FMP Conference Day 2 Session 3 11.30 - 12.20

Emma: Hi everybody and welcome back after that quick comfort break. Thank you for staying with us and welcome back to our 3rd and final session this morning looking at soil carbon and water. We're going to start this session with Penny Anderson who is Chair of the Board of Penny Anderson Associates and a retired managing director. She's going to talk about some work she has been doing on carbon across habitats with a focus on grasslands. So welcome Penny and thank you very much. The floor is yours.

Penny Anderson Soil carbon storage across UK habitats with a focus on grasslands

Penny: Thank you very much. I'm delighted to see so many people here. I feel quite overawed I think. I just want to say basically that what I've been doing is actually reviewing the carbon soils and habitats and that's basically being part of the 2030 Climate Change Group which is one of the subgroups of the Chartered Institute of Ecology and Environmental Management. The overall paper that I produced out of that is available for anybody and there's a link there if you want to use it. I must stress though that I'm not an expert on carbon at all. I'm an ecologist specialist in habitat creation, restoration particularly on peatlands actually, which is where a lot of the carbon interest came from. Our reaction in the group basically came from the government mantra, and actually also from the Climate Change Committee, which was to plant trees but also restore the peatland. The peatland bit is fine but planting trees everywhere is not the only solution and we were just concerned that they would be the wrong tree in the wrong place. So that's why I started exploring what else could be useful in terms of habitat. I think one of the major conclusions which everybody's talking about as well, is that much of what you can do in terms of sequestrating carbon will also benefit ecosystem services.

Just a few figures here and a few things to point out as well, I'm sure most of you know, much of what I'm saying actually today has already been explained by a lot of other people but perhaps I'm just trying to pull it together, that globally there's 3 to 5 times more carbon in soils and vegetation, which just stresses the importance of the soils and that too is very much more than in the atmosphere. What I've done here is just to pick out some of the figures that I've collated on the carbon stock in some habitats and soils. Apart from the woody vegetation you can see how really important the soils are for carbon, and this is a stock and don't forget that stock could actually be increasing or decreasing over time and that's quite important. But just to pick out a few figures, the soils, peatland in particular when its deep, peat has very high concentrated carbon, much of which is being lost at a high rate from a lot of peatlands, particularly agricultural ones in the country. But then your humic-alluvial gley soils come out really at the top and then you go down the system if you like,

through podzols, acid grass and soils and then down to neutral and calcareous grass and soils, and there's far less carbon in the calcareous grassland soils than in some of the others. But the other thing to point out is that an awful lot of papers vary enormously which has been mentioned too today on the depth of soil that they look at the carbon in. So some of the material that came from the Milne paper on soils actually only goes down to the top 15cms so comparing that was actually quite difficult and there's a few figures there that illustrate that.

What are some of the factors that affect the amount of carbon as a stock in the soil? Again some of this has already been alluded to, the soil type itself is really important and the high clay rich soils are going to hold the most carbon and the thin calcareous soils the least, but there's a huge variation in between and that in itself is going to be affected by other factors like climate. I've just mentioned that the depth is really also important from a grassland point of view about 60% of the carbon is below 15cm depth, but that will vary again in terms of the soil depth and the soil type. That is actually very similar, not quite the same, but similar under woody vegetation like trees and things as well. So a lot of it is at a greater depth than just the superficial layer. The vegetation itself actually also has a major impact which has already been explained today, particularly grasslands with slow growing species or deep rooted species like the legumes that have been mentioned promote high soil organic carbon. I thought Simon's explanation of some of that was really, really useful. So microbes also vary with vegetation, soil type and climate which was also explained this morning and that was very helpful as well. The climate and geographical location are also very important if you think of altitudinal and west to east and north to south differences just in this country, let alone across Europe influencing productivity, decomposition rates, for example, but also the length of the growing season and the vegetation type itself. But it should also be noted because that's very relevant to climate change consideration that drought can reduce carbon sequestration quite significantly and it has also been shown that carbon stocks in soils can actually be lost in drought conditions as well.

