Dataset Documentation

Solute concentrations in water samples from clearfelled and standing Sitka spruce (*Picea sitchensis*) forest ecosystems, Kershope Forest

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Dataset Summary

Dataset Name:	1. Solute concentrations in drainage water from clearfelled and standing Sitka spruce forest at Kershope, England. 2. Solute concentrations in water samples from a clearfelled and standing Sitka spruce forest ecosystem at Kershope, England.
Dataset Description:	Solute concentrations (Potassium, Calcium, Magnesium, Iron, Sodium, Aluminium, Phosphate, Nitrate, Ammonium, Chlorine, Sulphate), also pH and suspended solids, in waters sampled from clearfelled and standing Sitka spruce forest ecosystems
Geographic Coverage:	Block 1 of the Crookburn Hill Drainage Experiment, Kershope Forest, Cumbria, England. NY493790
Time Period:	17/6/1981 – 30/12/1987 (drainage water) 17/6/1981 – 23/12/1985 (water samples)
Data Categories:	• Solute concentrations from water samples taken from main exit drain of each plot • Solute concentrations from water samples taken from : Soil solution samplers, lysimeters, rainfall, stemflow, throughfall, throughflow, needle trays
Survey Design & Methods:	Data were collected from experimental plots in one block from an experiment established to look at forest hydrology. Samples of water from soil solution samplers, lysimeters, rainfall, stemflow, throughfall, Knapp throughflow samplers and needle trays were collected weekly from the ditch systems of six plots, 3 draining standing forest, the other ground felled at 35 years of age. When sampling began all plots had standing forest and after a comparison period felling took place on three. Samples were collected by staff from the Institute of Terrestrial Ecology (ITE), Merlewood, Grange over Sands, Cumbria. Chemical analysis of samples was undertaken by the Chemical Analysis Section, ITE Merlewood, Cumbria.
Key documents & publications:	• The effect of clear felling a Sitka spruce (Picea sitchensis) plantation on solute concentrations in drainage water (1990). Adamson, J. K.; Hornung, M. Journal of Hydrology (Amsterdam) Vol. 116 No. 1-4 pp. 287-297 • Changes in Solute Chemistry of Drainage Waters Following the Clearfelling of a Sitka Spruce Plantation (1987) J. K. Adamson, M. Hornung, D. G. Pyatt, A. R. Anderson Forestry 60 (2): 165-177. doi: 10.1093/forestry/60.2.165
Originator Details:	J.K. Adamson, Institute of Terrestrial Ecology, Merlewood Research Station, Grange over Sands, Cumbria.

Kershope Forest - Background to dataset

This work formed part of a programme of field and laboratory work to determine the effects of felling plantation forest on soil processes.

In upland Britain, large areas of nutrient-poor, former sheep grazing land were planted with Sitka spruce (*Picea sitchensis*) in the second half of the 20th century. Many of these plantations were due to be clearfelled before the end of the 20th century.

Clearfelling results in changes in:

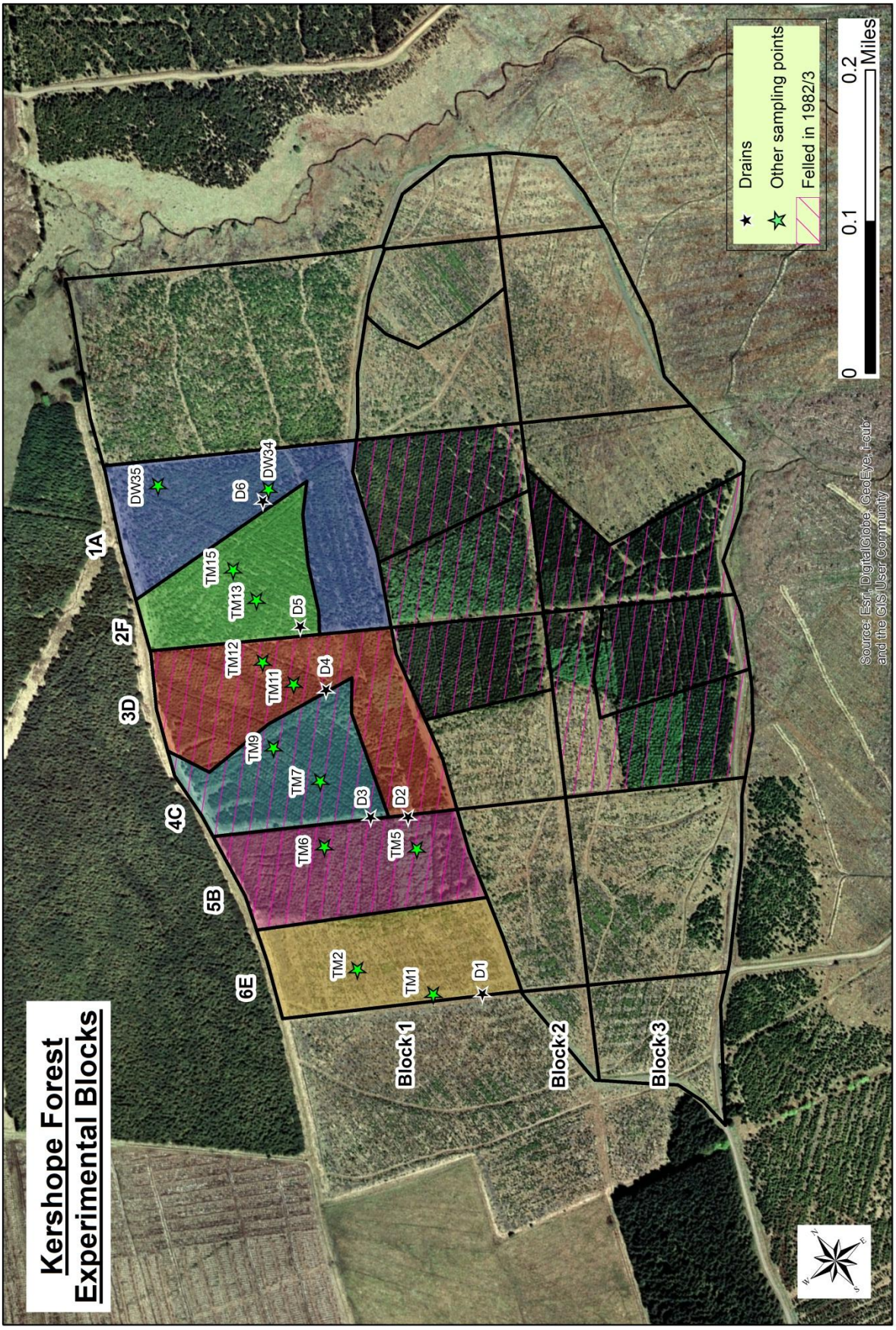
i. soil decomposer activity, because of changes in temperature and moisture regimes;
ii. increases in material for decomposition (branches etc);
iii. the cessation of nutrient uptake by roots.

Research around the world indicates that these processes may cause a significant loss of plant nutrients in drainage water, resulting in reduced soil fertility. To determine if the clearfelling of spruce plantations would have a significant impact on soil fertility in Britain, research was conducted at Kershope Forest in Cumbria.

Water was collected for analysis from 6 ditch systems, each of which drained a separate plot of approximately 2 ha. All plots were on a peaty gley soil which had never been fertilized and which were planted with Sitka spruce in 1948. Three plots were felled during the period of the study. Sampling began 2 years before felling was completed and continued at weekly intervals, on standing and felled plots. To determine the sources of nutrient fluxes and likely effects on the next forest rotation, water was also sampled at all stages in its passage through the standing and felled forest systems (including 4 soil horizons).

The hydrological impact of felling on this site was studied by staff of the Forestry Commission's Northern Research Station (Graham Pyatt, Russell Anderson, Duncan Ray). A companion site using similar field and laboratory methods was operated at Beddgelert Forest by staff of the Institute of Terrestrial Ecology's Bangor Research Station (Mike Hornung, Mark Hill and Paul Stevens). Some of the analysis of data from Kershope and Beddgelert was undertaken by Colin Neal of the Institute of Hydrology (later CEH Wallingford).

Geographical Coverage



Kershope Forest - Experimental Design and Site Description

The catchments used in the study were adjacent plots of a drainage experiment (see Pyatt et al., 1985) in Kershope Forest, Cumbria (see map on page 3).

The site had formerly been upland grassland, which was ploughed and planted with Sitka spruce (*Picea sitchensis*) in 1948. The former drainage experiment comprised three blocks, each containing six plots with a range of drain spacings and drain depths (see below). The drains were open and dug between 1965 and 1968, replacing the pattern of drainage which existed on the plots before afforestation. The drainage water from each plot was led away by a single exit drain.

