Comparison of test strip, conductivity, and novel smartphone digital image colorimetry methods for field assessment of soil chloride and salinity

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Supplementary information

SI.1 Calibration

Calibration standards were prepared from oven-dried NaCl (Normapure, VWR) which was precisely weighed to 4 decimal places. Calibration standards were prepared by serial dilution in deionised water at a concentration range from 0 - 2000 mg L^{-1} Calibration graphs for all methods other than DImC (which is shown in figure 3 of the main text) are shown in figures S1 and S2. A chloride standard solution (1000 mg L^{-1} Cl^- in water, Sigma-Aldrich) was used to prepare independent check solutions of 100 mg L^{-1} which were measured at regular intervals throughout the analysis.

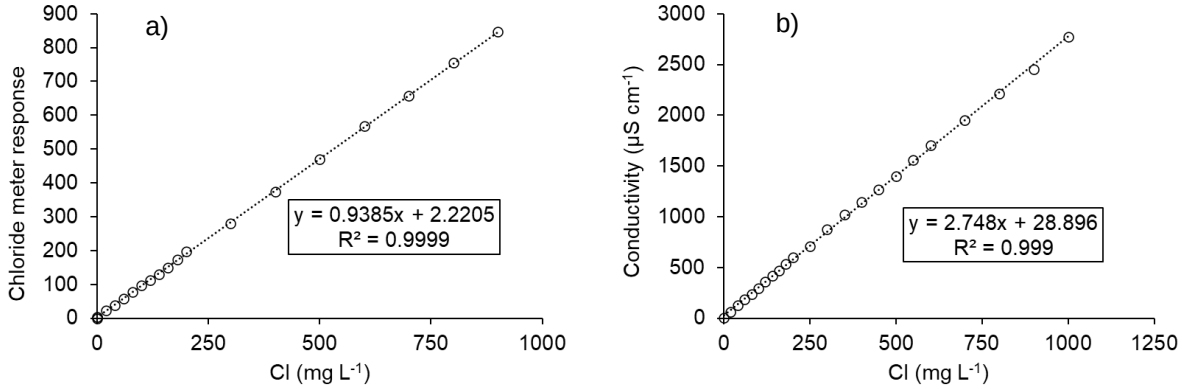

Figure S1 Calibration graphs prepared for analysis of a) chloride by CA and, b) by C_{ext}.

The analysis of standard solutions prepared from solid NaCl (AnalaR Normapur, VWR) by the CA and C_{ext} methods produced linear calibration curves for concentration ranges of 0 – 900 and 0 – 1000 mg L^{-1} Cl^-, respectively (figures S1 i. and ii., respectively). The concentration of

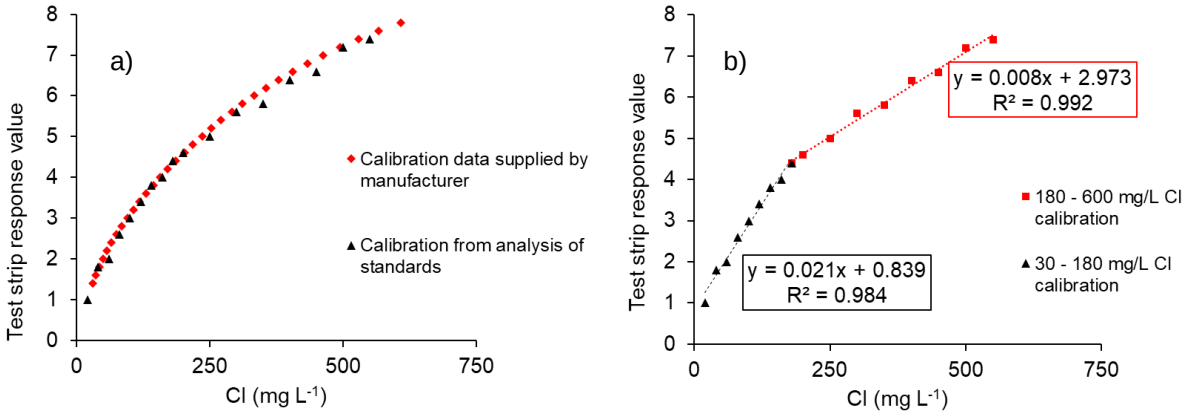

Figure S2 a) Calibration data supplied by manufacturer (red diamonds) and obtained from measurement of NaCl standard solutions (black triangles). b) Linear calibration models used for analysis of chloride by titration test strips for low (30 – 180 mg L^{-1}) and high (180 – 600 mg L^{-1}) concentration samples.

unknown samples was calculated from the linear calibration models which both had R^2 values of >0.99.

