

Relocation of pig production in EU27 to reduce external N pollution costs

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Why relocate?

We test the hypothesis that relocation of pig production within the EU27 can reduce the external costs of nitrogen (N) pollution. For economic reasons, pig production is often concentrated in regions close to urban consumers and ports to facilitate trade of feed and meat. As a consequence, emissions from pig farms, pig manure application to (feed) crops and transport are concentrated in these regions. In 2008 the external cost of pollution by emissions of ammonia and nitrate from agriculture in the European Union (EU27) was estimated at 61-215 billion € (0.5 to 1.8% of GDP). The average contribution by pig production was 15%, with hotspots in Belgium, Denmark, the Netherlands, western Germany, Bretagne and Cataluna (**Figure 1**). External N costs are dominated by health impacts of ammonia containing aerosols and impacts of N inputs to aquatic ecosystems.

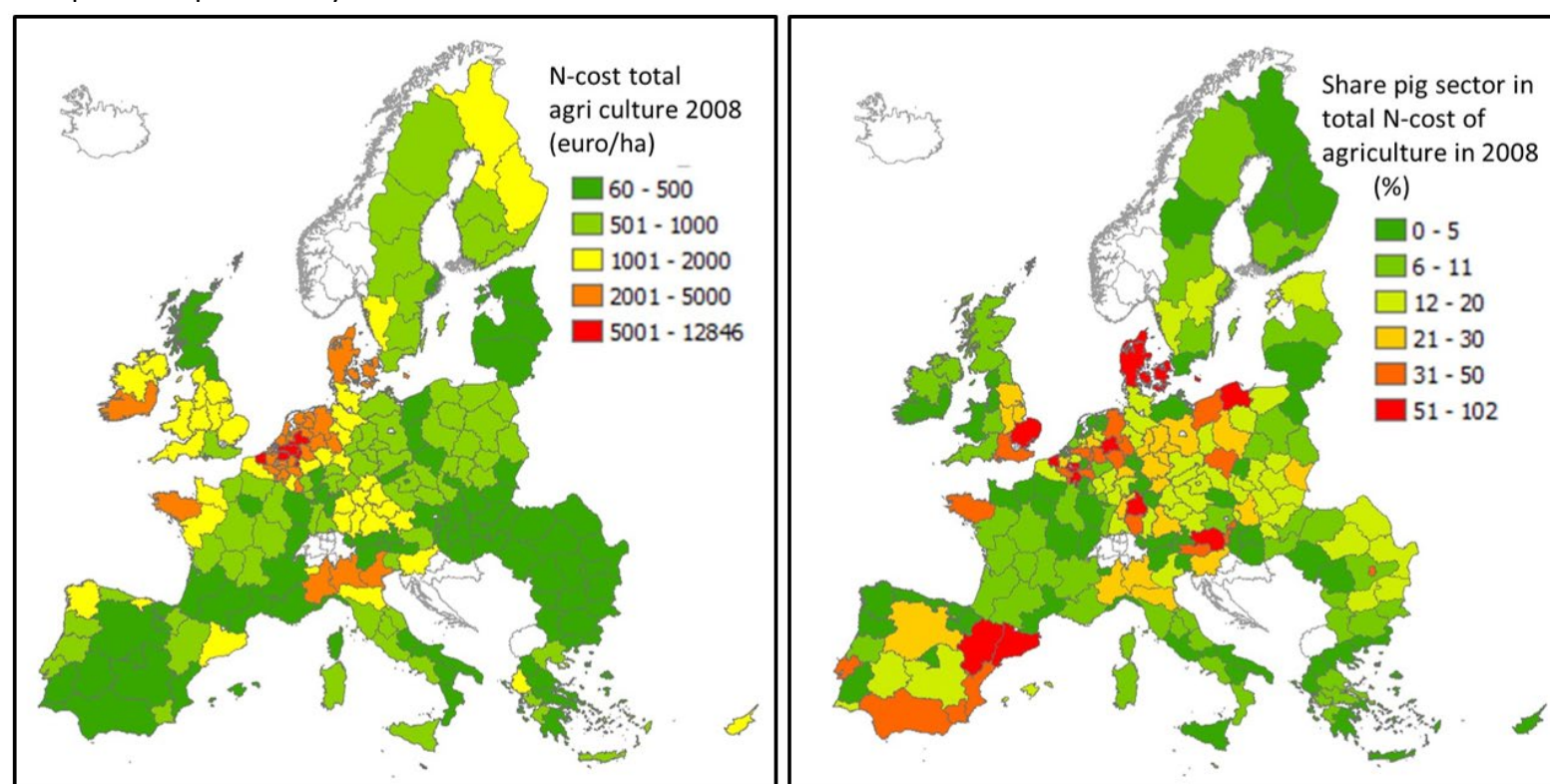


Figure 1. Left: Total external N cost of agriculture in EU27 in 2008 due to NH₃ emission and N leaching and runoff per hectare, and Right the share of these costs by pig production

Calculation procedure

We quantified the marginal increase in external costs of N pollution associated with an increase of pig production at NUTS2 level in the EU27 (provincial scale - 224 NUTS2 regions in EU27). Marginal N cost was calculated as:

$$N \text{ cost} = \sum (N \text{ flux} * \text{Unit N cost})$$

We distinguished six different pig production activities and six transport flows between those activities, potentially emitting NH₃, NO_x, PM_{2.5}, greenhouse gases to air and N to water. N fluxes were calculated using the MITERRA-EUROPE model (Velthof et al., 2009). External unit costs of N pollution were taken from Van Grinsven et al. (2013). We minimized external N cost by relocating pig production between NUTS2 regions while maintaining total EU pork production in 2008.

