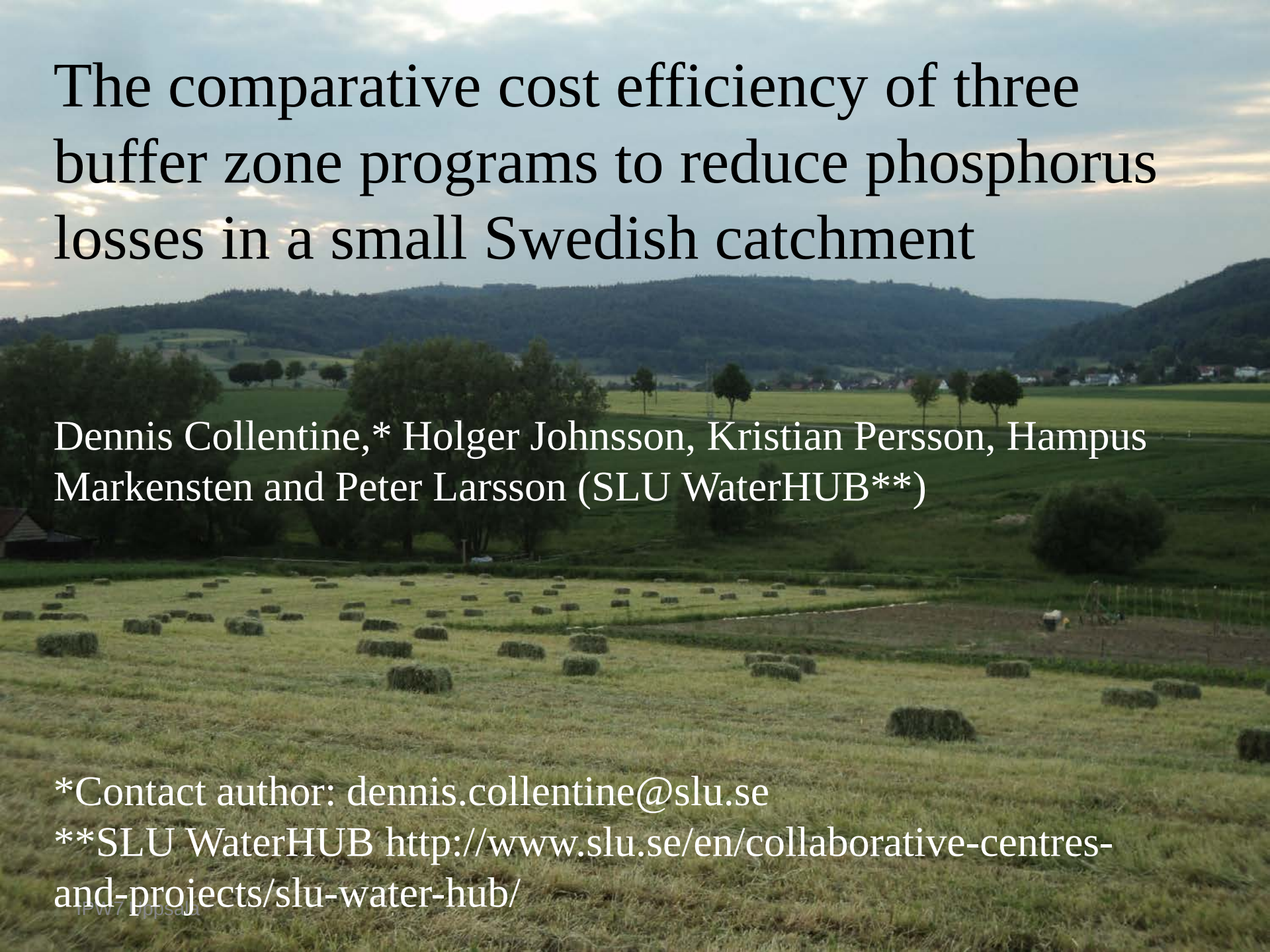
The comparative cost efficiency of three buffer zone programs to reduce phosphorus losses in a small Swedish catchment



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**SLU WaterHUB http://www.slu.se/en/collaborative-centres-and-projects/slu-water-hub/

BACKGROUND

- Increasing eutrophication of the Baltic Sea
- Of the total anthropogenic phosphorus loads from Sweden, 40% originate from farmland
- Riparian buffer zones are the only measure which has been used extensively in Sweden to reduce phosphorus losses from agricultural land
- Supported by payments to landowners from the EU Rural Development Program (RDP)
- Uneven and low participation in the program

Agri-environmental program evaluation

- "Is agri-environment support well designed and managed?" EU Court of Auditors (2011)
- Report recommendations to the EU Commission:
  - **agri-environmental expenditures should be more precisely targeted;**
  - there should be a higher rate of EU contribution for sub-measures with a higher environmental potential;
  - there should be a clear distinction between simple and more demanding agri-environment sub-measures;
  - and that the Member States should be more proactive in managing agri-environment payments.

Why aren't programs targeted?

- Uniform payments are easy and accepted by:
  - Swedish Board of Agriculture and Ministry
  - Program administrators (County boards)
  - EU (and WTO)
  - Farm lobby groups (fairness)
- There is also a common belief that efficiency gains from targeting will be equal to or less than the the higher costs of administering targeted programs

Transaction costs

- Costs for entering into a contract (*ex ante* and *ex post*)
- Include costs of information, contracting and control
- There has been little attention paid to how to reduce transaction costs to increase efficiency.
- One of the reasons for the lack of attention has been the difficulties associated with calculating these types of costs.

