Environmental impact of commercial poplar and willow Short Rotation Forestry stands on water and soil

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Sweden in brief

- Population: 9.6 million
- Land area: 450 km2
- 23 million ha forest
- 3.4 million ha agricultural land
- 4.5 million ha bogs and swamps

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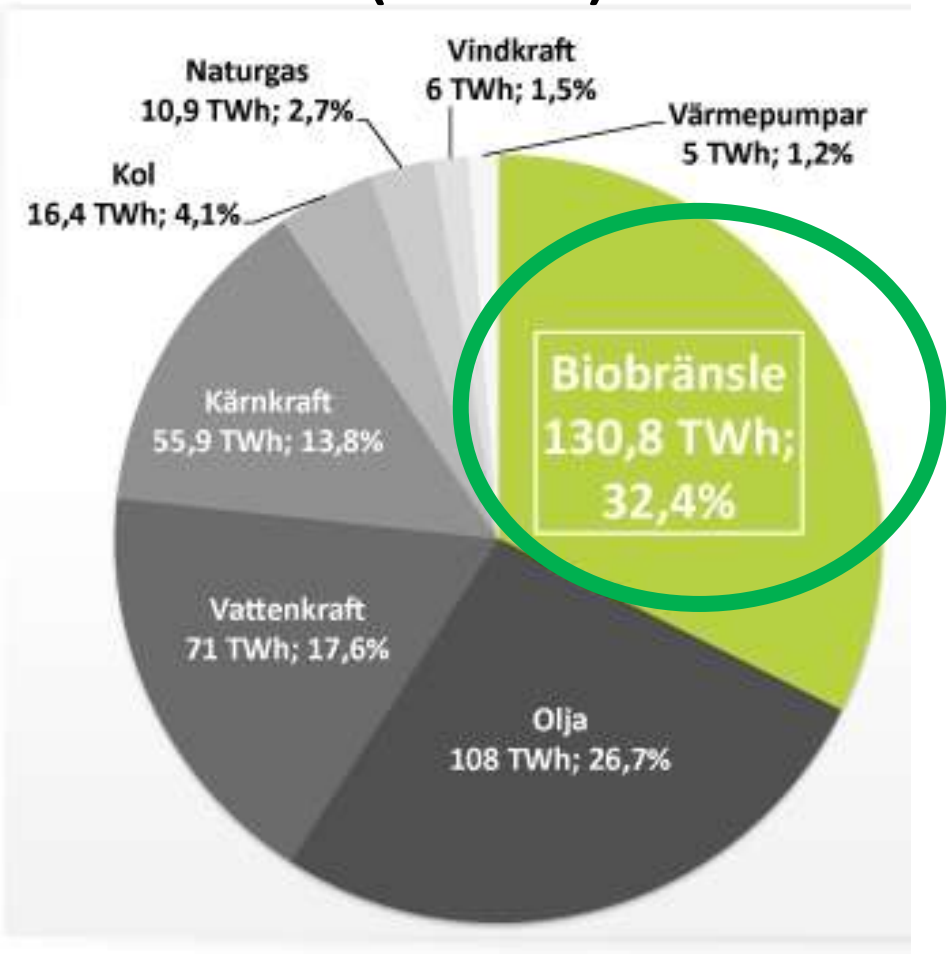
Energy production by source in Sweden (2012)



From www.svebio.se

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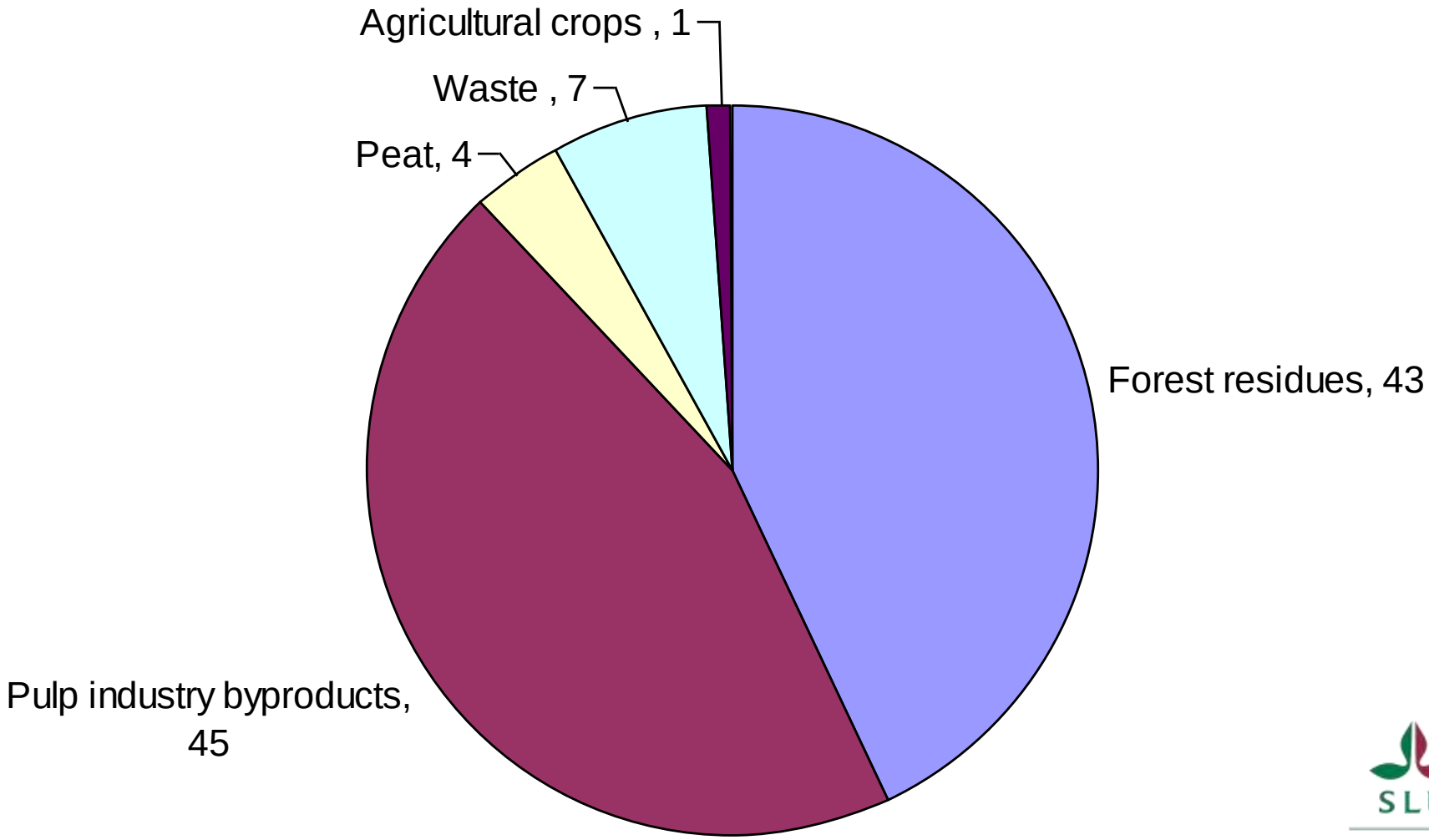
Energy from biomass sources in Sweden (2010, %)



