Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 3, Issue 12 (2025)

Online ISSN 3007-3197
Print ISSN 3007-3189

http://amresearchreview.com/index.php/Journal/about

Human-Induced Landform Evolution in South and West Asia Since the Neolithic: A Geoarchaeological Synthesis

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ABSTRACT

This study performs an extensive regional analysis of human-induced landform change in the region of South and West Asia, the Indus, Mesopotamian, and Nile rivers. The study combines geo-archaeological, geomorphological, and environmental data collected lately on the impact of hydraulic engineering, agriculture, and settlement development on geomorphological processes since the Neolithic period, based on approximately 150 peer-reviewed publications. Results indicate that human beings are important geomorphic agents because of their functions such as irrigation, deforestation, terracing that have led to the perpetuities of soil loss, channel changes and aggradation of flood plains over time. According to this synthesis, early hydraulic civilizations did not only adapt their surrounding landscapes, but also affected local sediment budgets, which determine traditions of sustainability and resource management to the modern. Elaborated in future researches, high-resolution dates of sediments, GIS-based simulation processes, and the interdisciplinary partnerships are favored in study in order to develop better predictive insights of anthropogenic progression of landscapes under the present and forthcoming pressure of climate.

Keywords: Geo Archaeology, Indus Valley, Mesopotamia, Nile Basin Human-Environmental Interaction

INTRODUCTION

Since the start of the Holocene, human activity has radically altered the surface of the earth. Early Indus, Tigris-Euphrates, and Nile rivers civilizations in South and

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West Asia were the first to alter the landscape with the use of irrigation, terracing, and deforestation (Giosan et al., 2012; Wilkinson, 2014). These actions caused geomorphic changes in the environment that are still shaping the modern environments. The role of exploration of the rich past of these change processes helps to understand the origins of the Anthropocene and inform the sustainable management of land use (Ellis, 2023).

Methodology

The Web of Science, Scopus, and Science Direct databases were used to complete a comprehensive literature review, paying special attention to the articles released since 2000 and not older. Of interest were search terms such as: geo archaeology, human-induced geomorphology, irrigation, terracing and Anthropocene landscapes. Articles were deemed fit to be included as long as they had empirical or conceptual contributions to anthropogenic evolution of landforms of a region in South and West Asia. One hundred and fifty articles were shortlisted after 1,000 articles were appraised to undergo synthesis. Thereof, common geomorphic processes, spatial characteristics, and change of methodological were also exhibited in qualitative content analysis.

Results and Discussion

3.1 Indus Basin: Early Hydraulic Landscapes.

Indus basin Geomorphological and archaeological evidence indicate extensive sedimentation of the sediment due to the presence of settlements and irrigation since the third millennium BCE (Madella and Fuller, 2006; Giosan et al., 2012). Canalization and deforestation led to acceleration of the aggradations in floodplains and modification of monsoonal drainage. Early agricultural intensifications are validated by optical datings and geochemical signatures because the important alterations (the main fluvial ones) cause them (Pokharia et al., 2020; Singh et al., 2021). The results shed light on the way of how the prehistoric water management impacted the deltaic morphology and the soil salinity distribution. When it comes to the distribution of the study sites, see the spatial distribution of the study sites as illustrated in Figure 1.

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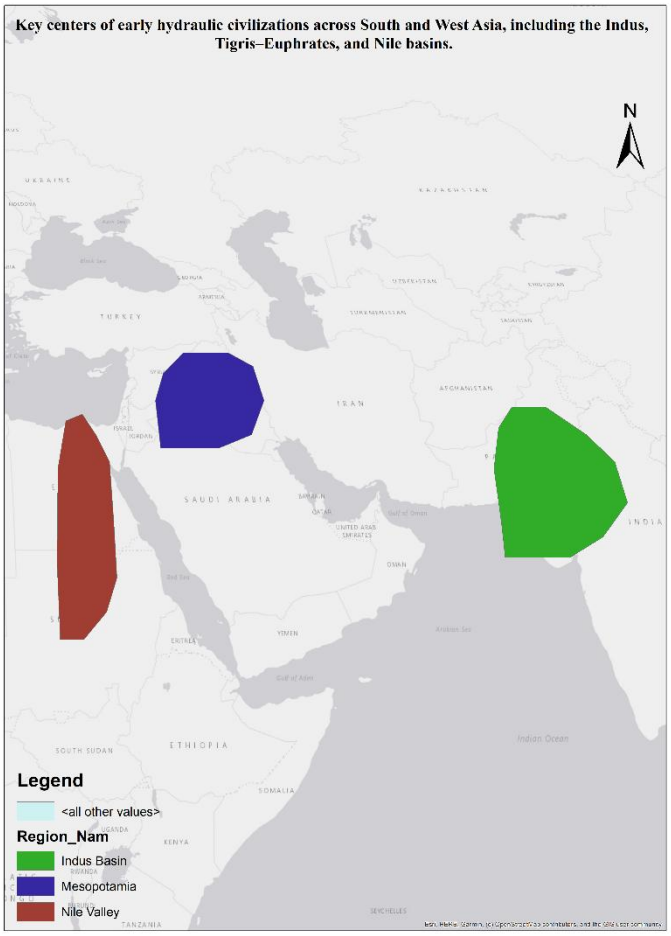


Figure 1. Regional map of South and West Asia with major River basins (Indus, Tigris-Euphrates, Nile).

