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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☒	☐	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☒	☐	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐	A description of all covariates tested
☒	☐	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☒	☐	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	OriginPro (2020)
Data analysis	R (4.2.0), Excel (2021)

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

All data generated or analysed during this study are included in this published article (and its supplementary information files).

Human research participants

Policy information about studies involving human research participants and Sex and Gender in Research.

Reporting on sex and gender	not applicable
Population characteristics	not applicable
Recruitment	not applicable
Ethics oversight	not applicable

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Archaeological and palaeo-environmental study that aims to reconstruct palaeo-hydrological and geomorphological context and function of earliest drainage system at a late-Neolithic walled site in Central China.
Research sample	11 OSL dates, 67 bulk samples for grain size analysis and 2 soil/sediment blocks obtained from three profiles in/around the site; 5 bulk samples for grain size analysis collected from the drainage system; and 17 animal bones for radiocarbon dating as well as 59 sediment blocks for micromorphological and engineering (experimental) analyses collected from various archaeological features (e.g., ditch sediments, mudbricks and ground-raising layers) during the excavation. In addition, 147 sediment cores were carefully examined during the regional geological survey.
Sampling strategy	The archaeological and sediment samples collected during the excavation were arranged based on different types of archaeological contexts, which were situated both inside and immediately outside the enclosed area of the site. This arrangement was to make sure that the collected samples could represent a full picture of water management practices at the site. The geological cores were arranged at every 1km in the region. This is a common sampling strategy adopted in large-scale regional geological survey.
Data collection	The collection of the different types of archaeological and environmental samples mentioned above followed strict procedures in recording, packing, shipping, laboratory processing and analyses that are commonly adopted by scholars (see detailed information in the supplementary information folder). These works involved both project participants (including all the authors listed in this article) and some specialized technicians.
Timing and spatial scale	Most samples were collected during the archaeological excavation in 2019. Samples from Profile 2 were collected on November 14, 2020. Samples from Profile 3 and three samples for OSL dating from Profile 1 were collected on August 15 and 16, 2021. All samples were collected at and around the Pingliangtai site and the Huaiyang region in Henan Province.
Data exclusions	No data were excluded from the analyses.
Reproducibility	For OSL dating, the preheating temperature was carefully determined and at least 9 aliquots were measured for each OSL sample. For particle size analysis on Mastersizer, at least three measurements were taken for each sample. Other types of analyses (e.g., micromorphology, measurement of ceramic drainage pipes) generally do not require reproducibility.
Randomization	The samples were naturally categorised into groups based on primarily on the different types/materials they belonged to and different contexts from which they were collected.
Blinding	Archaeological sampling normally does not involve blinding as the sampling is restricted by what is available to sample. Nonetheless, as we have explained above, we tried to collect a wide range of archaeological and sediment samples during the excavation to represent the fullest possible scenarios of water management during the occupation of the site. The geological coring survey was arranged at every 1km, which is a good sampling strategy to avoid bias and hence effectively offset the absence of blinding during the survey.

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	The annual rainfall is about 740mm, and the average annual temperature is about 14 °C.
Location	Profile 1: N33° 42' 29.148", E114° 55' 26.920"; Profile 2: N33° 42' 21.442" , E114° 55' 23.227"; Profile 3: E114° 55' 29.862" , N33° 42' 18.039" .
Access & import/export	All the samples were processed in different laboratories in China and thus not export permission were required. The collection of the archaeological and environmental samples was discussed and agreed by all the project participants and also with permission from local institutes.
Disturbance	N/A

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☐	☒ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Palaeontology and Archaeology

Specimen provenance	The collection of the archaeological and environmental samples was discussed and agreed by all the project participants and also with permission from local institutes.
Specimen deposition	Most of the bulk samples are stored at Institute of Geographic Studies of the Henan Academy of Science; archaeological samples (e.g., ceramic drainage pipes) are curated at the Henan Provincial Institute of Cultural Relics and Archaeology and Henan Provincial Museum. Thin section samples are stored at School of Archaeology and Museology of Peking University
Dating methods	The OSL dating were performed at the Institute of Geographic Studies of the Henan Academy of Science following standard single-aliquot-regenerative method (see the supplementary information folder). 14C dates were obtained from the Beta Analytic following their standard treatment. IntCal20 was to calibrate the dates.

☒ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.

Ethics oversight	No ethic requirements were needed as they samples do not involve human specimen and the collection of them followed strictly Chinese laws.

Note that full information on the approval of the study protocol must also be provided in the manuscript.