Losses of Nitrogen and Phosphorus from Norwegian Agriculture to the OSPAR problem area

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RAPPORT

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Jordforsk

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Summary:

Losses of nitrogen and phosphorus from agriculture to the first order water recipients are calculated for the years 1985 and 2000 based on normalized weather conditions. In addition, losses based on actual weather conditions in the year 2000 are calculated. The affected area are defined as the drainage area for the coastline between the Swedish border in the east and Lindesnes in the west. The calculations are based on the Agricultural Environmental Monitoring Programme, where losses from 5 catchments within the affected area are measured during the last decade. Additionally, a number of public available databases on agricultural practices, yields, weather, soil and terrain characteristics are utilized in the calculations.

The climatic normalised losses from agricultural land in the year 2000, are estimated to be 30 kg/ha for nitrogen and 0.85 kg/ha for phosphorus. Due to heavy rainfall in the autumn 2000, the actual losses in this year are estimated to be 1.5-2 times larger than normal.

The losses caused by agricultural activities are estimated to be reduced by about 24 % for nitrogen and about 32 % for phosphorus in the period from 1985 to 2000. These reductions are calculated as effects of changes in crop distributions and agricultural practices during the period.

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30/09/01

Contents

1 Summary

In preparation for the North-Sea Conference to be held in the year 2002, JORDFORSK has been contracted by the Ministry of Agriculture to calculate nutrient losses (Nitrogen and Phosphorus) from crop land in the part of Norway affected by the OSPAR problem area.

The objectives are: (1) Establish a revised methodology (compared to the 1990 calculations) for nitrogen (N) and phosphorus (P) losses, (2) calculate total losses of N and P from agriculture based on land use and farm practices in the year 2000 and the actual weather conditions this year and (3) calculate climatic normalized losses in years 1985 and 2000 based on actual farm practices in the respective years.

The affected area (at which the calculations have been done), is divided into 26 regions. The losses are calculated as contributions to the first order surface water recipients (creeks).

Results

The climatic normalized losses of N and P for year 2000 are estimated to 30 and 0.85 kg/ha respectively. Due to heavy rainfall in autumn 2000 the actual losses this year are estimated to be about 1.5-2 times the normal.

Considering only the losses caused by agricultural activities (background losses subtracted) the reduction in losses since 1985 are estimated to be about 24 % for nitrogen and 32 % for phosphorus, caused by changes in the crop distribution and farm practices.

Methodology

The calculations of losses are conducted in two separate parts: point sources (ie silage storage) and diffuse sources (crop land).

Diffuse losses

Nitrogen

The calculations of the actual diffuse N losses from crop land are based on an empirical model developed on the measurements in *Agricultural Environmental Monitoring Programme* (JOVA). The model explained 85 % of the variation in losses for the 5 catchments involved in the data analysis. Variables in the equation are:

- runoff (yearly water transport)
- soil organic matter content
- positive field nitrogen balance on small grain fields (difference between surface supply and N in yields)
- runoff in winter/spring (Jan-Apr)

- number of days from soil tillage till 1. May the following year
- sum of daily mean air temperature during summer (1. May - 1. Sept)
- runoff from grassland during Autumn/Winter/Spring period

In areas with more than 20 % grassland, the losses from grassland are calculated separately. This is based on measured losses in the JOVA catchment with dominating grassland and scaled through precipitation.

The normalized losses are calculated as a mean of the yearly estimated losses over a 10 year period.

The calculations of actual losses in the year 2000 are based on the measured losses in the JOVA catchments in 2000 relative to the average, and scaled through relative precipitation in the regions (precipitation in 2000 compared to average).

The losses in the year 1985 are calculated by adding the effects of changes in farm practices to the normalized losses in 2000. Measures included in the calculations are crop distributions, catch crops, tillage practices, yields and fertilizer application (manure, optimization, split application).

Phosphorus

The field losses of Phosphorus (P) are in two forms: particulate and dissolved.

A simple statistical analysis on yearly P losses in the JOVA catchments revealed a very good correlation between losses, runoff, soil P status (P-Al) and soil loss. This empirical model explained 92 % of the P losses int the JOVA catchments.

In the calculations of P losses in the regions, estimates of soil losses are based on USLE (*Universal Soil Loss Equation*), adjusted for Norwegian conditions. The precipitation factor in USLE are determined by calibrating USLE on the JOVA catchments, and then adjusted for differences in precipitation.

The estimated losses in year 2000 are the normalized losses scaled through precipitation in 2000 (1.Jan-31.Dec) relative to the mean precipitation.

The calculations of the losses in 1985 are done by adding the effects of changes in land use and farm practices to the normalized losses in 2000. Changes in crop distribution, soil tillage, fertilizer applications and improved soil stability on levelled land are included.

Data sources

The data sources for the calculations of losses at regional level are:

- *Agricultural Environmental Monitoring Programme* (JOVA) (observed losses in small agricultural catchments)
- *Norwegian Meteorological Institute* (DNMI) (precipitation and temperature for about 50 stations during the last 10 years)

- *Norwegian Institute for Air Research* (NILU) (Nitrogen supplied by precipitation and dry deposits)
- *Norwegian Institute of Land Inventory* (NIJOS) (soil properties and topography)
- *JORDFORSK Lab* (LA) (database with chemical analysis of agricultural soil samples (results from the last 13 years))
- *Statistics Norway* (SSB) (farm statistics on crop distribution, fertilizer and manure applications, soil tillage)
- *Norwegian Agricultural Authority* (SLF) (farmers applications for subsidies to reduced tillage)
- *Statkorn AS* (yields of small grain)

Point sources

Point source losses include the leakage of N and P from manure and slurry storages, and silage storages. Calculations of these losses are based on a special survey carried out by the county agricultural administrations (classification of the point sources with regard to technical quality), and typical loss figures related to technical quality (investigations performed by the University of Agriculture).

The calculations for the reductions in losses were based on the technical improvements/upgradings carried out during the time period after 1985. These upgradings were eligible for governmental support (30 % of the investment costs), and detailed statistics and descriptions were thus available from public data sources.

The calculations of losses in year 2000 do not include point sources, since the regression equations (N losses) and adaption of *Universal Soil Loss Equation* (P losses) are based on measurements in small catchments including farms and their current point source losses.

2 Introduction

In preparation for the North-Sea Conference to be held in the year 2002, JORDFORSK has been contracted by the Ministry of Agriculture to calculate nutrient losses from agriculture to first order surface water recipients.

The objectives are:

- Establish a revised methodology (compared to the 1990 calculations (VAGSTAD 1991)) for nitrogen (**N**) and phosphorus (**P**) losses
- Calculate total losses of N and P based on the land use and farm practices in year 2000 and the actual weather conditions during this year.
- Calculate climatic normalized losses in the years 1985 and 2000 based on actual farm practices during the respective years

3 Regions and characteristics

The part of Norway affected by the OSPAR problem area, is defined as ”the contributing area (drainage/runoff) to the coast between Swedish border in East to Lindesnes in West”. This contribution area is divided into 26 subregions. These are listed in table 1 on page 18 together with the municipalities they cover.

