

Water flow and transport of soil particles and nutrients by surface runoff and drainage in agricultural areas

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Pathways - background

- Surface runoff, matrix flow, macropore flow, drainage, percolation to groundwater
- Determine the fate of water, soil particles, nutrients, pesticides
- May influence
 - efficiency of mitigation measures
 - effect of climate change
- Are accounted for in many predictive tools (models)
 - Improved process description in model
 - Data for calibration and validation
 - → decreased prediction uncertainty

Pathways - quantification

- Monitoring of surface runoff and drainage + water quality (SS, P, N-conc.)
- Time series available for field scale catchments and plots/lysimeters
- Data from existing studies compiled and reanalyzed



Experimental sites

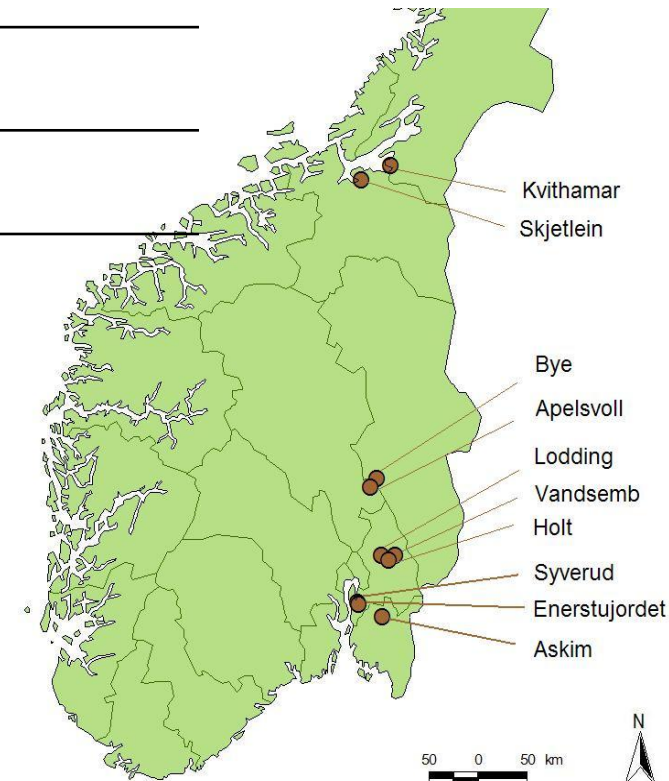
Other sites with either surface or subsurface runoff measurements:

Bjørnebekk – Ås (SURF)
 Hellerud - Romerike (SURF)
 Øsaker - Sarpsborg (SURF)
 Vinningland – Jæren (DRAIN)

Site	Region	Type	Period with available data
Bye ¹	Ringsaker, He.	Catchment	1995-09
Apelsvoll ²	Østre Toten, Op.	12 plots	1990-94, 2001-09
Vandsemb ¹	Nes, Ak.	Catchment	1992-05
Lodding ³	Ullensaker, Ak.	Catchment	1987-92
Holt ⁴	Ullensaker, Ak.	Catchment	1984-95
Askim ^{4,5}	Askim, Øs.	6 plots	1987-00
Syverud ^{4,5}	Ås, Ak.	8-12 plots	1992-00
Enerstujordet ⁴	Ås, Ak.	Catchment	1986-93
Kvithamar ⁶	Stjørdal, N.-Tr.	18 plots	1990-94
Skjetlein ⁷	Trondheim, S.-Tr.	3 plots	1991-97

