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Klaar, MJ, Carver, S [orcid.org/0000-0002-4202-8234](https://orcid.org/0000-0002-4202-8234) and Kay, P [orcid.org/0000-0002-9997-7860](https://orcid.org/0000-0002-9997-7860) (Cover date: September/October 2020) Land management in a post-Brexit UK: An opportunity for integrated catchment management to deliver multiple benefits? *Wiley Interdisciplinary Reviews: Water*, 7 (5). e1479. ISSN 2049-1948

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## Article Title: Land management in a post-Brexit UK: An opportunity for integrated catchment management to deliver multiple benefits?

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### 2 Authors:

|   |
|---|
| <b>First author</b><br>Megan J Klaar*, ORCID: 0000-0001-8920-4226, University of Leeds, Leeds, LS2 9JT, water@leeds, <a href="mailto:m.j.klaar@leeds.ac.uk">m.j.klaar@leeds.ac.uk</a> , no conflict of interest                         |
| <b>Second author</b><br>Stephen Carver, ORCID: 0000-0002-4202-8234, School of Geography, University of Leeds, Leeds, LS2 9JT, water@leeds, <a href="mailto:s.j.carver@leeds.ac.uk">s.j.carver@leeds.ac.uk</a> , no conflict of interest |
| <b>Third author</b><br>Paul Kay, ORCID: 0000-0002-9997-7860, School of Geography, University of Leeds, Leeds, LS2 9JT, water@leeds, <a href="mailto:p.kay@leeds.ac.uk">p.kay@leeds.ac.uk</a> , no conflict of interest                  |

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### 4 Abstract

5 Recent environmental policy bills outlined by the UK government in the wake of Brexit highlight an  
6 intention by the government to take a more holistic approach to land and water management.  
7 While previous legislation has taken a siloed approach to landscape management, often focusing on  
8 point source pollutions, the Agriculture and Environment Bills present the opportunity for effective  
9 protection of the environment whilst providing wider environmental benefits such as flood risk,  
10 biodiversity and cultural services. We outline how and why previous EU legislation has failed to  
11 deliver the intended environmental improvements relating to agricultural land management. We  
12 highlight how the adoption of integrated catchment management and proposed 'payment-for-  
13 outcome' schemes at a large scale could be used to push the UK into the forefront of sustainable  
14 farming, land management and championing environmental benefits to society.

### 15 Graphical/Visual Abstract and Caption

16 Caption: Beaver activity at the Cropton Forest beaver reintroduction site, North Yorkshire. The  
17 beavers have dammed the river, forcing flow out of the bank and onto the woodland floor, creating  
18 a large wetland which reduces local flood risk and increases biodiversity.

### 19 Introduction

20 Despite the schism in public opinion regarding the UK leaving the European Union, this major event  
21 in British politics provides a unique opportunity to overhaul environmental legislation and land  
22 management across the country. Previously, EU legislation such as the Water Framework Directive  
23 (WFD), Environmental Quality Standards Directive and Habitats Directive acted as major drivers in  
24 the improvement and transformation of the environment. This legislation, and the WFD in  
25 particular, introduced novel concepts such as the 'precautionary principle' and 'no-deterioration' in  
26 addition to the use of ecological parameters to assess the health of waterbodies. This has led to a  
27 fundamental shift in management objectives from simple pollution control measures to a more  
28 holistic, ecosystem wide approach (Hering et al., 2010). In reality, however, the legislation largely  
29 failed to deliver the intended improvements to waterbodies. This was predominantly due to  
30 member states and regulators focusing on improving element classifications, rather than the  
31 adoption of a 'systems-based' approach which applies a pressure-impacts analysis to identify the  
32 underlying reasons for waterbodies' failure to meet good ecological status in the first place  
33 (Giakoumis & Voulvoulis, 2019). Furthermore, previous siloed legislation (c.f.- terrestrial and aquatic  
34 based targets and assessment) failed to address the linkages between ecosystems and external costs  
35 of poor management in one system to the stakeholders in another.

