NRC Webinar Forest Waterways-20231123_022855-Meeting Recording

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58m 47s

Peter Cochrane 0:03

Welcome to this Natural Resources Commission webinar on 2 recent projects related to Forest Waterways.

The first on postfire erosion and the second on evaluating the forest road network to protect forest waterways. These projects were carried out under the Commissions state-wide, NSW Forest Monitoring and Improvement program, and this presentation will be followed by a Q&A session.

I'm Peter Cochrane. I'm an assistant Commissioner with the Natural Resources Commission and before we commence, I acknowledge the traditional owners of the lands from which we are each joining this meeting and pay our respects to elders, past and present. I acknowledge and respect the deep connection of First Nations people to country in the knowledge from this connection that they hold and share. I particularly welcome First Nations people joining this webinar.

Before I introduce our presenter, if you have any questions during or following the presentation, you can ask them through the Q&A function that's accessed by the Q&A button on the top of your screen.

We will be only answering questions about these projects and not addressing any policy, broader policy issues or any specific compliance or regulatory matters, webinars being recorded and the copy will become available on the NRC website where you'll also find the reports on these two projects together with links to their underpinning data.

Peter Cochrane 1:16

Now to introduce our presenter today, Doctor Petter Nyman.

Doctor Nyman is a senior scientist at Alluvium. He has a background in forest hydrology and geomorphology and he specialises in catchment modelling and advanced spatial analysis.

Doctor Nyman uses big data sets, high level computing programming and GIS software to analyse and visualize spatial data and modelling Earth surface processes. He currently holds an honorary position at the University of Melbourne and was a research fellow at the then CRC for Bush Fire and Natural Hazards.

Doctor Nyman has published over 40 articles in peer reviewed journals, and he's going to talk to us for about 25 to 30 minutes, followed by this Q&A session.

PC **Peter Cochrane** 1:55
Over to you, Petter.

PN **Petter Nyman** 2:03
Thank you, Peter. Thanks for the introduction. Thanks for the opportunity to come and talk about these two projects, which we've done with the with the NRC.

It's a really interesting time to work in forests and hydrology and geomorphology. There's a lot of little change going on and being able to work on these projects has been a real highlight for us and I just want to acknowledge that the work that I'm presenting is definitely a big collaboration.

So some of the work I did as part of my role with Jacobs a couple of years ago and some of the more recent work on roads is with Alluvium and also our collaborators, Melbourne University.

PN **Petter Nyman** 2:47
My presentation is basically two parts. The first part is looking at some post fire erosion mapping that we did following the 2019/20 bushfires in NSW and the second part is looking at roads and their potential impacts on water quality and developing up models to help inform how we can improve our management of roads.

Both talks are structured around first having an overview of the project objectives and then moving into outlining what the issues are and then the core components of

the projects and then some concluding remarks around what's next and what implications are these studies for our waterways.

Petter Nyman 3:45
The first presentation is about post fire debris flow mapping in southeast NSW forests. This was a project that was initiated opportunistically following the bushfires and we recognize that you know these large bushfires when followed by big significant rainfall events really represent an important event in terms of the processes that shape our landscapes and so capitalizing on that opportunity was a priority for us.

We managed to put some resources towards capturing aerial imagery and using existing methodologies to try and map where in the landscape we see these big erosion events occurring.

The intent was to collect the data set and inform analysis down the track that would look to improve our understanding of what drives these large geomorphic events and also help build and test risk assessment models down the track.

Petter Nyman 5:09
Now why map debris flows and why are we concerned with this in the 1st place?
I think the key driver here is the ecological values that catchment support and so the recent the bushfires in 2019/20 and also the large bushfires before that have highlighted that our waterways are quite sensitive to some of these extreme erosion processes.

Petter Nyman 5:33
This is a paper that came out shortly after the 19/20 bushfires by Silva E. al.
It's sort of a letter to one of the journals and they mapped the incidence of fish kills in Southeast Australia, both in NSW and Victoria, and they found that these big pulses of sediment triggered fish kills in both estuaries and inland waterways and in some cases these fish are Macquarie perch or Galaxias which have fairly limited distribution and are quite vulnerable to these types of impacts.

Petter Nyman 6:12

So obviously the fish kills are quite obvious, but beyond that there is persistent sort of water quality issues that remain within the waterways that don't necessarily kill fish, but they change the their aquatic ecosystems by modifying the sediment availability and the organic matter contents and nutrient contents within our waterways.

So whilst the events you can see in the bottom right panel are quite short lived - the actual sediment slug or the pulse of sediment can be quite short lived - the impact can persist for quite some time beyond that initial event. And over the years, through research, mostly that was done in Victoria, we've discovered that a lot of these significant impacts can be traced back to something called post fire debris flows.

