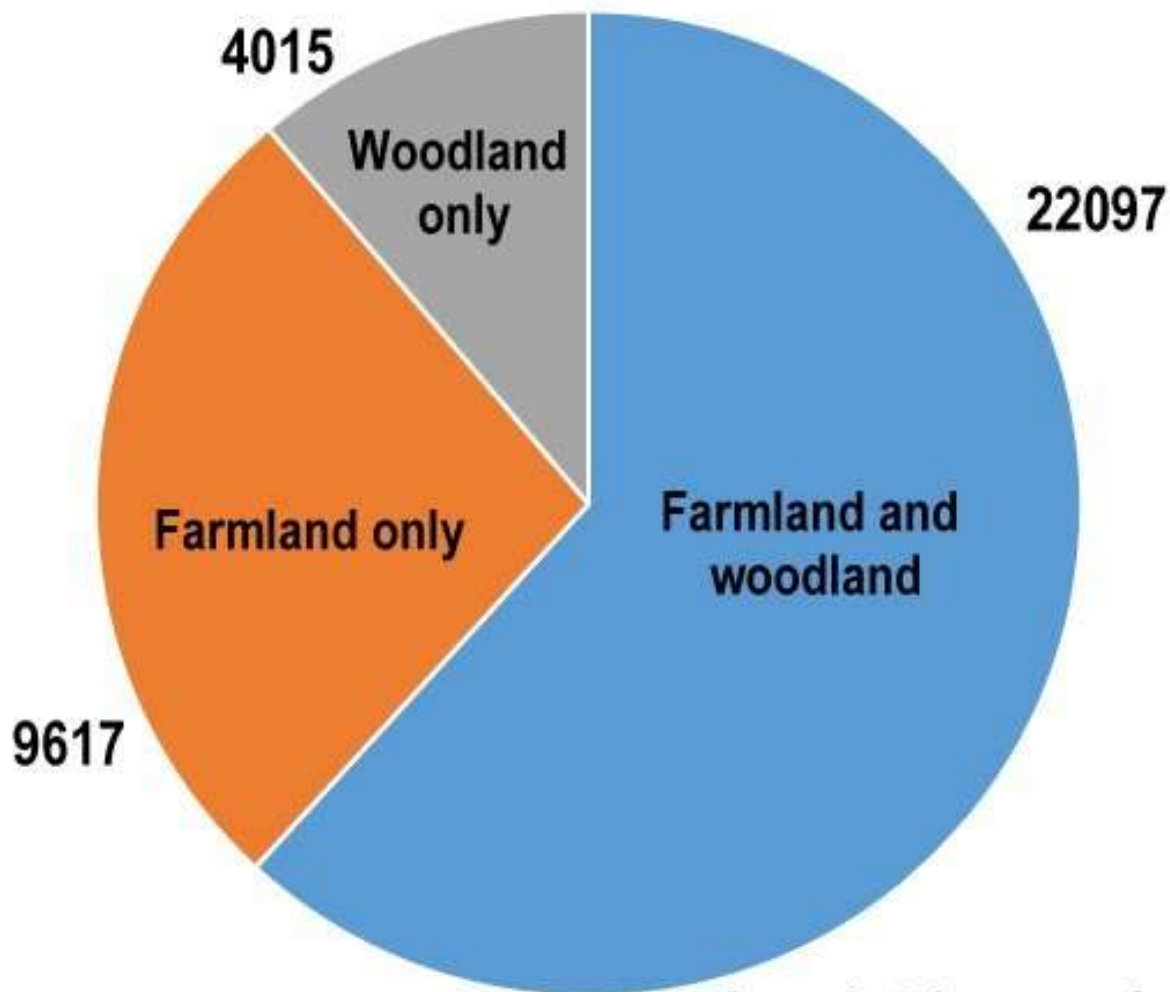
- Land use properties may not be subdivided.
- To inherit a land use property you must agree to live there, and work it, for at least five years
- To buy one, ten years and show a relevant qualification.
- Purpose: to keep ownership of the land, on the land; and so help maintain rural communities.

Number of farms practising agriculture, and average area of arable and improved pasture per farm, Norway, 1969-2011



Source: Farming statistics, Statistisk sentralbyrå

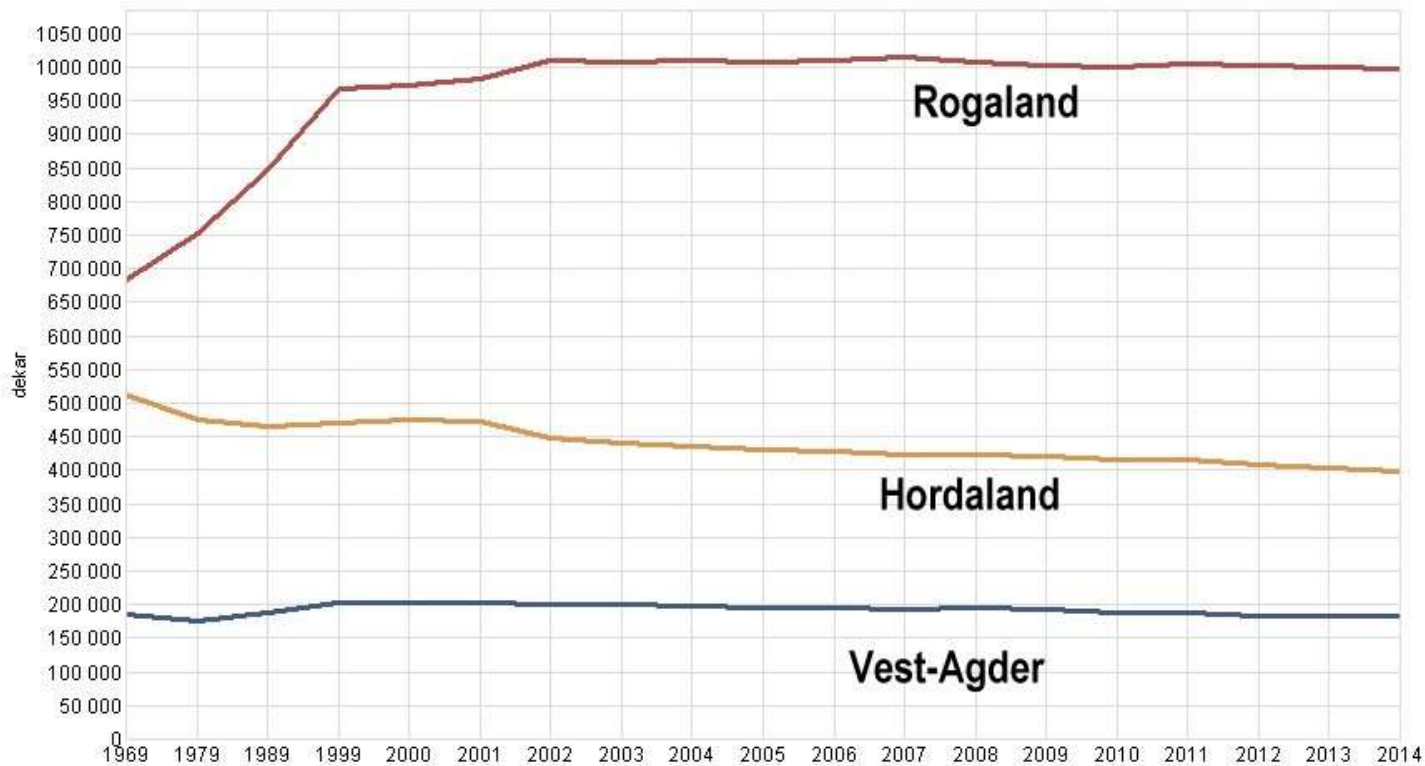
Land use properties with different combinations of farmland and woodland, SW Norway (Vest Agder, Rogaland, Hordaland), 2010