36 In 2012, only 27% of waterbodies in England and Wales were classified to be in good ecological  
37 status, and the Environment Agency estimated that 33% of known failures were due to agricultural  
38 land management (McGonigle et al, 2012). Agriculture-related diffuse pollution was shown to  
39 contribute 55% of nitrates, 20% of phosphorous, and 75% of sediments to waterbodies (McGonigle  
40 et al., 2012), representing a significant stressor to the environment. It has been estimated that the  
41 value of negative externalities caused by agricultural water pollution is between £750m to £1,300m  
42 a year (Defra 2016). Current regulation does little to incentivise good agricultural practices which  
43 can limit or even reduce diffuse water pollution. Contrary to the aim of agricultural stewardship  
44 schemes to do this, there is little evidence to suggest that they work at the catchment scale (Kay et  
45 al., 2012). The focus has thus been on relatively easy technological fixes with an emphasis on point  
46 sources, mainly those linked to the water industry, leading to significant costs being passed on to  
47 water users, including the water companies themselves and other businesses (Defra, 2016).  
48 Moreover, most actions on diffuse pollution have tended to focus on advice and voluntary schemes,  
49 resulting in less than 20% of programmes of measures designed to address diffuse pollution having  
50 actually been completed (Carvalho et al., 2019). This suggests that competent authorities (including  
51 governments) need to think more carefully about how to address difficult problems such as diffuse  
52 pollution and show greater commitment to actually dealing with them rather than continuing with a  
53 'business as usual' model (Jager et al., 2016).

54 The introduction of new environmental legislation in response to Brexit, including the Environment  
55 and Agriculture Bills (see Box 1) present the UK with the opportunity to improve upon existing EU  
56 environmental protection (Howarth, 2017) and derive integrated policies which work together to  
57 promote sustainable land and water management. This paper outlines how and why EU legislation  
58 has failed to deliver holistic environmental management in the context of agricultural land  
59 management and suggests how future legislation can deliver significant improvements to the  
60 environment whilst providing multiple benefits in terms of environmental protection, flood risk and  
61 food production.

62 **Integrated catchment management and payment-for-outcomes**

63 Recently, environmental managers and conservation groups have expressed a desire for  
64 environmental policy and funding to support the delivery of multiple environmental objectives, in  
65 addition to the removal and/or alignment of competing targets and legislation. The adoption of an  
66 integrated catchment management (ICM) approach, which combines both land and water  
67 management has the potential to allow the reformation of agriculture and land management  
68 practices in tandem with restoring nature, ensuring clean and plentiful water and reducing risk from  
69 future climate change. ICM takes into account the often competing ecological, social and economic  
70 values associated with catchment management (Jakeman & Letcher, 2003) by considering the role of  
71 ecosystem quality and functioning in providing and supporting those resources or services that are  
72 of value to society. The inclusion of a 'public money for public goods' clause within the Agriculture  
73 Bill signals the government's intention to ensure that publicly funded environmental management  
74 meets multiple objectives (e.g. natural flood management- see Box 2) and recognises the  
75 importance of the services provided by naturally functioning ecosystems. This is a move away from  
76 previous legislation and government-funded land management payments which awarded money  
77 based on the amount of livestock (headage payments), the area of land farmed and the  
78 implementation of measures of uncertain environmental benefit. Thus, most funds have been  
79 claimed by only a small percentage of land managers and, in some cases, promoted several  
80 agricultural practices such as greenhouse gas and ammonia emissions and soil erosion which actually  
81 caused harm to the environment (Defra, 2018).

82 The benefits human populations derive, directly or indirectly, for ecosystem functions are termed  
83 ecosystem services or ecosystem benefits (Constanza et al., 1997). These services can be divided  
84 into four categories; supporting, provisioning, regulating and cultural services (Millennium  
85 Ecosystem Assessment, 2005). Ecosystem services relating to catchment management include soil  
86 health, nutrient cycling and habitat provision (supporting services), clean water and healthy fisheries  
87 (provisioning), carbon sequestration, sediment and flood management (regulating services) and  
88 recreation (cultural services). The provision of these services are reliant on the ecological integrity  
89 of the ecosystems from which they derive. For instance, work by Grizzetti et al. (2019) has shown a  
90 positive correlation between the ecological status of water bodies and the provision of ecosystem  
91 services (water purification, erosion prevention, coastal protection and recreation). In contrast,  
92 provisioning services (water use and abstraction) had a negative correlation with waterbody  
93 condition, indicating such services acted as a pressure to the ecosystem. Pressure from provisioning  
94 services, agriculture and rural land management have been shown to account for 58% of  
95 waterbodies not reaching good ecological status (Defra, 2016). Targeted action within these  
96 industries is therefore a priority for improving ecosystem condition and continued provision of  
97 ecosystem services.