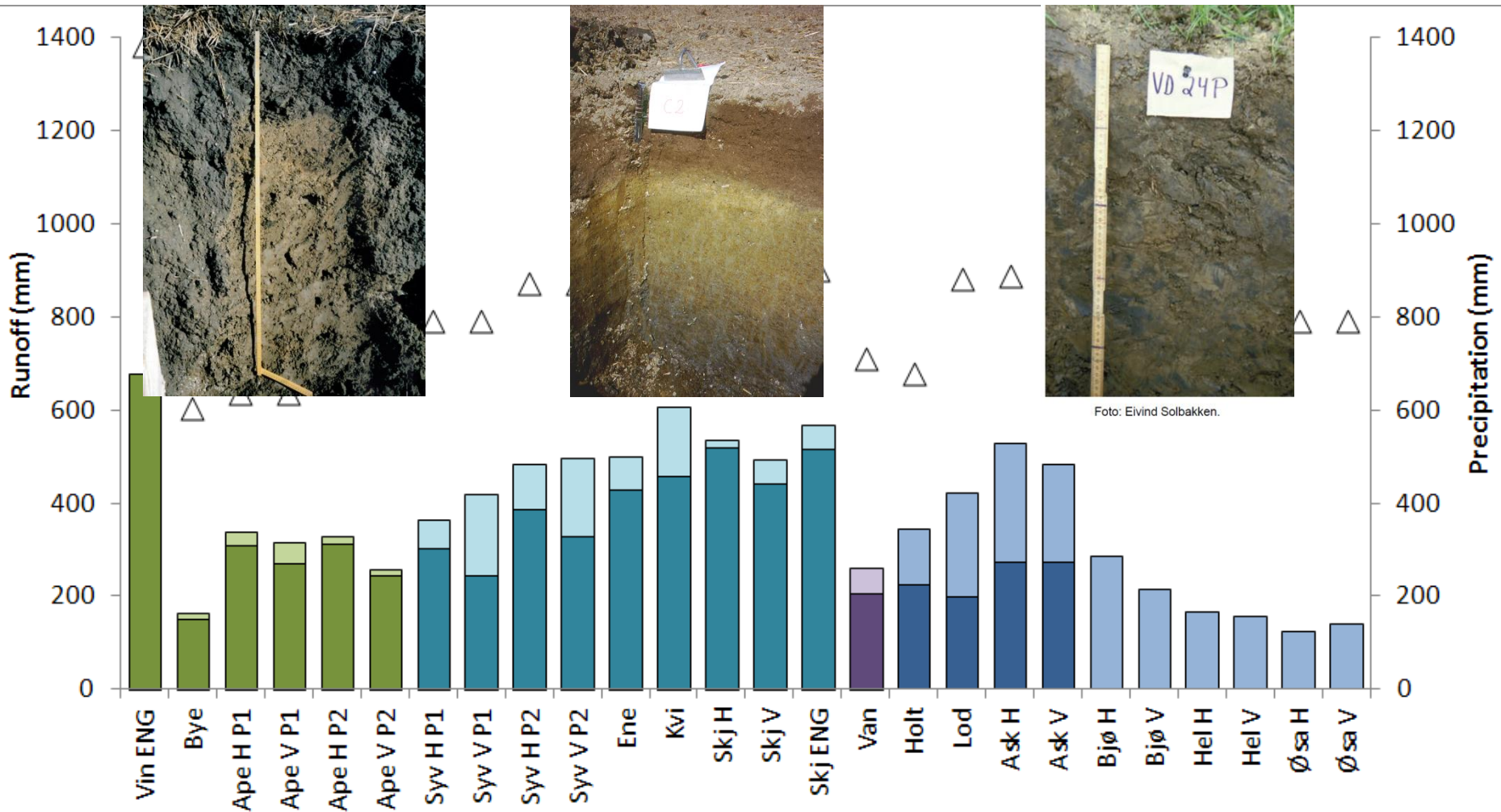
Data from:

- ¹ JOVA-database at Bioforsk
- ² Eltun et al. (1996), Eltun & Fugleberg (1996), Korsæth (pers.medd.)
- ³ Øygarden et al. (1997), Øygarden (2000)
- ⁴ Lundekvam (1997)
- ⁵ Lundekvam (2001)
- ⁶ Oskarsen et al. 1996
- ⁷ Haraldsen (1998), Haraldsen (unpubl).