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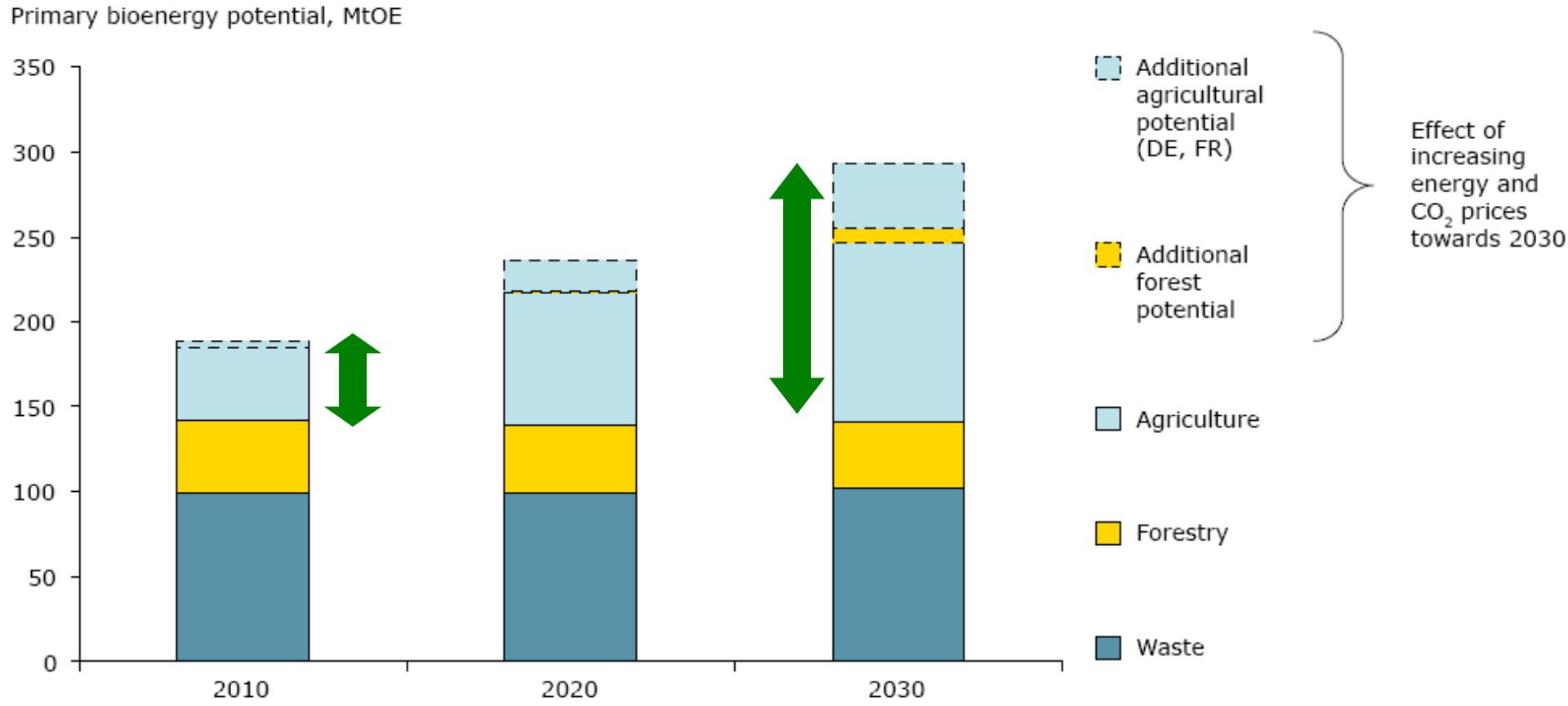
SVEASKOG
VOLVO

Figure 1 ***Environmentally-compatible*** **primary bioenergy potential in the EU**



Source: EEA (European Environmental Agency) 2006.

How much bioenergy can Europe produce without harming the environment?

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Short Rotation Coppice willow for energy in Sweden

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Mechanised planting with approx. 12 000 cuttings/ha


20 Sep-05

Short Rotation Coppice in Sweden

- Ca. 11 000 ha are currently cultivated in Sweden for energy (with willow – Salix sp.)
- Predictions for rapid increase (e.g. Ministry of Agriculture, 2006; Federation of Swedish Farmers, 2006)
- Grown on agricultural land (weed control, planting, fertilisation – similar to an agricultural crop)
- Harvested every 3-4 years, life span app. 25 years, average production: 6-10 t DM/ha/yr

Short Rotation Coppice in Sweden

- SRC cultivated area has remained almost stable during the last 15 years (decreased during the last 5 years from 14 t to 11 t), predictions have not become true...
- …farmers do not usually fertilise and biomass production is therefore lower than the potentially achieved…
- …the recent increases of grain prices give negative sings for area increase…

Short Rotation Forestry with poplar in Sweden

- Ca 800 ha, but increasing
- Agricultural soils
- Grown in less dense stands (e.g. 2.5 x 2.5 or 3 x 3 m)
- Harvest must occur <20 years …
- … but the crop is more flexible (market also for pulp industry)
- Growing interest compared to willow

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Can the ‘value’ of SRC/SRF improve?

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YES!

