

# Monitoring, modeling and risk assessment at different scales

Marianne Bechmann

Norwegian Institute for Agricultural and  
Environmental Research - Bioforsk

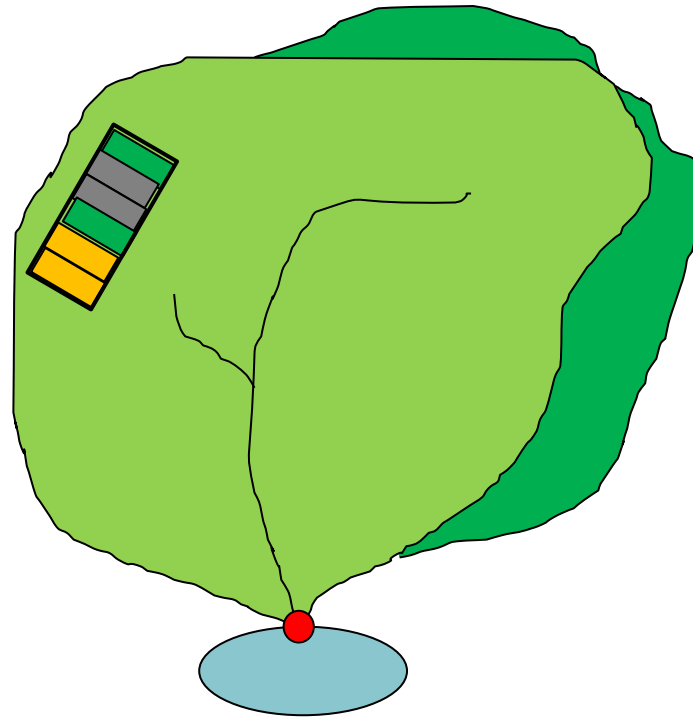
IPW7 - Sept. 2013

# Challenge:

To evaluate/document effect of mitigation methods at the catchment scale

## Tools:

- Monitoring
- Modeling

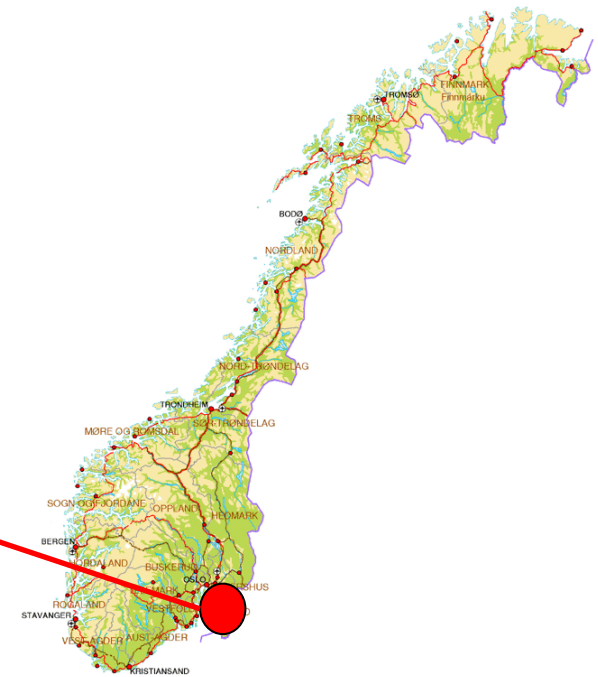




# Eutrophication in Norway

## Example: Lake Western Vansjø

Eutrophication due to increased phosphorus concentration



# Agricultural practice in the catchment

Mainly arable farming

- Winter and spring cereals
- Potato and vegetables

A few livestock farms



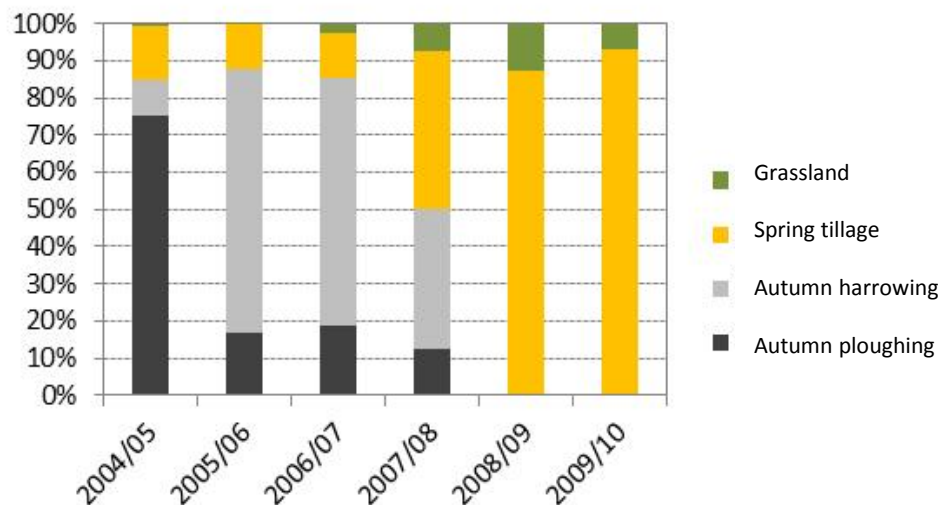
Local catchment area: 70 km<sup>2</sup>

Recreation area for 60 000 inhabitants



# Comprehensive mitigation methods implemented in the catchment of western Vansjø

Reduced tillage

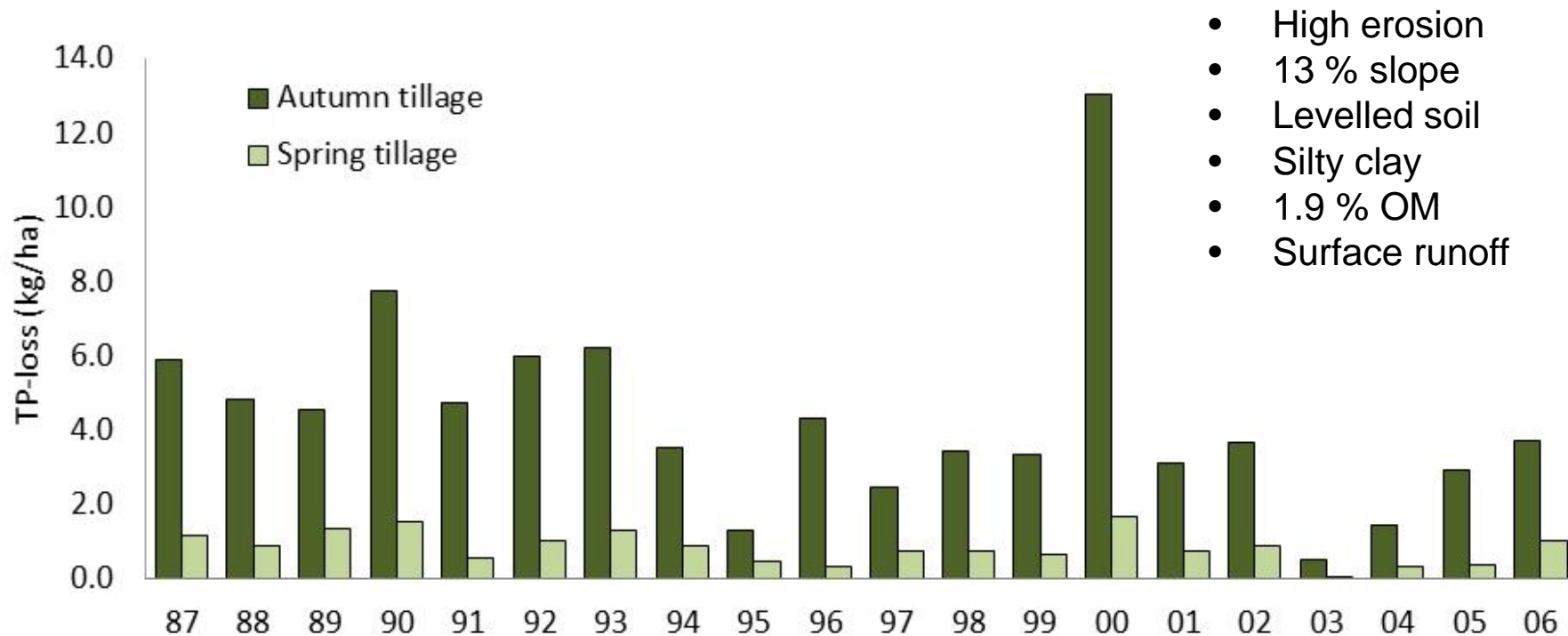


Reduced P application	kg P/ha				
	2004	2007	2008	2009	2010
Mean for area with contract	22	11	6	4	5

