CMER Data Use Notification

Proponent: Roads Project Team	**Date**: 10 April 2024
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Project Name/Issue: Road Prescription-Scale Effectiveness Monitoring Project	
Notification: Use of data collected during the Road Micro-Topography Evolution parameterization experiment in a paper discussing the experiment's results and implications.	
Funding Source: NA	**Urgency**: High

Data Description: The PI and other members of the Project Team, principally Mrs. Alvis, a UW doctoral candidate, are writing a paper discussing the results of the Roads Prescription-Scale Effectiveness Monitoring Project's Road Micro-Topography Evolution parameterization experiment. This paper, currently entitled *Temporal evolution of forest road micro-topography and flow pathways*, discusses using unoccupied aerial vehicle (UAV) structure-from-motion (SfM) technology to examine how wheel ruts evolve on mainline logging roads following road grading and the implications of said rut formation on the road surface drainage system. This paper will be submitted to a peer-reviewed journal by June 2024 at the latest (exact journal and date TBD).

Below are the figures and tables presented in the current paper draft. The figures may change slightly as edits to the paper are made, but the content should remain largely the same.

- Figure 1 presents a map of the field sites.
- Table 1 denotes seasons, dates, types, and times since baseline.at each field site.
- Figures 2-6 are presented to help explain data processing and analysis methods.
    - Figure 2 shows example orthoimages and digital elevation models (DEMs) overlaying hillshades for the first survey at each field site.
    - Figure 3 shows example difference maps for wet season year 2 (WSYR2) at one of the field sites (MEL-14) for both pre- and post-Gaussian filtering.
    - Figure 4 shows example cross-sectional profiles of unoccupied aerial vehicle (UAV)-derived DEMs at MEL-14 for WSYR2.
    - Figure 5 shows example empirical cumulative distribution functions of elevation change at MEL-14 for WSYR2, with a line denoting the 5^{th} percentile, which is used as a measure of rut incision.
    - Figure 6 shows example drainage area maps for each of the surveys during WSYR2 at MEL-14 developed using a Landlab flow routing component.
- Figure 7 is a schematic showing potential flow pathways for an idealized road surface and a rutted road surface to help explain the implications of rut evolution.
- Table 2 and Figures 8-10 are the main results of the study.
    - Table 2 lists the maximum rut incision depth in centimeters for all three seasons at each field site.
    - Figure 8 shows the relationship between rut incision depth in meters and time since grading in months for both field sites. This demonstrates the rate of rutting.
    - Figure 9 shows the relationship between the normalized drainage area center of mass (CM_{da}) and time since grading in months for both field sites with respect to the normalized drainage area center of mass for an ideal surface.
    - Figure 10 shows the relationship between fraction of total drainage exiting through the lowest boundary of the road segment (R_{da}) and time since grading in months for both field sites. This is a way to measure the impact of ruts on flow pathways.

One more figure may be included in future iterations of the paper that shows the impact of ruts on an erosion index of the road surface but requires further discussion among co-authors.

