Historical Landscapes and Mans Influence on Soils

How does a Water Meadow work?

By definition a water meadow is an area of pasture, near a river, which is deliberately flooded or 'drowned' to encourage the growth of grass or crops. This extracted water deposits any nutrients from the river in the land and so stimulating the growth of vegetation by increasing the fertility. In broad terms this enables the early production of animal fodder and an increased annual yield. The *'bedwork'* for a water meadow is usually located on alluvial soils of the floodplain where water is directed from a main river, by a canal ('main carrier') through a series of weirs, hatches, or sluices which act as restraining structures. The rich sediment flow is then focused into narrowing channels that spill down the sides of specially constructed ridges.

This system is a very complex method of increasing soil fertility in order to obtain more from an area of pasture, by both increasing the yield and by increasing the overall potential use of the land. A water meadow system is essentially driven by a small river or stream that is dammed by a sluice gate with water being drawn off into a main carrier. (The sluice gate is required to raise the level of water in the backed-up carrier canal). This main carrier is a man made canal which slowly increases the height of the water compared to the main river and contains a further series of hatches/sluice gates to control the flow of water. This usually occurs on the outside of a meander, but not always.

This water is then released from the smaller hatches into a network of progressively narrower and shallower carrier canals aligned with the natural gradient of the meadow. These carriers were on raised earth, removed soil from the furrows, (so to keep the gravitational potential energy) with a channel along its spine to carry the water. Water was then released onto the surrounding pasture or 'panes' and then drained away in the parallel furrows that led back to the main river further downstream. These furrows became progressively deeper and wider towards the lowest ground near the river. There are a few different types of water meadows; one like this one just described, which is a 'floating upwards' system, is where the main stream was dammed and the water forced back over the whole meadow. Alternatively, a 'floating downwards' system can be incorporated whereby networks of graded artificial channels are used if the topography doesn't permit the former option.

How did they affect the soil conditions as to increase the productivity of the meadow?

Essentially the waster meadow system increases the fertility of the pasture by drowning it in sediment rich water from the adjacent river. Thicker topsoil is produced in the panes as water is removed from the furrows and placed on these. This process provides an increased rooting zone depth, which is advantageous if previously the site was hindered by a relatively high un-rootable C horizon (e.g. Flints). The increased productivity of the pasture increases the amount of organic matter present. Plant residues can remain in the soil via two processes and aid good soil structure, which is important for hydraulic conductivity and aeration. Resistant plant residues such as waxes, fats and lignin are slowly decomposed and form aromatic structures within the soil aiding aggregate stabilisation. Less resistant plant material such as cellulose, hemi-cellulose, sugars and proteins from microbial by-products, condense to from insoluble compounds to be utilised by plant roots. Both of these inputs increase plant productivity.

The increased movement of water in the soil profile, translocation, determines the rates of mineral and organic material movement, creating some areas of the soil to become enriched while others are depleted of material (Eluvation and illuvation). This process can move ferrous and manganese materials further down the soil profile into the artificially increased rooting zone. Additional inputs of mineral nutrients will also be stimulated by the replenishment of water through the system by enhanced rates of weathering.

Weathering is the breakdown of rocks by mechanical disintegration and by chemical decomposition. For example, when water occupying pores and interstices within the soil body, freezes its volume expands by 9%. This can occur in water meadow systems in strong frosts or when there are problems with the drainage system i.e. when the carriers become too silted up that water is no longer continuously replenished but almost static. This increased volume builds up stress in pores and fissures, causing physical disintegration. This disintegration breaks apart mineral particles releasing the elements that aid plant growth. Also water filled fissures and pores freeze rapidly at the surface, and so the ex panding ice induces hydrostatic or cryostatic pressure that is transmitted with equal intensity through all the interconnected hollow spaces to the still unfrozen water below – this again can cause physical disintegration of mineral particles within stony soils. Usually this effect is seldom seen in most water meadows under normal conditions.

