A note on ecosystem services provided by on-farm reservoirs in UK

1 Background

The government's message is 'public payment for public goods'. Within this thinking we believe that aspects of irrigated farming have the potential to provide significant and beneficial eco-system services for which public payment would be justified.

This note looks specifically at eco-system services provided by on-farm water storage reservoirs.

The following is taken from UK National Ecosystem Assessment (UKNEA)[i] in June 2014. Chapter 22, pp1088-89. This chapter focuses on "Economic values from Ecosystems" and provides background thinking about water scarcity and the importance of reservoir storage in adapting to a changing climate with the prospects of increasing frequency and extended droughts.

This report focused on water providing an eco-system service to the water industry, agriculture, and the environment. It did not offer a value to the services but rather focused on the relative costs of investing in each, agriculture being the costliest. There is no mention about the ecosystem services that reservoirs can in turn provide to other water users or their value.

Freshwater ecosystems regulate the provision of water for human use. Water is vital to life and hence it is not meaningful to try and put finite estimates on its total value. Instead economic analysis focuses upon feasible marginal changes in supplies.

There is concern about how development pressures, exacerbated by climate change, could affect the capacity of freshwater ecosystems to provide sufficient water for people. Reduction in the amount of water available for abstraction could result in i) the loss of value from some water uses and/or ii) extra costs of providing water from alternative sources or adopting water-saving technologies.

'Unsecured' sources, such as for irrigation, are likely to be most vulnerable to variations in supply. This may justify additional expense of securing water by, for example, winter storage reservoirs. High-value uses of water, such as those associated with public water supply, clearly justify relatively high investment to improve water security.

Measures to secure water for nature conservation may be justified, especially in protected areas. Failure to restrict abstraction in the face of declining freshwater resources would compromise non-market ecosystems services. Increased investments may be required in future in order to avoid pressures on freshwater habitats associated with changes in climate and/or demographics.

Long-term, the economic value of freshwater provisioning will reflect the costs of achieving an appropriate balance of water demand and supply. On the demand side, the Environment Agency reports that measures, such as compulsory metering to reduce household water consumption by a target of 15% (from 150 to 130 litres/day) could cost between £1.40 and £1.6/m^3 (EA 2009)[ii]. By comparison, options to enhance freshwater supply by developing surface and groundwater resources appear more expensive (£1–£5/m^3), reservoirs (£3–£10/m^3) and desalinisation (£4–£8/m^3). A detailed review of water supply options (Mott MacDonald 1998)[iii], however, estimated incremental average costs for reservoir development ranging between £0.21/m^3 and £1.36/m^3 of water delivered in a given year in 2010 prices, assuming a 50% annual utilisation rate.

2 Benefits of farm reservoirs vs direct abstraction

The following is taken from Defra project in 2013[iv], which assessed the potential for on-farm water storage. As part of this study the investigators examined in outline the positive and negative effects of on-farm storage vs direct abstraction for irrigation from rivers and groundwater based on an ecosystem services framework (UK NEA,2011) which includes provisioning, regulating, and cultural services (Table 1).

In general, there are major provisioning benefits from storing high river flows (in winter and summer). Storage can enhance and secure agricultural production and in some localities that are water deficient, it can reduce pressures on summer flows, thus providing more summer water for other users.

There are also regulating benefits which can improve summer water quality (by maintaining higher summer river flows) and attenuate flooding (both in summer and winter) and reduce soil erosion. There is also potential for cultural services in some localities, but these may not necessarily be compatible with farm irrigation practices.

- Table 1 Comparison of on-farm storage with direct abstraction

Category	**Comparing on-farm reservoirs with direct abstraction**	
	Potential benefits	**Potential costs**
Provisioning services		
Agricultural food crops	More secure agricultural food production from irrigated systems Reduced exposure to climate change risk Maintenance of agricultural production systems and capacity Potential fish farming	Opportunity cost of land loss for reservoir. Potential retention of high irrigation costs rather than relocation to rainfed cropping elsewhere, especially under conditions of climate change and rising energy prices.
Fresh water supply	Reduced summer abstractions increase fresh water resources both quantity and quality Maintained summer groundwater levels and storage Reduced pressure on freshwater resources elsewhere	Lined reservoirs prevent water infiltrating to recharge aquifers Increased water 'losses' -- evaporation and leakage Depleted winter freshwater resources
Regulating services		
Water quality	Reduced summer abstraction maintains summer flows, water temperature and oxygen levels, reduced sediment and pollution loads and toxicity	Decline in winter flows and groundwater levels, increasing toxicity risks Raised nutrient levels in stored water, algae growth and anoxic conditions affecting quality of water bodies
Climate regulation	Potential cooling and humidity effects Displacement of rainfed agriculture elsewhere with lower water and energy/carbon footprint	Increased energy consumption and carbon emissions due to extra pumping. Modifications to the albedo reflectiveness effect of surfaces with implications for reflective radiation and temperatures, possibly affected by lining material.
Disease and pests regulation, pollination	Habitat for beneficial insects and pollinators	Refuge and habitat for pest and diseases associated with insects (mosquitos), and animals causing crop losses
Hydraulic erosion and flood regulation	Attenuate peak flows, maintain minimum flows, provide flood storage, and hence flood risk	Reservoir failure may generate a flood risk. Entrapment and concentration of substances (nutrients, salts, metals, pesticides)
Cultural services		
Landscape, heritage, recreation, amenity, biodiversity	Opportunities for water amenities and recreation, especially angling and some water sports (depending on scale)	Incompatibility of uses, risk to human health and safety, target for vandalism, loss of archaeological assets

	Increased diversity of landscape, habitats and species for enjoyment on and adjacent to reservoir Water space amenity in farmed areas, possibly linked to farm walks Protection of fish and wildlife habitats otherwise affected by low summer flows	Physical hazards of drowning (humans and animals)
Supporting services		
Soil formation, nutrient cycling, water cycling, photosynthesis	Supporting services influence provisioning, regulating, and cultural services, with variable effects according to local conditions Soil formation negatively affected by impounding water and increased total abstraction may reduce soil water elsewhere and associated formation of organic soils. May help to secure water supplies in dry periods thereby reducing soil loss, especially peat wastage. Modified water cycling could interact with nutrient cycling by maintaining summer flows that also help moderate nutrient loads and anoxic and toxicity risk in freshwaters, although the quality of stored water could deteriorate Secured water will support photosynthesis for crop production and freshwater vegetation. Increased levels of vegetation control may be required.	

3 What next...

If there is interest in following up the issues raised in the brief note, it could be reformatted into a statement of:

- context/rationale (why it's important, especially reference to public good issues)
- the key questions to be addressed (eg can (farm?) reservoirs deliver public and private goods simultaneously, are farm reservoirs a suitable case for public support?
- the approach (ecosystems/natural capital- net gain)
- the outputs of the work and
- the implications for policy and practice/decision making (an impact statement).

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[i] UK National Ecosystem Assessment (2014) Chapter 22: Economic values from ecosystems http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx [Accessed 07.12.18]

[ii] Environment Agency (2009) Water for people and the environment: water resources strategy for England and Wales. Environment Agency, Bristol.

[iii] Mott MacDonald (1998) Review of costs to balance water supply and demand. Report No. 48550/WSD/02B, August 1998. Ofwat, Birmingham.

[iv] J Morris, K Weatherhead, J Knox, A Daccache and M Kay (2013) Efficient supply of water for agriculture: Exploring collaborative approaches and use of on-farm storage. Defra funded project FFG1112)