Management is also quite important particularly levels of grazing, levels of cutting, fertilizer additions, slurry additions and so on and those are going to affect both the vegetation and the soils quite significantly. Time too, it was mentioned this morning that there was potential for a maximum capacity for carbon stock in mineral soils in particular. But some of the research that I've found was suggesting that it can take 70 to 100 years or maybe more for a new equilibrium to be reached. So it's still sequestrating carbon for a long time when you're starting particularly off with an arable or a disturbed situation.

How do you add more carbon to your soils and bearing in mind, which I should have just said, that the reasons for losses some of which have already been mentioned, but things like drainage of soils but also arable land if it's ploughed is actually probably losing carbon on average every year, so it's not going to be accumulating

more. So how do you add more carbon? We've heard from the Jena experiment, which was one of the ones I did find, about increasing plant diversity, increasing the amount of carbon and they didn't differentiate between different groups of plants in terms of that addition whereas some research at the Colt Park experiments, and that's a medium depth soil overlying limestone up in the Yorkshire Dales, adding red clover in particular, and that's one of the species that I have highlighted on your floodplain diagram as a deeper rooted species made a significant contribution to carbon sequestration to levels of something like 3.17 tonnes of carbon per hectare per year in the organic matter and that's a high level and equivalent to ancient woodland, for example, and a lot of other habitats as well. It's more than you would get in some heathlands, acid soils, acid grasslands so that is very positive. It's also been found that adding organic manures, not slurry and not inorganic fertilisers would also add to the carbon sequestration. But there's a wide range of papers which is quite interesting which suggest that a moderate level of nitrogen addition will actually increase carbon sequestration. If you then start dissecting that out and thinking about it, adding deep rooted legumes adds nitrogen to the soil. So if you've got a soil with very few legumes then instead you would need to add some nitrogen fertiliser in order to get that same effect. So from a biodiversity point of view, adding deep rooted legumes, and you've shown several on your diagrams which I thought was very useful, should actually enhance your carbon levels without any use of inorganic fertilisers, which of course also decrease biodiversity in terms of a diverse hay meadow.

Reducing high levels of stocking is also important because high stocking levels reduces root growth and it's also been shown how important that rhizobia is in producing carbon into the soils. A medium or a lower stocking level are much better for carbon. Reducing drainage effects. I've not found any papers yet actually on taking drains out of areas and presumably some of your flood meadow grasses have actually been drained in the past. So I'd be interested to know more about that. I think it's also really important that some of the levels of grass and sequestration, and there was a paper that I found recently which had various levels of sequestration from down to 0.5 to up to 4 tonnes of carbon per hectare, that is every year, at least for our generational period of time. That is equivalent to, or sometimes more than, the average you would get from planting a load of trees and that's where I think that the balance of grasslands is so important compared with woodland.

If we just move lastly on to some of the benefits that I have drawn out of this. First that biodiversity is going to provide you with other ecosystem services enhancement as well in terms of soil, soil quality, water quality, pollination and so on. There's a much more immediate carbon increase in soil diversification of hay meadows and grasslands in general than you would get from tree planting. Many of the tree planting schemes, particularly if they're disturbing existing soils and vegetation, can take 20 or 30 years or more or don't ever reach a positive carbon budget, particularly if you're dealing with a peaty soil. I think one of the other advantages for diverse

grasslands is that the grazing can continue, foraging can continue and maintaining it in agricultural use and producing food, which if you had woodland instead you can't do that, and you can do it on a much, much larger scale so it can be of more benefit than woodland because of that scale. But you can of course, as I've shown in the picture at the bottom which is one of my fields, you can include hedges, you can include scrub edges, you can create wood pasture and so on, so you can have a woodland element into that which can be very important for other ecosystem services as well. The scale I've already mentioned. The other thing is also, as other people have already said, is that from a health and wellbeing point of view, from the landscape and aesthetics point of view, flowers-rich grasslands are magnificent and I'll leave it at that.

The last slide has just got some references on it if anybody wants the additional ones that I've mentioned compared with what I put in the paper that's on the CIWEM website. Thank you.

Emma: Thank you Penny. That was absolutely brilliant. We're going to move straight on, but there'll be time for questions later, to our 2nd speaker this morning who is Jenny Phelps. Jenny has over 30 years' experience giving on-farm advice, the last 10 years of which have been with Gloucestershire Farming and Wildlife Advisory Group. She's going to talk about some current work on the development of a soil and farmland carbon code. Over to you Jenny. Thank you very much.

