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Events

European Sustainable Phosphorus Conference (ESPC4)

Registration is now open (on [Eventbrite](#)) for the 4th European Sustainable Phosphorus Conference, Vienna, 15-17 June 2020. This 4th ESPC will centre in plenary on business models, company success stories and city and regional actions towards nutrient circularity. Parallel sessions will mix research with application (see below, call for papers). The third day (17th June) will be the 4th European phosphorus R&D day, showcasing R&D into phosphorus recycling and recycled products and new approaches.

Registration: [Eventbrite](#)

Full details www.phosphorusplatform.eu/espc4

CRU Phosphates 2020

The full speaker agenda is now published for the 13th CRU Phosphates Conference, 8-10 March 2020 Paris. This is the world’s leading phosphate industry meeting, with over 400 industry participants from 40 countries annually. Sessions include technical showcases, market outlooks worldwide and by major region, fertiliser regulation update and phosphorus recycling, new developments (biostimulants, crystalline and soluble fertilisers), animal feed phosphates, phosphate chemical processing. See summary of the 12th CRU Phosphates Conference (Florida, 2019) in ESPP eNews [n°33](#). 10% fee discount for ESPP members.

CRU Phosphates 2020, 8-10 March Paris - <https://events.crugroup.com/phosphates>

RAMIRAN 2020

Europe’s leading manure and organic resources recycling conference, RAMIRAN, will take place in Cambridge, UK, 14-17 September 2020. The RAMIRAN network was established 25 years ago and the biennial conference attracts some 250 participants. This year’s RAMIRAN will look at “Managing Organic Resources in a Changing Environment”, including nutrient utilisation, soil quality, air and water, best practices, treatment technologies and policy. Abstract submission until 1st March 2019.

www.ramiran2020.org

Stay informed

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eNews newsletter: www.phosphorusplatform.eu/eNewshome

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Slideshare presentations: www.slideshare.net/NutrientPlatform

Regulatory

Sweden Enquiry recommends use of sewage sludge on crops

The Sweden Government enquiry into phosphorus recycling and sewage sludge published its conclusions on 17th January 2020. The report recommends that regulation should require at least 60% recycling of phosphorus from sewage works > 20 000 p.e., that specifications should be developed for other organic-carbon containing fertilisers (in particular sewage sludge biochars) and proposes two options concerning use of sewage sludge in agriculture: either (1) a ban with “very few exceptions” (e.g. individual households), including a ban on use of separated urine, or (2) continuing use of “sanitised and quality-assured sludge” with demanding quality requirements (to be defined within 2-3 years) and reevaluation over coming years to decide whether further restrictions or requirements should be implemented. **The report strongly recommends option 2, that is continuing use of sewage sludge in agriculture, with demanding quality requirements** (in the Swedish text, not in the English summary). In this case, the 60% P-recycling requirement would include sludge use on crops. For both options, the report recommends to ban use of sewage sludge for non-agricultural applications, such as landscaping, where phosphorus is not valorised (such use is currently 2/3 of Sweden’s sewage sludge spreading). The report states that “*current research on the spreading of sewage sludge has not yet shown adverse effects on health and the environment ... with the quality requirements applied for use in Swedish agriculture*” and underlines that sludge use in agriculture enables recycling not only of phosphorus, but also of nitrogen and organic carbon. The report concludes that a complete ban on sewage sludge use is not supported by risk assessment, whereas “*there is clear evidence that sludge fertiliser application supplies plant nutrients and humus that agriculture demands*”. An update of Sweden’s sewage and sludge regulations is recommended, with a strengthening of the role of the EPA in addressing sewage contaminants at source. It is also recommended that national objectives be developed for recycling of other resources in wastewater (nitrogen, potassium, carbon). The report notes that the market value of potentially recovered phosphorus in Sweden (c. 5 million €/y) is significantly lower than sludge mono-incineration and P-recovery technology costs (10-15 million €/y or higher).