Table 2 on page 19 lists the size of crop land and current crop distribution for the main type of crops (according to The Agricultural Survey in 1999 (*Statistics Norway* (**SSB**)).

4 Methodology

There are two main sources of losses from agriculture:

- diffuse losses (losses from crop land)
- point sources (ie storage losses)

For the calculation of diffuse nutrient losses from crop land, there were two possible approaches:

- simulation models
- empirical regression models

There are principally two main differences between the two methods: the first has the best potential to calculate the effects of different land use, but needs a lot of input data and calibration to be reliable on the *level* of losses. The second will probably give better estimates on the total losses provided the equations are developed on measurements covering the main variations within the area.

Important considerations when choosing between these two methods is the access of information, and what the main purpose for the calculations is. It was stressed to get the best possible estimates of agricultural contributions to the nutrient load in streams. The existence of *Agricultural Environmental Monitoring Programme* (**JOVA**) makes it possible to generate an empirical model, while simulation models are poorly tested in the actual area. In JOVA, actual losses from agricultural catchments are measured during the last approx. 10 years together with farm practice recordings. There are catchments covering the main regions affected by the OSPAR problem area. Therefore it was chosen to establish an empirical model based on regression analysis of the data in JOVA.

The procedure may be summarized as follows:

- Develop an empirical model on JOVA-data, based on types of data which is also available outside the JOVA catchments.
- Calculate the climatic normalized losses.
- Use the ”actual measured losses in the year 2000 compared to the average” to calculate the actual losses for 2000 in the regions.

4.1 Nitrogen

4.1.1 Empirical model

The empirical model was developed on data from the catchments listed in table 3 on page 19. Most of them are dominated by small grain production, but one catchment has nearly 100 % grass production. Some catchments properties are listed in the table. The measurements of nutrient losses are based on continuous discharge recordings and flow proportional water samples. The farmers register their activities on the fields, and crop yields.

All the catchments have mixed land use. Woodland and built-up areas cover between 30 and 60 % of the catchments area. The measured losses of nutrients are therefore corrected for losses from woodland and built-up areas before the data analysis. This correction is done by setting the losses of nitrogen from woodland to 10 % of the losses from crop land pr area unit, and for soluble phosphorus the losses is set to 60 g/ha (standard procedures in JOVA). These procedures are based on measured losses from forested areas in Southern Norway.

The data analysis are based on yearly losses. The year is defined as ”May 1^{st} one year to May 1^{st} next year”. This is due to the fact that losses in Winter/Spring depend on farm management and activities the previous year, not activities taking place later in the year.

More than 100 variables were generated from the JOVA observations, based on weather data, soil properties and farm practice recordings, and combinations of these variables (combined effects). The data analysis was done by a forward selection, stepwise multiple linear regression.

The data analysis gave the following equation:

$$N_{loss} = 0.01355Q - 0.7405\ SOM + 0.04522\ N\_bal\_pos\_tilled - 0.004197\ Q\_t3 + 0.01765\ tilldays + 0.002493\ temp\_sum\_t1 - 0.01385\ aharv\_Q\_meadow + 0.311 \quad (1)$$

where

N_{loss} = Nitrogen losses (kg/daa, 1 daa = 0.1 ha)
SOM = Soil Organic Matter (%)
$N\_bal\_pos\_tilled$ = Nitrogen balance on tilled fields (non grassland): difference between applied fertilizer plus manure plus Nitrogen precipitated and plant uptake (kg/daa, 1 daa = 0.1 ha)
Q_t3 = runoff in the period January through April (mm)
$tilldays$ = number of days with the mean temperature above zero between soil tillage (harrowing or ploughing) and 1. May
$temp\_sum\_t1$ = sum of daily mean temperature above zero in the period May through August
$aharv\_Q\_meadow$ = runoff from grassland after grain harvest (runoff $\times$ grassland acreage $\div$ crop land acreage) (mm)

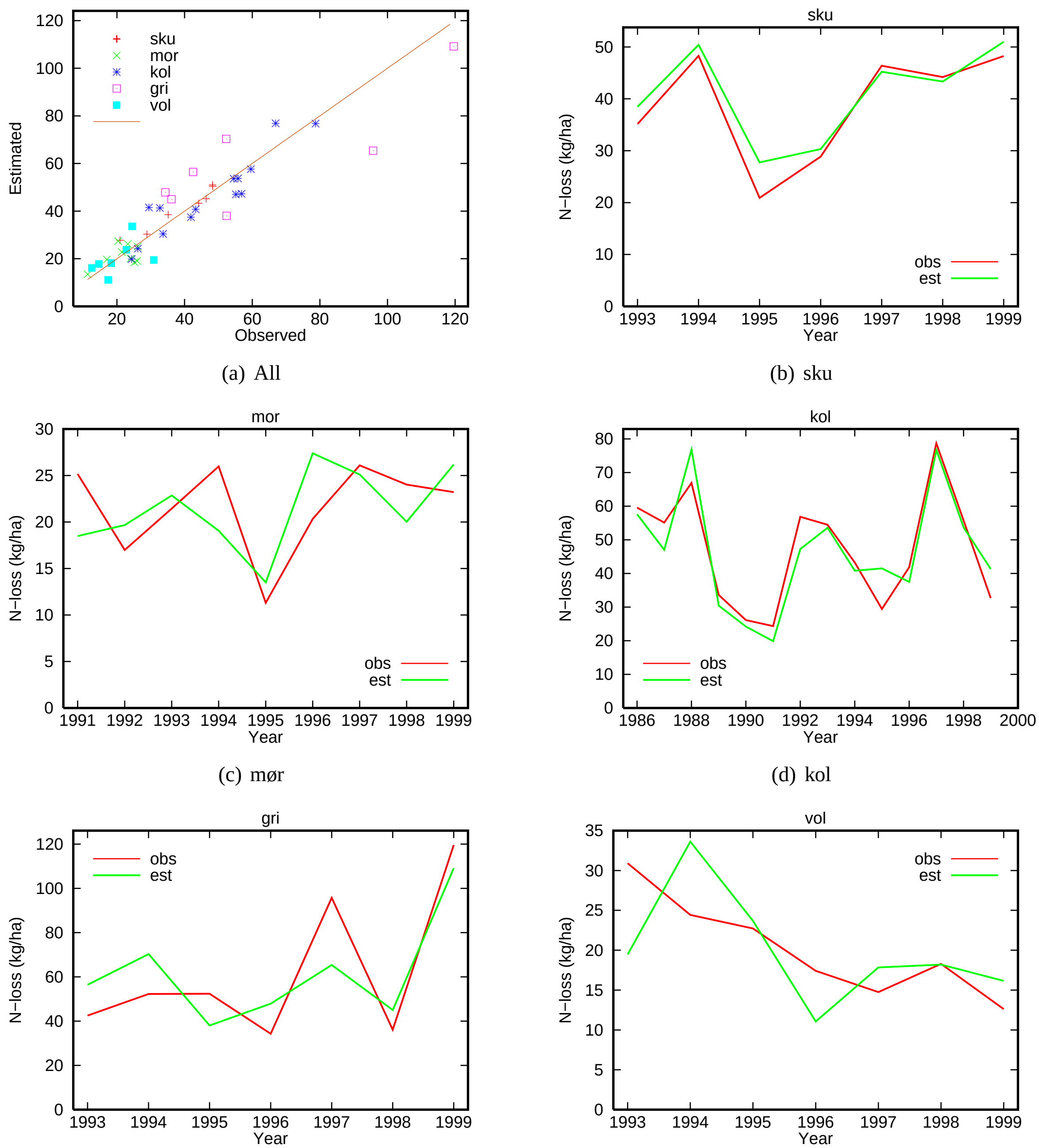
This equation explains 85 % of the variation of N-losses in these 5 catchments. In figure 1 on the next page the estimated losses are plotted against observed losses.