Petter Nyman 7:04

And what is quite characteristic of burned landscapes is that erosion appears in episodes and in patches, so you get this pattern of sort of episodic and patchy erosion.

Some areas after bushfire you don't see much erosion at all. In other areas you see huge events with lots of sediment and clay and debris coming, you know funnelling down catchments and causing all sorts of impacts. And that patchiness is in part driven by over time where in the landscape you see high severity fire and where you see those overlapping with significant rainfall events.

So on the left here is just a mathematical representation of that in space and time - the red blobs are disturbed areas that are burned by bushfire, and then the blue discs are rainstorms that appear in time that over intersect with those burnt areas. And where you get that intersection is where you get these significant events.

And when you look in the sedimentological record in alluvial fans or in lake sediments, you often see that you have periods that have very little erosion occurring so the sediment delivery to these depositional parts of the landscape is quite low. But then it's punctuated by quite large events and often these are debris flows and in fire prone landscapes, those debris flows have often been attributed to fires occurring in the landscape.

Petter Nyman 8:36

So they see a high charcoal content within those sediment layers that have been depositing following bushfires. So post fire debris flows are an important, you know, landscape shaping process. But it's also important from a forest management point of view in that they do trigger those really extreme events that tend to have a lot of impacts.

And so what is the post fire debris flow? It stems from, initially you have a change in the soil infiltration properties. So top left here you have a hydrophobic soil, so the fire generates hydrophobic particles in the soil which then results in really low infiltration rates that then translate into surface runoff.

That surface runoff, when it's occurring on hillslope, starts to pick up ash and gravels and sediments that have been released as a result of the burning of surface soils. Then together that slurry of ash and gravel and water converge into upland drainage networks and they incise and form gullies.

And these are forested environments that tend to have very little surface runoff in the absence of disturbance and so they tend to store a lot of sediments. So once you incise into those parts of the landscape, you are accessing a lot of sediment that's been stored for hundreds, if not thousands of years. And once you trigger that process, there's a cascading effect of it what we call sediment bulking. So they just build more and more sediment and more and more momentum and often the sediment is deposited into larger waterways and you end up with these big spikes in turbidity and you know other water quality issues.

This is an example of post fire debris flow in the Tambo catchments. This is in February 2020 and a sort of recovery crew from DELP were out driving as a thunderstorm intersected with one of these high severity burnt areas. And this is a catchment that normally wouldn't produce much flow. It's probably a little fairly minor culvert that would be able to accommodate the flow as you would expect during you know, winter, these small little flows.

But here's always your charging and generating all sorts of debris and clay and ash.

And this is the Tambo River, which obviously has taken quite some time to recover from this one initial event cause the sediment and the impacts obviously persist beyond just this one pulse that that you can see here in this in this Video. Now a bit of sort of regional context, I guess we see these events in response to cycles or wet and dry extremes and in ENSOs'.

Petter Nyman 11:30
So La Nina and El Nino is a big driver here and so during the Millennium drought when we saw this is the first sort of 10 years of this time sequence here where you have a lot of that time runs in a sort of an linear phase.
We saw a lot of areas burnt by bushfire in Southeast Australia and coinciding with that we saw a lot of areas prone to this debris flow activity.
So these little red bars are debris flow activities in 2009, which was not a huge burn in terms of being huge fire in terms of area burnt, but it was very high severity fire and he was followed by drought breaking rainfall and so we saw a very sort of strong intensification in the brief reactivity following that.

And if they look to the future, I guess there's indicators that suggest we're going to see more of this as we see on intensification in ENSO, this evidence of that and some publications looking at how that might, uh, unfold more downpours.

Petter Nyman 12:27
So an intensification in the rainfall events that we see. So for every degree of warming, we'll see 15 to 20% increase in rainfall intensities and obviously also more Bushfire events as we see more days with extreme fire weather. So its very important that we build some baseline data to understand you know what sort of rates of occurrence do we see in the landscape now and what might we expect into the future? And that was sort of a key driver for this project.

And as an example, I guess in Victoria we've done a fair bit of this work starting from the big fires in 2003 and start off with some fundamental research trying to understand what the processes are and quantify soil properties and sediment generation rates. But then that transitions into, you know, consolidating and understanding and building models.

And now here on far right, it's in a good space in terms of being able to anticipate where these impacts might occur and to what degree they are linked to fire regimes and rainfall thresholds and how that varies spatially across the landscape and that gives you then opportunities to manage and anticipate the risk associated with these extreme events.

Now in Southern NSW we went out to map debris flows in two study areas.
So the first one is in Tumut, so quite a large area where we acquired high resolution aerial imagery.

