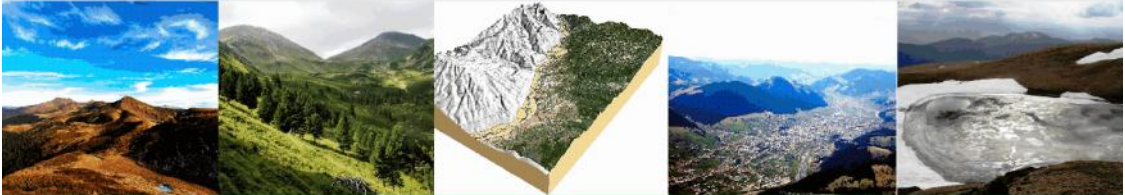




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Reconstructing recent environmental change in the Carpathian Basin; advocating an interdisciplinary approach for 2020 environmental science

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Introduction and rationale

An interdisciplinary approach to environmental science is particularly important in the field of palaeoenvironmental research. Indeed, while the majority of such studies employ a range of proxies in their investigation, the more innovative studies tend to truly cross discipline boundaries. The investigation of depositional environments (e.g., lake sediments and mires) as archives of environmental history has a long tradition in the Carpathian region. However, glacial lakes across the region have also been described as under-investigated despite their potential for palaeolimnological study (Buczko *et al.* 2009). Studies have also largely focused on relatively early (Late Glacial and Early Holocene) environmental change. Nevertheless, there is an increasing interest in the reconstruction of more human-driven impacts on the environment and events in the very recent past on a century to decade timescale e.g., post Industrial Revolution and following political change from the mid 1940s and in the late 1980s. Furthermore, efforts have also been made to inform the debate about future climate and environmental changes linking palaeoenvironmental records to predictive computer modelling.

Palaeolimnological records of recent environmental change; overview and prospects

To date our investigations (based on a research collaboration between the Universities of Salford (UK) and Suceava (Romania) and also with the Senckenberg Research Institute and Natural History Museum, Frankfurt (Germany)) of recent lake sediment deposits have covered a range of depositional environments across the Carpathian Basin, but have tended to focus on the more recent past and primarily the post Industrial Revolution period.

Short gravity cores taken in glacial lakes in the Rodna / Maramures and Fagaras Mountains in Romania have indicated the prevalence of probably trans-boundary atmospheric inputs at low levels of environmental contaminants such as Pb (Akinyemi *et al.* in press). At key sites such as Lacul Capra (Fagaras Mountain in the Southern Carpathians) radiometric dating has provided a chronology of these inputs recorded in the sediment geochemistry and mineral magnetic properties. Further collaboration with the Environmental Change Research Centre at University College, London (UK) has also allowed us to extend the map of spheroidal carbonaceous particles (SCPs) from a single site in Romania (Rose *et al.* 2009) across the region.

Mountain lakes are known to be sensitive environmental monitors, but are not exempt from direct human impacts. At Lacul Stiol (Rodna Mountains in the Eastern Carpathians) an illegal modification in the lake's hydrology hugely extended its surface area and depth. The impacts of this event were readily detected in the sediment column as both a change in stratigraphy and the rate of sedimentation (Mindrescu *et al.* 2010). Elsewhere catchment-derived inputs to the water body can provide an informative chronometer. Sediment cores taken from Lacul Iezer-Feredeul in the Obcina Feredeului Mountains (Eastern Carpathians) revealed over 4 m of

laminated sediments spanning around 1000 years based on radiocarbon dating at the base of the core. A cluster of lakes in this area, apparently formed by land sliding, have the potential to provide a unique and valuable insight into the environmental history of the last millennium (Mindrescu *et al.* in press).

More recent research has extended beyond the uplands of the Carpathian Basin and into Transylvania. Lacul Stiucii (Bont Valley, Cluj) provides not only a detailed, whole Post Glacial scale environmental record, but also, via short gravity Pb-210 dated cores, facilitates a detailed insight into the impacts of the rise of industrialised agriculture from the late 1940s and the consequences of its decline from the late 1980s following economic and political change. This study provides an excellent example of international interdisciplinary research that has led to important research findings and the development of an unexpected, additional dimension to the project.

It is apparent that environmental research in the Carpathian Basin is dynamic, that active researchers often link with organisations beyond the region, and that an interdisciplinary approach is imperative in addressing its environmental challenges. Our research has highlighted a number of areas where a palaeoenvironmental perspective will facilitate the investigation of a range of applied research questions. Therefore, on-going and future research will, for example, work with remote sensors, modellers and try to identify under-exploited depositional archives that may provide other environmental records. Remote sensing can act as a useful and impartial observer of land cover change. This approach covers more and more terrain in the Carpathian Basin with a particular focus on its forest (e.g., Kummerle *et al.* 2010). Whereas the technique can overcome some of the issues associated with the accuracy of forest management records, carefully linked to lake sediment-based records, the opportunity exists to quantify the effects and impacts of forest clearance and regeneration, and to put recent (post 1990s) environmental damage into a longer term perspective.

Effectively moving downstream from mountain lakes to below the tree line also suggests that the potential of artificial water bodies as retrospective monitors of human impact and environmental change merits further investigation. Romania has a large number of such lakes (see Radoane & Radoane 2005). On the one hand they can be difficult environments in which to try to exploit the sedimentary record, on the other they have been usefully employed elsewhere when carefully selected and successfully sampled (e.g., Shotbolt *et al.* 2005). In addition to investigating the consequences of human activities in the uplands, enhancing our understanding of the impacts of landscape change in the lowlands of the Carpathian Basin, where there has been a significant change in agricultural practices, is also a priority and one that may also benefit from a palaeoenvironmental perspective. A longer term time perspective can make a useful contribution to environmental management decision making and future land use planning.

Conclusions and prognosis

A palaeoenvironmental perspective on environmental issues is widely recognised as beneficial especially when making informed predictions of future environment conditions (e.g. Schmidt & Moyer 2008). Furthermore, it is particularly relevant to the Carpathian Basin. Interdisciplinary science is seen as essential especially when bidding for research funding e.g., via the EU. However, at least in the short term, it can be bad for your (career) health! Initially there can be a steep learning curve to working outside your discipline in that it can take time to learn the language (or jargon), become familiar with the modes of working and build up trust and respect

in another area's field. Therefore the initial outputs of interdisciplinary collaboration can be tardy in their arrival.

What about the future? To develop the field of palaeoenvironmental research in the region and thereby to usefully contribute to significant environmental issues it will be important to take young researchers forward. Thus, the need to develop graduate, interdisciplinary research centres of excellence, particularly in applied palaeoenvironmental requires serious consideration. This will provide one route to developing the critical mass required to effectively engage environmental decision makers and thereby inform environmental policy. In this respect making our findings clear and accessible to a non specialist audience is an additional challenge.

Post scriptum

Whereas the research activity mentioned above reflects the work of a number of individuals working together, the wider views expressed in this article are those of the author alone.

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