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New training to meet the global phosphorus challenge

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Meeting the Global Phosphorus Challenge (GPC)[1]

The sustainable exploitation of phosphorus (P) is essential for food and water security. However, our current poor management of this essential nutrient represents a pressing challenge causing

global scale pollution of water resources[2] whilst failing to achieve equitable access to fertilizers to support food production world-wide[3]. This is, in part, due to poor uptake of advances, for example, in new technologies to reduce losses of P from agriculture, in our understanding of P thresholds for ecosystem functioning, and in sustainable urban development approaches focused on nutrient recycling systems. We identify, here, a pressing need to develop a new generation of nutrient sustainability professionals working collectively to implement diverse and interdiciplinary approaches within large scale urban and rural planning, for example, following the UNESCO Global Action Programme on Education for Sustainable Development, to meet the diverse needs of communities and countries.

Scaling up adaptive regulatory programmes

At present no public institution has responsibility for governing global P resources. Where present, existing regulations that consider P are dated and fail to address sufficiently the wider aspects of sustainable use, or of future needs to support equitable access to resources globally. For example, the European Union (EU) Water Framework Directive and the American Clean Water Act cover some legal and management aspects relevant to the GPC by assigning the obligation to 'member states' to bring water bodies to a good ecological status. However, the success of these regulatory frameworks requires trans-boundary actions beyond the 'member states', do not account for future increased demand on services and food, and focus predominantly on ecological quality. Therefore, we must incorporate resource planning across existing and emerging national and regional regulatory directives to establish a global framework. Future regulatory frameworks should embrace a robust circular economic model to identify oppertunities for P recovery and sustainable reuse; improving access to affordable fertilizers that are culturally acceptable and transforming local food and waste management systems. Despite a lack of collaboration and coordinated governance globally, the EU appears to have many of the pre-conditions to lead the way[4], and is providing leadership in this respect. For instance, P was added to the EU list of critical raw materials in 2014 and in 2016 the EU adopted the Circular Economy Action Plan; a regulatory framework to extend the economic life of products, materials, and resources. However, policy is not enough. As seen in the large variablility in the amount of P recycled from human excreta back to agricultural lands, there needs to be alignment among policies, economic and physical capacity, knowledge, and cultural acceptance to move from theory to action[5]. In an increasingly urbanized world, P cannot be viewed as a national agricultural or local environmental issue. Planning must account for the complex nature of the GPC and the diverse stakeholders involved.

A way forward through training

Our current, almost linear, economic system is wasteful, extracting P for food production and producing large P pools in agricultural soils (from where it can be lost to the hydrosphere) or in landfills and asphalt concrete. Currently, P management and knowledge is fragmented between diverse sectors (Figure 1) – from the agricultural sector where P-fertilizer is a globally-traded commodity, to the sanitation sector where P is a costly pollutant that requires removal, to the environmental sector where P causes water pollution. To address these challenges, nutrient sustainability professionals must work across academic, industry, and government sectors to equip them with the expertise required to develop adaptive planning programmes focussed on achieving P sustainability targets across scales, but this is seldom done. To catalyse this approach, we argue that a crucial element in addressing the GPC is the need to establish a coordinated program to mentor and mobilise a new generation of professionals with the ability to span disciplinary siloes with the skills, experience, networks and tenacity to ensure transformative changes in the way P resources

are managed. In turn, training in such a way will also allow the mentors to learn and cross boundaries and participate in this new community.

We call for institutions across countries to form networks, and that programs within each institution open their doors to students from different faculties. Opportunties for industrial internships and policy development placement are also crucial so that students not only learn the skills needed in the workplace, but that they also contribute to changes in mainstream industry and policy implementation, including, for example, meeting the ambitions of the United Nations Sustainable Development Goals. This spans from helping local governments to develop nutrient management plans for emerging and growing cities underpinned by circular economy approaches to working across borders to relieve nutrient stress on transboundary water bodies through international nutrient management agreements. Importantly, such professionals should not be simple P specialists, but rather ´system thinkers´ who can inform judicious decision making on the management of multiple nutrients (e.g., nitrogen, potassium, and carbon) in the context of their environmental and socio-economic impacts.

Nutrient sustainability professionals must work together to provide evidence on emerging approaches, should they be related to technology and infrastructure or behaviors and practices, to better support the development of effective policy instruments at multiple scales. Only through this interdisciplinary approach can the complex interrelations of the GPC be effectively acted upon to secure agricultural productivity, together with a clean environment, a strong green economy and a closed loop for P.