Petter Nyman 13:53
So about 1700 square kilometre area, large areas of high severity fire, crown burn, mixed forest types, rainfall through 950 to 1400 millimetres and areas here are National Park, some are plantation and areas also some areas have quite extensive road networks and the bottom right figure here shows how following that bushfire there's some really large rainfall events and similar scenario in the Tuross

So again, we captured one year after the bushfire, this high resolution aerial imagery and again very high severity fire followed by significant rainfall events, less development in this catchment. So just mostly native forest and not a lot of roads.

And so the idea here is that we capture aerial imagery one year after the bushfire and then start mapping. Where do we see evidence of this channels forming as a result of the debris flows and so quite an labour intensive job of actually going in pinpointing the channel heads from this imagery and the fans that they produce.

And so we've tried to automate this through sort of image analysis software and code, but it is quite hard and it does require a fair bit of interpretation. So it's a manual exercise, where it will be mapped across all these burnt areas every gully head that has had one of these incisive erosion events occurring, and we assume that to be a debris flow and we can often see big fans associated with this. And so we end up with a maps of channel initiation points.

So the debris flow frequencies distributed across the burnt areas and we summarize

that into grids, so 1 kilometre grids, and said within this grid, what's the frequency of channel initiation points and that's the distribution of those frequencies.

Petter Nyman 15:56
So you can see they range from anywhere from, you know, no debris flows through to 10 or 20 debris flows within a 1 kilometre grid cell.

Petter Nyman 16:06
And you can see that real patchy nature and we can ask ourselves what are the drivers behind that - is it fire severity or is it topography is it something to do with soil properties and these are the sorts of questions that this type of data set that can help resolve and within the scope of this project we didn't have, you know, resources to go and do a fully fledged statistical analysis to unpack all the nuances here.

Petter Nyman 16:32
But this is sort of preliminary screening, you know, reveal that obviously that fire severity is a really important driver.

So when you move into sort of fire severity categories of three or four, that's when you shift into that crown burn and that's really a big precursor for these events to occur, it seems.

You know from this data, slope is important and also aridity index. So the aridity represents how dry the landscape is. And so the dryer you are, the more skeletal your soils tend to be, and so you end up with lower infiltration rates.

And so as you move from a wet system with high organic content and a lot of I guess resilience in terms of the ability to absorb the impacts from bushfires with soils retain quite high infiltration capacities and don't generate enough surface runoff, to trigger this process. So that's the far left of this this plot.

And as you move to the right, you get into these drier domains where you get a lot more surface runoff and highly likely to these events occurring.

Petter Nyman 17:32

So that's sort of an initial screening and then we can also look at some other aspects related to for example road densities. We looked at the length of roads within each of these one kilometre grids and try to see, you know, is there a relationship between the road length density and the frequency of these things occurring. And it appears that in the case of the Tuross, there doesn't seem to be much of a relationship.

So these orange dots are basically the debris flow density average within cells as a function of your role length density. In the Tumut he might see a weak relationship, so maybe there's some relationship there between you know, you introduce roads into the landscape, therefore you have more surface runoff being generated from roads and more concentrated flow. And therefore higher chance of these things occurring.

And then we can also dig into forest types and you can see quite clearly that these wet forest types in terms of the debris flow densities are very low compared to compared to the dry forest types, which are almost an order of magnitude higher in terms of their of their densities. And that's related back to that phenomenon that I talked about before.

Now, this data has been made available on TERN, so it's open for people to go and explore further what patterns they might find within the data sets and in terms of sort of recommendations going forward, I guess the first one here is to go actually into and mine this data a bit more and that was one of our sort of high level recommendations and also to build better datasets for aridity in NSW.

So in A.C.T. and Victoria, we built this high resolution aridity layer that allows you to resolve kind of find spatial scale nuance in erosion risk that you see as a result of elevation gradients, but also aspect as you move from exposed North facing aspects to South facing aspects, you tend to see a decrease in aridity, more moisture on the South facing aspect and less prone to this post fire erosion process.

Then moving on from that, using that information to start building conceptual models of sediment dynamics in forest and understand - including this image here on the right - what are the dominant processes as you move from sedimentary geologies with dissected uplands like you see in the Tumut through to sandstone

escarpments in around the Nattai catchments and the Sydney escarpments. Do you see a shift in the type of erosion response and the dominant processes that you see after bushfire and starting to build those conceptual models to help guide future research and model development and in parallel with that do you know start collecting real data on long term sediment delivery from forest to understand you what are the key drivers here - to what degree does Land Management have an impact on long term sediment yields and what's the fire signature in there - and also facilitate a process for knowledge exchange so you know we can do better in terms of cross jurisdictional collaborations and sharing models and data to help lift their capacity sort of across the sector so forestry, Bushfire, land management catchment management authority so we can start to get a bit of consolidation and coherence in how we think about bushfire and other disturbances in in in terms of waterways and ecological health.

