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Hydrology and Earth System Sciences Discussions

Interactive comment on "A geophysical analysis of hydro-geomorphic controls within a headwater wetland in a granitic landscape, through ERI and IP" *by* E. S. Riddell et al.

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Anonymous Referee #3

Anonymous referee #2, the authors are grateful for your positive review. Technical corrections will be applied to the final manuscript.

The results chapter has now been divided into 3 parts: 4.1 2-D Surveys; 4.2 3-D Surveys; and 4.3 Verification; followed by chapter 5 Discussion and 6 Conclusion. Thank you for the reference to Lindenmaier et al., 2005 – whose inclusion of vegetation distribution in ERI interpretation is acknowledged. However the Manalana catchment here

does not have a representative vegetation for this area, it has a composition of a highly degraded savanna with low basal cover (this has now been described in the text). This has occurred as a result of enforced resettlement programs since the 1960s in this part of South Africa under the previous political dispensation. Therefore the role of present day vegetation cover on the pedogenic, hydrogeomorphic process described in this manuscript are considered un-related. A couple of sentences have been added to explain dominant vegetation presently on the slopes and in the wetland. Soil forms have been included in a new table along with mean soil moisture and groundwater readings for the time of surveys, a table of soil textures determined at each hydrometry station has also been added. A simplified geology has been added to Fig. 2 (see comment to Anonymous Referee #2). The validation of 3D IP readings was only possible through inferrrences from the qualitative methods deployed in the study, quantification of the augered ground truthing was unfortunately not possible at the resolution of inverted longitudinal 3D plots, whose first outputs commence at 0.5 m below the ground surface and therefore do not incorporate a fair calculation of error as some of the auger sites struck clay at a depth less than 0.5 m.

Page 1976. The references to Slater & Lesmes, 2002 and Slater and Reeves, 2002 were useful thank you. We have referred to these manuscripts on Page 1976.

Page 1978 Lowveld region, a lowland wooded savanna dominated by Acacia, Combretrum and Terminalia species. Temperature information has been added, and reference to decreasing precipitation away from the escarpment has been removed. We have introduced the concept of elluviation/illuviation with respect to dominant soil forms in the catchment and included a summary table with indicators of mean moisture content and groundwater levels (see comment to Anonymous Referee #2)

Page 1979 – a reference to a table summarising mean moisture contents and groundwater levels has been included. 3D ERI information has been included in the table (Fig 1 attached).

Page 1982-1983. Location descriptions of vegetation and land-use have been added to the descriptions of the ERI images. A simplified geology with the location of the dolerite dyke has been added to Fig. 2.(see comment to Anonymous Referee #2)

Page 1983. The hydrological responses that the authors cite as an internal report has now been cited to a manuscript in review on hillslope hydrological modeling.

Page 1984. Sentence re-written at line 1-3. The creation of ridge and furrow systems by digging and re-deposition of material in this way has consequently disaggregated the wetland substrate, reducing its bulk density and hence inducing higher relative apparent resistivity. The furrows themselves are up to approximately 1 m deep, below the top of the raised cultivation beds. It is likely that the traversing of the resistivity probes and cables across both the furrows and raised cultivation beds has allowed for a certain degree of distortion of the observed vertical resistivity distribution in this region of the wetland, allowing for an over exaggerated measurement of resistant material at depth.

Page 1984. The nomenclature of the piezometers has been changed in Fig 2. Fig 9 (Fig. 2 attached) and in the discussion. A few sentences are included in reference to the deeper peizometers and how the failure of the deeper peizometer at H8 to recharge to a shallow level as the 2 m pizeometer suggests at lack of recharge – and a partial separation of near surface groundwater to that of a slightly deeper water table. The units of display have been changed from mm to m (referring to a comment by Anonymous Referee #2).

Page 1985. Refers to close vicinity of the origin, this sentence has been edited.

Page 1988 – a correlation coefficient has been included in the paragraph for Log K against chargeability and resistivity. Log-K against chargeability at 0.65 against resistivity at -0.45.

Page 1992 - sentence has been added to highlight possible sources of uncertainty and

a reference made to paper by Oldenborger et al, 2005.