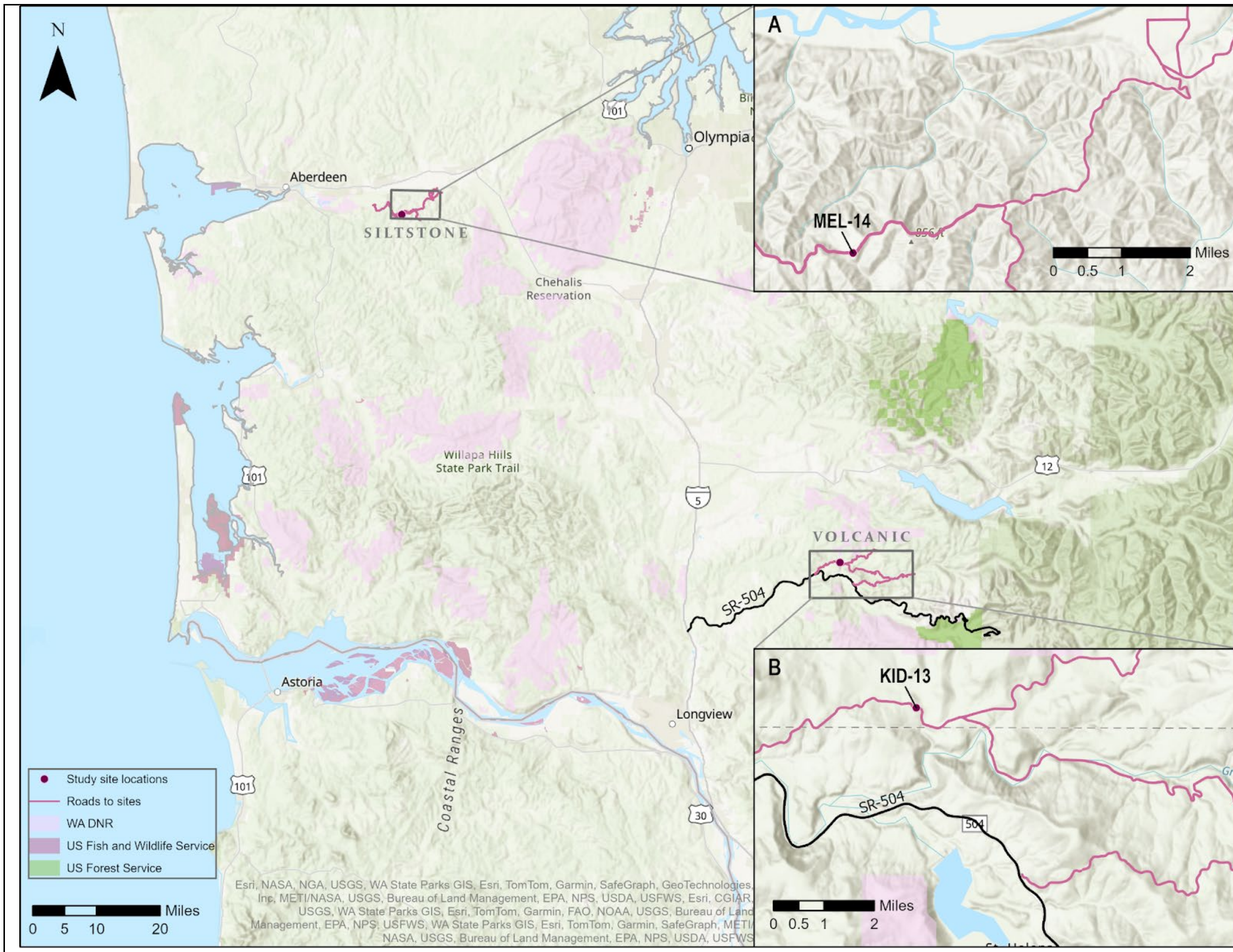

Figure 1. Map of field site locations in Washington state. Inset A zooms in on MEL-14, the field site in the siltstone lithology and inset B zooms in on KID-13, the field site in the volcanic lithology.

Table 1. Survey seasons, dates, types, and times since baseline at each field site.

Site	Season	Date of survey	Type of survey	Time since baseline
KID-13	Wet season year 1 (WSYR1)	11/09/2020	UAV; TLS	0
		02/08/2021	UAV	3 months
		04/06/2021	UAV	5 months
		05/13/2021	UAV; TLS	6 months
	Dry season year 1 (DSYR1)	06/04/2021	UAV; TLS	0
		08/19/2021	UAV	2.5 months
		09/13/2021	UAV; TLS	3.5 months
	Wet season year 2 (WSYR2)	10/07/2021	UAV; TLS	0
		02/08/2022	UAV	4 months
		05/03/2022	UAV	7 months
		05/31/2022	UAV; TLS	8 months
MEL-14	WSYR1	12/03/2020	UAV; TLS	0
		02/24/2021	UAV	2.5 months
		04/12/2021*	**UAV***	**4.5 months***
	DSYR1	06/03/2021	UAV; TLS	0
		09/14/2021	UAV; TLS	3.5 months
	WSYR2	03/09/2022	UAV; TLS	0
		03/16/2022	UAV	1 week (0.25 months)
		03/24/2022	UAV	2 weeks (0.5 months)
		04/11/2022	UAV	4 weeks (1 month)
		04/28/2022	UAV	7 weeks (1.75 months)
		06/01/2022	UAV; TLS	12 weeks (3 months)

*This survey was rendered unusable due to unforeseen interim road work.