Source: Statistisk sentralbyrå



Area of enclosed fields in production by province, SW Norway, 1969-2014

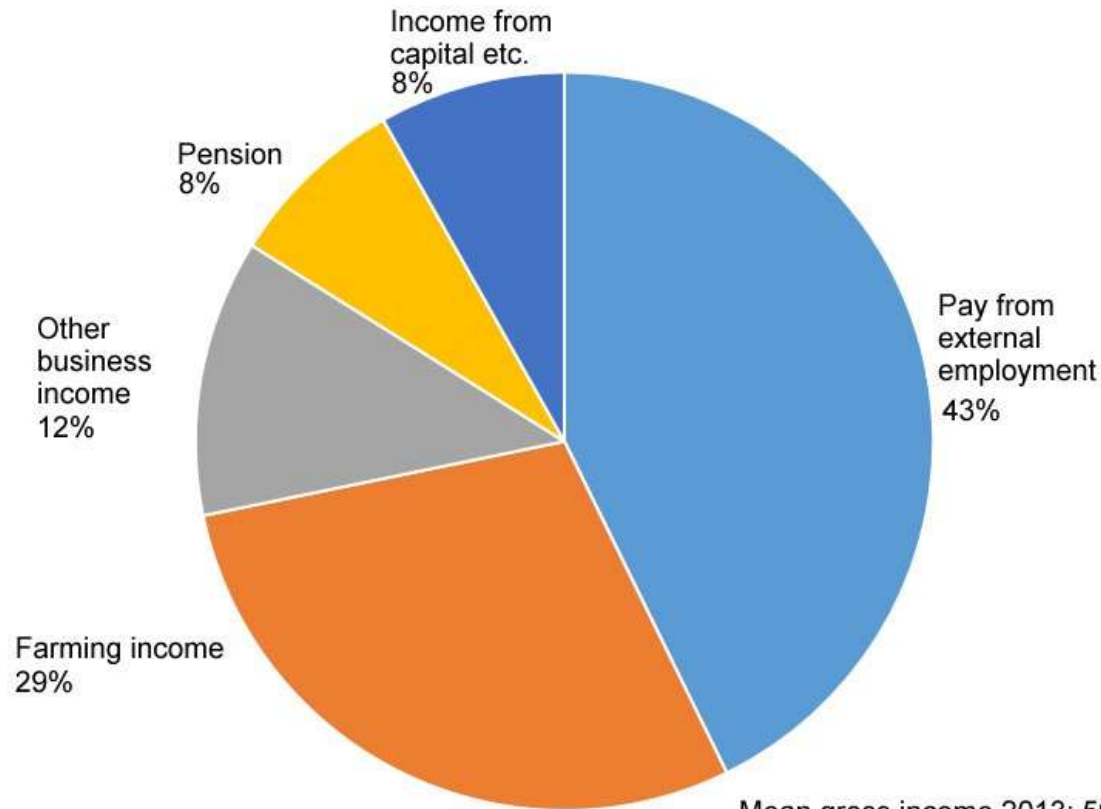


Kilde: Statistisk sentralbyrå

The increase in Rogaland (300km²) is due to conversion of moorland to arable and improved pasture.

Slow declines in Hordaland and Vest-Agder largely due to small outlying fields going out of production.

Average % farm owner's income by source, Norway, 2013



Mean gross income 2013: 568 700kr
(€75000 at 2013 exchange rate)