- via environmental services/multifunctionality

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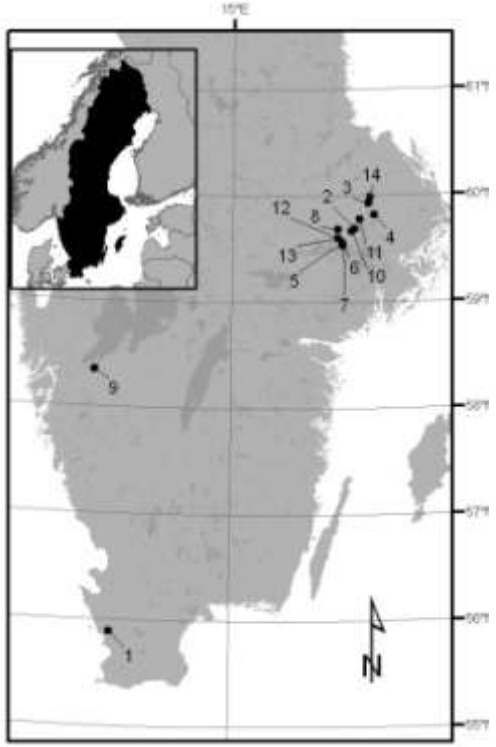
	Site	Year planted	Variety	Reference field crop	Sludge /Ash	Last harvest	Mineral fertilization	Soil texture (0-20 cm)	Biomass 2009	Previous use before SRC
1	Billeberga II	1994	Torhild	Cereals/rape seed	Y/N (3)	Annually	N	loam	2*	Cereals
2	Djurby Gård	1990	78021	Cereals	Y/N (3)	2007/2011 (5)	N	silty clay	5.3	Cereals
3	Forkarby	1991	78021	Cereals	N/N	2008 (5)	Y (2)	silty clay	11	Cereals
4	French Trial	1994	Mixture	Grass	N/N	2007/2010 (5)	Y (8)	clay loam	9.3	Cereals
5	Hacksta	1994	Jorr	Pea/Cereals	Y/Y (4)	2008 (3)	Y (1)	clay loam	4.2	Cereals
6	Hjulsta I	1995	Jorr	Cereals	Y/Y (2)	2008 (3)	N	clay	4.5	Oil crops/cereals
7	Hjulsta II	1995	Jorr	Cereals	N/N	2008 (3)	N	clay	9.6	Oil crops/cereals
8	Lundby Gård II	1995	78021	Cereals	N/N	2005 (2)	N	clay	2.5	Cereals
9	Puckgården	1992	78112	Cereals	N/N	2008 (4)	Y (4)	silty clay	10*	Cereals
10	Skolsta	1993	Orm	Cereals	Y/Y (1)	2004 (2)	Y (2)	silty clay	4	Cereals
11	Säva	1993	Rapp	Grass	Y/N (2)	2007 (3)	N	silty clay	7.4	Cereals
12	Teda I	2000	Tora	Grass	Y/Y (2)	2009 (2)	Y (2)	silty clay loam	8	Cereals
13	Teda II	1993	78112	Grass	Y/Y (2)	2007 (3)	Y (2)	clay	1.7	Cereals/Set-aside
14	Åsby	1996	Tora	Cereals	Y/N (1)	2008 (3)	Y (2)	silty clay	4.2	Cereals



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Asby
N


Asby
S 3
S 2
R 3
S 1
R 2
R 1
Image © 2010 Lantmäteriet/Metria
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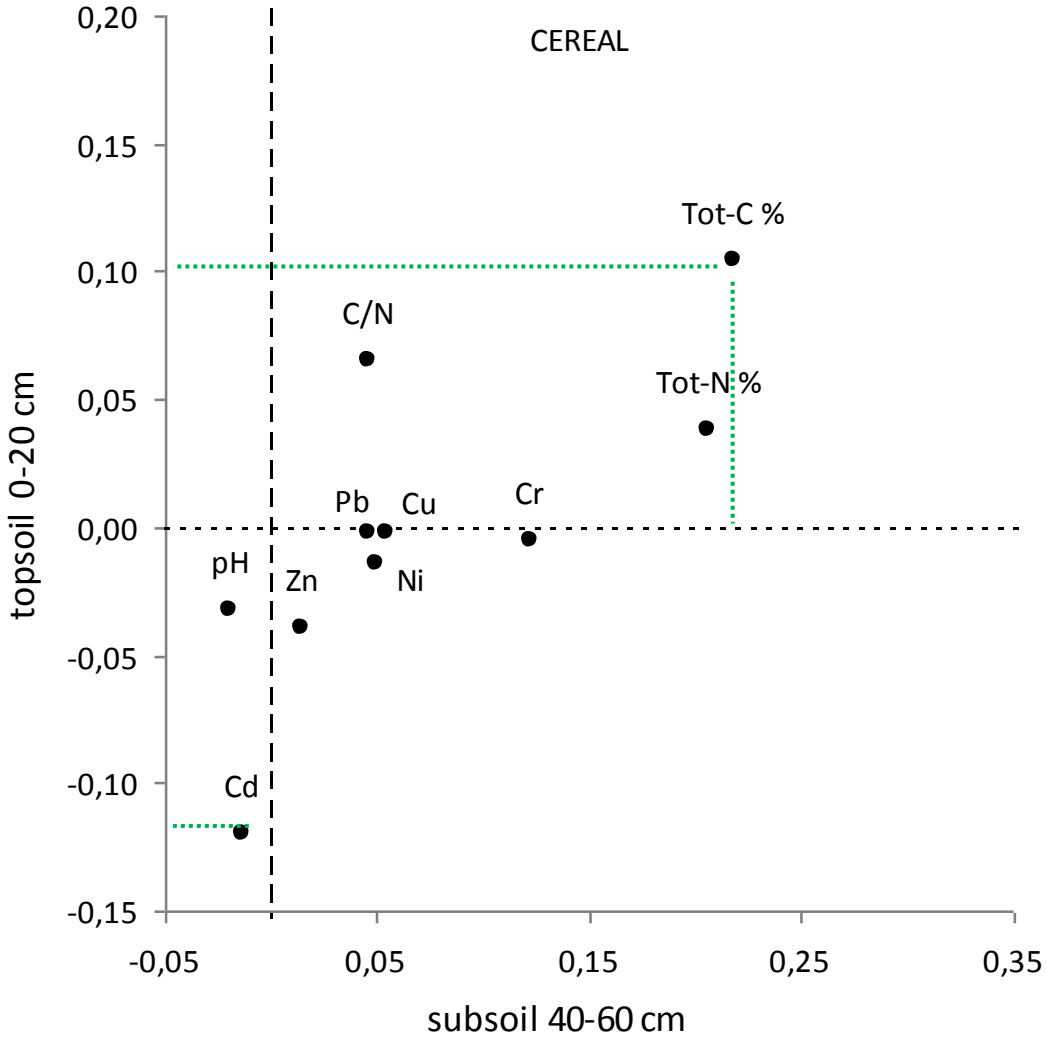

Relative differences between willow SRC plantations versus the reference. The values are the averages for all the locations of the different soil quality parameters investigated in topsoil (0-20 cm) and in subsoil (40-60 cm). Positive values represent higher observations of the studied parameter in the willow SRC plantations, in percentage (Dimitriou et al, Bioenergy Research, 2012).