In a data analysis on lysimeter experiments conducted as a first step in the development of the N model, the variable *SOM* was as $\sqrt{SOM}$. In this analysis the $\sqrt{SOM}$ was almost as good as *SOM*. Therefore, it was found more reliable to convert this variable and re-parameterize the equation so that the level of losses were unchanged.

After this adjustment, the equation became:

$$N_{loss} = 0.01355\ Q - 1.5\ \sqrt{SOM} + 0.04522\ N\_bal\_pos\_tilled - 0.004197\ Q\_t3 + 0.01765\ tilldays + 0.002493\ temp\_sum\_t1 - 0.01385\ aharv\_Q\_meadow + 0.311 \quad (2)$$

Figure 1 on the following page presents plots of observed and estimated N-losses in the JOVA catchments. The equation provides reasonable estimates of the losses, except for the two catchments with highest share of grassland. The model are therefore restricted to apply only for regions with less than 20 % meadow. It was attempted to build a dedicated empirical model for grassland, based on data from two catchments with grassland only (Naurstad in Bodø (north part of Norway) and Volbu). The data analysis gave a good equation (r^2 = 0.9) with the variables *runoff in autumn* and *field nitrogen balance* (applied - harvested), but the information on grass yields for the regions is scarce and inaccurate. The *runoff* alone explained 85 % of the variation in losses, so it was decided just to scale the N losses in Volbu catchment via precipitation, for the grassland part of the regions.



(a) All (b) sku

(c) mør (d) kol

(e) gri (f) vol

Figure 1: Plots of observed and estimated N losses. The first (a) include all catchments, and the other plots present the losses as time series for each catchment (the abbreviated catchment identity refers to table 3 on page 19)

4.1.2 Calculations of normalized N losses

Weather data, temperature and precipitation, are supplied by the *Norwegian Meteorological Institute* (**DNMI**). This institute selected 58 monitoring stations to be representative for the 26 regions. Table 4.1.2 on page 20 lists the stations used for each region, together with calculated average annual precipitation and mean temperature for the regions. Many of the weather stations are used only for some of the municipalities in each region.

Water runoff is needed in the equation. This is calculated from the precipitation. Based on the differences between precipitation and runoff in the JOVA-catchments, each region is given a yearly evapotranspiration rate. The runoff in the autumn, winter and spring is calculated by subtracting a soil moisture deficit of 70 mm from the precipitation and then the evapotranspiration is scaled via sums of daily temperatures.

The amount of Nitrogen in precipitation is based on the monitoring stations managed by the *Norwegian Institute for Air Research* (**NILU**). Data from 19 stations over the last decade is used in the calculations. Table 4.1.2 on page 21 shows which stations are used in which regions, and the average N-supply from the precipitation.

The soil property variable *SOM* (soil organic matter) is extracted from a database of soil analysis on samples submitted by farmers (*JORDFORSK Lab* (**LA**)). This source of data was also used to generate this variable for the data analysis on the JOVA catchments. The database contains data from the last approx. 13 years.

Data on farm practices are supplied by *Statistics Norway* (**SSB**) and *Norwegian Agricultural Authority* (**SLF**). Grain yields are based on the farmers deliveries to mills (*Statkorn AS*). Crop distributions and soil tillage originate from farmers applications for subsidies. Fertilizer and manure applications are based on the Agricultural Statistical Investigation conducted in 1999. This investigation did not ask about the actual manure applications, only about the acreage it was used on. The application is set to 25 t/ha on average.

The normalized losses are calculated as a mean of the yearly estimated losses over the last 10 year period.

4.1.3 Calculations of N losses for the year 2000

The calculations of actual losses in the year 2000 are based on measured losses in the JOVA catchments in 2000 and relative precipitation. A scaling factor for each region was calculated in two steps. The first step was to calculate a relative factor for measured losses in 2000 against the average for the JOVA catchment(s) closest to the region regarding soil/weather characteristics and farm practices. This factor was scaled via the relation between precipitation in 2000 and average (P_{2000}/P_{avg}) compared to the same relation in the JOVA catchment. Table 4.1.3 on page 22 lists which JOVA-catchments are used for each region to calculate losses in 2000 and the scaling factors.

4.1.4 Calculations of N losses for the year 1985

The losses in 1985 are calculated by adding ”effects of changes in farm practices” to ”the normalized losses in 2000”. Farm practices in 1985 are derived from the Agricultural Statistical

Survey in 1989 (SSB) and an extra survey carried out by the agricultural offices in affected counties.

Measures included in the calculations are:

- crop distributions
- catch crops
- tillage practices
- yields and fertilizer application (manure, optimization, split application).
- hydro-technical measures/improved soil structure on levelled fields

Catch crops. Effects of catch crops are based on results from Norwegian and Swedish plot and lysimeter experiments. The calculations assume that catch-crops reduce the N losses by 50 %, provided the catch crop are under-sown (in spring) and not ploughed during the autumn period.

Reduced tillage. Reduced or no tillage (in autumn) have effects both through reduced losses of soil organic matter and reduced leached losses. The soil loss part is based on the ”effects on phosphorus losses” and a ”N/P ratio of 2.5 in suspended solids”. The effects on leached losses are set to 15 % of the total losses based on various studies in Norway and Sweden.

Yield increase and fertilizer applications. Yields and fertilizer/manure applications are two sides of the same coin concerning effects on losses. A trend analysis on small grain yields the last 20 years, gave an average yield increase of about 200 kg/ha from 1985 to 2000 for the whole area. In the same period there are only small changes in the manure production, and the average fertilizer application has decreased a little according to Agricultural statistical survey of 1989 and 1999 (SSB). Within the period, obligatory fertilizer application plans on each farm have been established, and the Agricultural statistical surveys from 1989 and 1999 (SSB) reveal that in 2000 there are fewer farmers that either under- or over-fertilize. Split application to wheat have also become a common practice in the period.