Source: Farming statistics, Statistisk sentralbyrå

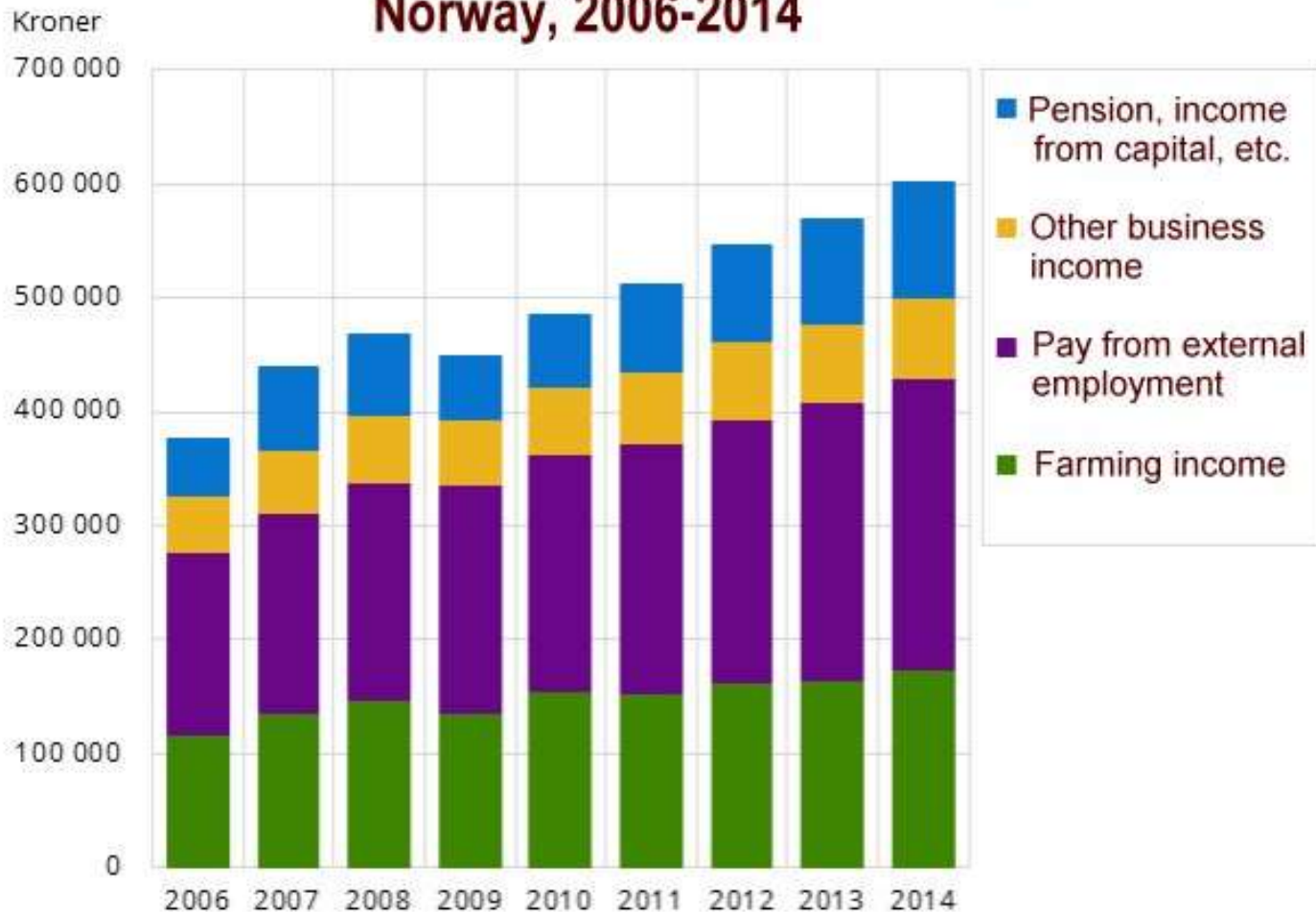
6.4% of the population of SW Norway are resident on Landbruk properties.

While ownership is individual, properties are typically worked by families.



Photo: <http://www.landbruk.no/>

Farm owner's income by source, average, Norway, 2006-2014



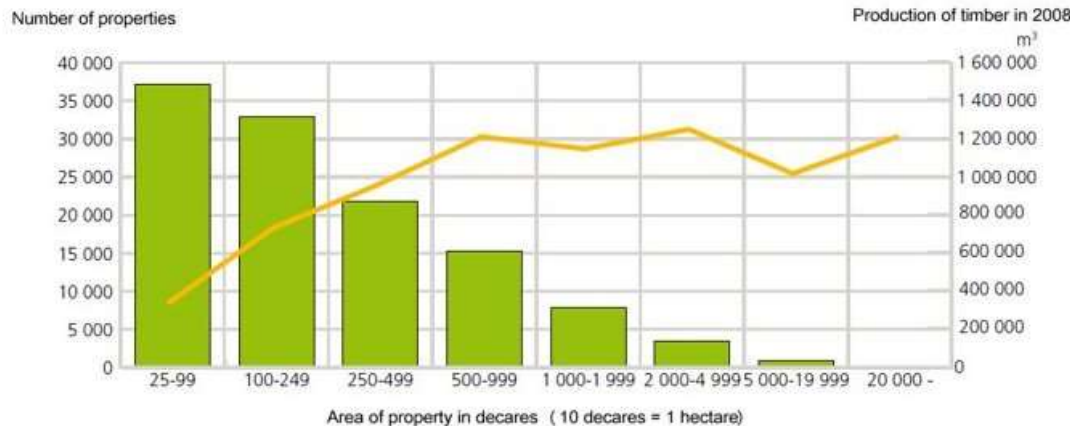
Kilde: Statistisk sentralbyrå.

Woodland

<http://www.nordicforestry.org/facts/Norway.asp>

Ownership structure

- 119600 woodland proprietors in 2008 (Total population: 4.9 million)
- Average property 58 hectares 'productive woodland'*
- 97% of owners private individuals
- 80% of area owned by private individuals
- 20% of area owned by forestry companies, state, etc.
- Forestry employs 3900 full time equivalents in direct timber harvesting
- The wider industry (processing etc) employs 22000 full time equivalents;
farm woodland employs 5400FTEs in nonforestry activities (not including livestock grazing)



