Linking agricultural fine sediment pressure and impacts on aquatic ecology for informing catchment management across England and Wales

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Introduction: Although fine sediment represents an essential component of fluvial habitats, excessive inputs to river systems can degrade water quality and ecological status. Improved management of the fine sediment problem requires revised targets for compliance assessment and tools for guiding management decisions at catchment scale to help close the estimated gap. In view of these requirements, a recent science project has reviewed sediment targets used internationally for compliance assessment [1] and constructed a national scale framework for supporting targeted sediment management interventions across England and Wales. This work was driven, in part, by the repeal of the EU Freshwater Fish Directive and its guideline annual mean suspended sediment concentration of 25 mg L^{-1}, which left Member States needing to decide how to assess the sediment gap and guide catchment management in the second round of River Basin Management Planning.

Methods: The project (a) reviewed the current evidence on the impacts of fine sediment on aquatic ecology (macroinvertebrates, fish, macrophytes and diatoms [2,3,4,5]) with a view to identifying critical gaps; (b) established a new predictive index combining the risk of sediment pressure from agriculture and in-stream sediment retention; (c) reviewed palaeolimnological evidence for estimating 'background' sediment pressures on rivers across England and Wales [6,7], (d) improved the existing evidence base on the ecological impacts of fine sediment by undertaking targeted new data collection and experimental work on the impacts on fish and macroinvertebrates, and (e) developed a novel national scale modelling framework coupling prediction of agricultural sediment pressure under different scenarios (e.g. structural land cover evolution, changing uptake of agricultural sediment mitigation measures) with biological endpoints for fish and macroinvertebrates, to be used to help inform river catchment sediment management. The new national modelling toolkit is called *ASPIRE*; *A*gricultural *S*ediment *P*ressures and *I*mpacts on *R*iverine *E*cology. The *ASPIRE* sediment pressure module provides data for all river catchments across England and Wales (represented by 3380 amalgamated WFD waterbodies) and includes 18 on-farm sediment mitigation methods. The time series of sediment pressure (baseline with no prior implementation, or with targeted (spatially) or optimised (using cost-effectiveness) implementation of single or multiple on-farm measures) is input to the channel routing model and the results are, in turn, coupled to the Sediment Intrusion and Dissolved Oxygen (SIDO-UK) model for those core catchments for which this end point is currently calibrated to allow the simulation of sediment stress and its mitigation on the emergence of Atlantic salmon and Brown trout. The sediment pressure data (without and with on-farm mitigation methods) available for all rivers across England and Wales can be used with a new macroinvertebrate biotic index to estimate the potential benefits of agricultural sediment mitigation for this alternative biological end point. For both biological endpoints, the 'background' sediment pressure is taken into account during estimation of any gap and the technically feasible potential for its closure with on-farm management scenarios, since no mitigation strategy should seek to reduce this semi-natural proportion of sediment loss to riverine systems.

References: [1] Collins et al. (2011) *Hydrol Proc* **25**:2112-2129; [2] Jones et al. (2012) *River Res Applic* **28**: 1055-1071; [3] Kemp et al. (2011) *Hydrol Proc* **25**:1800-1821; [4] Jones et al. (2012) *River Res Applic* **28**: `1006-1018; [5] Jones et al. (2014) *Hydrol Proc* **28**: 1226-1237; [6] Foster et al. (2011) *J. Paleolim* **45**: 287-306; [7] Collins et al. (2012) IAHS Publ. No. **356**: 125-131; [8] Collins et al. (2012) Extending the evidence base on the ecological impacts of fine sediment and developing a framework for targeting mitigation of agricultural sediment losses. Final report to Defra, Defra project WQ0128.