In addition to this the periodical wetting and drying of soil can increase the rates of physical weathering. Clay minerals such as smectite and vermiculite swell when wet and then shrink when dry and so soil containing these in significant volumes expand considerably, inducing micro-crack formation, the widening of existing cracks, or the disintegration of mineral particles. Finally chemical weathering will be enhanced by the replenishment of water through the soil profile. This can increase plant productivity by solution, hydrolysis, hydration and redox reactions. Mineral salts may dissolve in water, where by the dissociation of the molecules into their anions and cations and each ion becomes surrounded in water, altering the soils pH.

The interaction between organic matter and clay domains plays an important role in stabilizing microaggregates as organic matter has a close association with clay minerals (it tends to become more resistant to microbial degradation). The environmental factors mentioned above; wetting and drying and chemical weathering help to maintain good soil structure by exploiting the soils natural planes of weakness. This exploitation prevents the s oil becoming an amorphous soil by increasing pore volumes and fissure numbers, essentially creating a larger range of discrete macroaggregates.

In addition to this the movement of water through the profile helps to flush out any toxins that may be present in the soil, diluting them and returning them to the river source. Wilting stress will also never be a problem in water meadow soil and so potentially increasing productivity as plenty of water will be available almost all of the year round.

<u>How did they act as frost protection?</u>

The constant movement of water through the rooting system warms them and so protecting them from early frosts. Also deeper soils prevented the affects of any possible frost action penetrating all the way through the rooting zone .

<u>Why didn't they become anaerobic?</u>

At no time in the normal course of running a meadow does it become flooded. The whole concept of this system is for the meadow to have a constant supply of water but in the form of a trickle of water flowing through th e panes, bringing with it constantly aerated, oxygen filled water. So as the water is not actually standing in the soil profile it never actually becomes anaerobic.

<u>How did they increase the fertility of the meadow?</u>

Rivers contain much silt and sediment that contains essential nutrients for crop growth. As the water from the carriers is passed over the panes the effects of topographic friction reduce its energy and so the flow can no longer entrain the sediment it carries in suspension load. This sediment can no longer remain in motion with the water, as the energy threshold for deposition has been entered and so consequent deposition occurs on the pasture, increasing soil fertility. The increase in soil fertility is mirrored by an increase in crop produc tivity, as nutrient availability is no longer a limiting factor to the plants that grow there. In addition to this as frost protection is provided with this system further plant productivity is possible.

This system was most successful in the chalk river valleys of southern England as the water tapped off from the river was rich in base cations. Calcareous rocks, such as chalk, are a very good source for base cations that help to neutralise acidic conditions in soils, and so increasing the potential fertil ity of the meadow. **SEE OTHER FIELD TRIP NOTES!!!!**

<u>Do you think the vegetation would have been the same:</u>

A)100 years ago the vegetation was most probably similar to that observed in the field at present. A mixture of thick, lush grass mixed with dense clu sters of reeds. Of course there would be no vegetation in the actual carriers as there is today, these would have had no time to establish due to continual removal of silt and sediment. The reeds in the actual panes would have been removed an the growth o f lush grass encouraged so that early grazing could commence in the spring.

B) 400 years ago before the water meadow was in operation the meadows would have probably yielded only slightly tolerant water species that could survive the small seasonal floods from the river and the vegetation would have been of a lower grade due to the lack of nutrient replenishment.

