SHORT RESEARCH REPORT

Survey and Digital Documentation of Endangered Temple Wall Paintings in Shanxi Province, China

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Summary report on the fist season of digital recording of temple architecture and wall paintings in Shanxi Province, China.

Shanxi Province is at the heart of China, and home to some of its richest architectural heritage. Covering an area of 156,000 square kilometres the Province is larger than England and Wales combined. Many earthen and timber buildings and temples contain wall paintings, witnessing Chinese folk religion, Buddhist and Daoist beliefs. Scattered over a large geographic area these remote village temples present a fairyland of Chinese traditional folklore. Many of these sites are endangered, and most are unrecorded.

Funded by Arcadia, a charitable trust fund of Lisbet Rausing and Peter Baldwin, the Shanxi Digital Documentation of Endangered Temple Wall Painting Project (SDDP) is a four-year programme (2018–2021) aimed at recording these historic temples and wall paintings using high-resolution photographic and three-dimensional photogrammetric techniques, and also including selective capture of multi-spectral imagery. These records will form an open-access digital archive of temple paintings and associated architecture, structured by a Chinese-English bilingual database.

The SDDP is a partnership between Zhejiang University, Shanxi Institute of Architecture Conservation and University College London (represented by two research centres within the Institute of Archaeology: the International Centre for Chinese Heritage and Archaeology and the Centre for Applied Archaeology). The programme of survey and research is guided by the Shanxi Provincial Bureau of Cultural Heritage (SBCH) and an international advisory board.

Significance

Wall paintings in China are studied under three major categories: paintings in ancient tombs (墓室壁画); paintings in grotto caves (石窟壁画) and paintings in historic buildings and temples (寺观壁画) (Chai 1997, Zhang 2013). The wall paintings in Shanxi province fall mainly into the third group. Those temples and historic buildings are scattered over a large geographic area and many are located in extremely remote places. As a consequence of their dispersed location, the scholarly value of these historic wall paintings has often been overlooked. In

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addition to their aesthetic values they have a unique contribution to make to our understanding of local belief systems, bringing new data to a topic that has tended to rely on the partial evidence of documentary sources.

Work started with a pilot study in Guandi Temple of Baode County in May 2018, where the field methodology was tested and confirmed. Xinzhou City was subsequently selected as the first of the eleven prefectures within the province for detailed survey. 89 temples have been added to our geo-referenced inventory, based on their vulnerability and significance (**Figures 1** and **2**).

A mix of Buddhism, Taoism and Chinese folk religion is often combined within a single temple complex. For example, **Figure 3** presents the story of Guan Yu, a historic figure who was born in Shanxi and is recognised as a guardian deity in Chinese folk religion and Taoism, and as a bodhisattva in Buddhism. He is not only a local hero, but represents loyalty, bravery and prestige, as a protector of the land. The stories drawn together in these paintings reflect on the highly syncretic qualities of regional religious practices. Themes, such as Guanyin/Xi Wang Mu or Queen of Earth as the Fertility Goddess, the Dragon King as the Water and Weather God, and worship of ancestors, are widely referred to. These temple paintings present important new information on the dialogue of ideas represented in the iconography of pre-modern China. (see Chai 1997; Chai & He 2006; LI 2011; Meng 2011; Shanghai Museum 2017; Wu 2013; Zhang 2013; Zhao 2014).

By way of example, the Yangzhongwu Temple (**Figure 4**) is a shrine dedicated to the ancestors of the generals of the Yang family. It is listed as a provincial protected historic building complex. According to the steles in the Hall, it was built in 1329 and has been repaired several times from the Ming dynasty to the Qing dynasty. Portraits of two of the seven brothers of the Yang family were placed either side of the entrance. **Figure 5** shows one of these portraits, in a restored version of a style of painting that is typical of the region.
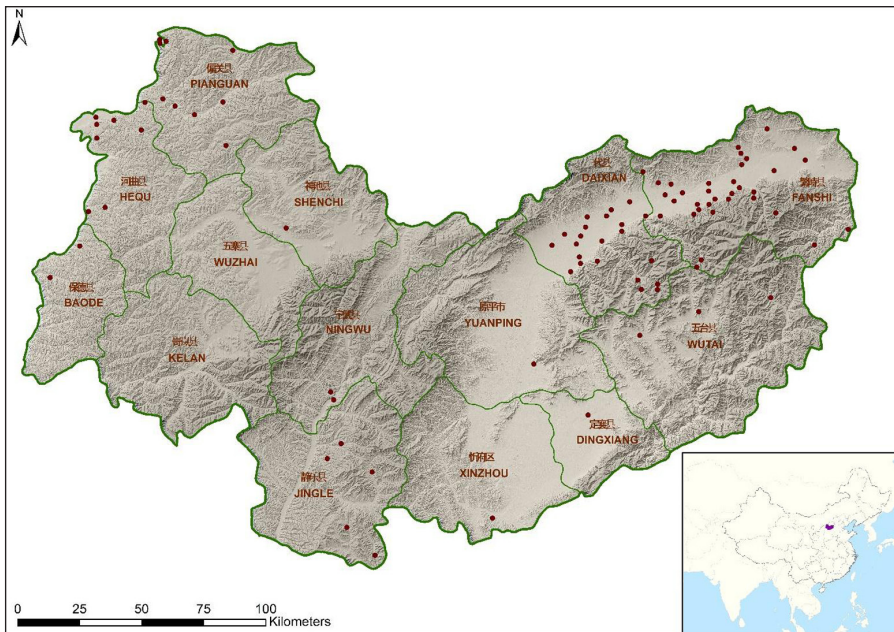