The yield increase effect on N losses is estimated to be 1 kg/ha. The yield increase will remove an extra 4 kg/ha from the soil, but a major part of this might be due to an increased application of N on under-fertilized fields. There are also N losses other than through water.

Reduced average application of fertilizer is regarded as a result of fertilizing planning and thus a reduction in over-fertilization. This is very difficult to quantify since the extent of both area and dose are unknown. The effect on losses is roughly set to 20 % of the reduced application calculated for the total area, e.g. a reduction in over-fertilization of 1 kg will result in a reduction of 0.2 kg in losses.

Split fertilizer application. Split application has in experiments given an increased plant uptake by about 5 kg/ha. In addition, it is assumed that bad growing conditions every 4-5’th year causes the second application not to occur, ie reduced over-fertilization amounting to a yearly average of about 10 kg/ha. The effect on losses by split application is estimated to be 5 kg/ha, and this measure are regarded as accomplished on the total winter wheat area.

4.2 Phosphorus

4.2.1 Empirical model

A similar approach to building an empirical model as for Nitrogen was done for Phosphorus too, based on the JOVA-catchments. The data analysis was split in two:

- Total loss involving soluble P and particle transport
- Particle transport based on the structure and variables in the *Universal Soil Loss Equation* (**USLE**)

The regression analysis on total P losses in the JOVA-catchments, gave the following equation:

$$P_{loss} = 0.0057615 * PAl * Q + 1.493 * SS - 1.589228 \tag{3}$$

where

P_{loss} = Total loss of phosphorus (*g/daa*, 1 daa = 0.1 ha)
PAl = Soil P content, analyzed by the Ammonium Lactate extraction method (*mg P/100 g soil*)
Q = Runoff (*mm*)
SS = Soil loss (*kg/daa, 1 daa = 0.1 ha*)

This equation explains 92 % of the variation in total P losses ($r^2 = 0.92$).

In the second regression analysis, for SS, soil and terrain properties was based on the Soil Survey Maps supplied by the *Norwegian Institute of Land Inventory* (**NIJOS**). Since the topography factor is based on a fixed slope length of 100 m, this factor was corrected to the actual slope length in the JOVA-catchments. This analysis gave no reasonable results. A further investigation of the data suggested that the *Soil Erodibility* factor was the main problem. For one catchment, the Soil Erodibility factor from the Soil Survey Maps and the measured soil loss gave a *R-factor* (weather factor) of about 20-30, against an expected value of about 200 on yearly average. This catchment differs from the other catchments on it's soil deposit category, morene, while the other catchment's soils are of a sediment type. Morenes have a much larger vertical permeability, and generate surface runoff much more rarely than sediment soils. By dividing the soil erodibility factor by 10 for morene, reasonable weather factors evolved.

4.2.2 Calculation of P losses for the year 2000

Since the regression analysis for soil loss was unsuccessful, it was decided to use the USLE equation unmodified, and use the JOVA catchments to estimate the weather factors. With land use factors adapted to Norwegian conditions, soil erodibility factors reduced by 10^{-1} on morenes, and adjusting topography factors according to actual slope length, an average weather factor were calculated for each JOVA-catchment. The weather factor reflects many properties other than just precipitation, like ”soil frost” and ”amount of snow melt”. The weather factor for individual regions, is therefore calculated by using the weather factor in the JOVA-catchments closest in climatic characteristics, and scale this through relative precipitation.

The calculation of total P losses are based on equation 3 on the preceding page.

The soil loss are estimated by use of USLE:

$$SS = R * K * LS * C * P \tag{4}$$

where

SS = Soil loss (*kg/daa, 1 daa = 0.1 ha*)
R = Weather factor
K = Soil erodibility factor
LS = Topography factor (slope gradient and slope length)
C = Land use factor (crop type and soil tillage)
P = Special erosion reducing measures

Table 7 on page 22 lists the C-factors used. Table 8 on page 23 shows which JOVA-catchments are used calculate the R-factors for each region and the calculated average R-factors.

The erosion risk varies a lot, and the actual soil loss depend very much on whether the different crops and tillage systems are distributed dependent of erosion risk. There is not much information available on this matter. However, a coarse classification of the fields accepted for governmental subsidies to reduced tillage indicates some adaptions to soil erosion risk (reduced tillage more frequent on fields with above average erosion risk). Further more, winter grain, which gives above average erosion risk, is usually not grown on flat land (low erosion risk) due to risk for ponding and formation of ice cover. In the calculations for year 2000, it is presupposed that these two effects add to zero, and thus the individual regions average erosion risk ($R * K * LS$ in equation 4) is used for all crop/tillage systems when calculating soil loss.

The data sources used in the calculations are:

- Soil erodibility and topography: Soil type database (NIJOS)
- Crop distributions: statistics from applications for governmental production subsidies (SSB)
- Soil tillage and catch crops: statistics from applications for governmental subsidies to environmental farm practices
- Weather factors: Calibrated weather factors in the JOVA-catchments, and precipitation from 58 meteorological stations (DNMI, PLANTEFORSK and ITF/NLH) (for the last 10 years)
- Soil P status (PAl): database for chemical soil analysis (LA)(13 years observations). Averages for each region.
- Runoff: based on precipitation (same procedure as for nitrogen)

The normalized losses for the year 2000 are calculated by using the average weather factor scaled through mean annually precipitation in the regions relative to their representative JOVA catchment. The actual losses in 2000, are calculated by scaling the weather factors through actual precipitation in year 2000 relative to the average precipitation.

4.2.3 Calculation of P losses for year 1985

Losses in 1985 are calculated by adding the effects of changed agricultural practices since 1985 to the normalized losses in 2000.

The agricultural practices in 1985 are estimated from the Agricultural statistical survey in 1989 and a survey carried out by the agricultural offices in the affected counties.

Measures included in the calculations are:

- crop distributions
- tillage practices
- manure
- hydro-technical measures/improved soil structure on levelled fields

Catch crops. Catch crops are left out, because these fields are the same as those eligible for reduced tillage subsidies. An eventual additional effect on reduced erosion is presumed to be met by an increased loss of soluble P due to freezing of plant material.

Yield increase and fertilizer applications. Effects of yield increases and reduced (or split) fertilizer application are also left out because moderate surplus of P applications tend to be rather heavily bound in metal-oxides, and a buildup of particulate P concentrations in the soils is moderated by the soil loss. Furthermore, the effects of these changes are very small compared to changes in the soil tillage.

Reduced tillage. Norwegian research (plot and field experiments) indicates a dependency between erosion risk and effect of tillage on both soil loss and P loss. The effects of reduced/delayed tillage increases with increasing soil erosion risk. In the statistics for subsidy applications, the measure *reduced tillage* includes both gentle harrowing and no till in the autumn, so the C-factor for this treatment is estimated as an intermediate effect of those two. Figure 4.2.3 displays the estimated C-factor for P loss depending on soil erosion risk.

