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TRANG AN LANDSCAPE COMPLEX WORLD HERITAGE PROPERTY, NINH BINH PROVINCE, VIETNAM

STATE OF CONSERVATION REPORT

NINH BINH PROVINCIAL PEOPLE'S COMMITTEE, NOVEMBER 2017

1. Introduction

This State of Conservation Report presents a response to the World Heritage Committee from the State Party of Vietnam to requests made at the 40th Session of the Committee in 2016, in Decision 40 COM 7B.67.

- In para. 5 of the Decision, the Committee noted its concerns about inadequate measures in the revised management plan relating to management of tourism, particularly regarding visitor overcrowding, and also relating to archaeological heritage, particularly staff training, conservation/restoration methods, cataloguing, condition-surveying, monitoring and long-term planning for protection.
- In para. 6, the Committee requested the State Party to assess the facilities and services required for the anticipated increase in visitor numbers.
- In para. 7, the Committee requested clarification of any additional recreational activities in terms of provision of facilities and impact assessment.
- In para. 8, the Committee noted its concern about potential population growth from a planned university in the buffer zone, and requested that the State Party observe the requirements in the *Operational Guidelines* regarding any proposed development projects in the property, its buffer zone or setting, and undertake a Strategic Environmental Assessment of the buffer zone, taking account of the potential impact on the OUV of the property, prior to allowing any such development projects.

These concerns and requests of the Committee are all addressed in this State of Conservation report. Also in this report are details of some other important developments in the property that are contributing to improved management for the protection and integrity of the OUV of the property. Specifically, these improvements relate to archaeological research, protection of biodiversity, visitor management, conservation education, promotion of the property and reform of the administration of the property.

2. Response to World Heritage Committee Decision 40 COM 7B.67

Para. 5. The Committee . . . Notes with significant concern that the State Party has not included adequate measures in the revised management plan concerning the management of tourism and cultural heritage, and requests the State Party to:

- 1. Ensure measures are in place to limit overcrowding, including the establishment of a clearly justified maximum daily quota for peak and normal visitation days,*
- 2. Include sections concerning the archaeological heritage, which clearly detail the actions to be undertaken, in terms of staff training, conservation/restoration methods, and long-term planning,*
- 3. Develop the skills of the management body to successfully plan the management of the archaeological heritage at the property,*
- 4. Establish a system for the cataloguing, condition-surveying, monitoring and protection of archaeological heritage through conservation measures, in order to adequately conserve archaeological artefacts;*

The revised management plan for the Trang An Landscape Complex World Heritage Property (November 2015) includes a comprehensive tourism management plan with measures addressing: eco-tourism; recreation; privately owned accommodation; cultural and religious tourism; visitor centres; interpretation; and visitor safety. The revised management plan also makes comprehensive provision for management of cultural heritage covering: pre-historic archaeological sites, resources and artefacts; later pre-historic and historic sites and monuments; and the Hoa Lu Ancient Capital. The plan covers the five-year period 2016 – 2020 with a vision to 2030. It is under continual review and is subject to formal revision every five years.

In light of the comments and requests from the Committee in its Decision 40 COM 7B.67, the State Party of Vietnam considers that it is appropriate and timely now to conduct a full review of the management of tourism and archaeological heritage in the property. This review has been conducted by the Management Board in consultation with all relevant agencies and key stakeholders and with assistance from domestic and international experts.

The review addresses all the matters contained in the Committee Decision 40 COM 7B.67. It focuses attention on actions taken in implementing the provisions of the management plan, while up-dating them from recent experience and new knowledge.

The review is presented in two separate reports annexed to this State of Conservation report, which should be read in association with this report:

- Annex I: Tràng An Landscape Complex Archaeological Heritage Management: Action Plan.

- Sub-Annex I.1: Human Adaptation to Coastal Evolution: Late Quaternary evidence from Southeast Asia (SUNDASIA) – A report on the first year of the project.
 - Sub-Annex I.2: SUNDASIA PROJECT – Contributions to Monitoring, Conservation and Potential Enhancement of Biological Diversity in the Tràng An World Heritage Property.
 - Sub-Annex I.3: Rabett, R. *et al.* 2017. Tropical limestone forest resilience and late Pleistocene foraging during MIS-2 in the Tràng An massif, Vietnam. *Quaternary International*, 448: 62-81.
- Annex II: Trang An Landscape Complex Visitor Management: Action Plan.

Para. 6. The Committee . . . Requests the State Party to undertake an assessment of the facilities and services required to adequately service the anticipated increase in visitation from one to two million visitors, including the extrapolated festival-day peaks of up to 50,000.

The revised property management plan of 2015 reported that about one million people visit the property each year, and it was predicted that by 2020 visitor numbers could rise to about two million per year. It was further noted that some 70% of visitors arrive in the 3-month peak season and that crowding occurs at the Trang An boat route on some festival peak days when up to 20,000 visitors arrive. Although this level of use created no significant problem for existing facilities and services, the management plan imposed a cap on the total number of boats operating in the property at 3,000 by 2020, which was expected to cope with the predicted increase in visitor numbers, including on the busiest days.

Following the past two years of experience, and with improved counting, it is necessary to revise these figures (*see* Annex II of this State of Conservation Report for details). Currently, approximately 2.4 million visitors arrive at the property annually and it is projected that numbers could rise to about 3.5 million by 2020. Some 56% of visitor use is concentrated in a 3-month peak season when traditional festivals are held, and there is a trend toward more use of the low season period. The greatest increase in numbers is occurring at the Hoa Lu Ancient Capital where visits are on foot, not by boat.

At current levels of use there is no observable undesirable environmental or social impact, and to date there has been no increase in the number of boats operating. The Management Board is highly confident that present and planned infrastructure and services are capable of ensuring this desirable situation will continue, despite anticipating a substantial increase in visitor volume.

Several important operational provisions have been introduced or are planned to establish the desirable carrying capacity of the busiest sites and to avoid crowding in the peak visitor season, as follows:

- Increasing the cap on the total number of boats to 3,865 by 2020;
- Increasing the number of trips per boat to up to three per day, while suspending ticket sales if all boats are operating;
- Opening a new boat route, within in the visitor-use zone, operating from the Trang An boat wharf during the peak season;
- Encouraging visitors to select less busy arrival times, less crowded sites, and alternative destinations outside the property;
- Internet ticket sales, and differential pricing, to encourage more low-season use; and
- Improved parking and ticketing arrangements at the gateways to avoid congestion.

Para. 7. The Committee . . . Further requests the State Party to clarify whether or not any additional recreational activities are to be encouraged, where they will be permitted, what facilities will be provided and identify the potential impacts on OUV and how they will be addressed.

Objectives for recreational activities are addressed in Sect. VII.3.2 of the revised Management Plan for the Trang An Landscape Complex World Heritage Property (2015). Current management action regarding recreation is covered in the Visitor Management Action Plan (*see* Annex II of this State of Conservation report).

The Trang An property is not suited to a wide range of recreational activities. Currently activities are of the passive type and limited to sight-seeing, walking, hiking and cycling, all of which are provided for in the management plan. There is no evidence of undesirable impacts on OUV from recreation. The management plan provides for support other appropriate recreation activities but to date there has been no demand for this. At this time, the Management Board has no plans to introduce new recreational activities or to develop any additional recreation facilities anywhere in the property.

Para. 8. The Committee . . . Also notes with concern that the revised Management Plan refers to a new urban university area in Bai Dinh, which would result in a population growth of 20,000 people within the buffer zone by 2030, and requests furthermore the State Party to:

Submit, in accordance with Paragraph 172 of the Operational Guidelines, detailed information on any proposed development projects within the property, its buffer zone and setting for review by the World Heritage Centre and the Advisory Bodies prior to any decisions being taken that could be difficult to reverse,

Undertake a Strategic Environmental Assessment for development of the buffer zone, taking into account potential impacts on the OUV of the property in line with IUCN's World Heritage Advice Note on Environmental Assessment and a Heritage Impact Assessment

(HIA) in conformity with the ICOMOS Guidelines on HIAs for Cultural World Heritage properties for the proposed projects, prior to allowing any such development to take place.

Law on Cultural Heritages and Decree No.109/2017/NĐ-CP dated 21/9/2017 of the Government of Vietnam on the protection and management of the world cultural and natural heritages in Vietnam regulate that heritage zones and heritage buffer zones are protected in accordance with the laws on cultural heritages. Therefore, construction activities that may impact the outstanding Universal Values of the Trang An Landscape Complex will be reported to the Ministry Culture, Sports and Tourism and the UNESCO World Heritage Committee for their approval.

There is reference in the Ninh Binh Province Tourism Master Plan to possibly establishing a new university area in the Bai Dinh area of the buffer zone, resulting in a population growth of approximately 20,000 by 2030. This Master Plan, produced by the Provincial Government, is intended to be a general guide to development of the tourism sector in the province, and presents a long-term forecast with a vision to 2030.

The property Management Plan makes no direct reference to development of a university area in the buffer zone, and does not contain any provision for such a development. Moreover, it is extremely unlikely that a university would ever be developed in the buffer zone.

If a university, or any other significant development, were to be proposed in the buffer zone, then such a project would be subject to rigorous environmental impact assessment (EIA) prior to being approved. That assessment would, among other things, take account of any potential impact on the outstanding universal value of the property and its natural and cultural integrity. The EIA would also give due attention to advice and guidance from IUCN and ICOMOS, and would be made available to the World Heritage Secretariat and Advisory Bodies in accordance with procedures in the *Operational Guidelines*.

In the existing management plan for the buffer zone (*see* Part VIII of the property Management Plan), priority is given to conservation of natural and agricultural landscapes, archaeological sites, architectural monuments, historic sites and relics, traditional villages and intangible cultural heritage values. Currently, there are no significant pressures on these natural and cultural values and attributes in the buffer zone, nor are any foreseen. The buffer zone remains fully effective in safeguarding the outstanding universal value and integrity of the property. Undertaking a Strategic Environmental Assessment for the development of the buffer zone is, therefore, not regarded as a priority at present, but would be considered in future should the need arise.

3. Significant developments and improvements in the Trang An Landscape Complex property

3.1 Archaeological research and conservation

Archaeological research, conservation and heritage management currently being undertaken (and being planned) with the Management Board in Tràng An is consistent with objectives laid out in the revised Management Plan, including for the protection of pre-historic archaeological sites, resources and artefacts (Section VII.1.1), staff capacity-building and training (Section VII.5.2) and research (Section VII.5.4).

The largest research programme operating within the property is the SUNDASIA Project (2016-2019), led by Queen's University Belfast. This international project is operating under a formal Collaboration Agreement with the Management Board, and the Vietnam Institute of Geoscience and Mineral Resources in Vietnam, and with partner institutions in the UK. The project is investigating how prehistoric communities adapted to changing environmental conditions (chiefly cycles of sea-level rise), and how the results of this work can be applied to modern climate-change driven changes in Southeast Asia.

Baseline data are being generated through archaeological excavation of sites within Tràng An; terrain mapping, using a range of digital and remote sensing technologies (including LiDAR, satellite imagery, and drone photogrammetry) to track long-term sea-level change and patterns of prehistoric occupation; palaeo-environmental (vegetation) and palaeo-climate (chiefly, palaeo-monsoon) reconstruction; and modern points of comparison particularly in floral and faunal biodiversity: linking people to landscape and climate evolution. The Project is also directly involved in capacity-building and knowledge transfer initiatives with the Management Board and other local stakeholders (e.g. Vietnam Institute of Archaeology, Cuc Phuong National Park). Full details of this work programme are presented in Annex I of this State of Conservation Report, as follows:

Annex I	Tràng An Landscape Complex Archaeological Heritage Management: Action Plan;
Sub-Annex 1.1	Human Adaptation to Coastal Evolution: Late Quaternary evidence from Southeast Asia (SUNDASIA) – A report on the first year of the project;
Sub-Annex 1.2	SUNDASIA PROJECT – Contributions to Monitoring, Conservation and Potential Enhancement of Biological Diversity in the Tràng An World Heritage Property;
Sub-Annex 1.3	Rabett, R. <i>et al.</i> 2017. Tropical limestone forest resilience and late Pleistocene foraging during MIS-2 in the Tràng An massif, Vietnam. <i>Quaternary International</i> , 448: 62-81.

3.2 Protection of biodiversity

Observations from guides (boat rowers), forest rangers and specialist Management Board staff indicate that over the past two years there has been considerable improvement in the condition of the natural forests and waters of the property. Particularly encouraging are the increased incidence of bats in the property's water caves, abundant fish in its waterways and recent sightings of macaques in the property's interior. These occurrences suggest that the protection programmes of the Board are proving successful in improving terrestrial and wetland habitats, and that local people are respecting the protection requirements in the property, with less illegal hunting and fishing. It also demonstrates that increased levels of visitor activity have not had a visibly detrimental impact on the vegetation and wildlife.

Nonetheless, monitoring programmes are being strengthened in collaboration with the SUNDASIA Project (*see* Sub-Annex I.3 of this State of Conservation report) and the Management Board's own longer-term plans (*see* Annex I, Item 3.2 of this State of Conservation report). These initiatives will provide more detailed and objective measurement of the property's natural communities, and proactive enhancement of Tr ng An's biodiversity is being considered; including the possible re-introduction, starting with a small trial population of 3-5 individuals in an isolated (insular) setting, of the endemic and critically endangered Delacour's langur (*Trachypithecus delacouri*).

3.3 Visitor numbers, trends and facilities development

In 2016 approximately 2.4 million people visited the Trang An property, revealing that the number of visitors has doubled in the two years since it attained World Heritage status. However, there was only an 11% increase over the previous year, which suggests that an initial surge in visitor numbers may be already be over. Numbers will undoubtedly continue to rise but with so many variables involved the rate of increase is difficult to predict at this early stage. Foreign visitors make up about 20% of the total number, but their rate of increase is greater than that of domestic visitors, which probably reflects the increased international exposure of Trang An since it became World Heritage. Notably, more people (especially domestic tourists) are arriving during the 9-month low visitor season, thus lessening the marked contrast between peak and low seasons and allowing more uniform management intervention throughout the year.

The current volume of annual visitors is generally within the carrying capacity of existing facilities. However, at the main Trang An wharf, which handles about 70% of all visitors, crowding has occurred on a few days during the 3-month peak visitor season. A second boat route has, therefore, recently been introduced, which operates during festival times and other high-use days but remains closed for much of the year. Its purpose, which is to spread the distribution of boat traffic and thus reduce the pressure of visitors on the primary Trang An boat route, has already proved beneficial in improving visitor use management in the property. A small temple along the route has been constructed on the site of an old stele, to be

used during festival celebrations. Development of this new route is compatible with measures for avoiding overcrowding contained in the revised property Management Plan (Sect.VII.3.1).

3.4 Education and training developments

An environmental education and training centre has been established in the property (*see* Annex II, Figure 15 of this State of Conservation report). Located in the north-eastern part of the property, and accessed from the vicinity of the Bai Dinh Pagoda in the buffer zone, the site covers 20 ha of which 12 ha is a lake. This area, which is second-growth forest and wetland, is within the conservation/sustainable management zone of the property that allows for some limited visitor use and associated facilities development. The Centre comprises three accommodation houses built in traditional architectural style, toilets, and a lake with a surrounding paved walking track. The purpose of the centre is to provide opportunities for students drawn from throughout Vietnam and some surrounding countries to learn about forest and wetland ecology, and for training in conservation. Walking access only will be allowed but there may also be some limited provision for disabled visitors to be transported by electric-powered cars. Establishment of this new facility is consistent with policies for promotion of education and training in the property contained in the Management Plan (Sect.VII.4.2).

3.5 Promotion of the property

Trang An is the principal setting for the blockbuster movie *Kong: Skull Island* released in early 2017. The spectacular scenery of the limestone karst massif, which is one of the key components of the OUV of the property, is a feature of the movie (along with that of another Vietnam World Heritage property, Ha Long Bay). The movie has greatly enhanced the profile and public perception of Trang An and has increased its popularity as a visitor destination. A small replica movie set has been established and has become a very popular visitor attraction. This development, which has caused no disruption or disturbance, is in conformity with objectives for promotion and marketing of the property contained in the Management Plan (Sect. VII.4.3).

3.6 Administration reforms

During 2017, as part of Government administrative reform in Ninh Binh Province, the Trang An Landscape Complex Management Board was transferred to the newly established Department of Tourism. A vice-director in the Department of Tourism now has responsibility for supervising and controlling the activities of the Board (*see* Annex II, Figure 9 of this State of Conservation report). The Board has a director and up to three vice-directors and is

composed of four divisions, responsible respectively for administration, environment and landscape management, foreign affairs and public relations, and technical and research matters.

The Management Board retains its identity and independence, but is strengthened by placement within the provincial Government framework. It is able to conduct its general operations and strategic planning more efficiently through having direct access to officials in the Tourism Department and all other relevant agencies, especially the new Department of Culture and Sport. The Board also now reports directly to the head of a principal Government Department in the province, and through that office to the Provincial People's Committee.

TRÀNG AN LANDSCAPE COMPLEX ARCHAEOLOGICAL HERITAGE MANAGEMENT: ACTION PLAN

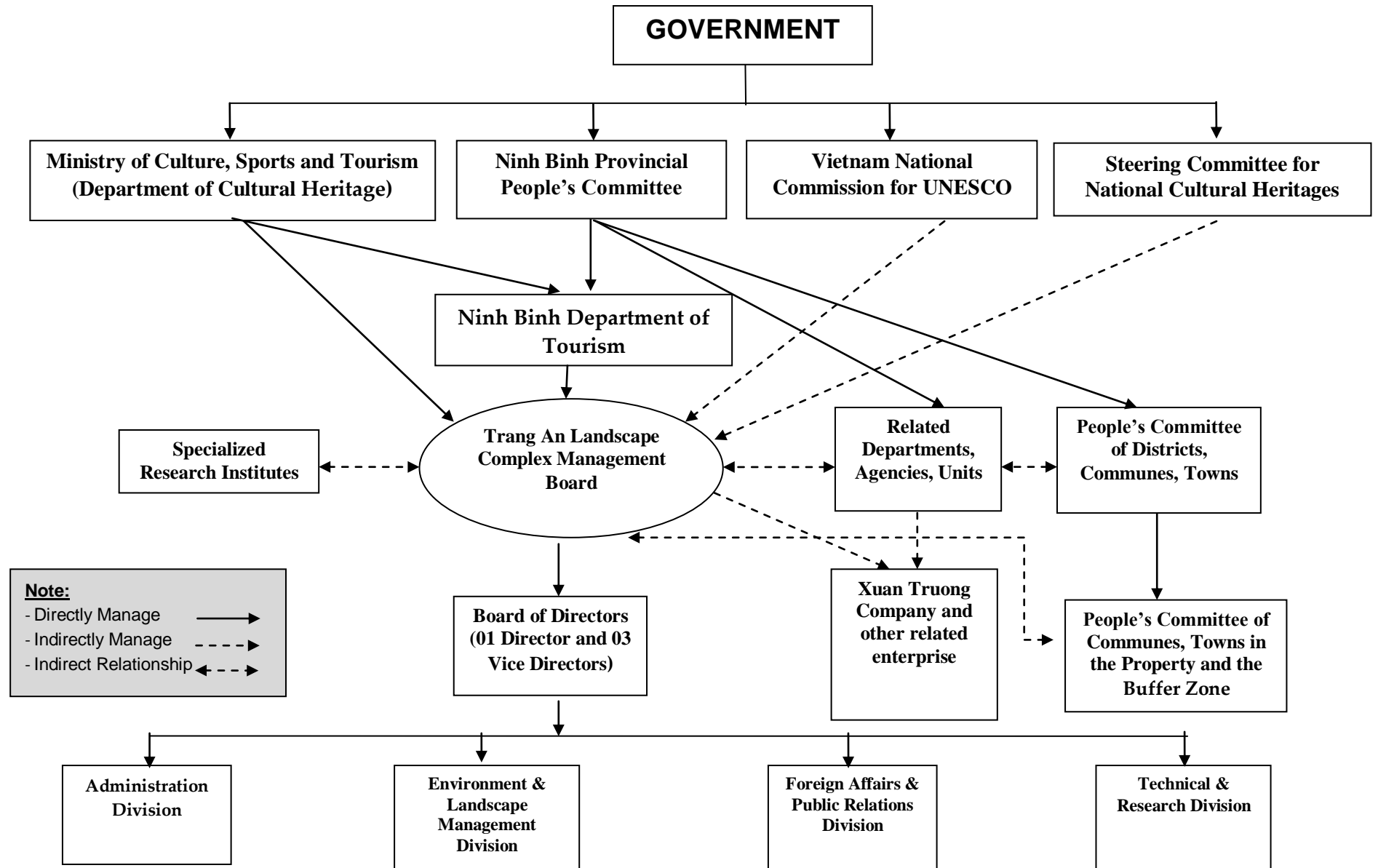
1. INTRODUCTION

Under the heading of ‘Protection of cultural heritage’ (Management Plan section VII), **Pre-historic archaeological sites, resources and artefacts** (VII.1.1) itemised 15 actions for the Management Board (*see* figure 1 for board organisation). At the present time (September 2017), twelve are already being implemented; the remaining three are under development. The following **Archaeological Heritage Management Action Plan** opens with reference to the proposed composition of the Tràng An Management Board’s Scientific Advisory Committee; a body who will provide guidance in this field. The Action Plan then proceeds to provide a brief assessment of the 15 above itemised actions (i.e. VII.1.1.1-15), before examining in detail the current state of actions associated with archaeological heritage management in Tràng An. **This is followed by specific treatment of the concerns raised in Decision 40 COM 7B.67.**

Serving as a point of scientific reference to the Board’s action, the Vice Director of the Ninh Binh Dept. of Tourism is formalising an *ad hoc* **Management and Scientific Advisory Committee**. This body will have a fluid membership depending on changing issues and priorities. Proposed members will be contacted directly by the Management Board and will be drawn from a range of scientific disciplines and stakeholder organisations.

- Tran Thi Hoang Mai (Vietnam Ambassador to UNESCO)
- Prof. Tran Tan Van (Director, Vietnam Institute of Geosciences & Mineral Resources)
- Dr Le Thi Lien (Archaeologist, Vietnam Institute of Archaeology)
- Dr Nguyen Viet Cuong (Chief of the Relics and Monuments Management Division, Department of Cultural Heritage, Ministry of Culture, Sports & Tourism)
- Mr Nguyen Cao Tan (Vice Director, Ninh Binh Dept of Culture & Sports)
- Mr Bui Van Manh (Vice Director, Ninh Binh Dept of Tourism)
- Mr Bui Viet Thang (Vice Director, Tràng An Landscape Complex Management Board)
- Mr Pham Sinh Khanh (Vice Director of Tràng An Landscape Complex Management Board)
- Prof. Paul Dingwall (IUCN)
- Dr Ryan Rabett (ICOMOS, Lecturer in Human Palaeoecology, Queen's University of Belfast)

Figure 1: Organisation chart of the Tràng An Landscape Complex Management Board



- Dr Nguyen Truong Dong (Archaeologist, Vietnam Institute of Archaeology)
 - Dr Nguyen Thi Mai Huong (Archaeobotanist, Vietnam Institute of Archaeology)
 - Dr Sonya Prosser (Director, Endangered Primate Rescue Center, Cuc Phuong)
 - Dr Tilo Nadler (Co-Director, Vietnam Primate Conservation Program)
 - Dr Christopher Stimpson (Zooarchaeologist, Zoologist, Queen's University Belfast)
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2. TRÀNG AN MANAGEMENT PLAN: THE EXISTING PROVISION FOR ARCHAEOLOGICAL HERITAGE MANAGEMENT

2.1 Actions pertaining to ‘Pre-historic archaeological sites, resources and artefacts’

Details pertaining to actions are listed under Part VII of the Management Plan: ‘**Management objectives, policies and actions**’, section VII.1. ‘**Protection of cultural heritage**’; sub-section VII.1.1 deals with provisions for ‘**Pre-historic archaeological sites, resources and artefacts**’ (pages: 58-60), items:

VII.1.1.1 (Implementation proceeding – this annex: p. 8)

Archaeological investigation in Tràng An will continue to be subject to protection afforded under Vietnamese law, notably through the Regulation for Archaeological Excavation No. 86/2008/QĐ-BVHTTDL (30 December 2008, Ministry of Culture, Sport and Tourism): specifically Clauses #5 on prohibited activities; #15 on the conduct of archaeological exploration and excavation; and #19 on protection, management and processing of sites at the end of excavation (see Part III.3 for details). Standardised systems will be established for assemblage of reference collections, creation of databases and recording of excavations.

VII.1.1.2 (Implementation proceeding – this annex p. 9)

In accordance with ICOMOS (Article 4, 1990) archaeological survey will be a basic obligation in the protection and management of Tràng An’s archaeological heritage. This will involve regularly monitoring the status of existing sites and identification of new ones.

VII.1.1.3 (Implementation proceeding – this annex p. 9-10)

Monitoring will include the instigation of appropriate measures to maintain and enhance site integrity against physical damage (e.g. erosion), bioturbation (e.g. termite infestation) and, where relevant, human damage (e.g. littering or graffiti). It will also include the assessment of the safety of

site access and on-site infrastructure (such as stairways). All monitoring visits will be documented and filed in a central register held with the Management Board.

VII.1.1.4 (Implementation proceeding – this annex p. 10)

Consideration will be given to establishing, in addition, a casual monitoring system so that anyone - workers, guides or visitors - can report perceived problems to the Board, enhancing primary monitoring and having the added advantage of encouraging wider involvement and participation in the maintenance and protection of cultural heritage.

VII.1.1.5 (Implementation proceeding – this annex p. 11)

The scientific investigation of archaeological sites will continue to emphasise non-destructive techniques and excavations of limited a real extent to minimise site impact (Article 5, 1990).

VII.1.1.6 (Implementation proceeding – this annex p. 11-12-13)

International collaboration in line with Article 9 (1990) and UNESCO (New Delhi Conference: Resolutions – Appendix 1: Recommendation on the international principles applicable to archaeological excavations, Article 15 (1956: 42) is already at the heart of archaeological (and other scientific) investigation within Tràng An. These relationships will continue to bring the best possible combination of expertise to bear on the study and protection of archaeological and related resources within the property.

VII.1.1.7 (Implementation proceeding – this annex p. 14)

All excavation and site study by international teams will be undertaken with the involvement of Vietnamese archaeologists or other local specialists as appropriate. This will ensure that Vietnamese cultural heritage interests are always foremost, while also encouraging the sharing of ideas, techniques and perspectives.

VII.1.1.8 (Implementation proceeding – this annex p. 14-15)

Research access will be granted on the understanding that the publication of results will come within a reasonable agreed-upon time-frame.

VII.1.1.9 (Implementation in development – this annex p. 15-16)

Parallel publication of research in English- and Vietnamese-language journals will be encouraged.

VII.1.1.10 (Implementation in development – this annex p. 16-17)

Emphasis will also be placed on the conservation of archaeological heritage in situ, so far as this is feasible and appropriate. No site will be exposed or left exposed after archaeological field investigation if appropriate subsequent management measures cannot be guaranteed - e.g. the back-filling of archaeological excavations or shoring against trench collapse (Article 6,

1990). *All material used in on-site conservation activities will continue to be locally sourced, in line with ICOMOS recommendations (Cleere 2015).*

VII.1.1.11 (Implementation proceeding – this annex p. 17-18)

Long-term conservation and curation of all artefactual and documentary records from site investigation (and site monitoring) will be handled through a central facility to be established within Tràng An (see UNESCO Article 10, 1956). This will operate under the guidance of, and through agreement with, local and national museums and scientific institutions, and where appropriate international consultants. Particular attention will be given to: the cataloguing, packaging and storage of material; the control of stores to promote an environment that enhances and ensures the best possible preservation; the conservation of artefacts prior to archiving; and checking the performance of the storage facility.

VII.1.1.12 (Implementation in development – this annex p. 18-19)

In accordance with Article 7 (1990) and Article 12 (1956), which underline the importance of conveying information about archaeological heritage to the general public, in order to promote understanding about this shared resource and the need for its protection, the Management Board already ensures regular television interviews are made by archaeological experts working in the property. The existing static display of archaeological material in the Tràng An visitor centre is small and outdated in style and presentation. This display will be greatly improved and modernised (also in line with the latest recommendations from ICOMOS - Cleere 2015). Similar displays will be established at other visitor centres (as noted in Part VII.4.1). Additional measures planned include: short informational videos about the property's cultural heritage; live-feeds and commentary to be screened in the visitor centres during archaeological excavations; brochures and booklets; and web-site communications.

VII.1.1.13 (Implementation proceeding – this annex p. 20)

Further to these Articles, for those with particular interest, provision will be made for their involvement under supervision as volunteers in either the conservation of an archaeological site (e.g. building shoring) or potentially with excavation itself.

VII.1.1.14 (Implementation proceeding – this annex p. 20-21)

Access to sites for research will be by permit only, issued by the Management Board. Public access to archaeological sites will be prohibited for the duration of this management plan. Consideration may be given later to allowing access to a selected few sites for students and other visitors, provided that the research is concluded and the sites are made safe, and codes of conduct would be strictly imposed and carefully monitored.

VII.1.1.15 (Implementation proceeding – this annex p. 21-22)

In 2016 a new phase of archaeological research will begin in the property. This is being jointly funded through the Management Board and the Xuan Truong Enterprise. Additional international research council backing is also being sought through Queen's University, Belfast (see Annex 5). Funding for three doctoral positions and one post-doctoral position (to be based at the universities of Queen's and Cambridge, UK) is already in place. All of these three posts will be advertised internationally and, therefore, open to qualified Vietnamese candidates. Principal participating institutions will be (in Vietnam) the Institute of Geo-science and Mineral Resources, Vietnam National Institute of Archaeology, and (in the UK) Queen's University, Belfast, the University of Cambridge and Bournemouth University.

