Inter-relationships with the Meteorological Office Rainfall and Evapotranspirational Calculating System (MORECS)
&
A Statistical analysis of tree related claim ratios (Inclusive: The 2003 – 2005 Weather Related Event)

Revised 01 September 2007

Vegetation Related Subsidence of Low Rise Buildings

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Abstract

The dynamic relationships between low-rise buildings, cohesive soils, vegetation and climate are now well understood **(1,2,3,4,5,6,7)**. It is well established that the loss of water from the soil matrix to vegetation leads to changes in overall volume of the soil, which in the presence of a loaded low-rise structure can lead to a differential downward / rotational "subsidence" exacerbated by the overall brittleness of modern buildings. This water loss is driven by plant requirements, which are principally a function of seasonal transpirational demand, which is equally of a higher magnitude during warmer and drier summers.

This paper now seeks to create a new model for interpreting and analysing the historical context of changing weather patterns over longer timescales. From this it is anticipated that better claims profile forecasting will be possible for the insurance industry, central and local government. The principle tools utilised in the analysis are the Meteorological Office Rainfall and Evapotranspirational Calculating System (MORECS). **(8)** and a statistical analysis of the data records of over 10,000 tree related claims handled by OCA UK Limited as a result of the claims experience of UK insurers during 1999 - 2005. **(10).**

Introduction

The development of the MORECS system from an agricultural management tool to multi-purpose land management and subsidence claims handling system has taken place against the context of rapidly rising subsidence claims since the 1970s. Throughout the 1990s the Meteorological Office and certain system users have researched and developed the MORECS model to more effectively interface with the real time problems of building failure.

However whilst the overall flow of MORECS data now spans many decades there is currently no single theory that describes the data in its full sense. This paper cannot hope to complete this task, however it is hoped that it will allow a basic first model to be developed from which a comprehensive theory of “how claims occur” can be established. The unique opportunity to cross reference the data has arisen as a result of the surge in claim numbers as a result of the hot dry summer of 2003, this has allowed OCA UK Limited to collect for the first time all claim data by a range of unique “identifying markers” into a central database for consideration and assessment.

The attached graphical representation of the MORECS data is for a single Grid Square representing a 40km square territory centered north of the river Thames and north London. The data is extrapolated from the deciduous trees profile data and plots weekly MORECS measurements.

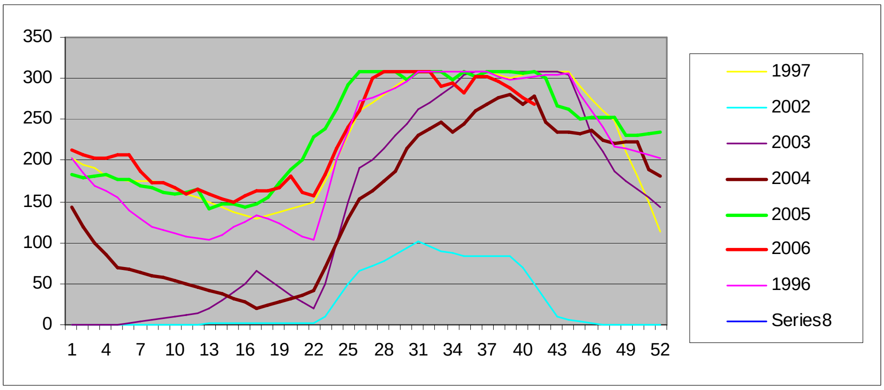
This particular Grid Square (106) is underlain by a highly cohesive London Clay which shows classical geotechnical properties of very high plasticity, high shrinking and swelling properties in the presence of vegetation and a poor rehydration profile following precipitation. It therefore drives a relatively “clean” picture of vegetation resource depletion of soil water and of root architecture across all plant species.

The meteorological picture is equally relatively settled with a fairly predictable annual rainfall total that need only move in modest percentage terms from year to year to produce clear trends.

The picture that emerges from the analysis is of two very pronounced and quite different soil – plant - atmospheric “states” of the overall phase space from which the system “flips” periodically to the opposite state.

The full MORECS data set covers a period from the beginning of policy inception of cover for subsidence of low rise buildings during the 1970s to the present day and therefore is a very accurate and well established model. However for the purposes of this analysis a detailed assessment has been carried out which sets the ordinary meteorological “phase” for the UK against the less typical hot/dry phase of “event years”.