#### 98 **The future of agricultural land management?**

99 There is a growing body of evidence that shows how agricultural stewardship can be used to reduce  
100 water pollution. For example, sustainable agricultural practices including soil and nutrient  
101 management, cover crops and rotational grazing have all been shown to mitigate environmental  
102 impacts (Horrigan et al., 2002), although most of this research has been undertaken in small areas  
103 and we have very little idea as to the likely impact at the catchment scale (Kay et al., 2009, 2012).  
104 Monitoring data, such as that collected for the WFD, suggest that current stewardship schemes will  
105 not have the desired effects and that more substantial changes will be needed. This might be spread  
106 over entire catchments or focus on specific areas that generate the most pollution. Attempts to

107 provide catchment scale data have, so far, provided limited information due to projects not actually  
108 changing land use at the required scale.

109 To date, the UK have been unwilling to make changes on a scale that are likely to bring about the  
110 effects we would like to see. One approach that potentially encapsulates the multiple objectives of  
111 integrated land and water management is rewilding, and while as an approach it is still in its infancy,  
112 it has attracted a great deal of attention in the public imagination and across the conservation  
113 sector. Multiple definitions abound, but rewilding can be defined as “a conservation approach aimed  
114 at restoring and protecting natural processes, providing connectivity between areas, and protecting  
115 or reintroducing species, which may or may not include large herbivores and/or predators” (see Box  
116 3).

117 While the term may be relatively new, rewilding is slowly creeping into government policy. The  
118 Lawton Report (2010) rebadged the 3Cs model as “Bigger, Better, More Joined” (but without the  
119 large carnivores), while both the Glover Report (2019) on National Parks and AONBs and the 25 Year  
120 Environment Plan mention opportunities for rewilding citing the Knepp Wildland Project in West  
121 Sussex. Despite this and other example projects around the country, rewilding hasn’t been applied at  
122 a large scale and so there is little evidence, as with agricultural stewardship, that any associated  
123 benefits will scale up. What ought to be clear, however, is that wilder landscapes should have less  
124 environmental degradation associated with over grazing, burning, agricultural intensification (and  
125 associated soil compaction, erosion, and diffuse pollution from pesticide, herbicide and fertiliser  
126 applications), etc. and will result in cleaner rivers, greater biodiversity and will likely deliver  
127 downstream benefits in terms of more natural flow regimes through NFM and predominance of  
128 other natural processes. At the same time there could be perceived, if not real, disbenefits in terms  
129 of loss of certain species that have adapted to occupy niche habitats within human modified  
130 landscapes. However, the greatest barrier to rewilding as an approach to ICM will be from land-  
131 owning and farming interests who see it as a threat to land-based economy and livelihoods, a recent  
132 example being the push-back seen from local sheep-dominated farming communities targeted in  
133 Rewilding Britain’s “Summit to Sea” project in mid-Wales which forced a re-think and a re-launch  
134 without Rewilding Britain’s involvement. Here, it is perhaps the term itself that creates the problem,  
135 with rewilding seen as “toxic” in some quarters due to associations with rural depopulation, land  
136 abandonment and the return of large carnivores. Whether real or imagined, such threats need to be  
137 addressed through enlightened top-down policy and fiscal mechanisms that will allow and  
138 encourage bottom-up buy-in amongst rural communities supported by meaningful stakeholder  
139 engagement and public participation in decision making. It is well known that, despite the concept  
140 of ICM having existed for some years now and various policies promoting it, ICM is not happening to  
141 the extent it needs to and catchment management is still driven in a top-down, siloed way. This  
142 results in the uneven involvement of different groups in land and water management and poor  
143 planning of the maintenance of measures following implementation (Rollason et al., 2018). This is  
144 where the government’s 25 year plan could have been much more ambitious and forward thinking,  
145 especially in regard to delivering environmental benefits with nature based ‘beyond food in a world  
146 threatened by climate change, disease and extinction events, bringing the wider population on  
147 board with well-funded ‘public money for public goods’ models.

148 **Box 1: Environment and Agriculture Bills**

149 The UK government's proposed Environment Bill will replace existing EU legislation and oversight  
150 and set out the environmental principles and governance relating to air, wildlife, water and waste.  
151 The introduction of legally-binding targets relating to air quality, nature and biodiversity, water,  
152 waste and resources will form the core of proposed improvements introduced by the Bill. In tandem  
153 with the Environment Bill, the proposed Agricultural Bill will replace environmental legislation and  
154 funding relating to the EU's Common Agricultural Policy. The Bill has set out a scheme whereby  
155 farmers and land owners will be paid for providing 'public goods'. The proposed Environmental Land  
156 Management (ELM) scheme will pay land managers for improvements in soil health, air and water  
157 quality, biodiversity, improving public access to the countryside and carbon reduction. In turn, this  
158 forms the key mechanism for achieving the outcomes set out in the government's 25 year  
159 environment plan (Defra, 2018). Recent consultation relating to the creation of a tiered payment  
160 scheme (Defra, 2020) suggests that sustainable agriculture will be a prominent feature within the  
161 new ELM approach.