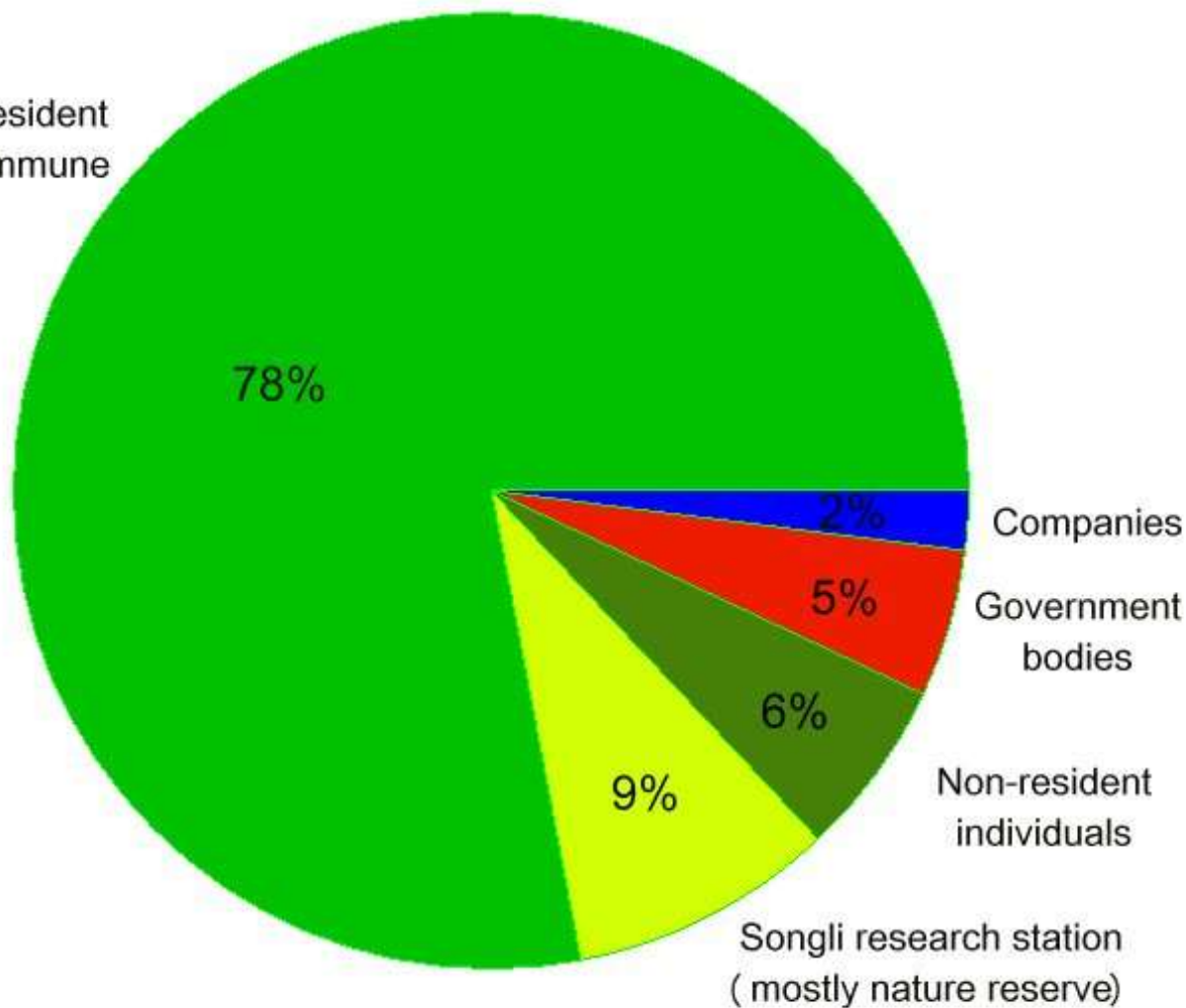
(all Norway)

Kjelde: Strukturstatistikk for skogbruket, Statistisk sentralbyrå.

*definition: area with annual growth of woody mass >1m³/ha

Forest ownership in Orkdal kommune, Norway

Individuals resident
in Orkdal kommune



Data by area.

Source: Orkdal kommune

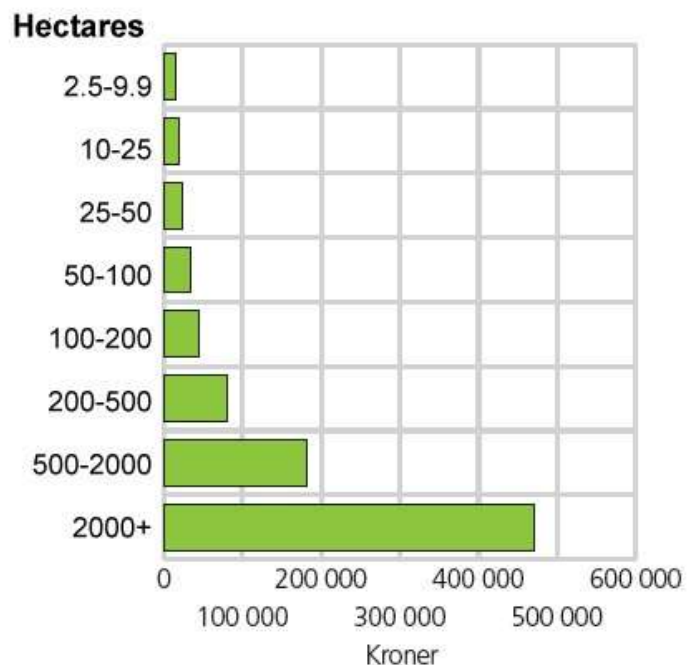
Forestry cooperatives



- Most forest owners belong to regionally-based forestry cooperatives
- These do the bulk of timber management, harvesting and sales
- This allows for investment in modern machinery and other economies of scale
- Woodland is exploited for other purposes (hunting, grazing, recreational sales, etc.) by the landowner individually



Average income from forestry for private individuals owning woodland by woodland area, kroner