Well, just quickly touch on some outcomes. And so just want to highlight just some extent work by Neda and Zach at the NSW department. They work in the estuary and catchments team and so they've actually taken these data and added additional datasets from their own mapping and build a susceptibility model, version one of for post fire debris flows in NSW.

This is work in progress, but they've actually taken this data and the recommendations and started to push forward to actually build some sort of predictive capabilities on the basis of these data sets. And so some really great work and I recommend getting in touch with them to see in more detail what the plan is there in terms of releasing this type of modelling for application to various management scenarios. As part of that, they also built this aridity index, which is another really important contribution.

Now we're moving on to the Forest Roads component and so this is work that we have done through over a two year period with the objective to build evidence into how we assess the effectiveness of Forest Road network design and management in reducing the impact on water quality.

And so few different sort of sub components to this somewhere field based and some are more so desktop and modelling based in this talk I'll mainly focus on the

ones that run the conceptual model development and the work we've done to try and turn that conceptual model into a physical web based model that can be implemented within a sort of ArcGIS toolbox environment.

This project sits within a broader program within the IFOA around monitoring and evaluation of waterway health in relation to forest management.

Now what's the issue here? I guess most people on the webinar here would be familiar with some of the processes that are gone in relation to forest roads and timber harvesting activities. But in this project we're mainly focusing on, you know, the in coupe roads and the broader forest road network as sediment sources.
And so when you see that from an individual timber harvesting coupe perspective, that's what you see on the left hand side, you've got your main road and you've got some roads coming into the coupe to help facilitate the extraction of timber.
And then on the right hand side, you can take a step back and think, OK, what does this look like over time?

So on the left is a snapshot for one particular coupe, but over time in a catchment scale context, you have these disturbances showing up in the landscape, then recovering, showing up and then recovering. And that happens as a patchwork with some roads being built as part of that and then they recover and so both these perspectives are really important. When we think about the implications of forest roads for our waterways, it's the localized impact within a unit, but also the broader sort of catchment scale applications of our management regime, I guess.

And when it comes to the actual processes that trigger water quality impacts, it's inadequate drainage. We have a lot of surface water accumulating on the roads and causing erosion on the road and concentrated flow that then gets readily delivered into waterways. There is gully formations at drain outlets as the top right here, and burned areas are particularly prone to this where you get a bit of the slope is destabilized as result of the fire and so when you get discharge onto the slope gullies form.

Bottom left here you have direct sediment inputs at crossings and those crossings might not necessarily be crossings that cross permanent waterways. They might also

be a little ephemeral drainages, little drainages where, when you do have significant rainfall events, they become a source of sediment from the road and into those drainage networks. And then on the bottom right, lack of maintenance and kind of legacy roads that sit out in the landscapes that no one really is accountable for and they sit there and they bleed sediment and become a persistent source potentially.

So these are all potential issues and what can we do about it? There's a lot of really good fundamental sort of hydrology geomorphology research that came out of the CRC for catchment hydrology back in late 1990s and early 2000s and really solid field based experimentation and data collection looking at what are the processes that really control, I guess the amount of sediment that reaches streams and the outcomes from this has been really instrumental in informing a lot of the guidelines around how we can manage the impact through road design, culvert spacing, placement of roads, etc. So these have made their way into our protocols and our codes.

And so there's a lot of really important role of research there and I guess the main mechanisms by which road management is looking to reduce the risk of water quality impacts is through reducing the connectivity.

So this little schematic here on the right basically has connectivity on the bottom axis here and so as we move from left to right, you're looking at increasing connectivity. So higher chance of eroding areas connecting with your waterways. On the vertical axis, you are looking at how much erosion is occurring within your disturbed patches. So if it's a log landing or a or a road or whatever, the disturbed patches, in our case, we're looking at roads.

Petter Nyman 26:27

PN How much erosion is actually occurring together? Those two make up your overall risk, so if you have high connectivity and a lot of erosion occurring, you're in that high impact zone and a lot of our mitigation activities is aiming to reduce connectivity.

So pull your connectivity down by increasing the spacing between your roads and your drainage networks, reducing your drainage spacing so you get less discharge at

your drainage point. But some of the works are also looking to reduce the manner erosion that you get through track rehabilitation, erosion control works, et cetera.

Now, how does this play out? So when we actually introduce these mitigation measures and we have huge expanses of road networks in our forest, it's like what where do we focus our efforts? You know, like sometimes these, you know, mitigation efforts don't go to planned or there's extreme events, extreme rainfall events or bushfires, and we know that the sediments coming into the system. But how do we prioritize where we go and look and where we invest our money towards mitigation.

So that's where this project comes in, where we sort of look to develop up a modelling toolbox that allows you to at a both catchment scale but also more broad laterals landscape look at where should I be focusing my mitigation efforts? How much sediment am I expecting from different road segments to make their way into waterways?