Model support for lowering the transaction costs of targeting

- Current support for buffer zones in Sweden; uniform payments, for buffer zones to reduce P losses (biodiversity), voluntary participation (6-20 meters wide zones along water courses)
- Assignment in 2012 from the Swedish National Water Authorities to **SLU WaterHUB** to develop a model for high resolution evaluation of buffer zone cost efficiency
- Result: **FyrisSKZ**

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FyrisSKZ: Assignment

- Develop a tool which will be able to estimate and summarize the cost effectiveness of buffer zones along lakes, watercourses and drainage ditches in the 12,864 sub-catchment areas of Sweden.
- Develop a web application to make this information available to users.

FyrisSKZ: Construction features

- Use of GIS to calulate the cultivated area contributing to P losses from agricultural land around lakes and watercourses (impact area)
  - 60 meter wide zone of agricultural land (blocks) along water courses (min 30 meters running length)
- Use of the FyrisCOST model to estimate the effects of buffer zones on the impact area (reduction in P losses).
- Use of opportunity costs for taking agricultural land out of production, and the costs for construction and maintenance of the buffer zone

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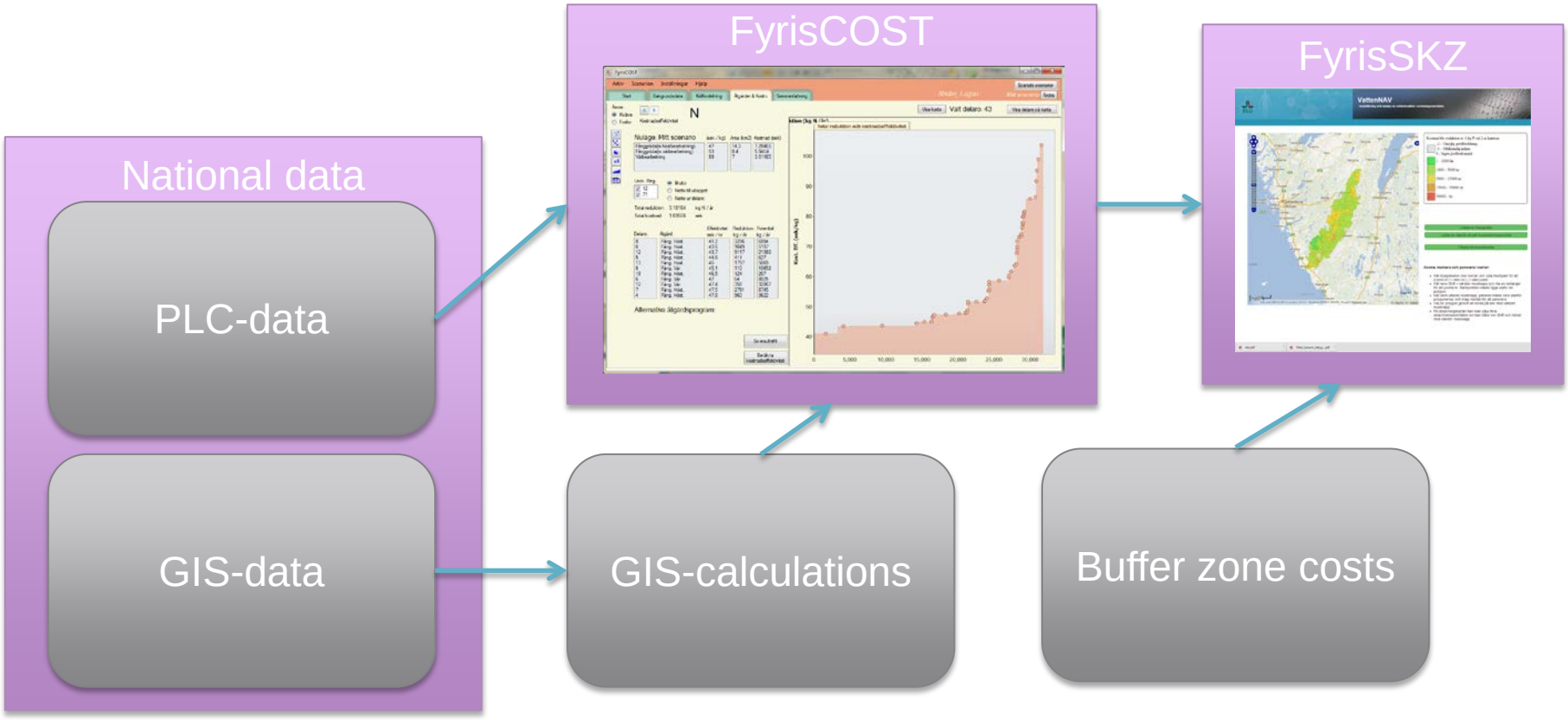
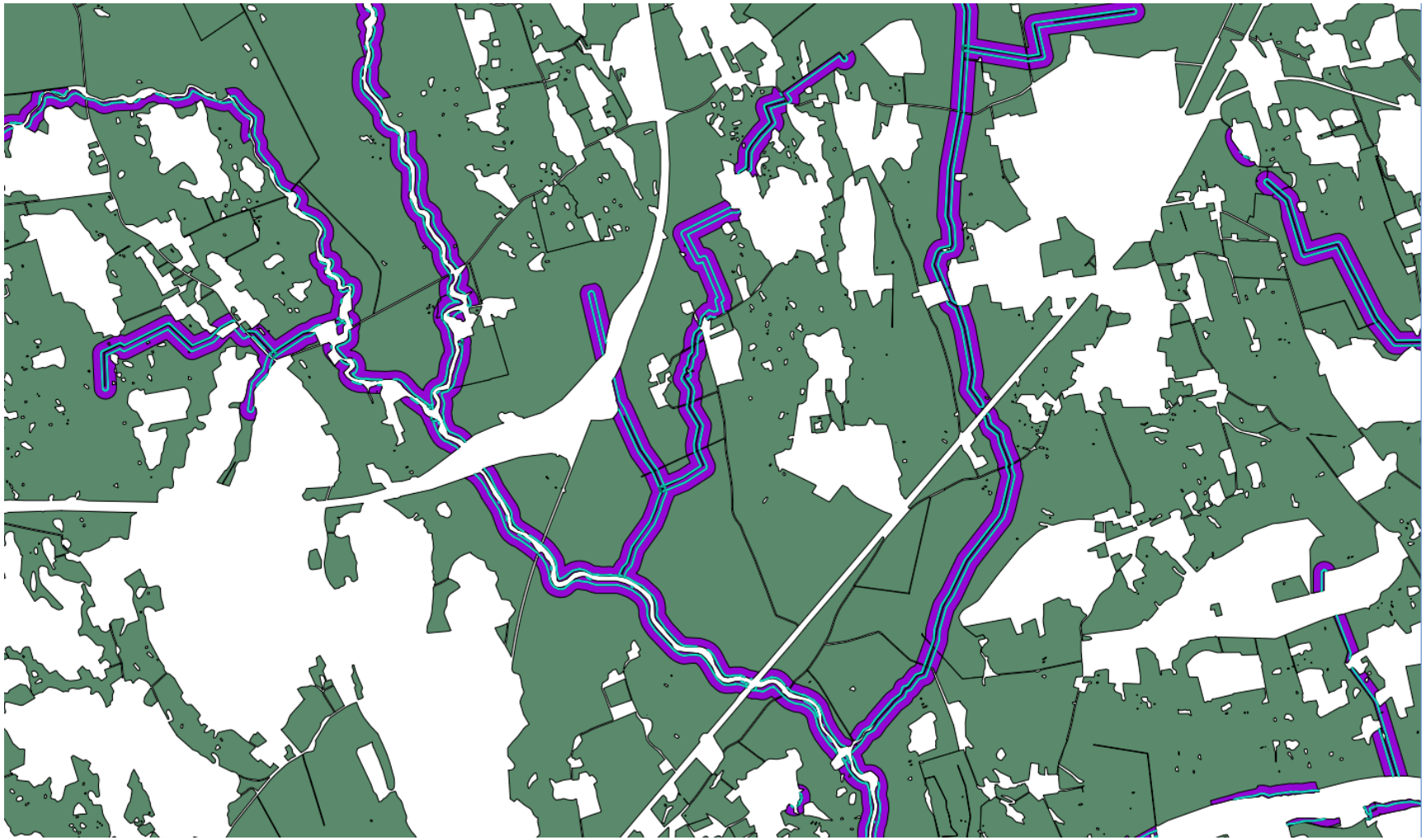
FyrisSKZ: Model structure