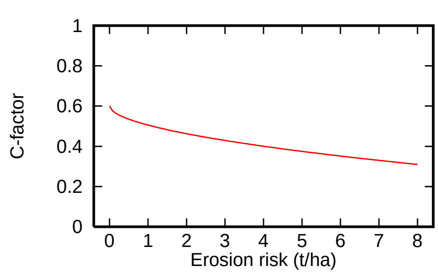


Figure 2: C-factor for reduced tillage on P losses

The classification of soil erosion risk on the fields applied for governmental subsidies during the last years, indicates an adaption to soil erosion risk. The average erosion risk on these fields is presumed to be 1.5 times the average erosion risk in the regions. In the 1980's, reduced or no tillage in the autumn was motivated by agronomical considerations (yields), and was primarily carried out on silty soils (low clay content). These soil exists mostly in flat areas and have an under average soil erosion risk. Consequently, an additional effect of this is calculated, with the actual average erosion risk estimated to be 70 % of the overall average erosion risk for each region.

Manure applications. Since 1985, the spreading of manure in the autumn without immediate incorporation in the soil is prohibited, and the store capacity for manure on the farms has improved considerably. According to SSB's survey on manure in 2000, manure applied in autumn occurs on about 5 % of the tilled area receiving manure, and on about 10 % of the grassland. The effect of reduced autumn applications and the immediate incorporation in the soil is estimated from the differences between practices in 1985 and 2000.

4.3 Point sources

Point source losses include leakage of N and P from manure, slurry and silage storages. A special survey carried out by the county agricultural administrations classified the point sources with regard to technical standards (type of construction, functionality and current state, need for improvements, etc). Based on measurements at different sites carried out by the University of Agriculture, typical loss figures had been established for the different categories according the above mentioned classification. The total losses were calculated based on these figures, the technical standards and the volume of stored manure and silage.

The reductions in losses were calculated based on the technical improvements/upgradings carried out during the time period after 1985. These upgradings were eligible for governmental support (30 % of the investment costs), and detailed statistics and descriptions were thus available from public data sources.

The calculations of losses in year 2000 do not include a separate estimation of point source losses, since the regression equations are developed on measurements in small catchments including farms and their current point source losses.

4.4 Background losses

The non-anthropogenic losses are the losses which would occur if the area was non-managed naturally vegetated. This means that an external input to the system, such as e.g. acid rain, is included in the calculations.

4.4.1 Nitrogen

The non-anthropogenic losses of nitrogen are based on the following considerations:

1. Nitrogen precipitated in the period without active growth (no uptake) are lost from the soil and thus included in background losses. This contribution is calculated from the measurements of N content in precipitation (NILU).

2. Dry deposits of N amounts to about 10 % of the precipitated

3. N in organic matter losses and leached N from mineralized organic matter (no contribution from acid rain) are 1.5 kg/ha in south central Norway (estimate from Norwegian Forest Research Institute: 1-2 kg/ha (pers.XXX H. De Wit)). This part of the background losses are scaled through annual precipitation in the regions relative to region ”ake2” (see table 1 on page 18)

The soils on crop land are much more fertile than todays' forested soils, and the share of broadleaved trees (some with N-fixation abilities) would be much higher if forested today. The background losses from the crop land are therefore higher than losses measured from todays' woodland.

4.4.2 Phosphorus

Losses from todays' forests in south central Norway, are usually in the range 40-80 g/ha. Based on the same presumptions about the soils and forest type as for nitrogen, the yearly losses are set as 100 g/ha for the region "ake2", and the losses from the other regions are calculated by scaling this figure through relative annual precipitation.

5 Results

The results are only briefly commented in this report. For both nitrogen and phosphorus, runoff has the largest effect on the losses. In the calculations, runoff is estimated from the precipitation. Consequently, the results becomes very dependent on to which degree the selected weather stations are representative for the regions and the estimates for evapotranspiration.

5.1 Nitrogen losses

Table 5.1 presents normalized N losses for 1985 and 2000, actual losses in 2000, background losses and the relative change in anthropogenic losses since 1985. Point source losses are included. The normalized losses are the average losses calculated for weather conditions the last decade. The difference between losses in 1985 and 2000 are therefore a result of changes in farm practices.

The average normalized losses for 2000 per area unit are 30 kg/ha. Due to extreme precipitation in the autumn of 2000, the actual losses for this year is much higher (estimated to 1.8 times the normal).

The changes in N anthropogenic losses from 1985 till 2000 are about 24 % for the whole area.

Table 5.1 on page 25 presents the effect of the individual measures (changes in land use and agricultural practices) since 1985.

Reduced tillage and fertilizer planning are the greatest contribution to the reduced N losses.

5.2 Phosphorus losses

Table 5.2 on page 26 presents normalized P losses in 1985 and 2000, actual losses in 2000, background losses and the relative change in anthropogenic losses since 1985. Point source losses are included. The normalized losses are losses estimated for the average weather conditions of the last decade. The difference in normalized losses between 1985 and 2000 are consequently a result of changes in farm practices.

The reduction in anthropogenic P losses from 1985 to 2000 is about 32 % for the whole area.

The average normalized losses for 2000 per unit area is about 0.85 kg/ha. The calculated actual losses in year 2000 are 1.5 times the normal. The heavy rainfall in autumn 2000 may have caused less autumn tillage than normal. This means that also the normalized losses for 2000 may be under-estimated.

Table 5.2 on page 27 presents the effect of the individual measures (changes in land use and agronomical practices) since 1985.

Reduced tillage has been the largest contribution to the reduction of anthropogenic P losses since 1985.

Table 1: Regions in the part of Norway affected by the OSPAR problem area.

