Observation of soil moisture dynamic at a landslide affected Alpine hillside using electromagnetic induction (EMI) and Kmeans clustering

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Motivation

Soil moisture and its spatial and temporal dynamic play a major role for landslides and their associated forecast (Talebi et al. 2007, Chambers et al. 2010)

Still difficult to obtain reliable information on spatial moisture dynamics for medium to large-scale areas

Information from soil moisture by means of electromagnetic induction (EMI) due to the (dependent) relationship between hydraulic and electric soil conditions (Dietrich 1999)

Partition of separate areas with significant differences in soil moisture dynamic

Methods

Methods

Test site **EMI survey**

nine-month monitoring with EM38 and 31 in both measurement modes (PD: 0.75m, 1.5m, 3m, and 6m); frequency 5Hz; track distance ~ 5m, approx. 8500 single data/survey

Methods

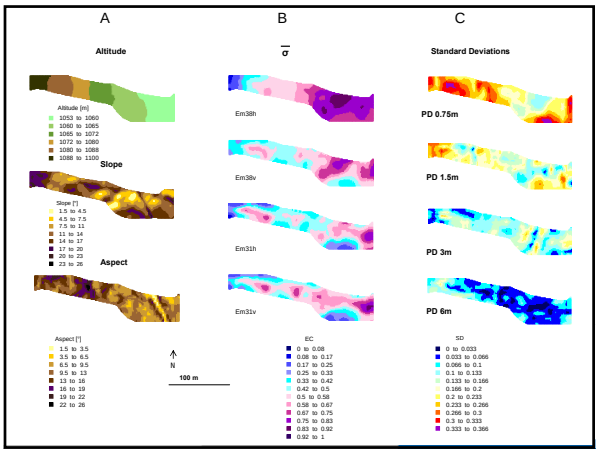
Generate EC map using six survey data and normalized them

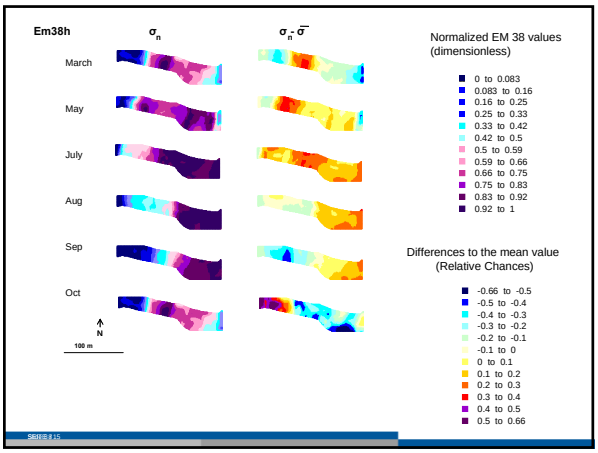
Separation of the dynamic moisture signal from the geological signal by subtraction of the temporal values from the mean values

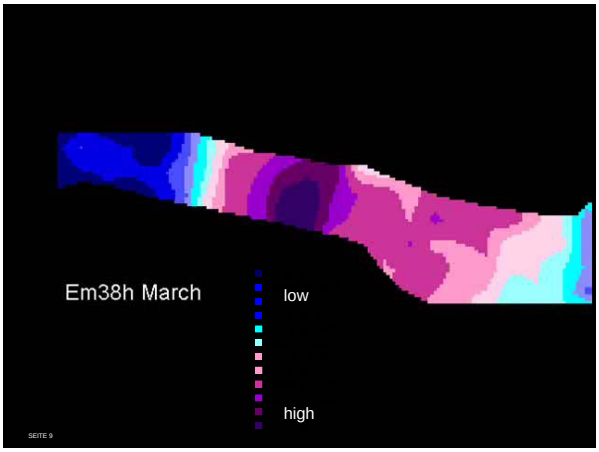
Identification of areas of higher and lower dynamics by standard deviation (SD) obtained from all temporal maps

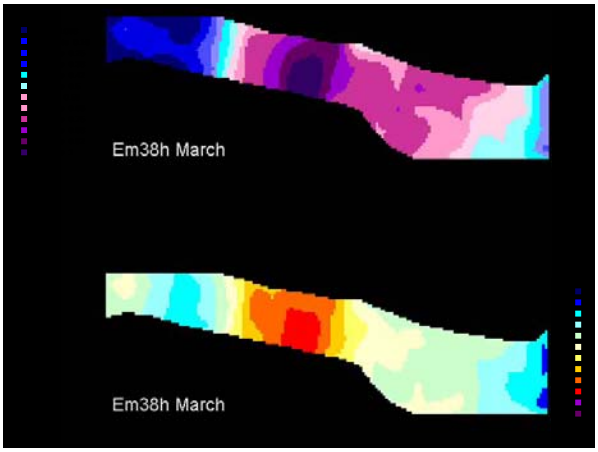
EC (SD) and topographic data used as input for K-means cluster algorithm for partitioning the test field