Fig 1 (MORECS data)



The wet phase (note “wet” is a descriptive term designed to simply assert it was not a noticeably dry year)

Within the wet phase (1998 - 2002) total precipitation and available soil water in the agricultural soil is sufficient annually to satisfy most plant growth with claim numbers relatively low, the repudiations against those claims (being that insurers representatives do not believe the cause is soil differential movement) relatively high and the vegetation related claims not being repudiated are associated with trees which are very close to properties, large and growing rapidly, large and with a very high moisture requirement adjacent highly susceptible buildings, contributory to some other cause (e.g. drainage problems) or associated with a policyholder or prospective policyholders intolerance of any building movements (i.e. new homebuyers).

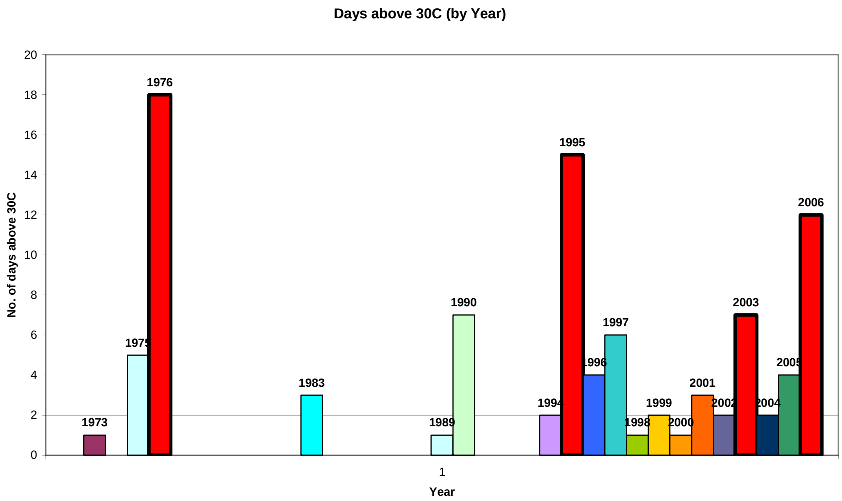
The dry phase (note "dry" simply indicates a movement towards higher soil moisture deficits)

In the dry phase (1995 - 1997 and 2003 - 2006) total precipitation has been below average at some critical period (e.g. low winter rain) or for an extended period and is characterised by an initiating event year of hot and dry summer temperatures putting plant communities under real and prolonged water stress.

An Event Year

Event years are a soil – climate – vegetation - insurance reality. Within the model, event (or *Alpha*) years are characterised by a warm / hot and/or extended dry summer / autumn period of between 10 and 20 weeks duration. This period is the initiating event, which leads to high evapotranspirational levels and a rapid rise in MORECS figures between May and September of that year. To be an event year the MORECS figures will achieve "model" exhaustion of the first 1m of model soil and a period of time will elapse (October – December) when the peak value is maintained against the gravitational force of precipitation by evapotranspirational activity of plants. The peak is reached and sustained against autumn rains.

Fig 2



The plant response

The model postulated suggests that fundamental changes occur as a result of this initiating event in the root architecture of clay specialist vegetation and clay opportunist vegetation. Root architecture for many tree species is flexible with high levels of plasticity in root form and function when subjected to drought conditions. **(9).***

As a result of the initiating event it is proposed that for many common plant species growing within the United Kingdom this plasticity whilst designed to invest the engineering soil "Resource Depletion Zones" (RDZs) has a second important outcome.

The *Beta* & *Gamma* years

There is no doubt that the *Alpha* year exists as a phenomena and that one can postulate factors that would lead to a higher claims total in the second year after the initiating event that are not technically related to geotechnical / arboricultural factors, (i.e. greater public awareness, lower repudiations by sub contracted specialists less familiar with the issues as a resource requirement of insurers). However to ignore the plant response is felt to be potentially damaging to our understanding of this issue.

**Plant response to be subject to a future article.*

One reality of an initiating event is that roots of plants are now "in-situ" within the engineering soil RDZ at depth. The very high MORECS "account" being at the maximum modelled and only slowly declining into the winter and following spring inevitably means that a "positive" MORECS figure elevates plant soil water requirements and the building deficit against the ordinary fully saturated soil model of a wet phase spring. The plants will require water many weeks earlier from available root architecture already fully invested and ready to "work" at transpirational requirements.

The model therefore proposes a "trajectory" for the *Beta* year as a result of the *Alpha* that is inevitable. This is regardless of the weather associated with the *Beta* year, although it is possible for hot dry weather in the *Beta* year to further extend the event duration. The current proposition is that this trajectory can in certain circumstances extend so far as a Gamma year regardless of the current climatological position and simply as a function of the energy applied in the Alpha year and the long-term cybernetic response from many clay specialist tree species and opportunist trees.