Conclusions report of Sweden Government Inquiry into phosphorus recycling and sewage sludge use in agriculture, including 12-page detailed English summary pages 31-43 - Report of the Inquiry into a non-toxic and circular recycling of phosphorus from sewage sludge “Hållbar slamhantering”, published 17th January 2020

Stockholm Environment Institute workshop on the Inquiry conclusions: [30th January](#) 15h30-17h00

Regulatory status of insect “manure” as fertiliser

The European federation of producers of insects for human and animal foods (IPIFF) has published a [position paper](#) on the use of insect larvae faeces (“insect frass”) as a fertiliser. In addition to their main outputs (whole insects, proteins, fats), insect farms produce “frass” - a secondary material which has potential to be upcycled as a fertilising product in agriculture. EU frass production in 2019 was circa ten thousand tonnes (of which 80-90% dry matter) forecasted to reach nine million tonnes/year by 2030. Its characteristics vary depending on the insect species and production method (e.g. the substrates used in insect farming). NPK values are similar to compost with values around 4:3:3 (4%N, 1.3%P, 2.5%K). In addition to nutrients, frass can contain bacteria which stimulate plant growth and health. At present, some EU countries authorise the use of insect frass under national fertilisers regulation, with varying requirements for sterilisation. This fragmented and unclear regulatory context is an obstacle to the development of appropriate processing of frass, and so to its commercialisation and the reintroduction of valuable nutrients in agriculture. IPIFF recommends: (1) the development of a specific EU regulatory definition of insect frass and its integration into the EU Fertilising Products Regulation; (2) that the status of insect frass be clearly aligned, across Europe, to standards and requirements for animal manure under the EU Animal By-Products Regulations (ABP); and (3) that an ABP Regulation endpoint be defined for direct use of non-sterilised insect frass on land (criteria on sieving/treatment to ensure absence of live insect larvae and microbiological and chemical safety).

“IPIFF Contribution Paper on the application of insect frass as fertilising product in agriculture”, 19th September 2019 International Platform of Insects for Food and Feed www.ipiff.org

Nutrient recycling

ESPP – NNP - DPP phosphorus recovery technology catalogue

A “catalogue” of technologies for P-recovery, particularly targeting operational information on processes today operating full-scale for P-recovery from sewage, is published online by the three nutrient platforms currently operational in Europe (ESPP European Sustainable Phosphorus Platform, DPP German Phosphorus Platform and NNP Netherlands Nutrient Platform). Ten processes for P-recovery from sewage (from sludge or sludge incineration ash), operating today full scale or under construction, are summarised, as well as a further c. 20 processes which concern P-recovery from manure (full scale), nitrogen recovery (full scale) or R&D scale P-recovery from sewage. The catalogue specifies the input materials for each process, output products, fate of iron/aluminium and of heavy metals or other contaminants, a summary of the process steps, current operating status (full-scale or pilot operation at how many sites, capacity and duration of operation) and websites of technology suppliers.

ESPP – DPP – NPP Phosphorus Recovery Technology Catalogue: <http://www.phosphorusplatform.eu/p-recovery-technology-inventory>

Italmatch acquires RecoPhos P4 production technology

The Italian chemicals group, Italmatch, specialist in phosphorus-based products for fire safety, energy storage applications, water treatment, oil & gas, lubricants and plastics, has acquired (from ICL) the RecoPhos thermal technology (see SCOPE Newsletter n°120) for production of P4 (elemental or “white” phosphorus) from secondary raw materials, in particular sewage sludge incineration ashes. P4 is specifically identified as one of the 27 EU “Critical Raw Materials”, separately and in addition to “phosphate rock”, because it is essential for a wide range of applications (see SCOPE Newsletter n°123), including fire protection, batteries, water treatment, pharmaceuticals, agrochemicals ... and because Europe is currently completely dependent on imports (essentially from Vietnam and Kazakhstan). There is today no EU producer of P4. The RecoPhos technology uses electro-magnetically induced heating of a reactor bed consisting of coke or graphite, and should enable P4 production with an improved energy efficiency profile compared to current industrial processes. It also aims to enable phosphorus recovery from ashes containing iron and to allow decentralised production units to be potentially viable. Because of its hazardous characteristics, P4 or its derivatives require very specific competence and organisation for production, handling and transport, and Italmatch has this industrial competence. A pilot RecoPhos plant was tested in Leoben, Austria, in 2015, treating around 10 kg/h of dry input material.