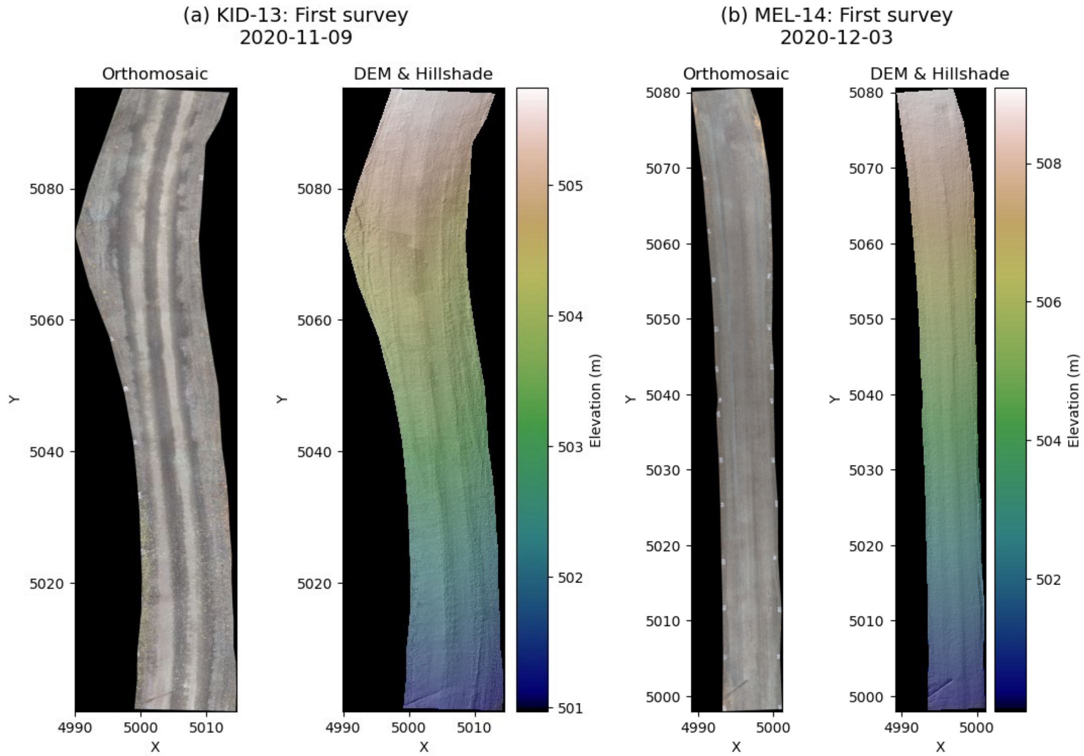

Figure 2. Example orthoimage and digital elevation model overlaying a hillshade for the first survey at (a) KID-13 and (b) MEL-14.