2.2. Evaluation measures: pre-historic

The attainment of qualitative and quantitative measures of the actions listed above is framed along a **five-year arc**, starting from November 2015. The evaluation measures relating to pre-historic archaeological heritage management listed in the Management Plan (page 61) are, as follows:

- 1. Compiled records demonstrating systematic cataloguing and clear monitoring of all cultural (and geo-culturally) sensitive locales within the property's boundaries.*
- 2. The level of interest generated by static displays and presentations on archaeological (and related ecological etc.) heritage. This will be read e.g. through visitor numbers and through feed-back mechanisms such as website hits.*
- 3. Evidence of research applications to the Management Board by national researchers (and international scholars) during the next five years.*
- 4. Demonstrable recognition of Tràng An's archaeological heritage management and research strategy first at national level (e.g. through numbers of television and newspaper reports/interviews, as well as scholarly output, also potentially through involvement in consultation studies for government departments), then internationally: with representation at regional or international policy meetings on economic development and heritage/ecological sustainability.*
- 5. Results of monitoring programmes.*

2.3. Actions pertaining to ‘Later Prehistoric and historic sites and monuments’

Details pertaining to existing actions are listed under Part VII of the Management Plan: ‘**Management objectives, policies and actions**’, section VII.1. ‘**Protection of cultural heritage**’; sub-section VII.1.2 deals with provisions for ‘**Later Prehistoric and historic sites and monuments**’ (pages: 61-62):

- 1. Conservation of sites and historic structures will be conducted as outlined in Part VII.1.2 above, and archaeological and historical research with relation to these will also be continued.*
- 2. Visitor regulations will be applied along with monitoring of visitor use, and intervention will occur to remove or minimise any discernible undesirable impacts.*
- 3. Consultation and co-operation will be maintained with members of the local communities to encourage their involvement and support in conservation and management of the historic as well as prehistoric heritage of Tràng An.*
- 4. Educational, interpretive and promotional materials will be prepared to increase knowledge of the later periods of settlement and interaction with the property’s landscape and to raise awareness of its historic heritage values.*

2.4. Evaluation measures: later pre-historic and historic

The attainment of qualitative and quantitative measures relating to later pre-historic and historic archaeological heritage management listed in the Management Plan (page 64) also follows a **five-year arc** and are, as follows:

- 1. Records of conservation works undertaken.*
- 2. Results of visitor monitoring and recording of any incidents of impacts or illegal activities.*
- 3. Record and results of local community consultations.*
- 4. Number of interpretive materials prepared and record of any tangible results of the public awareness projects.*

3. PROGRESS ON ACTIONS ITEMISED IN THE MANAGEMENT PLAN

Actions itemised in the property Management Plan are examined in turn, in the following sections.

3.1.Actions in the field of pre-historic archaeological heritage management (2015-16)

Item VII.1.1.1

Archaeological investigation in Tràng An will continue to be subject to protection afforded under Vietnamese law, notably through the Regulation for Archaeological Excavation No. 86/2008/QĐ-BVHTTDL (30 December 2008, Ministry of Culture, Sport and Tourism): specifically Clauses #5 on prohibited activities; #15 on the conduct of archaeological exploration and excavation; and #19 on protection, management and processing of sites at the end of excavation (see Part III.3 for details). Standardised systems will be established for assemblage of reference collections, creation of databases and recording of excavations.

Explanation:

The importance of protection through existing Vietnamese law is self-explanatory and has been covered elsewhere (*Supplementary Report 2014*, section 4.4). Standardised recovery, cataloguing and database systems are essential to ensure parity of presentation across the body of accumulating archaeological evidence from excavations in Tràng An, and to facilitate access for research and data processing activities.

Actions taken:

Standardised systems for reference collections, the creation of databases and recording of excavations are being developed through ongoing dialogue between the Tràng An Management Board and staff from the SUNDASIA Project (as the Board's first major international research collaborator), covering practical as well as technical details. For example, every effort is being made to ensure that the principal inventory and GIS database created between these two parties is searchable using standard terminology across a wide range of artefacts, recovered material and site locations, and that these are readily translatable between Vietnamese and English. The system will also have sufficient breadth in terminology and classification for the inclusion of Tràng An's build heritage (*also see Section 4.1.3*).

Item VII.1.1.2

In accordance with ICOMOS (Article 4, 1990) archaeological survey will be a basic obligation in the protection and management of Tràng An's archaeological heritage. This will involve regularly monitoring the status of existing sites and identification of new ones.

Explanation:

ICOMOS (Article 4, 1990) states that ‘the protection of the archaeological heritage must be based upon the fullest possible knowledge of its extent and nature. General survey of archaeological resources is therefore an essential working tool in developing strategies for the protection of the archaeological heritage.’ It further notes that survey inventories provide the primary resource for not only scientific investigation but also for the implementation of ‘protectional measures’.

Actions taken:

Building on the survey records of the VIGMR (Vietnamese Institute of Geosciences and Mineral Resources), Institute of Archaeology, Hanoi, and the independent report of Laumanns (2014), formal landscape survey work is presently being set-up jointly between the Management Board and the SUNDASIA Project. Work began on this action in March 2017. Out of a sample of 26 caves that have been located or re-located to date, 12 are previously unrecorded (**Annex 2**). The frequency of site monitoring by the Management Board is covered in **Item VII.1.1.3** below.

Item VII.1.1.3

Monitoring will include the instigation of appropriate measures to maintain and enhance site integrity against physical damage (e.g. erosion), bioturbation (e.g. termite infestation) and, where relevant, human damage (e.g. littering or graffiti). It will also include the assessment of the safety of site access and on-site infrastructure (such as stairways). All monitoring visits will be documented and filed in a central register held with the Management Board.

Explanation:

Regular and formalised site monitoring by the Management Board ensures that the integrity of this cultural heritage resource is maintained (including site infrastructure) and protected.

Actions taken:

- Periodic monitoring is implemented by Management Board teams from the Environmental & Landscape Division and the Technical and Research Division. Each team comprises two people (normally, one person from each division). Monitoring of archaeological sites and site integrity in the property is undertaken on a weekly basis. Reports are filed at the Management Board and any maintenance, infractions or other issues are dealt with directly.
- The Board also encourages local people, local management units (e.g. a commune's People's Committee) and other local authorities to monitor sites in their area regularly, and to file reports with the Management Board on an *ad hoc* basis, to ensure timely actions can be taken where necessary.

Item VII.1.1.4

Consideration will be given to establishing, in addition, a casual monitoring system so that anyone - workers, guides or visitors - can report perceived problems to the Board, enhancing primary monitoring and having the added advantage of encouraging wider involvement and participation in the maintenance and protection of cultural heritage.

Explanation:

Implementation of a complementary casual monitoring system helps to ensure that all employees of the Management Board take responsibility for the maintenance and protection of the property's cultural heritage. Casual monitoring and reporting are, therefore, fundamental aspects of the management monitoring programme within the property.

Actions taken:

The Management Board has staff at the tourist information centres situated at the main gateways of cultural sites in the World Heritage Property (namely: Tràng An, Tam Coc, Bai Dinh and Hoa Lu ancient capital) to supervise and receive tourist feedback. The Board has also set up a hotline and e-mail address so that it can respond immediately to any infringement of regulations and visitor conduct.

Item VII.1.1.5

The scientific investigation of archaeological sites will continue to emphasise non-destructive techniques and excavations of limited areal extent to minimise site impact (Article 5, 1990).

Explanation:

Archaeological excavation is unavoidably a destructive process: deposits are removed and processed through the act of excavation. Invaluable pre-historic cultural data is obtained through this activity, and often such data cannot be accessed any other way; however, because excavation is inherently destructive, ^{a)}it is rigorously conducted according to standardised and meticulous systems of recovery and recording; ^{b)} non-destructive techniques (e.g. ground-penetrating radar [GPR]) are used to help characterise the nature of sub-surface deposits before (or instead of) excavation; ^{c)}the areal extent of excavation is kept to a minimum, to preserve as much in-situ material as possible as an archive of data for the future (techniques of recovery are always improving).

Actions taken:

Working with the Management Board, the SUNDASIA Project has undertaken a season of survey work in September 2016 using GPR at five cave and rock-shelter sites within the property to guide excavations (*see* Green n.d.). It is also continuing an ambitious digital terrain mapping programme using remote sensing technologies over large parts of the property.

Item VII.1.1.6

International collaboration in line with Article 9 (1990) and UNESCO (New Delhi Conference: Resolutions - Appendix 1: Recommendation on the international principles applicable to archaeological excavations, Article 15 (1956: 42) is already at the heart of archaeological (and other scientific) investigation within Tràng An. These relationships will continue to bring the best possible combination of expertise to bear on the study and protection of archaeological and related resources within the property.

Explanation:

ICOMOS (Article 9, 1990) states that ‘...archaeological heritage is the common heritage of all humanity. International cooperation is therefore

essential in developing and maintaining standards in its management.’ It further highlights the importance of creating international mechanisms for the exchange of information and experience in the field of archaeological heritage through (though not confined to) conference, seminar and workshop activities, in addition to establishing educational (postgraduate) centres of learning, and encouraging international exchanges of professional staff to raise standards of archaeological heritage management.

Actions taken:

- National/international and interdisciplinary archaeological research is being undertaken through the SUNDASIA Project (principal funding body: Arts and Humanities Research Council, UK – Global Challenges Research Fund). This project is running in Tràng An from 2016 until the end of 2019.
- Between 18th and 19th March 2017, the Management Board hosted a significant international workshop by the SUNDASIA Project (<https://sundasia.com/workshops-conferences/>) (figure 2). Participants over these days included representatives from a range of stakeholders, including ICOMOS:

Lam Quang Nghia	Director (Tràng An Management Board)
Bui Van Manh	Vice Director (Tràng An Management Board)
Nguyen Cao Tan	Vice Director (Tràng An Management Board)
Phạm Sinh Khánh	Tràng An Management Board
Bui Thanh Dong	Director of Tourism Department
Nguyen Giang Hai	Director of Vietnam Institute for Archaeology
Nguyen Viet Cuong	Chief of the Relics and Monuments Management Division, Ministry of Culture, Sport and Tourism
Le Thi Lien	Vietnam Institute for Archaeology
Nguyen Thi Mai Huong	Vietnam Institute for Archaeology (VIA)
Nguyen Thi Bich Lua	Foreign Affairs Division of Ninh Binh People Committee
Tran Thi Hoang Mai	Deputy Director Dept of Cultural Diplomacy & UNESCO Affairs (and incoming Vietnamese Ambassador to UNESCO)
Tran Tan Van	Project CI, Director Vietnamese Institute of Geosciences and Mineral Resources (VIGMR)
Nguyen Dai Trung	Head of Dept of Tectonics & Geomorphology, VIGMR
Ryan Rabett	Project PI, lecturer (Queen’s University Belfast, ICOMOS)
Fiona Coward	Project CI, senior lecturer (Bournemouth University)

Christopher Stimpson	Post-doctoral research fellow, Queen's University Belfast
Thorsten Kahlert	Post-doctoral research fellow, Queen's University Belfast
Benjamin Utting	PhD candidate, University of Cambridge
I. Bachtsevanidou Strantzali	PhD candidate, Queen's University Belfast
Natalie Ludgate	(Dr) Senior Technician, Queen Mary University of London
Paul Dingwall	(IUCN)
Christopher Cleere	(ICOMOS)
Thomas Leppard	Renfrew Fellow (University of Cambridge)
Benjamin Marwick	Associate Prof. (University of Washington)
James Hardcastle	Director, Green List (IUCN)
Tran T.K. Quy	Curator, Long An Provincial Museum; Senckenberg Research Institute, Germany



Figure 2: Delegates at the SUNDASIA Project: International Workshop 18th and 19th March 2017, Bai Dinh Hotel, Ninh Binh (photo: T. Kahlert).

- Working with local stakeholders (including the Management Board and Institute of Archaeology) the SUNDASIA Project has established for the period 2017-2019 a paid consultancy position for Dr Nguyen Thi Mai Hung that will facilitate (e.g. through contracted visits to Queen's University) knowledge exchange in the field of palynology (pollen analysis) between UK and Vietnamese specialists.

Item VII.1.1.7

All excavation and site study by international teams will be undertaken with the involvement of Vietnamese archaeologists or other local specialists as appropriate. This will ensure that Vietnamese cultural heritage interests are always foremost, while also encouraging the sharing of ideas, techniques and perspectives.

Explanation:

Explanation for this action is provided within the above quote; namely: ‘to ensure that Vietnamese cultural heritage interests are always foremost, while also encouraging the sharing of ideas, techniques and perspectives’.

Actions taken:

- The Management Board is a recognised partner (through a formal multi-institution Collaboration Agreement) in the SUNDASIA Project.
- Dr Tran Tan Van (Director of VIGMR) is a Co-Investigator on the SUNDASIA Project and actively involved in its planning and fieldwork. As noted above, the project also directly employs Nguyen Thi Mai Huong on a consultancy basis from VIA
- The Board encourages and requires that SUNDASIA works routinely with experts and staff from VIGMR, VIA, and from within its own departments (see below) during all excavation activities. Vietnamese subject specialists currently or previously involved in field excavations include, for example, Tran Thi Kim Quy (zooarchaeology – Curator of the Long An Provincial Museum), Nguyen Truong Dong (stone technology – Institute of Archaeology), Pham Thanh Son (ceramics – Institute of Archaeology); Vo Thuy (10th Century urban planning – Institute of History, Hang Chuoi, Hanoi, Việt Nam; Pham Tuan Luan (Curator of the Ninh Binh Provincial Museum)
- VIA is also directly involved in assessing and granting permission for the itinerary presented by SUNDASIA to the Management Board ahead of each field season.

Item VII.1.1.8

Research access will be granted on the understanding that the publication of results will come within a reasonable agreed-upon time-frame.

Explanation:

While the Board recognises that research findings can take a considerable amount of time to reach publication in scholarly journals (months or even years), it is essential to the collaborative endeavour, knowledge exchange, and the effective use of data in archaeological heritage management, that there is an ongoing and timely dissemination of data arising from research.

Actions taken:

- At the end of every season the Management Board and VIA requests and requires that research projects (currently SUNDASIA) provide a field report of 20-30 pages outlining work that has been undertaken in the context of pre-agreed objectives.
- Courtesy copies of all publications and unpublished specialist field reports arising from research undertaken within Tràng An must be lodged with the Management Board. On file (2014-2016) these presently include e.g. Laumann (2014), Rabett *et al.* (2017), Green n.d., Loyer n.d. Open Access to publications should also be provided. For example, access to the SUNDASIA Project outputs (*see Annex 1.3*) are available through the project's website at the following link: (<https://sundasia.com/publications/>)

Item VII.1.1.9

Parallel publication of research in English- and Vietnamese-language journals will be encouraged.

Explanation:

The objective of parallel language publishing is self-explanatory: to widen dissemination of data across language barriers, thus increasing access and the potential for data to be reassessed or incorporated in a comparative manner into other scientific studies or into policy and management documents.

Actions taken:

- The Board has encouraged discussion between the SUNDASIA PI and Vietnamese institutes currently in collaboration with that project towards parallel language publication.
- It further advocates that publication in local scientific journals, ideally in both Vietnamese and English will increase data accessibility, which is often hampered by pay-walls around international journals.

- At this time (Sept. 2017) SUNDASIA has submitted its first annual report to the house journal of VIGMR (*Journal of Geology*), with the arrangement that part or all of the content shall be translated into Vietnamese. The second year report will be submitted (in Aug. 2018) to *Vietnam Archaeology* – the house journal of VIA.
-

Item VII.1.1.10

Emphasis will also be placed on the conservation of archaeological heritage in situ, so far as this is feasible and appropriate. No site will be exposed or left exposed after archaeological field investigation if appropriate subsequent management measures cannot be guaranteed - e.g. the back-filling of archaeological excavations or shoring against trench collapse (Article 6, 1990). All material used in on-site conservation activities will continue to be locally sourced, in line with ICOMOS recommendations.

Explanation:

The transfer of cultural heritage between locations invariably introduces new potential vectors for damage that are often not a factor at the point of recovery. As a result, the preservation of cultural heritage in its original context, where-ever this is appropriate and possible, is the preferred course of action. Excavated trenches also introduce changes to the depositional environment. Unattended, exposed trench walls (sections) can become desiccated and crumble; they can be colonised and damaged by vegetation growth, and/or become subject to weathering and erosional processes, which can be damaging to culture-bearing deposits and artefacts themselves. There are also carries health and safety implications for archaeologists and any others visiting or monitoring archaeological sites. Actions such as the back-filling and/or shoring of excavation trenches help to mitigate damage to trenches themselves, enhancing preservation, and promote site safety.

ICOMOS (Article 6, 1990), however, does acknowledge that ‘owing to the inevitable limitations of available resources, active maintenance will have to be carried out on a selective basis. It should therefore be applied to a sample of the diversity of sites and monuments, based upon a scientific assessment of their significance and representative character, and not confined to the more notable and visually attractive monuments.’

Actions taken:

- The Management Board has received advice on site management from ICOMOS during a post-inscription management workshop (September 2015), and subsequently at the SUNDASIA workshop in March 2017.

On the advice received and bearing in mind available resources, the Board is currently exploring how best to implement on site preservation of archaeological heritage – notably in terms of preserving or filling archaeological trenches.

- Working with the SUNDASIA Project, the Board has been trialling a backfill procedure between excavation seasons that utilises material from excavated spoil heaps at the sites of Hang Hanh and Hang Thung Binh 1, particularly with the aim of protecting these sites from livestock damage (*also see Section 4.1.2*)

Item VII.1.1.11

Long-term conservation and curation of all artefactual and documentary records from site investigation (and site monitoring) will be handled through a central facility to be established within Tràng An (see UNESCO Article 10, 1956). This will operate under the guidance of, and through agreement with, local and national museums and scientific institutions, and where appropriate international consultants. Particular attention will be given to: the cataloguing, packaging and storage of material; the control of stores to promote an environment that enhances and ensures the best possible preservation; the conservation of artefacts prior to archiving; and checking the performance of the storage facility.

Explanation:

Provision of a centralised repository has obvious benefits. It ensures that cultural material is curated under controlled conditions (including environmental conditions, such as humidity) that will limit degeneration of material after it has been lifted from its depositional setting. A repository helps to ensure that such material is not lost or misplaced; that artefacts and residues of excavation are readily accessible in a catalogued state for analysis and can be loaned for public display.

Actions taken:

- Currently, cultural artefacts are stored in a dedicated area of the third floor of the Tràng An Management Board Administration building, Ninh Binh City, and in facilities at the Tràng An Visitor Centre Tràng An Boat Wharf. For samples (chiefly environmental and zooarchaeological) under analysis in the UK, storage is within a licenced and limited access storage facility at Queen's University Belfast.

- In the near future, the facilities of the Board are scheduled to be expanded and upgraded to include additional storage on the fourth floor of the Administration Building. Systematic cataloguing of the archaeological finds will continue and appropriate measures will be taken to ensure appropriate conditions of conservation (*see Section 4.1.3*).
- The integrity of in-country storage facilities is checked on a monthly basis. In the unlikely event that an issue is identified (e.g. infestation), cultural materials will be removed and required improvements will be made. Where necessary, cleaning products will be used, but only where this is without detriment to the materials being stored.



Figure 3: A section of the current storage system in place for cultural artefacts on the third floor of the Management Board Administration building, Ninh Binh City (photo: Duy Linh).

Item VII.1.1.12

In accordance with Article 7 (1990) and Article 12 (1956), which underline the importance of conveying information about archaeological heritage to the general public in order to promote understanding about this shared resource and the need for its protection, the Management Board already ensures regular television interviews are made by archaeological experts working in the property. The existing static display of archaeological material in the Tràng An Visitor Centre is small and outdated in style and presentation. This display will be greatly improved and modernised (also in line with the latest recommendations from ICOMOS in 2015). Similar displays will be

established at other visitor centres (as noted in Part VII.4.1). Additional measures planned include: short informational videos about the property's cultural heritage; news-feeds and commentary to be screened in the visitor centres during archaeological excavations; brochures and booklets; and web-site communications.

Explanation:

ICOMOS (Article 7, 1990) states that the presentation of 'archaeological heritage to the general public is an essential method of promoting an understanding of the origins and development of modern societies. At the same time it is the most important means of promoting an understanding of the need for its protection.' Article 7 further recommends that information should be conceived of as a popular and accessible interpretation of the current state of the art, and that information should be updated on a regular basis.

Actions taken:

- The Board continues to organise media coverage of the archaeological heritage of Tràng An. For example, VTV1 and VTV2, NB TV (Ninh Bình provincial TV) interviews were given by key stakeholders during the SUNDASIA Project workshop (March 2017) and interviews continue to be given by Project members during excavations.
- The Board plans to work with SUNDASIA and individual local academics (e.g. Nguyen Thi Mai Huong) and overseas advisers (e.g. Mr Chris Jarvis, Oxford University Museum of Natural History) who are experienced in outreach activities to help disseminate archaeological heritage to a range of target audiences, including visitors to Tràng An and local schools.
- The Board, with the assistance of Xuan Truong, SUNDASIA and the Oxford University Museum of Natural History, is also exploring ways to present reconstructions of past life in Tràng An through dioramas and commissioned artwork (e.g. *see* figure 4: a perforated shark's tooth excavated from Hang Hanh by the SUNDASIA Project).

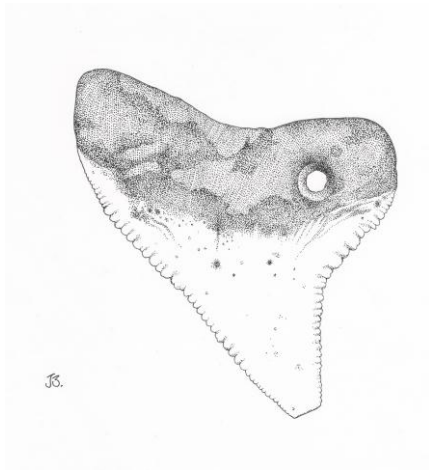


Figure 4: An illustration of a perforated recovered from archaeological deposits of probable Neolithic age, at the site of Hang Hanh, Trang An. (Illustrator: Jade Broadhead – reproduced under licence).

Item VII.1.1.13

Further to these Articles, for those with particular interest, provision will be made for their involvement under supervision as volunteers in either the conservation of an archaeological site (e.g. building shoring) or potentially with excavation itself.

Explanation:

This initiative has the immediate benefit of encouraging direct involvement with and identification with archaeological heritage, and gives staff direct experience and training in essential areas of cultural heritage management.

Action taken:

- The Board currently has five members of staff actively involved in archaeological and landscape heritage survey and excavation work (*see Section 4.1.1*)
-

Item VII.1.1.14

Access to sites for research will be by permit only, issued by the Management Board. Public access to archaeological sites will be prohibited for the duration of this management plan. Consideration may be given later to allowing access to a selected few sites for students and other visitors, provided that the research is concluded and the sites are made safe, and codes of conduct would be strictly imposed and carefully monitored.

Explanation:

A permit system ensures that access to the rich archaeological heritage of Tràng An is formally and legally regulated, but that it can provide a valuable learning environment for local and international students from collaborating institutions.

Action taken:

- Access for archaeological investigation requires a letter of invitation from the Ninh Binh People's Committee (administered through Ninh Binh Department of Tourism and the Management Board), and formal authorization by the Director of VIA.
-

Item VII.1.1.15

In 2016 a new phase of archaeological research will begin in the property. This is being jointly funded through the Management Board and the Xuan Truong Enterprise. Additional international research council backing is also being sought through Queen's University, Belfast. Funding for three doctoral positions and one post-doctoral position (to be based at the universities of Queen's and Cambridge, UK) is already in place. All of these three posts will be advertised internationally and, therefore, open to qualified Vietnamese candidates. Principal participating institutions are (in Vietnam) the Institute of Geoscience and Mineral Resources, Vietnam National Institute of Archaeology, and (in the UK) Queen's University, Belfast, the University of Cambridge and Bournemouth University.

Explanation:

Both in recognition of the terms of Tràng An's inscription (Decision: 38 COM 8B.14, Items 6a and 6b) and in the spirit of Criterion V under which the property was inscribed, the Management Board, State Party and other principal stakeholders (such as the Xuan Truong Enterprise, Institute of Archaeology and VIGMR) have sought actively to work with overseas collaborators to further develop understanding of the archaeological heritage of Tràng An.

Actions taken:

The archaeological research project in Trang An Landscape Complex was approved by the Ministry of Culture, Sports and Tourism in Decision No 2948/QĐ-BVHTTDL dated 24/8/2016 and Decision No 3217/QĐ-BVHTTDL dated 18/8/2017.

- The State Party has been working with local and international institutions through whose research the cultural component of the inscription was formulated (notably Viet Nam Institute of Archaeology and the University of Cambridge and Queen’s University Belfast) to undertake further archaeological research in and archaeological heritage management of Tràng An (e.g. figure 5).



Figure 5: Excavations under way at Hang Thung Binh 1, Trang An (March 2017) (photo: R. Rabett).

- The appointments listed in **Item VII.1.1.15** of the Management Plan have since been revised to include: three post-doctoral, one consultancy and two doctoral appointments as part of the SUNDASIA Project (<https://sundasia.com/team-members/>). As of Aug. 2017 all paid posts within that Project were filled. Both the VIGMR and VIA are equal field collaborators in the Project, and the Management Board is a recognised Project Partner through a formal Collaboration Agreement.
- In addition to paid appointments, there are currently five undergraduate dissertations associated with the Project. All of these are coming from collaborator institutions, though none is yet coming from a Vietnamese University – a feature that both the Board and SUNDASIA are keen to include in future years. There is, however, already one Vietnamese PhD student (Vo Thi Phuong Thuy) working alongside the Project, whose own work is focused on 10th Century urban planning in the Hoa Lu Ancient Capital. Ms Thuy has entered into an informal collaboration (including participation in fieldwork) with the SUNDASIA Project and the Management Board.

3.2.Evaluation measures in the field of pre-historic archaeological heritage management (2015-16)

Qualitative and quantitative measures to include, as follows:

Compiled records demonstrating systematic cataloguing and clear monitoring of all cultural (and geo-culturally) sensitive locales within the property's boundaries.

Action taken:

- Compilation of records is underway through collaborative work between the Management Board, VIGMR and the SUNDASIA Project affiliated institutions (see **Section 4.1.3**).

The level of interest generated by static displays and presentations on archaeological (and related ecological etc.) heritage. This will be read e.g. through visitor numbers and through feed-back mechanisms such as website hits.

Actions taken:

- The development of appropriately interactive and accessible displays of archaeological heritage is in active development. Public outreach for archaeological heritage was one of the issues covered at the SUNDASIA Project workshop (March 18th and 19th 2017). This included a presentation that drew on experience at the Smithsonian Institution; a group discussion and curatorial representation (T.T.K. Quy).
- As noted above in **VII.1.1.12 Actions taken**, an experienced member of the Oxford University Museum of Natural History is hoping to join the SUNDASIA team in Nov./Dec. 2017 to liaise with the Board on public presentation; and SUNDASIA/Institute of Archaeology member, Nguyen Thi Mai Huong, is also under contract to continue her outreach work with local schools.
- Also noted in **VII.1.1.12 Actions taken**, the Board, Xuan Truong Enterprise and SUNDASIA are working towards producing reconstructions of past life in Tràng An through dioramas and commissioned artwork.
- Exhibition activities at the Tràng An Visitor Centre are consistently generating anecdotally positive reception from the public and media – a

method of more systematic monitoring of public response is in development. Visitor Centre displays receive detailed attention and contributions from scientific experts and are produced in conjunction with those wishing to produce documentaries or films in Tràng An. This provision also helps travel agencies to visualise introductions to the property and thematic tours with the support of the Board. For example, the recent movie, *Kong: Skull Island*, which was partially filmed in Tràng An, has generated merchandising and tour interest among sections of the visiting public (*see State of Conservation Report, Item 3.5*).

Evidence of research applications to the Management Board by national researchers (and international scholars) during the next five years.

Actions taken:

- The Management Board is operating a schedule for research that is currently running approximately one year in advance. In addition to continued work with the SUNDASIA Project through to late 2019, the Board has already arranged to cooperate with the VIA in 2018 on an archaeological survey at the site of Vuon Am, in the Noi Lam Valley – in the Tràng An core zone;
- Between 2017-2020 the Board has arranged to work with the Vietnam Institute of Ecology and Biological Resources, and the Forestry University to carry out a large scale biodiversity research programme in the property that will build on the work carried out before inscription (e.g. Ngoc 2012) and since in collaboration with the SUNDASIA Project (e.g. *see Annex 1.2*).
- The Board also in the process of developing a research strategy to protect archaeological and geological heritage in consultation with VIA, VIGMR and members of the Management and Scientific Advisory Committee (for membership, see this document).

Demonstrable recognition of Tràng An's archaeological heritage management and research strategy first at national level (e.g. through numbers of television and newspaper reports/interviews, as well as scholarly output, also potentially through involvement in consultation studies for government departments), then internationally: with representation at regional or international policy meetings on economic development and heritage/ecological sustainability.

Actions taken:

- Tràng An's archaeological heritage continues to gain traction in the public consciousness. This reputation has been promoted through the property's growing recognition post-inscription in the context of local and national media coverage. The following link is a cultural segment on the country's popular VTV1 network (in Vietnamese): <http://vtv.vn/video/cau-chuyen-van-hoa-bao-ton-va-quan-ly-di-san-the-gioi-211543.htm>; <http://www.trangdanhthang.vn/video/cau-chuyen-van-hoa-quan-the-danh-thang-trang-an-thang-11-2016-.html>.
- Scholarly output, 2016 includes internal reports on archaeological investigations in:
 - Noi Lam Valley (Le Thi Liên n.d.);
 - Hang Ang Noi (Rabett *et al.* n.d.);
 - Hang Hanh (Stimpson *et al.* n.d.);
 - Hang Thung Binh 1 (Rabett *et al.* a & b n.d.);
 - Geophysical survey (Green n.d.);
 - Human remains (Loyer n.d.)

Published papers include e.g. Rabett *et al.* (2017); Rabett *et al.* (*forthcoming*).

<i>Results of monitoring programmes.</i>
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Actions taken:

- The records of the status of archaeological sites are updated continuously (*see* **Item VII.1.1.3**);
- The preservation and protection of archaeological sites (e.g. against the impact of animals, such as goats, or from natural damage such as can occur during monsoon rains) is maintained through cooperation between the Board, local authorities and local people. For example, this policy has been implemented in the protection of the Hang Hanh archaeological site in the Property's core zone, through collaboration with the local landowner.

3.3. Actions in the field of later pre-historic and historic archaeological heritage management (2015-16)

Item VII.1.2.1

Conservation of sites and historic structures will be conducted as outlined in Part VII.1.2 above, and archaeological and historical research with relation to these will also be continued.

Explanation:

There are more than 67 dry caves in the Tràng An Landscape Complex (*see* figure 6), with evidence of human occupation appearing within a significant proportion of these (*see Annex 1.1*). Most of these locations are situated in the core zone of the property. Locales with historical heritage potential are also distributed widely through the World Heritage property. More than 40 have been catalogued, with two of these recognised as special national relics: namely: the Hoa Lu Ancient Capital and Tam Coc, Bich Dong (e.g. the Hoa Lu is recognised under Decision 548/QĐ-TTg, dated 10/5/2012 and approved by the Prime Minister).

