

Responding to soil erosion in Spain: from Charles Darwin to John Thornes

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INTRODUCTION

During a discussion of the European Soil Framework Directive last year, John Thornes commented on the paradox that although there was much scientific progress in understanding desertification and erosion, relatively few scientists were responding to the opportunity of responding. Most scientists passively accept the situation of little effective soil and land governance in Europe. John Thornes thought that one difficulty is that researchers work in isolation and assume someone else is caring about the big picture. Those looking after the big picture are in fact managing soil and land from the perspectives of things such as rural poverty reduction and food security and interventions for farmers. These are in themselves excellent points of view but they need to be balanced and limited by guidelines provided from the perspectives of the requirements of medium and long term soil conservation and protection. There is an absolute need for a European Soil Conservation service as there is in the United States and China. As Darwin said when looking at the increase in population of animals in South America: "There must be something limiting growth". Now the only thing limiting growth in many places might be erosion and desertification.

The objective of this paper is twofold. Firstly, it is to stress the value and need for soil conservation and protection policy that is underpinned by a broad integrated approach such as that provided by geography or natural history. Charles Darwin and John Thornes were custodians of the same broad general knowledge and common sense. They understood cause and effect and how the changes caused by land use and climate affected geographical and ecological processes in complex systems. They understood that all things are interconnected, that you learn and do things with other people.

Secondly, the paper will stress the progress that can be made when new scientific frameworks are adopted by authorities to plan actions that address desertification and erosion.

Very many problems of today are made worse when policies develop soil conservation programmes that treat the environment as if it was just a collection of different layers that represent different factors or who use the Universal Soil Loss Equation under conditions for which it was not intended. Both Darwin and John Thornes applied systems thinking to understand and explain the changes they observed. John Thornes considered the greatest recent advance to be the emergence of the panarchy concept as a tool for applying policies to manage change (Adaptive Management).

One of the most challenging goals today is to establish national and international institutions (policies, laws and institutions) that conserve and manage natural resources. Problems are so complex and involve so many disciplines and points of view that it is hard to identify concrete strategies and action plans. John Thornes and Charles Darwin had this gift and this legacy might help contribute to the strategies that Spain and other countries are developing as a response to desertification. Today Spain is perhaps the country in Europe where the most soil erosion research and investigations are being made. Nevertheless, erosion is still occurring and what should be done about it can be evaluated in the light of John Thornes and Charles Darwins legacies.

CONTRIBUTION TO MEDITERRANEAN DESERTIFICATION AND LAND USE POLICY

One of the major achievement with respect to desertification is the implementation of the Medalus and other Integrated Projects between 1990 and 2000. Soil erosion and desertification are claimed to be major threats to sustainable development in Spain and many other parts of the world (UNCCD National Action Plan Spain). But what does this mean? What are the causes?

John Thornes devoted much of his time in helping Europe design and implement a research programme which would establish the current state of desertification in Target Areas in Spain, France, Italy, Portugal and Greece and at the same time provide data and models in support of policy (Medalus, 1996). The policy implication of ten years of research was presented at the Conference on Mediterranean Desertification (Peters 2000). John Thorne's enjoyed the confidence of policy makers because he was able to communicate the essence of the problem in an extremely focussed and effective way. This was particularly true at the workshops of the Concerted Actions he organised during which he surveyed and documented the actions being taken by the Annex IV Countries to implement the convention (Thornes and Burke 1996). At the same time his engagement with all kinds of stakeholder in each field area he visited based on empathy and respect and appreciation of all points of view. John Thorne's was a geographer with a understanding of history and complex processes.

At an EGU meeting on desertification soil erosion in April 2008, in his state-of-the-art lecture John Thornes highlighted the achievements of the last forty to fifty years. He saw the progress more in terms of the institutions and knowledge that had been accumulated and built up rather than in terms of soil still being lost. He described the transformation in the United Kingdom as being one from an approach that had originally been essentially archeological to one that was now that of panarchy. Formerly erosion and land degradation were seen as essentially of geological and geomorphological interest and he described the work being done on sediments found in Mediterranean valleys. In contrast he described the situation today as one in which land degradation and erosion were now being seen within the framework of an adaptive system in which social and biophysical systems were interacting.