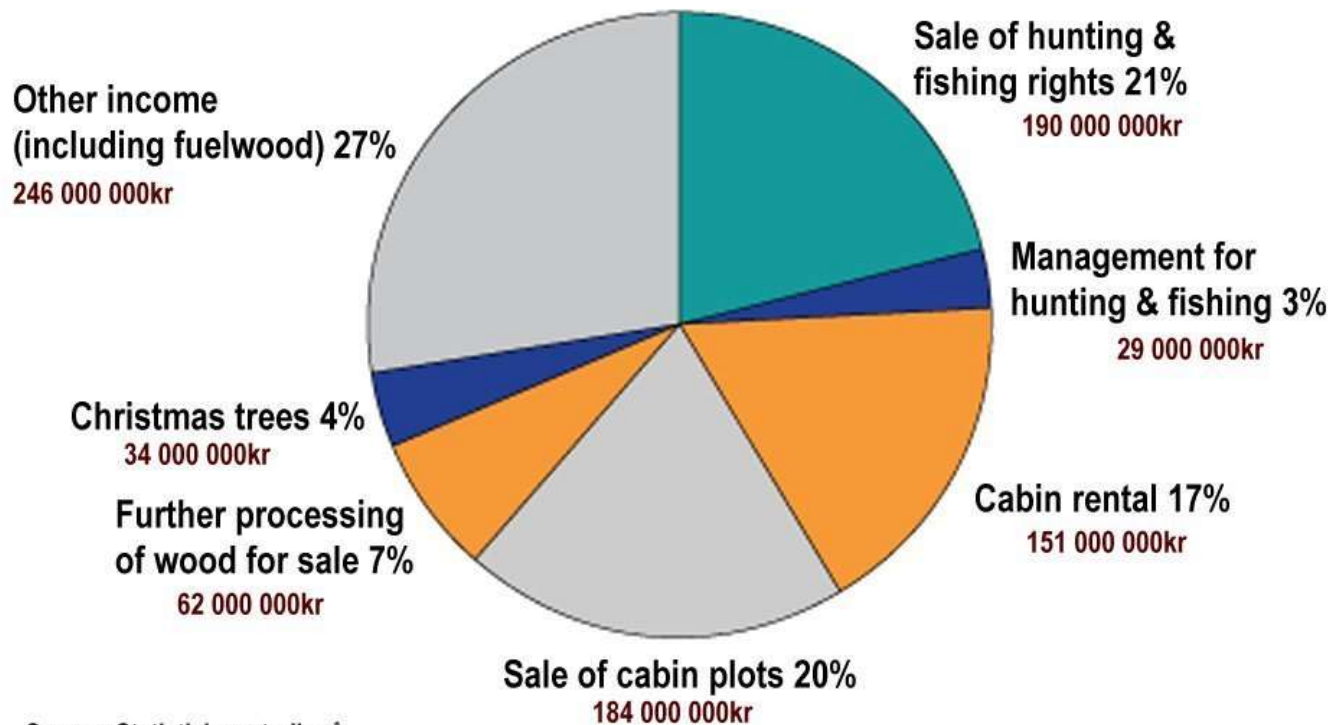


NB does not include non-forestry income from the same woodland

Kjelde: Inntektsstatistikk og skogstatistikk, Statistisk sentralbyrå.

100 000kr = €12 000, 2010 exchange rates

Non-timber sources of income from woodland, Norway, 2007



Source: Statistisk sentralbyrå

Total: 896 000 000kr (€110 000 000; £74 000 000; 2007 exchange rates)

Data for all Norway.

Does not include grazing of domestic animals.



- SW Norway was formerly strongly deforested; in coastal regions almost completely so since at least the Bronze Age.
- It 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.
- Most land is privately owned; owner-occupation is typical and strongly encouraged by government policy.
- Most Landbruk properties are an element in a wider family income