The analysis of standard solutions by the TS method yielded a curve which closely matched the calibration data supplied by the manufacturer (figure S2 i). The calibration data could be accurately modeled using a second order polynomial (R^2 = 0.989), however for ease of use, the results of the analysis of standard solutions were divided into two linear models (figure S2 ii) for determination of high (180 – 600 mg L^{-1}) and low concentration (30 – 180 mg L^{-1}) samples.

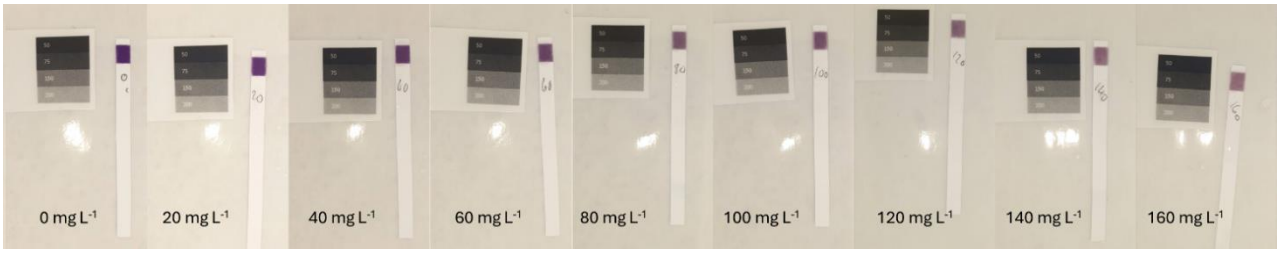

Figure S3. Images of the test strips after reaction with the Cl^- calibration standard solutions, from 0 – 160 mg L^{-1}. These images provide the data for the DImC calibration graphs given in Fig. 3 of the main text.

The images used to gather the data for the calibration graph in Fig. 3 of the main text are given in Fig S3. The purple reactive colour pad of the test strip becomes lighter with increasing Cl^- concentration. Table S1 shows the intensity of G pixels from the same images with and without the correction using the grayscale calibration card. In addition, the limit of detection (LOD) calculated from the uncorrected and corrected G pixel data shows that the correction improves the LOD from 30.50 mg L^{-1} to 20.30 mg L^{-1}.

Table S1. Values of G pixel intensity and calculated LOD for the image analysis data from calibration images with and without the correction using the grayscale calibration card applied

Cl (mg L^{-1})	G (uncorrected)	G (corrected)
0	41.77	44.97
20	59.14	55.73
40	61.91	74.88
60	71.51	87.36
80	74.60	97.76
100	82.70	109.13
120	97.53	126.39
140	102.88	137.92
160	109.13	146.97
LOD	30.50 mg L^{-1}	20.30 mg L^{-1}

SI.2 Summary statistics for the chloride analysis of Mersehead soils

Summary statistics for the analysis of chloride in samples from the Mersehead nature reserve by all methods are presented in tables S1 and S2. Many data points for the DImC, TS and CA methods were below the method LOD, whereas all samples were above the LOD of the C_{ext} method for dry soils, and only 4 below the LOD in the wet soil analysis.