And so we've designed this GIS toolbox which draws on a lot of work that we've done over the years with NRC and some of our own internal internally funded R&D funding to synthesize a lot of this research that came out of the catchment, the CRC for catchment hydrology and turn it into a toolbox.

And so essentially here we're looking at 2 inputs a DEM and a road network that then gets in and incorporated with information about your rainfall regime, your soil properties, your infiltration capacity and then a processing toolbox and then looks to map what the erosion risk group looks like. Some technical components here that I'll skim through because it's probably not that critical to understanding what we're doing here, but essentially what I want to sort of highlight with this slide is that we've built quite a sophisticated erosion and sediment delivery model that incorporates some of the key the modules.

I guess that research has shown are critical to understanding erosion and sediment delivery, and this is based on physical processes and empirical research, and we brought these modules into a GIS interface, and so now we've got a ArcGIS toolbox that toolbox is made up of three components, with the first one is a pre-processing

component where webring in the road network and have quite an elaborate piece of code - just try and segment up the road network into topographically meaningful units.

Petter Nyman 29:27
And so we can't just segment the road into fixed 100 meter intervals because we interested in topographic high and the topographic lows or each road segment. So that each unit is a catchment for each road unit is a catchment in its own right, and then we model that as a unit and so implementing that in a GIS environment is a big task. And we also split out segments that are at crossings, so crossings get a separate treatment in terms of erosion and sediment delivery risk versus the road network more broadly.

And so the road segmentation piece, then there's a core geoprocessing workflow which basically takes that conceptual model and the physical and empirical relationships that I showed in the previous slides and implements that within the GIS processing tool.

And then finally, this is a bit of work in development, but then taking the outputs from that we end up with road networks with segments that have a potential sediment delivery rate attached to them. And then we want to generate reports that give you a risk profile if you like that you can generate for a catchment.

Petter Nyman 30:37
You might have a critical asset and ecological asset or a wood supply catchment that you are interested in - what's the risk profile about this particular point in my drainage network and within this tool generate those reports to you then can identify what your baseline risk is but also moving forward like what are your mitigation options?

So for example, one of the parameters within the model is crowning, where crowning is the shape of your road. So if you have crowning of 1, it means that all your runoff is draining into your crossbank and you end up with a lot of concentrated flow at your culvert.

Petter Nyman 31:15

So you end up with all the runoff from your road being discharged at one point. If you have crowning or .5, it means that you're runoff is split into two, so half of the runoff drains off the road onto the hill slope as diffusive flow and the other half becomes concentrated flow.

And so that simple parameter might be something that one wants to examine and what's the implication of that for the overall risk?

So in this image here you got on the left hand you have a crowning factor of 1. So all the runoff drains in one direction, on the other one, you have half draining in either direction and you can see that there's a bit of change there in the risk. And we've deliberately just represented here sediment delivery risk as low, moderate and high a bit cautious at this point to start putting actual tons of sediment onto these estimates because we haven't yet gone out and tested fully tested this and you know this, this this modelling tool, another one you can explore is you know what's the impact of different types of rainfall events.

So on the left it's a one in 10 year event. That's the risk profile for that and you can see the road network down the bottom here, shifting from, you know, a few high to moderate risk to a lot of high risk when you shift to more intense rainfall events. And then there's other things you can explore here around drainage spacings, or how much impact can you have by modifying your drainage spacing. And in terms of planning for new roads, how two different road placements impact on the overall risk. There's a lot of opportunity here to refine and build more on this sort of modelling platform to incorporate more opportunities for scenario planning.

Petter Nyman 32:49

Mindful of time, but I'll just quickly touch on sort of some future work that we anticipate with this. With this tool it is to try and think about rather than just being a static sort of assessment tool for looking at the current management regime and the current road network and what that means for water quality - what if we can also use it as a planning tool where we look at, you know, future scenarios, all road

placements and in this case around you know, if we're going to introduce new timber harvesting areas that's associated with some new snig tracks or maybe some new in coupe roads.

Then here's a scenario where you have you've introduced, a snig track associated with a timber harvesting operation. And that snig track causes an initial spike in sediment concentration because it crosses a little stream here, there's a recovery time scale for that snig track. So once you cease your operation, it quite quickly this is an exponential decline in the sediment delivery. And so it goes back to background conditions.

And so if you have a water quality asset or monitoring site down here, you would see a similar signature down there at the larger scale.

We can look at that scenario but also add, you know another road. So we might build another road here for some other purpose. It might be related to timber harvesting operation or something else. This is a in coupe road or part of the permanent forest road network, and so it's a persistent source. It's not a snig track, so it actually has an initial - when we introduced the road, you have an initial increase in sediment concentration and it stays high because that road is always going to bleed sediment, whether it's a bridge or a crossing or whatever it is.

That's that additional bit of sediment being introduced into your catchment and so down at that same monitoring site, you see initial spike and then a return but not a return to your pre, you know undisturbed catchment conditions.