For the solute concentration experiment in question, the plots were located in Block 1 of the original experiment. 6 plots were used: 3 were felled in 1983, 3 remained unfelled. After felling, drains from all plots were carefully cleared of felling debris.

The soils on the plots were Cambic stagnohumic gleys (Avery, 1980) developed in clay-rich till derived from the underlying Carboniferous rocks. This till, originally calcareous, has been calcified to a depth between 75 and 150cm and the upper limit of water saturation of the soil fluctuates between 30 and 80cm below ground surface. The slope on the plots varies between 1 and 5 degrees and their aspect is easterly. The mean altitude is 225m. Blocks range in area from approximately 2 to 3 hectares.

Block treatments:

Block	Treatment	Drain Spacing	Drain Depth	Felled?
1	A	40	60	No felling - control
2	F	10	90	No felling - control
3	D	40	90	May-Dec 1983
4	C	10	60	Apr-Oct 1983
5	B	20	60	May-Dec 1983
6	E	20	90	No felling - control

Drainage waters

Drainage water from the main exit drain of each plot was sampled at weekly intervals from 1981 to 1987. To ensure that moving water was sampled and to avoid contamination of samples by disturbance of the drain floor, a 2m length of 15cm diameter PVC pipe was installed at the drain sampling point so that all water leaving the plot was channelled through it. The instantaneous discharge of each drain was recorded at sampling using a V-notch weir. A small number of extra samples were taken at times of flood.

Water from other parts of the forest ecosystem

Samples were taken from:

Soil solution samplers and lysimeters

Each plot had two sets of samplers located adjacent to either a Tensiometer (Tm) or Dip Well (DW). Each set of samplers consisted of two lysimeters (L [litter] and O [organic] horizons) and three soil solution samplers (O [organic], E [eluviated]), and B [illuviated] horizons).

Water entered the the lysimeter samplers under gravity after passing through the horizon(s) above (L and O). Samples were not taken when the lysimeters were flooded.

Water was drawn into soil solution samplers under vacuum and then removed from the sampler by pumping.

Samples were collected fortnightly.

Rainfall

Bulk precipitation was collected in 3 15-cm-diameter polypropylene funnel assemblies and bottles enclosed in PVC drainage pipe to exclude light from the samples. Rings of plastic cocktail sticks were fitted to the rims of the funnels to prevent birds from perching, and plugs of 500-/~m polyester mesh were inserted into the neck of the funnels to exclude debris. Collectors were installed with rims 70 cm from the ground. Samples were collected weekly volume was measured upon arrival of the samples in the laboratory.

Stemflow

Stemflow was collected from a selection of representative trees by being trapped by PVC tubing attached to the stems in a spiral and sealed with an inert sealant. Trunk diameters of all trees in the plot were measured and divided into four size-classes. Two collectors were fitted to trees selected at random within each size-class. The spirals were connected to tipping buckets and sample-splitters to provide stemflow volume data and samples for analysis. Equal volumes were bulked to provide a single sample every 2 weeks for analysis.

Throughfall

Throughfall was collected from static throughfall samplers sited at random near the experimental plots. Samples were bulked to provide a single sample for analysis each fortnight.

Knapp throughflow
Water flow through the soil was measured by using throughflow troughs as described by (Knapp, 1973).
Note: The throughflow data is not thought to be reliable due to problems with the sampling equipment.

Needle trays
Brash (needle) throughfall was sampled every two weeks, in five 16cm by 21cm plastic seed trays with outlet spouts located at random beneath fresh brash such that falling needles accumulated in the trays. Samples from the five trays were bulked prior to analysis at fortnightly intervals.

Chemical analysis methods

Samples were analysed in the Chemical Laboratories, Merlewood Research Station, Grange-over-Sands, Cumbria.

In the laboratory, a combination pH electrode was immersed in a sub-sample of water which was then stirred and allowed to settle for 1 minute before the reading was taken. The remaining sample was filtered through a glass fibre filter (Whatman GF/F rinsed through with distilled water). Calcium, magnesium, aluminium and iron were determined by atomic absorption spectrophotometry, and sodium and potassium by flame emission spectrometry. The molybdenum blue method with $SnCl_2$ reductant was used for phosphate-P (Allen, 1989) and the indophenol blue method for ammonium-N (Rowland, 1983). In the early years of the study, the thiocynate method was used for chloride (Allen, 1989), nitrate was reduced with hydrazine and the NO2 determined using the Griess-Hosvay method (Rowland et al., 1984) and sulphate-S was determined by the barium chloride turbimetric method; in the latter years, these ions were determined using ion chromatography. However, the old and new methods were used concurrently for three months to ensure the methods were comparable.
Suspended solids (TSS) and Total Organic Carbon (TOC) were measured using standard techniques as outlined in Allen (1989).