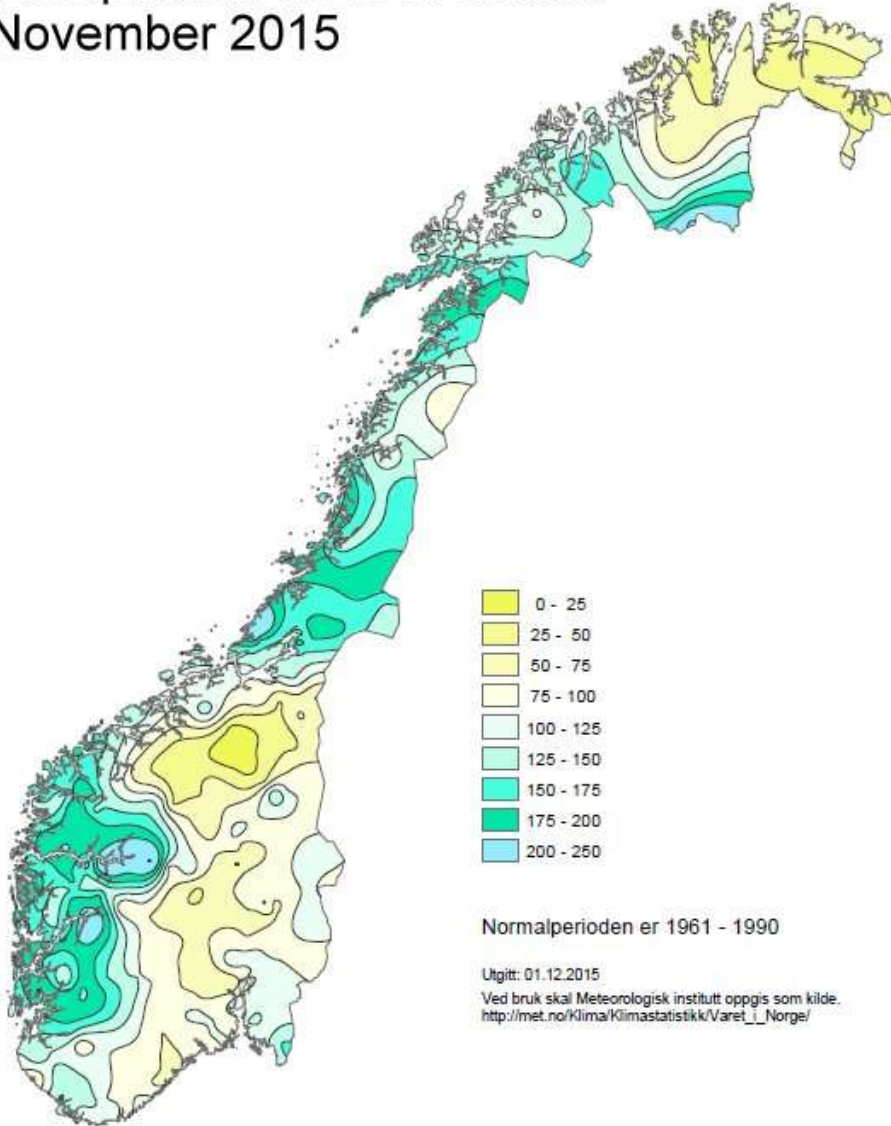


Photo: Erlend Tøssebro



Severe weather and floods

Precipitation as % of normal
November 2015

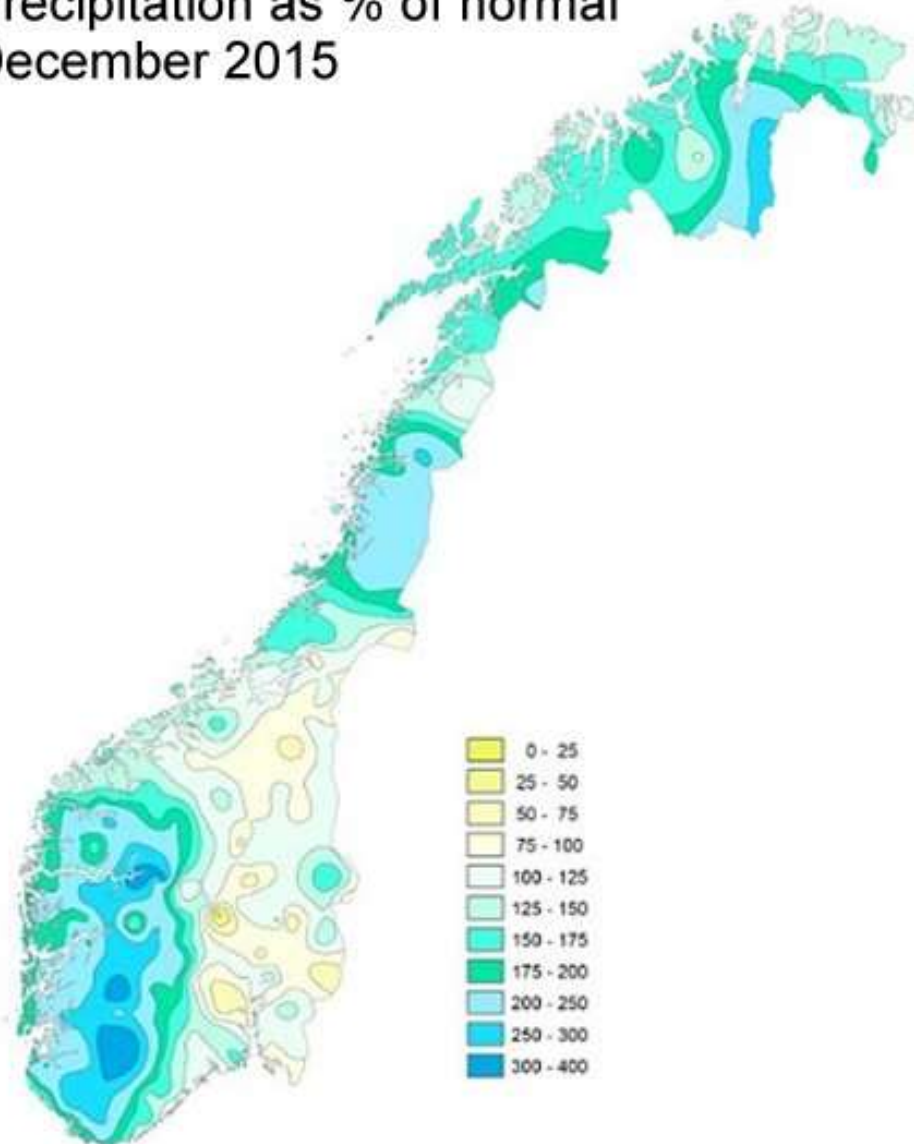


Normalperioden er 1961 - 1990

Utgitt: 01.12.2015

Ved bruk skal Meteorologisk institutt oppgis som kilde.
http://met.no/Klima/Klimastatistikk/Varet_i_Norge/

Precipitation as % of normal
December 2015

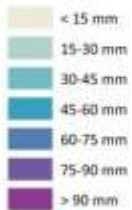


Storm Desmond (aka Synne)

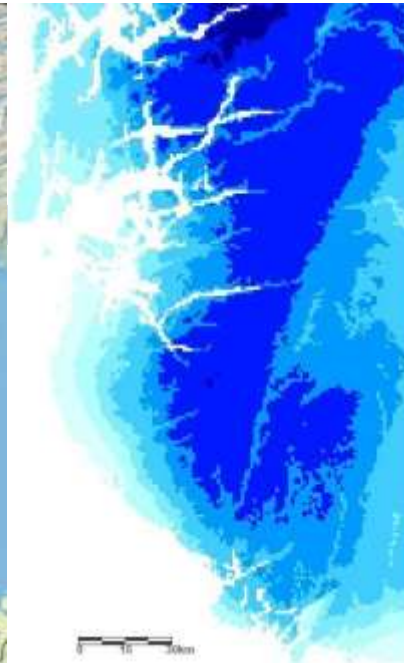


UK Floods "Storm Desmond"

Accumulated Rainfall 4-6 Dec 2015 (COSMO-EU Model)



Source: COSMO-EU, DWD
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Precipitation

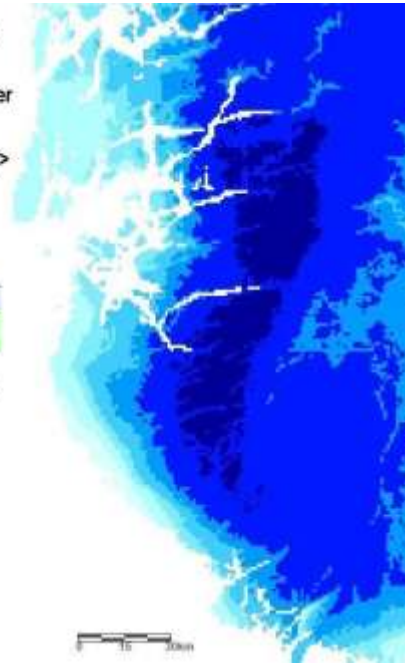
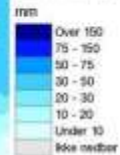
<07-07hrs 4-5 December

07-07hrs 5-6 December>

2015

▼ Dagestøber
 Observasjonsbasert
 Utløst: 17.12.2015 kl 13:46
 Basert på interpolerte vindstær
 Kartet viser nedbørsmenge siste 24 timer.
 Oppdateres ca kl 6, 8, 9, 12, 18, 19 og 21 normalt.

Dataseier: Meteorologisk institutt



Temperature

<07-07hrs 4-5 December

07-07hrs 5-6 December>

2015

▼ Temperatur

Observasjonsbasert
 Utløst: 17.12.2015 kl 13:46
 Basert på interpolerte vindstær
 Kartet viser midlere lufttemperatur for 24 timers perioden. Oppdateres ca kl 6, 8, 9, 12 og 21 normalt.

Dataseier: Norges værsbys- og eringsinstitutt



Storm Desmond (Synne) Damage

- **Storm Desmond/Synne:**

	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 Insurance claims estimates	€833.6 million	€31.8 million
Insurance 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)
- Detailed comparative research would be useful to compare river flood profiles and damage levels more rigorously
- And to explain the apparent very large differences in damage levels from an event of similar or greater magnitude in SW Norway
- The main land cover difference between the areas, a factor known to strongly affect runoff rates, is the difference in extent of woodland cover: Mainly wooded in SW Norway; very little woodland N England & S Scotland

Forestry

Much woodland is in clear-fell rotation for timber (as primary use)



A high-angle photograph of a lush, green forest covering a hillside. In the upper left corner, a small village with red-roofed houses and a winding road is visible. The forest is a mix of deciduous and coniferous trees. A dirt road or path is visible on the right side of the hill. In the foreground, there are large, mossy rocks and some green foliage. The sky is overcast.