Runoff

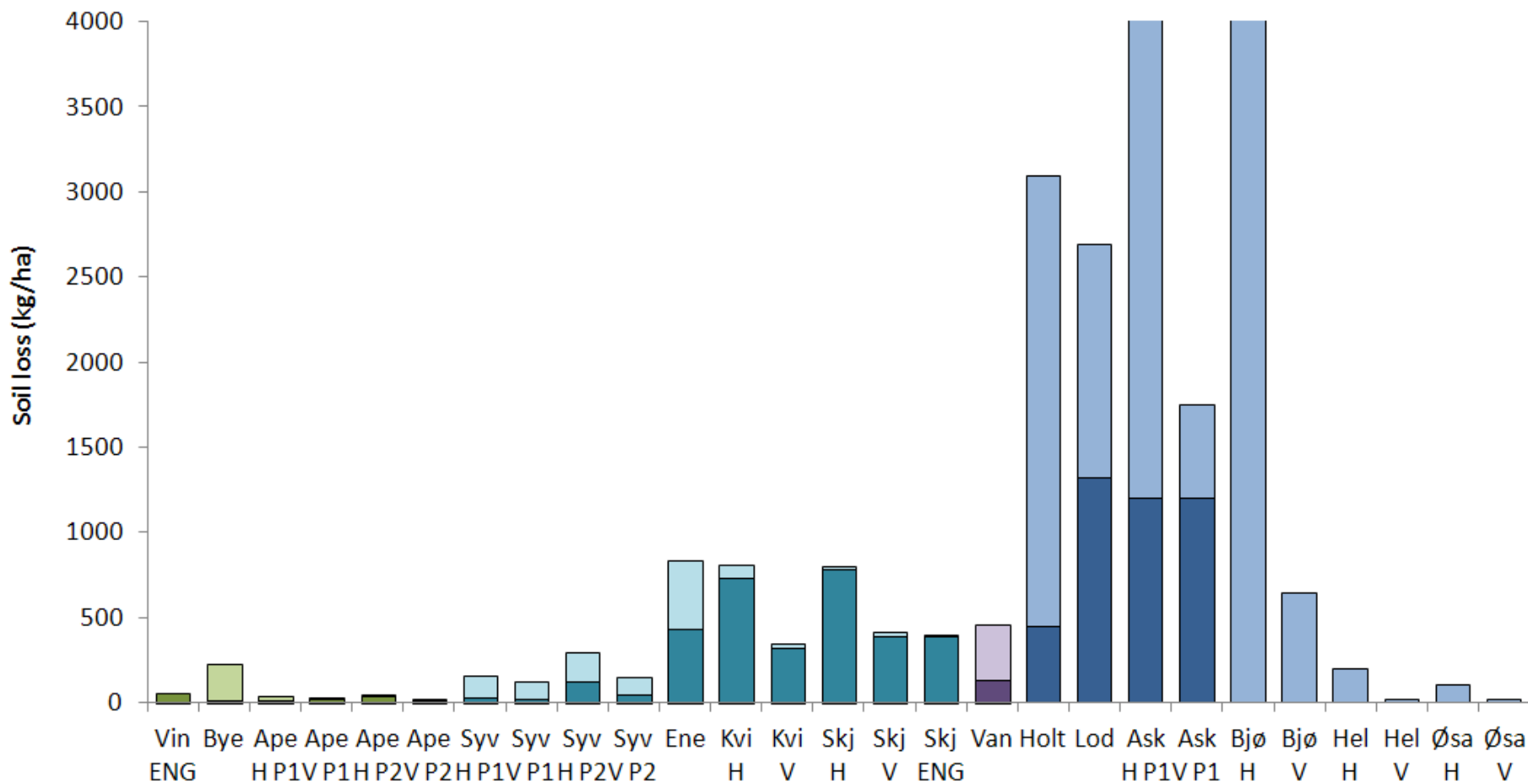
	Tot Q/Prec	Q surf/Prec	Q drain/Tot Q
Glacial till	44 (27-53)	4 (2-7)	92 (85-96)
Marine clay	56 (46-66)	11 (2-22)	81 (58-97)
Levelled clay	53 (48-59)	23 (16-34)	55 (47-65)



Soil loss



	SS drain/SS tot
Glacial till	60 (6 – 95)
Marine clay	64 (17 – 99)
Levelled clay	33 (15 – 49)





Poor soil structure
→ high erodibility



No plant cover
(autumn tillage)



Concentrated flow



Steep slope



High surface runoff

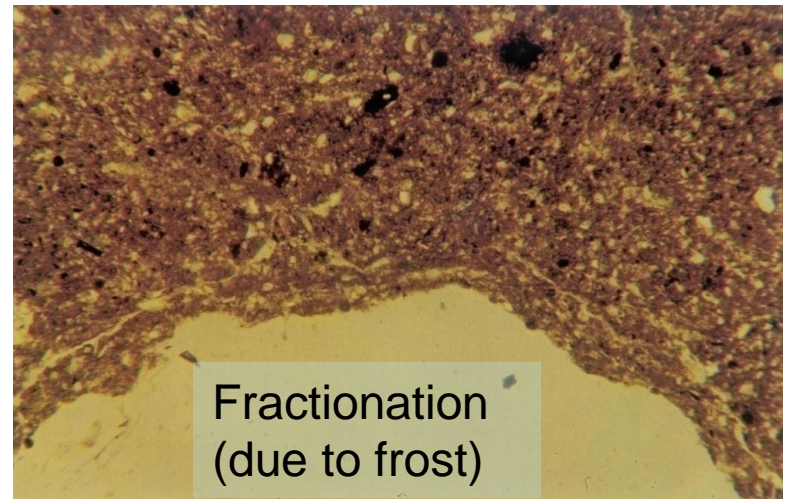
Soil loss via surface runoff

			Topography:		Soil:	Surface runoff:	Tillage:
	SS loss (kg/ha)	SS conc (mg/l)	Steep? (>10 %)	Depression?	Low Aggst?	High? (>100 mm)	Autumn?
Bye	213	1521	(+)	-	-	-	+
Ape H P1	25	83	-	-	-	-	+
Ape V P1	10	20	-	-	-	-	-
Ape H P2	2	16	-	-	-	-	+
Ape V P2	1	9	-	-	-	-	-
Syv H P1	133	218	+	-	-	-	+
Syv V P1	100	57	+	-	-	+	-
Syv H P2	176	181	+	-	-	-	+
Syv V P2	104	63	+	-	-	+	-
Ene	398	555	(+)	+	(+)	-	(+)
Kvi	53	35	-	-	-	+	(+)
Skj H	17	106	+/-	-	-	-	+
Skj V	18	35	+/-	-	-	-	-
Skj ENG	5	9	+/-	-	-	-	grass
Holt	2641	2219	+	+	+	+	+
Lod	1373	621	+	-	+	+	(+)
Ask H P1	3992	1559	+	-	+	+	+
Ask V P1	546	256	+	-	+	+	-
Bjø H	5214	1823	+	-	+	+	+
Bjø V	646	302	+	-	+	+	-
Hel H	197	119	+	-	+	+	+
Hel V	20	13	+	-	+	+	-
Øsa H	104	85	+	-	+	+	+
Øsa V	19	14	+	-	+	+	-
Van H	876	1718	+/-	+	+	-	+
Van V	53	84	+/-	+	+	-	-