Jenny Phelps - Soil and farmland carbon code

Jenny: Good morning everyone. So we've got the unenviable task of trying to pull all this amazing knowledge and research and everything together to try and create a code for soil carbon which as you can see from the presentations today is incredibly complicated. So I'm going to give you an outline in the next 10 minutes of where we've got to with that, who's involved and how everyone else can get involved. It is a consortium of organisations, academics, and practitioners and lots of different people trying to crack this nut. Everyone's welcome to be involved with the development of the code and hopefully I'll give you some outline as to how that's going to look and who's involved over the next few slides.

So really the whole objective about coming together as a consortium of organisations and the Farming and Wildlife Advisory Group feels incredibly privileged to be a part of this and be invited to be a part of this is to try and realise the opportunities for UK farmers that are being realised around carbon markets internationally. We know there are soil codes internationally, particularly in America and Australia, and we're working with a developer Robert Parkhurst to actually develop those codes. The UK at the moment can't really create a lot of integrity around that unless we actually get down to the devil of the detail so that we can understand the complexity of our own soils and also the huge number of different landowners and parcels and how we

create projects that might be suitable for that. So what we're really trying to do is to work with all the organisations that develop the woodland code and the peatland code and now the new organisations that are working on the development of codes around other habitat types, which I'll come on to soon, to see if we can actually create an opportunity for this for the UK farmers that does have integrity. That is something that the landowners can feel that they are de-risked from actually going into carbon trading where they might not feel that they know how that's going to be quantified in the longer term. But certainly for purchasers who want to have that integrity too and there seems to be a real run to trade before we've really got this baseline information. So as it says, you know, our ambition is that this is going to be something that's universal, that will have standard protocols that will enable projects to be developed that can be verified. We want it to be free so that everybody can use it and hosted and we're delighted having been funded now by the Environment Agency, that that will be something that will have integrity and run alongside the existing codes, the woodland code and the peatland code and those that are being developed. We want to make sure that it's there and it's flexible for you so that it fits into markets as they develop and creates that integrity. So as I say the criteria that's been put together, and the Sustainable Soils Alliance and Agricarbon have a lot of credit to be taken for putting together a real structure around what it is that we're trying to achieve. We feel that for this to take place and build this sort of middle ground around the real world where we want to sequester carbon, the opportunities for investment in carbon, that we have to have some real science and it has to be a credible way that we can actually create this opportunity for understanding how we can sequester carbon in our soils from multiple different habitats. But we're focusing primarily our pilots on arable soils going to herbal leys, and obviously there's an ambition for those herbal leys to become long term species-rich meadows even though the mix might be different if that was your long-term objective. It must be something that creates that additionality and one of the biggest fears that I have at the moment is that there's an opportunity at the moment to create negative drivers for degradation because a lot of the payments that are coming forward seem to be higher for going from arable to woodland than it does to maintaining our brilliant grasslands or restoring arable to grasslands. So we've been looking at international grassland protocols that Robert has given us to create protection for grassland at the moment. It’s something I've raised repeatedly with policymakers around this. We want to explore the permanence of carbon and how that might be. In an arable situation are we going to be looking at a dynamic system where we look at residual carbon and we do calculations maybe along the lines of RB209 that we use for nitrogen or is that something that we're going to say No, this is going to be a permanent transition from an arable soil to a pasture or to a woodland, obviously with those other codes. But the integrity must be there and we want to have validators and we want it to be verifiable. We want to make sure that the protocols around this and the design is actually completely transparent and it involves a huge amount of consultation with people like yourselves on this call. That was the point, when we get to the point that we've got something to share, and obviously we want

to build on brilliant work like Penny's, and actually make sure that we're researching everything that's gone before so we're not reinventing the wheel, so that we might be able to realise this opportunity. But our ambition really is this centre ground about something that has this integrity, is fair, is transparent and scalable.