GIS impact area; purple areas

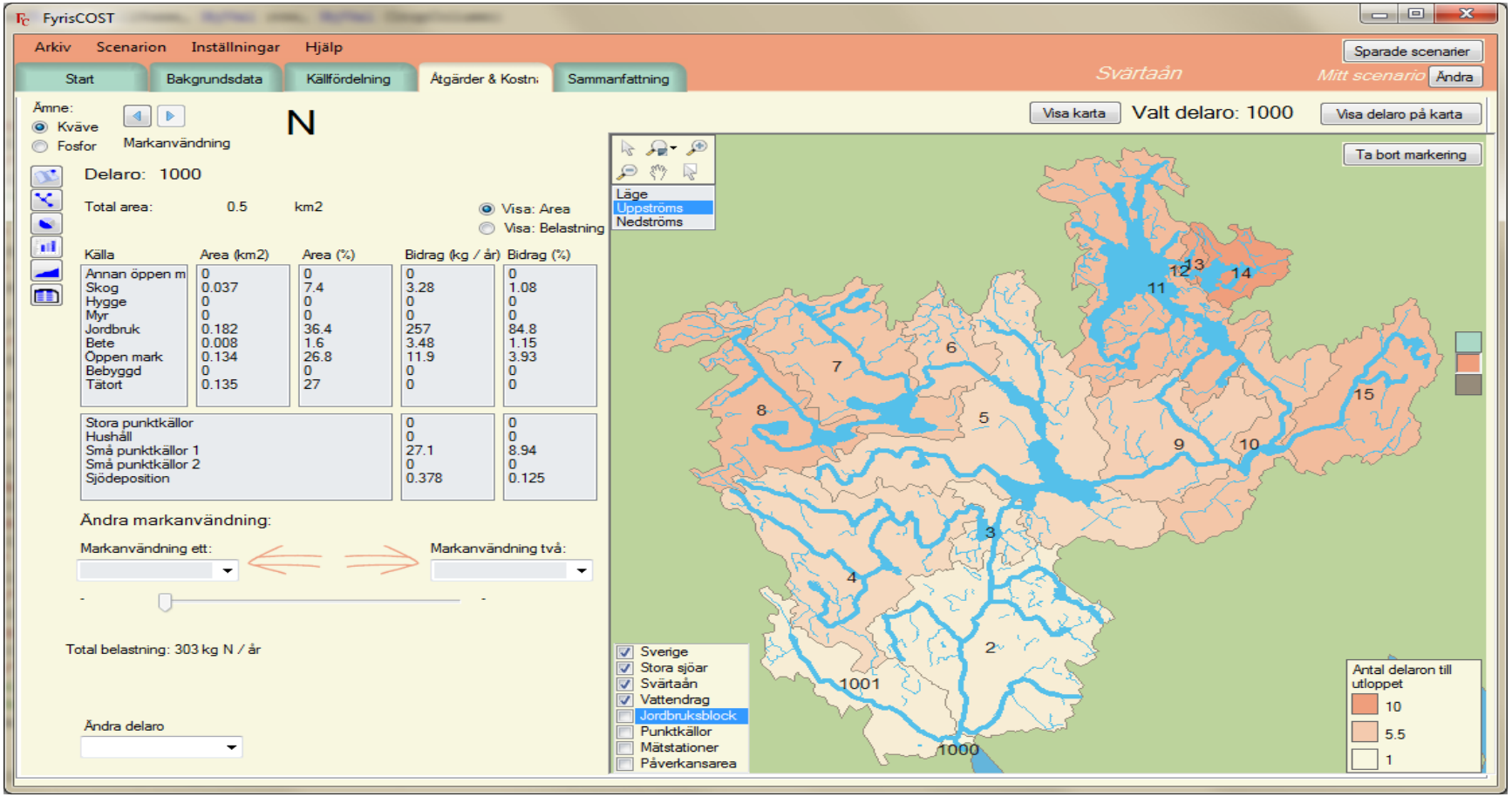


FyrisCOST (DSS)

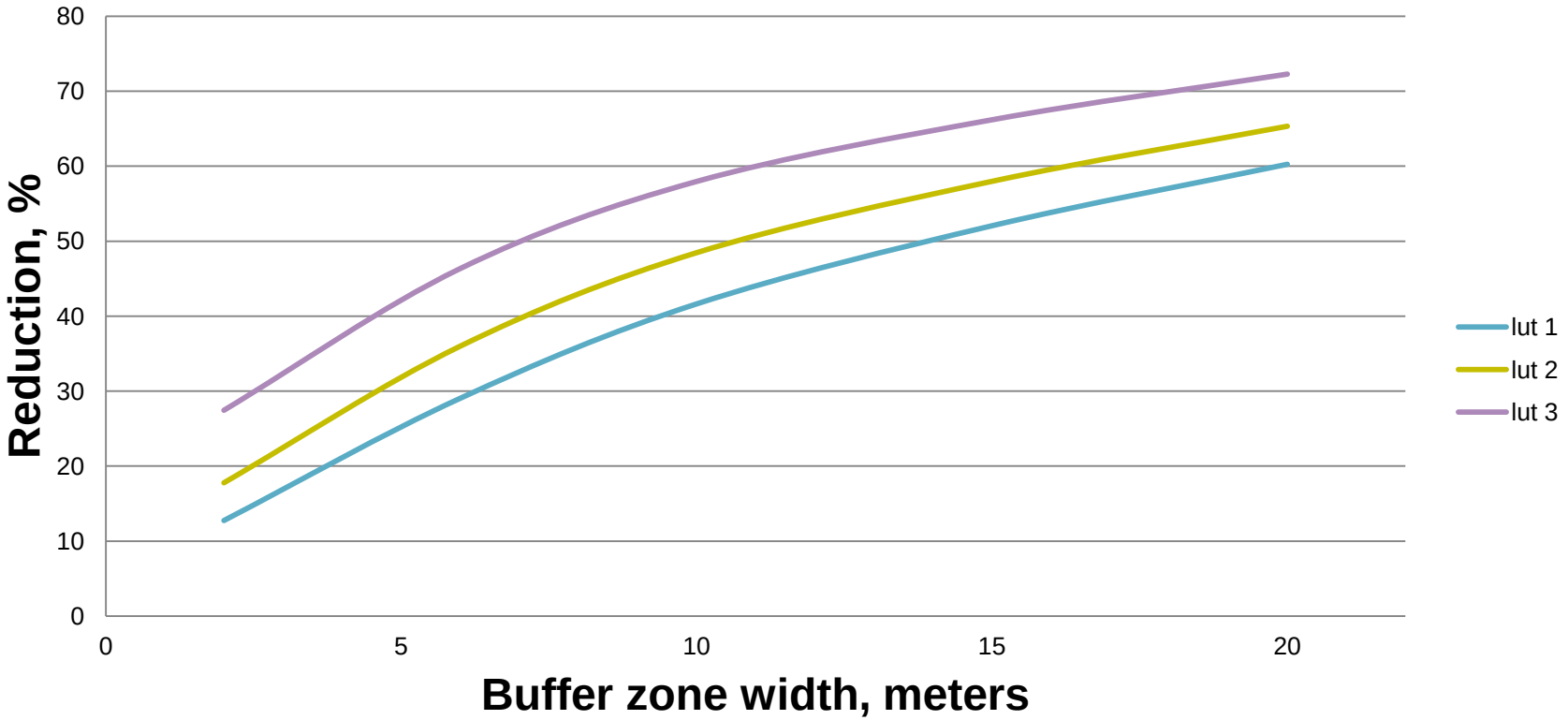
- The effect of abatement measures is calculated from available databases which include high resolution climate data, land use data, hydrological data, crop types, soil types, soil P levels, land elevations (gradient toward the watercourse) and buffer zone widths.
- Models included in FyrisCOST:
  - NLeCCS (ICECREAMDB, SOILNDB)
  - FyrisNP (Fyris)