Region	Title	Municipalities
øst1	Glomma	Askim, Eidsberg, Hobøl, Rakkestad, Skiptvet, Spydeberg, Trøgstad
øst2	Oslofjorden	Fredrikstad, Halden, Hvaler, Moss, Rygge, Råde, Sarpsborg, Våler
øst3	Haldenvassdraget	Aremark, Marker, Rømskog
ake1	Øyeren	Enebakk, Fet, Gjerdrum, Nannestad, Nes, Nittedal, Rælingen, Skedsmo, Sørum, Ullensaker
ake2	Oslofjorden	Asker, Bærum, Eidsvoll, Frogn, Hurdal, Lørenskog, Nesodden, Oppegård, Ski, Vestby, Ås
ake3	Haldenvassdr.	Aurskog-Høland
hed1	Mjøsa	Hamar, Løten, Ringsaker, Stange
hed2	Glomma	Elverum, Grue, Kongsvinger, Nord-Odal, Sør-Odal, Våler, Åsnes
hed3	Glomma	Alvdal, Folldal, Os, Rendalen, Stor-Elvdal, Tolga, Tynset, Åmot
hed4	Sverige	Eidskog, Engerdal, Trysil
opp1	Mjøsa	Gausdal, Gjøvik, Lillehammer, Vestre Toten, Østre Toten, Øyer
opp2	Lågen/Mjøsa	Dovre, Lesja, Lom, Nord-Fron, Ringebu, Sel, Skjåk, Sør-Fron, Vågå
opp3	Randsfjorden	Etnedal, Gran, Jevnaker, Lunner, Nordre Land, Søndre Land
opp4	Begna	Nord-Aurdal, Sør-Aurdal, Vang, Vestre Slidre, Øystre Slidre
bus1	Numedalslågen	Flesberg, Kongsberg, Nore og Uvdal, Rollag
bus2	Krøderen	Flå, Gol, Hemsedal, Hol, Krødsherad, Nes, Ål
bus3	Drammensfjorden/Oslofjorden	Drammen, Hurum, Lier, Modum, Nedre Eiker, Røyken, Sigdal, Øvre Eiker
bus4	Tyrifjorden	Hole, Ringerike
ves1	Vestfold	Andebu, Borre, Hof, Holmestrand, Lardal, Larvik, Nøtterøy, Ramnes, Sande, Sandefjord, Stokke, Svelvik, Tjøme, Tønsberg, Våle
tel1	Ytre Telemark	Bamble, Kragerø, Porsgrunn, Skien
tel2	Indre Telemark	Drangedal, Fyresdal, Hjartdal, Kviteseid, Nissedal, Seljord, Tinn, Tokke, Vinje
tel3	Nordsjø	Bø, Nome, Notodden, Sauherad, Siljan
aag1	Ytre Aust-Agder	Arendal, Grimstad, Lillesand, Risør, Tvedestrand
aag2	Indre Aust-Agder	Birkenes, Bygland, Bykle, Evje og Hornnes, Froland, Gjerstad, Iveland, Valle, Vegårshei, Åmli
vag1	Ytre Vest-Agder	Farsund, Flekkefjord, Kristiansand, Lindesnes, Lyngdal, Mandal, Songdalen, Søgne
vag2	Indre Vest-Agder	Audnedal, Hægebostad, Kvinesdal, Marnardal, Sirdal, Vennesla, Åseral

Table 2: Crop land area and crop distribution in the regions (table 1 on the previous page) (Agricultural Statistical Survey 1999 (SSB))

	total ha	meadow %	winter wheat %	spring grain %	other tilled land %
øst1	38437	15	4	80	1
øst2	31439	16	6	74	4
øst3	6316	17	2	79	1
ake1	47526	17	3	78	2
ake2	22208	21	4	71	3
ake3	9705	12	1	87	1
hed1	37207	30	1	62	7
hed2	39531	14	0	76	10
hed3	22881	84	0	9	7
hed4	7354	56	0	40	4
opp1	37181	56	0	36	9
opp2	31329	86	0	7	7
opp3	19870	50	0	45	5
opp4	13544	93	0	3	3
bus1	7612	56	0	41	3
bus2	11785	90	0	8	2
bus3	22445	31	2	64	3
bus4	9539	17	3	77	3
ves1	42879	23	4	67	6
tel1	5970	48	1	43	8
tel2	9588	92	0	6	1
tel3	9963	36	0	62	2
aag1	5171	77	0	17	6
aag2	6671	92	0	5	3
vag1	10470	90	0	7	4
vag2	9460	98	0	0	2

Table 3: JOVA-catchments used to develop empirical model

Catch-ment id	Name	Size ha	Crop land %	Above sea level m	Main crops	Average (min-max) N-loss kg/ha
mør	Mørdrefeltet (Nes, Akershus)	681	65	200	Small grain	22 (11-26)
sku	Skuterudbekken (Ås, Akershus)	449	61	190	Small grain	39 (21-48)
kol	Kolstabekken (Ringsaker, Hedmark)	308	68	300	Small grain	47 (24-79)
gri	Grimestadbekken (Stokke, Vestfold)	177	45	40	Small grain (meadow)	61 (34-120)
vol	Volbubekken (Fagernes, Buskerud)	166	42	620	Meadow	20 (13-31)

Table 4: Weather stations used for precipitation and temperature for each region (see table 1 on page 18), and calculated average annual precipitation and mean temperature. The assignment of DNMI's weather stations to region/county er done by DNMI). NORPRE are weather stations managed by PLANTEFORSK, and ITF/NLH by Norwegian Agricultural University

	Weather stations	Mean yearly precip. mm	Mean temperature °C
øst1	2520 Høland - Løken, 2540 Høland - Fosser	650	5.7
øst2	17150 Rygge	786	6.5
øst3	1130 Prestebakke	870	6.1
ake1	0494 Hvam-Tolvhus, 4440 Hakadal - Bliksrudhagan	841	5.0
ake2	ITF/NLH	772	6.2
ake3	2540 Høland - Fosser	650	5.2
hed1	NORPRE at Kise, 12520 Nes på Hedmark	551	4.3
hed2	5650 Vinger	604	4.6
hed3	10400 Røros, 7010 Rena - Haugedalen	507	1.8
hed4	700 Drevsjø, 2950 Magnor	580	2.4
opp1	11610 Gjøvik, 12680 Lillehammer - Sætherengen, 11500 Østre Toten - Apelsvoll	636	4.4
opp2	13420 Venabu, 16740 Kjøremsgrende, 13140 Fåvang - Tromsnes,	510	1.1
opp3	21680 Vest-torpa II, 4780 Gardermoen	758	3.7
opp4	23420 Fagernes	472	3.0
bus1	28370 Kongsberg IV, 28800 Lyngdal i Numedal	728	4.5
bus2	24880 Nesbyen - Skoglund, 25590 Geilo - Geilostølen	519	3.3
bus3	26890 Drammen - Marienlyst, 19480 Dønski	852	6.0
bus4	20250 Hole, 4780 Gardermoen	629	4.9
ves1	27450 Melsom, 27600 Sandefjord	875	7.3
tel1	30260 Porsgrunn brannstasjon, 32060 Gvarv, 34400 Farsjø, 34120 Jomfruland fyr, 32080 Gvarv - Lindem, 34130 Jomfruland	942	6.6
tel2	32930 Øyfjell i Telemark, 32920 Øyfjell - Trovatn	919	2.3
tel3	32060 Gvarv, 30530 Notodden, 32080 Gvarv - Lindem	651	5.4
aag1	35860 Lyngør fyr	845	7.8
aag2	39690 Byglandsfjord - Solbakken	1308	6.3
vag1	42160 Lista fyr, 41770 Lindesnes fyr, 39040 Kjevik, 41110 Mandal II	1234	7.6
vag2	41670 Konsmo - Høyland, 41640 Vigmostad	1894	5.7

Table 5: The NILU weather stations used for each region to calculate N supply in precipitation, and the average annual N supply in the last decade