So where are we at the moment? So we have got this funding from the Environment Agency under the Investment Readiness Fund, that gives us an opportunity to run pilots. At the moment we're creating a governance structure so aligning it very much as I said earlier with the learning from the woodland code and the peatland code. We've got, as I say, international co-drafting experts in Robert trying to help us to apply what is the way that these international codes might apply to this complex world of the UK geology and soils and land ownership I mentioned earlier, and the dynamic nature that you farm. We want to look for who is the right validators and maybe bring onboard more validators, there's the Soil Association, organic farmers and growers, and others doing validation around the woodland and peatland code. We want to see who would like to host this so it's available for everyone to use. So again, as I say, a lot of this is going back to look at what exists already, what research is out there, what evidence we can build on. We want to compare and contrast, we've been talking a lot with the farmers who are being invited to trade carbon already using proxy measures. We know there's a lot of those carbon trading organisations that are trying to build integrity into what they're doing. So they're very keen to work in this space but we'll certainly learn from them and see what we can do. The pilots that we're designing, I'm working with Associate Professor Nicola Cannon my friend at the Royal Agricultural University, and Dr Helena Black from SIUC and Mark Reed and obviously Matt Orman from the Sustainable Soils Alliance, and the pilots are going to be based around trying to understand on 20 farms across Gloucestershire how we can create verifiable projects by scanning and testing the soil and using multiple different means. So we're going to be using some infrared and scanning technology and soil samples. Once we've identified the maximum opportunity for us creating the benefits of taking arable land to herbal ley in a diverse pasture. There is a website, I'll put it in the chat after I finish speaking which has got an update on all of where we are so far. We'll welcome everyone being part of feeding in any papers they've got or any form of consultation that we're putting out, we'd love to have your feedback on what we're doing. We do want to link this if we can to the development of all the other codes that have been funded under the Investment Readiness Fund. So the hedgerow code and the saltmarsh code, and we have a really clear idea as to how this might all link to the way that we've been doing our natural capital mapping, with our ELMS trials so using UK habitat verification. Maybe we can plug in codes as they develop into UK habitat types across the UK building the verification on all the brilliant work of people that have been on this conference. So at the moment I think that the consortium of organisations that as I say this is very much an open collaborative approach. I've said several times already that we welcome everyone's involvement in this. Really the credit for bringing this together has to come to Annie Leeson at Agricarbon who has dedicated the last 18

months to actually researching the opportunities and trying to create and align people who have specialist knowledge to be able to link into this. As I say, it's very much a privilege to work with some extraordinary soil scientists who have been trying to crack this and the other experts within this field. So I'm hopeful that it's quite a challenge that we've actually taken on board, as has been demonstrated highly today that there is such a complexity around verifying soil carbon and how we do that. I'm very much aware of a lot of tools that are coming on in this space to be able to try and do that more efficiently and part of our pilot is going to be about trying to cross reference those tools to look at all the mapping technologies to cross reference that with physical soil samples to try and get some more integrity around that. As we say looking at the whole complexity around soil biology and the structure of soil and its ability to sequester carbon, the impact of climate change might have on that in different localities and how we might create something that actually enables us to understand the relationships between nitrogen and carbon and soil biology and soil health and that legacy of enabling residual permanent carbon to be quantified so that we can actually get investment into soil carbon that's linked directly to healthy biodiversity recovery, recovery of ecosystem services, and obviously rebalancing all of our priority habitats and not just creating carbon for the sake of sequestering carbon. Thank you. That's all I have to say.

Emma: That's absolutely great. Thank you very much. I'm sure that there'll be lots of interest in what you've just been saying. We're just going to move on to our final speaker now of this morning session. Our final talk this morning comes from Professor Jo Clark who is a Professor of Environmental Science at Reading University and she's going to talk about evaluating the effects of land use and management and soil properties for natural flood management in the Thames Valley as part of the LANDWISE project. So over to you Jo.