And then we can explore further, you know, multiple roads, multiple timber harvesting operations for example and over time you can then start to think about, OK, are we at a stationary regime here. So are we introducing disturbances at a rate which is commensurate with the rate at which it recovers. So we're not increasing the amount of sediment with time.

Or do we see an increasing trajectory and how does that regime management regime relate to, for example, ecological thresholds or drinking water thresholds?

Or, you know some other parameter that's important to manage for. So this is the sort of opportunity that, that type of modelling framework would allow us to explore.

And so in concluding remarks here, I think we have codes and prescription and protocols in place and they really a lot of time they work and they're really effective. But then there's things when they don't go to plan and the design specifications are overwhelmed, either through to wildfire or extreme rainfall event. Also, maintenance issues. There's a lot of roads out there and we don't necessarily have all the funding available to maintain them. Sometimes roads are built in emergency settings and so there's not enough time to plan around. You know, where do you put it to minimize the impact and then also governance, governance around legacy roads or sometimes you introduce roads into landscape and then once they have served their function, they stay there. But who owns them? And so they've got - they might not be maintained.

And then you have all the models here obviously to help refine and focus our management interventions. And so I think the presentation has little highlighted how we can do that and I think. You know the work that's been done in the past around, you know, your fundamental empirical research has really been instrumental to us being able to develop this work, and there's a lot of low hanging fruits here in terms of consolidating existing research rather than going out and doing new research. And I guess we're more broadly across the two projects I think, whether it's bushfire or roads or timber harvesting operations, I think it's really important to use strong conceptual models and data and evidence, and to try and understand where are the management levers and what are our priorities in terms of protecting our waterways. Where are the opportunities to intervene? We have limited amount of funding so we want to be sure that we spend that really effectively where it matters and I think stepping back a bit is often a really important feature of good management.

I think we can sometimes, you know, focus in on a particular issue and get hung up on that. I think stepping back and taking a long term landscape scale focus I think can help ensure that we have strategies in place that are effective and move away from that responsive mode and think that because we see some dirty water entering a waterway- that's the main issue. I think sometimes we just got to take a deep breath and think about the big picture and finally there’s obviously big gaps in data

and research. But I think we still can find some really low hanging fruits through better consolidation and synthesis of existing research.

Thanks, Peter. That's it for me.

Peter Cochrane 38:07
Thanks very much Petter -that's great.

So we're now in our Q&A session and I believe we've got a question already, but before we go to the question, we are joined by the doctor, Peter Hairsine, in a panel session with PETA and Peter Hairsine signs an independent expert who sits on the NSW Forest Monitoring and Improvement Program Steering Committee and he advises us on soil and water related topics including these projects.

He's a researcher at the Centre for Water and Landscape Dynamics at the Fenner School of Society, Environment and Society at the Australian National University, where he investigates sediment and pollution transport in landscapes.

Prior to his ANU role, he worked at CSIRO Land and water for 24 years, and he's an author of over 200 publications.

So remembering the Q&A function is located at the top centre of your webinar screen, we'll work our way through the questions and all unanswered questions will be answered eventually and posted on the NRC website.

So before we go to our first question, I might just turn to Peter Hairsine, just to reflect on this work, given he's been with us for a number of years as we've worked through a number of research projects on water and forests.
But Peter, you've got some reflections on this work first.

Peter Hairsine 39:27
Yes, thank you, Peter.
Yeah, just a couple of observations on each of the projects. Overall, the work that Petter has presented addresses two of the difficult aspects of protecting water quality and forest.

He first talked about this kind of period following bushfires, where there is a period of high vulnerability for water quality in in forested catchments and the real value of that is that we now can point to specific parts of the landscape that are vulnerable to these water quality issues. So that's a that's a big step forward.

Petter has emphasised this, but I just wanted to repeat that bushfires are becoming more frequent and more intense. We've known that for some time, but the analysis of recent fires has shown that very clearly. So we can expect more of these pulses of pollutants through our stream network as a result.

And I guess from a global point of view, it just points to us that there it's - this is just adds to one of the many reasons that we need is a global community to get climate change under control.

PH **Peter Hairsine** 40:48
With regard to the unsealed roads, I just wanted to emphasize that unsealed roads serve both forest harvesting, firefighting but also things like recreation and access to utilities.

So there's good evidence in the literature in the Australian context that roads do contribute a significant proportion of fine sediment to our streams and that roads is a water quality issue and not just confined to forest harvest areas, but also to other forests including plantations and national parks. So this approach to maintaining and prioritizing the spending on the maintenance of our roads spans across all tenures. In maintaining our roads, we need to consider trafficability - that's we won't forget about that.