# What do we know about effect of mitigation methods?



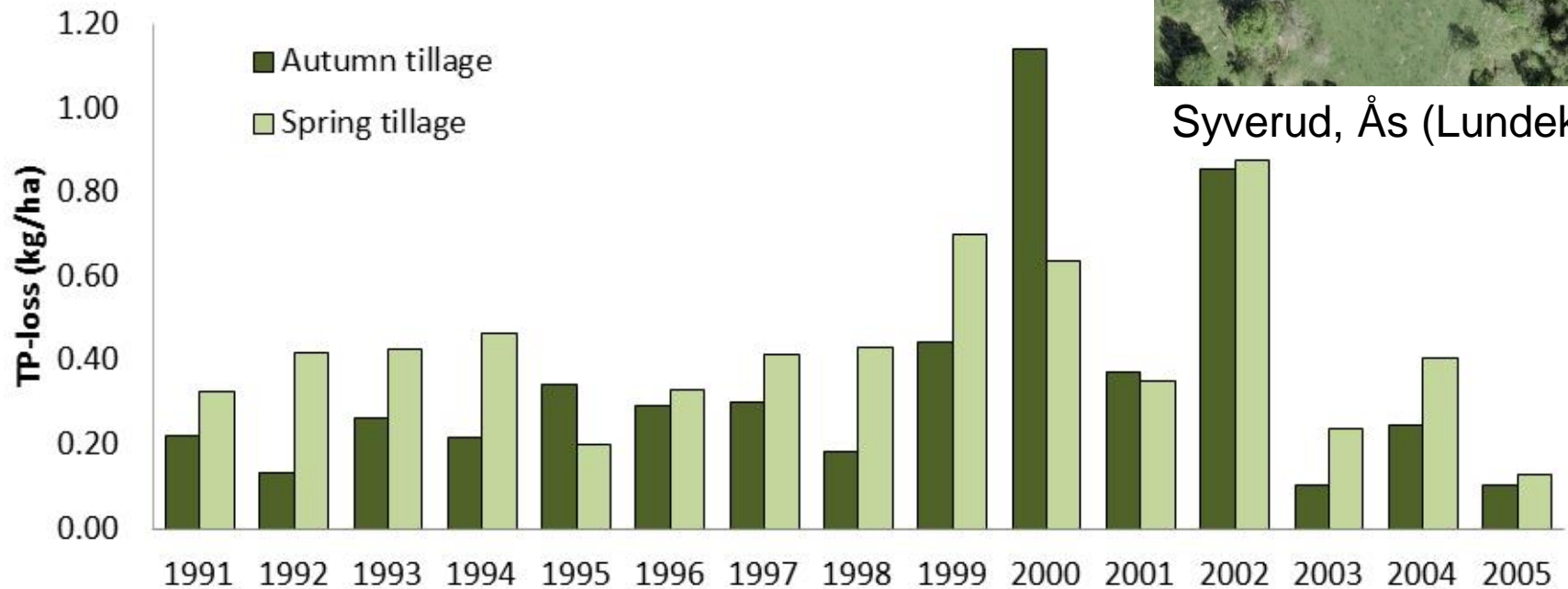
# Soil tillage and P loss at the plot scale



Bechmann et al. (2011)

# Soil tillage and P loss at the plot scale

- Low erosion
- 13 % slope
- 5,5 % OM
- Surface runoff



Bechmann et al. (2011)

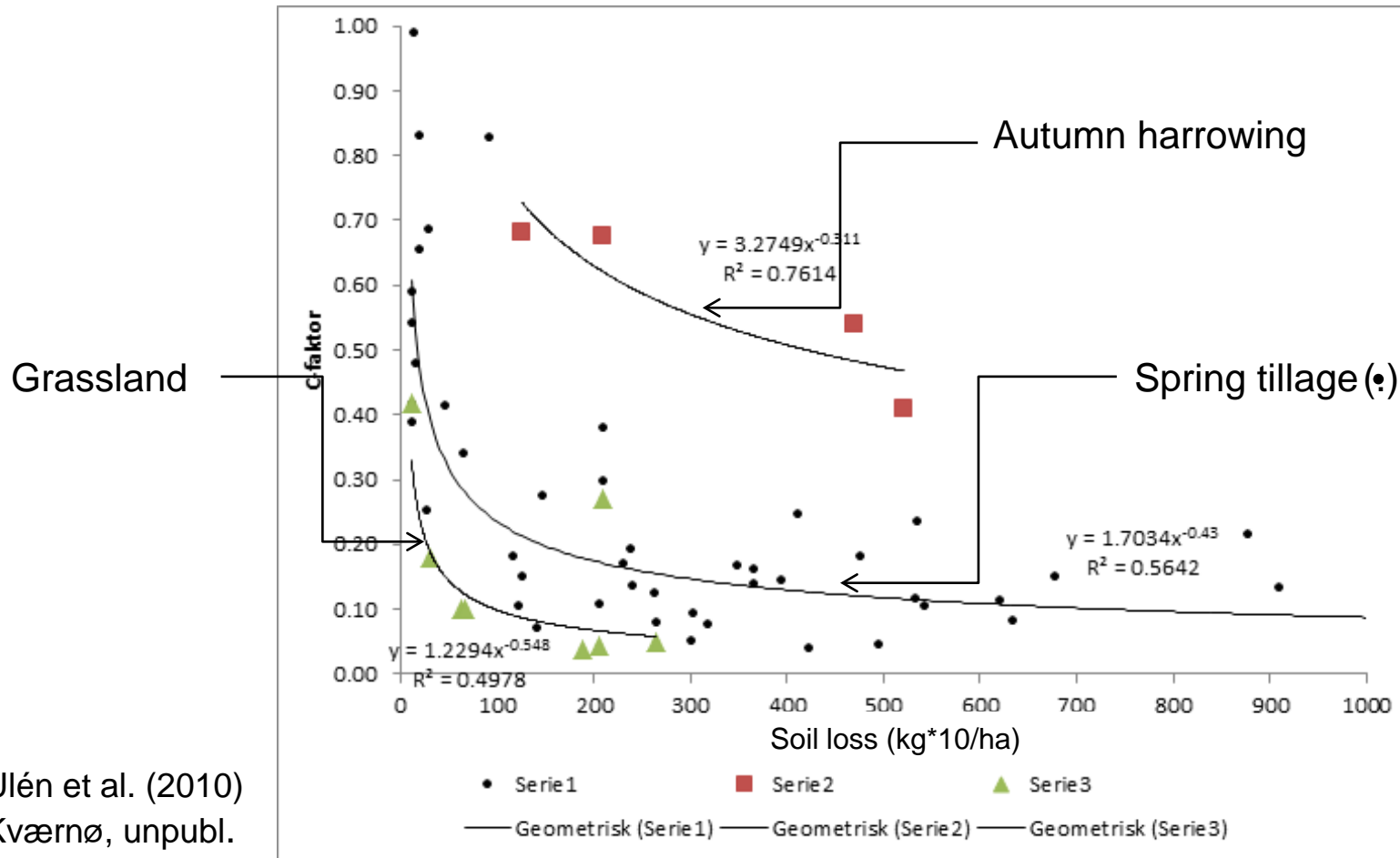


Syverud, Ås (Lundekvam)