Much is in mixed-use for timber, firewood, grazing, hunting, and forest products

Trees in this form of management are felled in small cuts, or selected individually ("plukkehøgst"). This results in a more varied woodland structure.



Grazing



Population of sheep, SW Norway (summer): c. 450 000 source: Statistisk sentralbyrå



Hunting



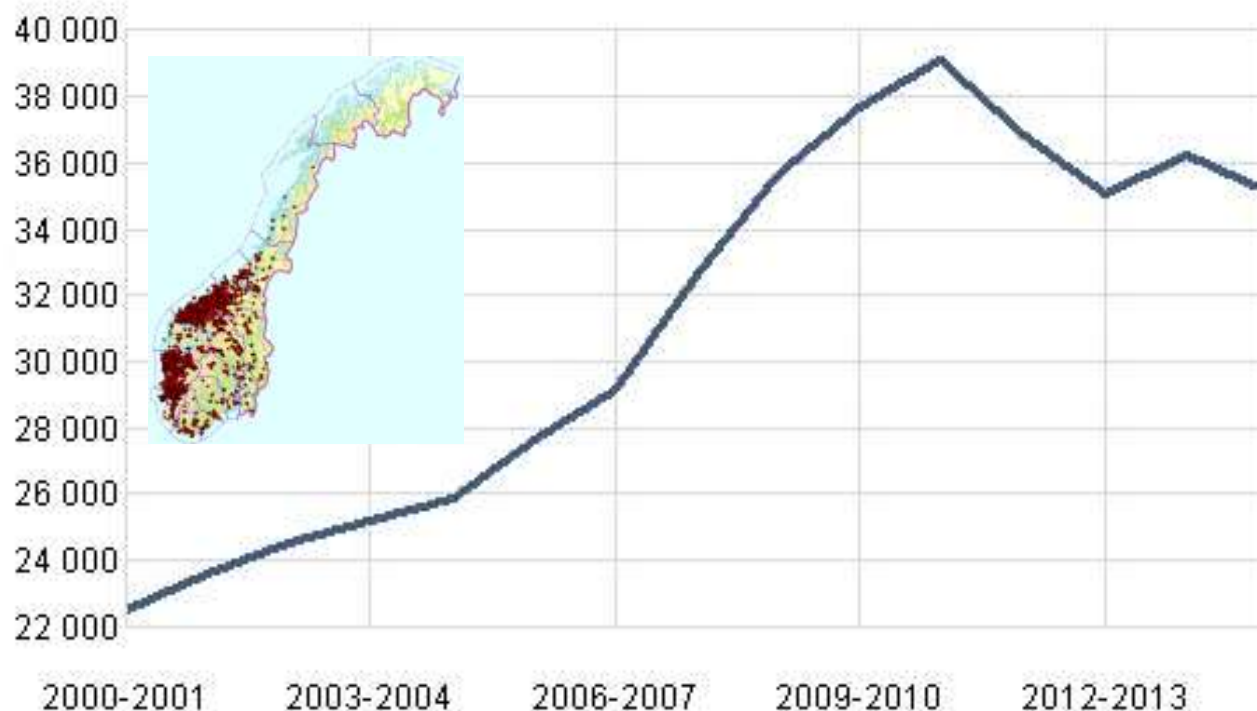


A hunting culture

- There were 473 100 registered hunters in Norway in 2014; 9.5% of the total population.
- 201 400 people paid the annual hunting licence fee (which pays for the game management system).
- Of whom 199 300 were Norwegian; 9% of adult males paid the fee.
- The game resource is a public asset.
- Hunting rights are owned by the landowner.
- Management is through a publically accountable system, in which government, communities, landowners, and hunters have clearly defined roles.
- Red and roe deer, and grouse, are the main game species in SW Norway



Red deer harvest, Norway 2000-2014



Source: Statistics Norway

Decline from 2010-11 hunting season is due to managed population reduction.

Source: Solberg, E. J., Strand, O., Veilberg, V., Andersen, R., Heim, M., Rolandsen, C. R., Solem, M. I Holmstrøm, F., Jordhøy, P., Nilsen, E. B., Granhus, A. & Eriksen, R. 2015. Moose, red deer and reindeer: Results from the monitoring program for wild cervids, 2012-2014. NINA Report 1177. 58 pp.

Reasons for managed reductions

- Carcass weights, body condition, and calving % all started to decline in recent years, due to incipient competition for food.

This indicated populations had risen to a point beyond the optimal for harvest purposes, and an animal welfare issue

- Reducing road accident risks.

- Reducing negative impacts on forestry and agriculture.



Gathering

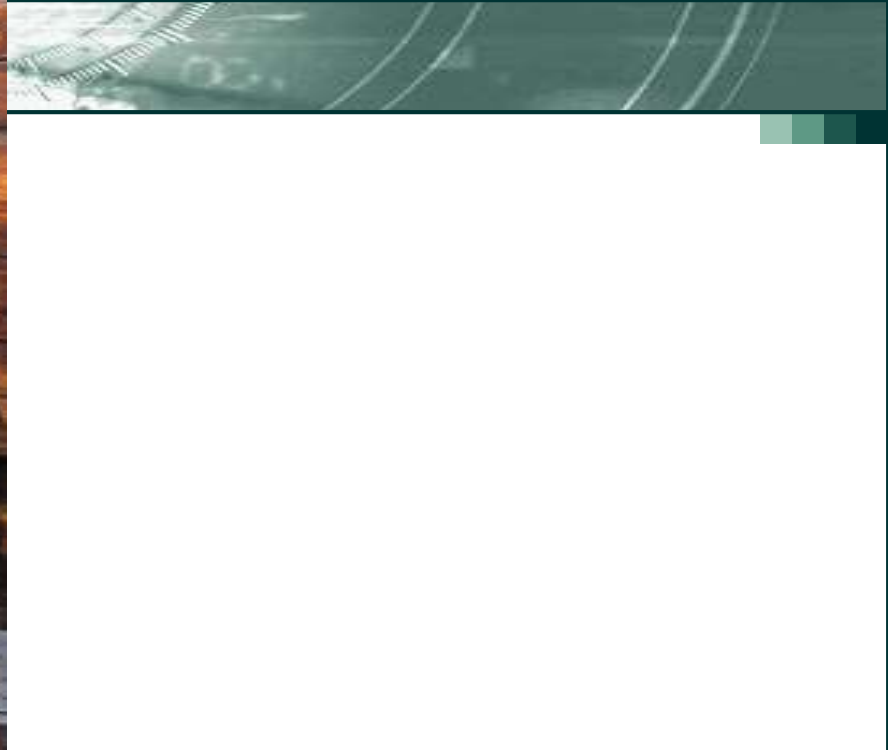
Berries, fungi and common flowers may be picked by anyone as part of 'Allemannsretten' ('Everyman's right')













Fuelwood



2009 household fuelwood consumption: 1 600 000 tonnes (9% up on 2008); or 816kg per household*

Energy yield: 7.29TWh/ 626 ktoe (kilotonnes oil equivalent)*

2008 declared income from fuelwood sales: 323 million kroner (€40 million)*

*Source: Statistisk sentralbyrå.