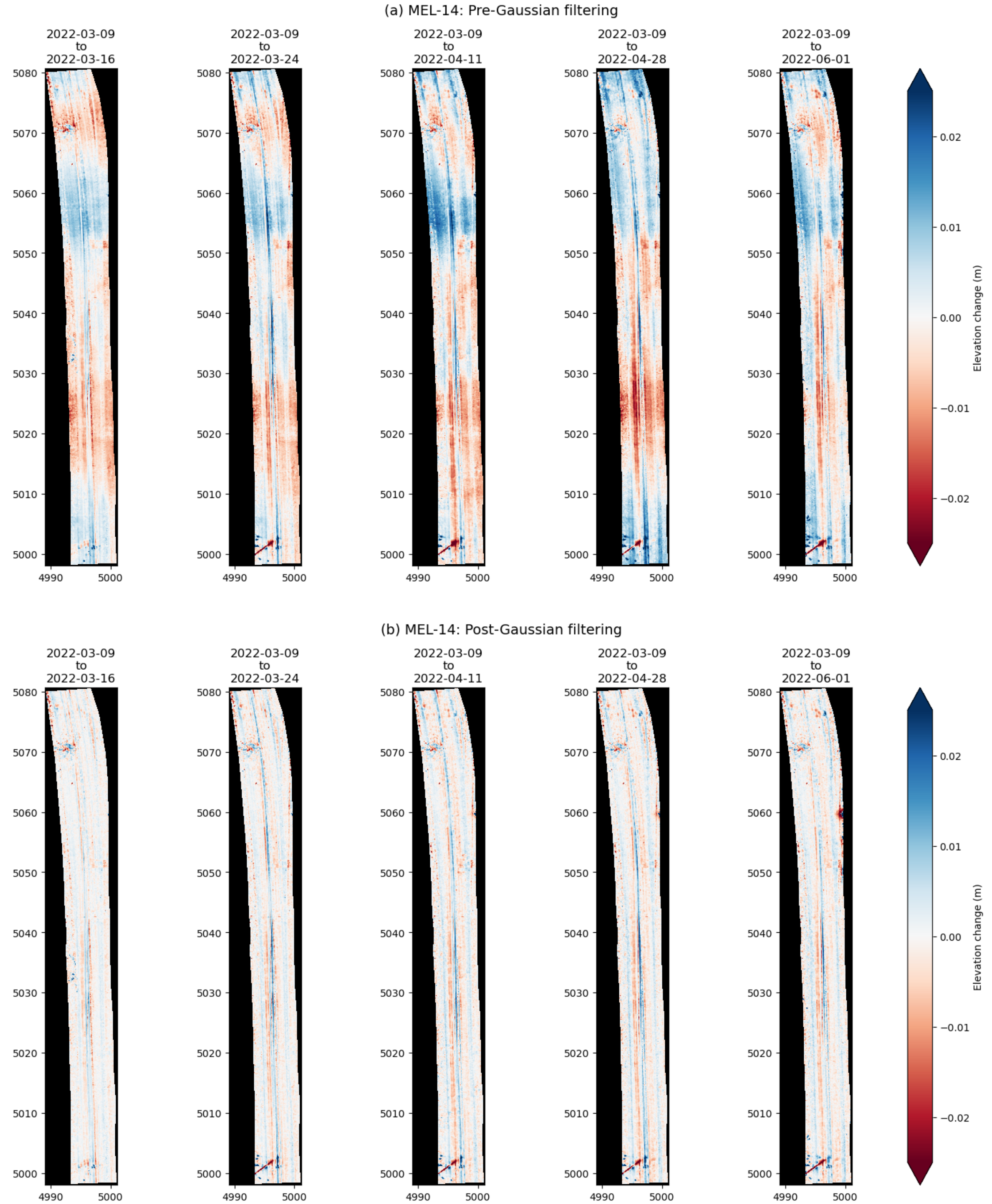

Figure 3. Example difference maps for MEL-14 WSYR2 (a) pre-Gaussian filtering and (b) post-Gaussian filtering.