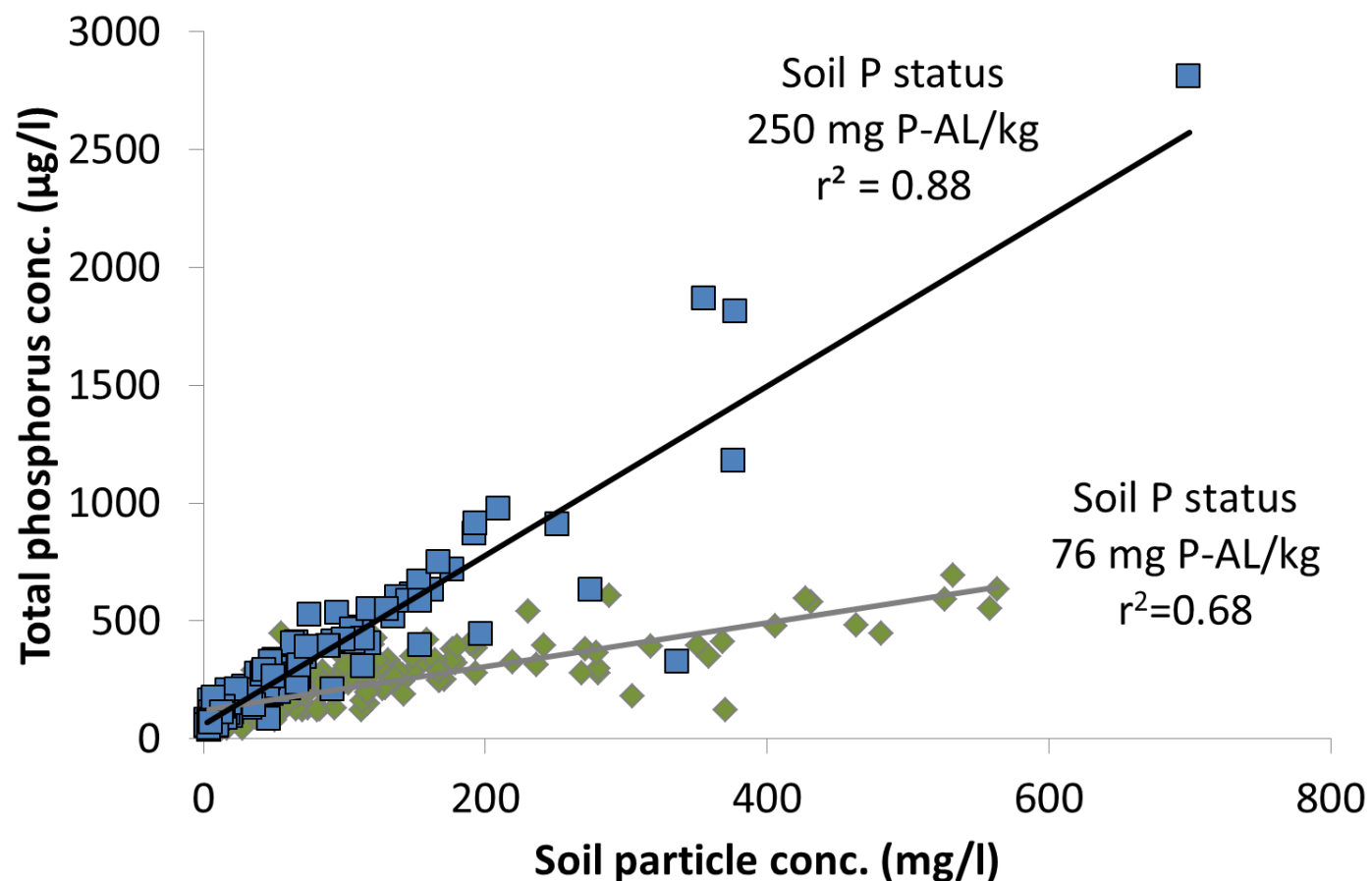


# Effect of soil tillage on erosion

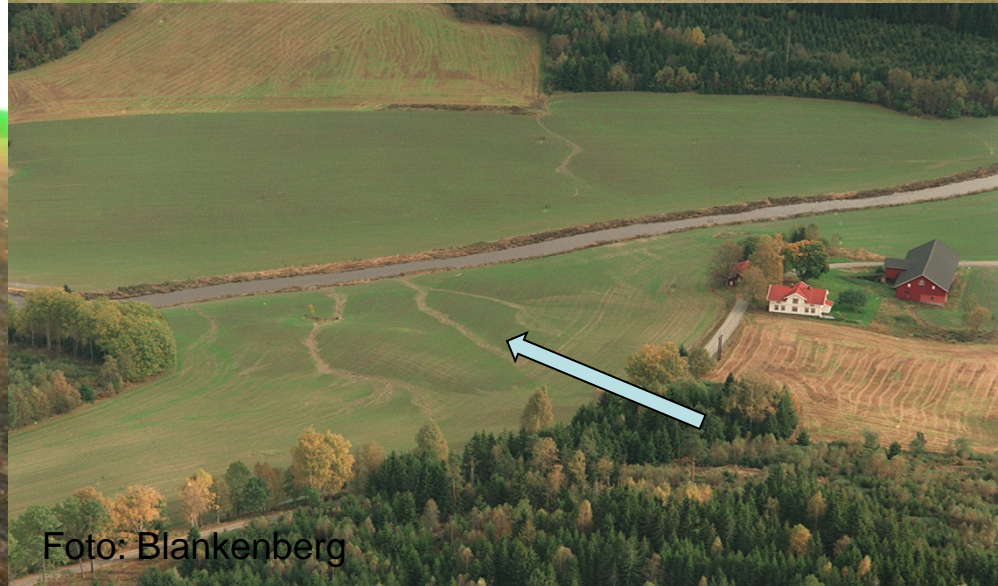
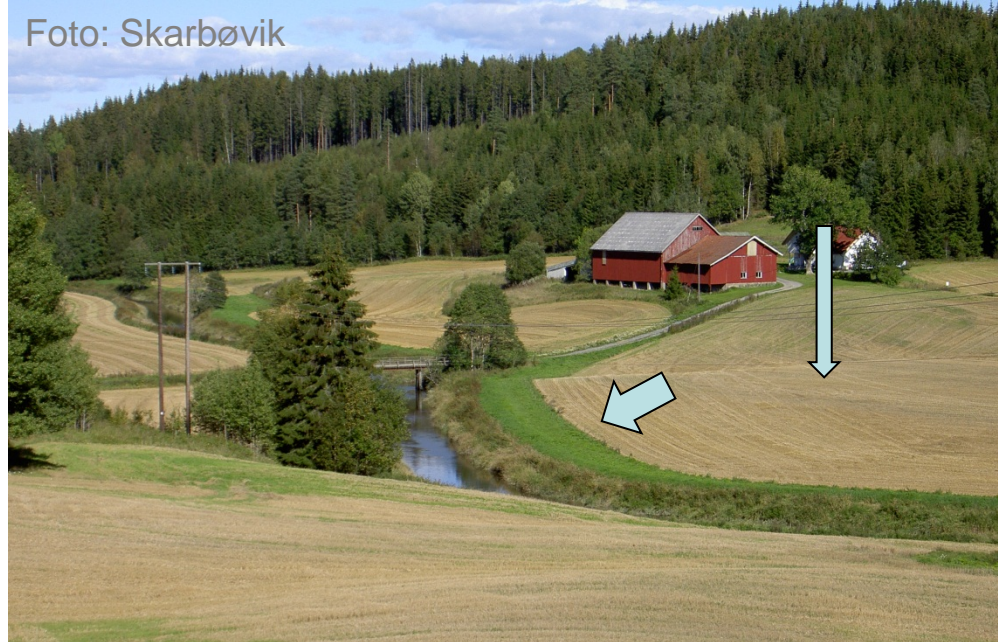
compared to autumn ploughing