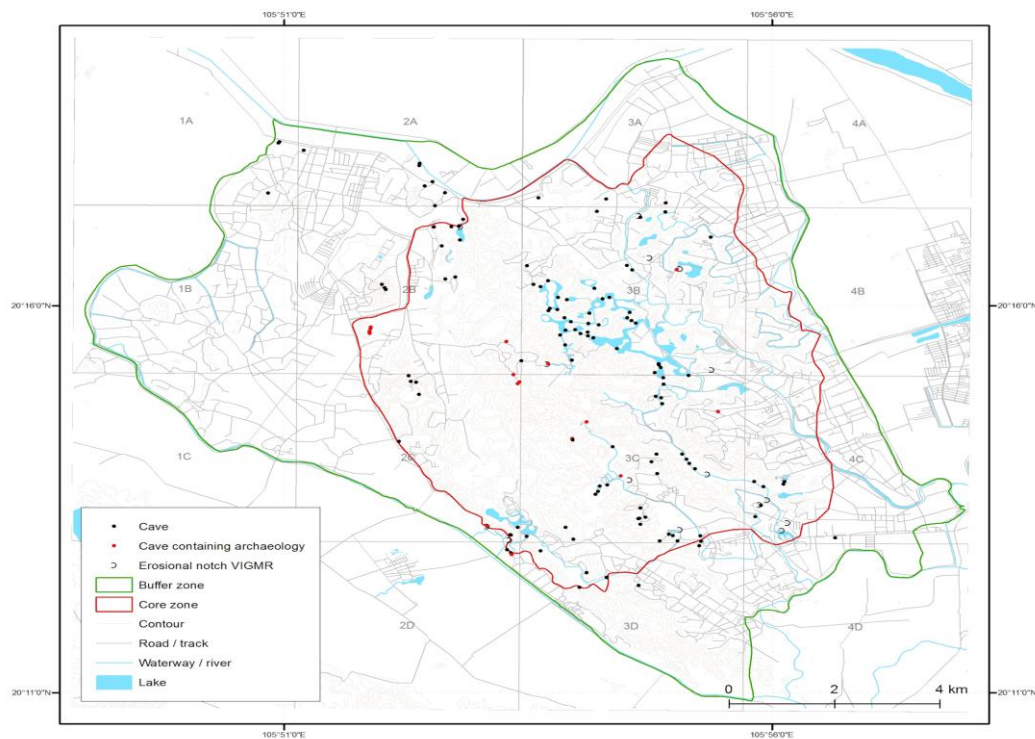


Figure 6: An example of the GIS-based distribution maps and spatial grid system being employed by SUNDASIA and the Tràng An Management Board to catalogue caves, including new caves with archaeological potential, and geomorphological features (illustration: T. Kahlert).

Item VII.1.2.2

Visitor regulations will be applied along with monitoring of visitor use, and intervention will occur to remove or minimise any discernible undesirable impacts.

Explanation:

For details on this item, please see the **Action Plan for Visitor Management**

Item VII.1.2.3

Consultation and co-operation will be maintained with members of the local communities to encourage their involvement and support in conservation and management of the historic as well as prehistoric heritage of Tràng An.

Explanation:

Local populations in the Tràng An area have played an important part in the preservation and protection of relics and heritage sites over several generations. The World Heritage title has taken that recognition to a national and international level, and has helped to create jobs and promote tourism within local communities. The rights, responsibilities and benefits to local people through the protection of cultural and historical relics are increasingly recognised by them as being inexorably linked.

Actions taken:

- Presentations and short courses for the general public on cultural heritage are under development and anticipated to be run on an annual basis to help further raise public awareness;
- Initiatives are also being developed to reward and encourage local people in heritage protection – further linking benefits to responsibilities;
- The Management Board is also hoping in due course to be able to involve local people as volunteers in field survey activities and archaeological work in particular, to bring them a more immediate appreciation of the research activities that continue to take place in Tràng An.

Item VII.1.2.4

Educational, interpretive and promotional materials will be prepared to increase knowledge of the later periods of settlement and interaction with the property's landscape and to raise awareness of its historic heritage values.

Explanation:

The archaeological heritage of Tràng An contains a deep history of cultural adaptation and interaction with the environment. Understanding how that process of adaptation extended into early historical periods and the role that this landscape has played in the emergence of Vietnam's first national capital is an essential part of Tràng An's wider appeal and cultural heritage story.

Actions taken:

- The Board is a participating member in developments within the management of the Hoa Lu Ancient Capital (e.g. in the creation of new appointments, such as Mr Nguyen Thanh Duc as the new Vice Director in charge of cultural conservation];
- The Board is exploring media options for temporary (i.e. special interest), cyclic (probably digital) and permanent displays for the general public in the Ninh Binh Museum and Tràng An Visitor Centre.
- The Board is also encouraging the involvement of Vietnamese doctoral students in its research programme – e.g. Vo Thi Phuong Thuy (Institute of History, Hanoi), and Le Thi Thanh Kim Quy (Senckenberg Research Institute and Natural History Museum, Germany).

3.4.Evaluation measures in the field of later pre-historic and historic archaeological heritage management (2015-16)

This aspect of management is still under development.

<i>Records of conservation works undertaken.</i>
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Actions taken:

- Fences have been constructed at a number of archaeological sites, including Ong Hang, Mai Da Vang, Mai Da Oc, and Hang Thung Binh 1-4;
- Restoration and enhancement of the traditional Vu Lam Royal 'Step-Over' Temple, Vu Lam, Tràng An (*see figure 7*).



Figure 7: Vu Lam Royal ‘Step-Over’ Temple renovation and expansion (photo: P. Dingwall).

Results of visitor monitoring and recording of any incidents of impacts or illegal activities.

Action taken:

- See Action Plan for Visitor Management

Record and results of local community consultations.

Action taken:

- For example, in 2015 a request tabled by a local commune to extend the Thung Nang road construction in the vicinity of the archaeological cave site of Ong Hay in Bich Dong, was rejected by the Management Board; however in consultation with the People’s Committee of this local commune, a compromise was reached allowing the upgrading of the existing road (*see* figure 8).



Figure 8: Members of the Management Board inspecting the existing Thung Nang access road in the vicinity of Ong Hay, Bich Dong (2015) (photo: P. Dingwall).

Number of interpretive materials prepared and record of any tangible results of the public awareness projects.

Action taken:

- See **Item VII.1.2.3**

4. DECISION: 40 COM 7B.67

Items 4b-d of the Decision from the World Heritage Committee argue that the State Party of Vietnam has not yet included adequate measures in the revised management plan of Tràng An concerning the management of tourism and cultural heritage. The preceding sections are demonstration of the work that has been carried out since inscription. The World Heritage Committee requests the State Party to undertake the following with relation specifically to archaeological heritage:

- 4b. Include sections concerning the archaeological heritage, which clearly detail the actions to be undertaken, in terms of staff training, conservation/restoration methods, and long-term planning;
- 4c. Develop the skills of the management body to successfully plan the management of the archaeological heritage at the property;

- 4d. Establish a system for the cataloguing, condition-surveying, monitoring and protection of archaeological heritage through conservation measures, in order to adequately conserve archaeological artefacts;

The following sections address each of the above points in turn.

Orientation to enhance the responsibility of Trang An Landscape Complex Management Board in the management of archaeological heritage in the coming time:

The Board will seriously and effectively implement the Government Decree No.109/NĐ-CP on September 21st, 1977, focusing on the following contents:

- Continuously planning to train and improve professional qualifications in scientific research, conservation of historical and archaeological sites, restoration of artefacts, protection of natural resources and environment; Raising awareness and participation of the community in heritage protection and management.
- Periodically monitoring the heritage conservation status, timely preventing the heritage from threatening activities.
- Strengthening propaganda, promotion, display and introduction activities; Researching, collecting, documenting and archiving information on archaeological sites in order to preserve and restore the heritage; Preserving, researching, collecting artefacts, geological, animal and plant samples and exhibiting them.
- Applying technology to preserve archaeological heritages; preserving geological, geomorphological values; preserving and developing fauna and flora to remain the biodiversity of the heritage.
- Cooperating with relevant authorities at all levels to prepare and approve the socio-economic plans within heritage areas and heritage buffer zones under the current regulations; organizing discussions and acknowledging opinions of the community on the socio-economic plans or other projects and programs related to the heritage.
- Reporting on management and conservation to UNESCO, Ninh Binh People's Committee, the Viet Nam National Commission for UNESCO, Ministry of Culture, Sports and Tourism and relevant authorities.

4.1 Archaeological heritage and staff training, conservation/restoration methods, and long-term planning.

This item from the World Heritage Decision is broken down into three separate response sections: 'Staff training', 'Conservation/restoration methods', and 'Long-term planning'.

4.1.1. Staff training

Several items make provision for staff training within the Tràng An Management Plan; these are, as follows:

Item VII.1.2, Action 4

The Board will assist local communities to obtain the necessary funding for conservation and maintenance work, and will support training and skill development programmes for local craftsmen. (p.62)

Item VII.1.2, Action 7

Training in cultural heritage management and conservation will be given priority in the staff training programme (discussed further in Part VII.5.2). Training will emphasise methods and technologies for protection, preservation, interventive and passive conservation, cataloguing, archiving, database development, condition surveying and monitoring. (p.62)

Annex 5

On-site training - *there will be a formalisation of the pre-inscription practice to involve selected (and interested) property staff in excavation and other scientific research-related activities in more than simple supportive roles. Staff will be encouraged to work with visiting specialists and learn from them both field, cataloguing and conservation methods (see Section 7). Specialists will, reciprocally, accept responsibility for ensuring that staff are included in these scientific works at a level appropriate to their ability and experience in any given field-work period (i.e. with increasing responsibility commensurate to increasing experience). It is anticipated that the most promising of these individuals (e.g. those who are more engaged with the nature of the research being undertaken) will be encouraged to form the core of the TAMB's own Monitoring, Sustainability and Research division... (p.135)*

Explanation:

Training and improving the quality of human resources is one of the top priorities of the Board's heritage management and preservation programme. Ninh Binh has also extended considerable support to staff of the Management Board and local officials; allowing them to participate in training courses, especially in the field of scientific research, management of archaeological excavation, landscape survey and tourism activities.

Actions taken:

- **On-site training in Archaeology** – Since inscription in 2014 three members of the Management Board (Research Division and Department of Promotion and International Cooperation – see TA Management Plan p.90) have received on-site training with

international and Vietnamese field archaeologists (e.g. figures 9-11; namely: Vu Duy Linh, Le Thi Thanh Kim Hue and Nguyen Thi Loan) – including in excavation techniques, finds identification and on-site processing (see photographs below). In 2017 three further management staff (Vu Thi Lien, Vu Thuy Linh and Truong Thi Quynh Trang) have begun field training with the SUNDASIA Project. A representative from the Ninh Binh Provincial Museum, Department of Artefacts (Pham Tuan Luan) has also been working with the Project.



Figure 9: Vu Duy Linh and Phạm Sinh Khánh of the Management Board finds processing on site at Hang Hanh rock shelter (December 2016) (photo: C. Stimpson).



Figure 10: Bui Van Manh and Nguyen Cao Tan (Deputy Directors of the Departments of Tourism, and Sport & Culture, respectively) in discussion

with Dr Christopher Stimpson (SUNDASIA Site Director) at Hang Hanh (December 2016) (photo: T. Kahlert).



Figure 11: Vu Duy Linh and Vu Thi Lien excavating at the Thung Binh 1 cave under the guidance of SUNDASIA Project members (March 2017) (photo: R. Rabett).

- Number of staff at the Management Board holding cultural heritage-related qualifications:

Year	Doctor	Master	University	College	Other	Total
2014	01	04	34	06	01	46
2016	02	09	30	05	01	46

- Doctoral degree: 2 members of staff – with specializations in cultural and tourist management;
- Master’s degree: 9 members, and including the following specializations (construction, State Management, and culture and archaeology);
- Bachelor’s degrees: 30 people, with specializations in culture and cultural heritage, tourism, forest management and conservation...
- The Board has the equivalent of USD 5,000 (c. VND 100,000,000) per year to allocate to staff training.

- Record of the number of courses attended annually by staff:

No	Courses	2015	2016
1	Preservation of relics	2	1
2	Environmental Heritage Management	1	1
3	Tangible and Intangible heritage Conservation	1	1

4.1.2. Conservation/restoration methods

Provision for this action is found in the following section of the Tràng An Management Plan:

Item VII.5.2 Staff capacity-building & training

The Board will convene its own workshops and seminars from time to time, and also actively engage in sessions, conferences, workshops and training courses in heritage conservation conducted by national and regional organisations and by the UNESCO World Heritage Centre and Advisory Bodies. Co-operation with research institutions will continue to provide valuable skill development.

Explanation:

- The hosting of national and international seminars, workshops and colloquia in fields associated with cultural heritage, cultural management, conservation, and heritage promotion work not only helps to maintain staff knowledge and experience at contemporary levels, it also helps to promote the creation and maintenance of cultural heritage networks and collaborative cross-over between different interest groups.

Actions taken:

- **The hosting workshops/conferences in relation to World Heritage conservation.** In addition to gaining invigorated commitment from academic and Management Board stakeholders in the pursuit of archaeological research and curatorial conservation, an additional tangible outcome in came in the project sub-field of biodiversity. This latter provides an excellent example of the synergy that is being enacted within this mixed inscription property. The long-term (tens of thousands of years) stability of limestone forest habitat in Tràng An (Rabett *et al.* 2017) in the face of significant regional climatic and environmental changes has been identified as providing genuine potential for the successful re-introduction and survival for locally

endangered primate species (Delacour's Langur) (Nadler 2015; *also see Annex 1.2*)

- **Skills development** through co-operation with research institutions (*see Section 4.1.1*).
- **Biodiversity** (Management Plan VII.5.4 p.93) – Working in collaboration with the SUNDASIA Project, local stakeholders and IUCN, the Management Board has embarked on a programme of biodiversity assessment (*see Section 3.2* above and **Annex 1.2**)
- As noted in **Item VII.1.1.10**, the conservation of archaeological cave excavation trenches is in the process of being implemented. Further discussion and consultation was made on this matter during the SUNDASIA workshop (March 2017), with guidance from Chris Cleere (ICOMOS). The intension is to extend implementation of this action in the following way:
 - Line each trench with a permeable membrane (locally sourced geotextile) to lie between the trench sections and the backfill.
 - A thin layer of sand will then be spread across the base and walls (as the trench is progressively filled), to ensure that when/if there is future re-excitation of the trench a sedimentary colour change will be apparent before the membrane is reached.
 - The aim is to use local materials that will introduce the lowest level of instability to the depositional environment. The most appropriate solution is to backfill using spoil originally excavated from the trench (as already implemented at the sites of Hang Hanh and Thung Binh 1).

4.1.3 Long-term planning

Provision for long-term planning with regard to archaeological heritage management is presented in the following sections of the Management Plan:

Item VII.1.2 Later Prehistoric and Historic sites and Monuments

Action 5

A central digital archive will be developed to record structures before and after conservation interventions.

Action 6

Consideration will be given to establishing a museum, or similar storage and archival facility, to house, catalogue and preserve samples of original materials removed from structures at the time of restoration.

Annex 5

Curation and recording of finds will take place within customized storage facilities at the Centre. A detailed register of all archaeological, geological and ecological sites (containing information as appropriate: on period, state of Conservation, accessibility and history of investigation) will be created and maintained. Sampling protocols and specialist analysis that is to be undertaken away from the Centre (including internationally) will be regulated and administered; and a standardised approach to recovery and recording will be established for use by researchers working within the property. (p.134)

Explanation:

Ensuring that there is adequate provision for long-term curation of cultural heritage forms an essential part of the management within a mixed World Heritage property. The *Operational Guidelines for the Implementation of the World Heritage Convention* (OG) emphasise the integration of long-term measures along-side day-to-day actions to ensure the protection and conservation of cultural OUV. The OG state that *‘an integrated approach [involving the short, medium and long-term] to planning and management is essential to guide the evolution of properties over time and to ensure maintenance of all aspects of their Outstanding Universal Value,’* (OG 2016: 23, Item 112).

Actions taken:

- **Storage facility** – the Management Board has recently moved into new premises in Ninh Binh. At this site a facility has been set aside for the curation of archaeological artefacts and other relics from research excavations undertaken within Tràng An (*see above*). This facility is a precursor to larger dedicated premises which, so far as is possible will be reliant on ‘passive conservation’ – i.e. stable conditions will be maintained with limited recourse to air-conditioning or heating, which may be prone to outage. Windows will also be covered to exclude the potential of damage and degradation through UV light.

Following conservation advice from Christopher Cleere (March 2017), the expanded storage facility will include the following features with the aim of ensuring an enduring stable conservation environment:

- The storage facility will employ metal shelving (to ensure avoidance of damage by insects).

- There will be a standardised (and locally sourced) system of containers used to house artefacts to ensure consistency. These will likely be, in the first instance, strong metal boxes. Materials within these will be kept in hard sealable plastic boxes for fragile materials, or double bagging of more robust materials.
- The Management Board and SUNDASIA Project are in the process (since Aug. 2017) of creating a **database of archaeological sites and landforms** associated with Tràng An's prehistoric heritage (*see Items VII.1.1.1 & VII.1.1.2*). One post-doctoral researcher employed by the Project is working fulltime on this work package and is liaising closely with the Vietnamese Institute of Geosciences and Mineral Resources, the Vietnam Institute of Geodesy and Cartography, and other Vietnamese institutions.
- The structure of this GIS database is being built with particular attention to the Management Board's long-term requirements, its commitment and responsibility to the property's built heritage, and to curatorial conservation measures. This is a substantial undertaking as it must ensure that terminology (in Vietnamese and English) will be consistent and searchable. To this end, it is anticipated that a system of keyword descriptors will be devised that are comparable in both languages. The aim will also be for a seamless (or as close to seamless as is practical) system of cataloguing from the field to the storage facility, to ensure that all material can be located and linked to other relevant artefacts or data (e.g. elevation, geographic co-ordinates, date of acquisition, etc.), and can be tracked if a loan is granted for research purposes.

4.2. Develop skills of the management body to successfully plan the management of the archaeological heritage at the property

Reference to this provision is presented in the following section of the Management Plan:

Item VII.5.2. Staff capacity-building & training

The Management Board is newly created so inevitably there is some inexperience in managing the recently established World Heritage property. The managers, however, are recruited from senior ranks in the provincial Department of Culture, Sports and Tourism and related Government agencies. The managers and staff are well qualified and several are undertaking further studies. At present, the total number of staff is 46, with the following levels of education qualification: 02 doctors; 09 M.Sc.; 30 B.Sc.; 05 college level; 01 intermediate level. Two current vice-directors are

working towards their PhD and several other staff are undertaking Masters studies. (p.90)

The Board recognises the importance of further improving the capacity and capability of staff. It will encourage and support staff members to undertake relevant studies and other specialist courses with a view to improving their professional skills and specialist knowledge. Priority will be given to training and skills development in conservation and management of cultural heritage generally, and historic heritage in particular, to strengthen the work of the Centre responsible for the Hoa Lu Ancient Capital. (p.92)

Explanation and Actions associated with this item have been covered above in Section 4.1.1

4.3. Establish a system for the cataloguing, condition-surveying, monitoring and protection of archaeological heritage

Reference to this provision is presented in the following section of the Management Plan:

Item VII.5.4 Research & monitoring

...monitoring of the condition and trend of cultural and natural features was not common in the past. Monitoring became increasingly adopted in the Hoa Lu Ancient Capital after it was recognised as a national heritage site. The Board will progressively establish a comprehensive monitoring scheme over the next five years. [This will include]:

- 1. Develop a prioritised 5-year research plan, and provide budget support to implement it.*
- 2. Seek research support from domestic and international scientific institutions.*
- 3. Encourage and support the publication of research results and apply them as appropriate to management and protection.*
- 4. Implement monitoring procedures, including a comprehensive recording and documentation system.*
- 5. Explore the use of technology to support monitoring - for example the installation of cameras at key locations.*

Explanation and Actions associated with this item have been covered above in association with **Item VII.1.1.1, VII.1.1.3 and Section 4.1.3**

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SUB-ANNEXES:

- I.1 Human Adaptation to Coastal Evolution: Late Quaternary evidence from Southeast Asia (SUNDASIA) – A report on the first year of the project;
- I.2 SUNDASIA PROJECT – Contributions to Monitoring, Conservation and Potential Enhancement of Biological Diversity in the Tràng An World Heritage Property;
- I.3 Rabett, R. *et al.* 2017. Tropical limestone forest resilience and late Pleistocene foraging during MIS-2 in the Tràng An massif, Vietnam. *Quaternary International*, 448: 62-81.

SUB-ANNEX I.1

Human Adaptation to Coastal Evolution: Late Quaternary evidence from Southeast Asia (SUNDASIA) – A report on the first year of the project

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ABSTRACT

The 3.5-year SUNDASIA project is funded through the UK Global Challenges Research Fund (Arts and Humanities Research Council) and the Xuan Truong Enterprise. The project explores how prehistoric foraging communities adapted to cycles of inundation along the northern coastline of Southeast Asia, and how understanding of that process of adaptation can help inform modern responses to climate-induced rising sea levels and habitat change. This report presents a brief summary of work undertaken through the course of the first year of research. During this period, the project has made a solid contribution to the record of sites and cultural evidence pertaining to the early Neolithic Da But technocomplex of the (Mid-Holocene) Dong Da transgression period; and has presented new evidence relating to the Late Pleistocene occupation of Tràng An. Survey and laboratory analysis have begun to expand our understanding of local changes in sedimentological, vegetation and faunal records through both periods; new locales have been added to the record of known landscape features and caves within the Tràng An massif; and collaborative work with local staff and stakeholders is widening participation and building a collaborative initiative between the project's archaeological and local conservation programmes.

1. INTRODUCTION

Southeast Asian countries are currently experiencing sea level rise at a rate approximately three times the global average (Nicholls & Cazenave 2010). In Việt Nam more than 24 per cent of the population live in coastal districts, with more than 17 million people in the Song Hong River Delta alone (Thanh *et al.* 2004). Việt Nam has been identified as one of the top five countries likely to be most affected by sea level rise (DFID Operational Plan 2011-15) in the coming decades and the country's 2nd National Communication to the UN Framework Convention on Climate Change has conveyed the likely impact this will cause to economic production, livelihood, environment, infrastructure and public health (UNFCCC 2010: 12).

The SUNDASIA project, which is funded through the UK Arts and Humanities Research Council portion of the British Government's Global Challenges Research Fund, and by the Xuan Truong Enterprise in Việt Nam, is seeking to establish a greater understanding about the impact that changing sea levels and environmental conditions had on early socioeconomic systems in Việt Nam. It is undertaking this study both, to increase our knowledge of how communities and environments responded to global climate change in the remote past, and to assess how such knowledge can contribute towards modern mitigation and adaptive measures. As such, the ambitions of the project are aligned with six of the UN's 17 Sustainable Development Goals – i.e. 1.5, 2.4, 6.6, 11b, 13.1, 15.4, 15.5 and 15c (UN A/70/L.1 2015). There are three central questions that the project is seeking to answer and nine associated objectives; these are, as follows:

Question 1: How do coastal environments shape human behaviour?

1. *Create detailed datasets that track cultural and economic changes through time and from sites across the massif in relation to cycles of marine inundation. This will be achieved through archaeological excavation and analysis of cultural and faunal remains (including new and archival material).*
2. *Compile a series of digitised terrain maps using GIS to show the full extent of coastal flooding across three cycles of marine inundation and recession around the Trảng An massif. These will be constructed initially from existing data.*
3. *Obtain new sedimentary, chronological, palaeoclimate, biodiversity and vegetation records relating to cycles of inundation. These will complement existing data by bringing fine-grained detail to our terrain maps and context into which early human activities can be projected.*

Question 2: How does coastal evolution impact upon tropical settlement systems?

4. *Develop a robust protocol for the radiocarbon dating of terrestrial and riverine molluscs in tropical contexts. This will build on recent success at Queen's University Belfast (QUB) in creating a protocol for AMS dating Mediterranean shells (Hill 2015), and refine the chronology of cultural and environmental transitions in Trảng An.*

5. *Establish high-resolution (near-annual) tracking of precipitation, especially monsoon cycles, linked to environmental change. The isotopic samples for this work will be obtained from ubiquitous shell midden material. These data will further assist in identifying patterning in human subsistence and periodicity of site occupation.*
6. *Build a pioneering reconstruction of tropical forager site networks, how these responded to cycles of coastal change and the transformative impact on cultural and economic strategies. This will be achieved by synthesising the results of archaeological, palaeoenvironmental, climatic and chronological analyses and digital modelling. Particular attention will be paid to tracking transitional and transformative periods of human behaviour in relation to the extent and timing of environmental change (sea level rise).*

Question 3: How do past cycles of cultural adaptation to sea level change inform on future responses to sea-level change in Southeast Asia and globally?

7. *Present a new long-term perspective on human responses to coastal flooding: essential contextual data for Southeast Asian and particularly Vietnamese stakeholders in their consideration of responses to modern rising sea levels.*
8. *Streamline methods (e.g. quantifying sea level change) and outcomes to fit with and address issues of current global climate-change models. For example the project will produce key data on adaptive processes that can be translated into general principles of adaptation and risk mitigation, and will help to build understanding about non-linear changes in coastal environments and human responses to them.*
9. *Highlight the importance of the *longue durée* (i.e. long-term records) as revealed archaeologically, particularly with respect to economic and climate change research models (e.g. Integrated Assessment Models), through knowledge-transfer efforts with international organisations and policy advisory bodies.*

At the end of the first year of work, significant progress has been made towards addressing the first of the three central questions and its associated objectives, and preliminary progress is being made in response to questions two and three (e.g. with reference to Objective 9: combined efforts of the project zooarchaeological work and local conservation). This report summarises SUNDASIA's preliminary results across these fields.

2. HOW DO COASTAL ENVIRONMENTS SHAPE HUMAN BEHAVIOUR?

The SUNDASIA project set out to accumulate detailed datasets from a range of different archaeological and palaeoenvironmental proxies to track cultural and economic change through time and from sites across the Trảng An massif in response to cycles of marine inundation. It has already been established that this landscape contains multiple prehistoric archaeological sites spanning at least the last 30,000 years, as well as evidence for the last three major marine transgression episodes: the Quang Xuong (c. 2600–1500 cal. years before present [BP]), the Dong Da (Flandrian) (c. 7000–4000 cal. BP) and the little known Vinh Phuc transgression (c. 59,000–30,000 BP) (Trung *et al.* 2012; UNESCO Nomination Document-1438 2014).

2.1 Tracking the prehistoric cultural and economic change through time

Fourteen of the 30 caves recorded in the World Heritage nomination document for Tràng An, and known to contain cultural evidence, had been archaeologically investigated by the time the property was inscribed in 2014. Three of these had been excavated by the Cambridge-led Tràng An Archaeological Project, which ran from 2007-14 (Rabett 2012, 2013; Rabett *et al.* 2009a, 2009b, 2011, 2017); the remainder were excavated by Vietnamese colleagues from the Institute of Archaeology, Hanoi during the latter part of the same period (e.g. Đồi & Dang n.d.; Mai Huong *et al.* n.d.; Su 2012a; Su n.d.; Su & Tuan n.d.). The existing body of investigated sites include examples relevant to all three of the inundation cycles being considered by SUNDASIA. Many of these sites are shell middens (dominated by terrestrial, riverine and marine molluscan taxa in varying proportions). Although such middens are common in Tràng An (and elsewhere in the region), past analysis of them has rarely examined underlying inter-site variability and the potential significance of this to reconstructing human movement and behaviour (Piper & Rabett 2014). The aim of the archaeological component of this project is to expand the record of known sites from each phase of inundation in order to more fully understand site selection criteria in relation of resources and palaeo-shorelines; how early human communities exploited and settled this landscape; and how cultural practices changed in space and through time in response to short-term coastal evolution. During the first year of work, three seasons of geophysical and archaeological work have been undertaken at four sites associated primarily with the Dong Da transgression (Green *et al.* n.d.; Loyer n.d.; Rabett *et al.* n.d.[a, b]; Stimpson *et al.* n.d.).

2.1.1 Hang Ang Noi

This cave site with an internal surface area of *c.* 240 m² is located in the NE of the Tràng An massif (20.275000N, 105.916667E) *c.* 45 m asl and featured in the property's World Heritage nomination (UNESCO Nomination Document-1438 2014, Annex 4: 103). Cultural remains recovered during excavations in 2012 by the Institute of Archaeology, and ahead of the World Heritage nomination, pointed towards ephemeral occupation during the last 2000 years, as evidenced by ceramic sherds from a range of periods from the Dong Son to Medieval period (Toan n.d.). This places use of the site within the time window of the most recent Quang Xuong transgression.

Excavations by the SUNDASIA project at Hang Ang Noi were carried out between 25th August and 5th September 2016. These were preceded by a ground-penetrating radar (GPR) investigation of the site (Green *et al.* n.d.). Drawing on the results of the GPR work, we initiated further excavation in 'Trench 1', which had been opened in 2012. Over the period of work on site three additional trenches were opened: 'Trench 3' within an area of apparent midden accumulation adjacent to the southern wall of the cave; 'Trench 4' to the southeast of Trench 1 and excavated into silty layers that contained large quantities of small vertebrate remains (bird, bat, rodent and amphibian); and 'Trench 5' at the back of the cave. Each of these was initially 1 x 2 m in size, Trench 3 was extended to 3 x 2 m as we sought to understand the complex and disturbed deposits we were finding here from multiple cultural periods.

None of the new trenches at Hang Ang Noi (nor extended excavation within Trench 1) yielded appreciable cultural remains. Of those examined, Trench 3 proved to be the most productive. Hints of ash and charcoal concentrations found in this part of the cave, quickly led to much greater concentrations in sub-surface contexts (notably in square 615/201) and areas of ash across that square. Some of this might be the result of material dropping from an overhanging ledge, used in recent and possibly historical times for burning incense, but

the presence of 13th century polished ware, together with several fragments of Da But corded ware (which included several surface finds) suggest that the cave has been visited over a much longer period of time, seemingly back to the Neolithic. The depositional character of the cave stratigraphy here probably involved some degree of water action – possibly periodic flood events. The direct effect these may have had on any cultural remains that did accumulate cannot be determined at this stage, though the scarcity and positioning of such evidence that does survive, including Da But fragments at points around the perimeter of the cave floor, hints that this might have been considerable. Silty and guano-rich surface deposits towards the back of the cave (intersected by Trench 5) produced a rich faunal assemblage of small vertebrate taxa: roof-fall from bird and bat roosting sites above. This material is being collected and examined periodically (including as part of a Queen's University Belfast student dissertation), to provide a contemporary comparative for the archaeological evidence being recovered and to help inform the modern status of biodiversity within the park.

2.1.2 *Hang Moi*

This cave site is located in the north-central part of the massif *c.* 23 m asl. at 20.254111N, 105.894889E and with an exposed surface area of *c.* 200 m². The site was initially excavated two trenches as part of the Tràng An Archaeological Project (TAAP) in 2011 (Rabett 2013). The first of these (1 × 2 m) was located at the back of the cave and revealed a complex sequence of hearth deposits and likely evidence of hearth accoutrements: stake-holes suggestive of a tripod structure. Numerous Da But ceramic sherds (particularly in context 6007) and a small trapezoidal jade adze (context 6009) with all surfaces polished, typical of middle phases of the Da But (Viet 2005), were excavated here. The second trench (1 × 3 m) was located immediately adjacent to the northern wall of the cave. This trench had fewer discernible stratigraphic contexts and appeared to bear the character of a food midden from which large quantities of fish, crab and mollusc (predominantly of marine affinity) were recovered, together with equally numerous, but often larger fragments of Da But pottery (3-5 cm) (Nyiri n.d.). Charcoal samples obtained from the base of the trenches date to 5464-5591 cal. BP and 5436-5611 cal. BP, respectively (Calib. Rev. 7.0.0. – 2-sigma).

