A celebration of the 20th anniversary of the Fluvial Archives Group (FLAG)

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1. FLAG at 20: new research themes and foci

The Fluvial Archives Group (FLAG) was founded in 1996 to bring together researchers looking at the development of fluvial systems over multiple timescales and global spatial scales. Fluvial archives of various types are important not just because they provide insights into past landscape dynamics, e.g., driven by climate or crustal processes, but also because they frequently contain fossil or archaeological material for which they provide stratigraphic control. Since 1996, FLAG has evolved from a research group of the British Quaternary Research Association into an organisation with around 500 members in over 20 countries. The research group held 12 biennial meetings, comprising both presentations and field excursions, as well as multiple themed sessions at international conferences. These had resulted by 2017 in 19 journal special issues, all fully detailed by Cordier et al. (2017). The goals of FLAG are:

- provision of a community for discussion of key issues concerning fluvial archives, including organising the aforementioned biennial discussion/field meetings, sessions at relevant international conferences and special issues of journals;
- continued promotion of the value of fluvial archives by means of readily accessible published information;
- coordination of activity with other research groupings with overlapping interests, e.g., by co-convening sessions and collaborating on publications.

Over time, the exact focus of FLAG activities has evolved, reflecting changes in approach, often relating to the availability of different techniques for studying fluvial archives, such as improved dating techniques (e.g., Rixhon et al., 2017) and landscape evolution modelling (e.g., Veldkamp et al., 2017). In 2015, following discussion amongst the executive and after presentation at a business meeting at the 2015 INQUA Congress in Nagoya (Japan), FLAG activities were reorganized into eight foci, grouped within three key themes:

Themes/Foci:

1. Natural and anthropogenic forcing at various timescales

   1.1. Fluvial response to long-term (Pleistocene) climate and sea-level change, tectonic activity and other crustal movements

   1.2. Fluvial response to Holocene climate, sea-level change and anthropogenic forcing

2. Approaches and methods for studying fluvial archives

2.1. Study of palaeoenvironmental, biostratigraphical and archaeological data contained within fluvial archives (fluvial deposits and landforms, alluvial fans, lakes, caves), including geoarchaeology of river corridors.

2.2. Modelling and otherwise quantifying long-term evolution of fluvial systems

2.3. Geochronological constraints on fluvial archives

2.4. Application of new field techniques to fluvial archives, e.g. geophysics

3. Fluvial activity in relation to present and future climate and environmental change

3.1. Applied elements of fluvial archives, .e.g., economic geology (aggregates & placer deposits) or archives as sources of baseline information for river restoration.

3.2. Using fluvial archives to inform future climate change planning

From 12th to 18th September 2016, the 20th anniversary meeting of FLAG was held in Kielce-Suchedniów, Poland (Figure 1), followed by field visits to the area of Oder-Warthe glaciation and the foothills of the Carpathians, covering a wide range of fluvial archives and timescales (video montage available at: http://flag2016suchedniow.pev.pl/ (accessed 5/10/18)). This special issue of Quaternary Research comprises a selection of papers showcasing research that was presented at this meeting. Below, we show how each of the 10 papers presented contributes to one or more of the themes identified above.

Figure 1: FLAG 2016 participants outside the conference venue in Suchedniów, Poland

2. Contents of the special issue

Foci 1.1 and 1.2 are overwhelmingly represented, with all papers relating to fluvial responses to external forcing factors over different timescales, in addition to contributing to other foci. In relation to the oldest timescales of focus 1.1, these studies often lack direct geochronological control and fluvial responses need to be investigated using alternative approaches. For example, Anton and Martin (2018) apply new techniques (focus 2.2) to quantify the amount of material removed from the Duero basin in Spain since capture-based opening. They test multiple methodologies and provide evidence for which methodology was most effective in reconstructing the pre-capture surface, to guide future research. In addition, the authors use the comparison of reconstructed denudation rates with other systems to suggest an age of < 3 Ma for basin opening, an event that is otherwise unconstrained chronologically. Similarly, Soria-Jáureguia et al. (2018) use geomorphic indices (focus 2.2) to study the impact of the endo- to exhorheic transition of the Ebro basin in Spain on the subsequent Ebro river system. There is still some debate about the age of the transition, either before or after the Messinian. In this paper, Soria-Jáureguia et al. (2018) show that the Ebro and the Pyrenean tributaries are at a mature stage of development, which seems to be in agreement with a Tortonian or Messinian age of the transition. The tributaries in the south are still in a transient state. Finally, Krzyszkowski et al. (2018) outline the drainage evolution of the Polish Sudeten Foreland since the Saalian glaciation. A provenance-based (gravels and heavy minerals) reconstruction of the buried, pre-glacial, Pliocene – Early Pleistocene fluvial system shows that there was a significantly different drainage pattern in the Pliocene to early Middle Pleistocene, with the Palaeo–Nysa Kłodzka operating as the main river in an area now dominated by the Odra (Oder). Also noted as important, in this part of Poland and more widely, are variations in crustal properties and the extent of mafic underplating of the crust, both seeming to have affected the distribution and preservation patterns of Quaternary fluvial deposits.