NB: Fuelwood is not the primary use of any of the land from which it is produced. Fuelwood is a carbon neutral energy source. Almost all fuelwood is naturally regenerated.





Education

Most Norwegian children go to kindergarten
All kindergartens often go on excursions into the woods
About a third of kindergartens are "nature kindergartens",
outdoors all day in most weathers







www.ImagesfromtheEdge.com



<Photos: Niall Benvie





Excursions and longer stays ('camp school') in the outdoors are a required part of the curriculum throughout the period of compulsory education



Hytter (cabins)

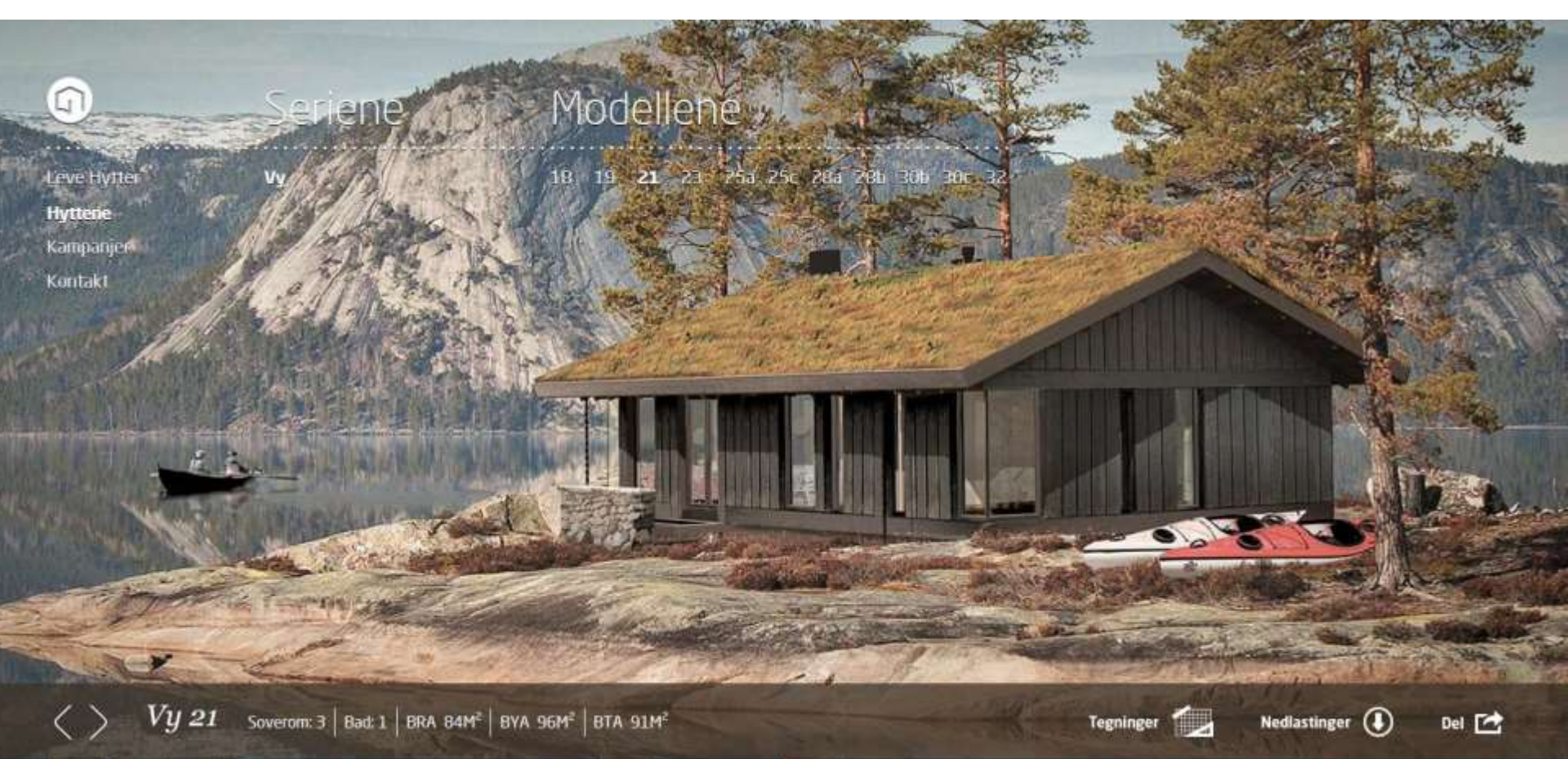
Number of cabins, summer houses, etc, Norway, 2009: 398 884

(1 per 12 inhabitants)

Source: Statistisk sentralbyrå







- Sales of cabin plots, rental of cabins, and services to cabins (repairs, providing self-catering food, local restaurants, selling e.g. hunting or fishing to cabin users) are important rural income streams in rural Norway.
- Sales, rental, hunting, fishing incomes flow to landuser.
- Taxation income flows to local government (property, sales taxes).
- Scope in Maramures, with a potential large market from e.g. Germany? (as, e.g. Spain; Alps); and from Romanians living elsewhere – many Norwegian cabins owned by people with family links to area.
- Needs good transport links – air and road.

Hiking and rambling (etc.)



Det norske turistforening (Hiker's Association) membership: 258 000 (5% of population)



"Out on tour – never unhappy!"
(392 000 hits for exact phrase, Google)





All of the income streams/ecosystem services in this talk take place in these landscapes

100 years ago rough grazing was the only significant economic activity.