But the water quality issue has become a real priority and as Petter's emphasised, the tools that he's developed enable us to spend wisely the limited funds that we have to do that. So yeah, I'll turn back to the group and very happy to answer specific questions. Peter.

PC **Peter Cochrane** 42:14
Thanks Peter.

So Steven Dobbins has asked. Re the crowning factor. Have you modelled outfall drainage? That would be directly to Petter.

Petter Nyman 42:30
So outfall drainage. So we have in our model only considered the water that leaves at the drains. We don't actually model the water that comes as diffuse flow of the road onto the hill slope. The assumption here is that it's water that's not concentrated flow and therefore would infiltrate fairly quickly before it makes its way down into downstream areas. So if you understand the question correctly, I think I think no, we don't model the water comes off the road as diffuse flow. We only measure or model, the concentrated flow that comes at drains.

Peter Cochrane 43:19
OK.
Thanks.

Petter and Steven, if you've got an additional point to that question, please feel free to elaborate.

In the meantime, Petter, in terms of current forest management managers, how would they utilize the report findings to better prepare for the next big event?
Is your work enabling the identification of mapping of high-risk areas that are susceptible to more soil and water impacts post high intensity fires?

Petter Nyman 43:52
I guess there's this in terms of, you know, management implications.
So I think there's the actual work that we did was very much focused on the data collection and we did some preliminary analysis there that indicates you know, what are the landscape controls that help that might determine where you see some of these big impacts occurring.

The work that's happened subsequently to that led by Neda and Zach within DPE, I think that brings us closer to you know having those tools that you actually need to map post fire erosion risk after bushfires.

Petter Nyman 44:40

So you have a fire severity map and you can feed that into that type of modelling framework and actually look at you know, what's the susceptibility of the landscape given a fire event to these different type of erosion process. And with that information, you can then inform and prioritise recovery efforts.

So if you have particular waterways that you're concerned about, or particular ecological assets, then you can focus on those where the debris flow risk is high and likewise with some of the kind of direct impacts of debris flows on road infrastructure or agricultural infrastructure or campgrounds and things like that.

There's an element of actually providing information to the community around the actual natural hazard component of the debris flows, because they have been instances of people, you know, losing their lives to these and also quite a lot of loss to in terms of infrastructure damage. So the work has facilitated the development of those types of models.

And then I think in terms of informing sort of fire management, I guess is also role of this information in plan burning and understanding where are the really sensitive parts of the landscape in terms of potential erosion response after Bush fire and that might have implications for how you plan your burns and where you want to try and keep high severity fires out .

Peter Cochrane 46:08

OK.

Peter Hairsine 46:09

Peter I'll add a little to Petter's response, which has been quite comprehensive for must say, but I guess at the root of that question is to what degree of control that we have around these episodes and that the two things clearly we don't have control of – well, look, we largely don't have control of.

One is where the high intensity burns occur, because that's the sensitivity in in the model. There's some degree of, umm, controlled by the prescribed burning as Petter has just mentioned.

The other thing that we don't have control on is where the high intensity rainfall occurs, and clearly that's beyond our control.

But there is this issue of roads. One of the datasets showed a possible sensitivity around roads. We need to follow through on that to have a better understanding of this kind of interaction of roads in the kind of post fire period. If that was the case, if that turned out to be a sensitivity, then we've got a further tool to give us some prioritization about getting in and rehabilitating those roads.

And this is particularly an issue for the post fire fighting period, where oftentimes there's a lot of road disturbance. Sometimes we build new tracks in the firefighting effort so that's a priority for us too. Thanks.

PC **Peter Cochrane** 47:45
Thank thanks, Peter. Steven has come back with an elaboration to his question on sediment loads and erosion risks. Does the data that feeds the model compare areas that are impacted by bushfires with previous hazard reduction in the catchment and its influence on fire severity and resultant sediment load? Petter, I'm assuming you can see the question as it's written.

PN **Petter Nyman** 48:15
So you're referring here to the roads model in particular is that what the question is related to?

PC **Peter Cochrane** 48:22
I think so, yes.

PN **Petter Nyman** 48:24
So at the moment, we don't have Bush fire impacts explicitly represented in there. But the way the model is structured, so conceptually you could quite readily

incorporate a bushfire impact through changes in your you know the parameters that determine the degree of connectivity that you see between roads and waterways. And so you obviously change the buffering capability of your hill slopes and your forests between your road and your waterways. And so you end up with higher level of connectivity and also a higher chance of gullies forming at outlets of culverts. And so we haven't incorporate that in our modelling framework yet, but those obviously areas that we be very keen to explore further.

PC **Peter Cochrane** 49:10
So I think the key part this question is also prior hazard reduction work in the catchment. So can you look at what sort of legacy issues there might be in terms of hazard reduction that might impact on fire severity and therefore the impacts on sediment load.