	Weather stations (NILU)	Mean N precip. kg/ha
øst1	Løken	4.67
øst2	Løken, Prestebakke	6.51
øst3	Løken	6.40
ake1	Hurdal, Løken, Nordmoen	5.29
ake2	Løken	5.67
ake3	Løken	4.67
hed1	Hurdal, Nordmoen	3.62
hed2	Hurdal, Nordmoen	3.71
hed3	Valdalen, Osen	2.29
hed4	Osen	2.52
opp1	Hurdal, Nordmoen	3.99
opp2	Fagernes	1.84
opp3	Gulsvik, Hurdal, Nordmoen, Brekkebygda	5.31
opp4	Fagernes	1.70
bus1	Lardal	5.40
bus2	Gulsvik, Fagernes, Brekkebygda	3.11
bus3	Lardal	6.28
bus4	Gulsvik, Lardal, Brekkebygda	4.77
ves1	Lardal	6.44
tel1	Treungen, Lardal	6.80
tel2	Vatnedal, Møsvatn	3.86
tel3	Vatnedal, Treungen, Lardal	3.99
aag1	Søgne, Birkenes	8.93
aag2	Skreådalen, Valle	6.82
vag1	Ualand, Søgne, Lista	12.92
vag2	Skreådalen, Valle	9.91

Table 6: JOVA-catchments used to calculate scaling factors for year 2000 losses. *Corrf 2000*: N losses in 2000 relative to average in JOVA-catchment, *Scaled corrf 2000*: *Corrf 2000* scaled through relative precipitation.

	JOVA-catchments	Corrf 2000	Scaled corrf 2000
øst1	sku	1.81	1.59
øst2	sku, gri	1.73	1.67
øst3	sku	1.81	1.63
ake1	sku, mor	1.77	1.93
ake2	sku	1.81	1.73
ake3	sku	1.81	1.62
hed1	kol	1.55	1.75
hed2	mor, kol	1.64	1.64
hed3	vol	1.55	1.69
hed4	vol	1.55	2.03
opp1	kol	1.55	1.93
opp2	vol	2.82	3.03
opp3	mor, kol	1.64	2.01
opp4	vol	2.82	3.09
bus1	mor, kol	2.24	2.40
bus2	mor, kol	2.24	2.11
bus3	sku	1.73	1.63
bus4	sku, mor	1.77	1.71
ves1	gri	1.66	1.71
tel1	gri	1.66	1.69
tel2	vol	2.24	2.28
tel3	mor, kol	2.24	2.46
aag1	gri	1.66	1.47
aag2	mor, kol	2.24	2.28
vag1	gri	1.66	1.38
vag2	mor, kol	2.24	2.20

Table 7: C-factors for calculations of soil loss

winter wheat	0.9
meadow	0.03
spring tillage	0.4
autumn harrowing	0.6
autumn ploughing	1.0
non-grain one year crops	0.8
reduced tillage (gentle autumn harrowing and spring tillage)	0.45

Table 8: R-factors for each region and the JOVA-catchments they are based on

	JOVA-catchment	R-factor
øst1	sku	245
øst2	sku, gri	256
øst3	sku	318
ake1	sku, mor	295
ake2	sku	291
ake3	sku	241
hed1	kol	156
hed2	mor, kol	181
hed3	kol	129
hed4	kol	164
opp1	kol	176
opp2	kol	139
opp3	mor, kol	228
opp4	kol	126
bus1	mor, kol	219
bus2	mor, kol	157
bus3	sku	316
bus4	sku, mor	220
ves1	gri	260
tel1	gri	260
tel2	kol	244
tel3	mor, kol	195
aag1	gri	254
aag2	mor, kol	389
vag1	gri	354
vag2	mor, kol	561

Table 9: Normalized N losses in 1985 and 2000, actual losses in 2000, background losses and reduction in anthropogenic losses since 1985

Region		Normalized losses		Actual losses	Background losses	Reduction (anthro-pogenic)
		1985	2000	2000		1985-2000
		kg	kg	kg	kg	%
øst1	Glomma	1179436	884042	1405627	157590	28.9
øst2	Oslofjorden	1593719	1351877	2257635	194922	17.3
øst3	Haldenvassdraget	317232	258956	422098	39159	21.0
ake1	Øyeren	2372443	1853522	3577297	237631	24.3
ake2	Oslofjorden	1058907	866120	1498388	117703	20.5
ake3	Haldenvassdr.	286167	213510	345886	39790	29.5
hed1	Mjøsa	1456798	1116201	1953352	115341	25.4
hed2	Glomma	1543239	1264998	2074597	122547	19.6
hed3	Glomma	482448	320333	541363	38898	36.5
hed4	Sverige	234247	183848	373211	13972	22.9
opp1	Mjøsa	1244478	1003884	1937496	130133	21.6
opp2	Lågen/Mjøsa	572050	344621	1044202	46994	43.3
opp3	Randsfjorden	639148	496748	998463	89415	25.9
opp4	Begna	198469	148982	460354	20316	27.8
bus1	Numedalslågen	307864	235956	566294	33491	26.2
bus2	Krøderen	242628	141416	298388	29462	47.5
bus3	Drammensfjorden-/Oslofjorden	1132920	897816	1463440	130183	23.4
bus4	Tyrifjorden	269287	190778	326230	38156	34.0
ves1	Vestfold	1944780	1672265	2859573	265847	16.2
tel1	Ytre Telemark	198255	143282	242147	39403	34.6
tel2	Indre Telemark	256798	201342	459060	28763	24.3
tel3	Nordsjø	292002	219195	539220	34872	28.3
aag1	Ytre Aust-Agder	156604	124094	182418	41365	28.2
aag2	Indre Aust-Agder	311518	266828	608368	45361	16.8
vag1	Ytre Vest-Agder	497779	408334	563501	125641	24.0
vag2	Indre Vest-Agder	582844	548703	1207147	96496	7.0
Sum		19372057	15357651	28205755	2273450	23.5

Table 10: Effects of changes in land use/agricultural practices since 1985 on N losses, calculated for the anthropogenic part of the losses