Vietnamese colleagues returned to the site in 2012 and undertook further work: opening a third trench (1 × 2 m), which was dug to an average depth of *c.* 1.4 m, with cultural deposits of Neolithic (Da But) affinity with faunal evidence of a coastal economy in the upper layers (1-4), mirroring those of the TAAP excavation. These were found to overlie an upland interior phase of site-use, comprising a terrestrial and freshwater shell midden of probable early Holocene antiquity (layers 7-12) (Masanari & Toan n.d.).

A SUNDASIA project team, together with members of the Institute of Archaeology returned to the site again in December 2016 with the aim of obtaining additional cultural evidence for the Da But that would shed further light on socio-cultural adaptations from the period of the Dong Da (Flandrian) transgression. Trench 2 of the TAAP excavation was expanded by two further 1 × 1 m grid squares and dug to a depth of 0.8 m in close stratigraphic correspondence to the 2011 excavation sequence. Vertebrate remains were less abundant than shell and crab remains, which were recovered in quantities, as were Da But ceramics, including a large base sherd (Small Find No.3), lifted from the interface between spits 4 and 5 of context (6303) in grid square 323/414; however, no stone tools were recovered.

2.1.3 *Hang Hanh*

This previously unstudied site comprises a small rock-shelter (of surface area *c.* 30 m²) situated on the south side of an isolated karst tower on the eastern margin of the Trảng An massif (20.243917N 105.924167E) *c.* 19 m asl. The site was first visited and identified as of potential interest in December 2015. The site contained comparatively shallow deposits, but guided by a GPR survey, conducted in late August 2016 (Green *et al.* n.d.), the SUNDASIA team and colleagues from the Institute of Archaeology opened a 1 x 2 m trench (figure 1) adjacent to the back wall of the rock-shelter 7-9th September 2016 (Rabett *et al.* n.d[a]). Excavation here immediately started to yield a productive set of depositional contexts: Da But ceramic sherds, marine and riverine shell, crab and diagnostic large vertebrate faunal remains began emerge. Work was resumed in December 2016 (Stimpson *et al.* n.d.) over a period of seven days, and the midden deposits that we had opened continued to produce substantial archaeological remains and a second trench (1 x 2 m) was opened to expand areal coverage and ease of access. As work progressed, however, it became clear that the site had experienced considerable disturbance historically and that this would diminish the clarity of archaeological associations. For example, Da But sherds were emerging mixed with ceramics from later periods.



Figure 1: Excavations in progress at Hang Hanh, Trảng An (Sept. 2016); pictured (L-R): C. Stimpson, R. Holmes, P.T. Son and N.T. Dong. (Photo. R. Rabett).

Small vertebrate remains recovered from the site include insectivorous bat, frog, bird and rodents – these are likely to be intrusive, rather than archaeological. The remains of larger vertebrate taxa were highly fragmented, but diagnostic specimens include reptile

(*Python* sp.; *Varanus* sp.), large caprine (cf. *Capricornis*) deer (Cervidae), pig (*Sus* sp.), macaque (*Macaca* sp.) and civet (Viverridae).

The most notable osteological discovery at the site came from square A of Trench 1 (context B500): a human mandible fragment (figure 2). This was followed in quick succession by a series ($n = 9$) of additional but highly fragmented human remains (isolated teeth and post-cranial elements) from across both trenches. Preliminary laboratory analysis (Loyer n.d.) has been carried out and the possibility offered that several of these pieces could be from the same individual (taphonomy and age-related features show consistency). No grave cut or other burial-like context was identified, though interment within midden deposits during this period is not without precedent – e.g. burials excavated at Con Co Ngua (Vinh 1991). Our current reading of site formation processes at Hang Hanh would suggest that the human remains (and other archaeological material) are likely to have been redeposited from their primary context through human and animal activity, erosion or water action, or indeed a combination of these. Indications are that archaeological material has been accumulating at the site since at least the Mid-Holocene. Much of the observed disturbance identified (e.g. trampling and midden re-working) probably occurred in antiquity; however, erosional processes affecting the locale are likely to be ongoing, even if not necessarily at a rate consistent to that in the past.



Figure 2: Recovery of human mandible fragment (centre-right of frame) from square A, Trench 1 (context B500) at Hang Hanh, Trảng An. (Photo: R. Holmes).

Efforts to directly-date the mandible proved unsuccessful when the 14Chrono laboratory at Queen's University Belfast determined that nitrogen levels within the bone

(0.13‰) were below the required minimum threshold of 0.5‰ (J. MacDonald *pers. comm.* 2017). An alternative approach is being sought that will utilize one of the isolated teeth that have been recovered, as the datable dentine is likely to be better preserved. As this procedure is destructive, the aim is to extract the maximum amount of data from the chosen specimen including, in addition to nitrogen, analysis of carbon and hydrogen isotopic values as a way to investigate palaeodiet; and ideally analysis for ancient DNA, which remains a comparative rarity in eastern Asia generally (e.g. Siska *et al.* 2017).

Other notable artefact finds at Hang Hanh included a pierced shark tooth (from Trench 1, square A) and a small stone adze, recovered in a disturbed context in a void fill in Trench 2, square D. The lithic technological assemblage at Hang Hanh comprised of several notched flakes, possible cores, a quern, and a Neolithic groundstone adze. However, turbulent site formation processes make it difficult to place any specimen within a discrete temporal context. Furthermore, goats frequent the rockshelter, so many of the observed fragmentation patterns might be attributed to goat trampling, which may generate false positives in the archaeological record (Pargeter & Bradfield 2012). With this being said, the Neolithic groundstone adze has the greatest potential for further analysis. By applying sourcing techniques to the piece, we may contribute to a greater understanding of raw material sourcing and exchange in the Vietnamese Neolithic. Use-wear studies and residue analysis may also prove fruitful in placing the specimen within technological context.

2.1.4 Hang Thung Binh 1

This small two-chambered cave (20.26162N 105.86474E) *c.* 20.4 m asl. was surveyed by the Vietnamese Institute of Archaeology in 2008. The cave mouth faces east over fields towards the north-west margin of the massif. It is the most accessible of five small caves located within an isolated limestone outcrop (see below), four of which were investigated by members of the Institute of Archaeology (Su & Tuan 2012). A 2 x 2 m trench was excavated towards the back of this cave and considered (on the basis of cultural remains) to span the Holocene (UNESCO Nomination Document-1438 2014: 41).

A GPR survey of the floor of the main chamber of this cave, carried out for the SUNDASIA Project in September 2016 (Green *et al.* n.d.), produced further positive results; however, without immediate access to artificial lighting, and recalling the surprising productivity of Hang Hanh, it was decided instead to explore seemingly undisturbed deposits in the smaller and well-lit adjoining chamber (Rabett *et al.* n.d.[b]). A single trench was excavated. Initially, a 2 x 1 m test pit was opened. This was subsequently expanded to a 2 x 2 m over the digging season (20th March – 3rd April 2017) to a maximum depth of *c.* 0.7 m. An ephemeral ash deposit, containing significant quantities of charcoal, was passed and a dense shell midden, comparable to that seen in the Institute's trench in the main chamber was uncovered. The new midden contained frequent terrestrial molluscs (predominantly *Cyclophorus* sp.) and moderately frequent river gastropods. Comparatively little charcoal was recovered, though burnt bone was quite frequent as were vertebrate remains generally – from large mammals, fish and turtles.

Vertebrate remains included well-preserved porcupine mandibles (Hystricidae) from square 150/251 (context C804) spit 2. A softshell turtle costal fragment came to light during on-site dry sieving of an adjacent square in the same context and spit. Aside from three sherds of Da But corded ware associated with the interface between the midden and overlying deposits, artefact evidence was sparse – including small numbers of flakes with apparent platforms, and one piece of modified shell: a perforated Neritidae (*Neripteron* [*Neritina*] *violacea*) from the base of (C804) spit 2 in square 151/250. A small cowrie-like shell

fragment (possibly worked/pigmented) was also found again during sieving (C804) spit 1. The proportion of sediment within the matrix of the midden began to increase noticeably within the fourth 0.1 m spit of (C804) and had become compact and clay-dominated. The frequency of bone and shells dropped precipitously and indications were that the base of the midden had been reached. Radiocarbon dating of the midden has shown it to be of considerably greater antiquity than was expected: two almost indistinguishable dates place its accumulation 17,500-17,940 (UBA- 34739) context (C804) spit 2 and 17,422-17,889 (UBA-34737) context (C804) spit 3 (Calib. Rev. 7.0.0. – 2-sigma). The slight reversal in these dates and the presence of a third historical date of 653-717 cal. Ka (UBA-34738) from (C804) spit 2 suggests that some mixing or disturbance of these deposits has probably occurred. The consistency between the two early dates, though, does provide a case for attributing the midden to the period immediately after the Last Glacial Maximum; a settlement phase that has also been identified at Hang Trong in the massif interior (Rabett *et al.* 2017). The Thung Binh 1 data will thus provide further environmental and climatic detail to the setting of human activity during that time.

2.1.5 Research programme – Archaeology

Inter-site comparison of the vertebrate and invertebrate faunal remains – including modified material and human remains (from Hang Hanh) – is currently underway at the Oxford University Museum of Natural History, University of Cambridge, and Queen’s University Belfast. Discussions with the Endangered Primate Rescue Centre (Cuc Phong National Park) have also laid the ground-work for mutual supportive measures, including facilitating primate osteological identification. An attribute-analysis based study of the artefactual material (lithics) is taking place at the University of Cambridge, while preliminary typological study of the ceramic inventory has been undertaken by staff from the Institute of Archaeology, and residue analysis (using XRD) is being conducted at Queen’s University Belfast. Further site excavations are planned for 2017 and 2018.

2.2 Data collection for a digital elevation model (DEM) of Tràng An

Geographic Information Science (GIS) is a powerful tool in geological and archaeological data-processing; one that has been used in Việt Nam for more than a decade (e.g. Hung *et al.* 2002) and which permits analyse of large quantities of data drawn from different sources and to map, model and query relationships between different datasets within their spatial context. Working with sea level, chronometric, topographic (Digital Surface Models – DSM) and geological datasets, SUNDASIA is using GIS to create detailed maps of each marine transgression and the position of ancient shorelines around the massif. Relationships between Tràng An’s past and present vegetative landscapes and the record of existing and new archaeological sites and other environmental characteristics (e.g. slope, slope aspect, geology, proximity to resources, elevation, vegetation type, orientation of cave entrance, distance to other sites) are then accessible to study within the context of local landscape and coastal evolution. Collation of data using a GIS platform also facilitates translation of observed prehistoric variables (e.g. any lag-time in adaptation, resource investment or risk management), which can be usefully integrated into modern economic and climate change scenarios.

Building on field data collected by the Vietnamese Institute of Geosciences and Mineral Resources (VIGMR), existing literature sources (e.g. Laumanns 2014), and in collaboration with surveyors from the local office of the Xuan Truong Enterprise, the first of the current project’s planned surveys was carried out in March and April 2017. During the

field assessment, erosional notches were recorded at two locations using a compass and laser distance metre offset measurement from the GPS unit (table 1, figures 3 & 4). The greater part of this survey, however, catalogued cave locations. A sample of 29 caves had been selected out of an existing catalogue of more than 100 known locales. Those selected were also known or suspected to be inactive and had been minimally described in the literature. Known caves were included in this work to ensure replicable and uniform data collection. Twelve of the caves that were located and catalogued ($n = 26$) are previously unrecorded (figure 5, table 2).

Name	Long.	Lat.	Elevation (asl.)
Mai Da Ham Rong notch	105.87317	20.29725	2.42 m
Hang Muoi notch	105.90856	20.275239	9.02 m

Table 1: Location and elevation of newly recorded erosional notch sites.



Figure 3: Erosional notch at Mai Da Ham Rong 2 (scale: 1 m). (Photo: T. Kahlert)



Figure 4: Erosional notch at Hang Muoi (scale: 1 m). (Photo: T. Kahlert)

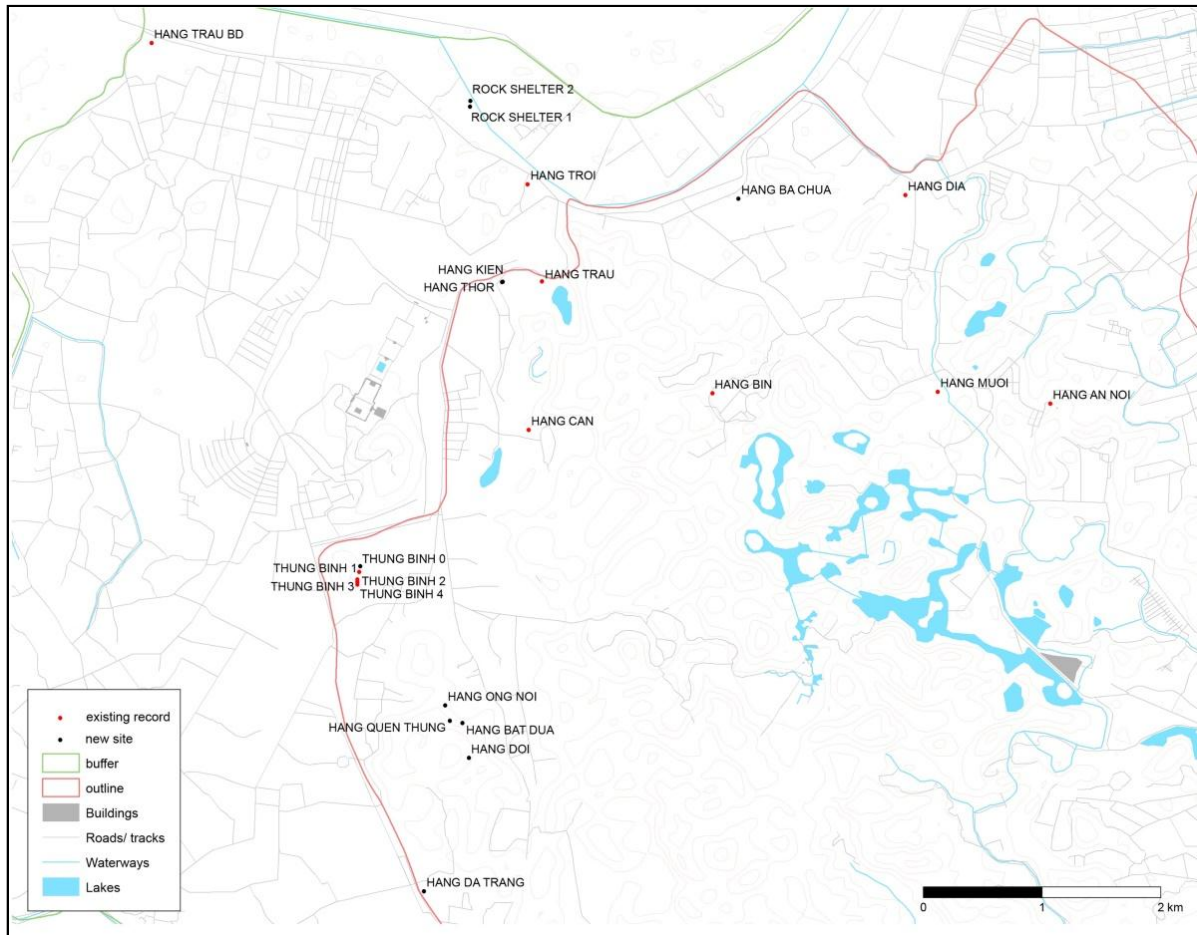


Figure 5: Sites visited in the western part of the Trảng An massif during the March 2017 season. (Illustration: T. Kahlert)

Point_ID	Long.	Lat.	Status	Archaeological potential	Finds	Date
HANG LUON BD			located but not recorded	Cave visible as small entrance near top of steep limestone hillock, inaccessible at the time of visit. Not expected to be of archaeological potential due to location and size of entrance		03/25/2017
HANG TIEN	105.90606	20.29015	located but not recorded	Very small chamber, not a true cave		03/31/2017
HANG THUNG BINH 1	105.86474	20.26162	location added	Excavated, archaeological		03/20/2017
HANG THUNG BINH 2	105.8646	20.26104	location added	Excavated, archaeological		03/21/2017
HANG THUNG BINH 3	105.86461	20.26084	location added	Excavated, archaeological		03/21/2017
HANG THUNG BINH 4	105.86461	20.26067	location added	Excavated, archaeological		03/21/2017

Point_ID	Long.	Lat.	Status	Archaeological potential	Finds	Date
HANG CAN	105.87757	20.27237	location verified	None, converted for farm use		03/23/2017
HANG TROI	105.87749	20.29097	location verified	None, concrete floor, used for offerings		03/23/2017
HANG TRAU	105.87858	20.28361	location verified	Ex-water cave, possibly prone to frequent flooding. Very low potential		03/24/2017
HANG TRAU BAI DINH	105.84903	20.30165	location verified	At least 30 cm sediments (possibly much more), surface and buried historical archaeological material	2 bags, pottery, shells	03/25/2017
HANG MUOI	105.90853	20.27526	location verified	None, modified		03/25/2017
HANG BIN	105.89149	20.27514	location verified	Low potential. Possibly ex-water cave and modified for farm use		03/31/2017
HANG BIN	105.89149	20.27514	location verified	None, modified for farm use. Through cave, probably ex water cave		03/31/2017
HANG DIA	105.90606	20.29015	location verified	None, temple Cave		03/31/2017
HANG BA CHUA	105.89344	20.28988	New site	None, modified		04/02/2017
HANG THUNG BINH 5	105.86483	20.26204	New site	Deposits present in some areas		03/24/2017
MAI DA HAM RONG 1	105.87313	20.29683	New site	Sediments present but close to water table		03/23/2017
MAI DA HAM RONG 2	105.87317	20.29728	New site	Sediments present but close to water table		03/23/2017
HANG KIEN	105.87555	20.28355	New site	Few sediments, low potential		03/24/2017
UN-NAMED CAVE	105.8756	20.28357	New site	Sediments, some surface finds	1 bag, pottery	03/24/2017
HANG BAT DUA	105.87256	20.25017	New site	At least 30 cm sediments (possibly much more), surface and buried historical archaeological material	3 bags, pottery, bones, lithic	03/28/2017
HANG QUEN	105.87162	20.25036	New site	Thick sediments, surface pottery finds	1 bag,	03/28/2017

Point_ID	Long.	Lat.	Status	Archaeological potential	Finds	Date
THUNG CHUA				(historic)	pottery	
HANG DA TRANG	105.86965	20.23744	New site	Some sediments present, surface finds (historic pottery)	1 bag, crab	03/28/2017
HANG DOI	105.87305	20.24753	New site	Thick sediments, surface pottery finds (historic)	2 bags, pottery, bones	03/30/2017
HANG ONG NOI	105.87125	20.25151	New site	Sediments present, some surface finds (historic pottery)	1 bag, pottery	03/30/2017
HANG CAU DEN			No cave present at location			03/23/2017
HANG CHUA BACH			No cave present at location			03/24/2017
DONG SUA			No cave present at location			03/24/2017
HANG DUC			No cave present at location			03/23/2017
HANG DOI BE			No direct GPS location taken, however, cave is 10 m north of Hang Doi	No significant level of sediments present		03/30/2017
HANG VONG			Water cave			03/24/2017

Table 2: List of caves visited during the topographic survey (March-April 2017).

The west and southwest of the park are the least explored areas of the Trảng An, evident in a distinct paucity of caves as well as sea notch sites. These areas consist of steep karst towers and dense limestone forest and it presents itself as the most promising part of the park for new discoveries. Trackways leading into the general area, however, are sparse making access difficult. During the March-April 2017 season only the outer fringe of the western protected zone was explored, where some degree of road access is available and where possible tracks were discerned from the study of aerial imagery. With the help of local guides, a number of previously unrecorded caves were discovered in this area.

2.2.1 Hang Thung Binh 5

A local farmer drew our attention to this cave (Quy 2017, *pers. comm.*). Access was difficult due to thick vegetation. The cave features two entrances set *c.* 10 m apart and at similar altitude of 33 m. The southern entrance is larger and gives access to two principle parts of the cave. The first part is a narrow passage that leads to the smaller, second entrance. It is *c.* 1 m wide and 1.5 m to 1.8 m high. The passage runs parallel to the hill and is *c.* 15 m long.

The floor slopes towards the centre of the passage and is covered with a thin layer of small stone mixed with little silt. Some isolated areas, where sediments seem to consist of more silt deposits may contain archaeological material. The second part of the cave can be entered via either of two small apertures that both pierce the cave wall near its southern entrance. Both apertures open into a spacious chamber, which leads into a complex network of further chambers that are interconnected by multiple winding passages. The cave was not explored in detail because of health and safety concerns. The entire cave is decorated in speleothems.

2.2.2 *Hang Ba Chua*

The cave is close to the road and its location is marked by a large rock that resembles a pregnant woman. Hang Ba Chua consists of a single open chamber *c.* 12 m above the surrounding ground and can be accessed via a short climb up a steep slope. The interior of the chamber measures 6.5 m deep by 3.3 m wide and 4.1 m high. There are some speleothems on the walls. The cave floor is mostly covered by concrete which is inscribed with: '4.4.1991 25. 2. Tân Mui'. A local told us that the cave is an 18th or 19th century burial site but the concrete slab seems to be commemorative rather than sealing a burial.

2.2.3 *Mai Da Ham Rong 1 and 2*

These two rockshelters are located on the north facing side of an isolated karst tower remnant at the edge of the buffer zone *c.* 2 km NE of the Bai Dinh Pagoda. Both rockshelters overlook the Song Boi river and are used by local farmers to house animals. The karst tower features several other rockshelters and erosional notches (see figure 3 and table 1). The ground is very compact and, due to its proximity to the river, likely prone to seasonal flooding.

2.2.4 *Hang Kien and 'Un-named Cave'*

Hang Kien and Hang Thor are two caves set *c.* 7 m apart that are located on the Bai Dinh Pagoda proper. They penetrate a low karst tower on the north-western edge of the Tràng An protected zone. They both consist of a single straight passage of *c.* 15 m length and are of similar width and height. Both passages can be accessed via a climb up a 1.5 m high ledge that leads into the main chamber. Both passages feature very limited sedimentation, with 'Un-named Cave' producing some historic pottery sherds on the surface.

2.2.5 *Hang Bat Dua (Cave of the broken pots)*

This cave can be reached via a short walk down a track between field and through a short stretch of light undergrowth. The cave is at *c.* 46 m asl, faces north and consists of a short passage leading into a small chamber, measuring *c.* 5 x 6 m and is decorated with several large speleothems. The floor is covered with a large quantity of sherds of glazed pottery and stone ware. Deposits inside the chamber are made up of loose sediments overlaying compact alluvial material. Bone fragments and gastropod shells were also recovered.

2.2.6 *Hang Quen Thung Chua*

Situated 100 m to the west of Hang Bat Dua and at an elevation of *c.* 60 m asl lies Hang Quen Thung. This locale is reached by following a track that crosses a saddle into a neighbouring doline. The cave was found to comprise a sheltered overhang that leads into an upper and lower chamber. The upper chamber was not explored. The lower chamber is slightly below the ground surface and measures 4 x 5 m. The chamber floor consists of loose sediments that

cover compact alluvium. A 0.2 x 0.2 m *sondage* was dug in the north of the chamber to a depth of 0.3 m but did not produce any archaeological material below the top 5 cm. The *sondage* was not excavated to the base of the deposit and it is possible that archaeology is present at deeper strata.

2.2.7 *Hang Da Trang*

This cave was shown to us by a local man who used to hunt in the western hills of Trảng An and used Da Trang Cave as a shelter. The cave penetrates a karst tower remnant that stands amidst rice paddies c. 100 m west of the Trảng An massif. A rock overhang shelters the cave entrance and provides extensive views along the massif in a southerly direction. An overgrown path leads to the rockshelter, which lies at c. 10 m asl. A low entrance leads into a 1.5 m high by 2.5 m wide winding passage that opens into a small chamber. From there, as well as from the short passage, several crawls lead up onto two balconies; both are formed from slipped bedding planes, which are the result of the advanced erosion of the hill. Modern refuse and historic pottery is scattered across the floor. Among these, one piece of crab was found. Sediments are present through the cave but their depth was not tested.

2.2.8 *Hang Doi and Hang Doi Be*

This was the second most extensive cave system found during the March-April 2017 survey. Situated in an isolated doline the low cave entrance is reached via the same track that leads to Hang Quen Thung. Six chambers were explored. These were connected via short rift passages. A small bat colony (c. 20-30 individuals) was identified within the cave, as were animal tracks – subsequently identified (by CMS) to be those of a porcupine (cf. *Hystrix brachyura*). Large speleothems decorate almost all parts of the cave. A 10 x 10 cm *sondage* was excavated to a depth of c. 0.3 m. The upper 10 cm produced glazed pottery sherds and bone fragments. The deposits extend below the depth of the *sondage* and it is possible that archaeology is present at deeper strata. Hang Doi Be is situated 10 m north of Hang Doi and consists of a single 2 m by 2 m sunk chamber. The cave floor consists of large stones covered by a thin layer of sediment, which appeared to be archaeologically sterile.

2.2.9 *Hang Ong Noi*

Hang Ong Noi is situated on the steep slope of a low karst outcrop on the western edge of Trảng An. Access to the cave is challenging, with several scrambles up rock ledges and through dense vegetation. The cave consists of a 2.2 m wide by 8 m long and 2 m high entrance chamber. At its rear is a 1.5 m high ledge that leads into a narrow short winding passage. At the end of the passage is a slightly smaller chamber, measuring 3 x 3 m. Several smaller chambers connect to this chamber. Speleothems are present in the passage, inner chamber and its extensions. A small pile of brush-wood and some refuse indicate recent human activity in the entrance chamber and some historic pottery was found on the surface inside the cave. Sediments were compact, clay-rich and mixed with a large quantity of stones. No other archaeology was noted.

2.2.10 *Research programme – GIS*

During the first survey season essential infrastructure for data-collection was put into place for future work – e.g. the Real Time Kinematic (RTK) network has been established for Trảng An, with access provided by the Việt Nam Institute of Geodesy and Cartography (VIGAC); technical collaboration was also discussed with VIGMR and VIGAC. Existing DEM data at a resolution of 0.5 m (through VIGMR) only exists for selected areas within the

massif and will need to be supplemented. An application to the German Space Centre (DLR) for TerraSAR-X / TanDEM-X data was approved and the resultant data is currently being examined, though the nature of the topography presents a considerable challenge to satellite remote sensing and it is unclear at this stage if these data will add significantly to the project's GIS analysis. The possibility of creating a photogrammetric 3D model of Trảng An via a fixed-wing drone survey to augment these data has also been explored with VIGAC though was found to be cost-prohibitive. Further exploration of the western area of the property is planned during the remaining two 2017 field seasons, including with the objective to expand our database of wave-induced and bio-erosion features, such as sea notches (Abensperg-Traun *et al.* 1990), and bio-constructive features, such as palaeo-oyster beds, on the western flanks of the massif. The second year of the project will also see particular focus on integrating data sources into a GIS database.

2.3 Palaeoecology: sedimentology, chronology, palaeoclimate, biodiversity & vegetation

The reconstruction of coastal and landscape evolution provides the environmental context for the history of human activity in Trảng An. The palaeogeographical evolution of the Song Hong delta has been the subject of several studies, employing both onshore and near-shore sediment cores (e.g. Hori *et al.*, 2005; Tanabe *et al.*, 2003, 2006). While these established that shallow seas extended to the Trảng An massif during the 7000–4000 cal. BP (Dong Da) transgression, specific details about how this and earlier transgressions progressed have yet to be determined. A multiproxy archaeological and palaeoenvironmental study of data from Hang Trong – the oldest archaeological sites in Trảng An – indicates that the limestone tropical forest that predominates across the landscape of the massif today was also present as early as the Last Glacial Maximum (26-19 cal. BP) and appears to show considerable resilience to global climatic and environmental changes (Rabett *et al.* 2017). This not only highlights the potential importance of karstic landscapes as foci of human activity in the remote past for the access they offered to reliable resources, it also has significant bearing for 21st century conservation if such settings are less susceptible to capricious climate-change.

2.3.1 Sedimentology

A 9.11 m sediment core (TAK101) was drilled by the TAAP/Xuan Truong Enterprise in 2012 in the NE corner of the massif (20.285281N, 105.905997N), close to the site of the Hoa Lu ancient capital (Simpson n.d.). Indications are that the site experienced a complex depositional and erosional sequence. Four ¹⁴C dates were obtained from the following levels within the core – spanning most of its total depth: a) 2.47-2.46 m, b) 5.25-5.24 m, c) 8.77-8.76 m, d) 10.30-10.29 m. The dates returned included no reversals and were, as follows (using Calib. Rev. 7.0.0 – 2-sigma): a1) 7458-7576 cal. BP (UBA-25527), b1) 7589-7702 cal. BP (UBA-25528), c1) 7654-7801 cal. BP (UBA-25529), d1) 7720-7948 cal. BP (UBA-25530). This implies that the rate of sedimentation over most of the length of the core was rapid, spanning a maximum of 500 years. It also suggests that post-7000 year deposits were either, subject to a very much slower rate of accumulation, or were removed by processes of erosion associated with the Mid-Holocene high-stand. The latter proposition is currently more in-keeping with existing data from the nearby (c. 35 km distant) Nam Dinh (ND)-1 core (Tanabe *et al.* 2003). It is also note-worthy that the apparent high rate of sedimentation, and hence mobility of sediment in the landscape, appears during a period of enhanced monsoon activity in the Early Holocene (e.g. Wu *et al.* 2012); a period that is also linked to heightened hydrological activity, concretion and/or flushing of cultural cave deposits at a number of sites regionally (Rabett 2012), implying that impact to human settlement or site use patterns might be

expected over this period (for initial observations on the vegetation record obtained from this core, please see section 2.3.5 below).

2.3.2 Chronology

Radiocarbon (^{14}C) dating provides the chronological framework for the project's research questions. A total of 78 ^{14}C dates currently exist from archaeological and geological deposits in Trảng An. These include organic (charcoal) dates ($n = 48$) from cave and rockshelter sites within the massif and dates obtained on stranded oyster shell beds from erosional sea-notches on its flanks and interior ($n = 13$), and a small number ($n = 17$) taken on terrestrial snails. The chemical signature of the dominant land snail (*Cyclophorus* sp.) component of occupation middens excavated thus far in Trảng An have hampered the dating of shell by Amino Acid Racemization (Rabett *et al.* 2011), and a formal calibration curve incorporating carbon reservoir offsets are only now being examined in detail by this project. Working in collaboration with the Oxford Radiocarbon Accelerator Dating Service, 14CHRONO Centre, and Stable Isotope Facility (QUB), and the School of Geography (QMUL), we have begun working towards a more widely applicable tropical shell calibration protocol.