Results

The potential reduction of external N-cost by relocation of pig production was estimated at 14 billion € (10% of total; **Table 1**). Regions most eligible for decreasing the pig stock were in western Germany, Flemish region, Denmark, the Netherlands and Bretagne, while Romania is most eligible for increasing pig production.

Relocating 20 million pigs (13% of total EU stock) decreased average external costs per capita from 900 to 785 € in the 13 NUTS2 regions where pigs were removed, and increased from 69 to 107 € in 11 regions receiving pigs (**Figure 2** - Config-1).

Table 1. Total external cost by emission of NH₃ and NO₃ from agricultural sources in EU27 in 2008 under current practice (CP 2008) and cost change due to relocation of pig production and introduction of best N management practices (BP). *BP applied to NUTS2 regions if pig stock is increased

		NH ₃ emission (health)	NH ₃ deposition (terrestrial eco systems)	N-leaching (health)	N-leaching (aquatic eco systems)	NH ₃ deposition (aquatic eco systems)	Total
billion €							
CP	2008	38	5	1	58	35	138
Change relative to CP 2008							
BP	2008	-3.5	-0.5	-0.1	-7.5	-1.9	-13.6
CP	Config-1	-2.8	-0.4	-0.1	-6.2	-4.2	-13.7
BP	Config-1	-3.1	-0.3	-0.1	-6.1	-3.8	-13.4
BP	Config-1A*	-3.7	-0.4	-0.2	-6.2	-4.4	-14.9
CP	Config-2	1.9	0.3	0.0	2.1	0.0	4.2
BP	Config-2	-0.1	0.0	-0.1	-0.5	-1.2	-1.8
BP	Config-2A*	-1.2	-0.1	-0.1	-0.6	-2.0	-4.0

A second alternative configuration (**Figure 2** - Config-2) of pig production was targeted at reducing exceedance of critical N deposition and closing regional nutrient cycles. This configuration relocated pigs within Germany and France, for example from Bretagne to Northern France, and from Weser-Ems to Ober-Bayern.