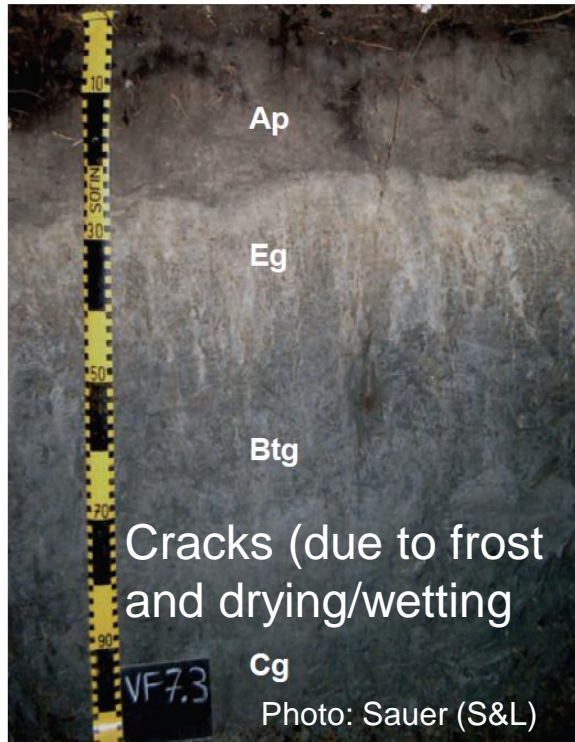
Recent drainage



Photo: Nationen



Fractionation
(due to frost)



Cracks (due to frost and drying/wetting)

Cg

Photo: Sauer (S&L)