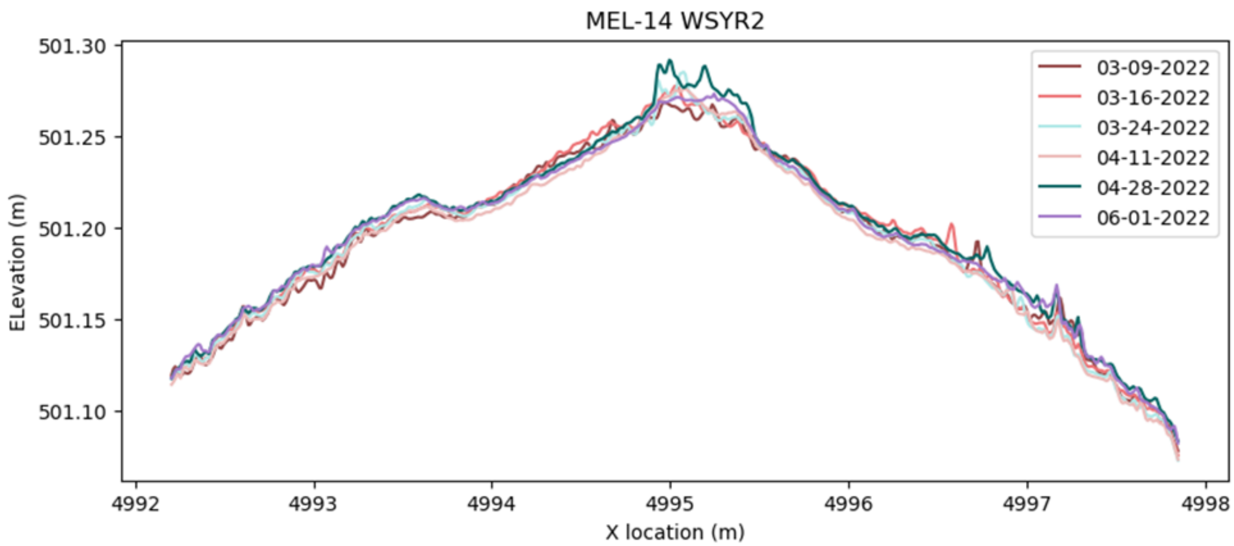

Figure 4. Example cross-sectional profiles of UAV-derived DEMs at MEL-14 for WSYR2.

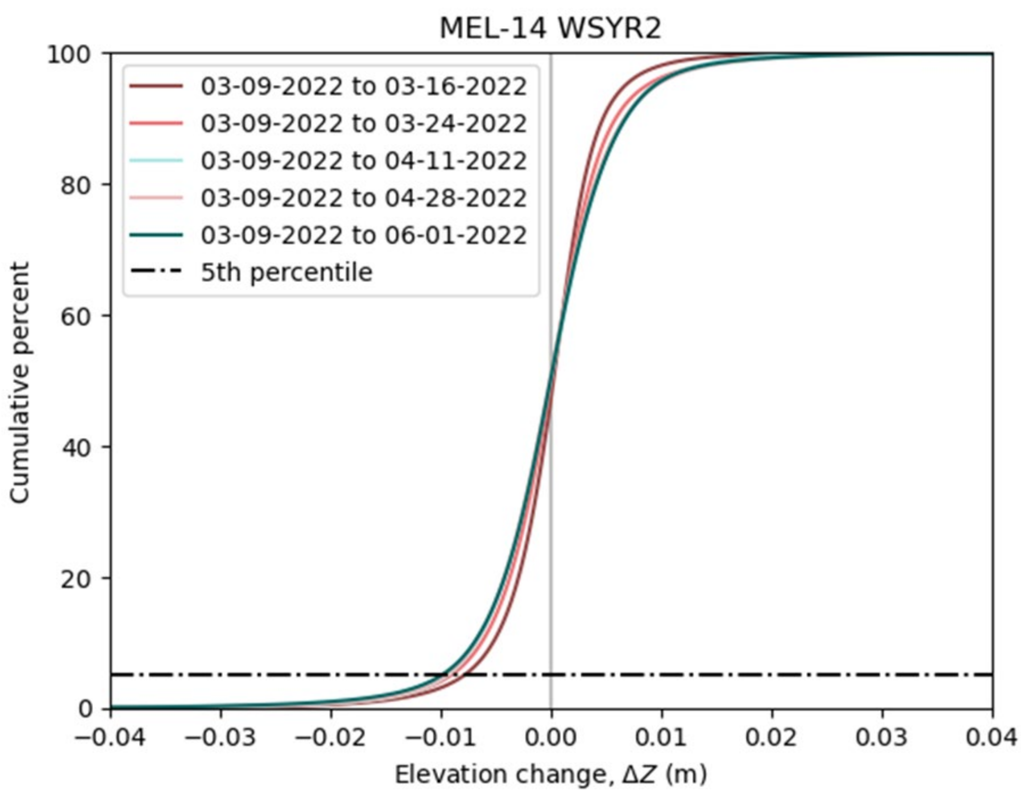

Figure 5. Example eCDF of elevation change for WSYR2 surveys at MEL-14.