# P application -> Soil P status from small catchments



# Effect of grassed buffer zones





# Effect of mitigation methods at the catchment scale





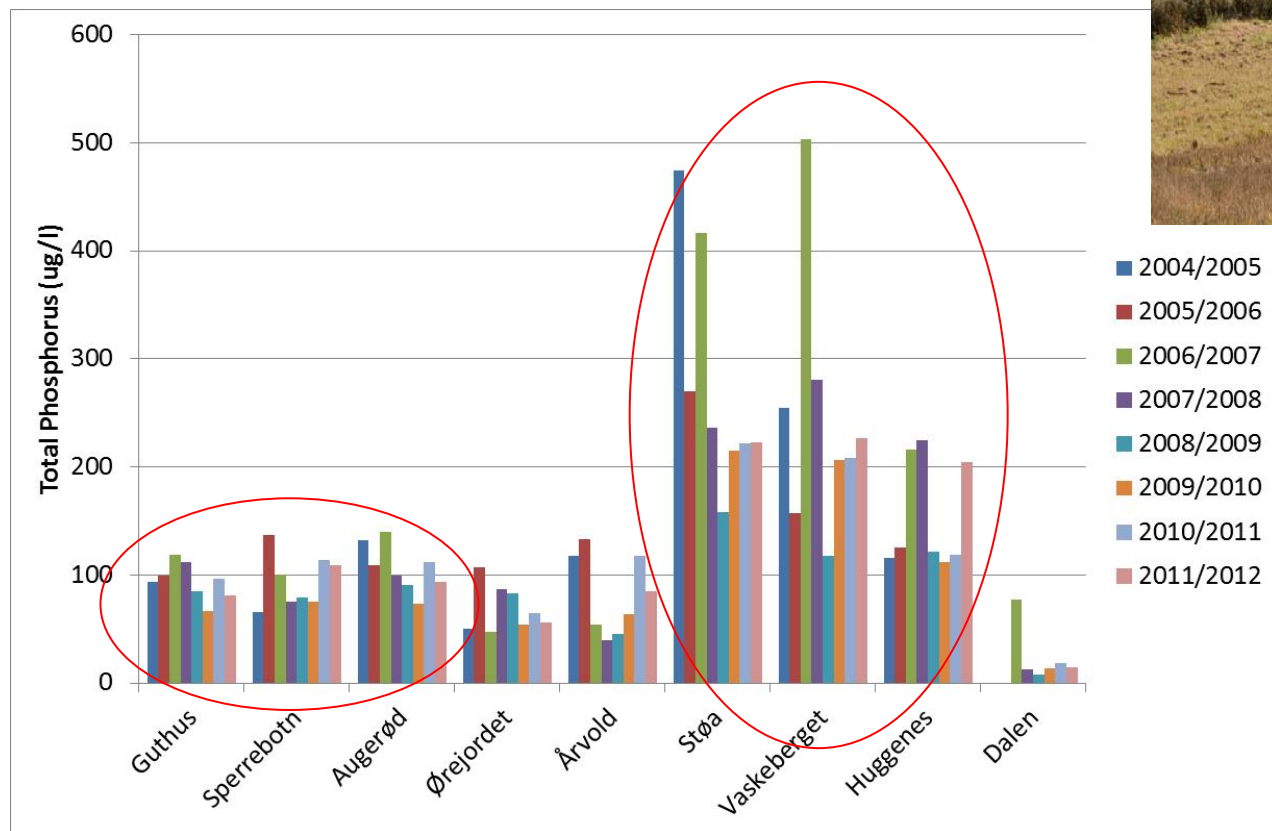
# Monitoring



western Vansjø

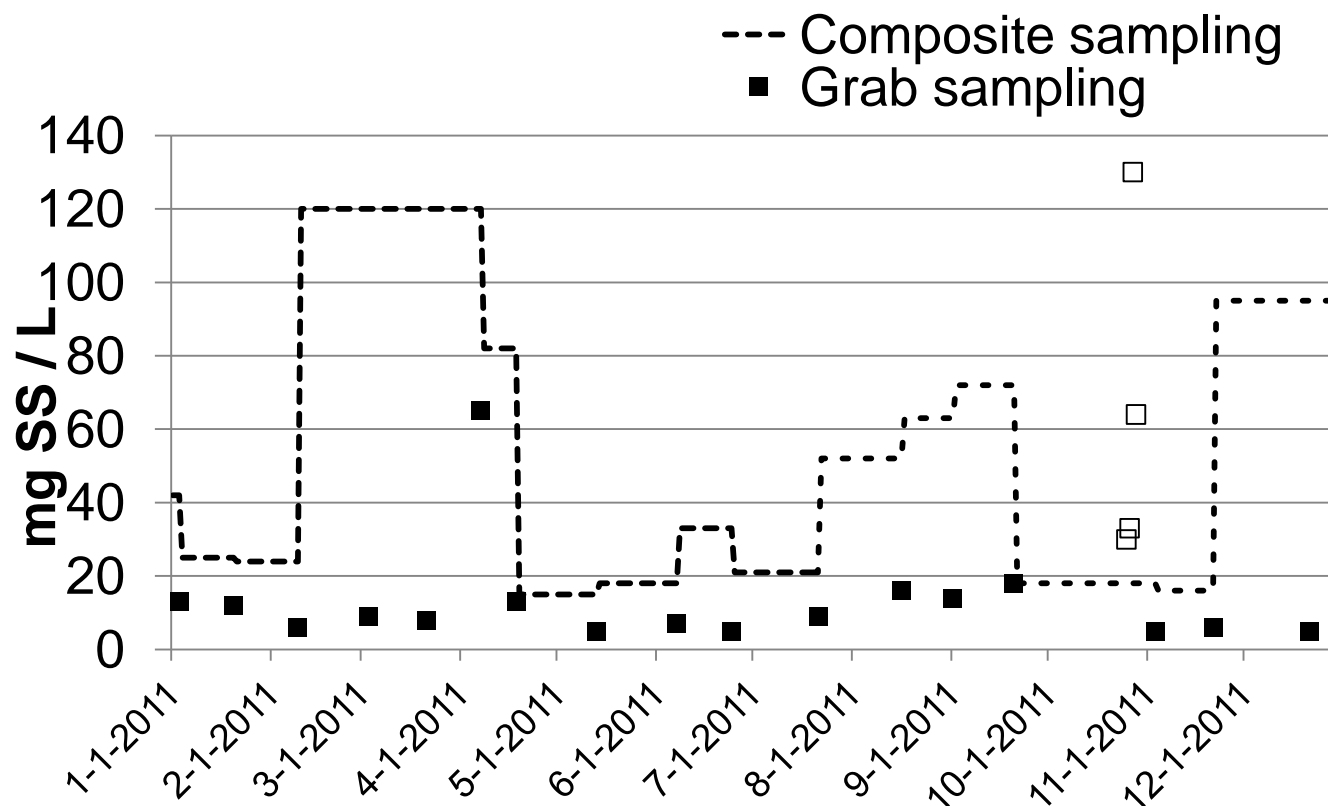


# Western Vansjø



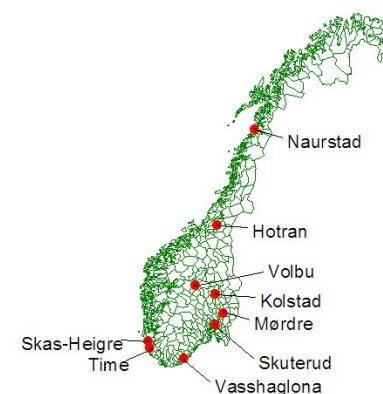


# Monitoring methods



Skarbøvik, 2013

# Composite flow proportional sampling



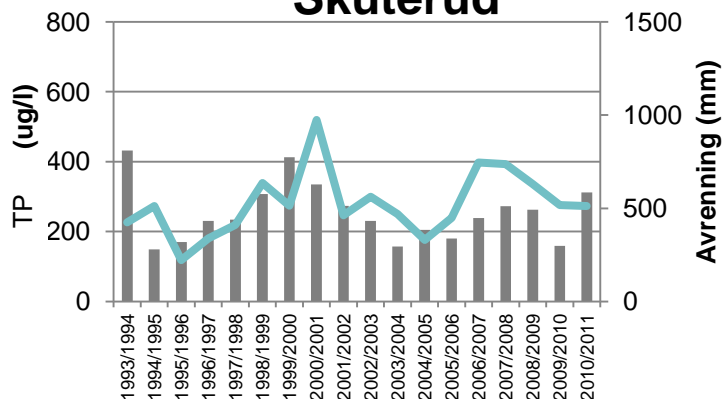
The Norwegian Environmental Agricultural Monitoring programme



# Trends in phosphorus concentrations



## Skuterud

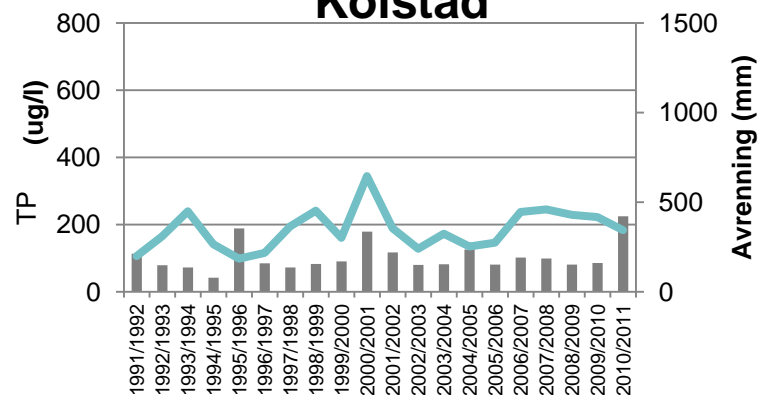


No significant trends

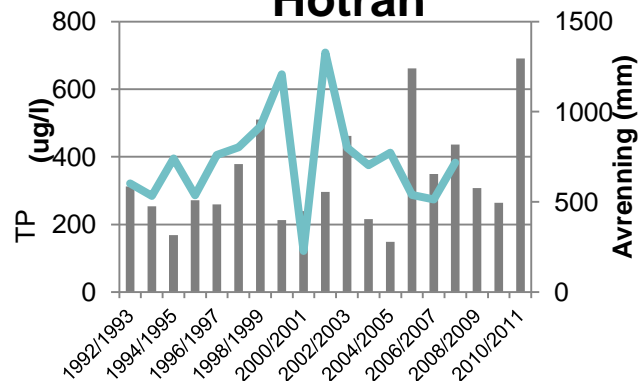
■ P tap

— Avrenning

## Kolstad



## Hotran





# Time trends

- Contrary changes in agricultural management - increased livestock density
- Changes in weather
- Retention in the catchment
- Monitoring started too late
- Spatial variation in effect og mitigation methods

# Monitoring



*National monitoring*



*Western Vansjø*

Two examples with no effects of mitigation methods

# Complex systems -> modeling

- If too many factors influence P loss - modeling may be used to sort out the relationship
- Keeping everything else constant - only effect of mitigation methods
- Estimate the effect of changes in weather