Beta & _Gamma_ Years – analysis

An assessment of the key-initiating *Alpha* years; 1976, 1990, 1995, and 2003 indicates all of the factors and trends earlier referenced, what is clear against these trends is that the elevated MORECS figures in the following springs produced meteorological and geotechnical *Beta* years. For the first 3 events the "flip" to the new state was sudden and achieved in a matter of weeks whilst the return to the wet phase was slow and achieved over many months. The model suggests that an initiating event will guarantee a minimum of 12 months of elevated claims numbers with lower repudiation rates with the possibility of a 20 month+ dry phase affected and directed by the *Alpha* year impact on soil / vegetation continuum, almost regardless of the precipitation rates in the *Beta* year.

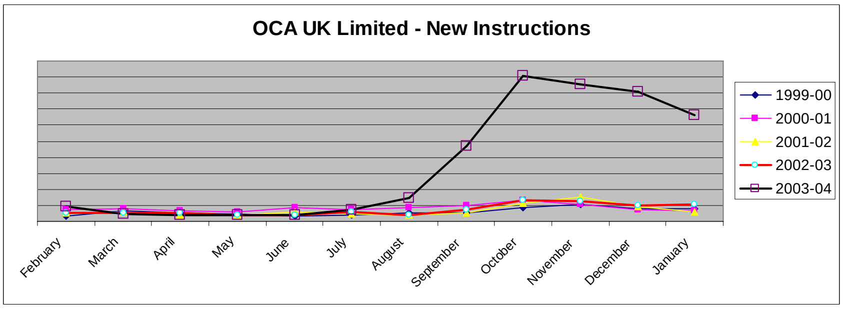
The 2003 Alpha year

The 2003 event follows this classical and as predicted pattern with MORECS figures growing towards the figure of 300 mm deficit against a highly variable weather pattern with wild swings in anomaly against the long-term average. It is suggested that this obvious trend for upward MORECS growth even in a year of such inherent unpredictability and anomaly confirms the author's hypothesis.

The claims experience – OCA UK Limited

By July 2003 it was clear that a major dry weather event was in progress and OCA UK Limited in line with the agreed insurers surge plan of operations authorised its own response both financially and operationally as of 1st August 2003. This surge plan assumed a sudden and sustained rise in claim numbers with low repudiations and high numbers of tree related claims moving across the UK but focussed on the south and east, (a continental effect).

Fig 3
Increase in claim numbers against base.

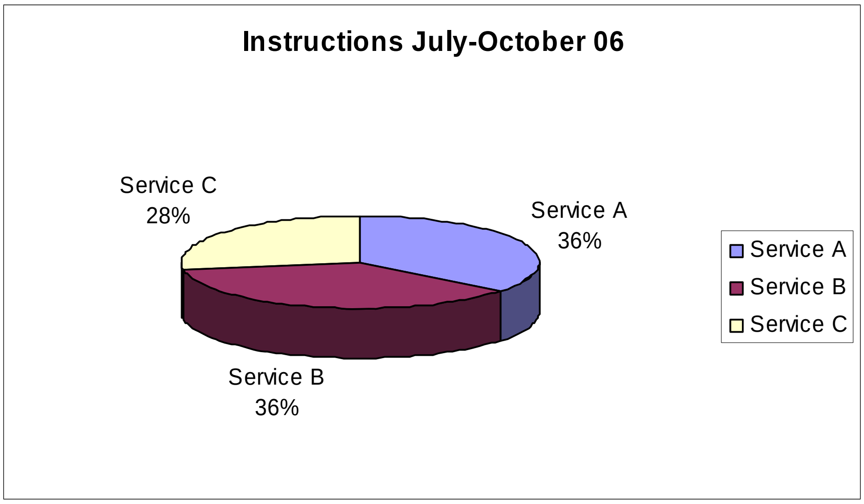


It should be obvious that the claim experience confirms an initiating role of the Alpha year in plant response to a dry weather event.

Ratio of claim

Given the statistical validity of the sample what will be of equal interest to land managers is the relative frequency of occurrence of claim type against the total and the following results diagrammatically illustrate some clear trends visible from the claim experience and which may assist those involved in this topic in formulating policy and /or for the purposes of further investigation.

Fig 4
Land use and tree coverage (the profile of vegetation types)



The data can now be utilised to assess the land use coverage by vegetation type.

