

Soil Disturbance Surveys in Pine Tree Plantations of the Basque Country

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Introduction

In commercially managed forests where stands are clear-cut and heavy machinery is used for harvesting and site preparation, the maintenance of forest soils sustainability is greatly questioned because plant cover is disturbed and the risk of erosion intensifies.

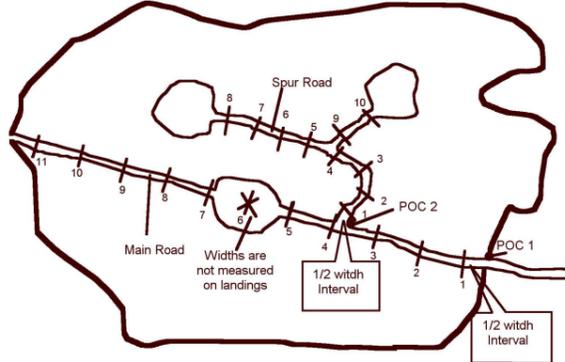
Pinus radiata plantations that are harvested every 30-40 years account for 60% of the forest surface in the Basque Country. Besides, the steep and mountainous terrain which is characteristic of the Atlantic part of the Basque Country along with the high precipitation that is distributed all year round (1500-2000 mm year⁻¹) makes erosion hazard to be very high in this region, mostly during inter-rotation period. Almost all the harvesting and over 50% of site preparation involve the use of heavy machinery in the Basque Country. In the Basque Country the effect of mechanisation during the first year may lead erosion to change from 8 tn/ha when site preparation is done manually to 60 tn/ha when machinery is used for this purpose (Olarieta et al. 1997). The effect of machinery can also be seen in terms of a 50% reduction of organic matter in forest soils and significant reductions of other essential nutrients (Merino et al 1998; Merino & Edeso, 1999; Olarieta et al. 1999).

Objective

To develop a quick and easy procedure to measure the disturbance of the soil caused by forest practices during harvesting and site preparation in the Basque Country based on "Soil Conservation Survey Guidebook" published by B.C. Ministry of Forest in "Forest Practices Code of British Columbia Guidebook" series (2001), in order to assess the effects of the use of heavy machinery and to evaluate forest practices themselves.

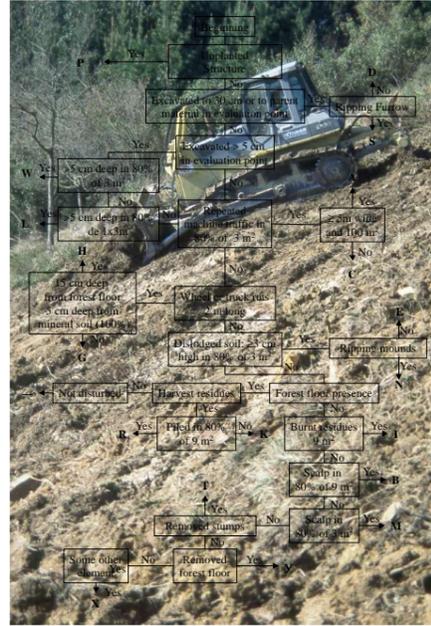
Survey Method

Lineal Structure Surveying

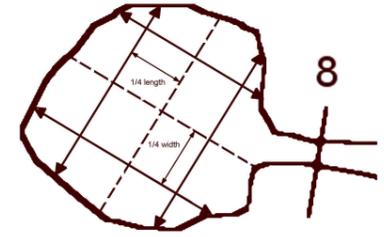


Lineal structures are, for example roads, fire-brakes or electrical lines. For each structure the whole horizontal length and at least ten horizontal widths will be measured to estimate the area occupied by it. The width is measured as the distance from the outer points of it considering as part of the structure the upper part of the cut and the end of the horizontal plane unless if there is a fill that is 2 m wide. If this happens, and if the fill is left unplanted the fill is also considered as part of the structure. The length of this interval and its slope is then recorded along with the width of the structure at that point and its slope.