Table 1: now include monthly mean soil moisture and groundwater levels for October and November 2006, an antecendent precipitation index is also plotted (see comment to Anonymous Referee #2)

Fig. 2: Now Fig 3. Has been left as a separate figure but contains a simplified geology, better nomenclature for hydrometry stations, and coloured lines for transects.(see comment to Anonymous Referee #2)

Fig 4-7: Now Figs 5-8 in manuscript (Figs 3-6 attached). Positions of hydrometry stations have been superimposed

Fig 8: Now Fig 9. Name convention in accordance with Fig 3 and in metre units rather than millimeters.

Fig 15: Now Fig 16. Auger depths added, a depth scale for headcut and description of soil form added (Fig 7 attached).

Fig. 16: Now Fig 17. On page 1988 it was noted that these were single readings due to the very low recovery time of the wells to bail tests, such that these readings are treated with caution. Thus the lines are used to assist in interpreting the single reading 'scatter' plots. A correlation coefficient is now given in the text describing this figure.

References:

Lindenmayer, F., Zehe, E., Dittfurth, A., Ihringer, J.: Process identiïňĄcation at a slow-moving landslide in the Vorarlberg Alps, Hydrological Processes 19, 1635-1651, 2005.

Oldenborger, G.A., Routh, P.S., Knoll, M.D.: Sensitivity of electrical resistivity tomography data to electrode position errors. Geophysics Journal International, 163, 1-9, 2005

Slater, L.D., and Lesmes, D.: IP interpretation in environmental investigations, GEOPHYSICS, 67(1); 77-88, 2002.

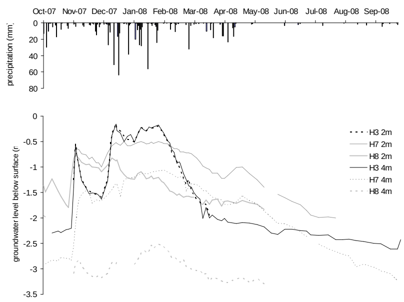
Slater, L.D. and Reeve, A.: Investigating peatland stratigraphy and hydrogeology using integrated electrical geophysics, GEOPHYSICS, 67(2); 365-378, 2002.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 1973, 2010.

ERT Survey	array type	electrode spacing (m)	date of survey	orientation	purpose
Gully longitudinal transect	Wenner-α (long)	2.5	May 2005	W-E	material and bedrock distribution wetland and gully floor
Transect 1	Schlumberger (short)	5*	November 2006	SW-NE	material and bedrock distribution hillslope-wetland-hillslope
Transect 2	Wenner-α (long)	5	October 2006	S-N	material and bedrock distribution hillslope-wetland-hillslope
Wetland transect	Wenner-α (short)	5*	October 2006	NW-SE	material and bedrock distribution
Longitudinal Grid Transects 3-D	Wenner-α (long)	2	July 2008	SW-NE & SE-NW	identify clay distribution underlying wetland
Grid Transects 3-D	Wenner-β (21 probe)	0.75	August 2008	SW-SE-NE-NW	identify clay distribution at wetland-footslope interface

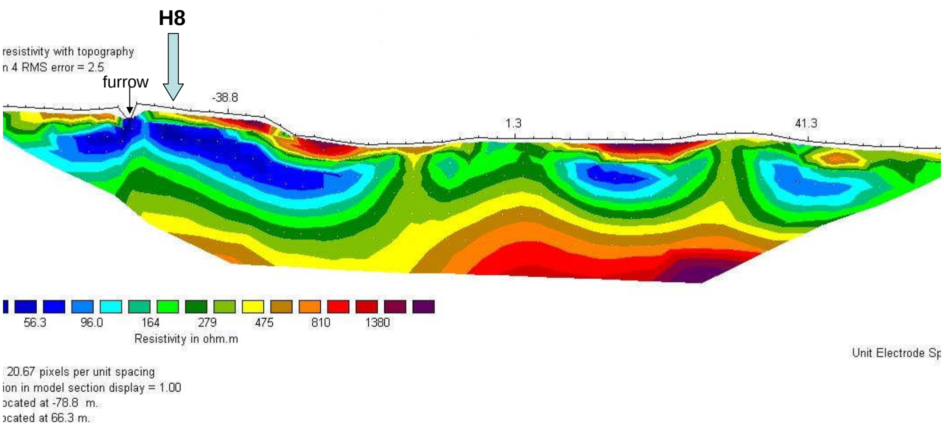
*used model refinement in inversion to half unit electrode spacing

Fig. 1.