The radiocarbon dating of mollusc samples shells will provide a higher resolution and stratigraphic constraint on contexts within excavated sites. Preliminary results indicate a good correlation between modern snails and the expected percentage of modern carbon values from the cyclophorids tested so far. This means that terrestrial snail shells will be of considerable value when radiocarbon dating contexts where charcoal recovery has been limited or as a complementary line of dating evidence where charcoal is present. Preliminary analysis and measurements undertaken at the 14Chrono Centre, and at the Stable Isotope Facility (QUB) indicate that 'modern' cyclophorids recovered in the field date from 0-85 years of age. The radiocarbon dating of individual archaeological *Cyclophorus* sp. shells will also provide a greater time constraint on all palaeoclimate $\delta^{18}\text{O}/\delta^{13}\text{C}$ data, enabling a deeper understanding of environmental patterns and processes. Thus far *Cyclophorus* sp. shells have been systematically recovered from early post-LGM archaeological contexts at Hang Thung Binh 1; further sampling at this site is envisaged for the coming year.

2.3.3 Palaeoclimate

Growth-increment analysis of land molluscs has been used successfully to reveal changes in isotopic character and thus a proxy for high-resolution (potentially annual) records of rainfall (Leng & Lewis 2012; Ludgate 2013). This approach permits reconstruction of changing precipitation patterns (chiefly in relation to the palaeo-monsoon) around each sea-level transgression, and can identify the potential effects this might have had on settlement and resource availability, and hence on human occupation and activities. As a work-package on the project, this is still in its early stages but data is being generated that will contribute to a forthcoming publication (Ludgate *et al.*, *in prep.*) with external collaborators.

Modern snail shells were recovered from Trảng An to test for comparison between modern expected $\delta^{18}\text{O}$ data and those recovered from the snails. Initial data show that modern *Cyclophorus* sp. shells are comparable to modelled $\delta^{18}\text{O}$ patterns. Previous $\delta^{18}\text{O}$ *Cyclophorus* sp. shell data used to reconstruct monsoon patterns show good comparison with other proximal data. Records demonstrate the sensitivity of the Southeast Asian monsoon system in relation to wider global climate events such as the Heinrich Event 1 (c. 17.5-14.7 cal. Ka), which takes place in the North Atlantic (Ludgate *et al.*, *in prep.*).

2.3.4 Biodiversity

A preliminary (invertebrate) biodiversity survey was led by Darren Mann (Head of Life Collections at the Oxford University Museum of Natural History) in late August-early September 2016. Light-traps and baited overnight traps were set in two areas of the core property (Hoa Lu Ancient Forest and Tam Coc), and daily traverses were made within the core and buffer zones of the property to produce an initial assessment of the extant insect fauna. Initial indications are that the diversity of insect life is significantly greater in the core zone than in the buffer zone of the property. This would suggest that the buffer zone of this property is working. It was also apparent, even from a cursory study of the samples collected, that some of the specimens will either extend the range of known insect species in Việt Nam, or may even reveal species within the Tràng An property that are new to science. Further work in this part of the project is anticipated during the remainder of the project.

The maintenance of biodiversity within and across the buffer zones of World Heritage properties is a matter that is drawing increased attention in conservation management (e.g. Laurance *et al.* 2012; Martin & Piatti 2009) and is one to which the SUNDASIA project is well-positioned to make a positive contribution. The likelihood that the core zone continues to be a habitat for larger vertebrates, such as monkeys, civets and mustelids (badgers) will be the subject of investigation by the project through a campaign of camera trapping across eight locales, beginning in September 2017.

The zooarchaeological record within this landscape (>25,000 years), which investigation by the TAAP, the Vietnamese Institute of Archaeology, and SUNDASIA have uncovered, has demonstrated the existence of a range of fauna, including primates, large felids, wild boar and pangolin that are currently not found (or have not been recorded recently) within the Tràng An massif. The archaeological evidence for these taxa and the apparent stability of the environment within the massif (Rabett *et al.* 2017) are lines of evidence that may be brought to bear in cases for reintroductions, particularly of locally endemic fauna that have suffered greatly through industrial development and hunting over the last half-century. Following discussions in March 2017, between SUNDASIA, IUCN Việt Nam and other local stakeholders (e.g. Endangered Primate Rescue Centre, Cúc Phương National Park, the Tràng An Management Board, the Ninh Binh Ministry of Tourism, and local industrial partner – the Xuan Truong Enterprise), the overlap between zooarchaeological and conservation research has become a focus of work in line with SUNDASIA's Objective 9 (see above), with the ultimate ambition of helping to facilitate reintroduction the critically endangered primate, Delacour's langur (*Trachypithecus delacouri*), into Tràng An. This would be a significant achievement and one following in the footsteps of that gained for this species in the Van Long Nature Reserve (Dao 2008). It would also have the potential to further enhance the Ninh Binh's growing heritage-based tourist economy.

2.3.5 Vegetation history

The TAK101 core has been provisionally divided into five environmental phases based on the character and condition of its palynological record (Simpson n.d.). The base of the sequence up to 8 m was found to contain low frequencies of pollen and spores in varied states of preservation. On the basis of the identified record, the local environment comprised open woodland, though taphonomic mixing at this level might be creating a spurious picture.

From 8-6 m pollen preservation continues to be variable – implying some recycling is likely, though spore preservation is generally good. This appears to have been a landscape

of low taxonomic diversity: with grasses and coniferous trees in predominance. The 6-4 m phase grasses and Carophyllaceae point towards some locally dry areas, but recycling is probably still impacting this assemblage. Micro-charcoal concentrations suggests some burning, possibly anthropogenic, was taking place. Pollen and spore preservation is notably better in the 4-2 m phase. Significant charcoal in the core at this point indicates increased levels of burning. The upper 2 m of the core contains well-preserved pollen, suggestive of an herbaceous wetland environment; however owing to uncertainty about depositional processes in this part of the core this is liable to be a mixed assemblage: containing ancient and modern signals. Taken in conjunction with the rapid sedimentation rates observed within TAK101, the environment immediately outside the massif may have experienced more dynamic shifts in composition and structure than that inside it, though recycling and mixing of assemblages is likely to factor in the record obtained from this locale: meaning that it may or may not be more widely representative.

2.3.6 Research programme – Palaeoecology

Working with the VIGMR and the Institute of Archaeology, and building on what has been learnt from the TAK101 core, the project's new members, working in the field of palaeoenvironmental reconstruction (Drs Shawn O'Donnell and Nguyen Thi Mai Huong), will undertake compositional and facial analyses from cave samples and additional cores taken from the environs of Tràng An. The project will be looking to examine sediment cores records that it obtains (and those previously obtained by collaborators, where appropriate) for micro-tephra signals to enhance both the environmental and chronometric stories; while it will also be using other proxies (e.g. phytoliths) to complement and diversify its palaeoenvironmental programme. Forthcoming work will also explore the *Cyclophorus* sp. $\delta^{18}\text{O}$ shell records obtained through archaeological excavation to build a longer and more geographically extensive pattern of past climatic events. Stable isotope analysis will take place at the Stable Isotope Facility (QUB) using Analytical Precision 2003 IRMS with Acid Digestor for the $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ analysis of carbonates.

3. CAPACITY BUILDING AND OUTREACH ACTIVITIES – YEAR 1

In the context of SUNDASIA's commitment to local capacity building and outreach, three areas of work have either emerged or have been formalised during the first year of work.

3.1 Staff training

The Tràng An Management Board and SUNDASIA are using this research opportunity to enhance staff capacity through on-site training in archaeological excavation, post-excavation processing and surveying. This represents only one skill-set within cultural heritage management; however the mutual exchange of insights between Board staff and Project members has been positive and constructive, and further development in areas such as remote monitoring and artefact archival and conservation work are planned.

3.2 Biodiversity

Building from the Project's 2017 Workshop, on-going discussion with the management board of Cuc Phong National Park, the Endangered Primate Rescue Center, and IUCN Việt Nam present an important opportunity to contribute towards Ninh Binh's conservation efforts and burgeoning heritage economy.

3.3 Media coverage and public engagement

The project has been active in raising awareness about the value of Tràng An's natural and cultural heritage through television interviews and media coverage through major international platforms (Facebook and Twitter) and international institutions (with blog postings through the University of Cambridge and Smithsonian Institute). SUNDASIA members are also working directly with the Tràng An Management Board towards the development of public displays and interactive, immersive experiences (e.g. 3D digital renderings of cave excavations, and artistic reconstructions of ancient life within the park) for the Tràng An Visitor Centre.

4. CONCLUSION

Research undertaken during the first year of the SUNDASIA project has been focused inevitably on ensuring robust methodological overlap between existing datasets in relation to each work-package, and beginning collection of new primary data. As such, the greatest attention has been placed on building evidence in reply to the first of the three principle project questions, and its associated objectives, though linkages have already started to extend beyond this. The different lines of evidence that have been collected so far cover only part of the project's chronological span, the expansion of which will be a key focus of field work during the Year 2. The project has already amassed and begun to analyse a significant body of new evidence pertaining to the Dong Da (Mid-Holocene) transgression record. In doing we have added considerably to the catalogue of known archaeological sites (and in particular cave sites) attributable to the early Neolithic Da But technocomplex. The radiocarbon dates from the midden at Hang Thung Binh 1 align its deposition with a significant period of occupation at a site in the massif interior (Hang Trong), which will expand our understanding of human activity in different parts of the landscape during the centuries ahead of the climatically arid phase associated with Heinrich Event 1. The period in-between and particularly the period of enhanced monsoon activity during the Early Holocene (c. 11,600-7800 cal. BP) and the effect this shift in conditions had on the local landscape and its people will be another focus for the forthcoming year. Through its conservation-linked work, capacity building and outreach, the project is already making progress towards the UN Sustainable Development Goals to which it is linked. The data that has been generated during the first year of the SUNDASIA project will provide valuable points of reference as it expands its work in relation to the second and third of its research questions, and its commitment to assisting in local natural, cultural and economic sustainability over the coming months.

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Contributions:

- RR – PI/principal editor
 FC – CI/GIS
 TTV – CI/geology
 CS – Site director/Zooarchaeology report, biodiversity (large vertebrate survey)
 TK – DEM cave survey data
 IBS – Shell survey data: isotopes (& ¹⁴C dating)
 BU – Technology (lithics)
 TND – Karst geology
 AG – GPR survey data
 RH – Phytoliths/field data collection
 LTTKH – Cave survey data
 VTL – Field data collection
 NL – Shell survey data: isotopes (& ¹⁴C dating)
 VDL – Trainee site supervisor/field data collection
 JL – Human remains report
 DM – Biodiversity (invertebrate survey data)
 NTD – Technology (lithics)/field data collection
 NTL – Field data collection
 PSK – Vice-director TAMB/field operations
 PHS – Technology (ceramics)/field data collection
 DS – Sedimentology/palynology (TAK101) report
 TTKQ – Zooarchaeology/field data collection
 MV – Field data collection
 NCT – Vice-director, Ninh Binh Ministry of Culture
 BVM – Vice-director, Ninh Binh Ministry of Tourism

SUB-ANNEX I.2

SUNDASIA PROJECT – Contributions to Monitoring, Conservation and Potential Enhancement of Biological Diversity in the Tràng An World Heritage Property

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Introduction

In addition to the specific archaeological and palaeoecological aims of the SUNDASIA research programme, the project has implemented (starting in September 2016) a range of measures pertaining to the monitoring and conservation of biological diversity. These measures are in line with Project's stated aim to characterise limestone forest floral and faunal communities over a long-time scale (from c. 30,000 years before present); and is further intended as a contribution to help address the current paucity of data for biological diversity within the Tràng An World Heritage area today. This brief supplement outlines four initiatives that SUNDASIA is undertaking with key stakeholders in Tràng An and Vietnamese and international institutions. These initiatives are: ¹) an invertebrate survey; ²) a trail camera campaign; ³) a small vertebrate monitoring programme; ⁴) an island botanical survey.

These measures will yield scientific data with intrinsic value not only to the project aims but also to the wider scientific community. However, the results could also form the basis for dissemination, in an accessible form, to the wider community, living around or visiting the property. This would be achieved in collaboration with the Management board staff and, potentially, through displays in the Visitor Centre to promote this under-represented aspect of the World Heritage site.

1) Preliminary invertebrate survey

A preliminary survey, focused on insects, was led by Darren Mann (Head of Life Collections at the Oxford University Museum of Natural History) between 27th August and 1st September 2016. This work involved using light traps to attract insects at night, as well as the setting of baited overnight traps in two areas of the core area of Tràng An (Hoa Lu Ancient Forest and Tam Coc), and daily traverses within the core (Tran Temple to Hang Boi) and buffer (in the area around the Bai Dinh hotel and the Thunh Binh caves) zones of the property to produce an initial assessment of the insect fauna present. Full details on this work are forthcoming, but indications are that the diversity of insect life is significantly greater in the core zone than in the buffer zone of the property – an indication that the buffer zone is providing protection of the core zone, in line with its intended function in a World Heritage property. Beetles (Coleoptera) and other invertebrate fauna that live off the dung of medium and large mammals (e.g. badgers, deer) were not identified in this survey, which would suggest that the larger mammal fauna in the property may be very sparsely distributed. Sampling, however, was limited to the cave trails in the north of the core area,

and restricted to 24 hour intervals. Further sampling effort is required (see also **Section 2**, below).

From an strictly entomological point of view, however, it was apparent even from a cursory study of the samples collected, that some of the specimens will either extend the range of known insect species in Vietnam, or may even reveal species within the Tràng An property that are new to Science.

2) Trail Camera Campaign

Through the identification of animal bones recovered in the archaeological excavations, the SUNDASIA project is also building picture of larger vertebrate diversity in the Tràng An World Heritage property, dating from at least the period 30,000 years to 5000 years before present. While this record reflects largely the hunting behaviour of prehistoric people, and as such is an inherently incomplete sample (as indeed all such fossil records are), it is nonetheless establishing a broad long-term picture of animal communities within this area. These data are essential to the archaeological reconstruction of past behaviour and responses to environmental change (as well as potentially environmental impact of human behaviour), but it is equally important for the aims of the project that these trends and patterns are followed through and linked into modern conditions, rather than being left isolated from them. At present, we already know more about the prehistoric animal life in the karst area than we do the animal life that occurring here today. There have been, however, limited direct observations of larger mammals by project members. For example, a hog badger, *Arctonyx collaris* (a poorly-known mustelid classified as “Vulnerable” by the IUCN due to habitat loss and hunting pressure (Duckworth *et al.* 2016)), was seen near the Tran Temple in 2014, and the (at least periodic) presence of primates was reconfirmed by sightings of macaques (likely *Macaca mulatta*) in September 2017 within the core area of the property.

As well as consulting with local people about their knowledge of animals in the World Heritage area, the Project has initiated (in September 2017) a passive monitoring programme using trail cameras to begin to address this gap in our knowledge of the property – the initial focus is on medium to large terrestrial mammals (e.g. civets - Viverridae, deer – Cervidae, badgers - Mustelidae). This method has been shown to be a reliable and robust means of monitoring mammals in the forested tropics (e.g. Tobler *et al.*, 2008). A series of motion-activated, static 24MP trail cameras using infrared flash are being set up within the property: first as a trial (figure 1), and then from November 2017 the Project will intensively sample 1 km grid squares (i.e. accumulate *c.* 500 ‘camera days’ per square, using up to eight cameras per square) in the core area of the World Heritage, over the next year. The results from these campaigns will not only provide data for comparison with the prehistoric samples, but also provide basic, but invaluable insights into the current state of vertebrate biodiversity within the park.



Figure 1: Dr Christopher Stimpson (Queen's University Belfast) checking preliminary trail camera placements within the core zone (vicinity of the Tran Temple) (19th September 2017) (photo: R. Rabett).

3) Small vertebrate monitoring programme

Details of the archaeological investigation at the site of Hang Ang Noi (20.275000 N, 105.916667 E) are presented in Annex 2 of this document. As noted therein, our work at this site further revealed an abundance of recent (i.e. non-archaeological) skeletal remains of small vertebrate taxa in surface deposits towards the back of the cave. These assemblages comprise of skeletal remains from naturally-occurring cave vertebrates (chiefly, bats - Chiroptera) along with the bones deposited by owls (likely fish owls: *Bubo* sp.) using the cave as a roosting site: the latter comprise the remains of ingested prey that is essentially skeletonised and then regurgitated by the owl and incorporated into the cave deposits. The study of cave-roosting species, like bats and owls, provides a ready and inexpensive means to characterise and even assess trends in the character of local small vertebrate communities. Hang Ang Noi occupies a position within the core zone of the property that is comparatively close (c. 0.5 km) to an arterial route through Tràng An, making the record from here potentially sensitive to external disturbance and a good marker for the health of the local environment.

At the time of writing (September 2017) systematic collection of samples of this material by the SUNDASIA project (see figure 2) has been made on four occasions (commencing in September 2016). Identification of small vertebrate taxa is being undertaken at the Oxford University Museum of Natural History and Queen's University Belfast. Analysis is in its early stages; however, a preliminary examination has indicated that the assemblages include skeletal elements from fruit bats (*Rousettus*, *Cynopterus*), insectivorous bats (*Hipposideros*, *Taphozous*, *Scotophilus*) shrews (Soricidae), murid rodents (Muridae), tree shrew (*Tupaia belangeri*), voles (Microtinae), frogs (Anura) and birds (Aves) and thus, a range of small vertebrate taxa are represented. While the focus will be necessarily on cave-dwelling vertebrates and be biased by the hunting preferences of owls, this material will

yield basic biodiversity data, where none exists currently, as taxonomic identifications are refined.



Figure 2: Dr Christopher Stimpson, Aaron Redmond and Dr Nguyen Truong Dong collecting guano and deadfall samples at Hang Ang Noi, Tràng An (September 2017) (photo: R. Rabett).

4) Island Botanical Survey

On the afternoon of 18th September and the morning of 19th September 2017, a team from SUNDASIA (led by Dr Shawn O'Donnell and Dr Nguyen Thi Mai Huong) surveyed the vegetation on the small limestone island approximately one kilometre northwest of the Tràng An Visitor Centre main wharf (figure 3). A significant element of the SUNDASIA project involves the reconstruction of past environments across this landscape and, as with the project's faunal analysis, connecting long-term patterns of vegetative change to present conditions forms an essential part of that work. This particular exercise not only expands upon the current state of knowledge regarding vegetation communities in Tràng An (*see e.g.* Do Yen Ngoc 2012), it is linked to an initiative being explored by the Management Board with the Xuan Truong Enterprise and Vietnam Primate Conservation Programme, which in time may see the reintroduction of the critically endangered Delacour's Langur (*Trachypithecus delacouri*) to Tràng An.



Figure 3: An aerial view of the island whose vegetative cover is described in this report. The boat carrying the survey team is visible in the bottom right of frame. The island is located in the Trảng An core zone, close to the Visitor Centre (photo: T. Kahlert).

The island vegetation in this brief survey is described as limestone scrub. Soil is usually absent (most of the interior area), or composed of thin clays (e.g. within crevices between angular limestone boulders). There are several exposures of bare, sharp limestone, especially on the island's steeper slopes. The architecture of the vegetation can be described as simple, comprising a single open stratum. Across most of the island, this stratum comprises closely spaced shrubs and small trees rarely exceeding two to three metres in height, with scattered larger trees (usually *Ficus* spp., of the family Moraceae) on gentler slopes, growing within localised pockets of thin soil, or at the water's edge. Climbing vines (especially *Cissus modeccoides* Planch., *Paederia foetida* L. and a papilionoid legume) are present atop and bind adjacent shrubs and treelets. The most abundant plant family is Moraceae, which alone account for more than 30 per cent of the *c.* 70 preferred species of plant in the diet of the wild Delacour's Langur (Nadler & Brockman 2014). This family is represented predominantly by several species of fig (genus *Ficus*) and collectively, species of Moraceae cover over one third of the area of the island. The second most abundant family is likely to be Annonaceae. This covers *c.* 15-20 per cent of the island surface area. Several individual small trees of a species of *Alangium* (Cornaceae, previously Alangiaceae) were noted as prominent elements, as well as the heavily armed *Zanthoxylum nitidum* DC. (Rutaceae). Cultivated fruit trees such as jackfruit (*Artocarpus heterophyllus* Lam.), longan (*Dimocarpus longan* Lour.), banana (*Musa acuminata* Colla) and guava (*Psidium guajava* L.) are growing at the water's edge, alongside several common agricultural weeds (e.g. *Bidens pilosa* L., *Ageratum conyzoides* L. and *Lantana camara* L.) and fast-growing taxa that are pioneers in forest gaps and edges (e.g. *Mallotus* spp., *Gmelina* sp. and *Mimosa invisa* Mart. ex Colla). Table 1 lists the taxa identified in the field. These identifications were made primarily from

the water's edge, with only limited progress over the sharp limestone terrain and tangled vegetation of the interior.

Taxon	Family <i>sensu</i> APG IV (2016)
<i>Annona muricata</i> L.	Annonaceae
<i>Desmos chinensis</i> Lour.	Annonaceae
<i>Desmos cochinchinensis</i> Lour.	Annonaceae
<i>Alocasia macrorrhizos</i> (L.) G.Don	Araceae
<i>Alocasia</i> sp.	Araceae
<i>Caryota monostachya</i> Becc.	Arecaceae (Palmae)
<i>Dracaena cochinchinensis</i> (Lour.) S.C.Chen	Asparagaceae (Dracaenaceae)
<i>Ageratum conyzoides</i> L.	Asteraceae (Compositae)
<i>Bidens pilosa</i> L.	Asteraceae (Compositae)
<i>Impatiens</i> sp.	Balsaminaceae
<i>Begonia</i> sp.	Begoniaceae
<i>Argyreia acuta</i> Lour.	Convolvulaceae
<i>Alangium</i> sp.	Cornaceae (Alangiaceae)
<i>Bryophyllum pinnatum</i> Asch. & Schweinf.	Crassulaceae
<i>Luffa cylindrica</i> M.Roem.	Cucurbitaceae
<i>Momordica cochinchinensis</i> Spreng.	Cucurbitaceae
<i>Dillenia</i> sp.	Dilleniaceae
<i>Euphorbia hirta</i> L.	Euphorbiaceae
<i>Euphorbia</i> sp.	Euphorbiaceae
<i>Mallotus</i> sp. 1	Euphorbiaceae
<i>Mallotus</i> sp. 2	Euphorbiaceae
<i>Chirita hamosa</i> R.Br.	Gesneriaceae
<i>Callicarpa</i> sp.	Lamiaceae (Verbenaceae)
<i>Gmelina</i> sp.	Lamiaceae (Verbenaceae)
<i>Mimosa invisita</i> Mart. ex Colla	Leguminosae
<i>Papilionoidea</i> sp.	Leguminosae
<i>Lygodium</i> sp. 1	Lygodiaceae
<i>Lygodium</i> sp. 2	Lygodiaceae
<i>Hibiscus</i> sp.	Malvaceae
<i>Grewia</i> sp.	Malvaceae (Tiliaceae)
<i>Melia azedarach</i> L.	Meliaceae
<i>Artocarpus heterophyllus</i> Lam.	Moraceae
<i>Ficus</i> sp. 1	Moraceae
<i>Ficus</i> sp. 2	Moraceae
<i>Ficus</i> sp. 3	Moraceae
<i>Ficus</i> sp. 4	Moraceae
<i>Streblus asper</i> Lour.	Moraceae
<i>Musa acuminata</i> Colla	Musaceae
<i>Psidium guajava</i> L.	Myrtaceae

<i>Oxalis corymbosa</i> DC.	Oxalidaceae
<i>Phyllanthus reticulatus</i> Poir.	Phyllanthaceae
<i>Piper lolot</i> C.DC.	(Euphorbiaceae)
<i>Bambusa</i> sp.	Piperaceae
<i>Rubus molluccanus</i> L. var. <i>alcaeifolius</i> (Poir.) Kuntze	Poaceae (Graminae)
<i>Mussaenda</i> sp.	Rosaceae
<i>Neolamarckia cadamba</i> (Roxb.) Bosser	Rubiaceae
<i>Paederia foetida</i> L.	Rubiaceae
<i>Clausena lansium</i> Skeels	Rutaceae
<i>Zanthoxylum nitidum</i> DC.	Rutaceae
<i>Dimocarpus longan</i> Lour.	Sapindaceae
<i>Pouteria lucuma</i> Kuntze	Sapotaceae
<i>Solanum</i> sp.	Solanaceae
<i>Symplocos cochinchinensis</i> S.Moore	Symplocaceae
<i>Laportea interrupta</i> (L.) Chew	Urticaceae
<i>Lantana camara</i> L.	Verbenaceae
<i>Cissus modeccoides</i> Planch.	Vitaceae

Table 1: Botanical taxon list of preliminary field determinations by Drs Nguyen Thi Mai Huong and Shawn O'Donnell on 18th & 19th September 2017.

Taxon spellings and author abbreviations follow the International Plant Names Index (IPNI) (www.ipni.org); family-level classification follows the most recent revision of the Angiosperm Phylogeny Group (APG IV, 2016; www.mobot.org/MOBOT/research/APweb/), with previous family-level placements and alternative family names from literature following in brackets.

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Tropical limestone forest resilience and late Pleistocene foraging during MIS-2 in the Trảng An massif, Vietnam



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ABSTRACT

In this paper we present a multi-proxy study of tropical limestone forest and its utilization by human groups during the significant climatic and environmental upheavals of MIS-2 (29–11.7 kBP). Our data are drawn from new field research within the Trảng An World Heritage property on the edge of the Red River Delta, northern Vietnam. Key findings from this study include ¹⁾ that limestone forest formations were resilient to the large-scale landscape transformation of the Sunda continent at the end of the last glaciation; ²⁾ that prehistoric human groups were probably present in this habitat through-out MIS-2; and ³⁾ that the forested, insular, karst of Trảng An provided foragers with a stable resource-base in a wider changing landscape during the late Pleistocene and into the Holocene. These results have implications for our understanding of the prehistoric utilization of karst environments, and resonance for their conservation in the face of climate and environmental change today.

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1. Introduction

Profound climate and landscape changes were witnessed at a global scale during Marine Isotope Stage 2 (MIS-2) 29–11.7 cal kBP. As conditions deteriorated into the Last Glacial Maximum (LGM) 26–19 cal kBP (Clark et al., 2009), heightened aridity was experienced in many parts of the dry tropics (e.g. Weyhenmeyer et al., 2000; Barton et al., 2005; Cook, 2009). Both at these and at

higher latitudes (that were more directly under the influence of LGM ice-sheet expansion) biotic and human communities tended to contract into refugial enclaves (see e.g. Pala et al., 2012; Rose et al., 2013; Williams et al., 2013; Husemann et al., 2014).

While the effects of the LGM were comparatively less pronounced in the humid tropics of Southeast Asia (e.g. Huang et al., 1997; Pelejero et al., 1999; Visser et al., 2003; Shintani et al., 2011), local marine, terrestrial and lacustrine archives indicate that substantive shifts in regional precipitation and vegetation cover did occur (Huang et al., 1997; Sun and Li, 1999; Sun et al., 2000). In the post-LGM late glacial especially, climatic variability

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and environmental changes had far-reaching and transformative effects on Pleistocene landscapes. The increased aridity associated with Heinrich Event 1 (H1) (c. 17.5–14.7 cal kBP) brought tangible climatic impact (Wang et al., 2001; Huang et al., 2011; Marwick and Gagan, 2011; Stanford et al., 2011; Partin et al., 2015). The final resurgence of near-fully glacial conditions during Greenland Stadial 1 (GS-1 or Younger Dryas) 12.7–11.7 cal kBP in the circum-Atlantic does not seem to have impacted on equatorial latitudes in South-east Asia (Partin et al., 2007), though its effect at more northerly tropical latitudes is tenable (Huang et al., 2011).

The process of deglaciation also initiated sustained sea-level rise and flooding of regional coasts. With rates of inundation ranging from c. 0.4 m to as much as 5.0 m per 100 years, the effect on human and biological communities would have been considerable in Southeast Asia (Hanebuth et al., 2000, 2009; Kienast et al., 2003; Schimanski and Statterger, 2005; Verleyehh et al., 2005; Soares et al., 2008; Kopp, 2012; Hunt and Gilbertson, 2014). Ultimately, c. 75 per cent of the region's low-lying Pleistocene landmass, 'Sunda Land' (Molengraaff and Weber, 1921) – incorporating the Greater Sunda Islands (Borneo, Sumatra and Java) together with numerous smaller islands and island chains, which extended Asia into the Southern Hemisphere – was submerged by the mid-Holocene. Across this continent and latter-day archipelago, limestone karst environments have played a prominent role in early human and archaic hominin occupation for at least a hundred millennia (e.g. Brown et al., 2004; Yi et al., 2008; van den Bergh et al., 2009; Mijares et al., 2010; Rabett, 2012; Stimpson, 2012; Barker, 2013).

Investigation of karstic habitats in northern Vietnam has been closely tied to one particular palaeo-cultural entity: the 'Hoabinhian'. Various described as, a Mesolithic culture (e.g. Matthews, 1966), a 'technocomplex' (e.g. Gorman, 1970; Forestier et al., 2015) reflecting a common ecological adaptation, or an 'industry' (see Shoocongdej, 1996), it is now argued that the Hoabinhian represents the most important point of cultural reference for the late glacial occupation of the seasonal tropics (Ji et al. 2016). It is certainly the case that it has featured conspicuously in our understanding of early human adaptation to these environments through almost a century of research (Gorman, 1970, 1971; Reynolds, 1989; Shoocongdej, 1996; Tan, 1997; Rabett, 2012). Despite this attention, the significant technological and subsistence variability that exists within the Hoabinhian continues to be a point of debate and reinterpretation (e.g. Rabett et al., 2011; Marwick, 2013; Forestier et al., 2013, 2015). Although generally considered to have emerged as a distinct technological system during, or soon after, the LGM and lasting into the Holocene, the duration of the Hoabinhian and its geographic extent (e.g. Shoocongdej, 1996; Ji et al. 2016) are also yet to be formally agreed upon. Its heartland, though, continues to be situated today, much as it was following initial discoveries by Patte in 1923 and Colani and Mansuy (1926–31): in the forest-clad karstic hills of northern Vietnam; and its emergence through the process of living in that environment.