Table S2 Summary statistics for the analysis of wet soils by each method

	n	Mean (mg kg^{-1})	Median (mg kg^{-1})	Min, Max (mg kg^{-1})
CA – all data	69	595.01	<33.25	<33.25, 6504.52
CA – values below LOD removed	26	1553.15	897.22	44.46, 6504.52
C_{ext} – all data	69	609.15	39.33	<1.5, 6020.36
C_{ext} – values below LOD removed	65	646.69	48.91	2.52, 6020.36
DImC – all data	66	633.25	<101.50	<101.50, 8189.54
DImC – values below LOD removed	24	1649.05	835.20	111.21, 8189.54

Table S3 Summary statistics for the analysis of dried soils by each method

	n	Mean (mg kg^{-1})	Median (mg kg^{-1})	Min, Max (mg kg^{-1})
CA – all data	69	649.62	43.52	<33.25, 6331.24
CA – values below LOD removed	46	962.51	80.35	38.10, 6331.24
C_{ext} – all data	69	796.58	133.12	52.92, 6778.58
C_{ext} – values below LOD removed	69	-	-	-
TS – all data	69	489.56	<150.00	<150.00, 5524.96
TS – values below LOD removed	22	962.51	1468.10	230.84, 5524.96
DImC – all data	69	711.41	<101.50	<101.50, 8297.60
DImC – values below LOD removed	26	1854.02	966.61	106.24, 8297.60

SI.3 Maps showing interpolated results of chloride analysis using dried soils

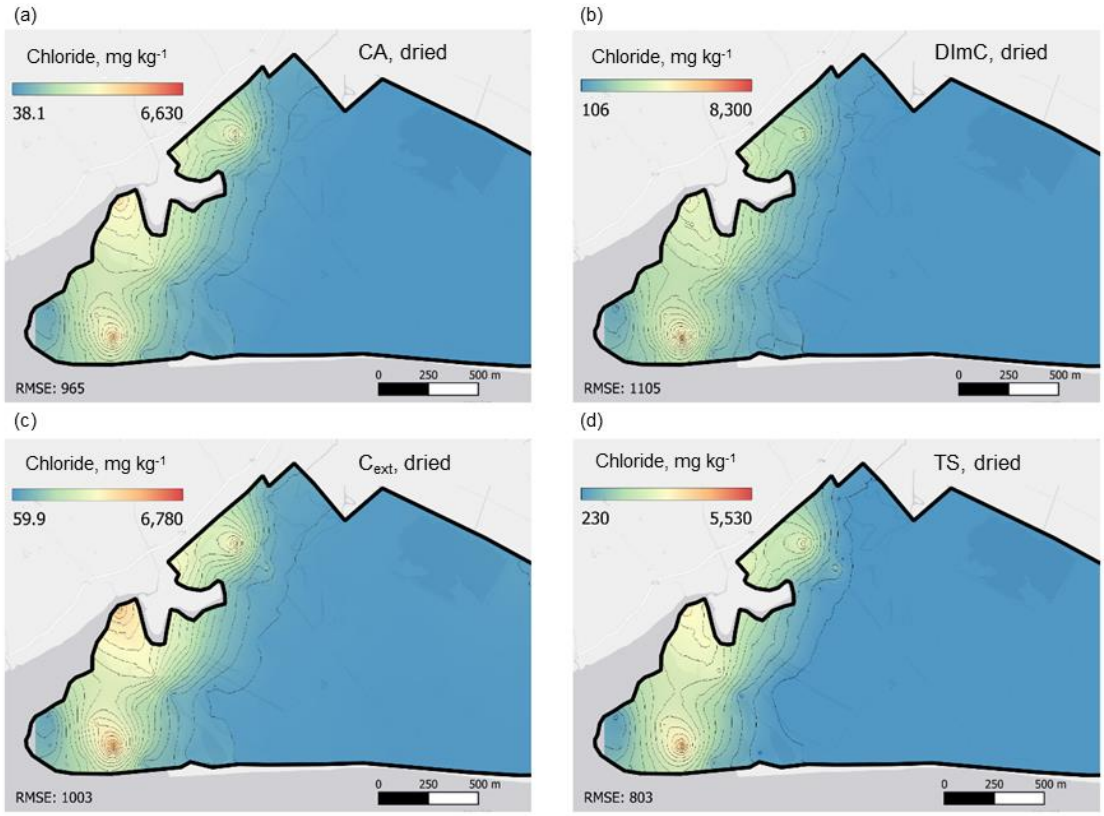

Figure S4. Interpolated chloride concentrations by different methods using dried soils at the Mersehead nature reserve. The methods used are: a) CA, b) DImC, c) C_{ext}, and d) TS. Residual Mean Squared Error (RSME) provided for each interpolation.