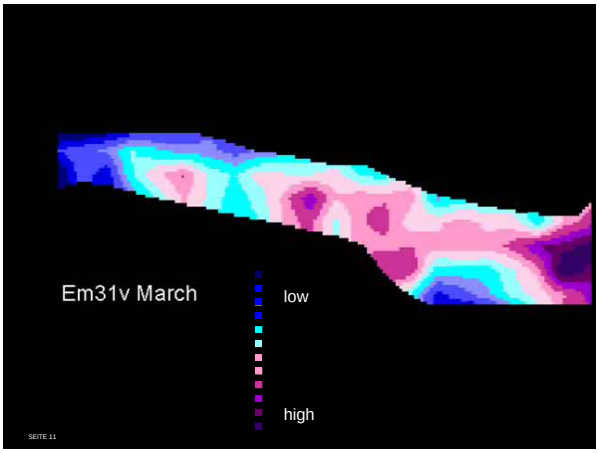
Results

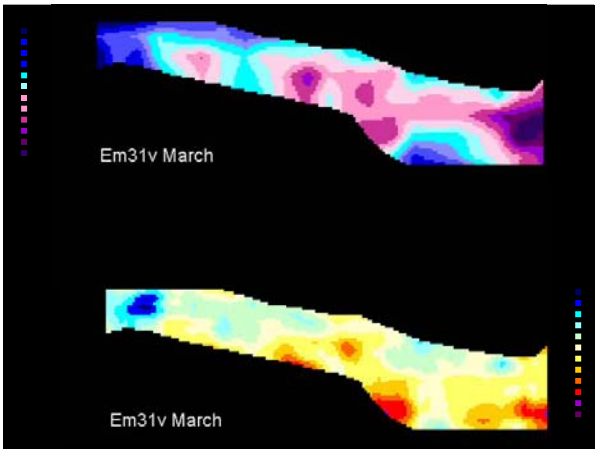

A
B
C
Altitude
Slope
Aspect
Standard Deviations
PD 0.75m
PD 1.5m
PD 3m
PD 6m
100 m


Em38h
March
May
July
Aug
Sep
Oct
Normalized EM 38 values
(dimensionless)
Differences to the mean value
(Relative Chances)
100 m

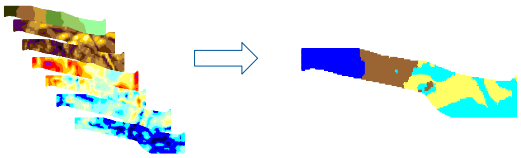

Em38h March
low
high
SEITE 9


Em38h March
Em38h March


Em31v March
low
high
SEITE 11


Em31v March
Em31v March

Motivation Methods **Results** Conclusion



Merging the fundamental characteristics of the input data by K-means clustering (MacQueen, 1967)

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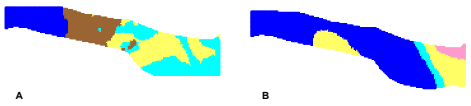
Motivation Methods **Results** Conclusion



A – Cluster results

B – Hydrotope map generated by vegetation, topography, moisture data, geological data (Lindemayer 2005)

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Motivation Methods Results **Conclusion**

Derived successfully the soil moisture dynamic from temporal and spatial EC maps

A two-layer system could be indentified: one upper (more dynamic layer) which is associated with hill E-W altitude and a deeper, more stationary layer with a N-E structure.

Working with normalized EMI data is a opportunity to face calibration challenges and for further working

The cluster partitions separate areas with significant differences in soil moisture dynamic

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Thank you!

References:

-Brevik, E.C., T.E. Fenton, and A. Lazari 2006. Soil electrical conductivity as a function of soil water content and implications for soil mapping. Precision Agriculture 7(6): 393-404.

-Chambers, J.E., P.B. Wilkinson, et al. 2010. Three-dimensional geophysical anatomy of an active landslide in Lias Group mudrocks, Cleveland basin, UK. Geomorphology.

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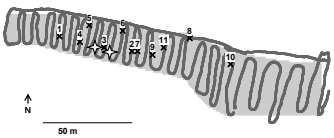
-McNeill, J. D. 1980a. Electrical conductivity of soils and rocks (Geonics Ltd., Mississauga, Soil textural class using electro-magnetic induction



SS #	clay 0-60	silt 0-60	sand 0-60	clay 60-100	silt 60-100	sand 60-100
1	20,67	57,62	21,71	43,36	49,04	7,60
2	33,34	45,69	20,97	36,00	47,00	17,00
3	22,86	56,47	20,67	41,32	44,52	14,17
4	25,67	51,48	22,85	25,67	51,48	22,85
5	42,21	42,52	15,27	42,21	42,52	15,27
6	33,73	51,72	14,55	34,14	51,49	14,37
7	37,39	50,90	11,71	45,38	37,19	17,43
8	42,84	45,93	11,24	42,84	45,93	11,24
9	43,56	41,52	14,92	45,63	40,25	14,11
10	29,89	53,38	16,73	29,71	50,91	19,38
11	19,57	49,97	30,46	18,76	64,96	16,28
Min	19,57	41,52	11,24	18,76	37,19	7,60
Max	43,56	57,62	30,46	45,63	64,96	22,85
Mean	33,34	50,90	16,73	41,32	47,00	15,27

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