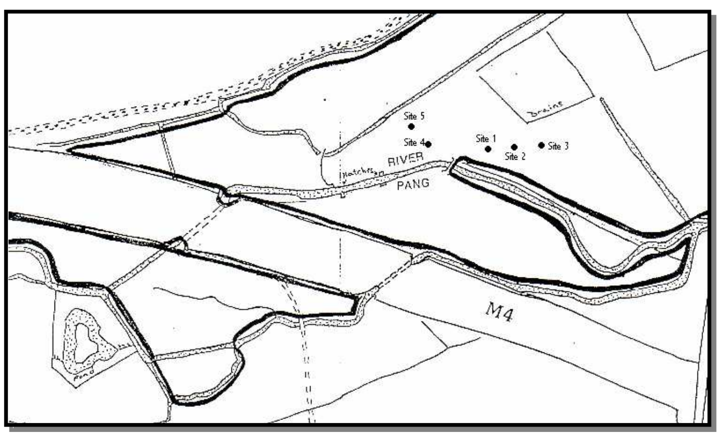
A historic water meadow system:

Traditionally, in southern England, a large labour force throughout the year managed water meadows but this work was often seasonal. Most people require full time work and not seasonal employment and so this has becomes an inappropriate farming practice. The maintenance of the numerous ditches and sluices needed to operate the system was very high and exceedingly time consuming. As a result, the traditional management of water meadows is now largely obsolete. However, with either volunteer work or the use of machinery this historical farming practice can be re-established once again.

There are many different types of water meadows and each is characterised by having different plant communities. So, it is important to attempt to bring back many of these ecosystems before they are lost forever. From past attempts to manage such historical water meadows, the research indicates that they can actually be restored or recreated successfully, but it takes a long time to establish the complex ecosystems present in old meadow systems.

I personally think that such an integral part of our British farming heritage should not be left to dwindle into obscurity as many others have, but to be re-invented so that an example can be shown to all. I think that it is important to maintain and enhance the conservation awareness of the river valley meadow system in a sustainable manner to ensure that this part of our history lives on in the England, not just in a leaflet or a history book. I believe that part of our farming landscape around such areas should be reverted to permanent grassland as they once were.

Soil Profiles of the Englefield Estate –



Both site 1 and site 3 were located on the ridges and so have almost identical soil profiles:

Site 1 and 3:

Horizon name	**Description**	**Horizon thickness (cm)**	**Total Horizon Depth (cm)**
O_h	Grass with some decaying leaf litter	2	0-2
A	Friable with a good root network and a crumb/blocky structure. Ochreous root mottling present with macro fauna – earthworms.	31	2-33
B_1	A silty clay loam with a 'very dark grey' 10YR 3/1. Non-calcareous	15	33-48
B_2	The following horizon was much darker – 'black' 2.5YR 2/0 and had clay loam texture. Traces of organic matter	7	48-55
B_3	Final horizon was 'grey' in colour (10YR 5/1) and a silt clay loam.	-	55+

Observations: B_2 and B_3 horizons were the buried topsoil horizons, removed from the drainage furrows and place on the ridges to make them higher than the surrounding panes covering the original topsoil.

The second site had a much higher water content and was chosen to depict the soils of the furrows, indicated by the presence of clumps of reeds growing there.

Site 2

Horizon name	Description	Horizon thickness (cm)	Total Horizon Depth (cm)
O_h	Mostly reeds with some grass.	2	0-2
A	This horizon was a 'very dark grey' colouration,10YR 3/1, and had a silt loam texture.	30	2-32
B_1	The first B horizon changed texture from the A horizon to a clay loam and a 'black' 2.5Y 2/0 colouration	22	32-54
B_2	The next horizon was a 'grey' 10YR 5/1 colour with clay loam texture.	38	54-92
B_3	The final horizon changed to a sandy silt loam with a grey' 10YR 5/1 colouration.	-	92+

The forth and fifth site were located further east of the other three sites and had very contrasting soil horizons:

Site four was dry to a depth 30-40 cm, where at 40cm a layer of chalk was found. This band of chalk was 15cm thick and was identified as a foreign horizon, laid possibly as a road surface enabling the farmer to use heavy machinery. After penetrating the chalk seam the soil became much wetter and grey in colour. The final site, site five, had a very deep Oh horizon containing mostly reeds and some grass litter. The A horizon that followed was a uniform, very thick dark peat material with lots of organic material. This horizon was saturated at went to a depth of 1.10m+