FyrisCOST:

http://www.slu.se/en/collaborative-centres-and-projects/slu-water-hub/



Reduction effect: Buffer zone width on one soil type, three gradients

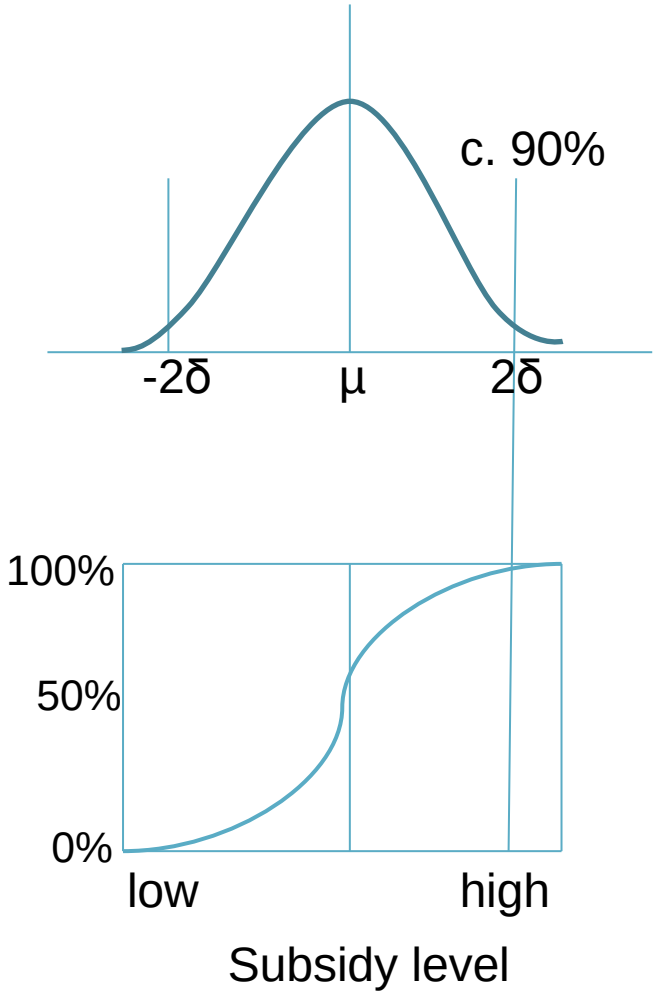


Buffer zone costs

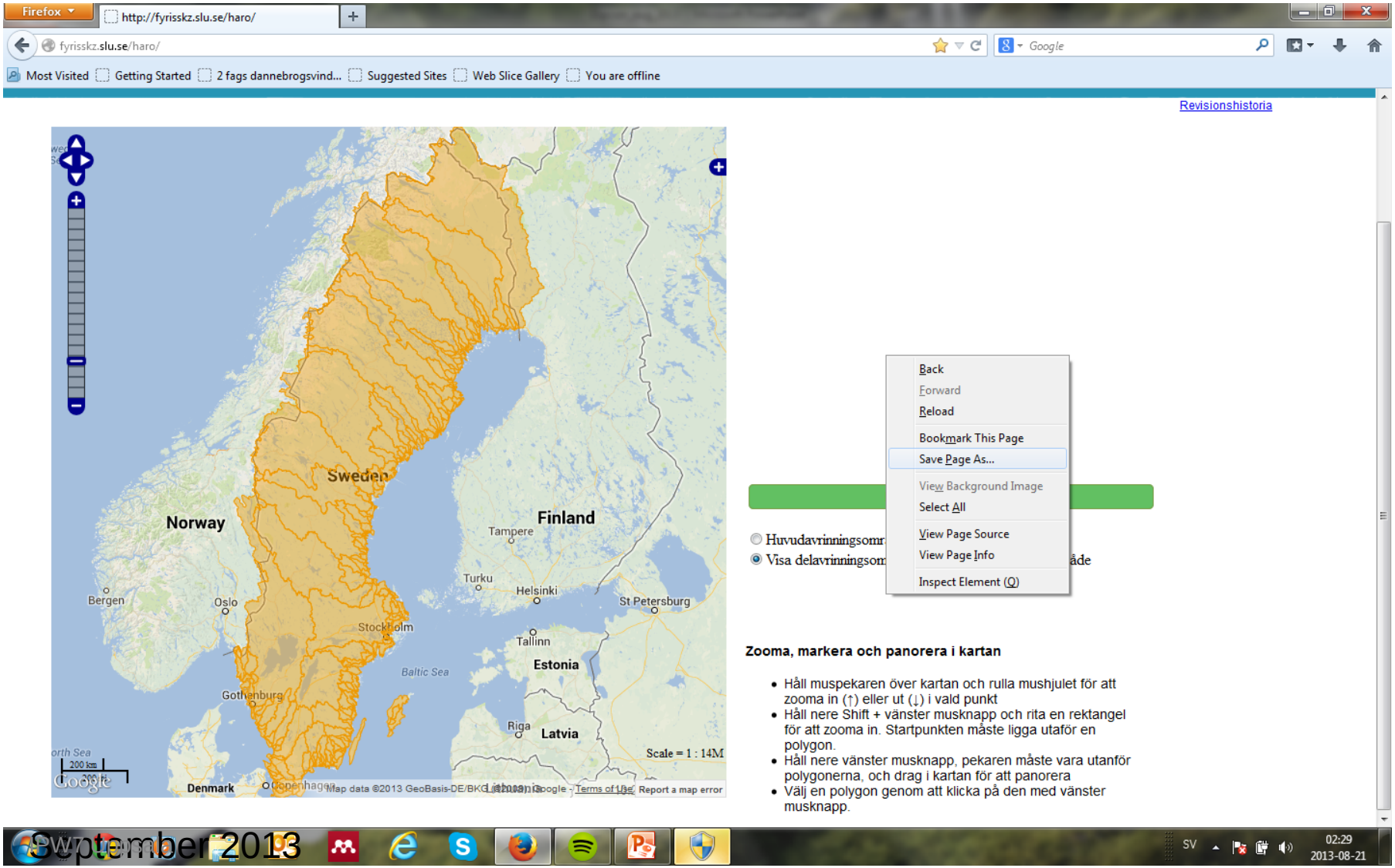
- Construction and maintenance costs uniform for all production areas
- Evaluation of opportunity costs for land use in eight production zones
  - based on leasing prices for agricultural land (90th percentile)
  - data from Swedish Board of Agriculture

