CENTA Project Proposal Form – 2024 entry

Project Title	Why the grass is greener in Herefordshire floodplain meadows? Impact of herbicides on plant biodiversity, conservation and restoration of floodplain meadows.
University (where student will register)	The Open University
Which institution will the student be based at?	As above
Theme (Max. 2 selections)	Climate & Environmental Sustainability ☒ Organisms & Ecosystems ☒ Dynamic Earth ☐
Key words	Floodplain meadows, biodiversity, meadow restoration, agricultural herbicides
Supervisory team (including institution & email address	PI: Dr Irina Tatarenko (irina.tatarenko@open.ac.uk) Co-I: Dr David Gowing
Is the PhD suitable for part time study?	Yes ☒ This is a requirement of NERC

Project Highlights:

- Effect of herbicides on biodiversity of floodplain meadows situated in the same river valley as arable fields, is largely unknown
- Herbicides can have long lasting effect being deposited in the river sediments and re-distributed across floodplain landscape with floods, preventing meadow restoration.
- Lack of plant species propagules in the landscape can be caused by earlier herbicide applications.

Overview:

Selective herbicides have been widely used in agriculture to control weeds both in arable crops and in improved meadows and pastures. Herbicides destroy Dicotyledons while grasses have advantage to grow. This effect appeared to be long lasting. Even recorded half-life of herbicides appeared not very long, e.g., 2,4-D breaks down in soil in 1-14 days, however, some forms had a much longer half-life in aquatic sediment of 186 days (Gervais et al, 2008). Another very widely used herbicide Atrazine has a half-life of around 578 days in anoxic conditions (Hanson et al, 2020). However, the fields, which didn't receive herbicides for 5 and more years remain mostly grassy. Some meadows, according to their owners' records, never received herbicides, however their swards contain grasses only. Attempts to restore species rich plant communities in such meadows give poor results.

Herbicides often contaminate non-target sites (Schreiber et al, 2018). The herbicides were detected remaining in ground water, river sediments and anoxic soils for much longer than in the dry soils. Flood water going across river valley can re-distribute herbicides from the river sediments as much as from the neighbouring arable fields, where herbicides are applied annually. While effect of nutrients brought into the species-rich floodplain meadows with flood sediments, is well understood (Rothero et al, 2016), there is little knowledge on distribution of herbicides within a floodplain system.

The project aims to measure effect of herbicides on ancient floodplain meadows and on restoration meadows.

Figure 1: Floodplain meadow restoration in the river Wye valley.

The photo shows a meadow situated in the River Wye floodplain with a village at the distance. No brightly colored flowers can be seen in vegetation, which is dominated by grasses. The river bank exposes Old Red Sandstone type soils underlying the meadow.

Methodology:

Suggested study site is located in the River Wye floodplain. Local Wildlife Trust and Meadow Conservation group are interested in the study and will provide support in arranging access permissions to the particular fields.

Fieldwork will include sample collection from the soil and from the river sediments. Experimental methods to evaluate herbicides behaviour in soil will be selected after identification of soil types in the River Wye floodplain. Chemical tests will be carried out at the Lab.

Another part of fieldwork will include botanical surveys of selected fields in June-July, plant species and their abundance will be recorded in 1x1 m plots randomly located across the field.

Some areas of the meadows will be identified for meadow restoration experiments. Forbs seeds will be sown to test effects of soil on young seedlings. Experimental plots will be revisited through the year to monitor germination rates.

Training and skills:

Students will be awarded CENTA2 Training Credits (CTCs) for participation in CENTA2-provided and 'free choice' external training. One CTC equates to 1⁄2 day session and students must accrue 100 CTCs across the three years of their PhD.

Student will learn a range of environment survey skills: plant ID, botanical survey, soil survey, and water survey techniques along with working with large datasets.

Partners and collaboration (including CASE):

Name of L1/L2 Partner (where applicable)	River Trust, CEH

Further information on partners and collaboration (including CASE):

The Rivers Trust are a potential project partner.

Possible timeline:

Year 1: Literature review. Planning experimental design. Fieldwork: collection of soil, sediments and water samples to analyse presence/concentration of herbicides. Botanical surveys of the meadows. Field experiments on meadow restoration.

Year 2: Re-survey of the field experimental plots. Data analysis.

Year 3: Re-survey of the field experimental plots. Data analysis, thesis preparation.

Further reading:

Boivin, A., Amellal, S., Schiavon, M., van Genuchten, M.T. (2005) 2,4-dichlorophenoxyacetic acid (2,4-D) sorption and degradation dynamics in three agricultural soils. *Environ. Pollut.* 138, pp. 92-99.

Gervais, J., Luukinen, B., Buhl, K., Stone, D. (2008) '2,4-D Technical Fact Sheet' National Pesticide Information Center, Oregon State University Extension Services. Available at: http://npic.orst.edu/factsheets/archive/2,4-DTech.html (Accessed: 11 September 2023).

Hanson, W., Strid, A., Gervais, J., Cross, A., Jenkins, J. (2020) 'Atrazine Fact Sheet' National Pesticide Information Center, Oregon State University Extension Services. Available at: http://npic.orst.edu/factsheets/atrazine.html#env (Accessed:10 September 2023).

McPherson, A. K.; Moreland, R. S.; Atkins, J. B. (2003) *Occurrence and Distribution of Nutrients, Suspended Sediment, and Pesticides in the Mobile River Basin, Alabama, Georgia, Mississippi, and Tennessee, 1999-2001*; Water-Resources Investigations Report 03- 4203, U.S. Geological Survey: Montgomery, AL, pp 1-2, 44, 57.

Mueller, T.C., Senseman, S.A. (2015) Methods Related to Herbicide Dissipation or Degradation under Field or Laboratory Conditions. Weed Science 2015 Special Issue, pp. 133–139.

Ney, R.E. (1995) *Fate and Transport of Organic Chemicals in the Environment*, 2nd ed.; Government Institutes, Inc.: Rockville, MD.

Pesticides in Surface and Groundwater of the United States: Summary of Results of the National Water Quality Assessment Program (NAWQA); U.S. Geological Survey: Reston, VA, 1998.

Rothero, E., Lake, S. and Gowing, D. (eds) (2016) '*Floodplain Meadows – Beauty and Utility'. A Technical Handbook*. Milton Keynes, Floodplain Meadows Partnership.

Schreiber, F., Scherner, A., Andres, A., Concenço, G., Ceolin, W.C., Martins, M.B. (2018) Experimental methods to evaluate herbicides behaviour in soil. Revista Brasileira de Herbicidas, 17 (1), pp.71-85, DOI: https://doi.org/10.7824/rbh.v17i1.540

Wilson, R. D.; Geronimo, J.; Armbruster, J. A. (1997) 2,4-D Dissipation in Field Soils After Applications of 2,4-Dimethylamine Salt and 2,4-D Ethylhexyl Ester. *Environ. Toxicol. Chem.* 16 (6), pp. 1239-1246.

Further details:

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