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PROWATER
European Regional Development Fund

Tree planting & wetland restoration for climate adaptation

Results of changes implemented to the 'West & East Devon' site by Westcountry Rivers Trust

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DISCLAIMER

COLOFON

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Tree planting and wetland creation for climate adaptation

On the Clinton Devon Estate in the Otter catchment (East Devon), Westcountry Rivers Trust developed the Interreg 2 Seas PROWATER site 'West & East Devon' to demonstrate how the region can adapt to the consequences of climate change through Ecosystem-based Adaptation.

Westcountry Rivers Trust (WRT) is a registered charity working to care for Westcountry rivers, streams, brooks, estuaries and wetlands. Through science, evidence and experience, our charity preserves, protects and improves the region's freshwater environments for all who depend on them. Our aim is to inspire a long-term love for, and understanding of, this vital natural resource. Our mission is to restore and protect the rivers, lakes, and estuaries of the Westcountry for the benefit of nature, people, and local economies. Our vision is to see people helping our Westcountry rivers flow freely and teem with life, while valuing our most precious of resources, water. WRT have acted as the ethical broker between farmers and the local Water Company for over 10 years, so far only for raw water quality projects. There are another 19 drivers (also impacting water resources/quantity) that could employ catchment solutions, but these are not yet integrated into a single assessment.

By implementing Ecosystem-based Adaptation measures with PROWATER, we want to deliver water resource (water quantity) projects and make our region more resistant to the consequences of climate change (including increasingly frequent drought spells, as well as extreme rainfall events). Ecosystem-based Adaptation (EbA), a Nature-based approach to climate change adaptation, harnesses ecosystem services to increase resilience and reduce the vulnerability of human communities and natural systems to the effects of climate change. These EbA measures can be integrated into adapted agriculture, forestry and environmental management.

This publication summarises EbA measures and results of three sub-sites on the Clinton Devon Estate. These are all parcels of agricultural land that lie within the groundwater catchment of the river Otter. In two sub-sites tree planting was implemented to break through compacted soils and allow more infiltration to groundwater. In one sub-site wetland scrapes and leaky dams were installed to restore a temporary (seasonal) wetland, promoting water retention and slow infiltration to groundwater.

The results are summarised using various steps (chapter 1 to 4) that represent the process for successful planning and implementation of climate change adaptation measures (see Output 1). Presented insights and lessons learnt can help governments (national, provincial and municipal), knowledge institutions, consultancies, managers of nature areas, drinking water companies and landowners in the design of climate change adaptation projects.

Figure 1 - The dot situates the demonstration site for Ecosystem-based Adaptation in the Interreg 2 Seas region.

1 Understanding the catchment

1.1 Geographical & hydrological context

The River Otter rises in the Blackdown Hills, from a Cretaceous Upper Greensand scarp at 275 m above sea level, which forms the eastern edge of the catchment as far south as Sidmouth, on the coast. The western edge is formed by a ridge of Permian Sandstone. Between these two ridges lies an area of Triassic Mercia Mudstone which runs to Ottery St Mary. East and south of Ottery St Mary the geology changes to Otter Sandstone.

Otter Sandstone and Pebble Beds provide regionally important aquifers which are extensively exploited for both public and private water supplies. The catchment is considered to have some of the most vulnerable soils combined with farm practice that creates a compaction-runoff problem. Ecosystem-based Adaptation measures could be implemented within the catchment to reduce the risk of flooding and improve the resilience of the groundwater supply for drinking water.

The Clinton Devon Estate demonstration sites are located in the groundwater dominated area around the village of Colaton Raleigh, in the Otter catchment. There are three sub-sites where PROWATER interventions have been implemented to promote infiltration of water into the soil and the temporary retention of water in the landscape. These three subsites are located on under used agricultural land.

