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▶ **To cite this version:**

Marion Le Gall, Olivier Evrard, Anthony Foucher, J. Patrick Laceby, Salvador-Blanes Sébastien, et al.. Measuring fallout radionuclides to constrain the origin and the dynamics of suspended sediment in an agricultural drained catchment (Loire River basin, France). EGU General Assembly 2015, Apr 2015, Vienne, Austria. pp.EGU2015-5621-1. cea-02648081

HAL Id: cea-02648081
https://cea.hal.science/cea-02648081

Submitted on 29 May 2020

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Geophysical Research Abstracts
Vol. 17, EGU2015-5621-1, 2015
EGU General Assembly 2015
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Measuring fallout radionuclides to constrain the origin and the dynamics of suspended sediment in an agricultural drained catchment (Loire River basin, France)

Marion Le Gall (1), Olivier Evrard (1), Anthony Foucher (2), J. Patrick Laceby (1), Sébastien Salvador-Blanes (2), Irène Lefèvre (1), Olivier Cerdan (3), and Sophie Ayrault (1)

(1) Laboratoire des Sciences du Climat et de l'Environnement, (LSCE), UMR 8212 (CEA/CNRS/UVSQ) – Bâtiment 12, Avenue de la Terrasse, F-91198, Gif-sur-Yvette, France, (2) Laboratoire GéoHydrosystèmes Continentaux (GéHCO), E.A 6293, Université F. Rabelais de Tours, Faculté des Sciences et Techniques, Parc de Grandmont, 37200 Tours, France, (3) Département Risques et Prévention, Bureau de Recherches Géologiques et Minières (BRGM), 3 avenue Claude Guillemin, 45060 Orléans, France

Soil erosion reaches problematic levels in agricultural areas of Northwestern Europe where tile drains may accelerate sediment transfer to rivers. This supply of large quantities of fine sediment to the river network leads to the degradation of water quality by increasing water turbidity, filling reservoirs and transporting contaminants.

Agricultural patterns and landscapes features have been largely modified by human activities during the last century. To investigate erosion and sediment transport in lowland drained areas, a small catchment, the Louroux (24 km^2), located in the French Loire River basin was selected. In this catchment, channels have been reshaped and more than 220 tile drains outlets have been installed after World War II. As a result, soil erosion and sediment fluxes strongly increased. Sediment supply needs to be better understood by quantifying the contribution of sources and the residence times of particles within the catchment.

To this end, a network of river monitoring stations was installed, and fallout radionuclides (Cs-137, excess Pb-210 and Be-7) were measured in rainwater (n=3), drain tile outlets (n=4), suspended sediment (n=15), soil surface (n=30) and channel bank samples (n=15) between January 2013 and February 2014. Cs-137 concentrations were used to quantify the contribution of surface vs. subsurface sources of sediment. Results show a clear dominance of particles originating from surface sources (99 $\pm$ 1%). Be-7 and excess Pb-210 concentrations and calculation of Be-7/excess Pb-210 ratios in rainfall and suspended sediment samples were used to estimate percentages of recently eroded sediment in rivers. The first erosive winter storm mainly exported sediment depleted in Be-7 that likely deposited on the riverbed during the previous months. Then, during the subsequent floods, sediment was directly eroded and exported to the catchment outlet. Our results show the added value of combining spatial and temporal tracers to characterize and quantify sources of sediment and particle transport processes within an agricultural catchment.