Cost per hectare for income loss from buffer zones (90%)

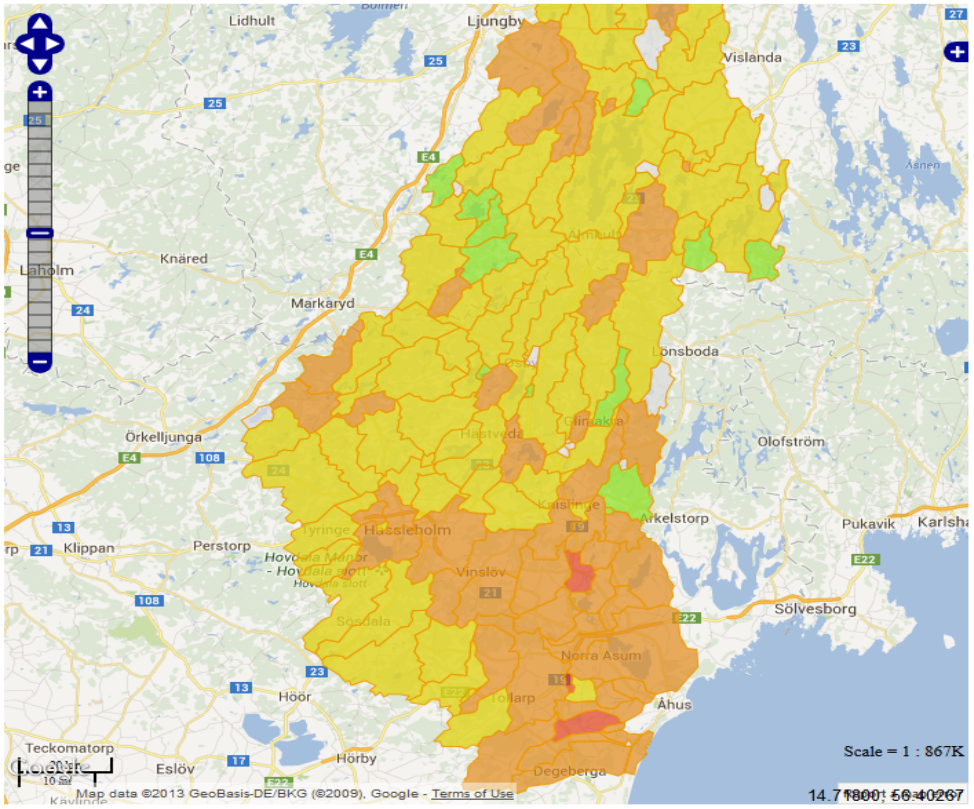
PO8	€ cost/yr
1.GSS	719
2.GMB	462
3.GNS	347
4.SS	239
5.GS	239
6.MSS	148
7.NN	114
8.ÖN	95
Sweden	458



Web Application: http://fyrisskz.slu.se/haro/



Web Application: Selected catchment area



Kostnad för reduktion av 1 kg P vid 2 m kantzon

- -2 - Omöjlig grödfördelning
- -1 - Ofullständig indata
- 0 - Ingen jordbruksmark
- 1 - 1000 kr
- 1000 - 5000 kr
- 5000 - 15000 kr
- 15000 - 50000 kr
- 50000 - kr

Ladda ner Sverigedata

Ladda ner data för aktuellt huvudavrinningsområde

Tillbaka till översiktskarta

Zooma, markera och panorera i kartan

- Håll muspekaren över kartan och rulla mushjulet för att zooma in (↑) eller ut (↓) i vald punkt
- Håll nere Shift + vänster musknapp och rita en rektangel för att zooma in. Startpunkten måste ligga utaför en polygon.
- Håll nere vänster musknapp, pekaren måste vara utanför polygonerna, och drag i kartan för att panorera
- Välj en polygon genom att klicka på den med vänster musknapp.
- På delavrinngskartan kan man välja flera delavrinningsområden om han håller ner Shift och klickar med vänster musknapp
- Håll muspekan över en rubrik i tabellen för mer information

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FyrisSKZ: Results table - inputs

Catchment name	Subcatchment ID	Subcatchment area (km^2)	Runoff (mm/yr)	Agricultural area (%)
Svärtaån	652798-157219	42.0	239.67	32.642
Pasture area (%)	**Soil type**	**Phosphorus class (1-3)**	**Slope class (1-3)**	**Impact area (ha)**
18.4	Silty Clay	3	3	303
Impact area along watercourse (km)	**Possible buffer zone length (km)**	**Land opportunity cost (SEK/ha)**		**Area of support 2008 (ha)**
57.23	40.25	2033		13.17

