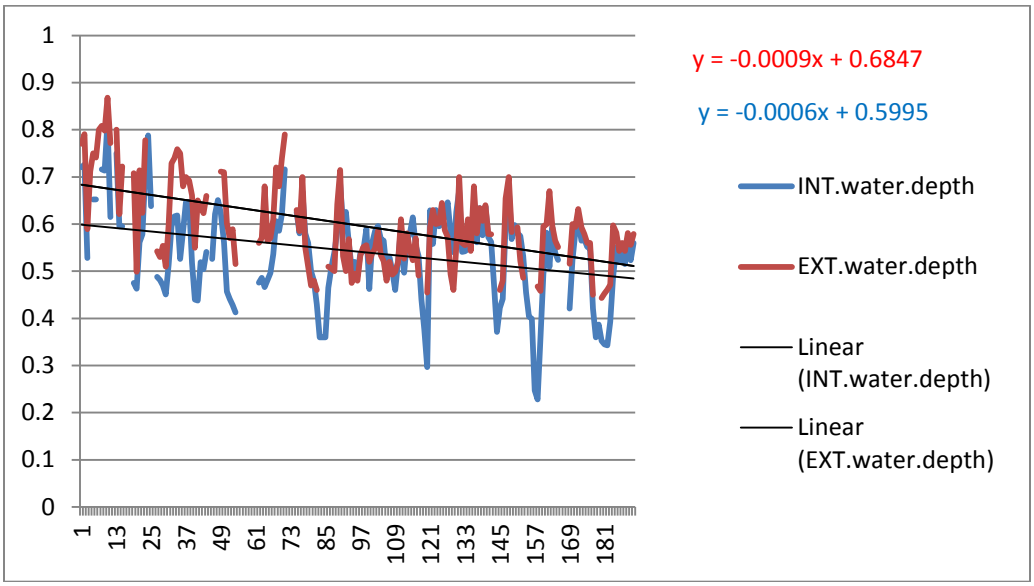
Annex 3. Statistical Analysis of Water levels data (Internal and external gauge boards) from RSPB to NE 13.11.13. R. Mason

Summary

During the meeting between NE, RSPB and BC on 05/11/2013 there was some discussion about water levels graphs provided by RSPB and BC. To summarise there was ambiguity as to whether the apparent trends were significant or not.
It was agreed that I would ask Lucy Mason to run some statistical analysis of the apparent trends. This is presented below.

Data set 1 – monthly EA logger data from Gauge boards G1 (External) and G2 (Internal), referred to as external and internal from this point on.

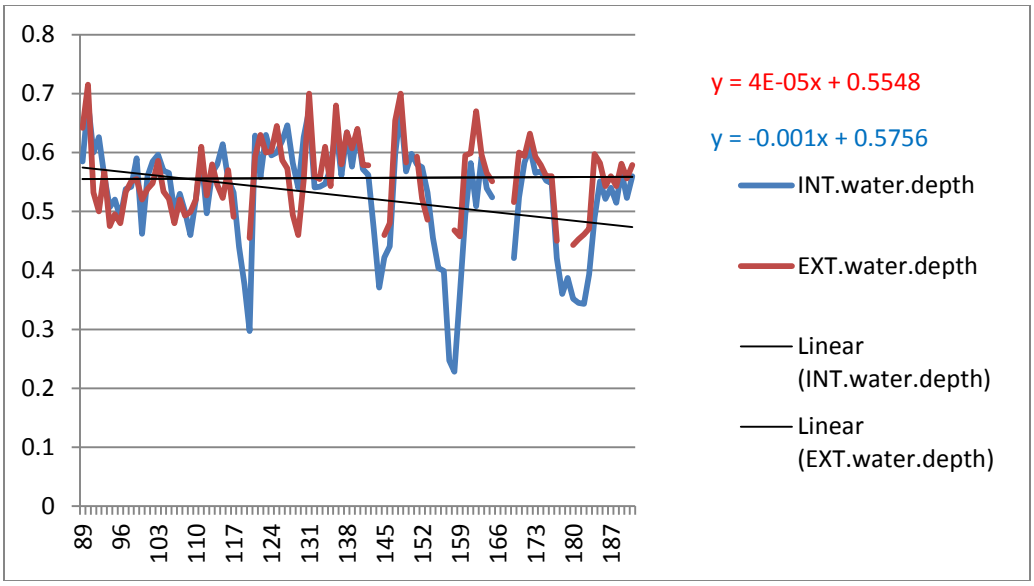
Internal / External trend from 1996 - 2012



