Neogene and Quaternary evolution of European river systems, controlling mechanisms

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Abstract

The evolution of the drainage system of lowland North-West Europe will be discussed on the basis of available geological evidence. The stratigraphy throws considerable light on landform and river development. The influence of Atlantic rifting and thermal doming in northern Britain appears to have been stronger and more temporally focused than the persistent flexuring that determined and maintained Tertiary drainage lines in the lowland areas. Drainage antecedence, the destruction of the Solent system and the breaching of the English Channel are also evident. By contrast, the major river systems of the western coastal areas are now entirely submerged.

The foundations of the modern drainage system of northwestern Europe were laid in the Miocene when earth movements associated with Alpine orogenesis and the opening of the North Atlantic were at their height. In general, these early rivers occupied shallow valleys and transported only chemically-resistant minerals and lithologies. Long-term stability of the drainage pattern reflects the persistent tectonic regime, with a subdued low-relief landscape having a weathered regolith and dense vegetation cover. Within the Neogene meandering river channels and alluvial styles predominated, although channel forms varied according to sediment load, slope and discharge variability. Coarse gravel-dominated accumulations are rare and localised. Chemically-stable lithologies dominate the clastic component throughout.

The Quaternary/Pleistocene was marked by the appearance of cold climates. It is apparent that the deeply-incised river valleys seen today are related to high, predominantly coarse sediment yields, encouraged by substantial, rapid climate changes in the Pleistocene. This emphasises the significance of mechanical compared to chemical weathering for the rate and nature of landscape dissection, and the modifications that have arisen as a result of glaciation, frost-climate weathering, rapidly-changing climates and sea-levels. River systems apparently responded significantly to the increased intensity of climatic deterioration and duration of climatic events during the Mid-Pleistocene transition (1.2-0.8 Ma). The increased activity has been attributed to intensification and prolongation of periglacial regimes, characterised by frost weathering and related to coarse detrital sediment supply, in the mid-latitudes, particularly in Europe. Here they are marked by increased incision and depositional terrace sequence and incision cycles in river systems that begin during the interval (Gibbard & Lewin, unpublished work), e.g. in the Lower Rhine, the Moselle, the Thames, Somme and Seine and the Danube.

Throughout the latter part of this period the river systems have undergone repeated

adjustments in response to continental glaciation. Examples of these responses will be discussed. Particular attention is paid to the impact of the Middle Pleistocene Elsterian and Saalian glaciation that blocked the southern North Sea to produce a vast ice-dammed lakes, the overspill from which initiated the Dover Straits and caused catastrophic floods that passed through the English Channel to the Atlantic Ocean.

The review of the histories of the major rivers of northwestern Europe include the rivers Elbe, Saale, Weser, Rhine, Meuse, Scheldt, Thames, Somme and Seine, and the Baltic and Channel rivers. The histories of these rivers illustrate how the interplay of tectonics and climate have influenced the northwest European drainage system through the late Cenozoic.