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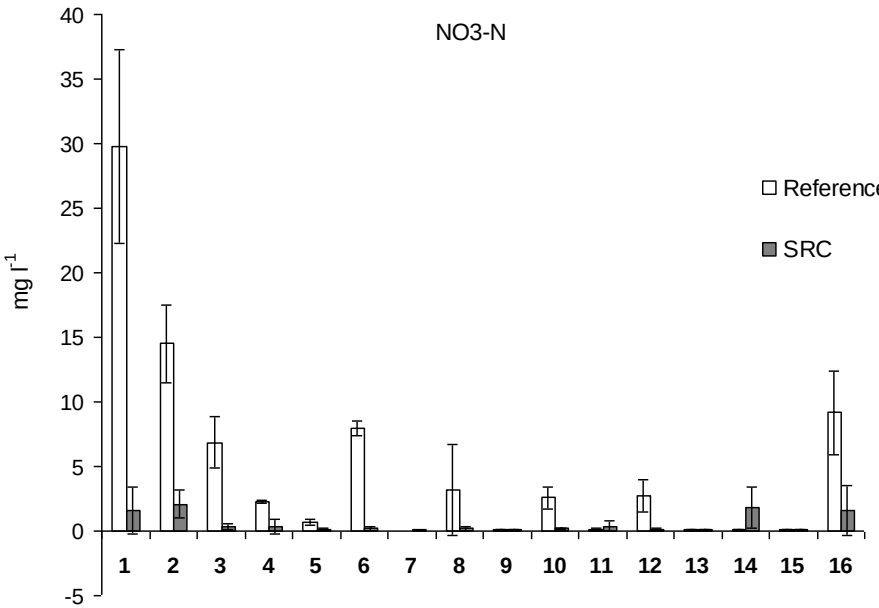
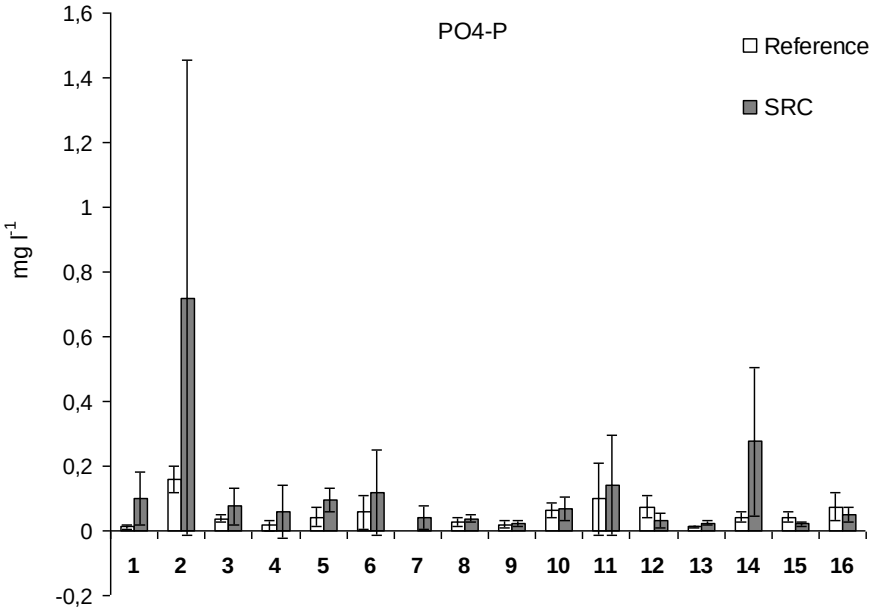
Willow SRC and water





Averages of NO_3-N and PO_4-P concentrations in the groundwater of SRC and reference in each of the different locations throughout the whole experimental period. Numbers correspond to the locations as described in Tab. 1 (Dimitriou et al., Bioenergy Research, 2012).

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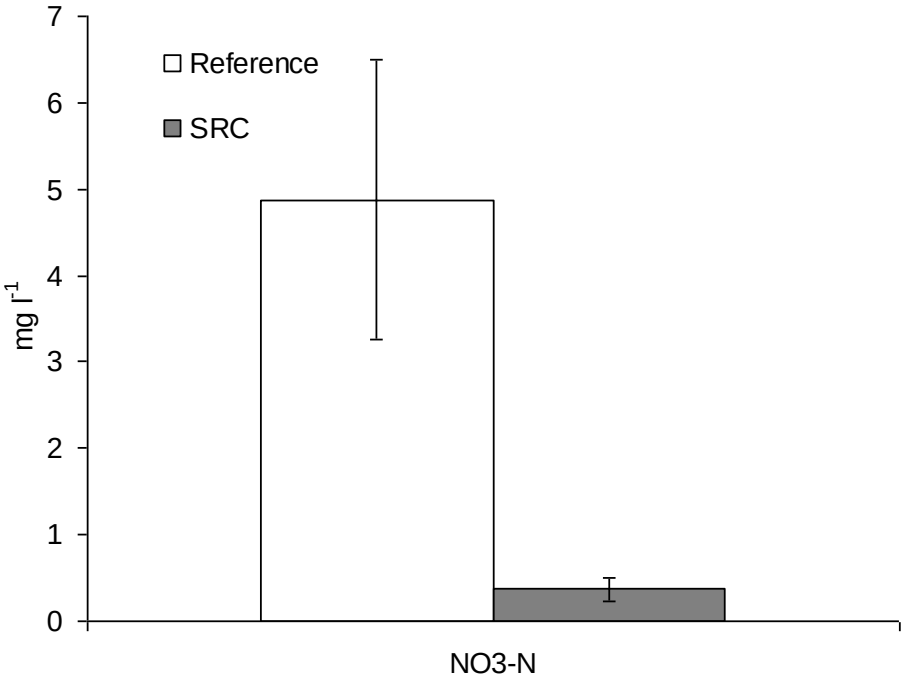
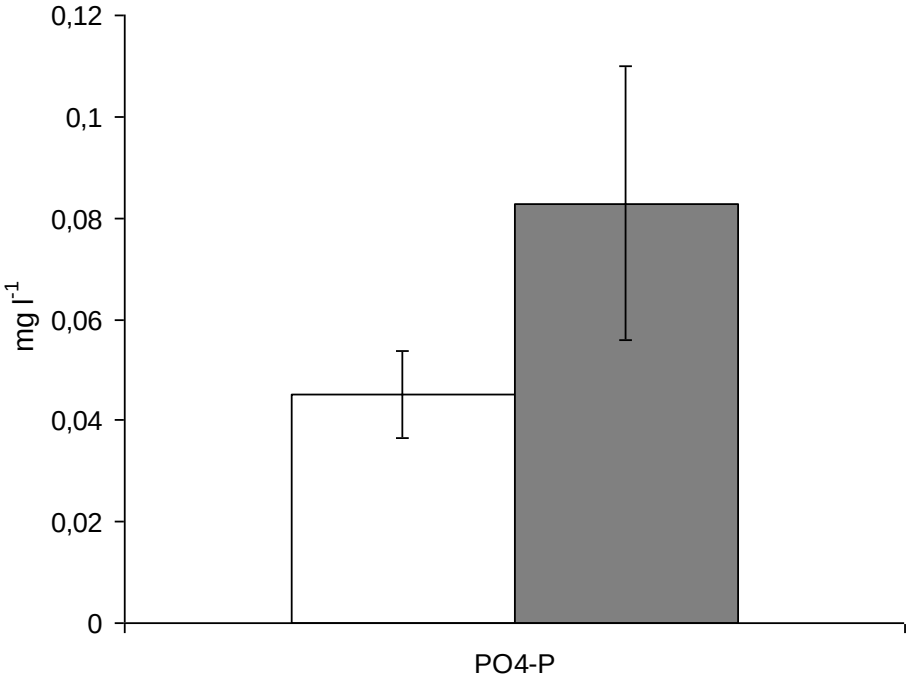
Willow SRC and water