Jo Clark Evaluating effects of land use and management on soil properties for NFM in the Thames area

Jo: Hi, thank you for the invitation to talk. So my background is actually a soil and catchment scientist who works a lot on the carbon cycle and I've infiltrated literally and metaphorically the flood management community over the last few years. So what I'd like to present to you today is some summary results we've got from a project we've had running for the last 4 years that will illustrate to you how the carbon cycle and the water cycle are actually very linked. For me natural flood management in the context of land use and management is actually about managing the carbon cycle to manage the water cycle. So I've got a large number of co-authors here that would probably take me 20 minutes to read through, so please note that what I'm presenting today isn't just my work, it's actually the work of others as well. We've got a large team, over 40 project partners and over 30 researchers working on this project that started in 1997-98. We're going to finish next year. We've had extensions due to COVID impacts and the large number of people that have got involved in this

project is testament to the number of people you have to have in the conversation when you're talking about natural flood management.

I'll give you an overview of the project as a whole then just to set the context of what I'm going to show you today. So the idea of the project is that we've got 3 work packages around collecting data. So we've got Work Package 1 where we're collecting local knowledge and technical knowledge to create scenarios for natural flood management. Work Package 2 is making some measurements in the field of soil properties. Work Package 3 is we're making measurements using satellites and remote sensing techniques in the field and that's getting integrated in some modelling work and being developed on a web tool. So what I'm going to show you today is mainly Work Package 2 some of the field work, and also some of the work we've got from local knowledge around how we're using and managing our floodplains compared to other parts of the catchment. I thought that might be useful to share. So the kind of questions we're looking at are how effective are different land base LFM measures at increasing infiltration, evaporative loss and below ground water storage in different locations in lowland catchments? So that's the question that all the work I'm showing today is relating to. Then we've got other questions that we're looking at with modelling about how this scales up. We're effectively testing a theoretical framework that was proposed by Simon Dadson and colleagues where they suggested that land use and management was only really effective at reducing small floods and peaks and wouldn't be very effective at larger peaks. So we're having it but there's not a lot of evidence to look at this. This is just what they think based on what's available. So we're having a look at this to see if actually land use and management can do more for these bigger floods by looking at a range of different events over time. We're working in the Thames Valley, it used to be called West Thames and then the Environment Agency used to have a West Thames office and now they just have a Thames office. Then the Environmental Agency have told me to stop calling it West Thames so I've gone to Thames Valley now because it is the Thames Valley too and it's a name that people seem to identify with more. So this is our focus area. We've got particular catchments that we're looking at. We've been working in particular catchment partnerships and we're doing modelling across different scales identified here. The key thing to note is the difference in geology. In the area we've got carbonate geology you associate with chalk and limestone. It's very permeable, it's a very shallow soil. There's a little bit of sandstone, it tends to be the acid geology associated with heathlands and then we've got the mudstone, so the flatter lands around our floodplains, quite clay rich soils, they tend to have high run-off rates. So if you look at the soil map for the area, this is a technical, national nursery soil associations, we've got lots of diversity in our soils represented by the different colours here. But broadly speaking you've got the shallow soils that are linked to the map units that start with 3. You've got the earths that are linked to the map units that start with 5 and are shown in pinky colours and then the floodplain soils are the ones here on the map units that start with 8 and are the bluish soils. There's a lot of complexity with the soils and how do you make

sense of this when you're trying to study it in a project with budgetary constraints. So we've taken these higher technical categories, we've been using soilscapes as well because the language in which soils are described in soilscapes is much more accessible than the very academic technical terms like kallo soil and argillic brown earth doesn't necessarily have a lot of meaning to people beyond immediate soil scientists. We've also through this project, it's a participatory project and we've got farm advisors involved, so Jenny and me are involved in the project and Jenny's team and through that they've been educating us university researchers about the language of RB209, which is much more familiar and usable with farmers. So shallow soils, medium soils, deep clay soils and we found that the language we use and how we talk about soils, it's a no brainer really but it really affects how we interact with farmers and what people can share and what people can know and the terminology really needs to be taken seriously. So if you take one thing away from this talk it's that RB209 is a good way to talk about soils with farmers.