Kershope Forest - Dataset Descriptions

'Drainsker.csv' *(Format: Comma separated values)*
Solute concentrations in drainage water from clearfelled and standing Sitka spruce forest at Kershope, England. Contains solute data from 6 main drains as described above. (Note: The code"-1" is used if no sample was taken).

Column	Description	Unit
SAMPLING	Sampling occasion	-
SAMPLING_DATE	Sampling date	-
SAMPLE	Sample code	-
FLOW	Measurement of water discharge from drain	$m^3 s^{-1}$
SUSP	Suspended solids	mg l^{-1}
PH	pH value	pH
K	Potassium	mg l^{-1}
CA	Calcium	mg l^{-1}
MG	Magnesium	mg l^{-1}
FE	Iron	mg l^{-1}
NA	Sodium	mg l^{-1}
AL	Aluminium	mg l^{-1}
PO4P	Phosphate-P	mg l^{-1}
NO3N	Nitrate-N	mg l^{-1}
NH4N	Ammonium-N	mg l^{-1}
CL	Chlorine	mg l^{-1}
SO4S	Sulphate-S	mg l^{-1}
TOC	Total organic carbon	mg l^{-1}

Drain information

Drain sample number	Block Number	Felled?
D6	1A	No felling - control
D5	2F	No felling - control
D4	3D	May-Dec 1983
D3	4C	Apr-Oct 1983
D2	5B	May-Dec 1983
D1	6E	No felling - control

'Soilsker.csv' *(Format: Comma separated values)*

Solute concentrations in water samples from a clearfelled and standing Sitka spruce forest ecosystem at Kershope, England. Contains solute data from water samples taken from different samplers as described above.

Column	Description	Unit
WEEK	Numeric week code	-
WEEK_DATE	Date of sampling week	-
SAMPLE	Sample code (see table below)	-
VOL	Volume of sample	ml
PH	pH value	pH
K	Potassium	mg l^{-1}
CA	Calcium	mg l^{-1}
MG	Magnesium	mg l^{-1}
FE	Iron	mg l^{-1}
NA	Sodium	mg l^{-1}
AL	Aluminium	mg l^{-1}
PO4P	Phosphate-P	mg l^{-1}
NO3N	Nitrate-N	mg l^{-1}
NO4N	Ammonium-N	mg l^{-1}
CL	Chlorine	mg l^{-1}
SO4S	Sulphate-S	mg l^{-1}
TOC	Total organic carbon	mg l^{-1}

"-1" in a column indicates no sample analysed
In the Volume column:
"-4" Denotes full bottles for R1, R2, N1, N2
"-5" Denotes full bottles for the litter lysimeters and R3
"-8" Denotes a flooded lysimeter
It is not known what codes "-2", or "-3" denote.