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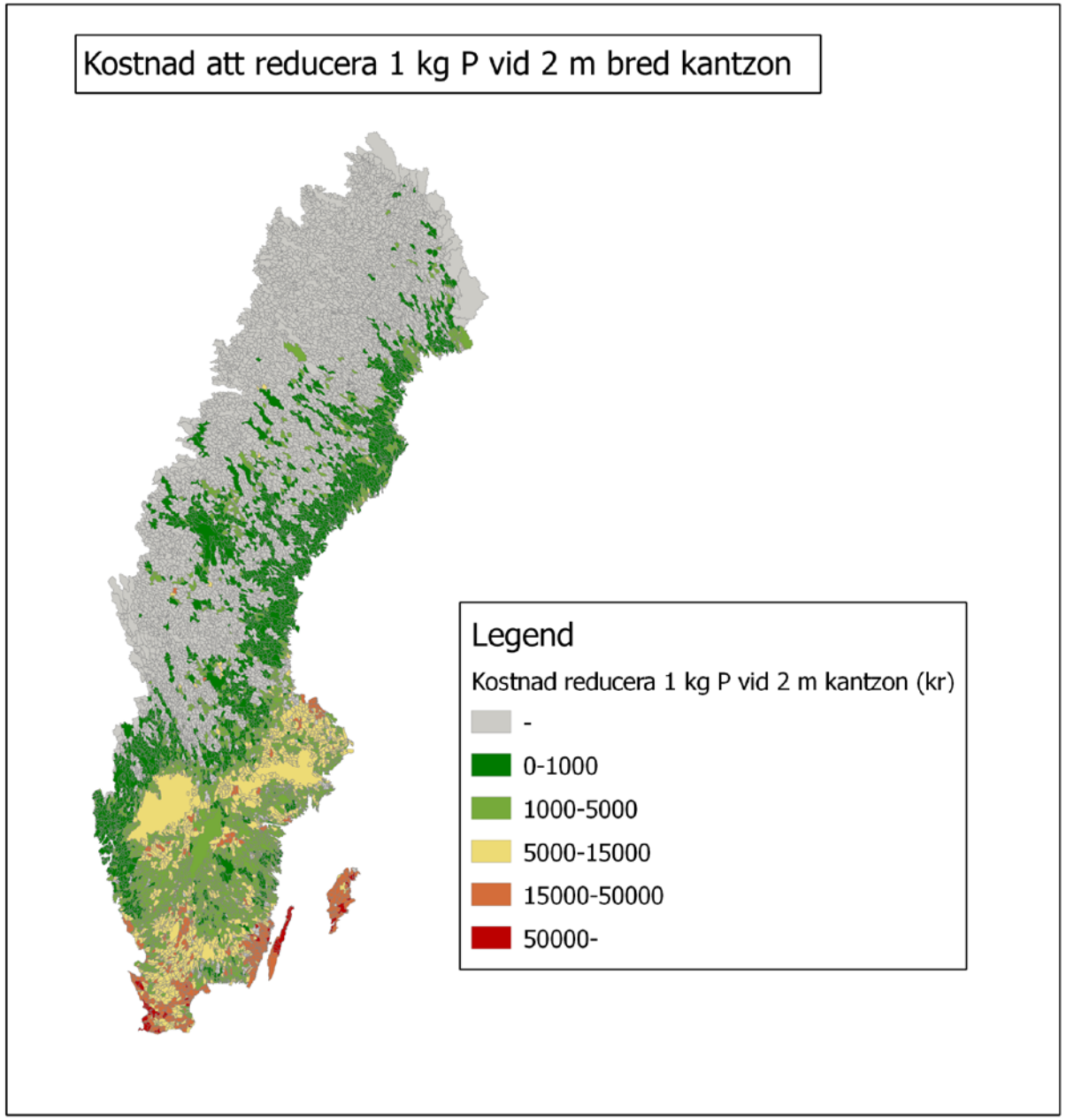
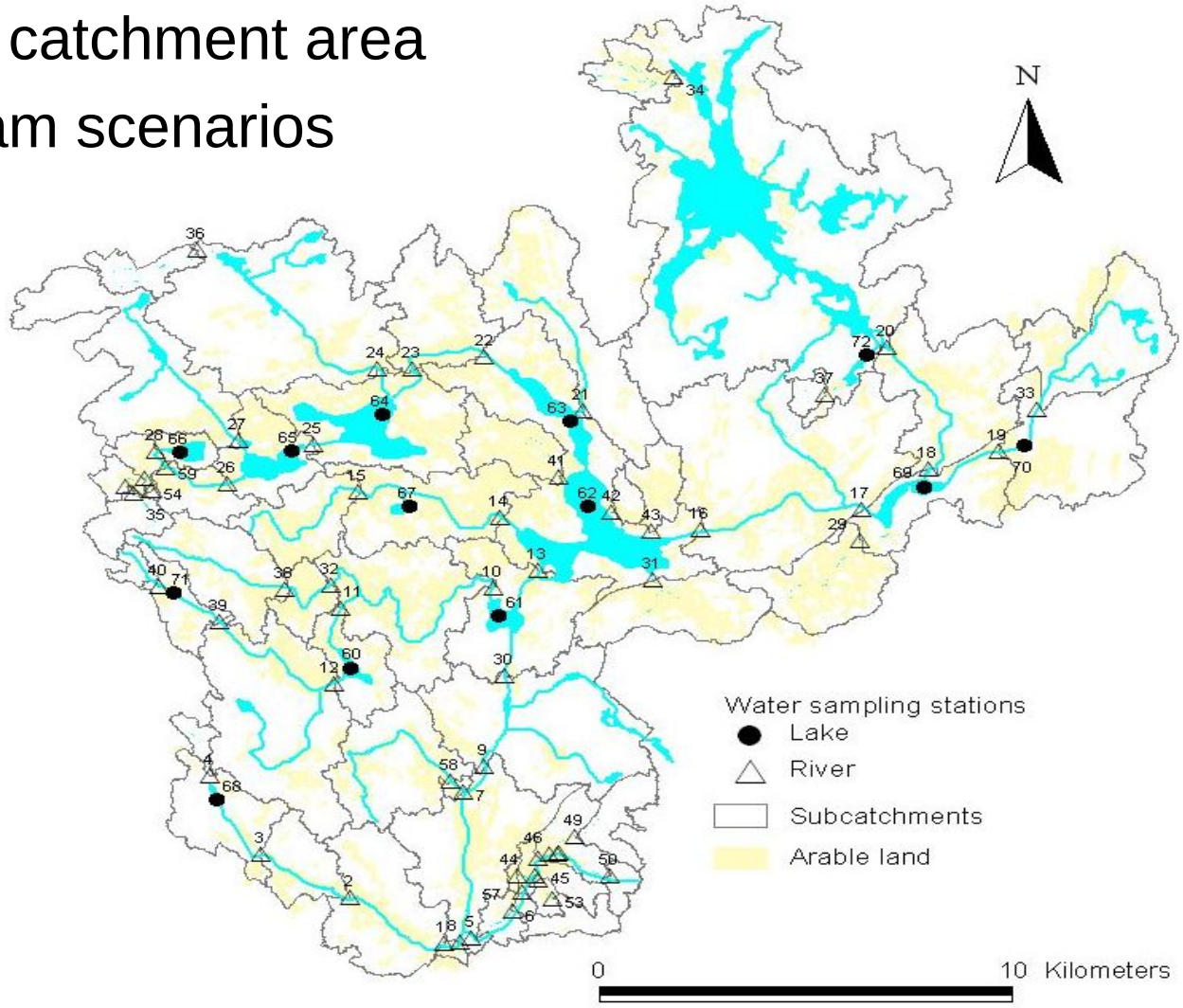
FyrisSKZ: Results table - outputs