Italmatch press release, 16th January 2020 <http://www.italmatch.com/italmatch-chemicals-group-acquires-the-recophos-project-technology/>

AquaGreen pyrolysis of sewage sludge & fish manure

DANVA, the Danish Water and Wastewater Association, has launched a “PCP” (Pre-Commercial Procurement) project, funded by the Danish Market Development Fund to treat and recycle sewage sludge by use of superheated steam drying and pyrolysis. The technology is developed by the Danish start-up company AquaGreen ApS in corporation with the Danish Technical University (DTU) and Norwegian Akvaplan Niva, funded by the Horizon 2020 Eurostar program. A pilot plant with a capacity of 2.5 tons sewage wet weight sludge per day, at 25% DM, was installed and successfully demonstrated in 2018 at VandCenter Syd A/S, Odense Municipal Waste Water Treatment plant. In 2019, authorisation was given to AquaGreen and Nordlaks Smolten AS to test the system for treatment of fish manure from land based salmon farms in Norway. The dried sludge is pyrolyzed at 650 °C, and the flue gas provides the thermal energy for the superheated steam drying. The resulting biochar is rich on phosphorus (6-8% Vol.) and the plant availability has been proven and documented in field-trials performed by SEGES and green-house trials performed by Copenhagen University, Department of Plant and Environmental Sciences.

<https://www.aquagreen.dk/>

Food systems

Future of food and food production

A report from the Swiss investment bank UBS gives perspectives for future food production, looking at societal tendencies and industrial opportunities. The bank identifies as key drivers: scarcity (water, land, nutrients ...), sustainability, new consumer attitudes, wellness (obesity, health inducing molecules), and digitalisation. Replacement of animal products by plant, algae or cell cultured foodstuffs is expected to develop strongly, for resource, environment and health reasons. ESPP notes that phosphorus will remain essential for all such production, opening opportunities for new recycling routes and efficient use. USB see major opportunities in technologies (e.g. drones) and data management to develop precision farming (connectivity, big data, satellite data ...) and reduce food waste (internet of things). Challenges include consumer attitudes (traditional preferences), political defence of existing production systems and consumer attitudes to new products and bio-technologies (e.g. gene editing).

“The food revolution. The future of food and the challenges we face”. UBS Chief Investment Office, [July 2019](#). UBS

“Plant-based protein is disrupting meat markets” UBS Investment Insights, [24 July 2019](#)

Towards a radical move away from animal protein?

A report from an independent thinktank on disruption predicts that non-animal derived proteins will be five times cheaper than animal proteins by 2030, as well as healthier, better tasting and more convenient, leading to a halving of the number of cattle in the USA by 2030 and making the cattle farming industry “all but bankrupt” (disruption of only a third of the industry’s revenues would be sufficient to push it to bankruptcy), leading to a 40-80% fall in farm land prices and a 45% reduction in agriculture’s greenhouse emissions. The key driver will be precision fermentation, enabling micro-organisms to produce almost any organic molecule on demand. Food engineers will then be able to personalise recipes, to develop new products, target consumer tastes or nutrition and health needs. Precision fermentation will be supported by gene sequencing and genetic engineering of micro-organisms, artificial intelligence and robotics, enabling local production. Precision fermentation is already today used to produce e.g. insulin (medicine), human collagen (cosmetics) and artificial sweeteners (food). The report notes that a relatively small substitution can disrupt an existing market (e.g. only 3.3% wet weight of milk is protein) and predicts reductions in the (US) market for beef steak of -30% by 2030, ground beef -70% and milk -90%. The resulting job losses in cattle production and processing (1 million job losses in the USA) would be of a similar order to job creation in precision fermentation. The report suggests that the fertiliser industry would be negatively impacted by the move away from livestock production (-50% fertiliser consumption predicted). ESPP notes however that this assumes that land is not converted to plant production for food or