# The INCA-P model - application for the Skuterud catchment

## 1. Parameterisation

- Available data from the Skuterud catchment and stream
- Literature review
- Expert assumptions (qualitative information)

## 2. Calibration procedure

- Stepwise calibration approach (flow; SS&TP)



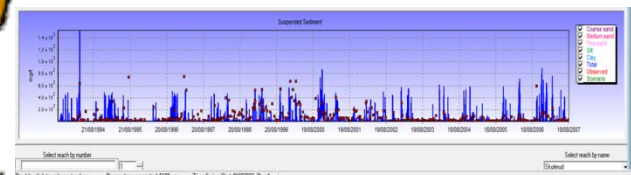
## 3. Validation procedure

## 4. Scenario analyses

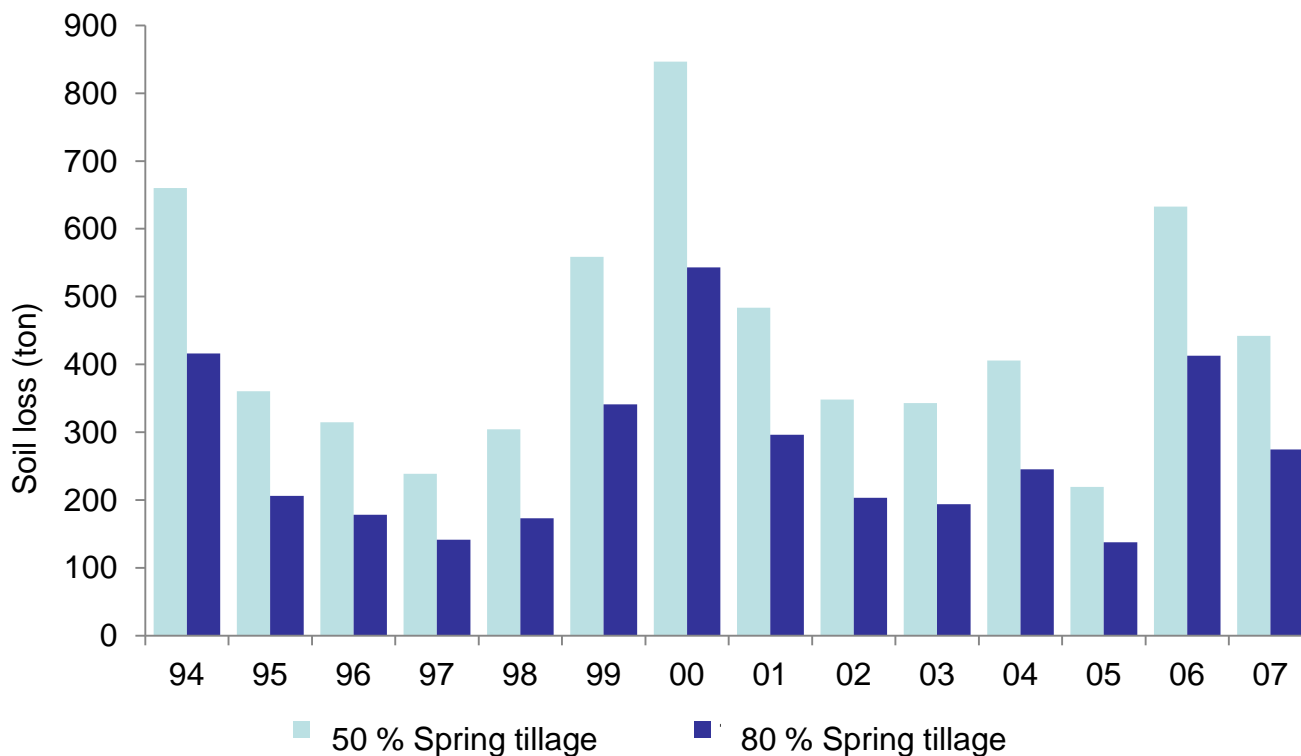


Sensitivity analyses results

Parameter sets defining 100% and 100% values											
Reference date: 1990		Reference date: 1990		Reference date: 1990		Reference date: 1990		Reference date: 1990		Reference date: 1990	
44%		44%		44%		44%		44%		44%	
1990		1990		1990		1990		1990		1990	
1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12	12	12	12	12
13	13	13	13	13	13	13	13	13	13	13	13
14	14	14	14	14	14	14	14	14	14	14	14
15	15	15	15	15	15	15	15	15	15	15	15
16	16	16	16	16	16	16	16	16	16	16	16
17	17	17	17	17	17	17	17	17	17	17	17
18	18	18	18	18	18	18	18	18	18	18	18
19	19	19	19	19	19	19	19	19	19	19	19
20	20	20	20	20	20	20	20	20	20	20	20
21	21	21	21	21	21	21	21	21	21	21	21
22	22	22	22	22	22	22	22	22	22	22	22
23	23	23	23	23	23	23	23	23	23	23	23
24	24	24	24	24	24	24	24	24	24	24	24
25	25	25	25	25	25	25	25	25	25	25	25
26	26	26	26	26	26	26	26	26	26	26	26
27	27	27	27	27	27	27	27	27	27	27	27
28	28	28	28	28	28	28	28	28	28	28	28
29	29	29	29	29	29	29	29	29	29	29	29
30	30	30	30	30	30	30	30	30	30	30	30
31	31	31	31	31	31	31	31	31	31	31	31
32	32	32	32	32	32	32	32	32	32	32	32
33	33	33	33	33	33	33	33	33	33	33	33
34	34	34	34	34	34	34	34	34	34	34	34
35	35	35	35	35	35	35	35	35	35	35	35
36	36	36	36	36	36	36	36	36	36	36	36
37	37	37	37	37	37	37	37	37	37	37	37
38	38	38	38	38	38	38	38	38	38	38	38
39	39	39	39	39	39	39	39	39	39	39	39
40	40	40	40	40	40	40	40	40	40	40	40
41	41	41	41	41	41	41	41	41	41	41	41
42	42	42	42	42	42	42	42	42	42	42	42
43	43	43	43	43	43	43	43	43	43	43	43
44	44	44	44	44	44	44	44	44	44	44	44
45	45	45	45	45	45	45	45	45	45	45	45
46	46	46	46	46	46	46	46	46	46	46	46
47	47	47	47	47	47	47	47	47	47	47	47
48	48	48	48	48	48	48	48	48	48	48	48
49	49	49	49	49	49	49	49	49	49	49	49
50	50	50	50	50	50	50	50	50	50	50	50
51	51	51	51	51	51	51	51	51	51	51	51
52	52	52	52	52	52	52	52	52	52	52	52
53	53	53	53	53	53	53	53	53	53	53	53
54	54	54	54	54	54	54	54	54	54	54	54
55	55	55	55	55	55	55	55	55	55	55	55
56	56	56	56	56	56	56	56	56	56	56	56
57	57	57	57	57	57	57	57	57	57	57	57
58	58	58	58	58	58	58	58	58	58	58	58
59	59	59	59	59	59	59	59	59	59	59	59
60	60	60	60	60	60	60	60	60	60	60	60
61	61	61	61	61	61	61	61	61	61	61	61
62	62	62	62	62	62	62	62	62	62	62	62
63	63	63	63	63	63	63	63	63	63	63	63
64	64	64	64	64	64	64	64	64	64	64	64
65	65	65	65	65	65	65	65	65	65	65	65
66	66	66	66	66	66	66	66	66	66	66	66
67	67	67	67	67	67	67	67	67	67	67	67
68	68	68	68	68	68	68	68	68	68	68	68
69	69	69	69	69	69	69	69	69	69	69	69
70	70	70	70	70	70	70	70	70	70	70	70
71	71	71	71	71	71	71	71	71	71	71	71
72	72	72	72	72	72	72	72	72	72	72	72
73	73	73	73	73	73	73	73	73	73	73	73
74	74	74	74	74	74	74	74	74	74	74	74
75	75	75	75	75	75	75	75	75	75	75	75
76	76	76	76	76	76	76	76	76	76	76	76
77	77	77	77	77	77	77	77	77	77	77	77
78	78	78	78	78	78	78	78	78	78	78	78
79	79	79	79	79	79	79	79	79	79	79	79
80	80	80	80	80	80	80	80	80	80	80	80
81	81	81	81	81	81	81	81	81	81	81	81
82	82	82	82	82	82	82	82	82	82	82	82
83	83	83	83	83	83	83	83	83	83	83	83
84	84	84	84	84	84	84	84	84	84	84	84
85	85	85	85	85	85	85	85	85	85	85	85
86	86	86	86	86	86	86	86	86	86	86	86
87	87	87	87	87	87	87	87	87	87	87	87
88	88	88	88	88	88	88	88	88	88	88	88
89	89	89	89	89	89	89	89	89	89	89	89
90	90	90	90	90	90	90	90	90	90	90	90
91	91	91	91	91	91	91	91	91	91	91	91
92	92	92	92	92	92	92	92	92	92	92	92
93	93	93	93	93	93	93	93	93	93	93	93
94	94	94	94	94	94	94	94	94	94	94	94
95	95	95	95	95	95	95	95	95	95	95	95
96	96	96	96	96	96	96	96	96	96	96	96
97	97	97	97	97	97	97	97	97	97	97	97
98	98	98	98	98	98	98	98	98	98	98	98
99	99	99	99	99	99	99	99	99	99	99	99
100	100	100	100	100	100	100	100	100	100	100	100