Averages of NO_3-N and PO_4-P concentrations in the groundwater of all fields pooled together for willow SRC and reference fields for the whole experimental period (Dimitriou et al., Bioenergy Research, 2012).

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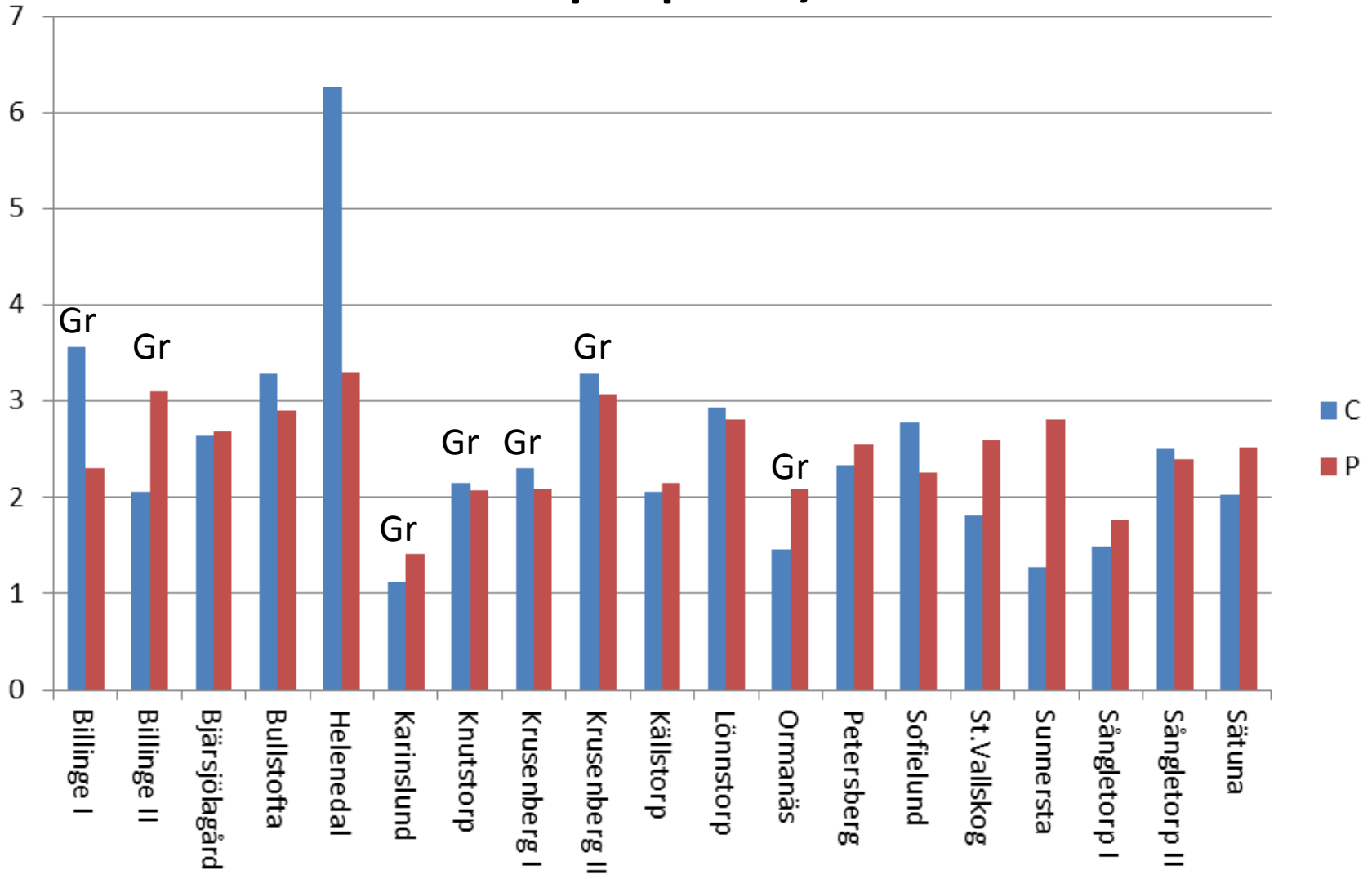
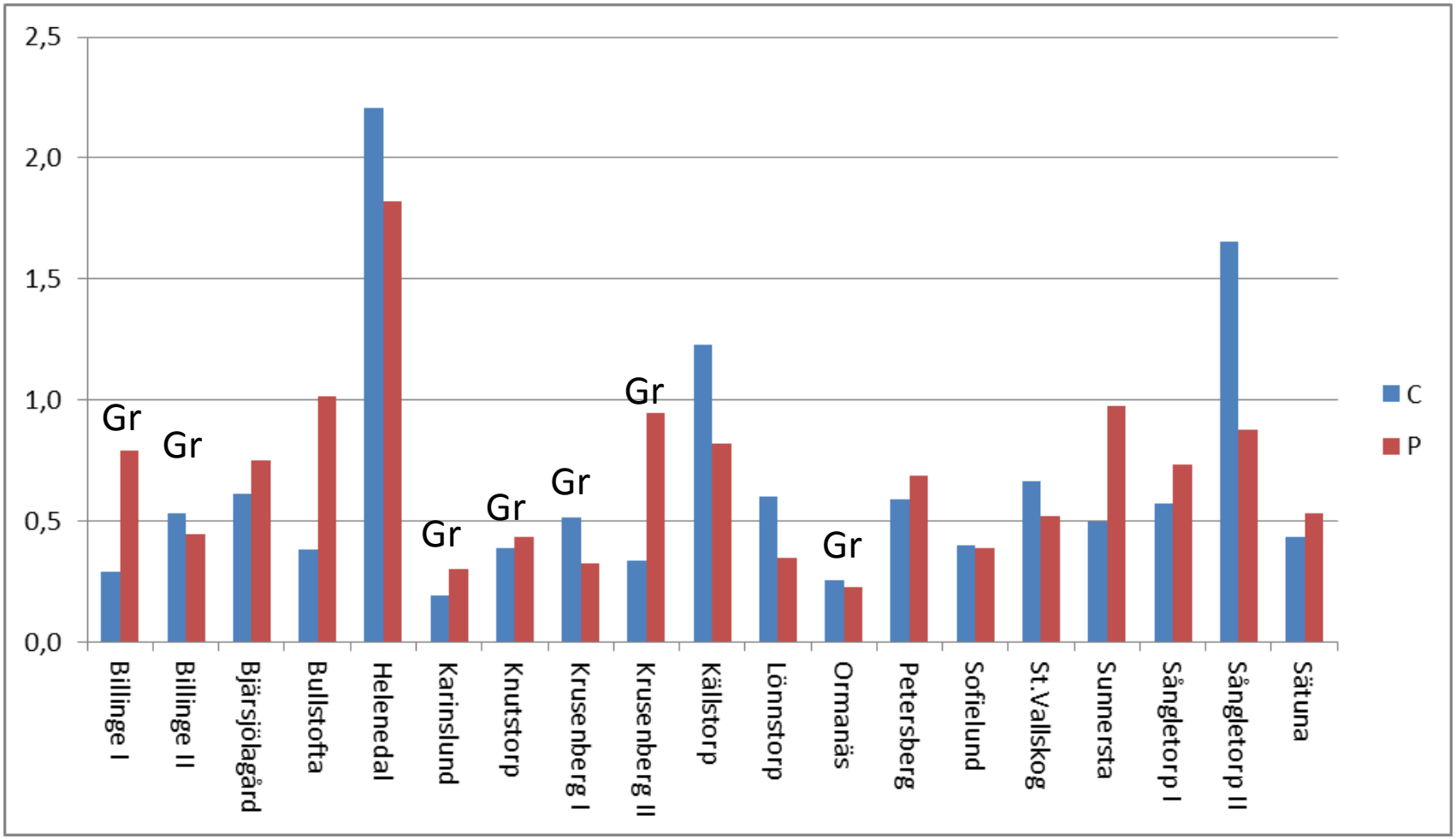
SRF poplar vs agricultural land