Tropical limestone forests differ significantly in structure and species composition from other tropical forest formations (Sterling et al., 2006). The insular and refugial character they exhibit reflects high levels of biodiversity and species endemism (e.g. Adam and Mamat, 2005; Clements et al., 2006, 2008; Sodhi et al., 2007; Furey et al., 2010; Gao et al., 2015). Soils are generally thin, poor in most minerals and nutrients, and derived directly from the underlying limestone. Modern precipitation levels in the northern sub-tropics, close to the Red River delta of Vietnam, are concentrated (c. 80%) during the southwest monsoon between May and October, where receipt of rainfall ranges from 1300 to 1800 mm (Li et al., 2006b). The colder and drier northeast monsoon between November and April brings much lower levels of annual rainfall: 200–250 mm (Thung, 2014). Surface water run-off is often rapid in

karst landscapes. This has the effect of heightening local aridity. Surface water accumulation in poorly drained locales, though, can result in the formation of acidic peat, leading to the creation of varied microhabitats and the ability of limestone areas to host vegetative components adapted to a range of different conditions (Sterling et al., 2006). While precipitation arrives with marked monsoon seasonality and is often poorly retained for plant-life at sub-tropical latitudes generally, compared to their southern low-land rainforest counterparts (Chang et al., 2005), summer insolation levels are routinely more intense than those experienced closer to the Equator (Paillard et al., 1996; Wang and Enfield, 2001). This combination has a profound effect on the production of plant *n*-alkanes and *n*-alkanoic acids that can be tracked and through them past environmental conditions reconstructed (Rommerskirchen et al., 2003).

The particular association of northern Vietnam's palaeo-cultural record with tropical limestone forest emphasises that greater consideration needs to be made of the diversity that exists in tropical forest ecologies and the impact this has had on the history and scope of human adaptation within them (e.g. Roberts and Petraglia, 2015). With less currently known about human adaptive capacities than about the responses to climate change by many natural systems (e.g. IPCC, 2007-II), examining the long-term relationship between humans and tropical forest habitats offers considerable potential to enhance our understanding of the diversity of socio-cultural responses to climate-driven environmental change. In this paper we present a multi-proxy terrestrial record from the cave site of Hang Trống, located in an isolated limestone massif on the western edge of the Red River delta, Ninh Bình, Vietnam. This record spans the last twelve thousand years of MIS-2 and affords a rare opportunity to assess the local impact of late glacial climate and environmental change on northern tropical limestone forest; to consider the significance of this habitat for early human settlement of the area; and to explore the potential value of such Pleistocene records to modern conservation management. The Trảng An massif, where this study is set, is recognized internationally as an exemplar of the combined natural and cultural heritage value preserved within such landscapes.

2. Trảng An Landscape Complex

The Trảng An Landscape Complex World Heritage property is centred on an isolated massif of Upper Palaeozoic massively-bedded limestone karst of shallow marine lagoon and reef origin (Fig. 1). The core property is forested and covers 6226 ha or 62.2 km² (surrounded by a buffer zone of 6026 ha, of mostly rural land with rice paddy fields). Trảng An is administered by the Ninh Bình Province People's Committee and a semi-autonomous management board. The property exemplifies an outstanding humid tropical tower-karst landscape in the final stages of geomorphic evolution, comprising karst cones and towers, enclosed depressions and an intricate system of fresh water-filled foot-caves. Although currently emergent, this landscape has been invaded by the sea several times in the recent geological past and is often compared to the flooded tower karst seascape of Ha Long Bay. Trảng An's inscription also recognizes its prehistoric archaeology, which spans in excess of the last 30,000 years and contains one of the country's oldest archaeological sites: Hang Trống.

3. Hang Trống

The cave site of Hang Trống (20.250444N, 105.890111E) is situated approximately 142.3 m above sea level, and 60 m below the apex of a limestone karst tower in the central part of the Trảng An massif. The cave forms a tunnel that is orientated along a

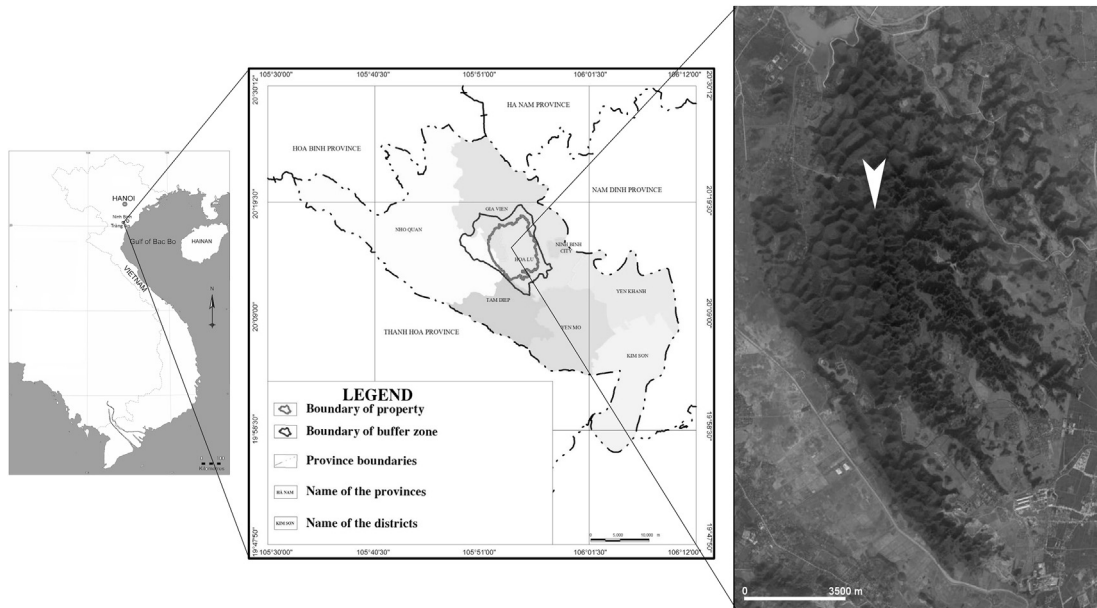


Fig. 1. The location of Trảng An, Ninh Binh province; the World Heritage Site core and buffer zone boundaries of the property; and the location of Hang Trống within the Trảng An limestone massif (right-hand image: Google Earth).

Table 1

¹⁴C dates obtained from excavations at Hang Trống during 2007, 2009 and 2010 field-seasons.

Grid square	Context	Depth (cm) Relative to datum	Material	Radiocarbon years BP	Calibrated years BP	Lab code	Year
607/708	8001	142.25	Charcoal	80 ± 17	32–355	UBA-14883	2009
	Test pit	Surface – 3 cm ^a	Charcoal	10,827 ± 32	12,594–12,854	UBA-09301	2007
610/715	8308	142.00	Charcoal	12,363 ± 51	14,056–14,902	UBA-21288	2010
606/708	8010	141.57	Charcoal	13,227 ± 35	15,522–16,663	UBA-14884	2009
607/708	8013(=8020)	141.22	Charcoal	14,878 ± 45	17,845–18,520	UBA-14885	2009
606/708	8016	140.89	Charcoal	15,300 ± 38	18,229–18,708	UBA-14886	2009
606 + 607/709	8111	139.71	Charcoal	20,537 ± 61	24,244–24,887	UBA-17272	2010

^a Sample collected from a shovel test pit, depth measurement is approximate and not relative to site datum. All dates were calibrated using the CALIB 6.1.0 calibration curve (2-sigma).

north-south axis through the apex, with a total exposed floor area of c.170 m² (Fig. 2). Hang Trống's elevated position, coupled with a marked difference in the size of its two apertures, promotes air flow, accelerating it substantially when winds are northerly. Aeolian processes have been a significant force in site formation: affecting not only rates of deposition but also rates of the erosion and transportation of sediments from the cave (probably exiting via the southern aperture). The noticeable loss of c. 1 m of sediment (indicated by surviving material adhering to the walls), was probably lost through a mix of hydrological and aeolian erosion.

3.1. Chronology

Radiocarbon dates have been obtained using the accelerator mass spectrometer (AMS) at the 14CHRONO Centre, Queen's University Belfast (Table 1 – ¹⁴C ages were calibrated by Calib 6.0 on the 2nd January 2013, using the INTCAL09 calibration curve, Reimer et al., 2009). All ages are quoted in calibrated age before present (BP), with BP being AD 1st January 1950; the abbreviation 'kBP' is used to describe calibrated thousands of years. Aside from one surface-modern age from mixed deposits, all ¹⁴C dates are in sequence (see Fig. 3) and demonstrate the potential for accurately determining a time-depth profile at the site, pushing evidence of human occupation here deep into the LGM. The aeolian processes at work within Hang Trống have probably aided the chronological resolution of the stratigraphy, bringing sediments in to Hang Trống

regularly and preventing post-depositional mixing of the shell midden. The onset of the LGM coincides with the base of excavation (2010) in Trench 1.

4. Methods and results

Hang Trống was surveyed using a Geo Fennell 20x automatic level and mapped at high resolution using a Leica HDS3000 LiDAR scanner. Systematic excavation began in the middle of the cave with Trench 1 in 2009 and then, in the second season (2010), concurrently in two additional trenches, Trenches 2 and 3, close to the western and eastern walls, respectively (Fig. 3) (see Rabett, 2013). All three trenches contained cultural evidence, including hearths. In addition to macroscopic data from these material remains, geochemical analysis was undertaken on the sediments (and shell), providing a multi-proxy approach to interpreting the location, its occupation and local environment.

4.1. Macro-botanical remains

Samples of macro-botanical remains were collected from dry sieving (2 mm mesh) on site and also in bulk sediment samples that had been processed using bucket flotation (1 mm). Data on carbonized plant remains, in particular, provides a useful line of evidence on vegetation composition, fuel collection and plant processing strategies (Ceron, n.d.). In each case samples were

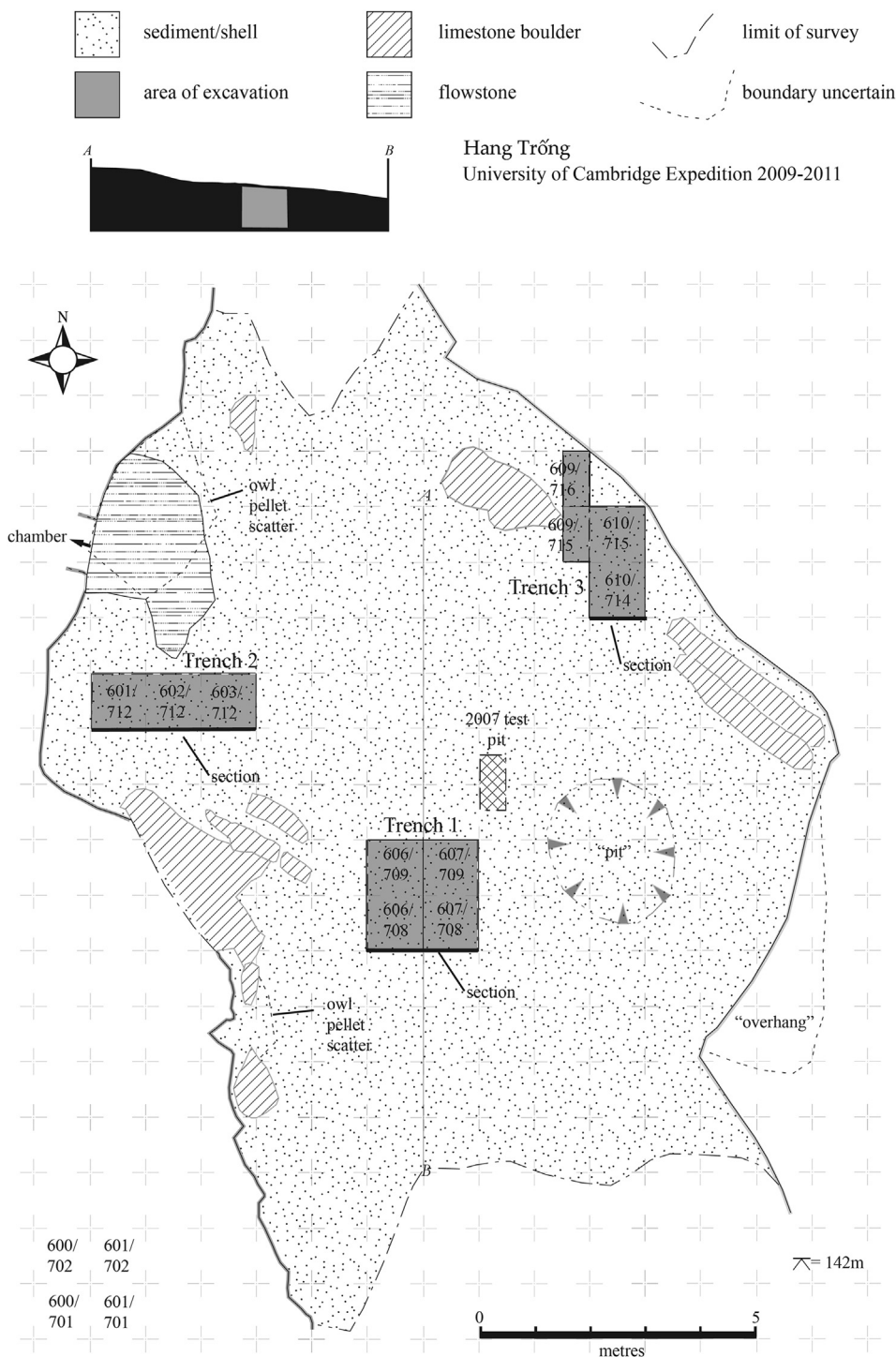


Fig. 2. Plan of Hang Trống showing pertinent site features, including geoarchaeological sampling points, the locations of the 2007 test pit and of TR1-3. Survey: J. Hawkes, C. Stimpson & M. Verhoeven. Drawing: C. Stimpson.

counted, weighed, measured and assessed for state of preservation. A total of 459 fragments were identified to family or higher taxonomic level (Table 2). Specimens were mounted and photographed with a NIKON Eclipse Ci with 4x.15 to 100x/1.25 magnification. The taxonomic identifications were based on comparisons with identified specimens, from the nearby Vietnamese Palaeolithic site of Con Moong (Nguyen Viet *pers. comm.* to Ceron 2011), from Ille Cave, Palawan (Carlos, 2010; Ceron *pers. observ.*), on published material (Paz, 2001), and with

the assistance of the Forest Product Research and Development Institute (FPRDI), Los Baños, Laguna. Following established criteria relating to characteristics such as pore topography, tracheids and fibre (e.g. Thompson, 1996; Ella et al., 2009) a pilot SEM study of four pieces of charred parenchymous material was also undertaken. The chosen material had been recovered through flotation from contexts: (8002), (8101), (8103) from Trench 1 at Hang Trống and from (8215) from Trench 2.

Table 2Identified macro-botanical remains ($n = 459$) from dry-sieving and flotation of sediments collected during the 2009 and 2010 excavations at Hang Trống.

Trench	Context	Phase	Sample	<i>Canarium</i> sp.	<i>Celtis</i> sp.	Dipterocarpaceae	Leguminosae	Pinaceae	Rhizophoraceae	Sapotaceae			
1	8002	Mixed	3004	2									
	8003	I	3016			2						Total	2
	8004		3006	1									
	8006		3008			2							
	8007		3034			15							
	8007		—		2								
	8009		3027			10							
	8010		3031						1				
												Total	33
	8012(=8020)	II	3052		5								
	8013(=8020)		—		5								
	8014		—		3								
	8015		3088		3								
	8016		—			18							
	8017		—		11								
	8100(=8018)		—			•		•		•		32	
												Total	77
	8101	III	3202		1								
	8103		—			16							
	8104		3211										
	8104		—		1								
	8105		3213							3			
	8107		3218										
	8109		3223										
	8110		3229			2							
												Total	23
2	Mixed	8203	3415			16							
		8203	3405		1								
												Total	17
	I?	8204	—		1								
		8206	—		1								
		8207	3410						4				
		8207	—		1								
		8215	3443		2								
												Total	9
3	Mixed	8302	3600	1									
	I	8307	3610	1									
		8308	3619			•	•			•		100	
		8308	—	3									
												Total	104
	II	8309	—		2								
		8310	3616			75							
		8312	3626			13							
		8312	—		11								
		8313	—		1								
		8315	3629							19			
		8315	3628		1								
		8316	—		3								
		8317	3632			33							
		8317	—		2								
		8317	3638		5								
		8317	3638	1									
		8318	—		2								
		8318	3640		7								
		8318	3640	2									
		8321	—		6								
		8322	—		10								
												Total	193
												Grand total	459

•' the quantities of individually identified taxa was not recorded for these contexts.

4.2. Palynology

Sediment samples were collected from the north-facing section of Trench 1 for palynological analysis. The surface of the section was cut back to remove loose material and ensure there was no modern contamination. Palynological analysis has been widely used as a method to determine past vegetation history (e.g. Birks, 1981; Birks

and Birks, 1980). In upland cave sites the sediments are dry and highly oxidic; unlike in water-lain environments where available oxygen (and hence degradation) is limited. As a result pollen grains oxidize rapidly and/or become 'crumpled'. This level of degradation of pollen grains can pose problems to the reliability when standard palynological techniques (those applied here) are employed. Due to the high concentration of molluscs at the site (chiefly cyclophorids),

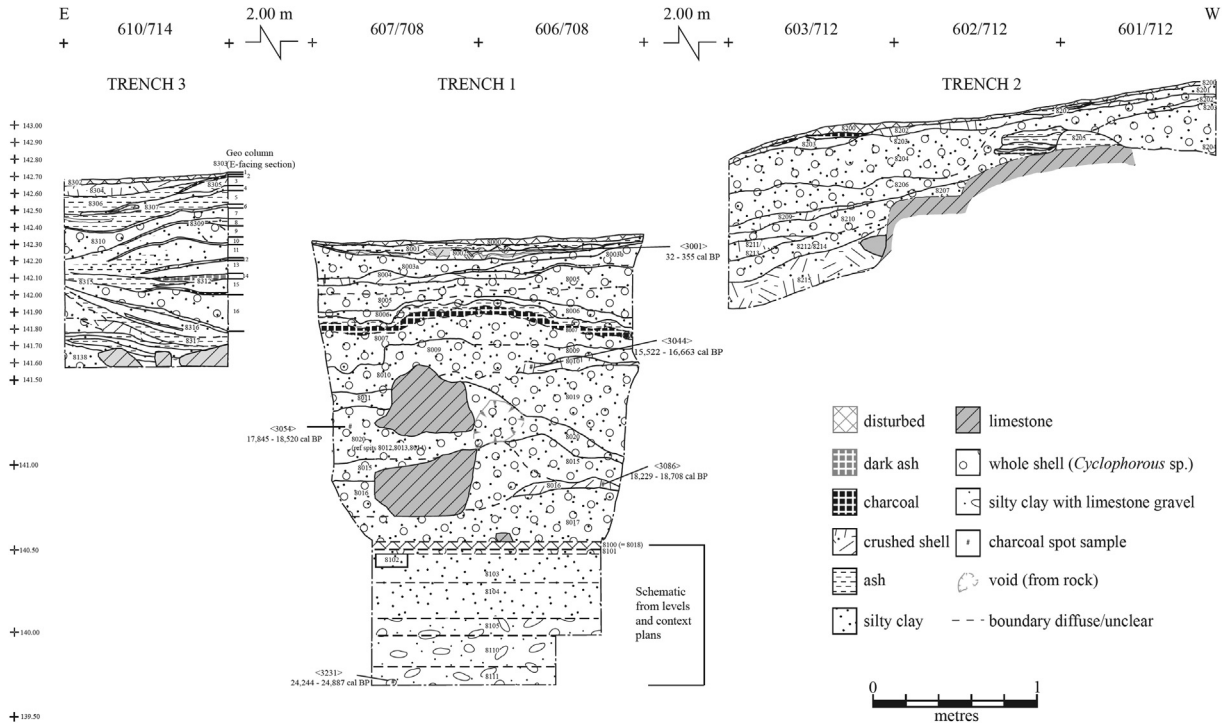


Fig. 3. Composite of the north-facing sections from Trenches 1–3 across Hang Trống. East-West distance between trenches has been fore-shortened for the purpose of this illustration. Original drawings: Borbala Nyiri, Lucy Farr, Mike Morley, Jason Hawkes, Marc Verhoeven, David Simpson and Jo Appleby; composition: C. Stimpson.

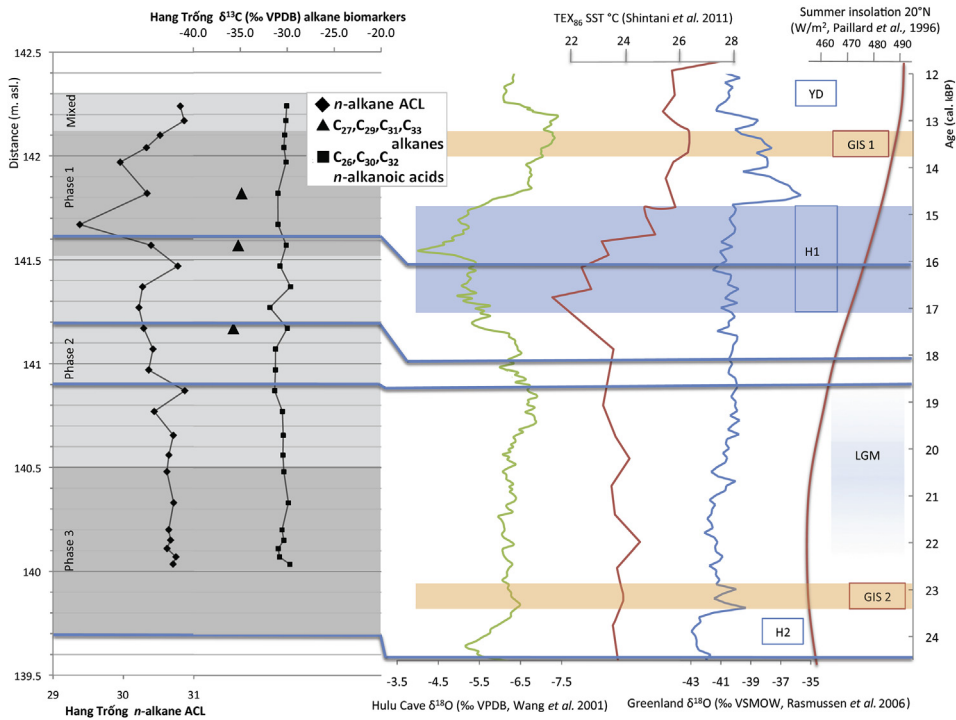


Fig. 4. n -Alkane data from Hang Trống compared to published palaeoarchive data during the LGM: thick horizontal blue lines indicate ^{14}C dates from Hang Trống at respective depths and ages along the cal. kBP scale. Hang Trống $\delta^{13}\text{C}$ biomarkers display the consistent trend of C_3 vegetation surrounding the site. Oxygen isotopes from Hulu cave have been shown to provide evidence of monsoonal changes, which coincide with sea surface temperature changes (SST) in the China Sea. Oxygen isotope records (Rasmussen et al., 2006) indicate global temperature changes, specifically Greenland Interstadial 1 (GIS 1) and GIS 2. Both oxygen isotope and SST records indicate little change during the LGM, during which time summer insolation values were low (c. 460 W/m^2). n -Alkane average chain length values (ACL) from Hang Trống also display a consistent trend across the LGM. H1 (c. 15 kBP), however, sees a dramatic change: a drop in oxygen isotope values from Hulu Cave, SST from the South China Sea and ACL from Hang Trống. Drawing: N. Ludgate. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

all samples were sieved to remove shell fragments prior to standard pollen analysis (after Fægri and Iversen, 1989). Pollen was successfully found in all six of the samples investigated, though in varying concentrations as shown in Table 3. Owing to the importance of aeolian processes in site formation here, the pollen record is likely to be drawn from a wide catchment, potentially extending beyond Trảng An onto the plains that surround the massif.

plants are hydrocarbons that are mainly synthesized in the leaf wax for protection against incoming solar radiation (insolation), desiccation and pathogens (see e.g. Hadley, 1980; Koch and Ensikat, 2008; Kosma et al., 2009). The longer the *n*-alkane chain length the more energy and resources are required for its creation, but the greater the protection provided (Rommerskirchen et al., 2003). Within equatorial regions where insolation is high plants produce

Table 3
Pollen counts from the pilot study at Hang Trống.

Context:	Phase	Approx. age (¹⁴ C cal. kBP)	Depth (m)	Identified grains	Unidentified grains	Degraded grains	Pollen grains counted (including unidentifiable grains):	Percentage of identified grains	Lycopodium spore counts (added for reference)
8000–8002	Mixed	0	142.25	196	77	133	329 grains	60%	231
8009	I	15.1	141.8	10	25	145	180 grains	5.6%	2003
8010	II	15.6	141.6	2	4	24	30 grains	6.7%	1000
8016		18.5	140.9	4	10	55	69 grains	5.8%	2008
8019		17.1	141.4	22	9	505	536 grains	4.1%	513
8019		17.6	141.3	5	5	175	185 grains	2.7%	1001
Totals:				239	130	1037	1329 grains		

Despite the degraded state of pollen at the site, unique identifying features could still be recognized (Table 4). The top context sample (8000–8002) displays a considerably higher concentration of identifiable pollen than other contexts (a value of 60% recoverable identification). It is deduced that this better preservation is largely due to modern wind-blown pollen becoming trapped within the sediments as erosion and localised micro-re-deposition of these takes place. Consequently, these data could provide an example of the modern vegetation surrounding the site, though admixture with Pleistocene sediments has probably distorted this picture. The underlying and, by comparison, undisturbed Pleistocene deposits exhibited a much reduced level of preservation, with only 2–6% of recovered pollen being identifiable using standard preparation techniques. Nonetheless, a range of plant types was identified and provided a workable dataset.

4.3. Plant biogeochemical markers

Cave locations can provide chemically stable environments suitable for the preservation of biogeochemical compounds from higher plants (Blyth et al., 2007; Huang et al., 2008). Plant biomarkers are released into the environment by plant metabolic processes and decomposition; they can be isolated from other organic molecules and used as environmental markers (see Eglinton and Hamilton, 1967; Van Bergen et al., 1997). *n*-Alkanes in

the long *n*-alkane chains provided there is also sufficient moisture. During periods of climate change that place stress on plants, they either produce shorter *n*-alkane chain lengths or are unable to survive. *n*-Alkanes preserve well in Quaternary deposits, and as the environment and climate are important controls on chain length distribution, they can furnish an independent and complementary record into past conditions (Meyers and Ishiwatari, 1993; Schwark et al., 2002; Blyth et al., 2007; Ludgate, 2013).

Bulk and compound-specific $\delta^{13}\text{C}$ analyses of sedimentary organic carbon preserved *n*-alkanes and *n*-alkanoic acids and provide information about the photosynthetic pathway of the plants they derive from and, therefore, the environment in which the plant grew. Ranges in carbon isotope values represent plants using different photosynthetic pathways. The $\delta^{13}\text{C}$ value can range from c. -35 to c. -15‰ per ml (relative to the Vienna Pee Dee Belemnite international standard) depending on a number of variables, including (but not limited to) plant genus, moisture stress or plant longevity (Quade et al., 1989; Lockheart et al., 1997). Plants using the C_3 photosynthetic pathway require sufficient amounts of water during their growing season to photosynthesise and give $\delta^{13}\text{C}$ values typically within the range -25‰ to -35‰ (O'Leary, 1981; Osborne and Slack, 2012). Plants that follow the C_4 photosynthetic pathway (including, in particular, most grass families) are able to survive in more arid conditions. C_4 plants have an average $\delta^{13}\text{C}$ value of -13‰ and range between -12‰ and -16‰ (O'Leary, 1981; Osborne and Slack, 2012).

Table 4
Pollen identification (Trench 1) from families identified using reference collections from Zhuo Zheng (*pers. comm.*), ¹Tseng-Chieng (1972), ²Li et al. (2006a) and ³Academia Sinica (Beijing), Institute of Botany (1982).

Context	Phase	Approx. age (¹⁴ C cal. kBP)	Dist. (m) above sea level	Apiaceae (Umbelliferae)	Aquifoliaceae (ca. Ilex)	Areaceae	Betulaceae 3 pore (Carpinus ca.)	Betulaceae 3 pore (Corylus ca.)	Betulaceae 5 pore (ca. Alnus)	Brassicaceae	Cyperaceae	Combretaceae/ Melastomataceae	Ericaceae	Euphorbiaceae (ca. Excoecaria)
8000–8002	Mixed	0	142.25	3	2	1		1			2	5	1	1
8009	I	15.1	141.8					1		1	2			
8010	II	15.6	141.6											1
8016		18.5	140.9											
8019		17.1	141.4				4		5	8				
8019		17.6	141.3							2				
	Identification reference:			1	1,2,3		1		1,2	1	1			3

(continued on next page)

Hang Trống: Trench 1 North-facing section

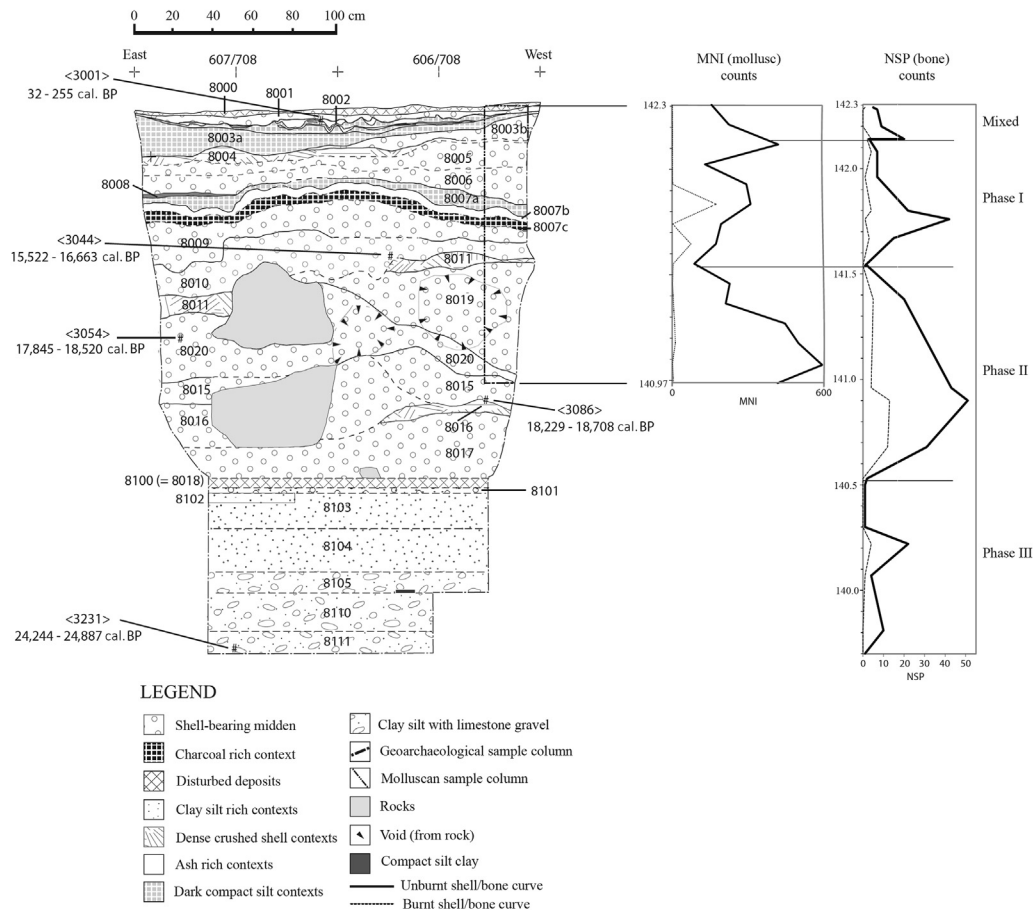


Fig. 5. North-facing section of Trench 1 at Hang Trống, showing molluscan sample columns, molluscan (MNI) and vertebrate faunal (NSP) count curves (latter combining data from all three excavated trenches). Drawing: C. Stimpson and R. Rabett.