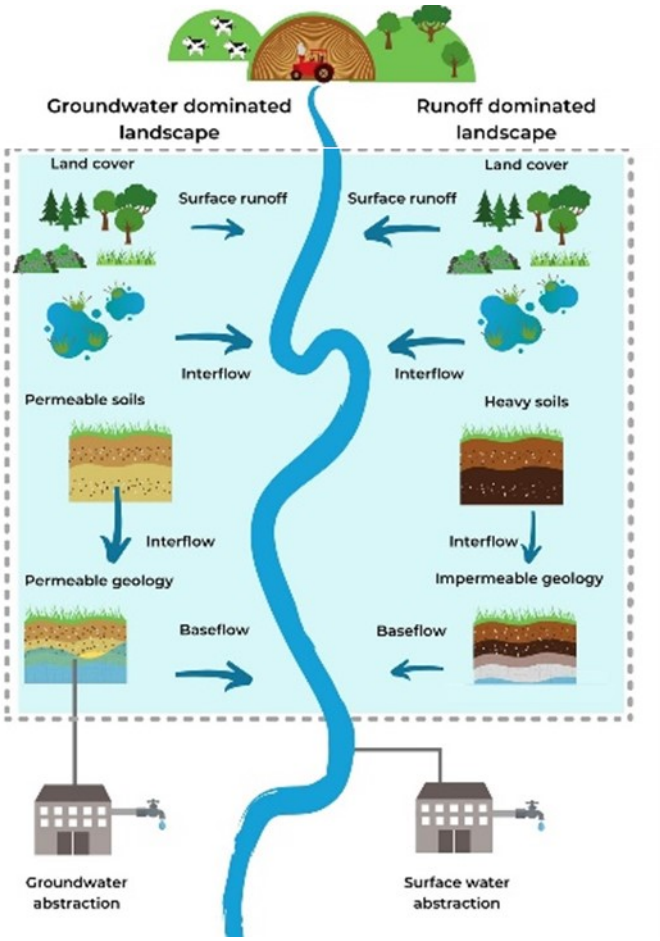


Figure 2 *– The Clinton Devon Estate is located in a groundwater dominated catchment.*

In unmodified or sustainably managed ***groundwater dominated catchments*** *there is little runoff following precipitation as water predominately infiltrates through permeable substrates and moves either laterally or vertically below the surface. However, modification such as surface sealing, soil compaction and land drainage reduce the ability of water to infiltrate and therefore result in greater levels of runoff. Groundwater replenishment depends on the hydrological connectivity to the surface. When connectivity is interrupted by these modifications the resilience of this water supply is reduced.*

In unmodified or sustainably managed ***runoff dominated catchments****, water predominantly moves above the surface but interflow and baseflow are still present. As above, when the landscape is modified, surface runoff dramatically increases and interflow and baseflow are further reduced. This leads to an increase in frequency and severity of low river flows during dry periods and an increased risk of flooding following periods of extreme rainfall.*

1.2 Human context

The Otter is a predominately rural catchment, with generally small, dispersed settlements. The only towns are Honiton, Ottery St Mary and Budleigh Salterton. The northern part of the catchment is characterised by rolling hills with small field systems, enclosed by hedgerows, supporting mostly pastoral farms, whereas more intensive agricultural practices, including arable land use, dominate the southern catchment. There are several conifer and broadleaved plantations on the greensand ridge that runs along the northern and eastern side of the catchment, with more conifer plantations around the East Devon Pebblebed Heaths to the southwest.

All three sites are within a small sub catchment that feeds into the Lower River Otter. This area is predominantly lowland agriculture with small villages. Along the edge of this sub catchment where site A lies is a large area of lowland heath. This is the East Devon Pebbled Heath, a protected site designated as a SSSI, SAC and SPA. There are a number of bore holes for public water supply downstream of the sites, but only site B lies within a groundwater drinking water safe guard zone.

Figure 3 - This area is predominantly lowland agriculture with small villages.

1.3 Water resource risks & challenges

The sandstone and pebble-beds of the Otter catchment comprises the most significant aquifer in Devon and Cornwall, with 23 boreholes from which South West Water abstract for public drinking supply from the sandstone to conurbations such as Lime Regis. Along within ongoing water quality issues, predominately from land use practices it is likely that the Otter catchment will be vulnerable to increasing frequency of droughts. Winter droughts will have a particular impact due to this key period of aquifer recharge. Investing in EbA measures across the catchment that can support the retention and infiltration of water can help build resilience into the future.

2 Identifying and engaging buyers, sellers, and brokers

The basic idea behind the PES (Payment for Ecosystem Services) financing model is that investments made by 'buyers' in climate change adaptation measures result in the targeted provision of ecosystem services provided by the 'sellers' (see Output 2). The site in East Devon was financed in the more traditional way, with the help of (European) subsidies, including the European Regional Development Fund (ERDF).

Table 1 - PES stakeholders & funding mechanisms involved in demonstration site.

Buyers	Sellers	Brokers
EU citizens, through Interreg 2 Seas public funding Regional public funding through support in kind Pebblebed Heaths Conservation Trust	Landowner of the Clinton Devon Estate	Local catchment partnership Westcountry Rivers Trust Farm advisors

The targeted ecosystem services that buyers (Table 1) receive in return are increased water retention resulting in a lower risk for flooding and a more stable supply of freshwater downstream, increased biodiversity, and more healthy nature (increased biodiversity) in which recreation can take place (cf. § 4).

The theoretical application of the PES financing model can help identify opportunities for future financing. The otter catchment is part of the South West Water Up stream thinking scheme, which is due to continue for the fourth phase. Once the next phase commences WRT will work to deliver this scheme in the wider catchment and support the inclusion of EbA measures.