			Fertilisation	Water qual.	Soil qual.	Planted	Reference	Species/clone
1	**Uppland**	Sätuna	x	x	x	1990	cereals	OP 42
2		St Vallskog	x	x	x	1991	rape seed	Angustifolium
3		Petersberg		x	x	1991	rape seed	Balsamifera
4		Krusenberg I		x	x	2003	grass	Trichocarpa
5		Krusenberg II		x	x	2003	grass	Trichocarpa
6		Sunnersta			x	1991	cereals	Trichocarpa
7	**Skåne**	Billinge I	x	x	x	2002	grass	OP 42
8		Billinge II			x	1991	grass	OP 42
9		Sångletorp I		x	x	1991, harv 2003	cereals	OP 42
10		Sångletorp II			x	1991, harv 2003	rape seed	OP 42
11		Sofielund (hyb. asp)			x	1991	rape seed	clone mix
12		Källstorp II (hyb. asp)			x	1990	cereals	
13		Lönnstorp (hyb. asp)			x	1988	cereals	
14		Knutstorp			x	1990	grass	OP 42
15		Karinslund			x	1990	grass	OP 42
16		Helenedal			x	1989	cereals	clone mix
17		Bjärsjölagård		x	x	1988	cereals	Balsamifera
18		Ormanäs			x	1995	grass	OP42/clone mix
19		Bullstofta			x	1993	cereals	Boelare
20	**Västergötland**	Stöpen	x*		x	2007	cereals	OP 42
21	**Halland**	Tröingeberg			x	2007	cereals	OP 42

Org. C (%) in 0-20 cm (control vs poplar)



Org. C (%) in 40-60 cm (control vs poplar)