biofuels/biomaterials. The report suggests that precision fermentation is 10-25x more “feedstock efficient” (presumably covering both energy and nutrients) than animal farming, and notes that it will generate wastewater and spent micro-organism biomass, which it suggests could be recycled as fertiliser.

“Rethinking Food and Agriculture 2020-2030. The Second Domestication of Plants and Animals, the Disruption of the Cow, and the Collapse of Industrial Livestock Farming”, RethinkX, C. Tubb, T. Seba, [September 2019](#), 76 pages.

Sustainable Development in the Food and Beverage Industry

ESPP participated at the ENG SDF&B (Sustainable Development in the Food & Beverage Industry) conference, Düsseldorf, 14-15 January 2020, chairing the second day and leading a round table on “The phosphorus challenge” for food and agriculture. Participants at the conference included leading food companies, agri-food suppliers and supermarkets, including Mars, Coca Cola, Nestlé, Brau Union (Heineken), Metro, Migros, Delhaize Group, Tchibo, Bunge, Friesland Campina, HK Scan ...) and the conference was sponsored by the World Business Council for Sustainable Development (WBCSD). Presentations and discussions included innovation replacing animal products (e.g. Oatly, oat based “milk” replacement; Protifarm, food ingredients from insect production, Proveg, non-meat product incubator ...); linking technology and data to sustainability enablement; sustainability from farm to fork, food prices and a living wage for farmers; identifying and reducing sustainability risks in supply chains; and the need for cross-industry cooperation and regulation to move the whole market to sustainability progress. Aquaculture was discussed, as an environmentally efficient source of healthy protein, with ongoing development of increasingly efficient, mainly plant based feed recipes (Mowi, Biomar).

<http://www.engevents.com/sustainable2020>

Food waste losses 16% of China’s fertiliser P use

A study estimating the phosphorus footprint of food waste in China estimates that over 83 000 tP/y are contained in at-table (commercial and home) food waste in China, with a total P footprint of over 420 000 tP/y including related crop or livestock production and food processing. This is over 16% of China’s annual consumption of mineral P fertiliser. The study is based on a modelling quantification of food waste, calculated per Chinese region, verified against data from several studies and statistics sources, concluding total at-table food waste of nearly 54 million tonnes/year in China (over 39 kg/person/year). This is then multiplied by “loss factors” for different production and processing systems (cultivated land, animal farming, crop processing ...), from other papers by the same author. This may however over estimate animal production losses, because these calculations assume that all phosphorus not transferred into food products is lost, in particular that all manure P is lost and none recycled back to land.

*“Food waste and the embedded phosphorus footprint in China”, B. Li et al., *Journal of Cleaner Production* 252 (2020) 119909*
<https://doi.org/10.1016/j.jclepro.2019.119909>

Studies and research

Nutrient balances and recycled nutrients in organic farming

The EU Horizon 2020 project [RELACS](#) (Replacing Contentious Inputs in Organic Farming Systems, or Improving Inputs for Organic Farming) has published preliminary results of a major ongoing study into need and use of nutrients, and of organic farmers’ attitudes to recycled nutrients. The study is based on interviews with a total of 79 organic farmers in seven European countries (Germany, Italy, Estonia, UK, Denmark, Switzerland, Hungary). The farms showed, on average, surpluses for nitrogen (average +28 kgN/ha) but near balance for phosphorus (average -1 kgP/ha) and potassium (average +2 kgK/ha). However, nutrient balances varied widely between farms (e.g. -15 to +40 kgP/ha for phosphorus). Farms with externally sourced nitrogen inputs tended to show surpluses of all three nutrients, while increasing reliance on biological nitrogen fixation induced more negative budgets of P and K. Nearly all farmers interviewed were open to using recycled fertilisers, including from urban waste streams, in order to close the nutrient cycle. Yet many farmers raised concerns about contaminants, in particular micro-plastics, as well as about consumer acceptance of use of sewage-derived products.