Biopores

Photo: Sveistrup/Haraldsen



Intensive drainage,
cracked backfill

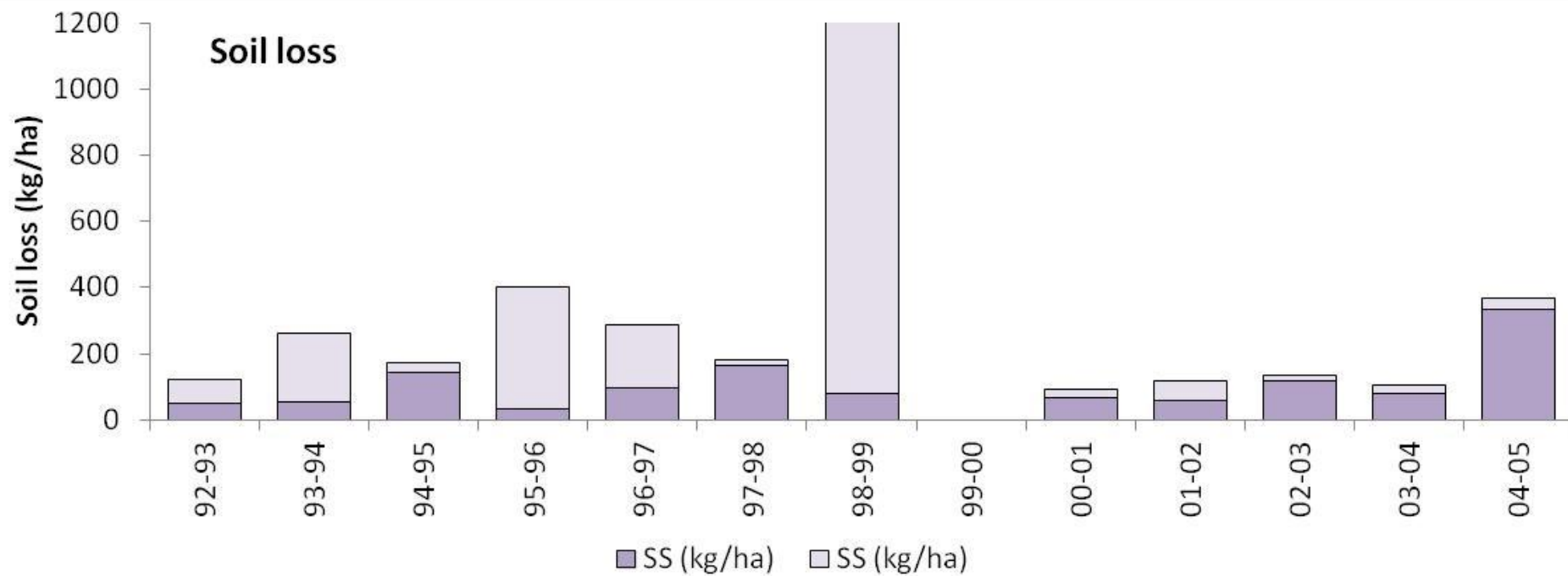
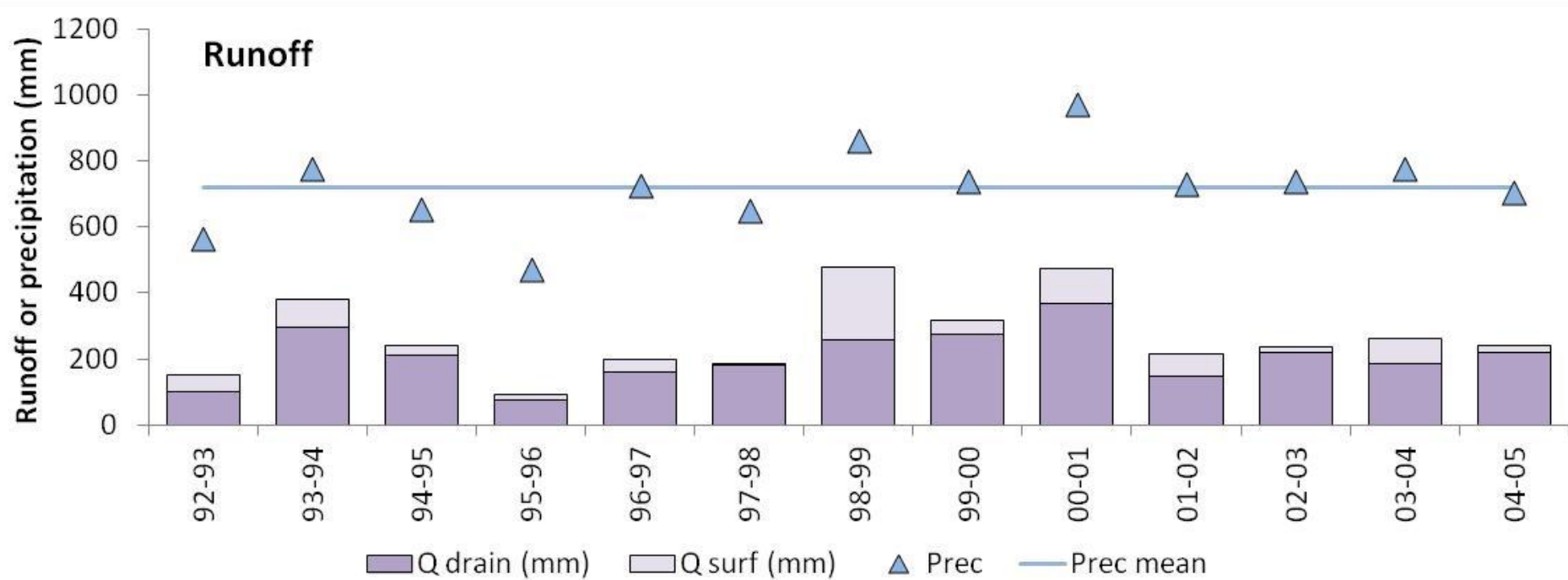
Photo: Øygarden