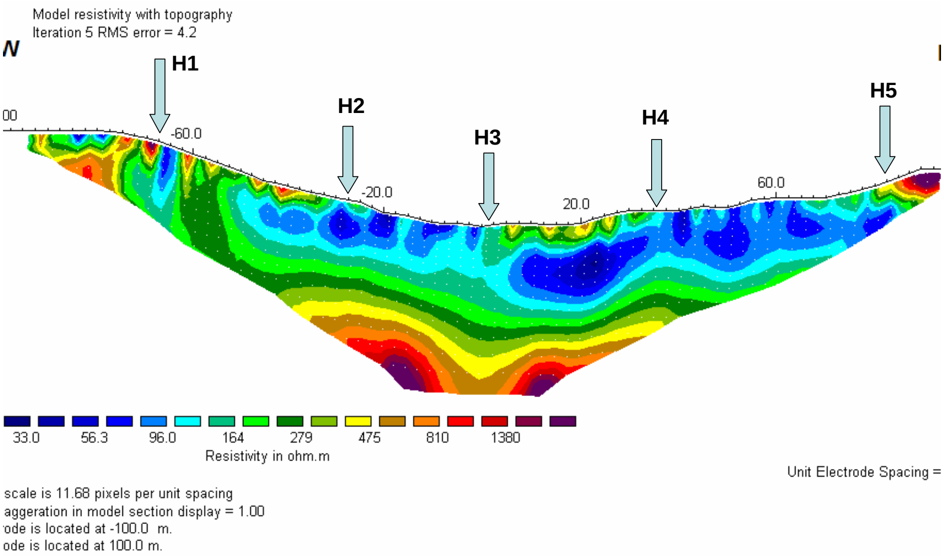
Oct-07 Nov-07 Dec-07 Jan-08 Feb-08 Mar-08 Apr-08 May-08 Jun-08 Jul-08 Aug-08 Sep-08
precipitation (mm
0
20
40
60
80
groundwater level below surface (r
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
H3 2m
H7 2m
H8 2m
H3 4m
H7 4m
H8 4m

Fig. 2.



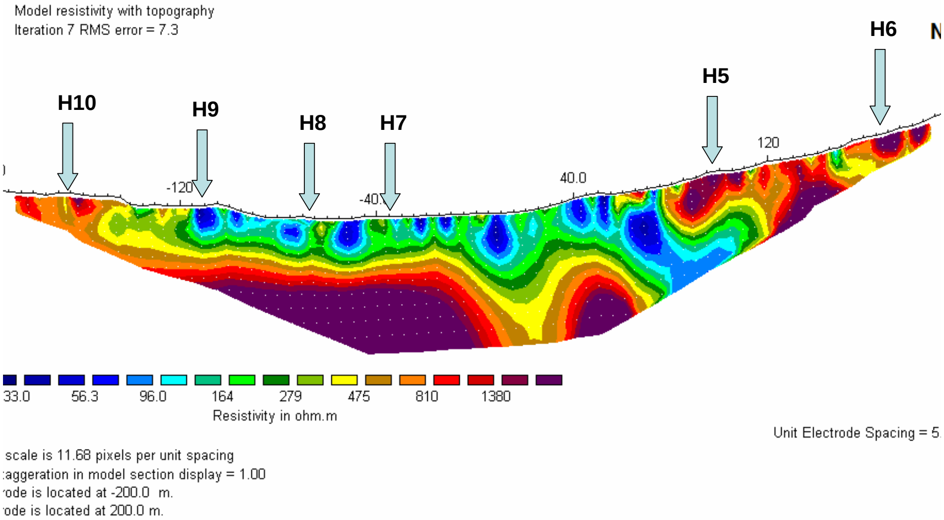
H8
resistivity with topography
n 4 RMS error = 2.5
furrow
-38.8
1.3
41.3
56.3
96.0
164
279
475
810
1380
Resistivity in ohm.m
Unit Electrode Sp
20.67 pixels per unit spacing
ion in model section display = 1.00
ocated at -78.8 m.
ocated at 66.3 m.

Fig. 3.