So the field survey concept. Basically we ran a broadscale field survey of 150 fields where we measured soil properties across these fields focusing on the soil surface. So if you think about soil as like a bucket, it's a bucket that can store water, what we're measuring in different fields are the properties of that bucket. So how deep is it, how much of it is filled with material, how much is there? So that's what we're measuring with the broadscale survey. We're currently doing a detailed survey of very specific locations where we're looking at things like infiltration and water storage and how water flow changes over time. So that's on-going at the moment. So what I'm going to do today is focus on the broadscale surveys, so a survey of different properties. We had over 150 field samples across 40 farms. Over 2019-20 we looked at 4 different land uses. So we looked at arable with a grass rotation, and arable without a grass rotation and this was a steer we got from the farmers as being a key question a lot of them had, was whether or not to have a grass rotation. Should they have livestock in their farm or not. A number of farmers in the area got rid of livestock over the last 20-30 years and some of them are actually bringing the livestock back because they believe it's beneficial to their soils. So this was something that we took a steer from farmers to look at. We also looked at permanent grasslands and also broadleaf woodland. Then to try and take that complexity in soils and make it into something more easy to study, we had the 5 aggregated categories that map onto these 3 RB209 classifications of heavy soils, medium soils, and shallow soils, so the heavy deep clay and silty soils. We're looking at properties like bulk density, texture, structure and organic matter. So this is a map using these aggregated classes so you've got a simplified soil map of the area. Again the floodplain soils here are shown in the pink areas there. You can see where we've been able to sample across the area to capture some of that variation. From this data I wanted to just explain a little bit about how the statistics work. So we're analysing these data using mixed models and it's a hierarchical model as well where we've got our response which is bulk density, and we can split it into lots of different factors that explain that variation and we can see which ones have a significant

effect on controlling the variation and which ones that don't. So we can look at things like the soil type, the land use, the position in the field, whether it was on a tram line or not, because we looked at that, and then we can look at other things that we didn't control for which were the crop type that could also affect it. We can also look at the farm, the researcher, the clay content of the soil, the loss and addition so all these other factors that affect the variation, and we can put it into one big statistical model and examine it.

So just pulling out some of the key findings from this analysis. So looking first at bulk density. So bulk density is if you had a bean can and you drove it into the soil, how much soil is in that bean can or how squashed is the soil. So how compacted is it? So bigger bulk density means the soil is more compacted and it means it's less likely that the water is going to sink in if it rains. Then we found that actually land use has a much more significant effect on the bulk density than the soil type. Although both of the effects are significant, it matters more whether you have a grassland or a woodland than whether it's a clay or a loam. There is some variation in there you can see. The floodplain soils tended to have a lower bulk density than the others. What's interesting in the context of this conference, you can see the letters show groups that are similar, is that the grassland and the woodland are actually quite similar in their bulk density so they're both in Group C, whereas the arable no grassland with grass, they're both in Group A which is similar and the arable with grass and grassland are also similar too. So that’s an interesting point.

In terms of organic matter. Again the effect of land use is much stronger than the effects of soil type. Although again they're significant. The floodplain soils tended to have higher organic matter content than other soils in the area. The woodland had much higher than the grassland here. What's important to note is this correlation that we have between bulk density and organic matter where as our organic matter content increases our bulk density goes down. So the implication is as we increase the organic matter inputs into the soil by changing the vegetation and the land use when we’re putting organic matter in we're actually making these soils maybe less compacted and it makes it easier for the water and the rainfall to seep in. So from a management perspective this is basically saying that in the Thames area we can through natural flood management policies and practices linked to changing our land use and management, we can manipulate and change the soil property to make it easier for the soils to accept rainfall by changing their properties. So that's a positive message there about what we can do, it's not just a case of we're stuck with clay soils that are going to produce run-off and there's nothing we can do about it. We can actually have a look at this.

I was talking about all these different management effects. So that's some initial statistical analysis, we're still working on the stats to actually unpick the effect of all these different management effects we've got from our soil survey. So that's work in progress here. Taking a step back and looking at some of the wider implications now