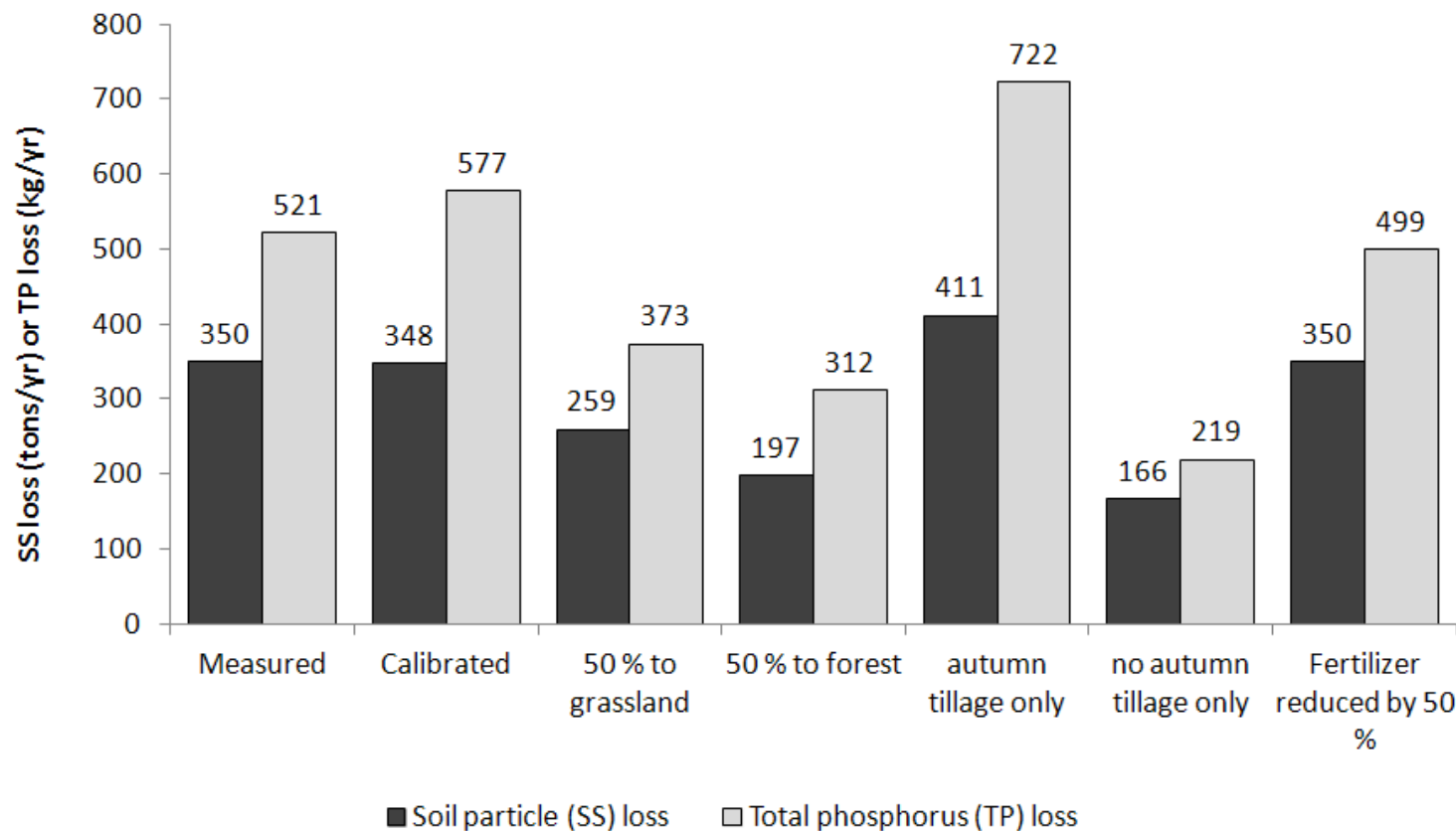


# Modeling effect of two scenarios for tillage



INCA (Kværnø et al., 2012)

# INCA-P



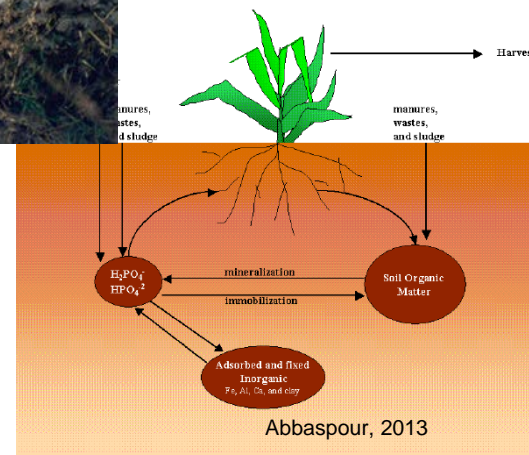
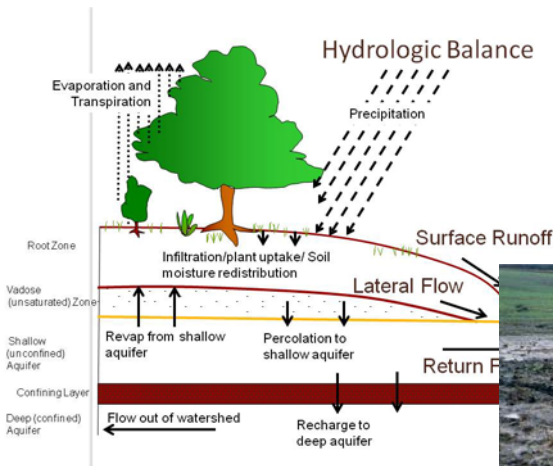
Farkas (2013)