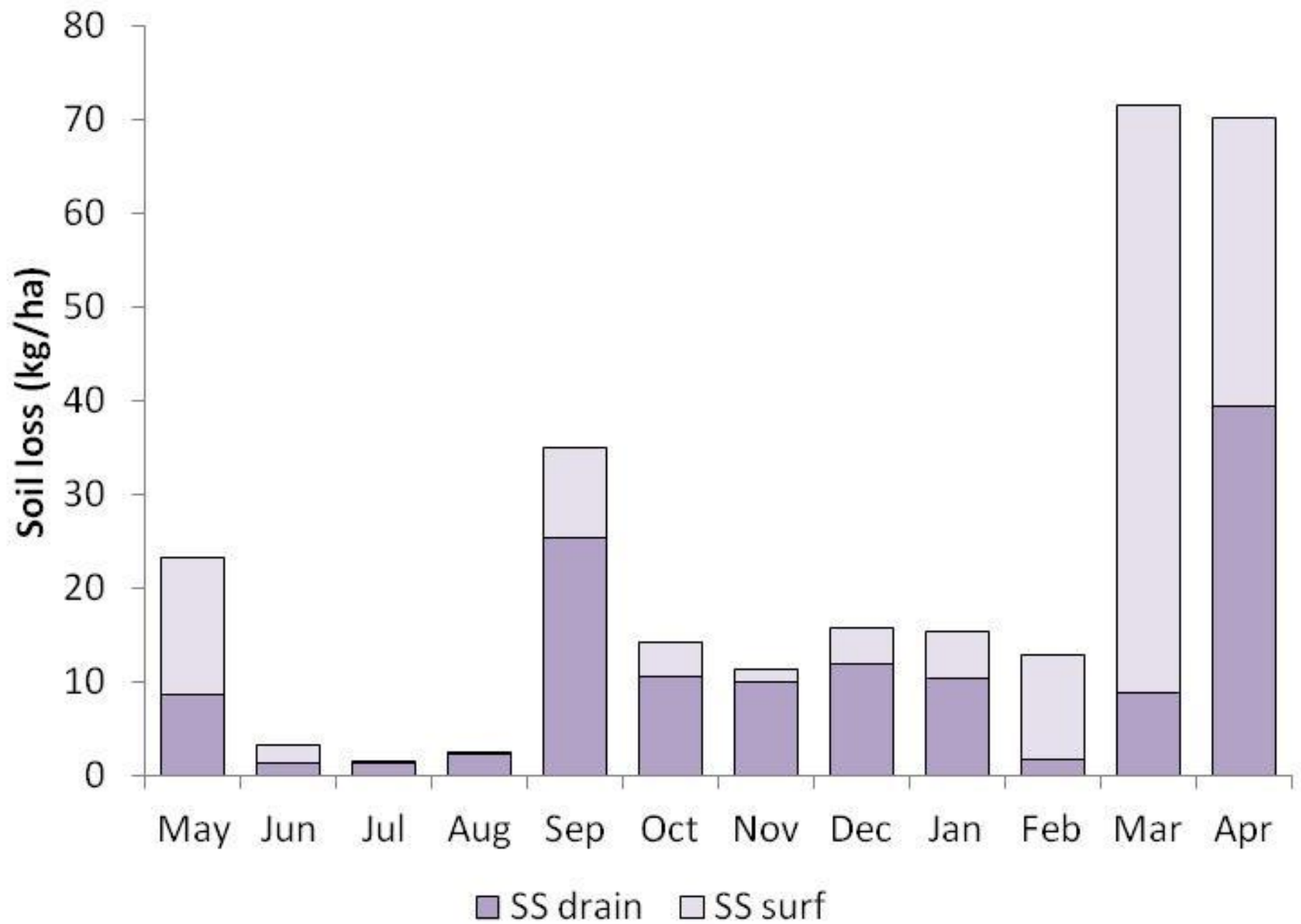
SS loss via the drainage system

	SS loss (kg/ha)	SS conc (mg/l)	Drainflow: High?	Slope: Gentle?	Soil: Low Aggst?	Drainage: Recent?	Drainage: Intensive?	Tillage: Autumn?
Vin ENG	56	8	+	+	-	-	-	grass
Bye	13	9	-	-	-	-	-	+
Ape H P1	18	6	-	+	-	+	-	+
Ape V P1	19	7	-	+	-	+	-	-
Ape H P2	43	14	-	+	-	+	-	+
Ape V P2	14	5	-	+	-	+	-	-
Syv H P1	28	9	-	-	-	-	-	+
Syv V P1	23	9	-	-	-	-	-	-
Syv H P2	124	32	-	-	-	-	-	+
Syv V P2	48	15	-	-	-	-	-	-
Ene	438	102	+	(+)	(+)	-	-	(+)
Kvi	528	115	+	++	-	+	-	+
Skj H	785	151	+	+	-	+	-	+
Skj V	395	89	+	+	-	+	-	-
Skj ENG	387	75	+	+	-	+	-	grass
Holt	450	202	-	-	+	-	-	+
Lod	1319	663	-	-	+	+	++	(+)
Ask	1200	443	-	-	+	+	+	(+)
Van H	162	85	-	+/-	+	-	-	+
Van V	113	52	-	+/-	+	-	-	-
Van H ravine	506	340	-	-	+	-	-	+
Van V ravine	353	218	-	-	+	-	-	-