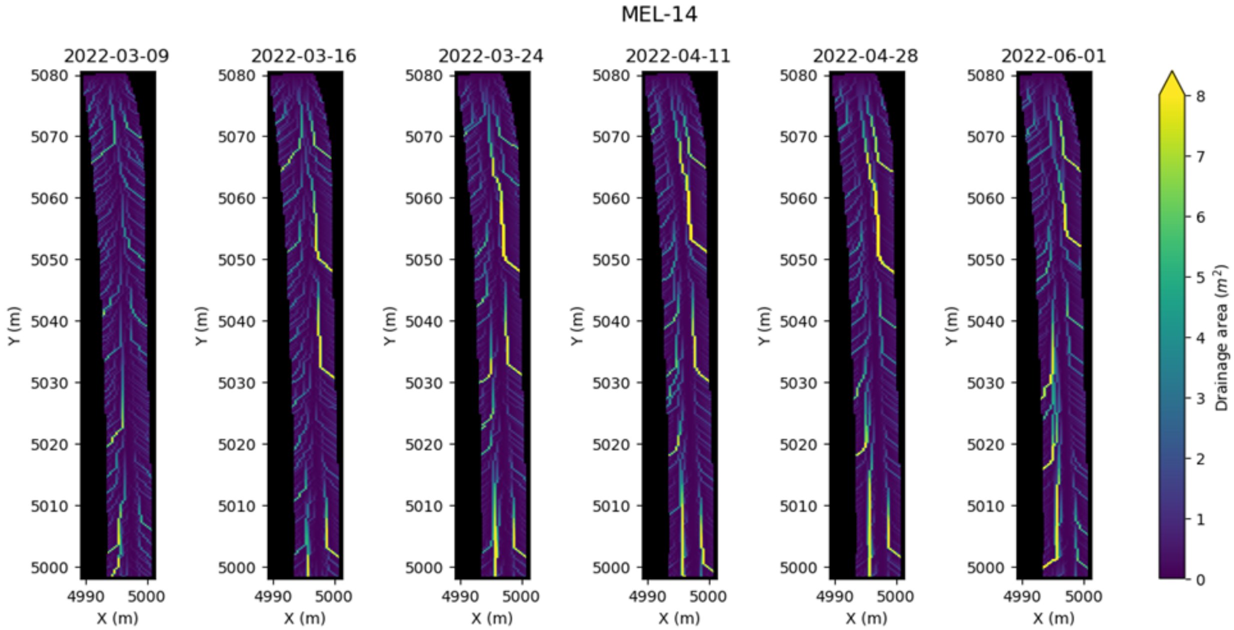

Figure 6. Example maps of the road surface drainage system for WSYR2 at MEL-14.