To sum up…

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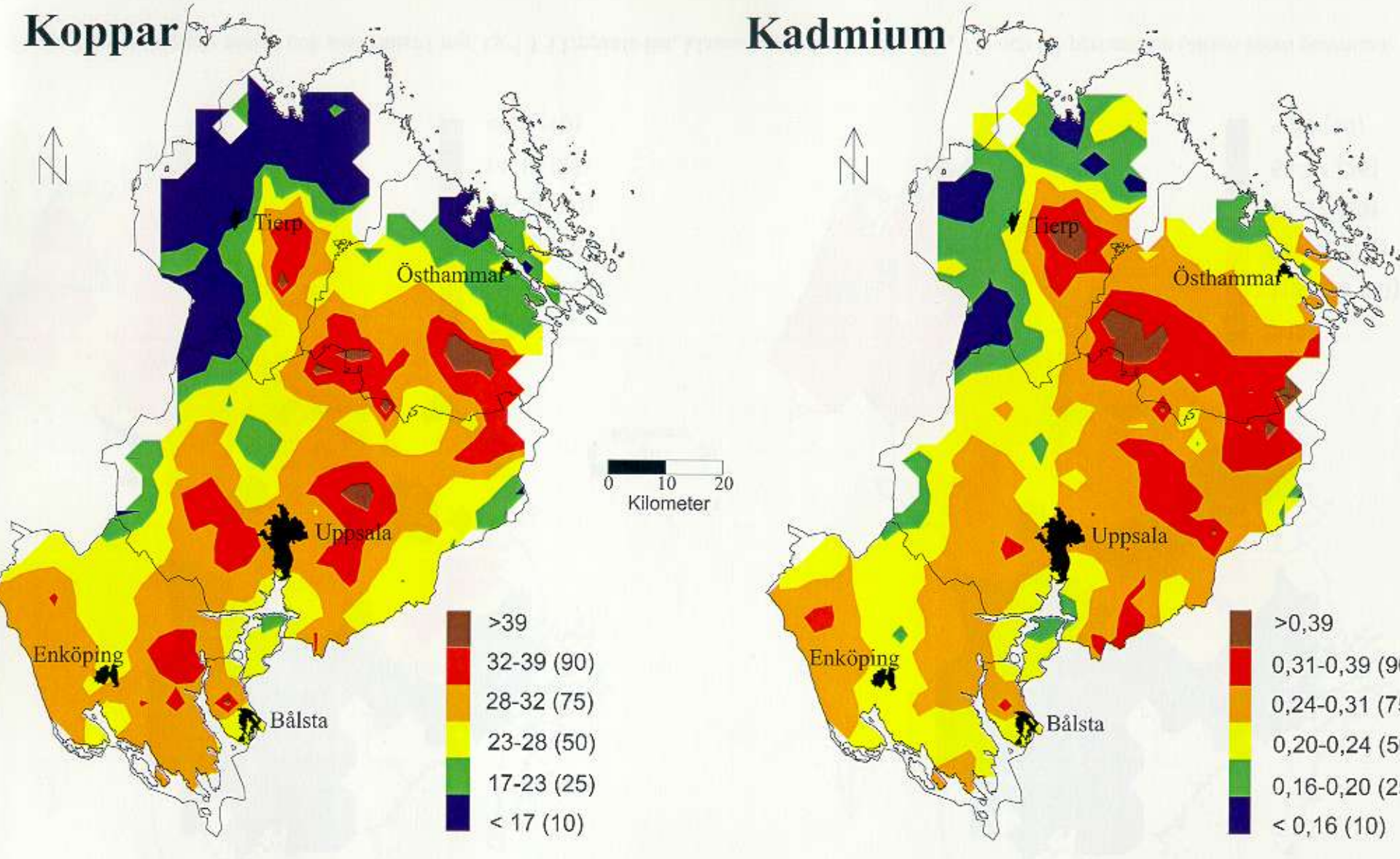
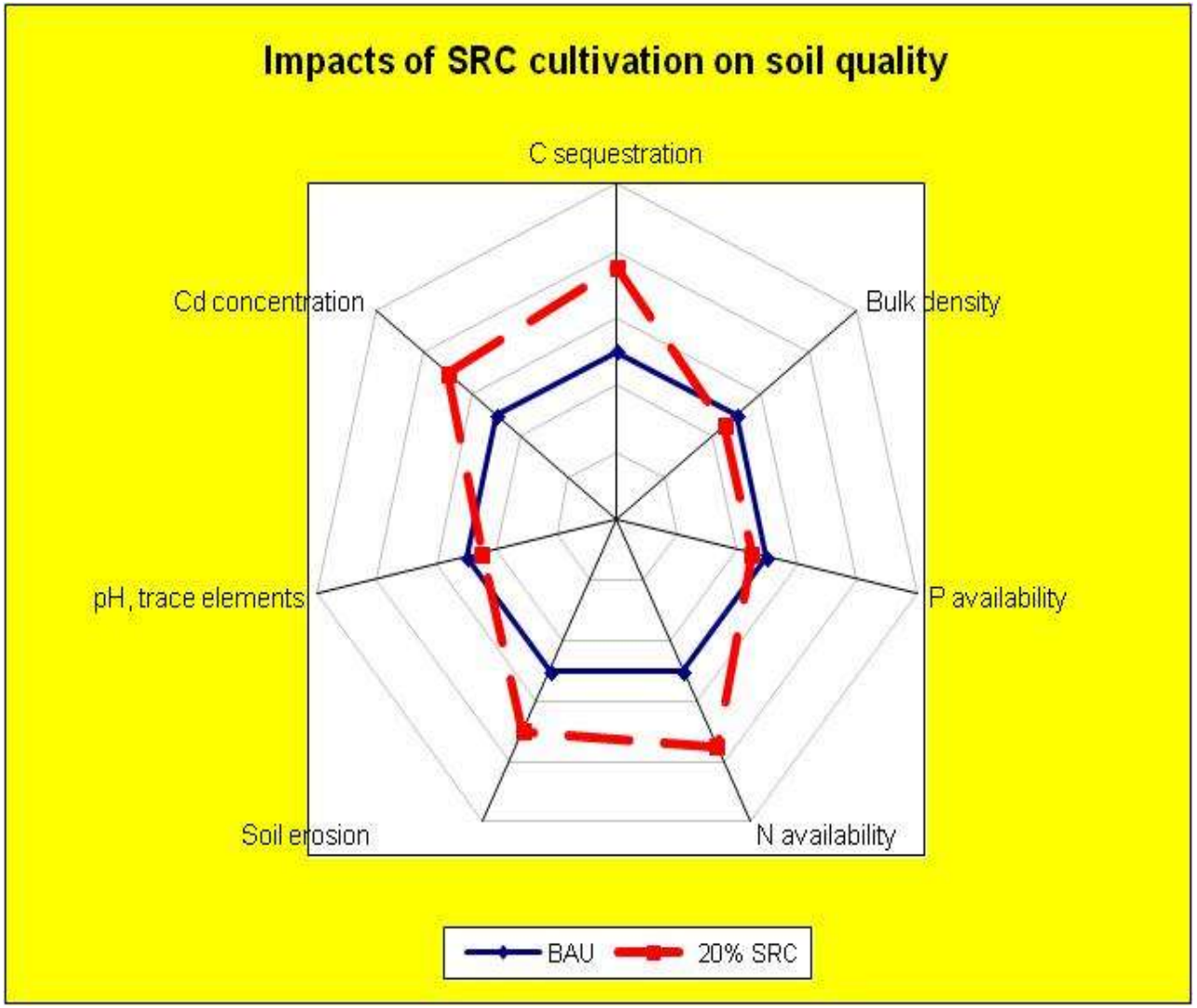
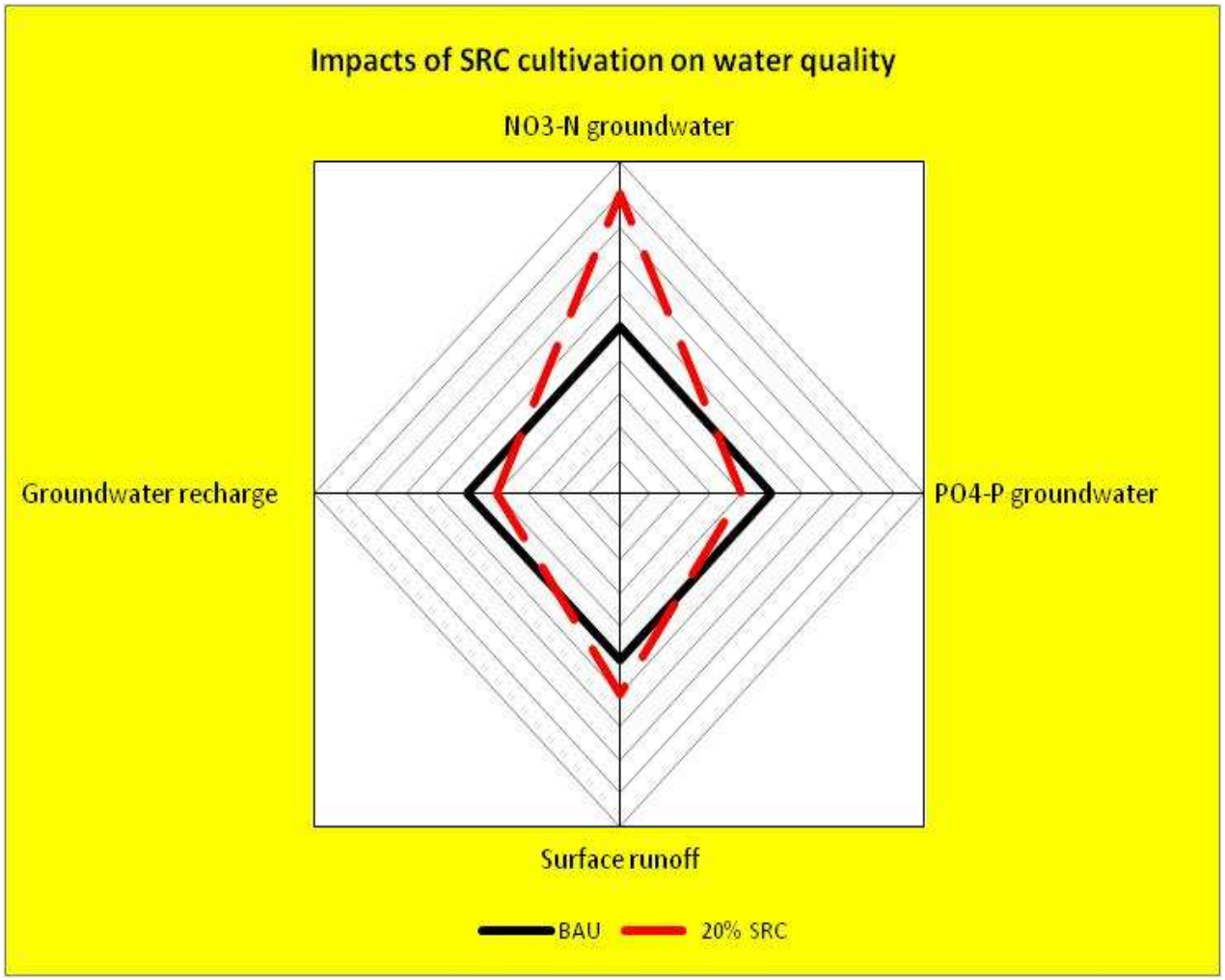