Both internal and external sluice data show significant negative trends

Internal: slope = -0.0006 ±0.00013 standard error, $t = -4.593$, $p < 0.0001$
External: slope = -0.0009 ±0.00011 standard error, $t = -7.938$, $p < 0.0001$

NOTE this is using standard regression analysis only and does not take into account the time series relatedness between each measurement.



Internal / external trend 2004 - 2012

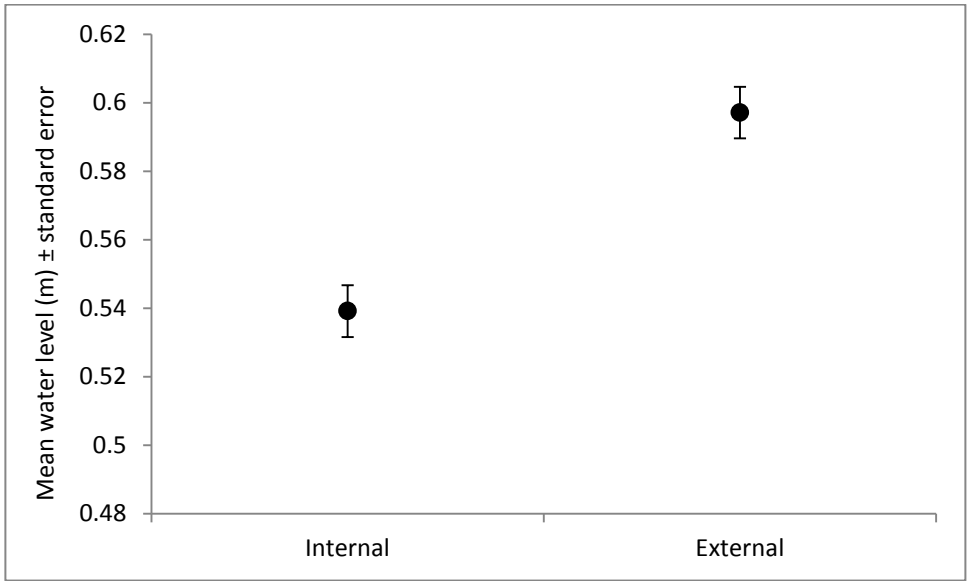
Internal sluice shows a SIGNIFICANT NEGATIVE TREND
Internal: slope = -0.001 ±0.0003 standard error, t = -3.347, p < 0.01
External sluice shows no signficant trend over the same time period
External: slope = 0.00004 ±0.0003 standard error, t = 0.174, p = 0.862

NOTE this is using standard regression analysis only and does not take into account the time series relatedness between each measurement.