3.2 Mesopotamia: Canal Systems and Anthropogenic floodplain

One of the oldest examples of landscapes which are altered purposely is the Tigris Euphrates area. Geo archaeological research suggests that it was in 6000 BCE that large-scale operations in the form of canal dredging, levee building, and salinization started (Wilkinson, 2014; De Klerk and Joosten, 2021). The evidence of the sediment core analysis in southern Iraq indicates that the floodplains are still being aggraded by humans. Also, various remote sensing and LiDAR mapping methods have revealed that many of the old canal networks still lie under the current farmland (Cigna et al., 2025; Schilt et al., 2022). On the one hand, such hydraulic infrastructures led to the development of urban areas, but on the other hand, they also caused serious ecological degradation in the long term.

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3.3 Nile Basin: Terracing, irrigation, and soil feed back

In Egypt, there was also a promotion of agricultural growth due to early damming and basin irrigation that caused salinization and compaction of soils in floodscenic areas (Bittner et al., 2022; Macklin & Lewin, 2015). Geoarchaeological evidence of course remains available at the Nile Delta has shown that Neolithic and Pharaonic amendments had an impact on the velocity of sedimentation as well as channels immigration. The interventions remain part of the present-day geomorphic instability and agricultural dilemma (Brown et al., 2021).

3.4 Cross-Regional Patterns and Feedbacks

Human-geomorphic modification exhibits the same ubiquitous template throughout each of the three basins combining first, water and terrestrial management innovation, second, landscape deterioration, and over-exploitation. The evidence of nonlinear interaction, emergent population growth and climatic variability as well as increased intensity of land use has led to threshold changes in sediment flux and hydrological regime, as demonstrated by system models of coupled human-Earth systems (Prosser et al., 2024; Tarolli et al., 2019). All these findings underscore the reality that ancient human-environment feedbacks give analogues of contemporary sustainability problems.

4. Synthesis and Future Directions

Human societies and geomorphic systems have long been co-evolving; this is recorded via the South and the West Asian paleohistorical record. Combining geoarchaeological data with the existing remote sensing techniques and hydrology philosophy, a re-construction of the anthropogenic modified landscape would be possible over time. Additional adoption of cosmogenic nuclide chronologies, LiDAR-based digital elevation models and isotopic tracing should further be applied in future studies to make estimations of sediment budgets quantitative. The interdisciplinary practices that rely on archaeology, geomorphology, and Earth-systems sciences should be capable of cutting across historical and contemporaneous environments and hence, guiding the adaptive management of the Anthropocene riverine and arid-zone environments.

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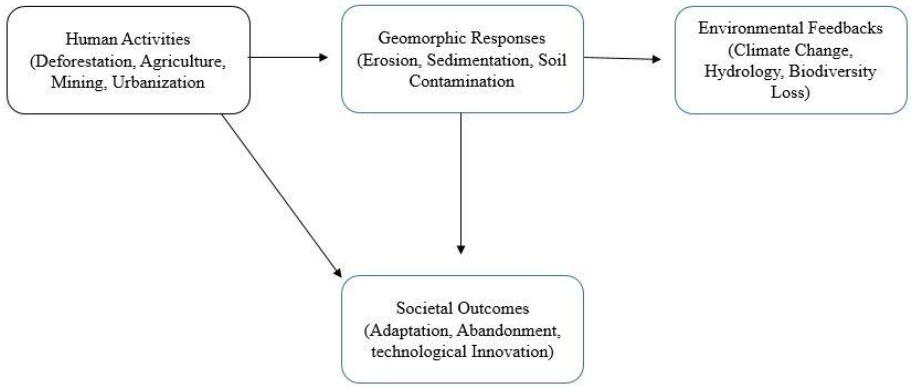


Figure 2. Human-Geomorphic Feedback Loops Conceptual Model.

Conclusion

The anthropogenic alterations of the landforms in South and West Asia indicates the diversity of the environmental manipulation over the eight thousand years. The Nile basin, the Indus and Mesopotamian sources show that the early agricultural communities have constructed their environment in a manner that has permanently changed the geomorphic processes. These primitive interventions emphasize human creativity and frailty of the relationships between people and human natural environment. Archaeological information coupled with contemporary geomorphic modeling can provide learning to help make the world today, particularly the realization that bounciness relies on the cognizance of the increasing effects of the long-lasting human landscape transformation.

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