For how long can soil successfully remove P from wastewater? *assessment of a 150 year old ' land infiltration system in the UK.*

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INTRODUCTION

Land Treatment Systems (LTS) have been used to treat wastewater since the nineteenth century and continue to be used today, principally at small rural works. LTS are able to remove phosphorus but our ability to predict the lifespan of these systems is limited. This paper characterizes the experience of a LTS situated in the South of England by studying the accumulated P in three plots that have been irrigated for approximately 120 and 150 years respectively and an unirrigated, control plot. The comparison of the theoretical P sorption capacity and the accumulated in the soil over the study period will help to improve the knowledge in order to get reliable long-term P removal estimations and how to use P sorption capacity for system lifespan predictions. The results of the field observations will help to develop a model of P dynamics in LTS.

MATERIALS AND METHODS

Soil samples were collected from a riparian meadow that has been irrigated with wastewater for approximately 150 years. The field is situated close to Knowle (Hampshire, England) and receives effluent from a Sewage Treatment Works (STW) owned and operated by Albion Water Ltd since 2009. The plant currently serves Knowle village and was previously used to serve Knowle Psychiatric Hospital. The grassland field was divided into three different sections with different effluent irrigation histories (including an unirrigated plot). Five soil samples were collected from each section at five different depths with a Dutch auger (0-30, 30-60, 60-90, 90-120, 120-150 cm layers). The sample locations were selected considering the spatial heterogenty of acumulated P due to water flow path and topography. After collection, the samples were placed in plastic bags and stored at room temperature and analysed for pH and TP. The inflow was estimated based on population data from admission registers of the hospital (Burt 2003) and the redeveloped residential area over the 1845 to 2014 period, and average domestic water consumptions (Anglian Water Ltd. 2008). A

climatic data series was obtained for 1970 to 2013 period from Hurn climatic station (50°46'N, 1°50'W and 10 m AOD) to calculate reference evapotranspiration (ETo). Monthly precipitation estimations were obtained from the CEH – Gridded Estimates of Areal Rainfall (CEH – GEAR) which contains 1-km gridded estimates of monthly rainfall for UK from 1890 to 2015 (Tanguy et al. 2014). Water quality analysis for pH, TP and phosphates of the influent wastewater and upstream and downstream from the field at River Meon were carried out by an independent laboratory from December 2014 to December 2015. The evolution of P concentrations in wastewater over the study period was taken into account. Two existing boreholes were used for groundwater quality assessment for TP, orthophosphates and levels. The P accumulated in each section of field was calculated with Eq. (1) (Eveborn et al. 2012)

$$m_p = \sum_{l=1}^{n} (pVc)_l \quad \text{Eq. (1)}$$

Where m_p is the P accumulated in the different layers *l= 1 to n*, *p* is the bulk density (kg/m^3), *V* is the volume of the layer *l* (m^3) and *c* is the concentration of P in the layer (kg P/kg soil). Initial sorption P capacity of the soil was calculated by batch kinetic sorption experiments through equilibration with different P solutions for the reference samples.

RESULTS AND DISCUSSION

The preliminary water balance shows that discharge effluent to the field dominates the balance in comparison with precipitation. The P load to the system over the study period (1852-2014) has been approximately 4.53 kg/m^2 (average inflow TP concentration 8 ±0.65 mg/L). River Meon monitoring quality levels showed no P additions due to the discharge arrangements (Fig 1), as did groundwater monitoring, with values below 0.17 mg/L. Mass balance calculations allows long term P removal performance estimation by comparing the P load with the P accumulated in soil. First results indicate that the storage in the soil over the period is significant (approx. 30 kg P /m^3). The comparison of the accumulated P, the nearby water bodies' quality and the theoretical P sorption capacity levels will provide more accurate answers regarding phosphorus accumulation in the soil and treatment efficiency in the long term.

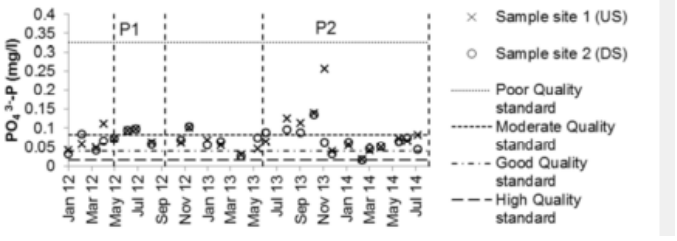

Figure 1 River Meon phosphate concentration monitoring

CONCLUSIONS

Long term P mass balance approach of LTS can help to better understand P removal capacity and mechanism over time of these systems. Therefore, lifespan predictions could be more accurate and be used as a treatments management tool.

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