Relative level of internal and external

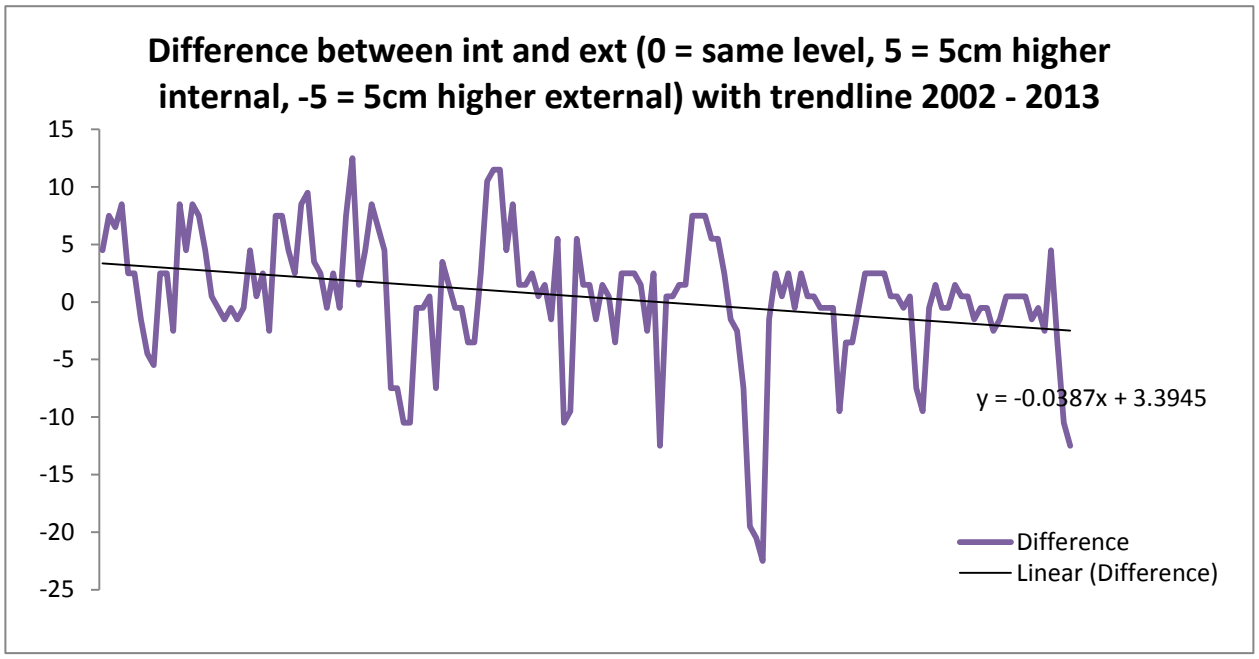
Though both levels show a negative downward trend from 1996 to 2012, Internal water level was significant lower than External water level throughout the series.

Using a Paired t-test (this calculates the difference between paired records from the same month/year and thenaverages these differences across all months/years and tests to see if this difference is significantly different from 0). This is displayed below;



p-value =2.67E-14
(< 0.0001)
Internal is significantly lower than external

Data set 2 – monthly water level data read directly from guage boards by BC volunteer 2002 - 2013



The negative trend in the above graph is significant (change in difference between internal and external water level = 0.039m over each unit of time)
Statistical results of the analysis: slope = -0.039 ± 0.010 standard error, $t = -3.855$, $p < 0.001$

This would indicate that the internal water level has DECREASED over time, while the external water level has INCREASED or remained STABLE

(when taken in combination with the trends in the individual internal vs. external data above).

NOTE this is just a standard regression analysis and does not take into account the true time series relatedness of the data,

Summary

In carrying out this analysis, it was realised that though a regression analysis will pick up trends, it is not the ideal way to analyse a time series of data. Lucy does not know how to do this more complex analysis, she expects it would show the same trends, but with increased significance. Lucy will try to carry out the time series analysis on this dataset soon.

The regression analysis does demonstrate that the dyke levels on both internal and external systems have decreased from 2004 to 2013, but have not confirmed this over the longer timescale of 1996 – 2012. This could be due to gaps in the data or could be because the decreasing water levels did not begin until around 2004.

Importantly, the last graph shows a significant decrease in the internal level compared to the external level from 2002 to 2013. This is the best evidence yet that water levels at Catfield Fen have decreased in recent years and when combined with analysis of plant quadrat data they strongly suggest the site has become drier during this period.