Studies of fluvial evolution in the recent time periods, whilst still contributing to focus 1.1, have better age control, often using optically stimulated luminescence (OSL) dating (focus 2.3). Thus, Olszak et al. (2018) present a comprehensive range of new OSL ages ranging from 3 to ~140 ka from the Dunajec River catchment in the northern foreland of the Tatra Mountains of Poland. The Tatra Mountains were repeatedly glaciated during the Quaternary period and fluvial aggradations of various types (alluvial fans and cut and fill terraces) have traditionally been linked to periods of cold climate. Olszak et al. (2018) show that instead, fluvial aggradation in this region since ~140 ka has overwhelmingly occurred during periods of warmer climate. They argue that sediment produced by glaciers during cold climate phases was stored and then extensively reworked during warmer phases, suggesting a new model of fluvial response to climate in glaciated regions. In a contrasting Mediterranean region, Avsin et al. (2018) also present new OSL ages from a low terrace of the Göksu River in the Mut Basin, Turkey. These ages of ~240 to 170 ka place deposition of this terrace into marine isotope stages 7 and 6. These two groups of ages correspond to two different lithofacies identified in the field. The authors argue that the presence of similar lithofacies transitions in higher terrace deposits suggest a similar response to climate recorded in all the deposits. This research suggests a much lower uplift rate than has been published in previous studies. Despite being in the Mediterranean, Avsin et al. (2018) record similarities with temperate-periglacial river systems in Europe and attribute any outstanding differences to different vegetation cover and greater thaw of more intense snowfalls.

At shorter timescales still, 4 papers explore fluvial evolution over the late glacial and Holocene (both foci 1.1 and 1.2). This research all has strong geochronological control and explores the interaction of fluvial systems not just with climate or tectonics but with other geomorphic systems and human activity, as shown in the geoarchaeological data available from some sequences. For example, Wooldering et al. (2018) take a different approach to the well-studied terrace sequences of the Lower Meuse in the late glacial and Holocene, by looking for reach-scale differences across different tectonic regions. The work integrates a database of previous sites with new, radiocarbon dated field data (focus 2.3) in regions of specific interest using GIS mapping (focus 2.4). This has enabled the authors to build a more nuanced reconstruction of changes in river planform, not just in relation to climate change, but also depending on tectonic movement, subsurface composition and upstream-downstream propagation of morphological change. Late glacial terrace fragments are best preserved in downstream reaches of the study area, where there is relative uplift, for example in the Peel and Venlo Blocks. In contrast, Holocene terraces are best developed upstream, in the Roer Valley Graben, but also the Campine Block. Interactions between landscape elements are also seen in the work of Wang et al. (2018) in China who report on the interaction between fluvial and aeolian processes, and the response of both to climate change during the late glacial and Holocene, in the semi-arid area of northwest China, a region visited during a FLAG meeting during 2017 (Hu et al., 2017). The data come from sedimentary sequences that have been dated by OSL methods, consisting of gravels and sand that were deposited during cold periods and finer-grained sediments (flood loams) representing warmer episodes. During cold-to-warm climatic transitions the river incised and channel and floodplain sediments were subject to deflation, leading to the formation of dunes, which were subsequently buried by flood loam deposition early in the following warm period. Wang et al. (2018) suggest that fluctuations of the SE-Asian monsoon as an agent for transporting moisture have perhaps driven the interactions between fluvial and aeolian processes in this dryland environment.

Geoarchaeological connections are seen clearly in two papers by Kalicki et al. (2018) and Niebieszczanski et al. (2018). Kalicki et al. (2018) summarise the body of continuing research at the University of Kielce upon which the field component of the FLAG 2016 meeting was based. This is a dominantly geoarchaeologically inspired research programme, the paper setting it within the context of Late Quaternary fluvial evolution (based on river terraces and sedimentary evidence) of the Holy Cross Mountain region. The work points to increasing anthropogenic influence on landscape development since the Middle Ages, as revealed by research in the valleys of the Kamionka, Kamienna, Czarna Konecka and Nida rivers, particularly in relation to the construction of numerous artificial ponds, channels and water-power installations, resulting in significant changes in river patterns and regimes and in problems for present and future management. Niebieszczanski et al. (2018) show how multiple phases of Neolithic and Bronze Age tell occupation in Greece are strongly related to their surrounding floodplain environment. The researchers use geophysical techniques (focus 2.4) along with more established palaeoenvironmental and radiocarbon dating methods to determine the nature of the relationships between archaeological and fluvial sedimentation. They show that the style of fluvial deposition changed radically between the Neolithic and the Bronze Age at Nea Raedestos in the Anthemous River Valley (Central Macedonia, Greece). Similar radical changes in fluvial style are also reported from Italy in our final paper by Mandarino et al. (2018). This research derives from detailed quantitative and multi-temporal analysis of historical maps, aerial photos and satellite images (focus 2.4) of the study reach in this Italian river (a tributary of the Po), documenting channel planform changes since the late 19th Century. Use was made of GIS software that combined data on channel length, area, width, braiding, sinuosity, lateral migration, activity and stability to facilitate the identification of patterns of change in the channel planform. Three evolutionary stages were outlined, (1) from 1878 to the 1950s, (2) from the 1950s to the end of 1990s and (3) from the end of 1990s to present. In the first the river was able to migrate freely within its floodplain, whereas the second saw channel narrowing and stabilization, a trend reversed in the final stage, when there has been generalized widening in response to the destabilization of surfaces and an increase in bank erosion.

This selection of papers shows that research into fluvial archives over multiple time and space scales is now routinely applying techniques such as GIS, geophysics and OSL dating, once considered to be new. GIS allows researchers to broaden their spatial scale away from the site-based study to multiple reaches (e,g, Woolderink et al., 2018; Mandarino et al., 2018) or whole basins (e.g. Anton and Martin, 2018; Soria-Jáureguia et al., 2018), whilst geophysical techniques can improve stratigraphic certainty at a site scale (e.g. Niebieszczanski et al., 2018). OSL dating has been crucial in understanding river activity beyond the radiocarbon limit, particularly allowing phases of deposition to be more decisively linked to the climate record (e.g. Wang et al., 2018; Avsin et al., 2018), providing insight into fluvial processes and sometimes overturning previous assumptions (e.g. Olszak et al., 2018).

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