The attached chart illustrates the number of cases that involve:

A. Policyholder only vegetation with no statutory controls (or residential landowners not disputing causation
B. Non statutory controlled and disputed by the third party landowner
C. Statutory controlled under the TPO legislation, Highway Acts and other Council managed estate vegetation

Clearly the relationship between private trees causing subsidence and Council managed trees almost perfectly matches the relative coverage of these vegetation types in our towns and cities with just over 20% of cases involving trees controlled by Highway Authorities (the remainder being TPO trees and other Council Departmental)

This data allied to Chart 1 (the relative soil drying caused by trees, grass and sunlight) conclusively demonstrates the role of trees as the principle driver of vegetation claims in the UK. Grass, shrubs and climbers represent a tiny proportion of all claims and are easily remedied before a claim might be considered.

Conclusions

It is hoped that this introductory paper may allow forward planners to better understand the potential for changes occurring to the "state" of soils, such that decision making can be informed and effective. The dry phase clearly has affected approximately 4 of every 10 years since the 1970s although the traditional paradigm is to locate events by the initiating event year i.e.1976, 1995, 1991, 2003. We would suggest this approach is simplistic and that it would be better to analyse dry periods as a continuum beginning with the Alpha Event.

Clearly the ability of insurers to overlay this model against claims experience, particularly with access to the statistical data available to the authors covering substantially more than 25,000 tree-related subsidence cases, would prove invaluable to strengthen the models scientific base.

Equally there are issues that require investigation associated with any extension of an event beyond the Gamma year and the impact on soils and tree strategies and survival in any extended event of that severity.

We would hypothesise that the current wider climate models predicting as they do overall elevated temperatures against a background of sudden sharp changes in the "state" of the weather over increasingly short periods, will only potentially exaggerate the magnitude and duration of the *Alpha* – *Gamma* phase state. It is the author's contention that the overall model is robust and capable of testing and further refinement.

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Example MORECS data for a site in north London

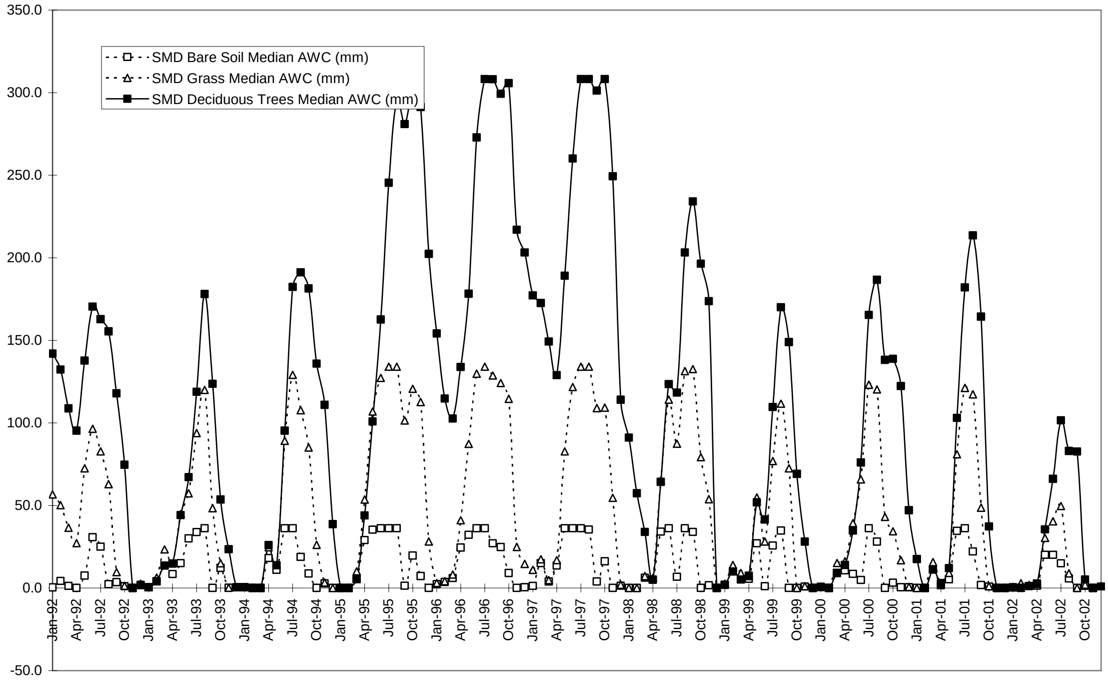

CHART 1
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OCA UK Limited
4 The Courtyards
Phoenix Square
Wyncolls Road
Colchester Business Park
Colchester
Essex CO4 9PE

Tel: 01206 751626
Fax: 01206 855751

E: info@landscapeplanning.co.uk

www.oca-arb.co.uk