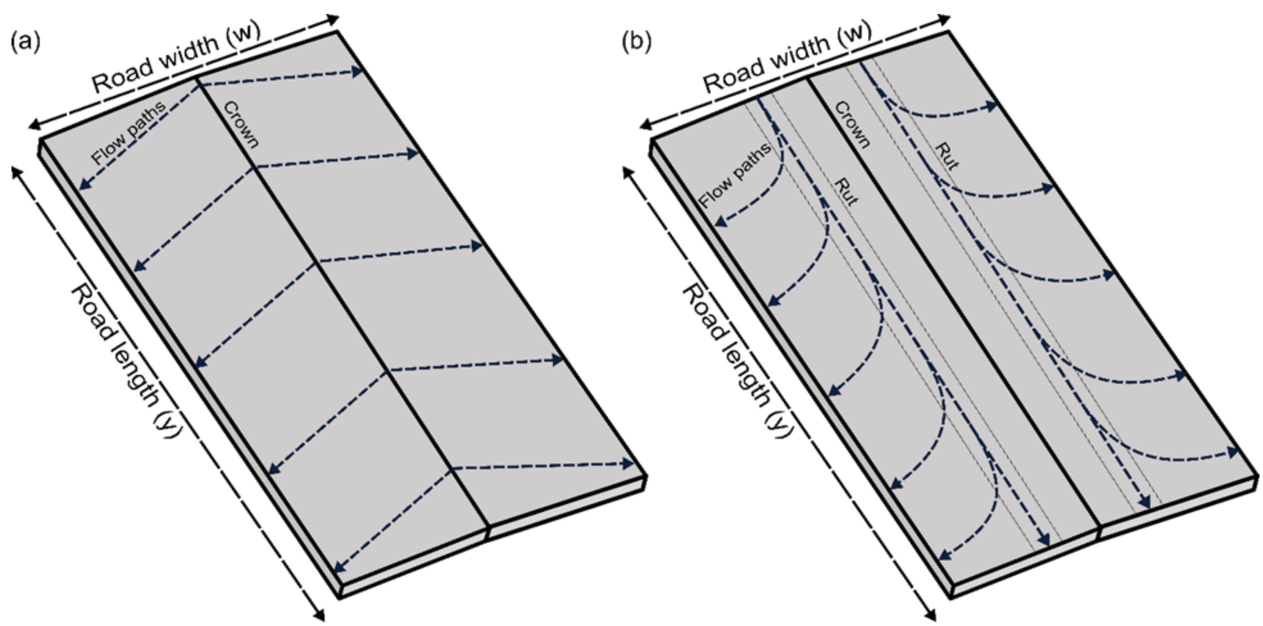

Figure 7. Schematic of a crowned road segment showing the flow pathways for (a) an idealized (i.e., perfectly smooth) road surface and (b) a rutted road surface.

Table 2. Maximum rut incision in centimeters for all three seasons at both field study sites.

Site	Season	Maximum rut incision (cm)
KID-13	WSYR1	1.09
	DSYR1	0.68
	WSYR2	0.41
MEL-14	WSYR1	0.49
	DSYR1	0.79
	WSYR2	0.53

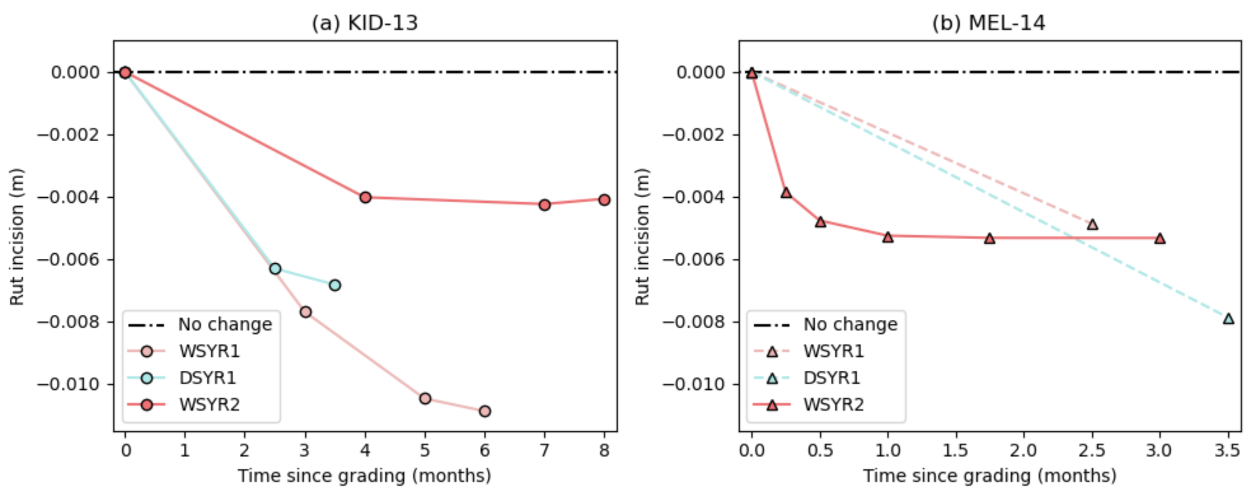

Figure 8. Plot showing the relationship between rut incision depth with respect to time since grading in months for (a) KID-13 and (b) MEL-14.