### 162 ***Box 2: Natural Flood Management***

163 One example of the use of catchment management to deliver multiple benefits is the concept of  
164 natural flood management (NFM). This is the promotion or creation of catchment features which  
165 slow, store or attenuate rainfall runoff or river flow in a way which reduces flood risk. A number of  
166 land management practices can be used to increase flood attenuation, by either restoring or  
167 promoting beneficial processes or reducing unfavourable features or management which increase  
168 rainfall runoff or stream discharge (Dadson et al., 2017). Lane (2017) summarised a number of land  
169 management factors, such as tillage practice, livestock density and field drainage which can  
170 contribute to increased flood risk (and impaired water quality). Conversely, the use of buffer strips,  
171 tree planting and pond and wetland creation have been shown to reduce flow conveyance on land  
172 and within rivers, resulting in reduced river flow, and hence, flood risk to adjacent areas. This  
173 obvious link between flood risk, land management and potential biodiversity benefits illustrate how  
174 NFM and ICM can be used to deliver multiple environmental benefits and public goods which land  
175 managers can implement at the farm level to deliver catchment-wide benefits.

### 176 ***Box 3: Defining rewilding***

177 Rewilding has been called a 'plastic term' (Jørgensen, 2015) because, rather confusingly, it has been  
178 defined in multiple ways and used to describe multiple management interventions across a range of  
179 scales and activities. Depending on the level of human intervention and management, there are two  
180 basic approaches: Passive or Active. Passive rewilding is the spontaneous colonisation of abandoned  
181 land by wild or native species in the absence of direct human management or influence from  
182 domestic plants or animals and resulting in/from the return of natural processes. Active rewilding  
183 involves some level of human intervention and/or management to return wild or native species and  
184 restore natural habitats and processes (Carver, 2019). Rewilding's ecological roots go back to the  
185 early 1990s when landscape ecologists and activists started to think about how to reconnect wild  
186 spaces at a continental scale to give wildlife the freedom to move through human dominated  
187 landscapes, enhancing ecological resilience to climate change. This gave rise to the 3Cs model  
188 (Cores, Corridors and Carnivores) built around three basic principles: protect and enlarge core wild  
189 areas (natural habitats), maintain and enhance ecological connectivity between cores using linear  
190 and landscape corridors, and ensure freedom of movement of keystone species (including large

191 carnivores) to improve and restore trophic interactions at all levels of the food chain (Soule and  
192 Noss, 1998).

193

## 194 **Conclusion**

195 Even though agricultural subsidies have been decoupled from production for fifteen years and  
196 farmers are now paid to implement environmental protection measures, little has really changed on  
197 the ground. The area over which measures have been implemented is relatively small and many of  
198 those things that have been done are unlikely to benefit the water environment. There is a need for  
199 greater honesty about what we really want and more of a balance between economic development  
200 and environmental protection if environmental legislation is to succeed. In the context of  
201 agriculture, we need to decide if we really do want a healthy environment or we would prefer an  
202 abundance of cheap food, because the two are never likely to co-exist.

203 The UK government's Environment Bill represents a strong statement that a step change is coming in  
204 the way that we protect and enhance the environment as we leave the EU. It is proposed that this  
205 Bill could be world leading and we foresee that it could easily be a model for other countries to  
206 follow, in much the same way as the catchment management work of the National Rivers Authority  
207 and then Environment Agency in the 1990's had a huge influence on the WFD. The Bill does not,  
208 however, set defined targets or make it clear that the proposed Office of Environmental Protection  
209 will have the power to enforce environmental protection on agricultural land in a genuinely effective  
210 fashion. Similarly, the Agricultural Bill sets out highly commendable aims which would ensure that  
211 farming is undertaken in an efficient and profitable way whilst protecting and enhancing the  
212 environment. At present, however, a lack of clarity exists as to how and when this bill will be  
213 implemented and how it will sit alongside the linked Environment Bill. These pieces of legislation, if  
214 implemented effectively, would move the UK beyond the EU in terms of sustainable farming but  
215 words need to be put into action and it remains to be seen if the UK government can do this.  
216 Returning to the WFD, it could be argued that one of the reasons that this has failed to live up to  
217 expectation in England and Wales is that the Environment Agency was not able to provide sufficient  
218 regulatory threat to effect a meaningful change to farmers' behaviour on the ground. This situation  
219 will need to be remedied.

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