Jakob Magid, Copenhagen University, one of the RELACS project partners, has commented to [SEGES](#) : RELACS’ preliminary data suggests that organic farms relying mainly on nitrogen inputs from plants, with few or no external inputs, have a much lower output productivity than farms with a higher ratio of external inputs. Around half of the organic farms examined in RELACS had outputs of less or much less than 60 kgN/ha in their produce, corresponding to c. 3 tons grain per hectare. Most of the 71 farms examined had few or no animals, and their output was estimated by using farmgate balances of nitrogen in various products or manure. The farms that had higher outputs used substantial amounts of different inputs. The farms that rely heavily on biological nitrogen fixation tended to use few or no external inputs at all, which could be due to low accessibility, and limited economy. If organic farmers want to be able to supply a much larger part of the future European market with organic products, they will have to use the organic farmland as efficiently as possible, Jakob Magid says.

“Reducing the use of external fertilisers in organic agriculture”, 11th July 2019, RELACS (Replacing Contentious Inputs in Organic Farming Systems, or Improving Inputs for Organic Farming) www.relacs-project.eu

Plant availability of thermochemically recovered phosphorus

Greenhouse container trials tested the plant availability of phosphorus in thermochemically treated sewage sludge: 170 kg soil, 1 ½ years, barley, spinach, rye grass, maize. The sludge was from a sewage works using iron salts for chemical P-removal, after anaerobic digestion. It was first dried to >93% DM, then pyrolyzed at 550°C (Pyreg) and finally reacted at 950°C with a reducing agent (lignite) and sodium sulphate or chloride (HCl) + sodium sulphate. The resulting ash contained 10-11%P and around 15% iron (Fe), 10% aluminium (Al), 12% calcium (Ca) and 13-14% magnesium (Mg). NAC phosphorus solubility was over 93% for the sewage sludge, dropping to 88% after pyrolysis and to 63 or 87% after the thermochemical treatment (the higher solubility was when chloride was added in the process). Dry matter yield in the container trials was significantly lower than for triple super phosphate for the pyrolyzed sludge and thermochemical ash for both barley and rape and marginally lower for rye grass (for spinach there were no significant differences from the control: no added P). The authors suggest that the container-scale crop trials can simulate real field conditions (significant root development) and that the results show “adequate” long-term plant availability of P in the thermochemical ash materials, but low short-term plant P availability. They suggest that this is because the thermochemical ash contains calcium sodium phosphate and calcium magnesium sodium phosphate (CaNaPO_4 and $\text{Ca}_{13}\text{Mg}_5\text{Na}_{18}(\text{PO}_4)_{18}$).

“Medium-scale Plant Experiment of Sewage Sludge- based Phosphorus Fertilizers from Large-scale Thermal Processing”, D. Steckenmesser, C. Vogel & D. Steffens, *Communications in Soil Science and Plant Analysis* [2019](#).

Recycling flame retardant boron from insulation to fertiliser

A R&D trial tested pyrolysed (600°C, biochar) produced from boric acid flame retardant treated cellulosic insulation material (produced from recycled paper, Isocell Austria) as a boron fertiliser in pot trials with rape and sunflower. Such boron-treated flame retardant cellulose can be recycled as building insulation material only a few times because of deterioration in fibre length. The pyrolysis reduces the solubility of the boric acid, which is important because boron is a necessary micronutrient for plants, but is toxic if released too rapidly. Challenges to possible industrial implementation include collection of spent insulation material without contamination, PAH (naphthalene) levels in the biochar and regulatory status of the product (end-of-waste, fertiliser authorisation).