THORNES, PANARCHY AND THE ADAPTIVE MANAGEMENT FRAMEWORK AS PROGRESS BEYOND THE STATE OF THE ART

The framework within which desertification is explained to policy makers is critical. Panarchy provided a structure that enabled the integration of historical and socio-economic models with bio-physical ones. A framework is a kind of model or structure for describing how things are related and conceptualised at different scales in space and time. At an EU Desertification meeting in Athens in 2002 John Thornes drew our attention to the book by Gunderson and Holling (2002) called Panarchy. He was very excited with the opportunities that these insights gave for the ways in which we could address erosion and desertification. The book by Gunderson and Holling presented a framework for integrating processes across scales and for explaining how interacting socio-economic and biophysical systems change and interact. The adaptive cycle which is a core concept in panarchy explains how and why things change cyclically. An overview of the methodology can be found at the resilience alliance home page. The concepts of panarchy were applied by John Thornes in his studies of the interactions between vegetation and erosion. They can also be to propose efficient and effective soil conservation strategies (Dorren and Imeson 2004).

THE LIMITATIONS AND WEAKNESS OF FACTOR TYPE APPROACHES ILLUSTRATED BY THE USLE

The tools used by many organisations to develop and implement soil conservation generate responses that are based on factors. This is illustrated here by the USLE to demonstrate the limitations. The Universal Soil Loss Equation (USLE) was developed and calibrated with soil erosion plot measurements in the United States (In it soil erosion is explained and quantified as a function of the factors rainfall erosivity, slope, soil erodibility, management practices and cover). This approach was intended for gently sloping agricultural fields to help farmers manage their own land and the US Soil Conservation service were happy with it. Wishmeier and Smith 1976 warned against its misuse but hundreds of people never listened to their cautions. The USLE treats erosion as if the main and only process is overland flow by water, which is in fact not the case.

The USLE has been adopted by organisations all over the world and used in ways that is was never intended. It is easy to use in a GIS and it enables soil erosion risk maps to be made without any data or knowledge of erosion processes nor of cause and effect. Erosion is seldom caused by farmers using the land in traditional ways.

When the USLE was used by governments to develop and implement policy, it was used to justify and plan land use changes over vast areas of the world, and this involved planting forests, various land use changes and in many cases removing farmers from the land. Many examples of this are in SE Spain. But also elsewhere huge areas of Europe and Africa (for examaple Marocco and Lesotho) were transformed as a consequence of the USLE. In many cases this brought benefits but in some cases where the processes were not taken into account there was a large increase in desertification and erosion.

When erosion is considered, the main erosion processes today are not caused by rain and water but by tractors and earth moving equipment on slopes. Ten years ago already it was calculated that more sediment was eroded by tractors than is carried by all of the rivers in the world.

It is a paradox that in many countries the main driver of land degradation are often soil conservation programmes. The construction of agriculturally terraces was traditionally beneficial and it is still the case in many parts of the world. Terraces enable farmers to grow crops on very steep land and totally stop erosion. They are often not allowed to do this because according to the USLE soils are critically too steep. However, when most terraces are constructed without proper management and guidelines the results can be very high erosion. One problem is the impact that tractors have on sometime fragile soils that are terraced and inverted on steep slopes.

Few take proper account of the impact tractors have on the hydrological functions provided by soils and this is a major reason for much of the flooding today. When the main erosion process is that of using the tractor the other factors of erosion become marginal. The policy of giving or selling tractors or bulldozers to farmers in Africa can have effects that are very destructive to the environment. Little considering to the devastating effect soil compaction and erosion has on the hydrological functions provided by African or South American soils.

The problem with tractors is not new as it was a major factor explaining the Great Dustbowl in the United States. But also, for example, in Illinois vast amounts of erosion occurred in the 1930's because of the adoption of heavy tractors by farmers who before this had farmed the land for nearly 200 years in a sustainable way. The explanation for the erosion was the banks and industry who lent money to the factors to mechanise their production on soil that they knew would be eroded to bedrock in ten years. When the farmers could not pay back the loans this was a contributory cause of the depression. In the Netherlands soil erosion in

1980 in South Limburg was a consequence of land consolidation and the use of bulldozers. Policies that address erosion in such cases should not be based on a hypothetical erosion risk that is obtained by a model using a USLE or Pasera type framework because the risk of erosion is caused by banks lending money to farmers in the case of the USA.

When erosion and desertification are explained in terms of different causative factors, as means that explanations will be weak and policy makers and farmers will have little confidence in them.

The factor approach of the USLE was applied of in Spain to identify areas of erosion risk by Icona. All over the world from Norway, to China and from Spain to Israel steep slopes were identified as being at risk when in fact field evidence often found the opposite. Research by the Department of Geography at Murcia for example at the Medalus 1 Field experiment sites (Lopez-Bermudez and co-workers) found that the lowest rates of erosion occurred on the steepest slopes under matoral and that the rates of erosion on steep matoral slopes was insignificant. Local knowledge and understanding of processes is necessary for effective decision making. There are many field and laboratory studies that provide information about relationships in practice rather than in theory (Bryan 1979 and De Ploey 1981) and these are often counterintuitive.