Transect Surveys for Disturbances Categories



Non-linear Structure Surveying



Non-linear structures are, for example landing areas. Four measures are taken in each structure. The mean of the horizontal lengths and of the horizontal widths are calculated and the area is estimated as the product of these figures for each of them, that can afterwards be added up to estimate the percentage area occupied by these structures.

Soil Disturbance



Compacted areas

Big Compacted Areas (A): i) at the survey point and ii) compaction on 100% of an area of 100m². Small Compacted Areas (C): i) at the survey point and ii) compaction on at least 80% of an area of 3 m².



Gouges

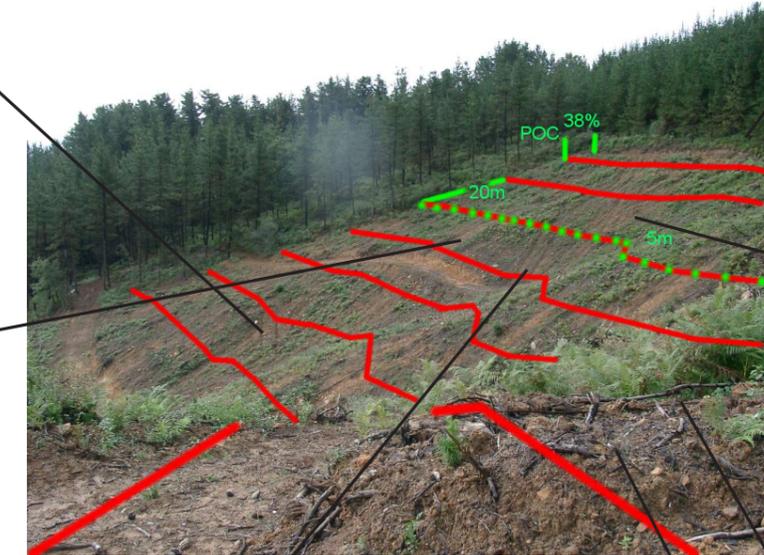
Deep gouges (D): Excavations into mineral soil deeper than 30 cm measured from undisturbed mineral soil or to bedrock at the survey point.

Wide gouges (W): Excavations into mineral soil that are i) deeper than 5 cm measured from undisturbed mineral soil at the survey point and ii) deeper than 5 cm or to bedrock, on at least 80% of an area of 3 m².

Long gouges (L): Excavations into mineral soil that are i) deeper than 5 cm measured from undisturbed mineral soil at the survey point and ii) deeper than 5 cm or to bedrock on at least 80% of an area 1 x 3 m.

Ripping furrows (S): Furrow generated during site preparation using a ripper or similar equipment at the survey point. The angle deviation from the horizontal line is also measured at the bottom of the trench. If ripping is a prescribed operation, the category where the furrow trench at the survey point lies is also recorded.

Ripping mounds (rest-balk) (N): Rest-balk generated during site preparation using a ripper or similar equipment at the survey point. If ripping is a prescribed operation the category where the mound lies at the survey point is also noted.



Wheel or track ruts

Deep Ruts (H): Impressions in the soil with a width of 30 cm and a minimum depth of 15 cm from the forest floor or 5 cm from the mineral soil at the deepest point in the perpendicular cross-section, over the entire length of 2 m.

Superficial Ruts (G): Impressions in the soil with a width of 20 cm and a minimum depth of 5 cm measured from the mineral soil at the deepest point in the perpendicular cross-section, on at least 50% of a length of 2 m.



Dislodged soil

Dislodged soil (E): Accumulations of dislodged mineral soil (mounds) with or without harvest residues that are i) higher than 5 cm at the survey point and ii) higher than 5 cm on at least 80% of an area of 3m².

Removed stumps (T): Stumps that have been pushed out from the soil by the machinery. It may be the stump itself or the hole left when the stump was removed.