so some work that Samantha Broadmeadow has done looking at technical mapping, policy and farmer knowledge and again this is drawing on the soil data. So we've got the map in the corner there Map A the green one, that shows the maps where countryside stewardship targets are in creation at the moment and again this is picking up some of these heavy clay soils and also they're working with a natural process one and again it's picking up the clay soils and the floodplain soils. Samantha's compared this with some farmer interviews and surveys we've done and what she's found is that actually there's quite a good alignment between the soil maps and what soils farmers report on their farms. There is not so good agreement at field scale with the soil map, but at farm scale there is good agreement there and that these policies seem to be targeted in the areas where farmers are telling us they're having problems managing their water. She's also done some extra mapping looking at structural degradation which picks out the importance of the clay on chalk soils. Another risk area that hadn't been identified previously. Management in terms of what farmers are growing. One thing that's popped out that is quite interesting, so these deep clay, deep silty soils they're the floodplain soils, is actually that the grass leys are really present on the floodplain and the clay soils in the areas and not on the chalk soils. In medium soils it seems to be absent from those areas in the catchment. Also in terms of tillage, we've actually got ploughing. A lot of farmers talk about the need to plough the heavy soils as well so we've still got conventional tillage. There's a lot of reduced tillage going on but there's no conventional tillage on these medium soils. They're on the chalk, on the chalky loamy soils as well.

So in summary, floodplain soils in the Thames Valley are groundwater clays or deep clay, deep silty soils if you're using the language of RB209. The soil surface properties affect the run-off generation and we found that land use had a greater effect than soil type on changing soil properties, bulk density and organic matter, and that higher organic matter is associated with lower bulk density and floodplain soils tended to have higher organic matter than the others. So there is a good association between the policy target areas and farmer knowledge on soil issues around water management but we also need to look at clay soils and chalk because they've actually been overlooked. The assumption is that all clay soils or all chalky soils are permeable and actually some of them aren't. There are some differences in crops and tillage on floodplains soils compared to other soil in the area, and the need to plough and the use of grassland and leys but our analysis is on-going. So on that note I'll end and hand over to the discussion. So thank you for the opportunity for sharing some of these findings and yes, watch this space, we'll be coming back with more to share.

Emma: Thanks very much Jo. We're slightly over time now but I still want to allow 10 minutes of questions. I apologise if people need to go but if we could put the 3 speakers from this morning back on the screen then I'll take questions.

Session 3 Questions

Ann: Thanks. It's a question about drainage. So we know that diversities is linked to hydrology of grasslands. So I'm just wondering what people's views are. Fields are getting wetter. Some of the fields are drained, they're managed as hay meadows, what should we be doing? What should our advice be around drainage to maintain that diversity, to maintain the hay crop versus the flood management type approach?

Clare: We do a huge amount of work in relation to looking at the flow of water across the whole water body because we found particularly with North Meadow Cricklade as an example which was one of the research sites that was presented earlier, that if you don't look at the downstream blockages, infrastructure, road infrastructure, culverts that are full of silt, you've actually got, this is what we've been saying for nearly 15 years, communities and farmers need to be able to go out and map and understand and share with partners or the local infrastructure that has an impact on the flow of water, because we can't manage soils without managing water. If we can look across the whole water body, we can look at where we can store it, where we can have woodlands and wet meadows. But actually to do that we need to understand what human infrastructure has been put across that water body over hundreds of years. One of the projects we've been doing, the Plant Project, we mapped over 20 villages and 20 water bodies, and shown that there's literally 1000s of tiny infrastructure points that need to be managed locally for the flow of water and with North Meadow Cricklade there was definitely an impact of some of the dereliction of downstream drainage. So I would say Yes, you definitely need to look at the wider landscape. If you link that to the catchment partnerships, you can find there's lots of resources quite often to help with that from Highways and other people, and water companies to help with that restoration of infrastructure.

Emma: We have a question from Rachel Remnant.

Rachel: So my question is I manage some peatland valley floodplain meadow in Winchester on the Itchen Valley. For the first time ever we haven't been able to take a hay cut this year due to the amount of torrential rain that we had and rising groundwater on the Itchen Valley. So I imagine this is a function of climate change. So when we're talking about permeability of soils and drainage, that is just not a possibility for those people who are on floodplain systems where you've got groundwater coming up. So I'm just wondering is this being factored into some of this analysis about soil carbon and everything that we're trying to achieve for these habitats, this is MG8 and MG22, if we're not going to be able to carry out the management and we're even struggling with livestock grazing at the moment. We're really on a knife edge in terms of managing welfare because the fields are actually quite hazardous to walk across even in wellington boots. So that's how wet it's been all summer. So is that being factored in with climate change, increased rainfall and water rising.