Figur 4 Interpolerade koppar och kadmiumhalter (mg kg^{-1}) i Uppsala län, klassade utifrån10-, 25-, 50-, 75- och 90-percentilen (anges inom paren

Impacts of SRC cultivation on soil quality





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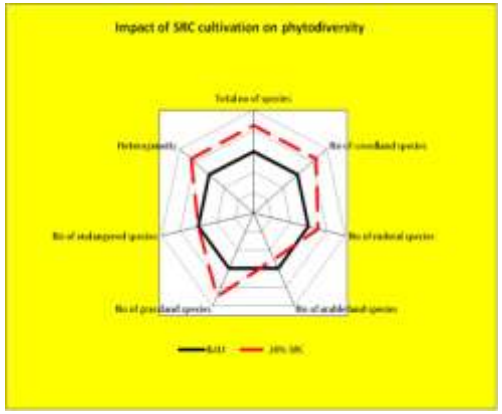

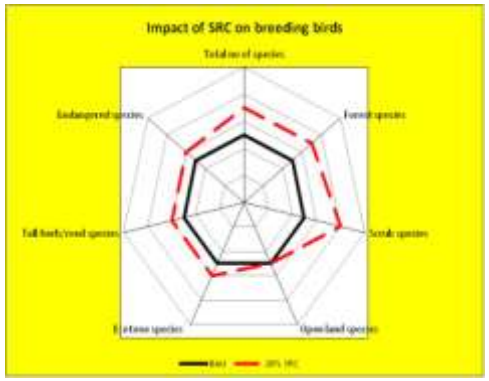

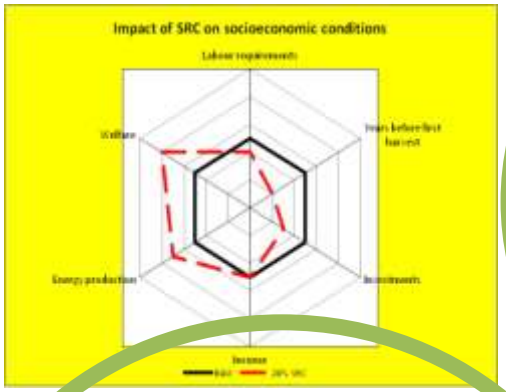

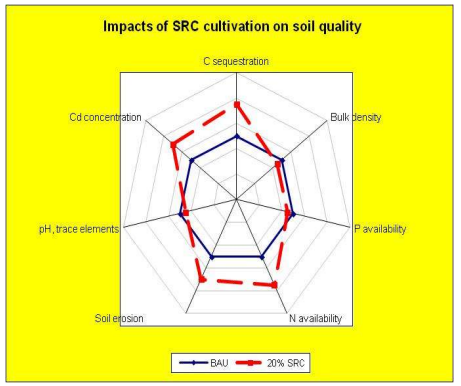

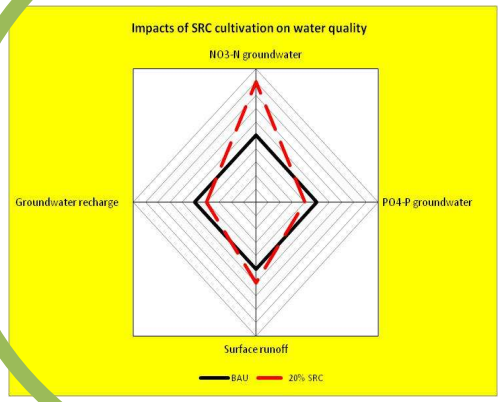

In Langeveld et al., 2012
(Bioenergy Research)