Reduction 2m (kg P/ha)	Reduction 6m (kg P/ha)	Reduction 10m (kg P/ha)	Reduction 15m (kg P/ha)	Reduction 20m (kg P/ha)
2.52	1.42	1.06	0.81	0.66
Potential reduction 2m (kg P)	**Potential reduction 6m (kg P)**	**Potential reduction 10m (kg P)**	**Potential reduction 15m (kg P)**	**Potential reduction 20m (kg P)**
20.28	34.25	42.84	48.92	53.43
Reduction cost 2m (SEK/kg P)	**Reduction cost 6m (SEK/kg P)**	**Reduction cost 10m (SEK/kg P)**	**Reduction cost 15m (SEK/kg P)**	**Reduction cost 20m (SEK/kg P)**
807	1433	1910	2509	3063


Kostnad att reducera 1 kg P vid 2 m bred kantzon
Legend
Kostnad reducera 1 kg P vid 2 m kantzon (kr)
-
0-1000
1000-5000
5000-15000
15000-50000
50000-

FyrisSKZ: Application

- Svärta River catchment area
- Three program scenarios



The Svärta river catchment

- located in central Sweden south of Stockholm
- total land area 345 km^2
- 25% is used for agriculture (9000 ha) with 7500 ha of this in crop production
- two dominant soil types in the catchment silty clay loam (80%) and silty loam.
- majority of the soil has a high soil P concentration and is erosion sensitive
- 14 sub-catchment areas

Buffer zone program scenarios

- Scenario 1: Baseline data from RDP 2008, buffer zone areas by sub-catchment, PLC5 average for 10 meter wide buffer zones.
- Scenario 2: Buffer zones on all potential area, 6m wide
- Scenario 3: Efficient allocation of buffer zones (max width for each sub-catchment where the cost/kg P reduction is less than € 172/kg P).

Scenario results

	Scenario 1	Scenario 2	Scenario 3
Buffer zone area (ha)	162	110	*71.5
Total reduction (kg P)	97.2	124.5	102
Average reduction (kg p/ha)	0.6	1.13	1.42
Cost per ha buffer zone (€/ha)	234	234	234
Total cost (€)	37 922	25 740	16 731
Cost/kg P reduction (€/kg P)	390	207	163

* Scenario 3 results: 6 sub-catchments with 6m wide zones

Scenario results

- Targeting improves cost effectiveness
- Is Scenario 3 the most efficient?
  - No, just more cost efficient per kg P reduced than the other two scenarios evaluated . There are many more scenarios!
  - No transaction costs are included. Would these be higher than for uniform costs? Probably.

Who will use the results?

- Allows for targeted evaluation
  - Programs (ex ante and ex post)
  - Individual measures (for example as trading offsets)
- But uniform payments are easy and accepted by:
  - Swedish Board of Agriculture and Ministry
  - Program administrators (County boards)
  - EU (and WTO)
  - Farm lobby groups (fairness)
- Who will change their policy? How? Why?


Thank you!
September 2013