Jo: If you've got peat though it's already telling you it's very wet because the peat needs saturated conditions. Not all of our floodplains are peaty. So I think when you've got that side of it as well it is a tricky issue, and this year has been quite wet. But then there is a question around how we manage the peaty areas and maybe that's different to how we might manage areas that are more clay-rich, and some of the systems that Jenny's referring to. So I think we need more differentiation between how we look at our floodplains and whether they should be managed in that way. We're working at Greywell Fen at the moment with Southeast Water, and they're actually about to stop drinking water obstruction because it's been damaging plants and that's raising water levels and they're clearing trees from the site as well. Yes there's a question there also around grazing. So I think the issues you raise are really important ones and I think the response is actually we need to be more specific in our differentiation around policies and we need to recognise peat as a separate soil class to mineral soil. That's becoming more common. It's more done in an uplands/lowlands context but we need to do it in a lowland context as well.

Sue: Well I've been absent and I'm sorry, I haven't got a question, I was just trying to get back in Chair. I was going to apologise for my appalling internet connectivity and sum up at some point because I have actually managed to listen to most of the presentations which has been fab. So I'm so sorry that I haven't actually seen you all face to face. There is one question in the chat if you'll pick one last one up and it's about grazing animals that nobody has yet said anything about grazing animals and the effect on microbial populations and consequently carbon storage. The questioner, Phil Wilson, says that surely grazing and dunging will have a huge effect and grazing is a major and traditional management process. So if anybody wants to pick any of that up then that would be a nice end question because we are running out of time.

Clare: Yes absolutely, I completely agree. We've been working through our ELMS trial which all links into the development of the soil code around the UK habitat classification and the management of land and we've been adding in with Phil and Jo who developed the UK habitat classification, all of the management codes around livestock, so including things like mob grazing to get ecosystem attribution from those but I think it's very much understood for those of us as practitioners, particularly learning from farmers on the ground who are doing a lot of trials, that livestock are integral to that soil biology, as you say, and actually as we heard from a previous presenter, that seems to be very integral to the ability to sequester carbon. So definitely livestock in the system, so you have our support on that. Thank you.

Sue: I don't think there's any more questions from anybody there so it falls to me as an absent Chair to sum up the presentations from this morning which is actually quite difficult to do because they were so brilliant and I personally have learnt an awful lot from these presentations because I think it's tied together a lot of the

themes, particularly about carbon sequestration, about getting a code, which we all seem to be very much behind, it seems to be essential. Some brilliant case studies, thank you National Trust for those inputs on that. I think that Team National Trust can really lead us forward on this. I was also quite aware of the knowledge base here that the soil scientists are bringing to the party without which we cannot carry out the management of these floodplain meadows and particularly as you know I'm interested in education and training and I actually held a 2 minute silence when they removed Soil Ecology from the A Level in Geography which was a stalwart for years and years and years and now everything we got in the introductions from David Gowing on the soil horizons, that structure just isn't in our syllabuses anymore. So it's falling to the universities such as Harper Adams, such as the rest of you, to bring us forward. So thank goodness Reading are in on it, thank goodness so many people are there to raise our awareness of soil and take it forward to continue to research. That's really, really important. So really I can't sum up each individual presentation, but just to say an enormous thank you, all of them have engaged a lot of people who are questioning either face to face or by the chat. So that's really, really great. I think that just is a real testament of how we managed to do this. I think that's really, really good. I think the last thing I need to say is something about the administration. We will actually be beginning again at 5.00 and that will give us a fabulous next stage because there we will be talking about restoration and there will be a Question Time session at the end. So if you've got more questions on anything that you've been raising this morning that has a particular yen to thinking about restoration, which is what we're all agreeing is necessary and obviously we need to choose which sites are the most suitable for that but we've got some fabulous case studies and some thinking about how we might do that so please a reminder to come back. So it might be the end of the day and we might be able to stretch and release a little bit of energy and go for our own comfort breaks. But please come back. This conference just goes from better to better to better so all we can do is learn more. Thank you very much and that's the end of this morning’s session.