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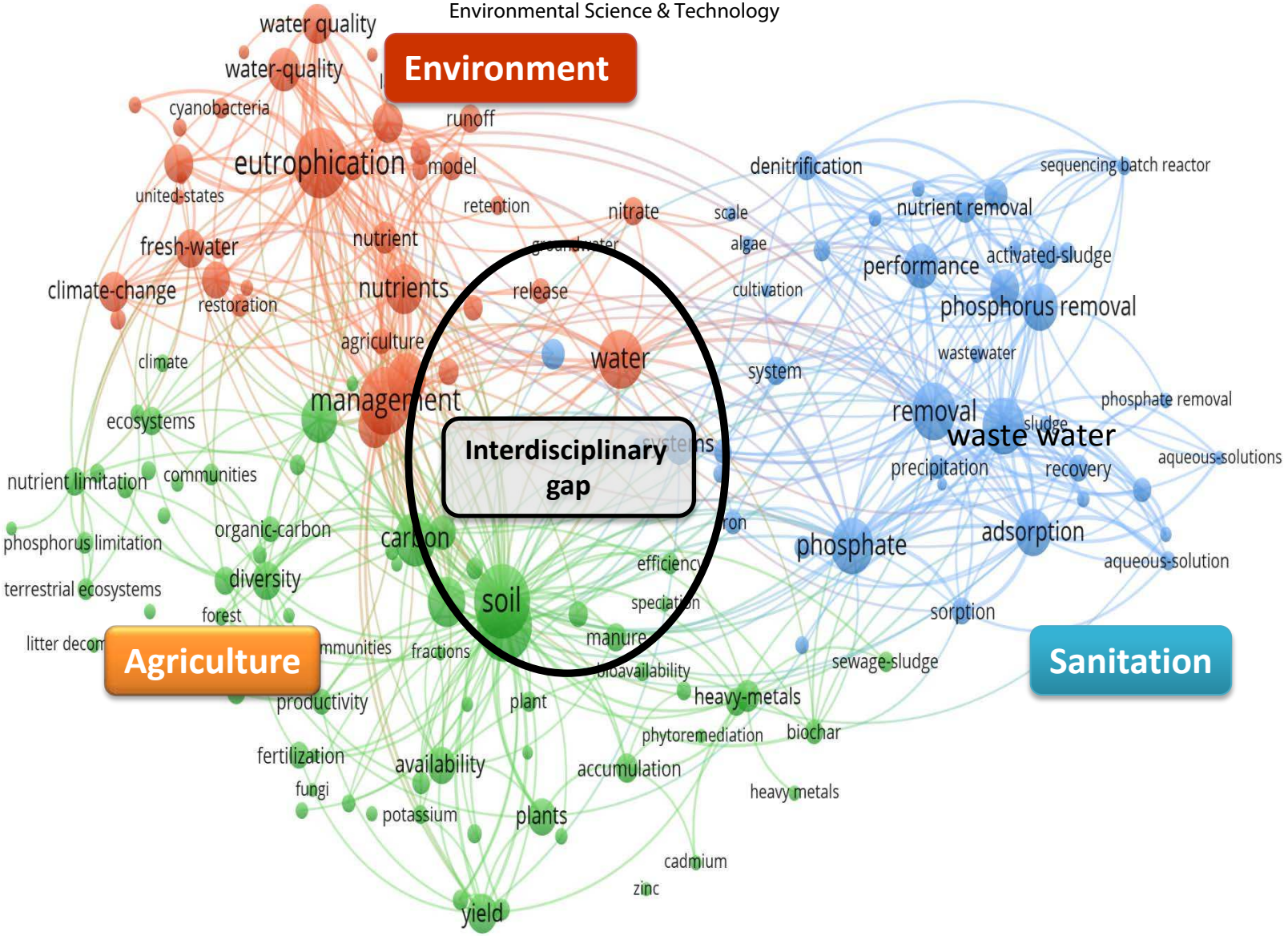

Figure 1. Intersectoral gap, in Phosphorus-related research generated with VosViewer and based on 8000 articles using the keyword “phosphorus” in research related to the agriculture, sanitation and environmental sectors. Each circle correspond to a keyword of the articles and are linked by a line if they co-occur frequently in articles.