“Functional recycling of biobased, borate-stabilized insulation materials as B fertilizer”, O. Duboc, J. Santner et al., *Environ. Sci. Technol* 2019, 53, 24, 14620-14629, [2019](#)

EC scientists conclude benefits of P-recovery

A study by three European Commission (JRC) scientists concludes that environment and health impacts of phosphorus recycling are “often lower” than for phosphate rock derived fertilisers, even without taking into account phosphate rock reserve depletion. The study models impacts of struvite recovery from biological P-removal sewage treatment, direct use of poultry litter incineration ash as fertiliser, pyrolysis of pig manure, and thermochemical treatment of sewage sludge or meat and bone meal, comparing impacts per kg bioavailable P compared to fertilisers produced from phosphate rock (via the “wet acid” route). The study assumes that, in regions with high livestock or population density, the secondary materials are currently either not recycled (co-incineration) or are used inefficiently (application up to Nitrates Vulnerable Zone maximum levels for manure nitrogen, resulting in over-application of phosphorus): phosphorus recycling is estimated to substitute more than twice as much phosphate rock in high density compared to low density regions (where the secondary materials are assumed to be spread appropriately on farmland as fertilising materials). This assumption “improves” results for regions of high livestock/population density, because the current management routes are thus calculated to have higher emissions and poorer use of P (i.e. more “burdens” in life cycle analysis) than if current use is assumed to be appropriate use on agricultural land. Consequently, their estimated “net” emissions (P-recycling minus current disposal route) are improved. With this calculation, most of the P-recycling materials/routes considered show lower overall emissions to air, water and/or soil than production and use of phosphate rock derived fertiliser. Overall the authors conclude that net societal costs for P-recycling products, for the materials/routes and scenarios considered, are 81%, 50% and 10% lower for sewage sludge, manure and meat and bone meal, compared to use of phosphate rock derived fertilisers (even without accounting for the societal benefits of reducing phosphate rock reserve depletion).

“Environmental and health co-benefits for advanced phosphorus recovery”, D. Tonini, H. Saveyn, D. Huygens, *European Commission JRC Seville, Nature Sustainability*, vol. 2, [Nov. 2019](#), 1051-1061