Not disturbed



Scalps

Very Wide Scalps (B): Areas where the forest floor has been removed i) at the survey point and ii) forest floor removed at least 80% on an area 9 m². Wide Scalps (M): Areas where the forest floor has been removed i) at the survey point and ii) forest floor removed at least 80% on an area 3 m². This category is not considered when the prescription allows the use of machinery.



Harvest Residues

Wide Harvest Residues (R): Piles of harvest residues higher than 30 cm i) at the survey point and ii) piles occupying at least 80% of an area of 9 m². Harvest Residues.

Windrows (K): Harvest residues piled on strips i) at the survey point and ii) residues on at least 80% of an area of 4 x 0.5 m.

Burnt Harvest Residues (I): Piles of burnt harvest residues i) at the survey point and ii) burnt residues occupying an area of 3 m². Burnt residues will be considered if the underlying soil shows a massive and oxidised structure different from undisturbed soil.

Results

Table 1. Results from forest soil disturbance surveys carried out during 2003 in 15 stands in the Basque Country. Stands are divided by site preparation practice. All of them were harvested with skidder. The name of the locality served as code for each stand. "Unplanted structures" is the percentage of the area occupied by these structures referred to the whole stand minus the confidence interval for the one sided distribution at 90% probability. "Disturbed area" and "forest floor removal" are the percentage of the area occupied by these categories referred to the planted area (stand surface minus unplanted area). Confidence interval for the binomial distribution at the 90% probability is subtracted to this figure. "Ripping furrows" is the percentage of furrows in slopes >30% referred to the total number of furrows surveyed. Mean slope (%) of these furrows in brackets.

	Surface (ha)	Mean slope (%)	Harvest residues	Unplanted Area (%)	Disturbed Area (%)	Forest floor Removal (%)	Ripping furrows in slopes > 30%
Manual site preparation							
Aretxabalagane	0.5	15	Windrows	7.51-0.32	59-5.5	47-5.6	NR*
Autzagane	1.5	14	Removed	2.29-0.14	47-6.9	57-3.8	NR*
Astei	1.5	39	Removed	9.53-0.63	74-6.1	70-5.7	NR*
Egia	1.5	25	Removed	3.13-0.21	21-5.7	22-5.8	NR*
Etaso 1	0.25	10	Windrows	7.5-0.46	75-6.1	73-5.9	NR*
Santa Lucía 1	1.5	30	Burnt	20.66-1.1	83-4.3	77-5.0	NR*
Sarasolaide	2.5	10	Removed	1.56-0.099	55-4.8	49-4.8	NR*
Xaibiko Landa 1	0.6	20	Removed	9.50-0.75	41-6.8	40-6.8	NR*
Xaibiko Landa 2	0.5	10	Removed	9.20-0.66	38-6.8	31-6.5	NR*
Mean (sd.)	1.2 (0.7)	19.2 (10.2)		7.8 (5.7)	55 (20.2)	52 (19.1)	
Mechanical site preparation							
Baluga	5.0	25	Piled	22.43-2.11	87-2.9	91-4.2	21.7 [38.33]
Etaso 2	0.75	10	Windrows	1.73-0.11	40-6.8	44-6.9	0 [0]
Maiaga	0.4	14	Removed	5.64-0.33	62-6.8	64-5.0	0 [0]
Santa Lucía 2	0.8	46	Removed	6.63-0.48	97-2.7	97-6.9	66.7 [52.36]
Txarreta	0.7	31.5	Removed	10.14-0.78	81-4.5	85-5.3	27.8 [42.71]
Txorierrota	1.5	12	Burnt	8.37-0.42	74-6.1	75-6.1	5.9 [32.49]
Mean (sd.)	1.5 (1.7)	23.1 (14.0)		9.2 (7.1)	73 (20.2)	76 (19.6)	20.4 (25.5)

Conclusion

The soil disturbance survey tool developed in this study has been shown as very useful one. It is easy to perform and once disturbance categories are redefined for each particular forest management system and when the electronic records are developed it is a very quick evaluation procedure that could be implemented as a feedback tool towards Sustainable Forest Management.

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