Figure 1: The distribution map of temple sites in Xinzhou City (elevation data provided by Japan Aerospace Exploration Agency (JAXA)).

Figure 2: SDDP field team in action: recording Dingxiang Temple. The field work condition
can be rather rough, as the local temperature can drop to −20°C in the winter and rise over
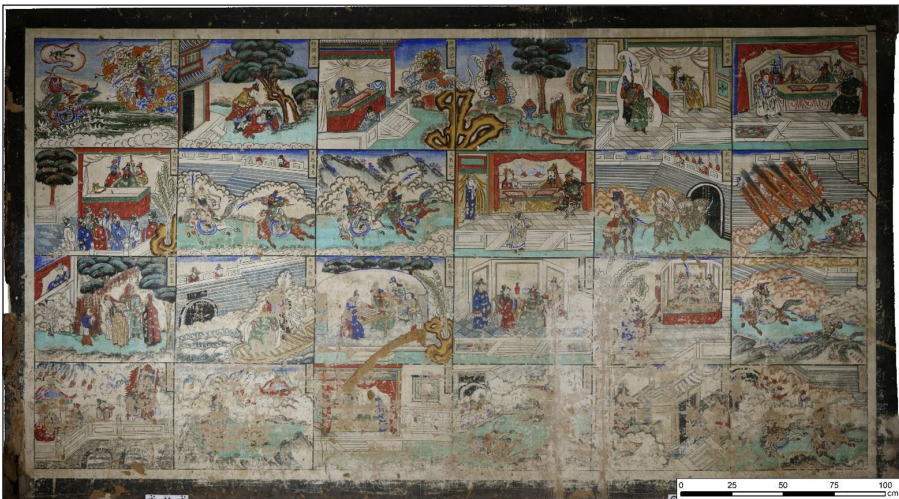40°C in the summer. Photo courtesy of the SDDP team.

Figure 3: Room 1 Wall 1 in Guandi Temple in Shangshahe Village, Daixian County, 代县上沙
河村关帝庙 (SDDP_DXSS004). Image courtesy of the SDDP team.

The Use of Photogrammetry

The project uses high quality DSLR and mirrorless cameras, robotic total stations and Unmanned Aerial Vehicles (UAV) to rapidly obtain a comprehensive high-resolution digital record of each temple. Typically, 100–200GB of raw data is gathered from sites where wall paintings are present. Not all of this data needs processing for our digital models, but forms part of the project archive. Images are stored in 16 bit sRGB TIFF format and, if needed, can be calibrated using a
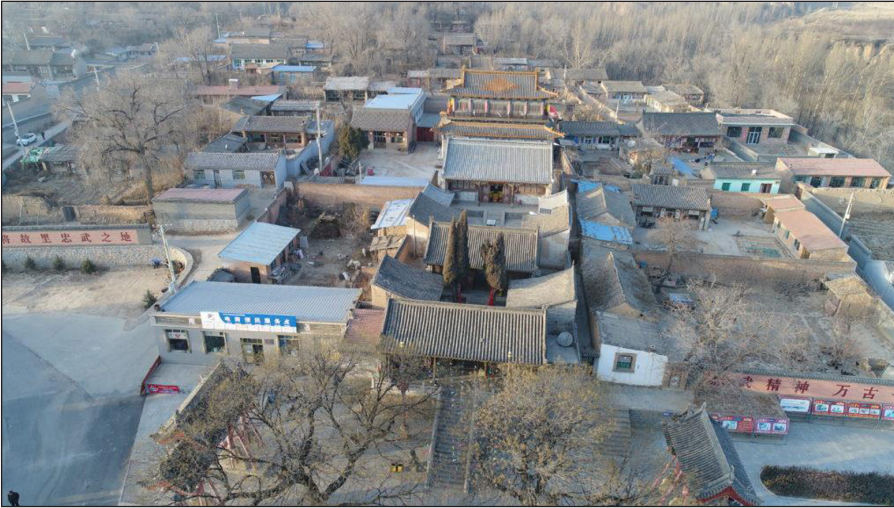
Figure 4: An aerial view of the Yangzhongwu Temple in Lutijian Village, Daixian County. Image courtesy of the SDDP team.

Figure 5: Room 2 Wall 6 in Yangzhongwu Temple, 代县杨忠武祠 (SDDP_DXZL008). Image courtesy of the SDDP team.

colour reference card captured in each set. Additional gigabytes are generated during processing of the data in the form of final outputs and processing files.