Table 2 - Potential PES stakeholders & Funding mechanisms to engage for more EbA implementation in similar context.

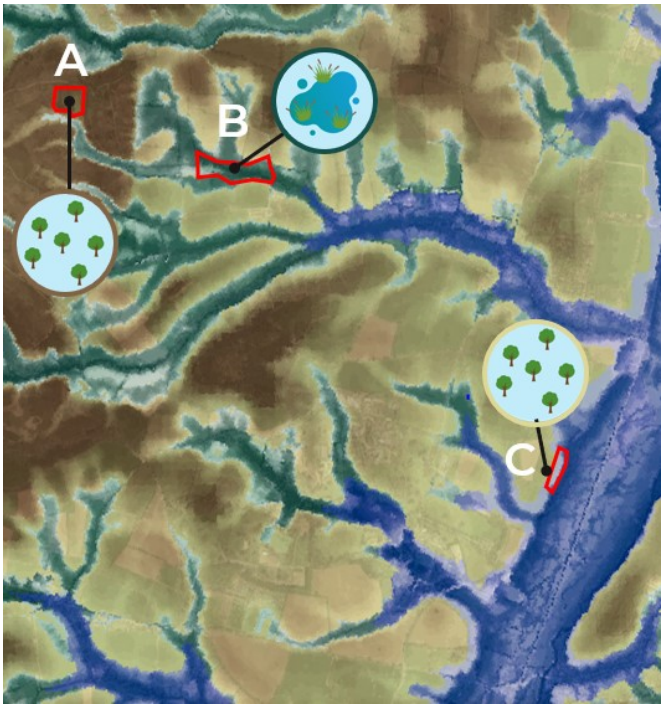
Buyers	Sellers	Brokers
Water companies Local communities at risk of flooding (through public funding mechanisms) Major water users at risk of water shortage (through different private and public funding mechanisms)	Landowners & farmers (land managers)	Local catchment partnership (such as WRT) Local water resources group Environmental NGOs and farm advisors

3 Prioritising locations for climate adaptation measures

3.1 Prioritisation by means of the water system map

For the project PROWATER, the University of Antwerp applied the water system map to the Interreg 2 Seas area (including catchments in Flanders, the Netherlands and South England) (Output 3). This map helps prioritise where to best apply EbA measures to infiltrate and retain water, based on hydrological characteristics, soil typology and topographical information. The map identifies 'natural places' in the landscape for seepage (groundwater coming back to the surface) and infiltration.

To aid the spatial planning of EbA measures across a catchment the PROWATER project applied the water system map to the demonstration site.



Groundwater dominated catchment

Hill top / Plateau – infiltration area, where water can infiltrate to groundwater bodies (indicated in brown)

Valley height – infiltration area, where water can infiltrate to groundwater bodies (indicated in yellow). Water that infiltrates here will have less residence time before it emerges in streams. However, flood attenuation can be achieved by infiltration.

Hill depression / Valley depression – Temporarily wet area, where runoff can be retained and slowly infiltrate. (indicated in green)

Floodplain – Temporarily wet area, where runoff and seepage can be retained and slowly infiltrate. (indicated in blue)

Site A: Hilltop - infiltration area (indicated in brown)
0.5 ha tree planting, increasing surface roughness

Site B: Hilltop depression – temporarily wet area (indicated in green)
Temporary (seasonal) wetland creation and enhancement

Site C: Valley elevation - infiltration area (indicated in yellow)
0.5 ha tree planting, increasing surface roughness

Figure 4 - The red outline indicates the location of the three sub-sites on the water system map. The map confirms the suitability to restore infiltration and temporarily wet areas (with the potential for infiltration areas indicated in brown/yellow and temporarily wet areas indicated in green).

3.2 The expected impact

These measures increase the sponge effect of the area. When it rains water is stored through increased water retention capacity (in temporary wetlands) and increased infiltration capacity (through breaking up soil compaction in tree planting sites and delayed infiltration in temporary wetlands). Stored water can be released slowly, diminishing flooding risks (downstream) during wet periods and increasing water availability (downstream) in dry periods.

Site A: promoting infiltration by increasing surface roughness and improving soil structure and breaking through compacted soil layers with tree root systems. As a result, the movement of water throughout the catchment is slowed down and more stable base flows are maintained.

Site B: Storing water in temporary wetlands. There it can slowly infiltrate to groundwater and release to slowly release to the environment, maintaining stable base flows throughout the year.

Site C: promoting infiltration by increasing surface roughness and improving soil structure and breaking through compacted soil layers with tree root systems. As a result, the movement of water throughout the catchment is slowed down and more stable base flows are maintained.

4 Monitoring and Evaluation

Fixed point photography will be used to monitor the establishment of the demonstration sites. In situ monitoring equipment was not deemed suitable due to the small scale of each of the interventions across the sites.