Rabett et al. (2011) demonstrated that plant biomarkers, preserved for over 10 kBP in sediments at another cave site in Tràng An, Hang Boi (c. 1 km from Hang Trống), display similarity to the biomarkers of plants within the surrounding vegetation today. For the biogeochemical analysis at Hang Trống samples were collected from the North face of Trench 1. The section surface was cleaned to remove cross-context contamination and some whole shells were removed to increase the mass of sediment. In the laboratory the bulk lipid fraction was soxhlet-extracted from the sediment using dichloromethane (95%) and methanol (5%) to maximise recovery (Banjoo and Nelson, 2005; Wang et al., 2010). The recovered organic matrix was then analysed using Agilent 6890 Series gas chromatogram coupled to an Agilent 5973 mass spectrometer

(GC–MS). Chemstation software was utilised to identify and quantify the *n*-alkanes. $\delta^{13}\text{C}$ values of *n*-Alkanoic acids was determined using Delta V Advantage ThermoFisher isotope-ratio mass spectrometer interfaced with GC-Isolink Trace GC Combustion conversion system. *n*-Alkanes were removed using off-line chromatography and analysed for compound specific $\delta^{13}\text{C}$ using Agilent gas chromatogram coupled to a Thermo MAT 253 isotope ratio mass spectrometer (GC–IR–MS). Sediment total organic carbon content and total organic carbon $\delta^{13}\text{C}$ values were determined using a Thermo Flash High Temperature Elemental Analyzer (Flash EA) coupled to a Thermo MAT 253 isotope ratio mass spectrometer (IR–MS). All $\delta^{13}\text{C}$ values were normalized to the Vienna Pee Dee Belemnite standard.

Table 4 (continued)

Fagaceae (Castanopsis)	Hamamelidaceae	Leguminosae (Fab/Mim)	Mimosaceae	Mimosaceae/ Acacia	Moraceae/ Urticaceae	Meliaceae/ Aglaia type or Chrysophyllum type	Pinus/ Podocarpaceae	Poaceae (Gramineae)	Rosaceae	Rubiaceae	Sapotaceae	Ulmaceae	Polyad
15		2	1	1	1	1	38	2	2	10	5	10	15
	1	1			2					2			3
					1		2			2		2	
		1					1			1		1	
		1			1,2		1,2	1		1			

n-Alkanes recovered from sediments have a greater proportion of odd-*n*-alkane carbon chain lengths rather than even; indicating that the sediments at Hang Trống contain a robust plant-derived lipid signal, similar to that observed at Hang Bôi. The most abundant *n*-alkanes (over 10% of the total measured) include C₂₉, C₃₁ and C₃₃; these are all known to be of higher plant origin and therefore of importance here. *n*-Alkane C₃₁ is the most dominant through the sediment column, with an average value of *c.* 40 per cent. This demonstrates that plants growing locally have tended to be subjected to some degree of environmental stress (high levels of insolation) but, generally, the nutrients and water required for the growth of protective lipids occur in abundance.

The δ¹³C value of *n*-alkanes and *n*-alkanoic acids recovered from cave sediments clearly indicate a C₃ photosynthetic pathway and therefore plants that require comparatively moisture-rich conditions in which to thrive. The slightly higher δ¹³C value for bulk organic carbon within the sediments highlights that preserved organic material is likely to be derived from multiple sources, including microbial and anthropogenic (Kohn and Cerling, 2002; Tu, 2011). Food sources introduced by early human groups into the cave from farther afield could, for example, have contributed a biasing factor in the recovery plant biomarkers – a vector for which we are seeking further clarification. Our current hypothesis, based on the available evidence, suggests that limestone forest similar to

that seen around Hang Trống today has existed in the vicinity of the cave through-out MIS-2.

4.4. Zooarchaeological evidence

4.4.1. Macro-vertebrate fauna

Bones from larger vertebrates were a relatively infrequent component of the excavated material in all three trenches (Table 5). Analysis of these assemblages showed them to be predominantly mammalian, highly fragmented, desiccated and in many cases coated with sediment adhered by calcium carbonate deposition. All recovered fragments >5 mm in length were counted and wherever possible refitted. A total of 1031 fragments (hereafter, Number of Specimens: 'NSP') were recorded, of which a total of 85 (8.2%) was found to be diagnostic (to element and taxa, hereafter, Number of Identified Specimens: 'NISP'). The majority was only identifiable to family, but in exceptional cases higher order identification were possible. Comparative materials included those held within the Grahame Clark laboratory, Cambridge, supplemented by collections of digital images and relevant textual sources (notably, Lekagul and McNeely, 1988). Despite the relatively low occurrence of bones, inspection of the data indicated that burnt fragments were present throughout the excavated sequence (Fig. 5 & Table 5). Both the high degree of fragmentation and the evidence of burning give us confidence in the anthropogenic origin of this material.

Table 5
Vertebrate fauna remains from Hang Trong (2009 & 2010) analysed from trenches 1–3 and from all four identified phases.

Phase	Trench	Context	Malacostraca (crab)	Osteichthyes (fish)	Amphibia (amphibians)	Reptilia (reptiles)	Aves (birds)	Mammalia		Total NISP	NSP (large animal)	Total NSP	Burnt NSP (large animal)
								(Small)	(Large)				
Mixed	1	8000	0	0	11	1	4	26	0	42	5	47	1
	1	8001	0	0	0	0	0	0	1	1	6	7	0
	1	8002	0	0	1	0	0	0	1	2	8	10	0
	2	8200	0	0	47	0	3	34	0	84	4	88	0
	2	8200–8201	0	0	1	0	1	22	2	26	4	30	1
	2	8201	0	0	1	0	5	9	1	16	11	27	0
	2	8202	0	0	0	1	1	6	0	8	1	9	0
	2	8203	2	2	1	0	0	1	1	7	35	42	1
	3	8302	0	0	0	0	0	3	0	3	1	4	0
			Totals	2	2	62	2	14	101	6	189	75	264
Phase I	1	8003	2	0	0	0	0	0	5	7	15	24	4
	1	8004	0	0	0	0	0	0	0	0	3	3	2
	1	8005	1	0	0	0	0	0	1	2	6	14	4
	1	8006	1	0	0	0	0	0	1	2	6	8	1
	1	8007	0	0	0	0	0	2	2	4	20	24	4
	1	8009	0	0	0	0	0	3	18	21	24	47	1
	2	8204	1	0	0	0	0	0	0	1	2	3	0
	2	8205	0	0	0	0	0	0	0	0	3	5	2
	2	8206	0	0	2	0	0	1	1	4	8	12	0
	2	8207	0	0	0	0	0	1	1	2	6	8	0
	2	8209	1	0	0	0	0	0	0	1	10	11	0
	2	8210	0	0	0	0	0	1	0	1	7	9	0
	2	8210/8211	0	0	0	0	0	0	1	1	2	3	0
	2	8211	0	0	0	0	0	0	1	1	7	8	0
	2	8212	0	0	0	0	0	0	2	2	5	7	0
	2	8215	0	0	2	0	0	1	1	4	3	7	0
	3	8303	6	0	0	0	0	0	1	7	11	18	1
	3	8304	11	0	0	0	0	1	0	12	11	23	3
	3	8305	0	0	0	0	0	0	1	1	8	9	2
	3	8306	2	2	0	0	0	0	0	4	8	12	0
3	8307	4	1	0	0	0	0	2	7	28	35	12	
3	8308	6	3	0	0	0	3	6	18	87	96	11	
		Totals	35	6	4	0	0	13	44	102	280	386	47
Phase II	1	8010	0	0	0	1	0	0	1	2	14	18	3
	1	8011	0	0	0	0	0	0	0	0	1	2	0
	1	8019	0	0	0	0	0	0	0	0	2	2	0
	1	8020	1	0	0	0	2	0	4	7	16	23	5
	1	8015	0	0	0	0	0	1	6	7	37	44	4
	1	8016	0	0	0	0	0	1	6	7	45	52	13

Table 5 (continued)

Phase	Trench	Context	Malacostraca (crab)	Osteichthyes (fish)	Amphibia (amphibians)	Reptilia (reptiles)	Aves (birds)	Mammalia		Total NISP	NSP (large animal)	Total NSP	Burnt NSP (large animal)
								(Small)	(Large)				
	1	8017	0	1	0	0	1	0	2	4	29	35	12
	3	8309	0	0	0	0	0	0	1	1	10	11	0
	3	8310	3	0	0	0	0	1	1	5	13	18	7
	3	8311	0	0	0	0	0	0	0	0	3	3	0
	3	8312	1	0	0	0	0	1	2	4	4	8	2
	3	8313	0	0	0	0	0	0	0	0	2	2	0
	3	8315	0	0	0	0	0	1	1	2	7	9	0
	3	8316	1	0	0	0	0	0	2	3	6	9	2
	3	8317	0	0	0	0	0	2	1	3	16	19	6
	3	8318	0	0	0	0	0	0	1	1	1	1	0
	3	8319	2	0	1	0	0	0	0	3	2	5	2
	3	8321	0	0	0	0	0	0	6	6	52	58	18
	3	8322	0	0	0	0	0	0	2	2	22	24	2
	3	8323	0	0	0	0	0	0	0	0	2	2	1
		Totals	8	1	1	1	3	7	36	57	284	345	77
Phase III	1	8018/8100	0	0	0	0	0	0	1	1	1	2	0
	1	8101	0	0	0	0	0	0	0	0	1	1	0
	1	8102	0	0	0	0	0	0	0	0	0	0	0
	1	8103	0	0	0	0	1	1	0	2	1	3	0
	1	8104 (=8109)	0	0	0	0	0	0	1	1	14	15	4
	1	8105	0	0	0	0	0	0	0	0	4	4	1
	1	8110	0	0	0	0	0	0	1	1	9	10	0
	1	8111	0	0	0	0	0	0	1	1	1	1	0
		Totals	0	0	0	0	1	1	4	6	31	36	5

4.4.2. Micro-vertebrate fauna

On-site observations and the characteristics of ground surface concentrations of micro-vertebrate bone near the western wall of the cave strongly suggested that these assemblages accumulated via pellet deposition beneath a contemporary owl roosting site. This record provides a valuable taphonomic control for the range and density of micro-faunal remains recovered during on-site excavations, and how they are to be interpreted.

A total of 2517 bones were identified to element and order from a collected sample of the surface assemblages. Frog bones (Order: Anura) dominated ($n = 2230/2517$, or 89%), with all identifiable ilia attributed to the genus *Rana*. All parts of the skeleton were represented and the bones exhibited minimal breakage and weathering, with no signs of burning or any marked damage from digestive acids (after Andrews, 1990; Stahl, 1996). The remainder of the sample comprised a minor component of small mammal bones, including *Rattus* sp., *Mus* sp., *Suncus* sp., and *Eonycteris* sp. as well as, as yet, unidentified fish remains. The taxonomic composition of the assemblage, with its strong bias towards amphibians, combined with the relative size of the prey items, inferred from skeletal elements, suggests that the bones were accumulated by a species of fish owl (*Bubo* sp. syn. *Ketupa* sp.) (Zukswert, 2014).

Prehistoric pellet deposition from generations of owls using this particular roost could also have been a pathway for the introduction of bones into the archaeological deposits of the site. However, inspection of the distribution of the small vertebrate component of assemblages recovered in the three excavated trenches from Hang Trống indicated that the majority was concentrated in the uppermost excavated contexts (Table 5). We conclude that the small mammal component of the upper archaeological contexts is most likely the result of mixing between modern and Late Pleistocene material and, therefore, we used their presence as a taphonomic marker and proxy for disturbance. Notably, such evidence was mostly confined to the upper few centimetres of deposit indicative both, that contexts below these carried no more than minor mixing through this particular non-anthropogenic vector, and that the roosting site itself may be of comparatively recent age – though still conceivably hundreds if not thousands of years in duration.

4.4.3. Molluscs

A stand-out feature of many mainland Southeast Asian archaeological assemblages dating from the Late-to early Post-Pleistocene are riverine or terrestrial shell middens (Rabett et al., 2011). To explore the taxonomic diversity and frequencies of represented molluscs within the Hang Trống midden, with respect to changes in site formation and wider environmental conditions, a column was removed (20×10 cm) from the north-facing section of Trench 1 to a depth of 1.33 m below the current ground surface (Fig. 5).

The majority of the species identified were terrestrial molluscs (Table 6). This included three species from the genus *Cyclophorus*: *Cyclophorus theodori*, *Cyclophorus unicus* and *Cyclophorus* cf. *cambodjiensis* – all of which live on or around trees. In addition to *Cyclophorus*, other terrestrial species were also identified, namely *Cryptozona* cf. *chrysoraphe*, and *Zonitidae* cf. *Oxychilus* sp. A further two examples of gastropods were noted for which only genus level attributions could be made; *Camaena* sp. and *Amphidromus* sp. both favour trees and shrub habitats.

Little data is available in the literature for the habitats of *Cryptozona* cf. *chrysoraphe*, and *Zonitidae* cf. *Oxychilus* sp. other than that the genera concerned have affinities with woodland settings. They continue to be found locally. A small number of aquatic taxa were also identified: *Unio* spp. and *Planorbis* sp. both favour larger bodies of freshwater such as lakes, ponds and rivers; *Cerithium* sp. and *Ellobium aurisjudae* can occupy a broad range of aquatic/semi-aquatic habitats including estuaries, mangroves, shallow water and rivers. Minimum Number of Individuals (MNI) counts were calculated on the basis of the largest number of identifiable parts present per sample (i.e. whole shells, with lip or tip intact; plus the highest number of fragmented lips or tips). Total unburnt and burnt shell MNI counts, plotted by depth, are presented for comparison against vertebrate faunal remains from Trench 1 in Fig. 5.

4.5. Technological evidence

Typological classification of Southeast Asian lithic assemblages has been hampered by the often amorphous character of the material. While types can and have been identified, the utility of this

Table 6
Hang Trống mollusc sample column from Trench 1, north-facing section: taxonomic identification and quantification by depth and sample number.

Context	Phase	Distance above sea-level	Depth below surface	<i>Cyclophonus theodori</i>	<i>Cyclophonus unicus</i>	<i>Cyclophonus cambodjensis</i> spp.	<i>Cyclophorus cf. cambodjensis</i> spp.	<i>Cyclophorus chrysoraphe</i>	<i>Zonitidae</i> cf. <i>Zonitidae</i>	<i>Ellobium</i>	<i>Camaena</i>	<i>Uvula</i>	<i>Cerithium</i>	<i>Amphidromus</i> sp.	<i>Planorbis</i> sp.	Sinistral <i>Gastropod</i> (indet)	<i>Gastropod A.</i> (indet)	<i>Gastropod B.</i> (indet)	Total (unburnt) MNI count	Total (burnt) MNI count
8000 + 8001	Mixed	142.30–142.24	0–6	0	1	0	96	5	2	0	0	0	0	0	1	1	1	0	107	0
8003a	I	142.24–142.21	6–9	15	4	5	137	5	3	0	0	0	0	0	0	0	0	0	107	0
8003b		142.21–142.10	9–20	35	24	7	267	6	5	0	0	0	0	0	0	0	0	0	169	0
8004		142.10–142.08	20–22	7	6	2	69	0	0	0	0	0	0	0	0	0	0	0	344	0
8005		142.08–141.96	22–34	31	8	2	186	2	2	0	0	0	0	0	0	0	0	0	84	0
8006		141.96–141.81	34–49	43	8	4	187	2	2	0	0	0	0	0	0	0	0	0	231	0
8007a		141.81–141.75	49–55	38	24	7	69	1	1	0	0	0	0	0	0	0	0	0	246	155
8007b		141.75–141.68	55–62	5	5	0	110	1	1	0	0	0	0	0	0	0	0	0	141	0
8007c + 8009		141.68–141.63	62–67	8	4	2	32	0	0	0	0	0	0	0	0	0	0	0	123	66
8010	II	141.63–141.56	67–74	33	19	0	120	0	0	0	0	0	0	0	0	0	0	0	1384	224
8011		141.56–141.47	74–83	26	27	4	101	0	0	0	0	0	0	0	0	0	0	0	172	0
8019 (S2)		141.47–141.33	83–97	55	28	7	276	0	0	0	0	0	0	0	0	0	0	0	158	4
8019 (S3)		141.33–141.20	97–110	34	43	13	321	0	0	1	0	0	0	0	0	0	0	0	368	8
8019 (S4)		141.20–141.08	110–122	27	8	10	452	0	0	1	0	0	0	0	0	0	0	0	416	10
8019 (S4)		141.08–140.97	122–133	38	60	15	229	0	0	0	0	0	0	0	0	0	0	0	500	0
Totals				395	269	78	2652	21	16	1	1	4	1	4	1	2	1	1	1956	26
																			3447	250

approach to Hoabinhian or Hoabinhian-like technologies has come into question (e.g. Reynolds, 1990; Marwick, 2008; Forestier et al., 2013). In an attempt to help address this issue, and to foster greater integration between technological actions and resource acquisition, the Hang Trống lithic assemblage was studied using techno-typological (see Reynolds, 1989) and attribute analysis (see Tostevin, 2013) methodologies. Both approaches concentrate on the way that lithics were manufactured and explore variability within assemblages rather than categorising them according to strict types. The former method emphasises distinguishing broad technological classes that group generally similar pieces; the latter emphasises the dynamic nature of the lithic reduction process and how that variability can be understood in relation to human adaptive strategies. The use of two complementary methods, applied by two different researchers, also helped us to control for biases in distinguishing artefacts from non-artefactual pieces. In what is an overwhelmingly coarse-grained assemblage, often without prominent bulbs of percussion or other clear markers of technological practice, we nonetheless accepted that levels of observer variance may exceed 5–10% (after Proffitt and de la Torre, 2014).

An initial techno-typological study of selected pieces from the 2009 excavations at the site (context 8016, Trench 1) has been published elsewhere (see Rabett, 2012, Fig. 6:17). This material has since been returned to Vietnam and is not integrated into the current study as it was not feasible to conduct an attribute-based analysis of it. Briefly, this initial study identified a core rejuvenation flake with at least two or three previous hard-hammer flake

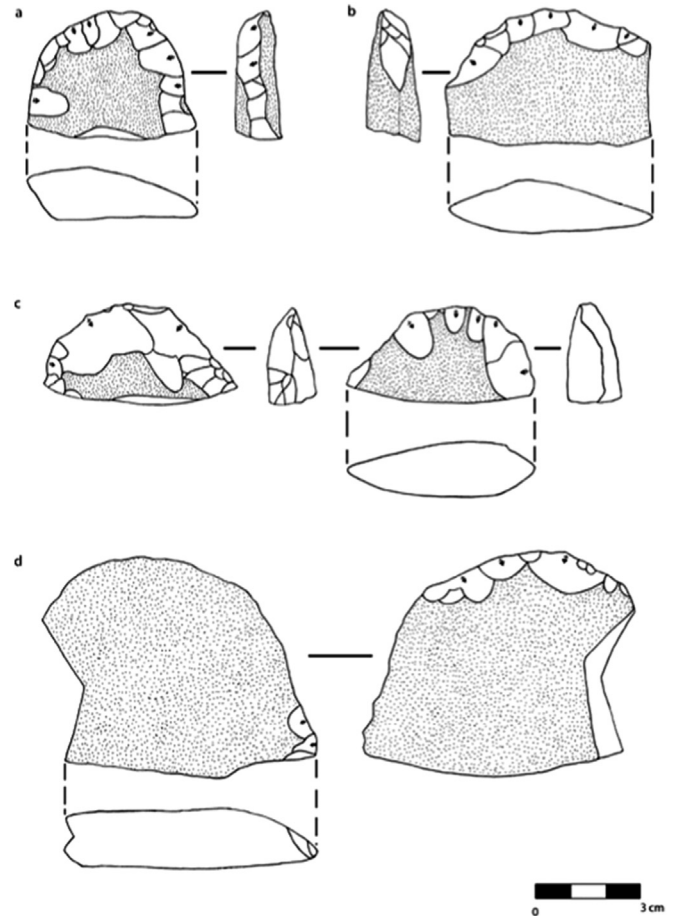


Fig. 6. Examples of flaked pebble tools or ‘short-axes’ from Hang Trống: Artefact nos. 13 (a), 7 (b), 10 (c) and 46 (d) – see Table 7. Drawing: L. Phan.

removals; a blade-flake, possibly struck using a soft-hammer technique; a large, thick secondary flake with a plain platform – this piece had slight rounding along the distal edge and evidence on its dorsal surface that many small flakes had been removed prior to this one – and finally a ‘steep-edged’ core that may also have been used as a pounder. These pieces suggested on-site production, including basic core preparation and possible use of soft-hammer reduction. Both study samples covered herein are drawn from the most extensive period of excavations at the site (in 2010). Material studied consists of, that recovered from LGM deposits in the lower half of Trench 1 (8201–8111) and post-LGM (MIS-2) deposits (and likely post-LGM deposits) from trenches 3 and 2, respectively.

Techno-typological analysis identified $n = 74$ modified pieces (Table 7), with a further 13 of ambiguous classification. The industry to be based on single-platformed hard hammer reduction, with no evidence for core preparation, platform edge maintenance or platform preparation. There are a small number of silet flakes

that may derive from the use of larger or heavier hammers (silet flakes are split longitudinally through the bulb of percussion). Secondary and tertiary flakes dominate the sample, indicative of non-intensive use of materials and possibly the reduction of materials elsewhere (either on site or off site). The formal flake tool-type list is limited to two scrapers and a burin (Table 7, artefacts 11 [from cleaning], 17 & 42, respectively). The pebble-based portion of the inventory includes a hammer/pounder with patches of hammering, pitting and micro-flaking on both ends. Seven pieces were defined as ‘short-axe’ fragments (see Fig. 6), following the northern Vietnamese typological nomenclature for the Hoabinhian. Attribute analysis of the sample (Phan, 2014, Appendix B) identified $n = 76$ modified pieces (with 63 confidently defined as cores, pebble tools, flakes, retouched flakes or flake fragments) (Table 7). The sample may be regarded as the background debris of lithic tool assisted activities. In-situ knapping could not, though, be further demonstrated and refits were not identified.

Table 7

Classification of material excavated in 2010 from Trench 1 (Phase III) and Trenches 2 and 3 (all represented deposition phases) using data generated separately by techno-typological and attribute analysis methods; classic typological referents are also given where relevant.

No.	Trench	Trench/Square	Context	Phase	Techno-typological analysis	Attribute analysis	Typological ID	Raw material	Length	Width	Thickness	Comments
1	1	Surface find	–	III	Secondary pebble fragment	–	Short axe	Shale	4.9	5.7	1.5	Transverse snap forms butt of tool
2		Deep Sounding	8101		Secondary flake with cortical platform	Complete flake	–	Limestone	2.7	2.4	0.8	–
3		Deep Sounding	8101		Secondary flake with plain platform	Flake fragment	–	Limestone	2	1.7	0.5	Stepped
4		Deep Sounding	8101		Burnt pebble fragment	?	–	Limestone	4.7	2.7	1.4	Burnt (natural?)
5		Deep Sounding	8101		Secondary flake with crushed platform	Complete flake	–	Limestone	4.3	8.1	1.7	–
6		Deep Sounding	8101		Flake core with single platform	Core	Core	Limestone	6	6.2	3.2	4 removals
7		Deep Sounding	8103		Secondary pebble fragment	Pebble tool	Short axe	Limestone	3.8	6.1	1.6	Transverse snap forms butt of tool
8		Deep Sounding	8104		Pebble half fragment	Core/Pebble tool	–	Sandstone	3.1	3.7	1.4	Transverse snap
9		Deep Sounding	8104		Pebble fragment burnt	Complete flake	–	Limestone	4.1	2.5	1.4	burnt
10		Deep Sounding	8104		Secondary bifacial pebble tool	Pebble tool	Short axe	Shale	2.7	5.3	1.5	Transverse snap forms butt of tool; bifacial edge trimming
11		607/709	Cleaning		Secondary fragment	–	Scraper	Limestone	6.2	7.3	1.8	Retouched natural fragment; transverse snap
12		606/709	8109		Tertiary silet flake with crushed platform	Complete flake	–	Limestone	3.4	2.5	1.9	Half-moon snaps
13		607/709	8110		Secondary pebble fragment	Pebble tool	Short axe	Shale	3.7	4.9	1.3	Flattened pebble
14		606/709	8110		Plain platform tertiary flake	Complete flake	–	Shale	3.2	3.4	0.9	–
15		607/709	8110		Secondary flake with plain platform	Complete flake	–	Shale	1.7	3.1	0.6	Off pebble
16		606/709	8110		Secondary flake with cortical platform	Complete flake	–	Limestone	2.2	2.9	0.7	Off pebble
17		609/709	8110/8105		Tertiary flake with crushed platform	Retouched flake	Scraper	Quartzite	2.2	2.5	0.7	Stepped
18	2	601/712	8200	Mixed	Flaked pebble fragment	Core	Core?	Limestone	3.8	5.3	6.3	Steep edged; platform on each end; stepped flaking removals
19		601/712	8200		Distal tertiary flake fragment	Complete flake	–	Shale	2	2.4	0.4	Transverse snap
20		601/712	8200		Distal tertiary flake fragment	Complete flake	–	Shale	1.6	2.5	0.4	–
21		602/712	8201		Tertiary flake with plain platform	Complete flake	–	Limestone	1.7	1.3	0.6	Edge snaps

(continued on next page)

Table 7 (continued)

No.	Trench	Trench/Square	Context	Phase	Techno-typological analysis	Attribute analysis	Typological ID	Raw material	Length	Width	Thickness	Comments
22		603/712	8200/8201		Tertiary flake with crushed platform	Complete flake	–	Limestone	3.5	2.7	0.6	Oblique transverse snap; half-moon snaps
23		603/712	8200/8201		Tertiary flake with crushed platform	Complete flake	–	Limestone	2.9	2.6	0.6	Edge snaps
24		601/712	8203		Distal primary flake fragment	Flake fragment	–	Shale	3.2	3.2	0.8	Transverse snap
25		602/712	8203		Elongate pebble fragment	–	–	Shale	5.8	4.9	2.6	Natural?
26	2	603/712	8207	I?	Tertiary shatter fragment	–	–	Shale	2.4	1.5	0.7	Natural?
27		603/712	8209		Tertiary flake with plain platform	–	–	Shale	2.5	4.5	0.8	–
28		603/712	8211		Distal tertiary flake/ blade fragment	Complete flake	–	Shale	2	1.3	0.4	Transverse snap
29	3	609/714	8300	Mixed	Secondary pebble flaked fragment	Pebble tool	Short axe	Limestone	7.8	9.5	3.2	Transverse snap forms butt of tool
30	3	610/715	8303	I	Secondary flake with crushed platform	Complete flake	–	Limestone	2.6	2.7	0.3	Edge snaps
31		610/715	8303		Secondary pebble fragment	–	–	?	4.1	3	1.2	Heavily burnt
32		610/715	8303		Secondary flake with crushed platform	Complete flake	–	Limestone	1.4	1.6	0.1	Edge snaps
33		610/715	8304		Distal tertiary flake fragment	Flake fragment	–	Shale	2.2	1.8	0.3	Transverse snap and edge flaking off it
34		610/715	8304		Tertiary shatter fragment	–	–	Limestone	1.7	2.4	0.5	Natural?
35		610/714	8304		Secondary fragment	–	–	Shale	–	–	–	Natural?
36		610/714	8304		Flake with plain platform	Complete flake	–	Limestone	3.4	4.4	0.7	Stepped; edge damage
37		610/714	8304		Tertiary pebble fragment	–	–	Limestone	–	–	–	Natural?
38		610/715	8305		Pebble single platform flake core	Core	Core	Limestone	3.5	5.3	9.4	Elongate pebble; 4 removals
39		610/715	8305		Tertiary flake with crushed platform	Complete flake	–	Shale	1.6	1.3	0.3	–
40		610/715	8306		Distal tertiary flake fragment	?	–	Shale	1	1.8	0.2	Transverse and edge snaps
41		610/714	8307		Secondary flake with cortical platform	Complete flake	–	Shale	3.6	2.6	0.8	–
42		610/714	8307		Distal primary blade fragment	Complete flake	Burin	Shale	4.2	1.5	0.8	–
43		610/714	8307		Tertiary flake fragment with cortical platform	Flake fragment	–	Shale	1.5	1.2	0.4	–
44		610/714	8307		Distal tertiary flake fragment	Flake fragment	–	Shale	1.3	1.2	0.4	–
45		610/714	8307		Secondary shatter fragment	–	–	Shale	3.2	1.8	0.6	Natural?
46		609/716	8308		Retouched pebble fragment	Pebble tool	Short axe	Shale	6.4	6.4	1.8	Flattish pebble
47		609/716	8308		Tertiary flake fragment with cortical platform	–	–	Shale	6.5	4.4	1.1	Half-moon snaps
48		610/715	8308		Flaked secondary pebble chopper/core	Pebble tool	Chopper	Shale	6.4	9.8	3.9	6 flake removals if this was core
49		610/715	8308		Secondary flake with crushed platform	Complete flake	–	Shale	2.3	2.8	0.5	–
50		610/715	8308		Secondary flake with crushed platform	Complete flake	–	Shale	1.7	2.8	0.3	–
51		610/715	8308		Secondary flake with plain platform	Complete flake	–	Shale	2.2	3.4	0.8	–
52		610/715	8308		Pebble	Pebble tool	Pounder	Limestone	9.6	9.1	6.7	Battering + flaking damage (opposed ends)
53	3	610/714	8309	II	Tertiary flake with plain platform	Complete flake	–	Shale	1.3	1.8	0.5	–
54		610/715	8312		Tertiary flake with crushed platform	Complete flake	–	Shale	4.1	3.6	0.9	Lateral snaps
55		610/715	8312		Primary flake with cortical platform	Complete flake	–	Shale	2.4	3.7	0.7	Half-moon snaps

Table 7 (continued)

No.	Trench	Trench/Square	Context	Phase	Techno-typological analysis	Attribute analysis	Typological ID	Raw material	Length	Width	Thickness	Comments
56		610/715	8312		Tertiary blade/flake with crushed platform	Complete flake	–	Shale	2.5	1.4	0.3	–
57		610/715	8312		Tertiary flake with crushed platform	Flake fragment	–	Shale	2.1	4.1	0.5	Large half- moon snaps
58		610/715	8312		Tertiary potlid	–	–	Shale	1.3	2	0.3	Natural?
59		610/715	8313		Tertiary flake with crushed platform	Complete flake	–	Shale	2.3	4.5	0.8	–
60		610/714	8315		Secondary siret flake with cortical platform	Complete flake	–	Shale	3.4	2.6	1.1	–
61		610/714	8315		Secondary flake with cortical platform	Complete flake	–	Shale	3.6	6.3	1.4	–
62		610/714	8315		Tertiary flake with crushed platform	Complete flake	–	Shale	3.2	2.5	0.7	–
63		610/714	8315		Secondary shatter fragment	–	–	Shale	2.8	2.1	0.6	Natural?
64		610/714	8315		Tertiary flake fragment	Flake fragment	–	Limestone	1.9	3.6	0.6	Snapped around whole edge
65		610/714	8315		Distal tertiary flake fragment	Flake fragment	–	Limestone	2.3	2.3	0.3	Transverse and edge snaps
66		610/714	8315		Tertiary potlid	–	–	Limestone	1.4	1.7	0.3	Edge snaps (natural)
67		610/714	8315		Tertiary flake with plain platform	–	–	Shale	1.3	2.5	0.5	Stepped
68		610/714	8315		Tertiary shatter fragment	–	–	Shale	1.6	2.1	0.3	Flaking debris or natural?
69		610/714	8315		Distal tertiary flake fragment	Flake fragment	–	Shale	1.2	2.1	0.3	Transverse snap
70		610/714	8316		Tertiary flake with crushed platform	Complete flake	–	Shale	2.2	2.2	0.2	Hinged
71		610/714	8317		Primary siret flake with crushed platform	Flake fragment	–	Shale	2.4	1.5	0.7	Half-moon snaps
72		609/715	8322		Secondary flake with plain platform	Flake fragment	–	Shale	0.9	3.2	0.8	–
73		609/715	8322		Tertiary shatter fragment	–	–	Shale	1.8	2.5	0.2	Natural?
74		609/715	8322		Tertiary shatter fragment	–	–	Shale	2.6	1.7	0.5	Natural?
75		609/715	8322		Tertiary shatter fragment	–	–	Shale	3	1.8	0.8	Natural?
76		609/715	8322		Tertiary flake with plain platform	–	–	Shale	2.8	2.9	0.7	–
77		609/715	8322		Tertiary flake with crushed platform	–	–	Shale	2.2	2.6	0.9	–
78		609/715	8322		Tertiary flake with crushed platform	–	–	Shale	2.4	3.2	0.5	–
79		609/715	8322		Distal tertiary flake fragment	–	–	Shale	1.8	1.8	0.6	–
80		609/715	8322		Tertiary flake with plain platform	Flake fragment	–	Shale	1.4	1.4	0.3	–
81		609/715	8322		Distal tertiary flake fragment	Complete flake	–	Shale	1.2	2	0.5	Transverse snap
82		609/715	8322		Distal tertiary flake fragment	–	–	Shale	1.4	2.4	0.3	Transverse snap
83		609/715	8322		Distal tertiary flake fragment	Flake fragment	–	Shale	1.4	1.5	0.2	Transverse snap
84		609/715	8322		Tertiary flake with plain platform	–	–	Shale	1.6	2.2	0.4	–
85		609/715	8322		Distal tertiary flake fragment	Flake fragment	–	Shale	1.2	1.7	0.4	–
86		609/715	8322		Distal tertiary flake fragment	–	–	Shale	1.3	1.5	0.2	–
87		610/715	8322		Secondary pebble fragment, retouched	Pebble tool	Short axe	Shale	4.6	6.4	1.8	Transverse snap forms butt of tool

5. Discussion

Distinct patterning within the results of the various proxy analyses permitted separation into four depositional phases: a mixed phase and three largely undisturbed phases of site use. Phases are described from the base of excavation upwards.