# Soil and Water Assessment Tool (SWAT) (Neitsch, Arnold et al. 2009)

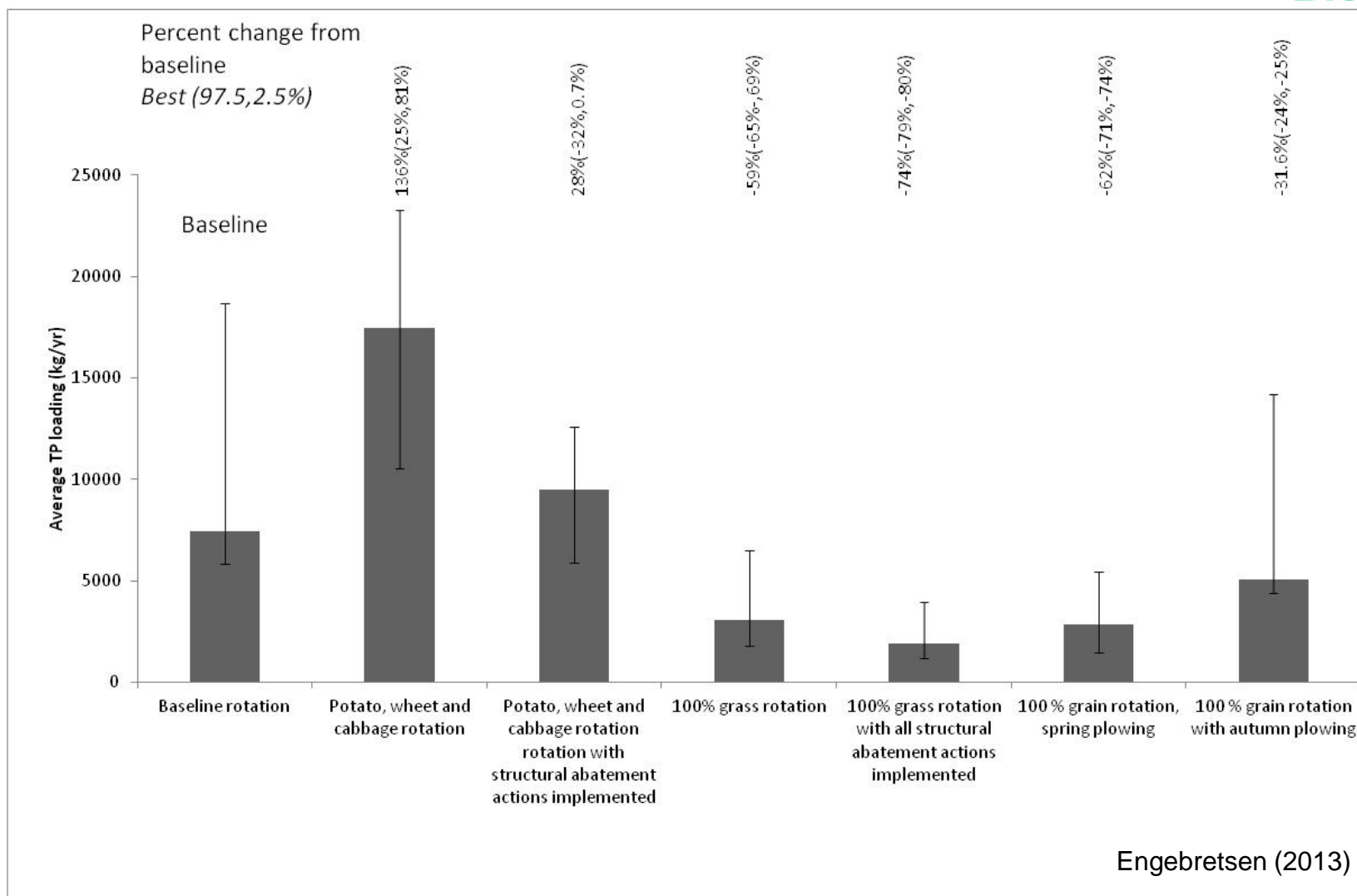
- Process based
- Dynamic

- Simulates changes in water quality based on farmer management practices
- Distributed in space
- Runs on a daily time scale

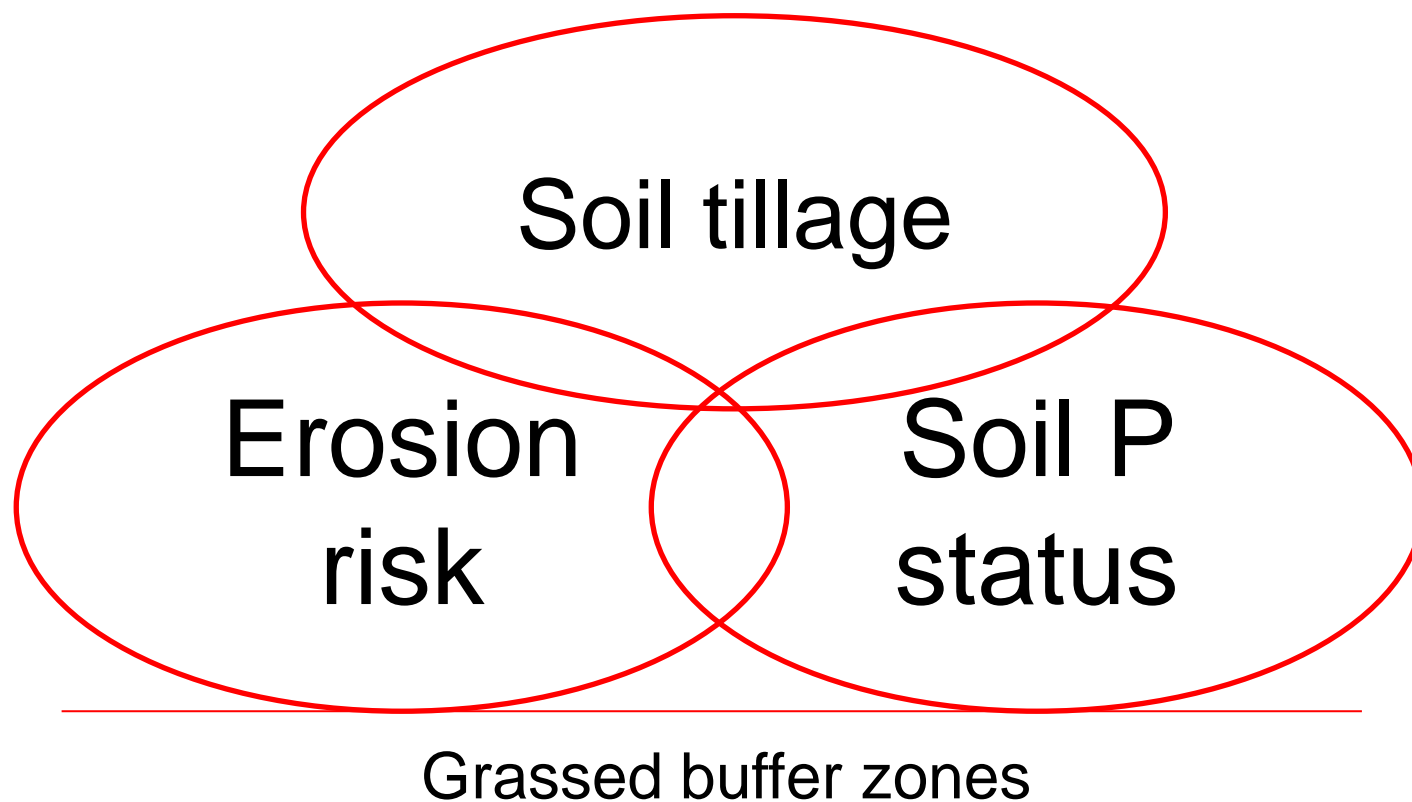


Engelbrechtsen (2013)

# SWAT in the western Vansjø catchment: Changes in crop rotations



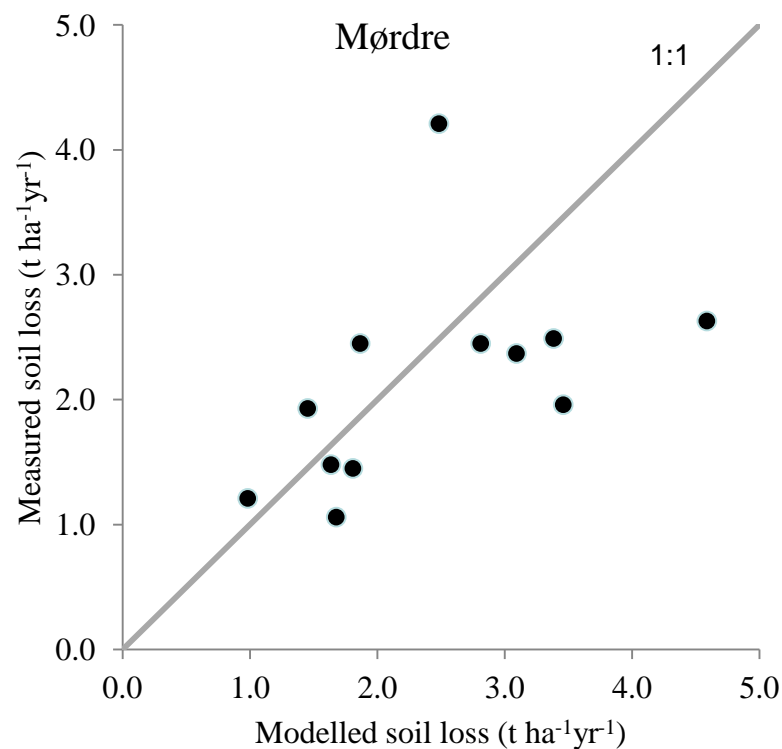
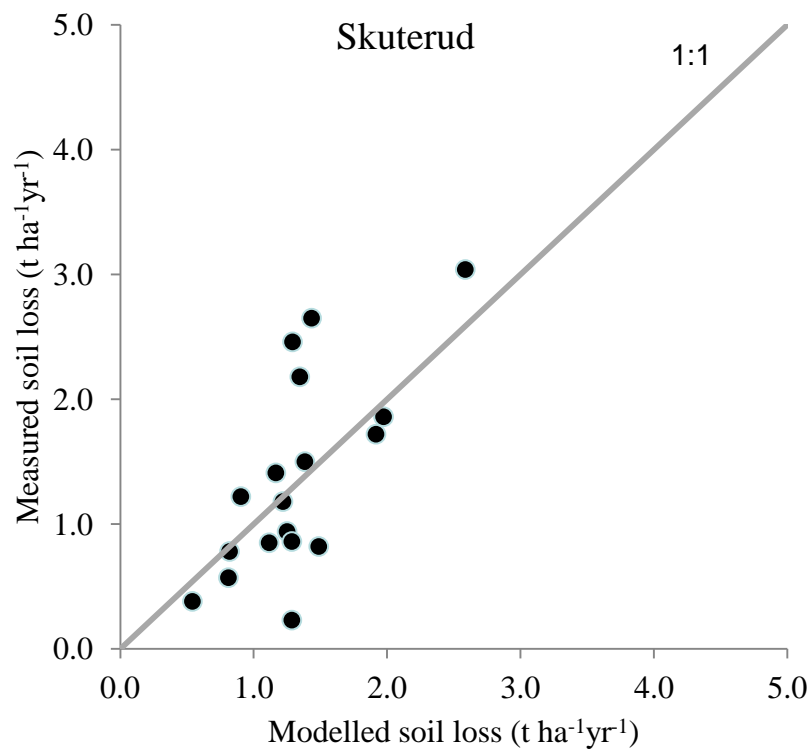
# The Agricat model