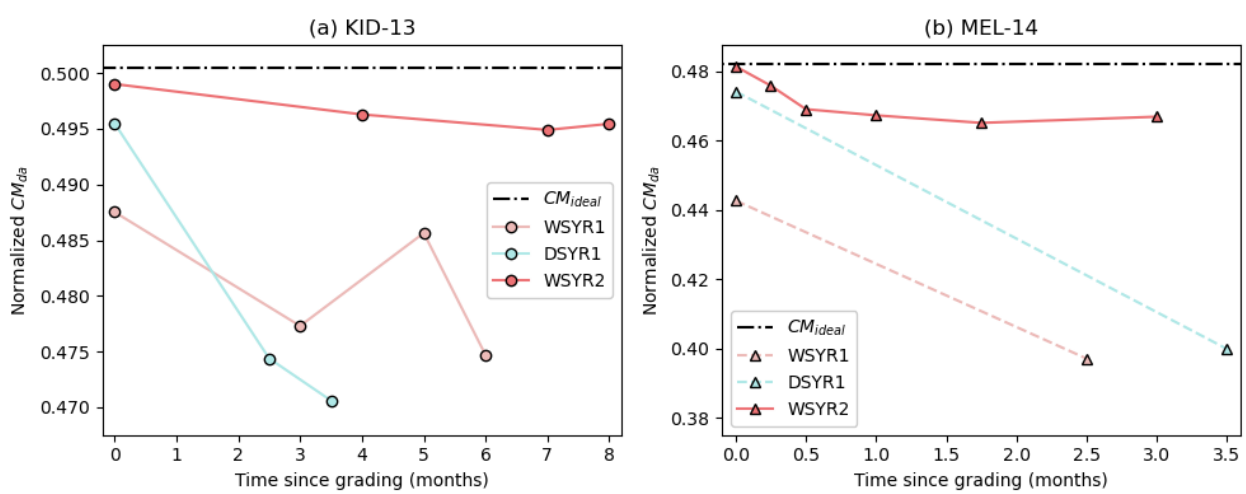

Figure 9. Plot showing the relationship between the normalized drainage area center of mass (CM_{da}) and time since grading in months for (a) KID-13 and (b) MEL-14.

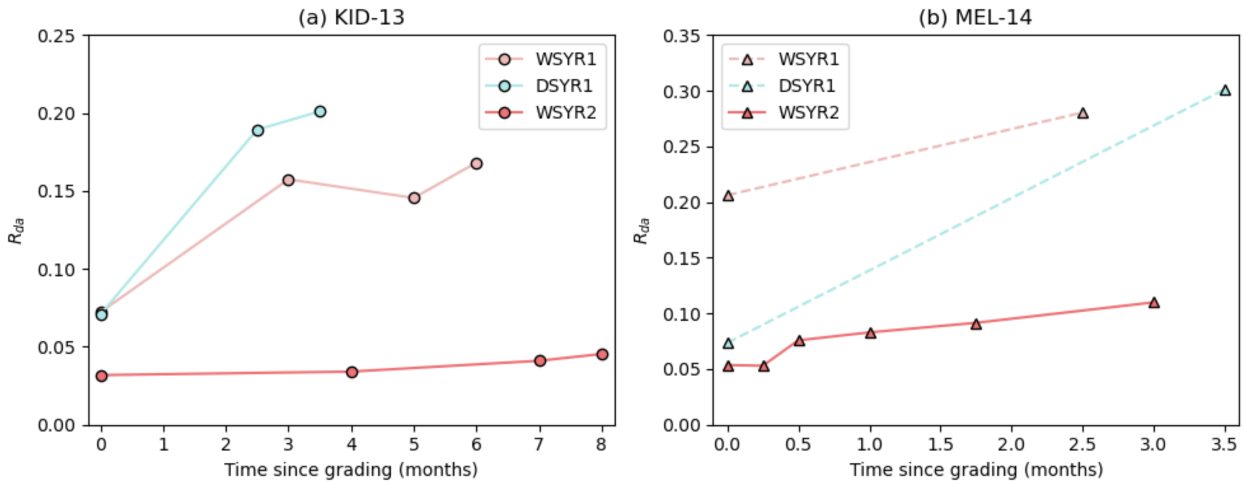

Figure 10. Plot showing the relationship between fraction of total drainage exiting through the lowest boundary of the road segment (R_{da}) and time since grading in months for (a) KID-13 and (b) MEL-14.