CHARLES DARWIN

The common research interests and methodological approaches of Charles Darwin and John Thornes is evident. Much of their work is still relevant for future soil erosion research and soil conservation strategies in Spain. Darwin was born two hundred years ago and this fact is being commemorated in many countries. Darwin's work is remembered mainly for its importance with respect to evolution and most people's perception of him is as an old man who was the father of zoology. All of Darwins publications can be read and downloaded at www.Darwin-online.org.uk/biography.html. A valuable source of easy to read source of information about Darwin can be found by reading the book "The Voyage of the Beagle" which he published in 1845. Although this book contains descriptions of the is a source of information regarding his field work mainly in South America between 1831 and 1836. A more appropriate image of Darwin at that time might be more as a post doc researcher in his early twenties with virtually unlimited resources and the total support of his Government. His task was to travel thousands of kilometres across Argentina, Chile and Brazil, mainly by horse but sometimes by foot or in small boat to record the geology and wildlife as well as the means of production. He describes the stories of the people he met, comments on the social and economic situation. He survives attacks from Indians and wildlife, is sometimes seriously ill and often nearly killed in storms or by cold. He was responsible for collecting climatological information, and for surveying the geology and natural history and also for communicating with the many Spanish and English people with who he lodged.

Darwin describes himself in the passport he presents in Buenos Aries Government as a naturalist. But from the travel notes, it is clear that he is also a geographer in every sense as well as a geologist, geomorphologist and biologist, climatologist and chemist. But he was also trained and competent as an etymologist and zoologist and able to formulate research questions that were at one time related to the local conditions and at the other linked this to the general theories relating the observations to the current knowledge in the world. At the same time he was recording details on the anthropology of the Indians he encountered and was analysing the impact of 200 years of land use change on the ecosystems of Patagonia, Brazil, Tierra del Fuego and Chile. He sometimes compared Spain and South America comparing the fauna, geology and soil. He made important observations regarding the

devastating impact of droughts and cattle grazing on land degradation desertification in Argentina. He also described how these affected erosion and sedimentation processes. The methods used by Darwin for his geomorphological process experiments are largely the same methods and techniques that are used today. His methodology and approach was the same as that used by British Geologists 200 years later, also in Spain. Darwin also describes climate change, biodiversity loss, desertification and erosion

A feature of Darwin's methodology is its systems approach. At that time, there was not much in the way of statistical theory so that if cause and effect were understood this enabled processes to be extrapolated globally.

In conclusion although the public perception of Darwin is that he is the father of zoology and evolution he was in fact a but a practicing geography. Just like John Thornes two hundred years later. Public interest in the importance of Darwin's fieldwork and findings focussed on media attention that his book on *The Origin of the species by natural selection* received. Perhaps more importance should have been given to the ecological and geographical implications of his work for sustainable land management, desertification and erosion.

CONCLUSIONS

Charles Darwin and John Thornes

What is at first surprising is the very similar interests and approaches of these scientists. Both were interested in relationships between vegetation and geomorphological processes including erosion. Both had a field based experimental approach to their work that can probably be traced back at least to Aristotle. They were systems thinkers and had the ability to understand the operation of cause and effect in complex systems. They both had the ability to write things simply and communicate this to society at large. Just as Darwin's work was based on field observations and experience so to was John Thornes. Both were also geographers able to integrate and compare conditions in different situations and at the same time both were quantitative in their approaches.

Darwin describes many examples of land degradation and desertification in Argentina and elsewhere. He analyses the combined influence of climate land use change on the geoecosystems he encountered. His work is interesting because it gives a point of reference and description of conditions made systematically according to prescribed methods between 1833 and 1836. Darwin was able to describe and assess the changes that had taken place during the previous two hundred years since colonisation. What is really valuable are the conversations with local stakeholders that reveal people's attitudes and explanations and which provide an interesting narrative. The changes taking place then and today in South America may provide an insight into the changes that occurred in Europe several thousand years ago or more recently by the process of bedrock stripping .

John Thornes was very much interested in understanding soil erosion and river channel processes and he was extremely eclectic in his research. His personal challenge was often to be able to develop mathematical models of the processes and responses he observed so that these could then be applied in theory and practice. Research as a goal in itself was not enough because if soil erosion and desertification were really issues then what was required was policy relevant advice.

John Thornes and Darwin both had an understanding of the dynamics of interacting human and biophysical system. They wrote both as observers and scientist witnesses to the changes taking place but also as being part part of the system.

Complex environmental problems can not be solved by specialists. An integrated vision and process based understanding is essential. Geographers, Historians and philosophers and other generalists with an overview should not stand back and let the world be mismanaged by specialists.

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