	Catch crop	Manure	Split fertilizer appl.	Hydro-technical measures	Fertilizer planning	Yields	Point sources	Reduced tillage	Crop dis-tribution
	%	%	%	%	%	%	%	%	%
øst1	0.5	5.1	3.8	0.8	2.3	6.5	1.3	9.2	−0.0
øst2	0.8	2.4	2.6	0.1	1.3	3.7	0.7	6.1	−0.1
øst3	0.3	1.1	1.9	0.1	1.4	3.8	0.3	13.5	−1.5
ake1	2.1	1.5	0.9	1.3	5.3	3.8	0.7	8.9	0.1
ake2	0.7	0.1	2.2	0.0	5.7	3.8	0.4	7.8	0.0
ake3	1.6	0.0	1.3	0.5	9.5	7.2	0.7	8.9	0.2
hed1	0.8	7.0	1.7	0.0	6.1	3.7	1.0	4.4	0.9
hed2	0.4	0.7	0.3	0.0	6.1	4.6	0.4	7.6	−0.3
hed3	0.1	16.2	0.0	0.2	11.3	1.0	5.5	4.9	0.2
hed4	0.0	4.0	0.1	0.0	7.3	2.8	2.1	7.0	0.5
opp1	0.6	4.2	0.6	0.2	6.7	2.6	2.5	4.1	1.6
opp2	0.8	23.0	0.0	0.2	11.9	0.9	5.0	9.3	−5.3
opp3	0.0	5.9	1.1	0.1	7.2	3.4	3.8	6.8	0.1
opp4	0.0	7.0	0.0	0.3	15.2	0.5	13.6	3.4	−2.8
bus1	0.2	2.6	0.9	0.1	8.9	2.4	1.8	9.8	0.5
bus2	0.2	16.0	0.2	0.0	17.7	0.9	6.6	8.4	1.2
bus3	0.7	1.0	1.6	0.2	7.2	3.1	0.9	10.1	−0.7
bus4	0.6	0.0	3.4	0.2	13.2	7.1	1.0	9.0	0.1
ves1	0.0	0.0	3.3	0.0	1.0	3.7	0.2	7.9	0.3
tel1	0.0	4.6	1.4	0.6	11.3	3.5	2.9	12.5	−0.2
tel2	0.0	4.2	0.1	0.3	12.6	0.6	5.7	9.9	−5.5
tel3	0.0	1.3	1.5	0.2	11.6	5.0	2.7	7.7	−0.0
aag1	0.0	4.2	0.1	0.0	15.3	1.6	4.9	5.3	−0.3
aag2	0.0	2.4	0.0	0.0	8.5	0.3	2.6	6.1	−1.6
vag1	0.0	4.2	0.0	0.0	9.6	0.4	2.7	8.9	−0.3
vag2	0.0	3.0	0.0	0.0	6.6	0.0	2.0	0.7	−4.4
sum	0.6	3.7	1.5	0.3	6.1	3.4	1.7	7.4	−0.3

Table 11: Normalized P losses in 1985 and 2000, actual losses in 2000, background losses and reduction in anthropogenic losses since 1985

Region		Normalized losses		Actual losses	Background losses	Reduction (anthro-pogenic)
		1985	2000	2000		1985-2000
		kg	kg	kg	kg	%
øst1	Glomma	74922	52543	74798	3563	31.4
øst2	Oslofjorden	34608	27415	40965	3422	23.1
øst3	Haldenvassdraget	10877	6619	9499	759	42.1
ake1	Øyeren	132029	86735	148757	5554	35.8
ake2	Oslofjorden	40176	30114	45482	2221	26.5
ake3	Haldenvassdr.	12093	8734	12743	886	30.0
hed1	Mjøsa	15732	12427	10790	2993	25.9
hed2	Glomma	31130	24154	34194	3310	25.1
hed3	Glomma	9698	5880	6315	1606	47.2
hed4	Sverige	4112	3125	4449	591	28.0
opp1	Mjøsa	18791	14612	16248	2998	26.5
opp2	Lågen/Mjøsa	20592	11279	14035	2214	50.7
opp3	Randsfjorden	11371	8445	12041	2089	31.5
opp4	Begna	5202	3806	4862	882	32.3
bus1	Numedalslågen	5624	3532	5640	773	43.1
bus2	Krøderen	6487	4419	5975	850	36.7
bus3	Drammensfjorden-/Oslofjorden	39163	25633	39167	2682	37.1
bus4	Tyrifjorden	9145	6553	9882	833	31.2
ves1	Vestfold	66354	52441	84428	5237	22.8
tel1	Ytre Telemark	5922	3248	5481	782	52.0
tel2	Indre Telemark	8307	5532	8236	1207	39.1
tel3	Nordsjø	5366	3587	5908	902	39.8
aag1	Ytre Aust-Agder	4417	3371	4778	616	27.5
aag2	Indre Aust-Agder	8226	6257	9339	1201	28.0
vag1	Ytre Vest-Agder	13133	9873	12962	1788	28.7
vag2	Indre Vest-Agder	15098	13396	19517	2460	13.5
Sum		608574	433730	646492	52420	31.6

Table 12: Effects of changes in land use/agricultural practices since 1985 on P losses, calculated for the anthropogenic part of the losses

	Catch crop	Manure	Split fertilizer appl.	Hydro-technical measures	Fertilizer planning	Yields	Point sources	Reduced tillage	Crop dis-tribution
	%	%	%	%	%	%	%	%	%
øst1	0.0	2.4	0.0	4.3	0.9	0.0	1.2	20.6	0.8
øst2	0.0	3.7	0.0	1.0	1.0	0.0	1.9	13.9	−0.1
øst3	0.0	1.0	0.0	1.1	0.7	0.0	0.6	37.5	−2.0
ake1	0.0	0.7	0.0	8.3	0.8	0.0	1.1	22.8	0.6
ake2	0.0	0.1	0.0	0.3	0.9	0.0	0.7	23.1	0.1
ake3	0.0	0.0	0.0	3.8	1.0	0.0	1.0	22.6	−1.1
hed1	0.0	11.5	0.0	0.0	1.0	0.0	6.5	4.2	0.2
hed2	0.0	0.5	0.0	0.0	1.2	0.0	1.4	20.5	−0.5
hed3	0.0	15.2	0.0	3.1	0.2	0.0	19.3	10.1	0.4
hed4	0.0	3.9	0.0	0.0	0.6	0.0	8.2	14.4	0.4
opp1	0.0	4.7	0.0	3.6	0.6	0.0	15.2	7.0	0.2
opp2	0.0	8.0	0.0	2.2	0.1	0.0	10.9	30.2	0.2
opp3	0.0	5.6	0.0	2.3	0.6	0.0	12.0	11.5	0.2
opp4	0.0	4.7	0.0	3.6	0.1	0.0	34.2	5.7	0.2
bus1	0.0	4.5	0.0	2.7	0.4	0.0	4.7	26.3	0.5
bus2	0.0	17.7	0.0	0.0	0.1	0.0	10.4	11.6	−4.0
bus3	0.0	0.7	0.0	1.8	0.7	0.0	1.4	32.1	−1.6
bus4	0.0	0.0	0.0	2.4	0.9	0.0	1.5	24.4	−0.2
ves1	0.0	0.0	0.0	0.0	0.9	0.0	0.5	19.3	0.5
tel1	0.0	5.2	0.0	6.0	0.5	0.0	5.7	30.5	0.3
tel2	0.0	5.5	0.0	3.8	0.1	0.0	9.5	18.6	0.7
tel3	0.0	4.5	0.0	4.6	0.8	0.0	7.7	20.1	−0.1
aag1	0.0	7.0	0.0	0.0	0.4	0.0	8.2	12.1	−0.1
aag2	0.0	6.4	0.0	0.0	0.1	0.0	5.1	14.3	0.3
vag1	0.0	5.6	0.0	0.0	0.1	0.0	5.5	15.6	0.2
vag2	0.0	5.1	0.0	0.0	0.0	0.0	4.5	2.1	1.4
sum	0.0	2.9	0.0	3.4	0.8	0.0	3.8	22.0	0.2