



Photo: Erling Fløistad

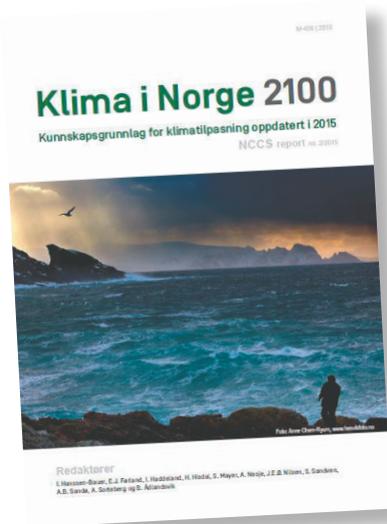
Climate change and potential effects on agriculture and water quality

Climate scenarios for Norway predict an increase in temperature, a longer growing season and more precipitation in most parts of the country (Hanssen-Bauer et al., 2015). More precipitation will likely have a negative effect on water quality because of the increased fluxes of nutrients like phosphorus (P) and nitrogen (N) into rivers and lakes. (Deelstra et al, 2011). Higher water temperatures are favorable to cyanobacteria, which could grow faster and create toxic waters. Even today, Norway experiences large problems related to heavy precipitation; for instance flooding, erosion, nutrient loss and damage to infrastructure. If precipitation continues to increase, the need for more or more effective mitigation measures in agriculture would become necessary.

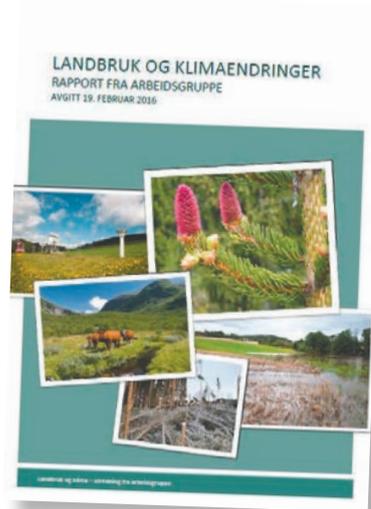
A survey in 2012 showed that most farmers believe that their farm will be affected by climate change in a somewhat negative way or not at all over the next 10 years. Very few said they believe climate change may affect farms positively (Asprang, 2012).

CLIMATE CHANGE IN NORWAY

The report "Climate in Norway 2100" provides an updated scientific basis for climate adaptation in Norway (Hanssen-Bauer et al., 2015). It describes climate change as expected through the 21st century under various assumptions about future emissions of greenhouse gases. Most of the calculations presented are based on global climate projections from the 5th Assessment Report of the IPCC.



Report: Climate in Norway 2100.



Report: Agriculture and Climate Change.

In a medium CO₂ emission scenario it is estimated that the average annual temperature in Norway in 2071-2100 will be 2.7 °C higher than in 1971-2000. Annual precipitation is expected to increase by 5 – 13 % in different parts of the country and precipitation is also expected to occur at higher intensities. The number of days with heavy precipitation is expected to increase by 34 - 58 %. Seasonal changes in precipitation are important both for agricultural production and for the related environmental effects.

There are no reliable estimations on the amount of snow cover in the future, but in mountainous areas snow cover will probably increase, while in lowland and coastal areas snow cover will be less and longer periods without frost will occur. In all areas snow melt is expected to occur earlier.

AGRICULTURAL IMPLICATIONS

The report “Agriculture and Climate Change” was delivered to the Ministry of Agriculture and Food in February 2016. The report gives the status of expected climate change and its implications for agricultural production, the need for adaptation and options for the reduction of greenhouse gas emissions and increased carbon storage. A moderate temperature increase may be beneficial in Norway because of the longer growing season (up to 1-2 months longer in different parts of the country). However, limitations regarding hours of sunlight still limit the potential yield. Moreover, since the number of consecutive dry days available for harvesting and tillage will decrease in the future, agriculture will have difficulties taking advantage of the longer growing season. Wetter conditions can give problems because of decreased trafficability, increased compaction, delayed sowing/

harvesting and, ultimately, yield loss. It can have negative effects on combating fungal diseases and weeds because it makes it difficult to carry out tillage and combating measures at the right time. Weed problems may increase if tillage and control measures are not done at the optimal time.

RUNOFF AND FLOODING

It is estimated that increased precipitation will increase annual runoff in all areas of Norway, but seasonal changes will probably be greater than the yearly changes. It is generally expected that the runoff will increase in the winter, while the runoff in summer will decrease.

Changes in precipitation and temperature will influence both the size and occurrence frequency of floods. Changes in the size of floods with a 200 year recurrence time have been analysed for 115 catchments in Norway, based on predicted climate change. On the west coast and in certain regions in northern Norway the expected increase in size of the flood is between 20 and 40 %. The increase of floods will increase the risk of damage to private and public property, infrastructure and agricultural areas and will bring about indirect costs related to measures associated with flood events as well. The Norwegian government estimated the average annual flood damage in Norway to be about 17 million euro per year in the period 1980-95 (NOU 1996:16).