Petter Nyman 49:31
PN Yeah, I mean, then you get into a fire regime, uh simulations and understanding the delay, the relationship between what we do in terms of fire management and the. resultant outcomes from a wildfire event.

That's beyond the scope of what we what we've looked at here, but clearly those sorts of questions are important ones to consider if we are thinking about long term resilience in our catchments around sediment delivery and the levers that we can pull and to what degree is that a lever or to what degree are these fire events purely weather driven and that the impacts is somewhat insensitive to past fire history. That's questions that we are still grappling with.

PC **Peter Cochrane** 50:18
To what extent do does your work translate to a fire breaks? Because with the as we know, with an increasing risk of fire and probably higher intensity fire, fire breaks are going to are an important management tool as well.

But whether they're existing ones or new ones that are particularly introduced, so one would assume new fire breaks are going to be even more erosive in their impacts so do your models able to take account of that or are you really only dealing with formed roads?

Petter Nyman 50:56

PN In principle it could. My limited experience from Victoria is that fire breaks I guess in the initial when they're initially constructed there's some soil disturbance, but quite quickly and not with a grassy understorey, which means that the erosion potentially is quite low in those and often they're in ridges.

So when they're on ridges, they might be fairly decoupled from your waterways. But conceptually, if you do have fire breaks that have soil disturbances associated with them and they are moving into the vicinity of waterways, then the way that we're framed up the model in theory could be used for fire breaks as well.

PC **Peter Cochrane** 51:31

Steven has just added in in the Q&A that he's sort of focused less on roads and more on water quality monitoring. In terms of areas that are impacted by bushfires and their previous history.

PN **Petter Nyman** 51:56

Yeah. I mean, I think monitoring is really important. I think we're, you know, catchment experiments and monitoring of water quality at scales that are meaningful for this type of work. We don't see a lot of that anymore catchment - paired catchment experiments and things like that. They're expensive and hard to get up in the research environment to these days.

But uh, there is clearly a role for that, because ultimately what we're modelling is the water quality response at fairly localised scales in order to attribute changes in water quality parameters to particular catchment processes. Then a lot of the water quality stations that are maintained sort of routinely by the Bureau of Meteorology and the like, they're often at much larger catchment scales and you start to get agricultural impacts and it is much harder to look at that attribution to particular forest management activities. And so, you know, it's a massive case for doing more of that work, but it's expensive and you don't see a lot of that these days.

PC **Peter Cochrane** 53:08

So given that we're always going to have roads in forests, whether it's harvesting related or fire management, recreation purposes or any other monitoring or

managing purposes, what advances are improvements to the tool would you suggest to better operationalise its use for different land tenure managers?

Peter Hairsine 53:33
Maybe I can help out there a little.

Peter Hairsine 53:36
I was personally involved in the original CRC catchment hydrology original research that Petter mentioned. There is this term of connectivity so and the interesting thing about that with connectivity is that we see many road segments which are disconnected from the stream network so and we can we got a fairly good evidence base for that not just experimental but also using sediment tracers so the nice thing about that is that it is possible to have road segments which don't contribute sentiment and other pollutants directly to the stream network.

So the kind of the primary lesson out of that piece of work was that it was the maintenance of the roads and the maintenance of the drainage of the roads. Petter's mentioning the crowning, but also the drain spacings.

And the other particular sensitivity was the approach is to stream crossings where existing roads crossed over either a ephemeral or permanent streams.
So there is an existing knowledge base that enables us to justify maintaining these roads, maintaining the drains for the many purposes that they serve. I think that's a message that's well established in the forest management community, both in national parks, in the plantation community and in the native forest harvest community.

But I would say that my observation is that it's limited by resources that in some water supply catchments, we're seeing good maintenance of our roads. In other tenures, there just simply isn't the funds to go around. So that's a consideration for all of us.

Peter Cochrane 55:44
OK, we don't have any other questions in the Q&A.

So just give participants one last chance to formulate a question if they have one. Otherwise, we might wrap up just a few minutes early and I'm not seeing anyone, so look in closing.

Well, thank Petter and Peter and you the participants for your interest and Steven in particular for his questions and encourage you all to go to the NRC website for publications from these two projects.

And the answers today's questions and answers will be posted in due course and there are many other publications on the extent and state of forested landscapes in NSW on the NRC website, and we've got two upcoming webinars from our work over the last year or so on monitoring forest biodiversity and on forest carbon balance. And I hope you'll join us for those. Their details should be on your screen and registrations are open for both.

So thank you very much your attention.

PN **Petter Nyman** 56:53
Thanks Peter.

PC **Peter Cochrane** 56:55
Thanks Petter and Peter.

PH **Peter Hairsine** 56:57
Thank you, Peter.

PH **Peter Hairsine** 56:59
Thanks Petter.

PN **Petter Nyman** 57:00
I thank you both.