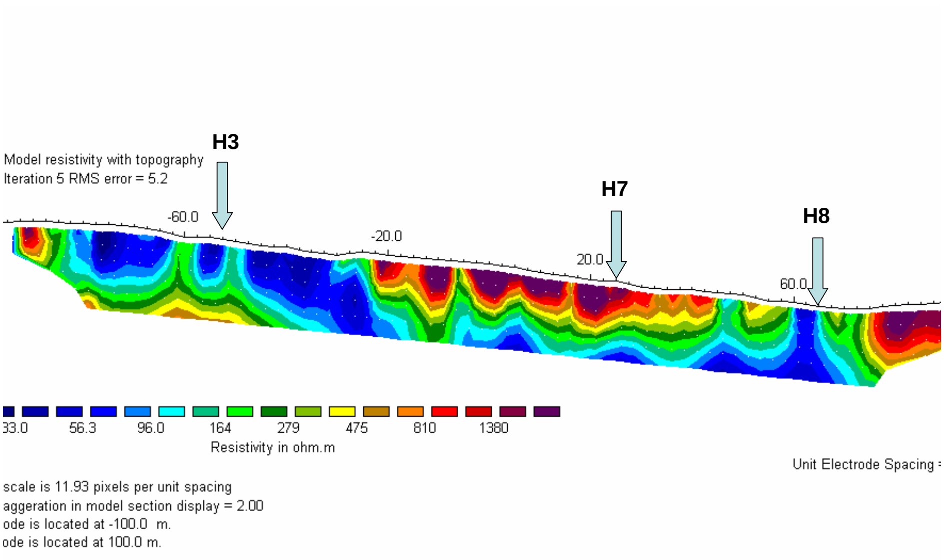
Model resistivity with topography
Iteration 5 RMS error = 4.2
H1
H2
H3
H4
H5
-60.0
-20.0
20.0
60.0
33.0 56.3 96.0 164 279 475 810 1380
Resistivity in ohm.m
Unit Electrode Spacing =
scale is 11.68 pixels per unit spacing
aggeration in model section display = 1.00
ode is located at -100.0 m.
ode is located at 100.0 m.

Fig. 4.



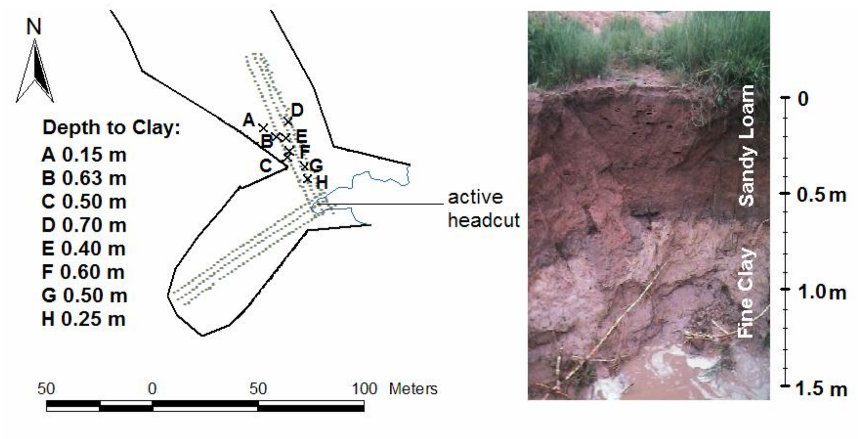
Model resistivity with topography
Iteration 7 RMS error = 7.3
H10
H9
H8
H7
H5
H6
-120
-40
40.0
120
33.0 56.3 96.0 164 279 475 810 1380
Resistivity in ohm.m
Unit Electrode Spacing = 5
scale is 11.68 pixels per unit spacing
aggeration in model section display = 1.00
ode is located at -200.0 m.
ode is located at 200.0 m.

Fig. 5.



H3
H7
H8
Model resistivity with topography
Iteration 5 RMS error = 5.2
-60.0
-20.0
20.0
60.0
33.0
56.3
96.0
164
279
475
810
1380
Resistivity in ohm.m
Unit Electrode Spacing =
scale is 11.93 pixels per unit spacing
aggeration in model section display = 2.00
ode is located at -100.0 m.
ode is located at 100.0 m.

Fig. 6.



N
Depth to Clay:
A 0.15 m
B 0.63 m
C 0.50 m
D 0.70 m
E 0.40 m
F 0.60 m
G 0.50 m
H 0.25 m
active headcut
50
0
50
100 Meters
Sandy Loam
Fine Clay
0
0.5 m
1.0 m
1.5 m

Fig. 7.