Key to sample Codes in "Soilsker.csv" *(supplied as: 'Kershope_codes.csv'):*

Sampling Location	Plot	Sample Code	Code	Horizon	Description	Sample Type
		N1	N	1	Felled	Needle trays
		N2	N	2	Felled	Needle trays
		N3	N	3	Unfelled	Needle trays
		N4	N	4	Unfelled	Needle trays
Site		F99				Stem-flow (bulked)
Site		R1	R	1	Rainfall sampler 1	Rainfall
Site		R2	R	2	Rainfall sampler 2	Rainfall
Site		R3	R	3	Rainfall sampler 3	Rainfall
Site		T99	T			Throughfall (bullked)
Unknown		K1	K		Knapp throughflow sampler	Throughflow
Unknown		K2	K		Knapp throughflow sampler	Throughflow
Unknown		K3	K		Knapp throughflow sampler	Throughflow
Unknown		K4	K		Knapp throughflow sampler	Throughflow
DW34	1	L23L	L	L	L horizon	Lysimeter
DW34	1	L24O	L	O	O (organic) horizon	Lysimeter
DW34	1	S30B	S	B	B horizon	Soil
DW34	1	S29E	S	E	E horizon	Soil
DW34	1	S36O	S	O	O (organic) horizon	Soil
DW35	1	L21L	L	L	L horizon	Lysimeter
DW35	1	L22O	L	O	O (organic) horizon	Lysimeter
DW35	1	S28B	S	B	B horizon	Soil
DW35	1	S27E	S	E	E horizon	Soil
DW35	1	S26O	S	O	O (organic) horizon	Soil
TM13	2	L17L	L	L	L horizon	Lysimeter
TM13	2	L18O	L	O	O (organic) horizon	Lysimeter
TM13	2	S23B	S	B	B horizon	Soil
TM13	2	S22E	S	E	E horizon	Soil
TM13	2	S21O	S	O	O (organic) horizon	Soil
TM15	2	L19L	L	L	L horizon	Lysimeter
TM15	2	L20O	L	O	O (organic) horizon	Lysimeter
TM15	2	S25B	S	B	B horizon	Soil
TM15	2	S24E	S	E	E horizon	Soil
TM15	2	S35O	S	O	O (organic) horizon	Soil
TM11	3	L13L	L	L	L horizon	Lysimeter
TM11	3	L14O	L	O	O (organic) horizon	Lysimeter
TM11	3	S18B	S	B	B horizon	Soil
TM11	3	S17E	S	E	E horizon	Soil
TM11	3	S16O	S	O	O (organic) horizon	Soil
TM12	3	L15L	L	L	L horizon	Lysimeter
TM12	3	L16O	L	O	O (organic) horizon	Lysimeter
TM12	3	S20B	S	B	B horizon	Soil
TM12	3	S19E	S	E	E horizon	Soil

TM12	3	S34O	S	O	O (organic) horizon	Soil
TM7	4	L9L	L	L	L horizon	Lysimeter
TM7	4	L10O	L	O	O (organic) horizon	Lysimeter
TM7	4	S12B	S	B	B horizon	Soil
TM7	4	S11E	S	E	E horizon	Soil
TM7	4	S33O	S	O	O (organic) horizon	Soil
TM9	4	L11L	L	L	L horizon	Lysimeter
TM9	4	L12O	L	O	O (organic) horizon	Lysimeter
TM9	4	S15B	S	B	B horizon	Soil
TM9	4	S14E	S	E	E horizon	Soil
TM9	4	S13O	S	O	O (organic) horizon	Soil
TM5	5	L5L	L	L	L horizon	Lysimeter
TM5	5	L6O	L	O	O (organic) horizon	Lysimeter
TM5	5	S7B	S	B	B horizon	Soil
TM5	5	S6E	S	E	E horizon	Soil
TM5	5	S32O	S	O	O (organic) horizon	Soil
TM6	5	L7L	L	L	L horizon	Lysimeter
TM6	5	L8O	L	O	O (organic) horizon	Lysimeter
TM6	5	S10B	S	B	B horizon	Soil
TM6	5	S9E	S	E	E horizon	Soil
TM6	5	S8O	S	O	O (organic) horizon	Soil
TM1	6	L1L	L	L	L horizon	Lysimeter
TM1	6	L2O	L	O	O (organic) horizon	Lysimeter
TM1	6	S3B	S	B	B horizon	Soil
TM1	6	S2E	S	E	E horizon	Soil
TM1	6	S1O	S	O	O (organic) horizon	Soil
TM2	6	L3L	L	L	L horizon	Lysimeter
TM2	6	L4O	L	O	O (organic) horizon	Lysimeter
TM2	6	S5B	S	B	B horizon	Soil
TM2	6	S4E	S	E	E horizon	Soil
TM2	6	S31O	S	O	O (organic) horizon	Soil

'Kershope_sampling_points.csv' *(Format: Comma separated values)*

Contains the sampling locations for the points listed in the table on page 9/10.

Column	Description	Unit
Sample_point	Name of sampling point (see table on p10).	-
Plot_name	Name of catchment plot	-
Felled	Date when felled if applicable, otherwise not felled	-
Block	Block 1 of original drainage experiment (Pyatt et al., 1985)	-
Drain_spacing	Distance between drain spacings	Metres
Drain_depth	Depth of drain	Centimetres
Easting	British National Grid OSGB1936 easting	Metres
Northing	British National Grid OSGB1936 northing	Metres

References and Further Reading

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- Neal, C., Reynolds, B., Adamson, J. K., Stevens, P. A., Neal, M., Harrow, M., & Hill, S. (1999). **Analysis of the impacts of major anion variations on surface water acidity particularly with regard to conifer harvesting: case studies from Wales and Northern England.** Hydrology and Earth System Sciences, 2(2/3), 303-322.
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