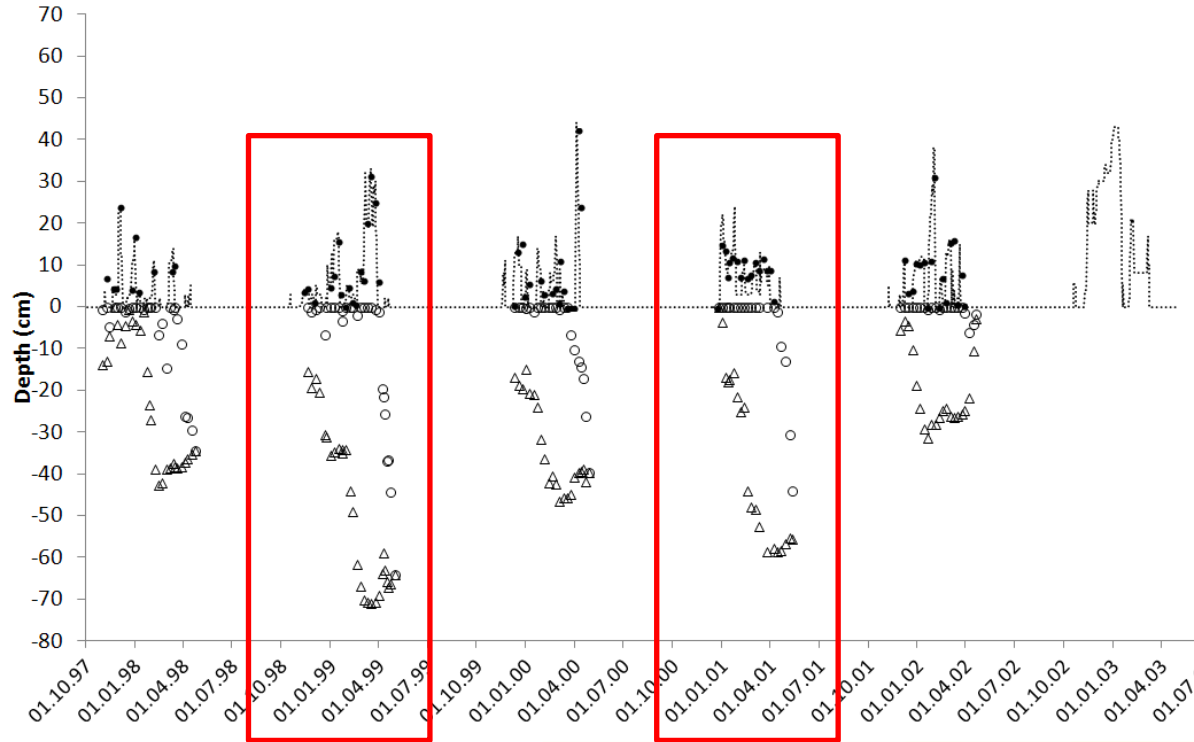
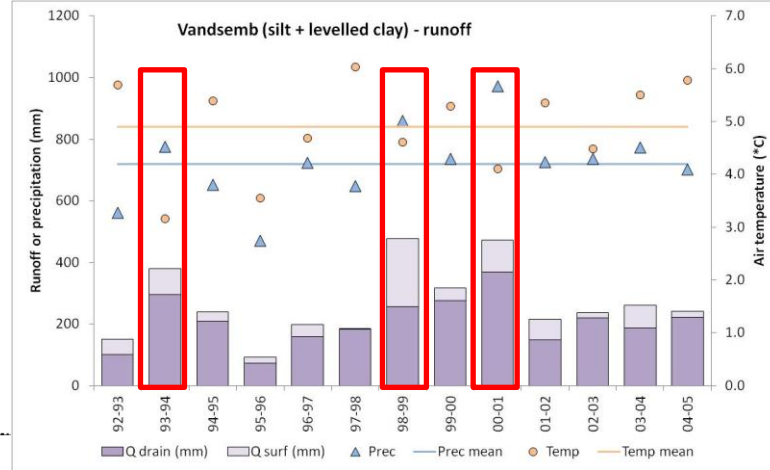
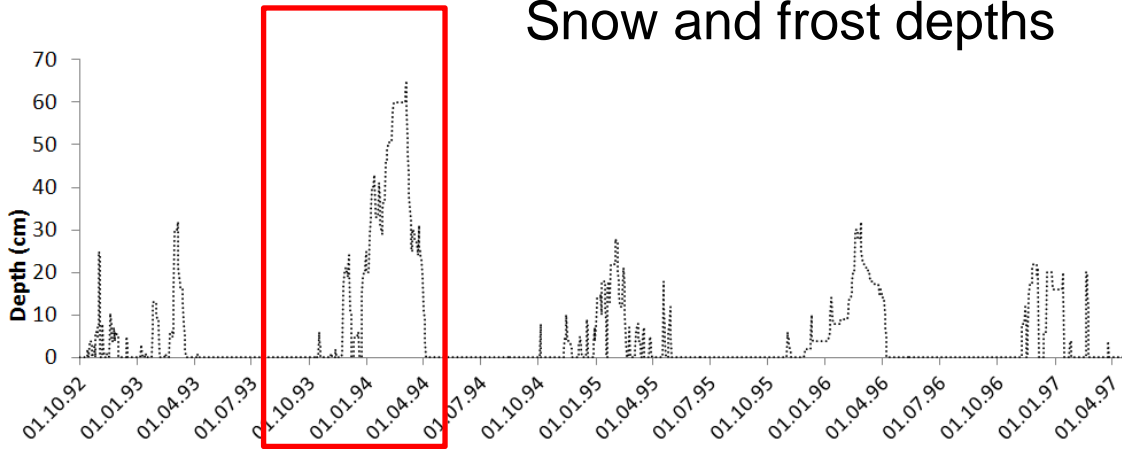
Year to year variation

	Bye (15 yr)	Enerstujordet (8 yr)	Vandsemb (13 yr)	Askim (20 yr)	Holt (11 yr)
% Drainflow					
Min	76	55	54	25	26
Max	100	96	99	95	92
% Soil loss via drainage system					
Min	1	15	2		1
Max	100	91	91		89

