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Estimating future scenarios for farm-watershed nutrient fluxes using dynamic simulation modelling – Can on-farm BMPs really do the job at the watershed scale?

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A dynamic model of Phosphorus (P) movement through the Peel-Harvey watershed in South Western Australia was developed using STELLA© dynamic-modelling software. The model was developed to provide a means to illustrate watershed P flux from farm to watershed via soils, plants, animals and sediment and to predict future P loss rates under a range of management scenarios. Model input parameters were sourced from extensive surveys of local agricultural practices and regional soil testing data. Model P-routing routines were developed from the known interactions between the various watershed P compartments and fluxes between the various P stores. Phosphorus-retention characteristics for a variety of management practices were determined from local field trials where available and published values where not. The model simulated a 200 year time frame to reflect 100 years to the present day since initial land development, and forecast 100 years into the future.

The use of STELLA© dynamic-modelling software, together with web-based model hosting and simulation software (Forio©), allowed simple and rapid testing of multiple, complex watershed-management scenarios and illustrated the practicality of this approach as both an educational and research tool.

Although the watershed has an annual P-loss target of 70 tonnes per annum (tpa), the measured (and modelled) present day loss is double this amount (140 tpa). This is projected to rise to 1300 tpa if current land management practices continue unabated. Broad implementation of neither "biological" BMPs such as perennial pastures and managed riparian zones, or of "chemical" BMPs such as reduced water solubility fertilisers and P-retentive soil amendments, produces reductions in P-loss from present-day levels. Even if implementation of all BMPs is combined, watershed P-losses are still projected to increase from the present level of 140tpa to approximately 200 tpa over the next 100 years. This has significant implications for both future land use and subsequent water quality in the watershed as well as questioning the wisdom and perceptions of efficacy of past and future BMP implementation strategies.