EROSION

The risk of erosion in rural areas is closely related to the amount and intensity of precipitation, land use (production system and soil management). Water erosion is a function of splash detachment by



Photo: Inga Greipsland

raindrops and flow detachment by runoff. During high intensity rainfall events, the risk of erosion is high. It is expected that the number of days with high intensity rainfall events will increase in the future. Winter conditions and snowmelt often outweigh the importance of precipitation as a driver for runoff and often cause the highest soil loss throughout the year. If the snowmelt occurs on partially or completely frozen soil with low infiltration capacity the erosion damages can be large, especially on tilled soil without soil surface protection. In the future it is expected that snowmelt will happen earlier in the season. In some regions the winters will be more unstable with an increase in freezing and thawing cycles, which could give an increased risk of erosion and nutrient loss due to soil structure degradation. In other regions the winters could become more stable and decrease the risk of erosion.

The correlation between precipitation, snowmelt, runoff and erosion is complex, and will partly depend on soil type, vegetation-cover (crop and soil management) and topography. Both splash detachment and flow detachment can be mitigated by increasing the vegetation cover. Analyses of monitored catchments in Norway (www.nibio.no/JOVA) show in general lower erosion in areas of grassland compared with grain production although precipitation and runoff is equal to or higher.

NUTRIENT LOSS

Phosphorus loss is closely related to soil loss. In lowland areas dominated by cereal production generally more than 80 % of phosphorus loss is particulate. In catchments dominated by animal husbandry, par-

ticulate phosphorus generally amount to 60 % of the total loss. If soil loss increases in the future then the phosphorus losses will also increase.

An increase in runoff can be expected to increase losses of water soluble substances. There is a good correlation between annual runoff and losses of nitrogen and dissolved phosphate in monitored catchments in Norway.

MITIGATION MEASURES

Good control of surface and sub-surface water is important for runoff and erosion, and also for the creation of conditions that favor crop production. Mitigation measures such as reduced tillage, buffer zones along streams and lakes and sedimentations ponds can become increasingly important when adapting to climate change.

Drainage systems, such as drainage pipes, manholes and underground creeks are important in directing water away from agricultural fields. However, old age and poor maintenance in combination with heavy rainfall has led to severe erosion around hydrotechnical installations in many parts of Norway. With the expected increase in precipitation, the upgrade and maintenance of hydrotechnical systems will be paramount to soil conservation.

SOCIETAL CHANGES

Food production in Norway has changed substantially the last 100 years and will continue to change in the future. Today's socio-economic trends in agriculture are likely to continue. These include the use of larger machines, increased automation and larger

farm units. There is an increased share of leased land, which could cause the soil to not be cultivated optimally with regard to long term damages and returns. There is great interest in local products, local foods, niche products and organic farming, but on the other hand, only 5.6% of Norway's total cultivated area is currently used for organic agriculture.

The Norwegian government has set a target of 20% increase in national food production by 2030 to follow up the expected increase in population growth (White Paper no. 9 to the Parliament 2011- 2012). This requires intensification of food production and an increased proportion of cereal cultivation. Meanwhile, Norway is committed to the implementation of the Water Framework Directive and to achieve good ecological status in all surface waters. This will increasingly require measures for sustainable and resilient agricultural production systems that nonetheless will produce more food.

REFERANSER

I. Hanssen-Bauer, E.J. Førland, I. Haddeland, H. Hisdal, S. Mayerm A. Nesje, J.E.Ø. Nilsen, S. Sandven, A.B. Sandø, A. Sorteberg og B. Ådlandsvik. 2015. Kunnskapsgrunnlag for klimatilpasning oppdatert 2015. Miljødirektoratet rapport 2/2015. ISSN nr. 2387-3027.

Deelstra, J., Øygarden, L., Buseth Blankenberg, A. & Eggestad, H. 2011. Climate Change and runoff from agricultural catchments in Norway. International Journal of Climate change Strategies and Management 3(4):345-360.

Landbruk og klimaendringer. Rapport avgitt av arbeidsgruppe 19 februar 2016 til Landbruk og matdepartementet. 237p.

NOU 1996:16 Norges offentlige utredninger. Tiltak mot flom.

Asprang, B. 2012. Norske bønder og globale klimaendringer. Masteroppgave i sosiologi. Norges Tekniske og Naturvitenskapelige Universitet.



With the increase in precipitation, the upgrade and maintenance of hydrotechnical systems will be paramount to soil conservation.

FORFATTER:
Greipsland, Inga.



Project number: EEA- CZ02-OV-1-039-2015

