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Environmental impacts of phosphorus recovery from municipal wastewater

Arabel Amann (1,2), Ottavia Zoboli (1,2), Jörg Krampe (1), Helmut Rechberger (1,2), Matthias Zessner (1,2), Lukas Egle (1,2)

(1) Institute for Water Quality and Resource Management, TU Wien, Vienna, Austria, (2) The Centre for Water Resource Systems, TU Wien, Vienna, Austria

Phosphorus mining from phosphate rock is associated with economic as well as environmental concerns. Through phosphorus recovery from municipal wastewater, countries could decrease their dependency on the global phosphate rock market, however, conceivably leading to an increase in environmental impacts from fertilizer production. In this work 18 phosphorus recovery technologies are evaluated in terms of cumulative energy demand, global warming potential and acidification potential with the methodology of life cycle analysis. These indicators are then contrasted with other environmental criteria, i.e. recovery potential, heavy metal and organic micropollutant decontamination potential and fertilizer efficiency, to determine their overall environmental performance. The LCA shows that a broad spectrum of changes in gaseous emissions and energy demand can be expected through the implementation of P recovery from wastewater. Linkage to further environmental performance results exposes certain trade-offs for the different technologies. Recovery from the liquid phase has mostly positive or comparably little impacts on emissions and energy demand but the low recovery potential contradicts the demand for efficient recycling rates. For recovery from sewage sludge, those technologies that already are or are close to being applied full-scale, are associated with comparatively high emissions and energy demand. Recovery from sewage sludge ash shows varying results, partly revealing trade-offs between heavy metal decontamination, emissions and energy demand. Nevertheless, recovery from ash is correlated with the highest potential for an efficient recycling of phosphorus. Further research should include implications of local infrastructures and legal frameworks to determine economically and environmentally optimised P recovery and recycling concepts.