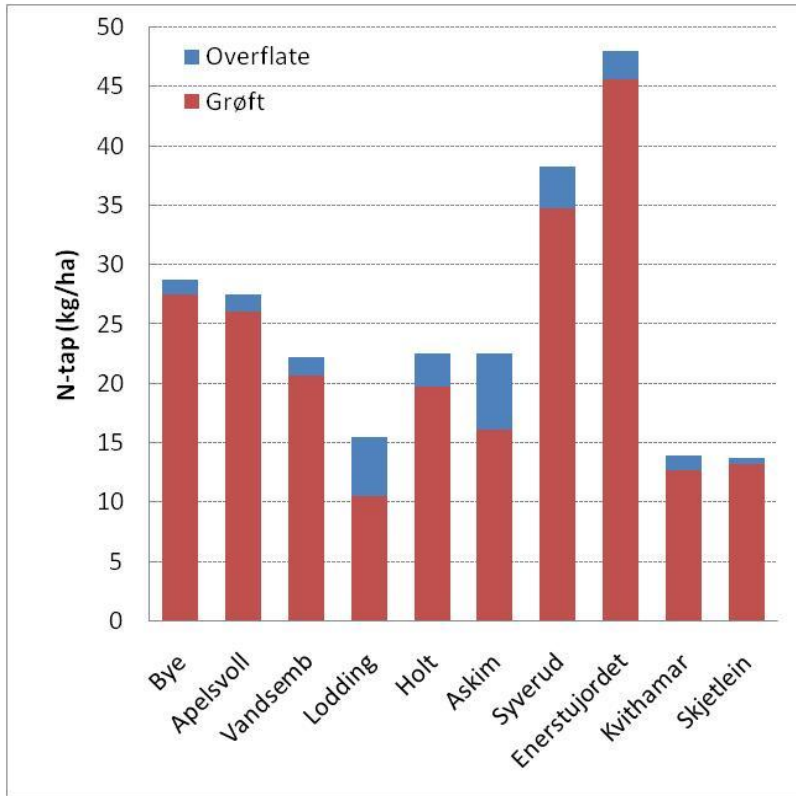
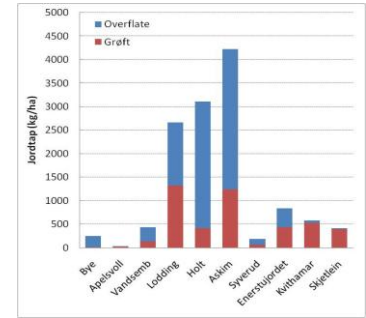




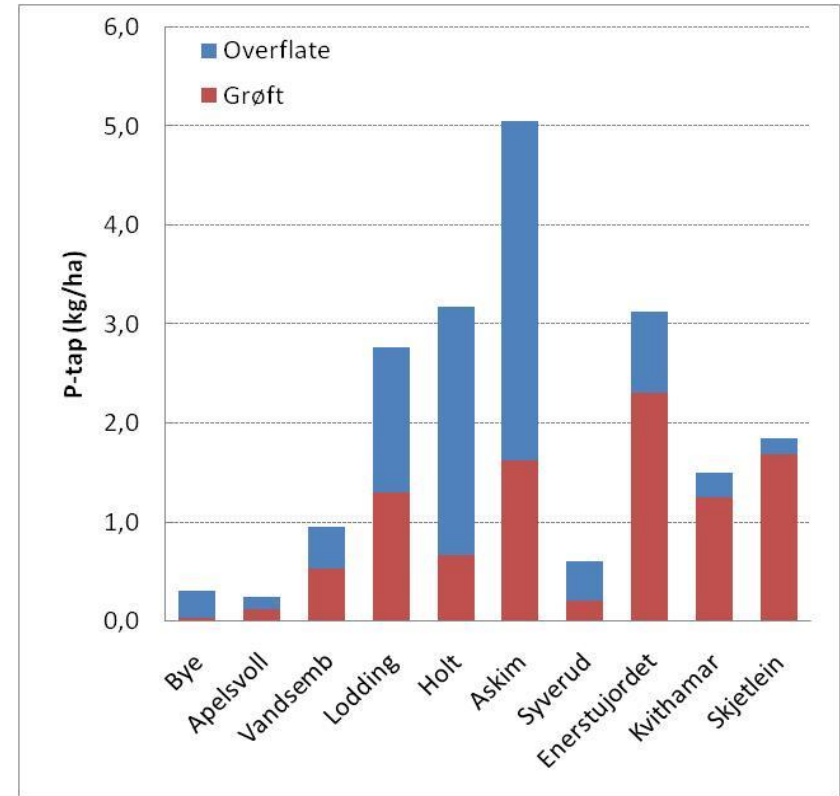
Snow and frost depths



Nutrients



Nitrogen



Phosphorus

Conclusions

- Time series with measured surface runoff and drain flow + water quality provide:
 - quantitative data to determine the importance of different pathways under different natural and anthropogenic influences
 - insight into processes
 - differences between sites with different characteristics well understood
 - within-site variations between and within years less well understood