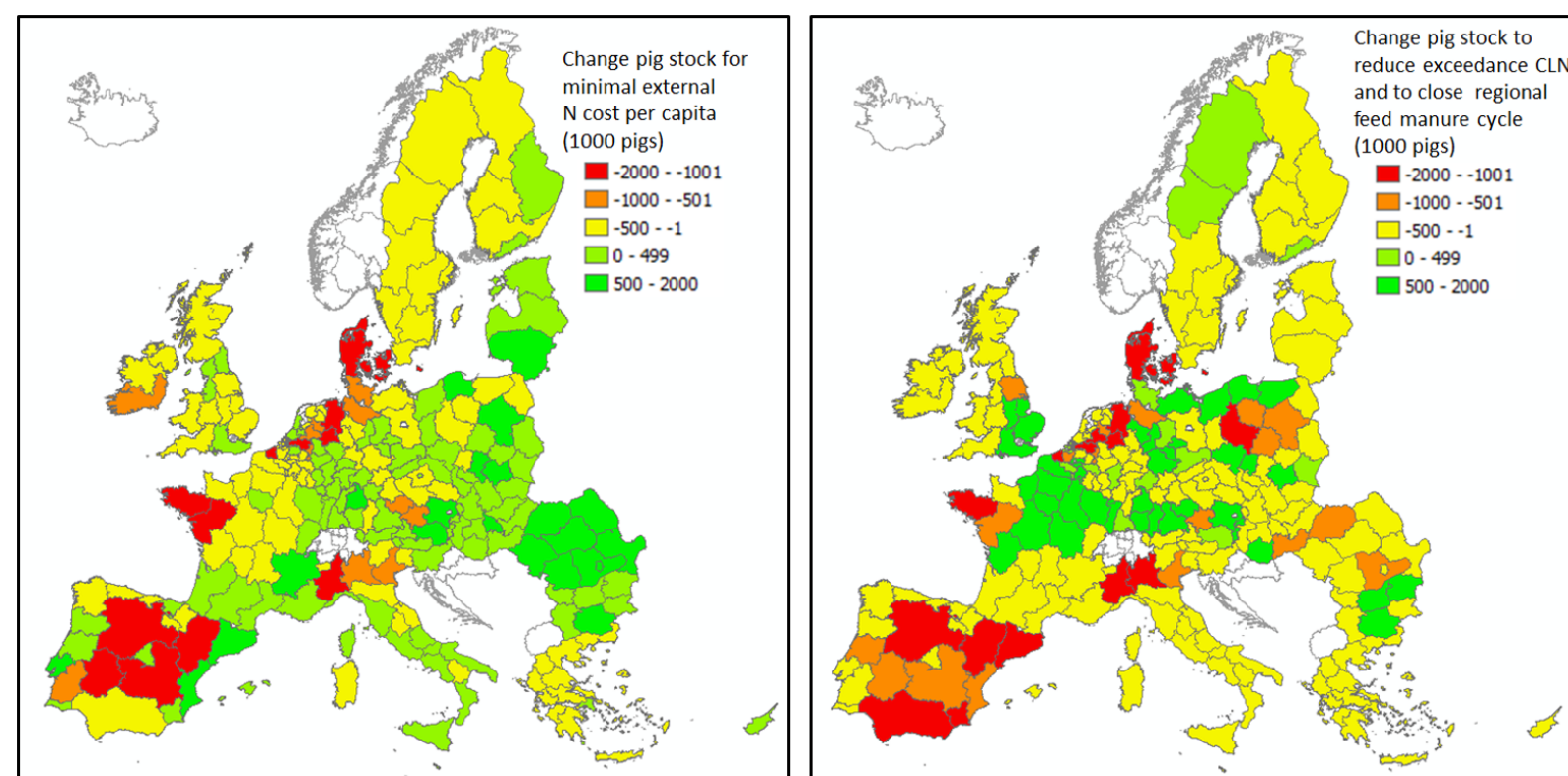


Figure 2. Change of the pig population in NUTS2 regions for two improved spatial configurations. Left Config-1. Right Config-2

Conclusion

Relocation of pig production in the EU can reduce external N cost by 14 billion € but likely will meet many socio-economic barriers. Realization requires new policy incentives. Relocation should always be accompanied by introduction of best N management practices.

Reference: van Grinsven, H.J.M., van Dam, J.D., Lesschen, J.P., Timmers, M.H., Velthof, G.L., & Lassaletta, L. (2018). Reducing external costs of nitrogen pollution by relocation of pig production between regions in the European Union. *Regional Environmental Change*, 18(8), 2403-2415.

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