Our main outputs are orthomosaics and models of the surviving paintings, architectural plans of the temples, and select 3D models of entire sites and buildings. Processing and production of the photogrammetric outputs for a single wall takes between 15 and 40 hours, depending on the size and level of detail. Detailed recording allows for sub-0.5 mm cell sizes in wall orthomosaics, usually with a 0.2 mm error threshold. Metadata for spatial outputs adheres to INSPIRE and GEMINI2 standards (European Commission 2013; The Association for Geographic Information 2018).

Our photogrammetric recording means that not only are we capturing

high-resolution images of the paintings, but also digital surface models of the walls on which they are found. These models aid the condition assessment of the wall painting, displaying features like cracks, holes and peeling layers of paint, which are often invisible to the naked eye (**Figure 6**).

Digital outputs and site data will be stored and managed using the Arches database system. Raw data will also be accessible via UCL's Research Data Repository on an Open Access basis. Some of the data's geographic properties need to be obscured, however, in order to avoid guiding looters to pristine sites. Looting is a major problem at these unguarded sites, along with the processes of natural decay, adding urgency to the programme of recording.

VR modelling

The Shanxi project is delivering high quality and high-resolution 3D datasets that lend themselves to different digital presentation techniques. 3D modelling is being used to prepare Virtual Reality (VR) models of temples within their wider landscapes. Additionally, some of the photogrammetrically recorded

wall paintings are fully VR-ready. The temples can be viewed with a range of VR equipment, helping us to find new audiences for the data and drawing attention to the importance and vulnerability of these sites. The investment in VR-quality recording is also helping us to future-proof the datasets that are being created. Most of these models will be made available in lower resolution either through Sketchfab or similar open platforms and made available directly on the project website in high-resolution. We are also exploring ways of augmenting these VR models with embedded links, captions and reconstructions. Proof-of-concept Augmented Reality (AR) applications have been developed for classroom teaching, although the full benefits of such approaches will require additional investment and support.

Legacy

In addition to creating a permanent and freely accessible public record of the temples in Shanxi province, the project is helping to train local expert teams for the continuing record and management of endangered heritage within China, pushing the boundaries
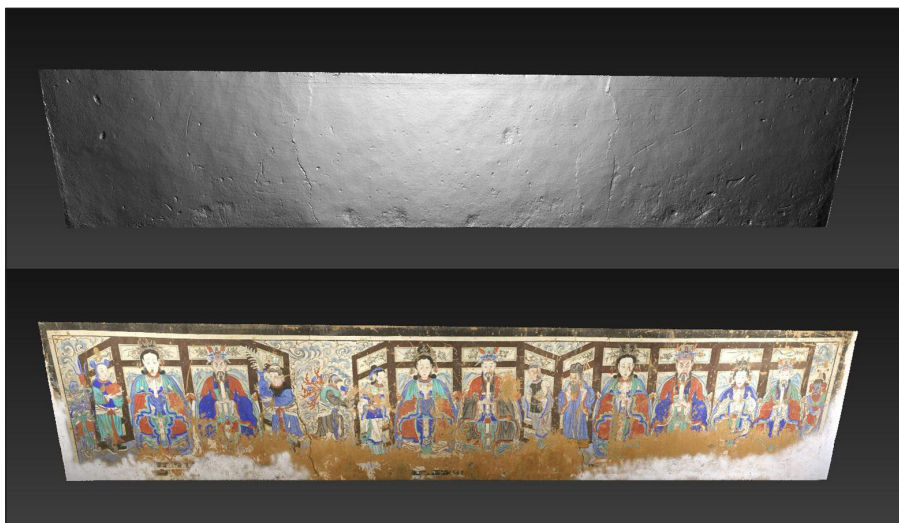

Figure 6: Main mural (10.80 × 2.15 metres) in the Temple of King Wuling of Zhao in Daixian County. The bare wall surface model (top) shows irregularities of the wall allowing for a better condition assessment, while the textured model (bottom) overlays that surface with RGB imagery. Image courtesy of the SDDP team.

of research practice and enhancing digital recording technologies and methodologies for future research and conservation.

The goal of the project is to establish a database of over 200 temple sites, with a complete record of their wall paintings, and to create a substantial data repository for future research. This will be an open-source resource in both Mandarin and English (facilitated by our use of the ARCHES database platform which supports bi and multilingual use). We are committed to making sure that our records are permanently, securely and publicly available. Although providing open access to datasets of this scale is a technical challenge that will test capabilities, the philosophy of open access between collaborating parties was easily agreed. All of the partners to the project were fully supportive of an open access platform, with a UCL-based institutional repository the preferred long-term solution for the deposition of datasets. All data is shared by our partner institutions in China, who are developing parallel platforms for nationally-based dissemination and publication that will serve as the basis for future research beyond the life of this project.

For more details, please visit the project website (https://shanxi-project.org/).

Competing Interests
The authors have no competing interests to declare.

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