Global map of phosphorus recycling potential

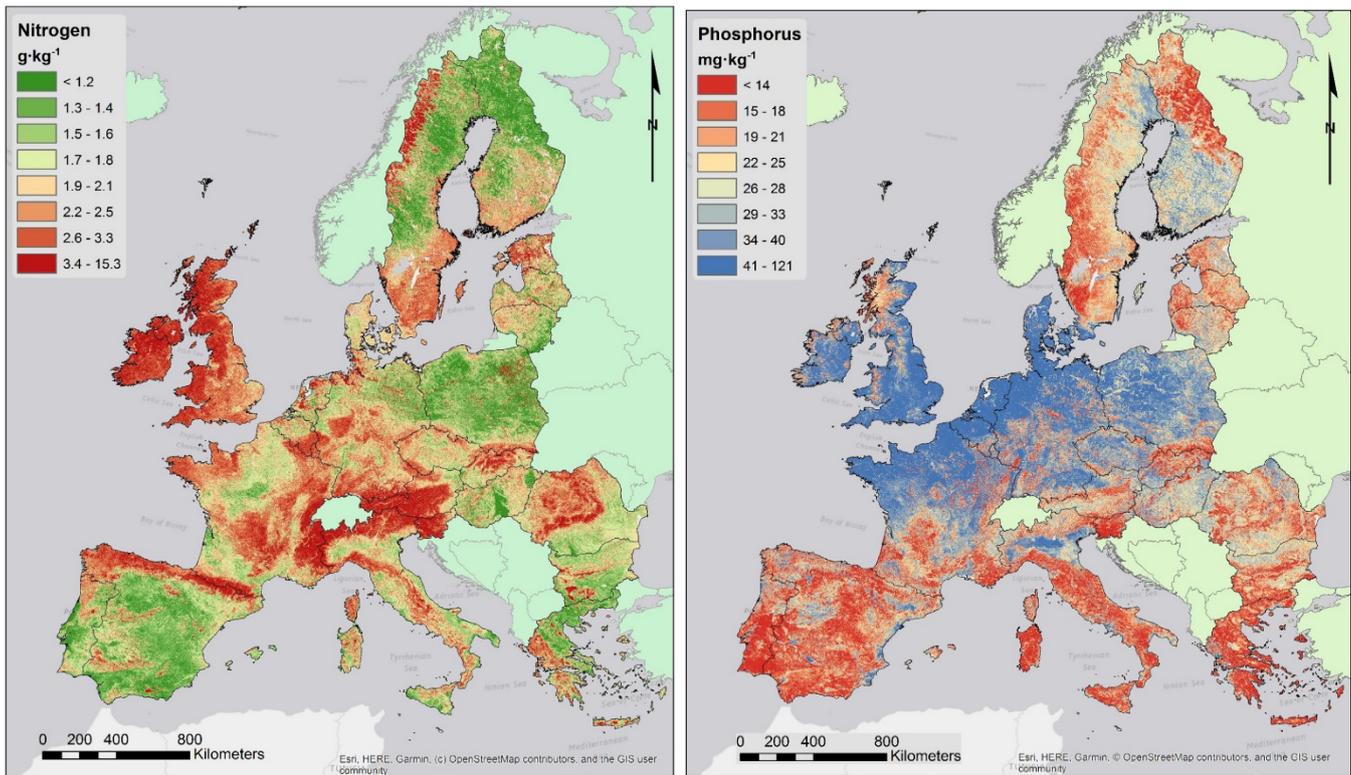
As an outcome of the P-RCN (Phosphorus Research Coordination Network, see ESPP Scope Newsletter [n°125](#)), scientists have mapped across the world, on a c. 18x11 km grid scale, livestock density and human population, so identifying regions with significant local secondary phosphorus. These are then compared to likely crop fertiliser demand, based on cropland (local % land use under crops) and national phosphorus import and fertiliser use tendencies, to identify zones with phosphorus recycling potential. The modelling concludes that most zones with high manure or sewage phosphorus, in India, China, South East Asia, Europe, North and South America, are close to cropland likely to have significant phosphorus demand. The study aims to enable identification, at a global scale of “hotspots” for phosphorus recycling potential.

“Global Opportunities to Increase Agricultural Independence Through Phosphorus Recycling” *Earth's Future*, 7, 370–383., [2019](#)

European topsoil maps for P, N, K and C/N

European Commission (JRC) scientists (with University of Basel) have published maps of topsoil properties for Europe, presenting phosphorus, nitrogen, potassium, carbon/nitrogen ratio, pH and cation exchange capacity (CEC), an output of the EU FP7 RECARE [project](#). The maps are based on over 20 000 soil sample tests, from 2009 and 2012 combined with 270 000 data points for land use and land cover and modelling (Gaussian Process Regression), leading to mapping with 250m resolution. Prediction was highest for C/N ($R^2 > 0.9$) and reasonable for the other properties ($R^2 > 0.6$) except CEC ($R^2 = 0.35$). The authors conclude that land use seems to be the main driver for topsoil phosphorus levels, with fertiliser use leading to higher levels in agricultural areas, whereas soil nitrogen is dependent on soil organic carbon, vegetation, climate and soil texture. The results do not aim to replace local monitoring data, but to provide a European level overview. Maps for phosphorus and nitrogen are reproduced below with permission – see the cited publication for the other maps and full details.

"Mapping LUCAS topsoil chemical properties at European scale using Gaussian process regression", C. Ballabio, P. Panagos et al., Geoderma 355 (2019) 113912



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