Borch et al., (2010)



# Agricat test on soil loss



# Effect of mitigation strategies in Agricat

Soil tillage change:

Scenario 1-3: No autumn till

Scenario 4-6: No autumn till and grass on very high risk areas

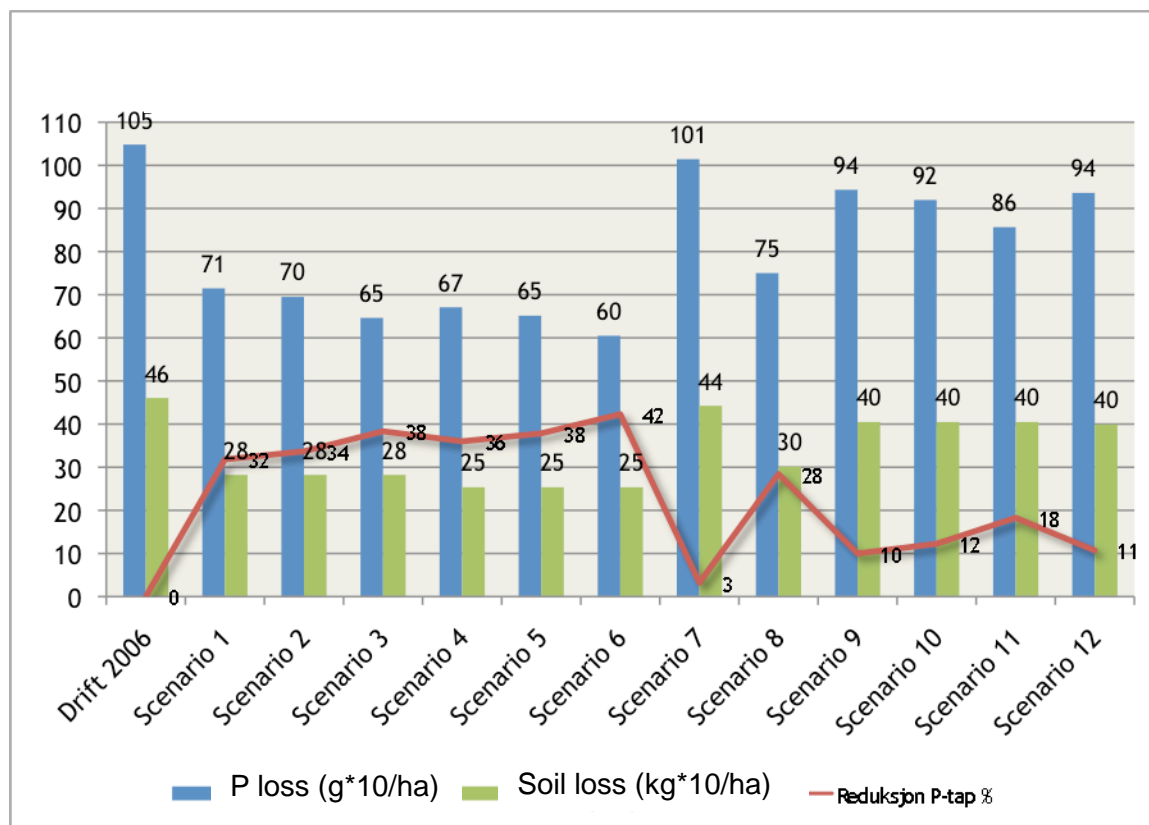
Scenario 7: Autumn harrowed area changed to no autumn till

Scenario 8: No autumn till on high erosion risk areas, flood risk and along streams

Scenario 9-11: 20 % of the area autumn ploughed

Combined with change in soil P status:

No change, reduction to 7 or 10



Borch et al., (2010)

# Different processes – does models account for these processes?





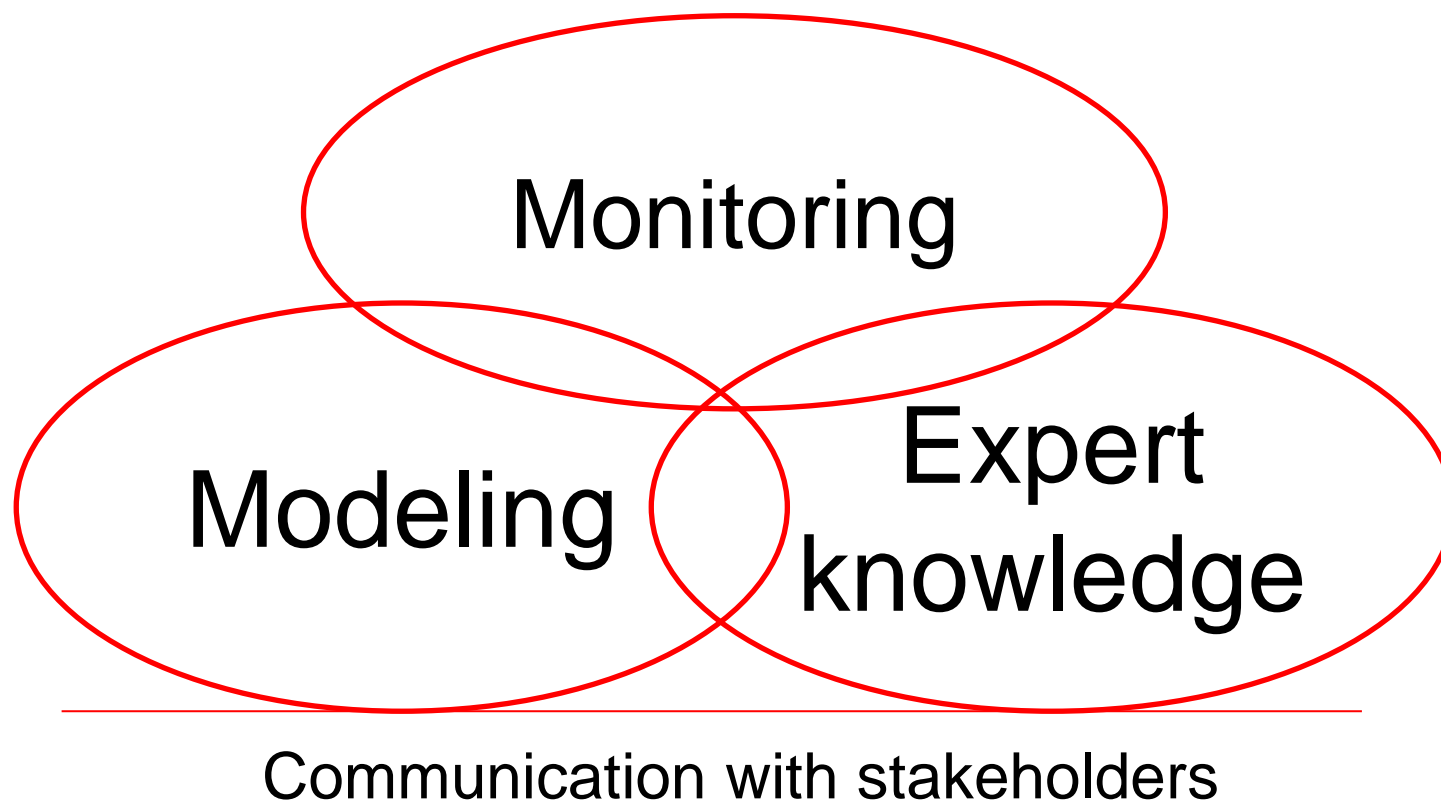
# Model uncertainty and costs

"All models are wrong, but some are useful" - George Box

- All models have inherent uncertainties related to:
  - uncertainties in input data
  - uncertainties in parameter values
  - uncertainties in process simplifications
  - processes not accounted for by the model
  - processes in the catchment that are unknown to the modeler.

Engelbrechtsen (2013)

Stakeholder tools consist of



A photograph of a small waterfall in a marshy area. The waterfall is in the foreground, with water cascading over a small ledge. The surrounding area is covered in brown, dry grass and patches of snow. The background shows a flat, marshy landscape with more snow and water. The text "Thank you for your attention" is overlaid in the center of the image.

**Thank you for  
your attention**