5.1. Phase III

This phase incorporates material from contexts identified between the current excavation base, dated to 24,244–24,887 cal. BP (UBA-17272), and the appearance of a large shell midden (commencing in Phase II). Data are drawn exclusively from Trench 1

(contexts 8100–8111) (Fig. 5). Compared to contexts higher in the stratigraphic sequence, sediments at this depth are almost devoid of cyclophorids; however, infrequent freshwater shells, charcoal and small numbers of bone fragments and cultural material was recovered to full depth. Notable amongst the modest vertebrate fauna recovered (Table 5) was a complete metapodial from a *Manis* sp. (pangolin) in context (8111). This piece is slightly damaged on the dorsal distal surface (lateral side) and proximally on the lateral side, preventing clear identification to element. Two species of pangolin are presently found in Vietnam: *Manis pentadactyla* (Chinese pangolin) in the north and centre of the country, and *M. javanica* (Sunda pangolin) in the centre and south (Lekagul and McNeely, 1988; Sterling et al., 2006).

Techno-typological analysis produced a diverse range of pieces, a greater predominance of which was made on limestone (62.5%, $n = 10/16$ – single surface find excluded), including: one core, five flakes, one flake fragment (from section cleaning), one pebble fragment/pebble tool ('short axe') and a burnt limestone pebble fragment. Shale pieces were less common (25% $n = 4/16$): two flakes and two pebble fragments ('short-axes'). This phase also yielded the site's only quartzite piece (artefact 17) – a tertiary, retouched flake ('scraper'), and the only piece of sandstone: a flaked pebble fragment. Fourteen modified pieces were also identified during the attribute analysis. These comprised: 1 core, 3 pebble tools, 7 complete flakes, 1 flake fragment 1 one retouched flake.

As this phase broadly covers the LGM it is significant that fragments of Dipterocarpaceae (cf. *Dipterocarpus*) and Sapotaceae (cf. *Manilkara* or *Palaquium*) were found in contexts (8100, 8103 & 8110, & in 8105) (Table 2). The genus *Dipterocarpus* contains c. 70 species of large (c. 60 m) rainforest trees, with a wide geographic distribution through the tropics (see Ashton, 1988). Sapotaceae (cf. *Manilkara* sp. or *Palaquium* sp.) is a pantropical family of flowering plants, most species of which produce edible fruit. Pinaceae and two endocarps of *Celtis* sp. (Family: Ulmaceae) were also recovered. The former ranges from subarctic to tropical environments, including limestone karst (Sterling et al., 2006) and also yields edible seeds. On the basis of the available comparatives, the Hang Trông *Celtis* sp. specimens are more likely to be *C. australis* L. (Mediterranean hackberry) or less likely the *C. elim. sinensis* Piers (Chinese hackberry). *C. australis* is a component of more open dry deciduous forest regionally (e.g. Sun et al., 1986).

The *n*-alkane data from this depth in the excavation indicates a vegetation cover that is similar to today (Fig. 4). The plants around the cave do not seem to have been adversely effected by the climate downturn. Compound-specific isotope analysis of both *n*-alkanoic acid and *n*-alkane higher plant lipids also indicate that the prevailing occurrence of C_3 vegetation. Pollen records from the South China Sea during this time indicate herbs and grasses, with some temperate broad leaf plant types dominated most lowland landscapes (Sun et al., 2003). The well-watered and enclosed environment within the Trông An massif appears to have provided a stable set of conditions for sub-tropical plants despite the climatic downturn.

5.2. Phase II

The deposits attributed to Phase II span a period of approximately 2000–2500 years: from 17,845–18,520 (UBA-14885) and 18,229–18,708 cal. BP (UBA-14886) to a little before 15,522–16,663 cal. BP (UBA-14884). Macro-vertebrate faunal remains are comparatively rare (NISP $n = 57$), with indeterminate large mammal fragments making up the bulk of this total (Table 5). Deer (Cervidae) are represented only by distal elements (including a burnt phalange and carpal). Cercopithecidae also feature, with notable finds including two mandibular fragments with partial *in situ* dentition. The first of these was recovered from near the base of

the shell midden in Trench 1 context (8016). Charcoal from this context is dated to 18,229–18,708 cal. BP. The specimen consists of a right M_1 with alveoli for M_2 and M_3 – indicating an adult of five or more years of age (Smith et al., 1994) and is attributable to *Macaca* cf. *mulatta* based on biometric data (Swindler, 2002, table 112). The second, recovered from Trench 3 context (8312), was from a juvenile: comprising a (left) dp_1 in wear a dp_2 and an erupting M_1 in one fragment, with a similarly faceted dp_2 in a second associated fragment (from the right of the mandible). Evidence of other terrestrial-arboreal and arboreal taxa includes: Sciuridae, from mandible fragments equivalent in size to *Sciurus* sp., Hystricidae by isolated teeth, and one avian family, Phasianidae, from a fragment of left coracoid, identified as being from a gallopheasant (*Lophura* sp.) also recovered from near the base of the shell midden in Trench 1 context (8107). Micro-vertebrate remains are noticeably rare compared to higher in the sequence, where they are linked to cave-roosting birds. Infrequent freshwater crab chelae were also identified.

The lower part of this phase yielded molluscan evidence from four consecutive and approximately equal spits within context (8019) and the highest quantities (MNI) of molluscs in the phase (Table 6). Cyclophorids dominated but a number of other taxa were also represented. These too are associated with forested/arboreal environments, such as *Amphidromus* sp., which lives on trees and shrubs. Three fragments of the freshwater mussel *Unio* spp. appear at this point, as do fragments of *Ellobium aurisjudae*. Unionidae generally inhabit freshwater environments, such as slow rivers, lakes or ponds; while *Ellobium aurisjudae* can inhabit quite a broad range of aquatic environments, from muddy estuaries to mangroves (Thach, 2005). From the top of the phase (contexts 8010 & 8011) only a low quantity of molluscs were recovered including three species of *Cyclophorus*. The molluscan data from Phase II, though, supports the picture that the area around the cave was at this time forested and contained a source of freshwater in its vicinity.

Techno-typological analysis indicated that shale was the predominant raw material used in the manufacturing of lithic artefacts 89.6 per cent ($n = 26/29$ – excluding potentially natural pieces). This included flakes, flake fragments and one pebble fragment ('short axe'). The three remaining pieces were limestone flakes/flake fragments (Table 7). Attribute analysis identifications were more conservative: $n = 20$, comprising: 1 pebble tool, 9 complete flakes and 10 flake fragments.

Although palynological work was hampered by the degraded state of pollen grains, some identification was possible for Phase II, including tree families: Brassicaceae (Crucifer), Rubiaceae, Leguminosae (Fabaceae/Mimosa), Betulaceae and *Pinus* or *Podocarpus*; and more diverse families, such as Moraceae or Urticaceae, which are both mixed families of trees, herbs, climbers or succulents, preferring warm tropical and lowland forest regions; Ulmaceae trees and shrubs persist, and Poaceae, which is an open ground grass taxa also appears. Proximal pollen records from comparable conditions in China reflect the findings from Hang Trông, whereby sub-tropical forests dominate (Wang et al., 2012). Charred fragments of Dipterocarpaceae (cf. *Dipterocarpus*) were recovered from contexts (8016 & 8100); as were specimens of Pinaceae and Sapotaceae (context 8100). Fragments of Rhizophoraceae (cf. *Rhizophora*) tree and shrub taxa came from the top of the phase (context 8010) in Trench 1. These latter are significant components of mangrove forest (Chinh et al., 1996) though the potential proximity of the site to this habitat at this time has yet to be determined. Leguminosae (cf. *Dialium* sp.) fragments were identified from this phase in Trench 3, context (8308). Remains of *Celtis* sp. endocarps are notably elevated compared to Phase III, while those of the nut *Canarium* spp. (Family: Burseraceae) appear for the first time (Table 2). It is unclear if these changes relate to more intensive use

of the site during Phase II (see Fig. 5) or to a shift in (through continuing presence of) forest conditions.

Towards the base of this phase (141.0 m. asl.) the *n*-alkane data display a slight increase in average chain length. This potentially signals that a resurgent southwest monsoon during the early post-LGM provided a more favourable growing environment; something that may also have been linked to more intensive use of the site. Compound-specific isotope analysis of both *n*-alkanoic acid and *n*-alkane higher plant lipids remains stable through-out the phase, indicating a predominantly C₃ vegetation cover, contradictory to evidence from islands further south where C₄ plant-type dominate at this time (Wurster et al., 2010). The *n*-alkane data indicate vegetation broadly similar to that seen in the property today.

5.3. Phase I

The final intact occupational phase in the excavation is associated with an age 14,056–14,902 cal. BP (UBA-21288) from Trench 3 and 15,522–16,663 cal. BP (UBA-14884) in Trench 1. Representatives from five macro-vertebrate mammalian families were identified: Cervidae, Hystricidae, Mustelidae (*Arctonyx collaris*), Cercopithecidae (cf. *Macaca* sp.) and Sciuridae. The deer (Cervidae) remains were represented by elements from the distal appendicular skeleton, namely phalanges and a left tarsal. Evidence of porcupines (Hystricidae) comprised of isolated teeth; the vector of introduction for this animal is unclear as porcupines are known to frequent caves in this region (e.g. Bacon et al., 2008). A well preserved right distal humerus belonging to a hog badger (*Arctonyx collaris*), provides one of the few intact element recoveries from Trench 1. A discrete assemblage of bone fragments from this phase in Trench 3 included pieces of humerus, ulna and femur from a monkey (cf. *Macaca* sp.), together with a complete femur and burnt mandible from a squirrel (Sciuridae). This concentration of remains – unique on the site – was found within context (8308) (sq. 610/715) and dated 14,056–14,902 cal. BP (UBA-21288). The faunal remains were also found in association with three stone implements, with patches of charcoal and possibly ochre adhering to their surfaces (Table 7, artefacts 48 & 52) and several flakes, all clustered underneath a single whole large freshwater mussel. This context was excavated beneath a large slab of roof fall, which also carried red and black linear pigmentation on its western face: it is as yet unclear if this colouration was deliberately applied or was the result of burning from hearths in the immediate vicinity, though the concentrated nature of these finds certainly bears the hallmarks of having been deliberately placed.

This phase also included low frequencies of micro-vertebrate remains. These were dark in colour (compared to examples from the taphonomic control and mixed contexts above) with calcium carbonate deposition clearly evident. Included among these remains were bones of birds, fish, rodents and shrews. The presence of this material is likely to be an indication that owls were roosting in this part of the cave; though the filtering of micro-vertebrate bones through the coarse matrix of shells cannot be completely discounted. The bones of insectivorous bats are also present, including *Taphozous* sp. (tomb bats). These are interpreted as cave-dwelling fauna and, therefore, almost certainly natural introductions. Small quantities of crab chelae were again found, including burnt specimens. These are more reliably considered to have been introduced to the site by people.

Data from the molluscan column sample from Trench 1 (Table 6) that relates to the lower part of this phase includes material from three contexts (8007a–c & 8009), which is again dominated by *Cyclophorus* sp., *Cryptozona* cf. *chrysoraphe* and Zonitidae cf. *Oxychilus* sp., present also now is *Camaena* sp. – an herbivorous terrestrial mollusc that lives in and around shrubs and trees. This

taxonomic representation is again indicative of a forested local environment. Single pieces of the aquatic *Unio* spp. and *Cerithrium* sp. were also identified; indications that nearby freshwater habitats were being exploited. Burnt shell suggests hearths may have been set in the middle of the cave. The molluscan sample from the upper part of the this phase (contexts 8006, 8005, 8004, 8003b & 8003a) was found to be dominated by *Cyclophorus* sp. Quantities of *Cryptozona* cf. *chrysoraphe* and Zonitidae cf. *Oxychilus* sp. were also identified. *Camaena* sp., which is found deeper in this part of the sequence were not present. This may indicate a shift in local conditions or a change in human gathering patterns.

Techno-typological analysis of the lithic assemblage from the 2010 excavations identified *n* = 21 artefacts from Phase I in Trenches 2 and 3 (Table 7). This consisted a predominance of shale flakes, flake fragments and blade/flake (with one a burin) specimens; as well as a shale pebble chopper/core ('chopper') and retouched pebble fragment ('short-axe') – 71.4 per cent (*n* = 15/21 – excluding potentially natural pieces) of the total. Other modified pieces were flakes, core and pebble ('pounder'), all of limestone; and a burnt pebble fragment of unknown material. A lower total of artefacts (*n* = 17 modified pieces) was identified through the attribute analysis study, comprising 10 complete flakes, 3 flake fragments, three pebble tools and a core were identified.

The climate is likely to have been variable during this phase: insolation levels were increasing; however the phase is also punctuated by H1, a noticeably cold-dry period, indicated by sea surface records from the Gulf of Tonkin and the Hulu Cave speleothem record (e.g. Huang et al., 1997; Pelejero et al., 1999; Wang et al., 2001; Visser et al., 2003; Oppo and Sun, 2005; Wei et al., 2007; Shintani et al., 2011). Pollen recovered from within this phase was noticeably degraded, though appears synchronous with a proximal lake pollen record from southern China (Wang et al., 2012). Grains of Brassicaceae (Crucifer) and Rubiaceae were, also identified, as were pollen grains of Hamamelidaceae, a family formed of tropical trees and shrubs. Betulaceae and Cyperaceae represent other community components from this phase. Dipterocarpaceae were confirmed in the macro-botanical data (Table 2). At this time the coastline is thought to have been still up to 500 km from the Trảng An massif (Yao et al., 2009). Sedimentary facies from coring in the Red River Delta (core ND-1, 20.372778N, 106.146667E) show that c. 14,900 cal. BP the low-lying landscape beyond the massif contained channels from a meandering river system (Tanabe et al., 2006).

Close to the onset of this phase (141.7 m asl) *n*-alkane chain lengths are noticeably shorter (average *n*-alkane chain length C₂₉). It is hypothesized that this reflects the change to colder and dryer conditions in H1. Taken together with increased post-glacial insolation, these factors inhibited production of the protective long-chain *n*-alkanes needed in this sub-tropical environment; plants only had sufficient resources to maintain shorter *n*-alkanes. Towards the end of the phase, and the expected increase in temperature and moisture, longer *n*-alkane lengths were being produced by the vegetation. Compound-specific isotope analysis of *n*-alkanoic acid and *n*-alkane higher plant lipids from Hang Trống sediments all indicate that the interior of the massif was still characterized by a dominant C₃ vegetation signal that was distinct from the environment setting that lay beyond it.

5.4. Mixed phase

Surface contexts (corresponding to approximately the uppermost 10 cm in each trench) were allocated to a mixed phase due to the likelihood of modern contamination of the sediments. This is borne out through the two radiocarbon dates obtained: 12,594–12,854 cal. BP (UBA-09301) from our reconnaissance test-pitting here in 2007 and a contrasting date of 32–355 cal. BP

(UBA-14883) from context (8001) in Trench 1 in 2009. In faunal terms, these contexts are dominated (NISP) by the remains of rodents (Muridae), amphibians (Ranidae: *Rana* sp.), bird bones (small passerines) and small numbers of fish bones. All are considered most likely to derive from owl pellets from roosting sites in the roof of the cave. Bones of insectivorous bats (Chiroptera) and reptiles (cf. Gekkonidae) likely represent natural deaths of cave-dwelling fauna. The bones of larger mammals were rare in this phase, but included a fragment of vertebrae from a non-human primate, possibly relating to historic occasional use of the site by hunters.

Molluscan evidence is relatively diverse, including *Clausilia* cf. *proctostoma* – a species that was only otherwise observed during the LGM (see Sec. 5.1), which may point to a cooling from within the Pleistocene data of these mixed deposits. Aquatic taxa are present, with *Planorbis* sp. a species of freshwater snail and a spike in the percentage quantities of *Cyclophorus*, from c. 65 per cent of the sample to 85 per cent in little more than a couple of centimetres. All of the terrestrial species identified from this phase are known to live in, around or beneath trees, and in the case of other identifications, such as *Cryptozonia* cf. *chrysoraphe* and Zonitidae cf. *Oxychilus* sp., they are likely to inhabit very broad environmental spheres that encompass arboreal environments.

Technologically, the upper-most contexts (8200–8203) in Trench 2 and (8300–8302) in Trench 3 produced eight lithics through techno-typological analysis, and eight through attribute analysis. Techno-typologically, the identified pieces included 1 limestone pebble fragment that might have been a core, 3 shale flake fragments, 3 limestone flakes and a limestone pebble flaked fragment ('short axe') (Table 7). Attribute analysis of the same sample identified 1 core, 5 complete flakes, 1 pebble tool ('short-axe') and 1 flake fragment.

This phase contains the only substantial concentration (60%) of identifiable pollen recovered. This is almost certainly due to modern wind-blown grains becoming trapped within the sediments as erosion and localized micro-re-deposition of these takes place, given the cave's morphology. Charred fragments from samples taken within this phase reveal a number of Dipterocarpaceae specimens; together with *Celtis* sp. and *Canarium* spp. fragments (Table 2). The climate signal contains both evidence of warm, moist conditions and also indications of sediment accumulating under cooler conditions. *n*-Alkane biomarkers average high chain lengths, possibly simply a reflection of contemporary sub-tropical conditions.

6. Conclusion

The results of work conducted at Hang Trống highlight the potential resilience of limestone forest habitats in the northern tropical zone of mainland Southeast Asia. Multiple lines of evidence suggest that these forest formations can sustain themselves through substantial local climatic and environmental change.

Palynological and macro-botanic evidence indicate the persistence of tropical forest cover within Trảng An during the LGM, a period when the surrounding lowlands were characterised by grassland environments. Invertebrate and vertebrate fauna data corroborate the strong arboreal nature of the local habitats within the massif and their durability across this climate downturn. Compound specific analysis of plant biomarkers shows a common C₃ photosynthetic pathway for local vegetation. The *n*-alkanes recovered from comparative samples and from Hang Trống indicate that the most dominant chain length in the modern vegetation (C₃₁) is also predominant in the sedimentary record at the site. This is concurrent with other plant zones from this latitude, thus we can be confident that evidence from our analysis of *n*-alkanes reflects, with some clarity, regional climatic conditions. At c. 15 kBP a change in the forest dynamics is indicated by a reduction in C₃₁ *n*-alkane

and an increase in C₂₇ *n*-alkane. A dramatic change in *n*-alkane chain length at c. 15 kBP coincides with the H1 event. This can be attributed to a strengthening of the northeast monsoon during this interval (e.g. Huang et al., 2011). The associated increase in aridity does not, however, appear to have instigated a substantial shift in local vegetation; conceivably in part due to adaptations toward aridity within limestone forest, conditions rebounded and have persisted through the Holocene.

The occupational record from Hang Trống appears to indicate intervals of more and less intensive site-use, peaking in the period immediately after the LGM, but always at a relatively low scale compared, for example to the later midden deposits from elsewhere in the massif, such as Hang Boi (Rabett et al., 2011). The abundance of particularly cyclophorids during the wet southwest monsoon is taken as a likely indicator that this was probably the main season of use, though visits outside of this time cannot be ruled out. There are hints of caching activity that, if correct, are suggestive of provisioning. The nature of this through-cave certainly raises the possibility that it was utilised primarily as a corridor to travel between valleys; the generally equitable conditions providing a useful temporary stopping point.

The technological sample obtained from the 2010 excavation was small ($n = 74$ artefacts), precluding statistically robust statements about observed variability, hence the conclusions we present here are tentative. Patterning in the frequency of artefact categories, form of platform (i.e. cortical, plain, pointed, crushed), flaking direction, striking platform thickness and exterior platform angle appeared within the lithic assemblage suggests a shift in knapping behaviour and hence potentially mobility between the LGM and the post-LGM (Phan, 2014). This shift was from one where limestone predominated, but where a wider range of materials were utilised, during the Phase III (LGM) use of the site, to sourcing that more particularly focused on shale, especially in Phase II. A higher observed frequency of dorsal flake scar counts is also suggestive of greater reduction intensity during the LGM compared to later phases of site-use. The frequency of flakes and flake fragments is considerably lower than is seen during the later phases. Both raise the possibility that occupation of the site during this period involved a change in curation and 'technological organization' (after Nelson, 1991), if not in site-use, and may turn out to reflect difference in risk levels and mobility strategies (Phan, 2014). As the classes of artefact recovered appear to have been largely consistent through-out, variability was perhaps situated primarily in how technological strategies were implemented rather than in technological forms themselves. In other words: the general reduction strategy (the technology) appears to not have changed, but attribute analysis of our sample suggests that components or steps in that strategy (the technological organization) were altered in response to external pressures.

Pieces resembling Hoabinhian 'short-axes' persisted through all three phases (Table 7, artefacts 1, 7, 10, 13, 29, 46 & 87). Artefact 13 from this list is from a secure context overlying the deepest current date from Hang Trống (c. 24.4 cal kBP), indicating an age-range for this artefact-type from close to that of the earliest proposed for the Hoabinhian in Vietnam (cf. Yi et al., 2008) up to the top of the sequence. This finding is in-keeping with the technological durability that has been observed elsewhere for the Hoabinhian (e.g. Forestier et al., 2015). The lack of other supposed type-artefacts attributed to the Hoabinhian, most notably 'Sumatraliiths' or unifacial discoid pieces, which have been considered definitive elements (e.g. Tan, 1997; White and Gorman, 2004) also highlights the variable expressions that the Hoabinhian encompasses. In a reversion to the original adaptive emphasis of Gorman (1970, 1971), we consider that the Hoabinhian record might be more aptly described in terms of a technological (and subsistence) 'eco-system'

of responses rather than as a singular entity (see also e.g. Viet, 2000; Doi, 2005).

Indications from the current study suggest that foraging groups focused attention on the exploitation of resources available within the Trảng An massif at least on a seasonal basis over a long period of time: many thousands of years. This stability and concentration of resources carries wider implications for our understanding of the archaeology of the region. The consistent recovery of occupational evidence from limestone environments may have significance beyond the better preservation offered by these settings and traditional research focus upon them. They may represent genuine 'islands of humanity': points on the landscape that early populations occupied consistently and exploited preferentially over millennia because of the surety they offered in resource access (Rabett et al., 2011), a fact likely tied to their refugial character (see Phoca-Cosmetatou and Rabett, 2014).

The results of our analysis point strongly to the presence of a forested environment within Trảng An throughout the course of the last twelve thousand years of MIS-2, and provide testament to its resilience in the face of large-scale climate and environmental change. Forest continuity here into the Holocene and present day (see Rabett et al. 2011; Ludgate et al., Forthcoming) underscores and extends that resilience. The effects of modern climate change on tropical environments had been seen as secondary to that predicted from deforestation and extractive industry (Sala et al., 2000); however, the projected climate-driven impact on environments and communities in Southeast Asia has grown significantly in the last decade. Coastal and low-lying island habitats and their associated populations are now known to face an acute threat from climate-driven inundation and environmental transformation (Nicholls and Cazenave, 2010; Rietbroek et al., 2016). While the corpus of literature on the impact to coastal habitats globally gathers apace (e.g. Virah-Sawmy et al., 2009; Kirwan et al., 2010; Holland, 2012; Mendoza-González et al., 2013; Hunter et al., 2015), with few recent exceptions (e.g. Wetzel et al., 2012; Faridah-Hanum et al., 2014; Latinne et al., 2015) the effect of climate change on coastal tropical terrestrial habitats is still an under-represented field, and a body of research to which this study contributes. In closing, then we suggest that there are notable implications for conservation arising from the Hang Trống study. Firstly, long-term early human presence in Trảng An, even under conditions when vegetation was more stressed, does not appear to have been adverse to forest survival. That being so, there is an argument to be made that with careful management the impact of modern visitors to this and similar karstic properties on the World Heritage List could be sustainable. Secondly, it is now generally accepted that refugia may offer the best chance for the survival of many taxa under conditions of anthropogenic climate change (e.g. Médail and Diadema, 2009; Ashcroft, 2010; Keppel and Wardell-Johnson, 2012; Keppel et al., 2012). The data from Hang Trống, therefore, add additional weight to that contention. In line with other refugial habitats, tropical limestone forests should be considered as a conservation priority. Finally, faced with the prospect of substantial transformation through climate change and regional sea-level rise our findings also give reason for optimism. With diligent management the chances of survival remain positive for these biodiverse, richly endemic and archaeologically bountiful landscapes.

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TRANG AN LANDSCAPE COMPLEX, NINH BÌNH PROVINCE

VISITOR MANAGEMENT: ACTION PLAN

INTRODUCTION

Purpose, objectives and use of the plan

This action plan is intended to provide a further basis for implementing, monitoring and evaluating the provisions relevant to visitor management in the Trang An Landscape Complex World Heritage property management plan. The property management plan addresses issues in terms of objectives, actions and evaluation measures, while in this action plan the focus is on actions. Here the implementation of all actions is examined together with their further development based on experience to date.

The property management plan is now in only the third year of its five-year term 2015-2020, and experience in management of the World Heritage property is still in its very early stages. However, it is timely to undertake a critical analysis of the management plan provisions and evaluate their adequacy and performance to date. This is even more appropriate in the light of the information and improvements requested by the World Heritage Committee in 2016, as follows.

World Heritage Committee Decision 40 COM 7B.67

In relation to visitor management the Committee noted that the State Party had not included adequate measures in the revised property management plan concerning the management of tourism, and requested the State Party to:

- Ensure measures are in place to limit overcrowding, including the establishment of a clearly justified maximum daily quota for peak and normal visitation days; and
- Undertake an assessment of the facilities and services required to adequately service the anticipated increase in visitation from one to two million visitors (*per annum*), including the extrapolated festival-day peaks of up to 50,000.

This action plan includes a detailed response to the issues raised by the Committee relating to visitor management.

MANAGEMENT PLAN PROVISIONS AND MEASURES FOR VISITOR MANAGEMENT

Objectives and actions for visitor management in the property are provided for in several sections of the existing property management plan, as follows:

Section VII.3. Management of human uses and activities

- **Section VII.3.1. Eco-tourism**
- **Section VII. 3.2. Recreation**
- **Section VII.3.3. Privately owned accommodation facilities**
- **Section VII.3.4. Cultural and religious tourism and festivals**

Section VII.4. Infrastructure, facilities and services for visitors and residents

- **Section VII.4.1. Visitor centres**

- **Section VII.4.2. Education and interpretation**
- **Section VII.4.4. Visitor safety**

Actions contained in the property management plan relating to each of these are examined in turn in the following sections.

VII.3.1. Ecotourism

Item VII.3.1.1 (Note that numbering of items differs slightly from in the Management Plan)

Carefully calculate the number of visitors to the property, using counts on a daily basis throughout the year at the major gateways, and estimate the likely increase in numbers in future.

Site	2015			2016			% change		
	Domestic	Foreign	Total	Domestic	Foreign	Total	Domestic	Foreign	Total
Trang An visitor centre	1,271,829	136,022	1,407,851	1,544,052	185,758	1,792,810	+21%	+37%	+23%
Tam Coc	288,873	189,549	478,422	78,404	204,062	282,466	-73%	+8%	-41%
Bich Dong - Sunshine Valley	4,862	3,833	8,695	865	2,798	3,663	-82%	-27%	-58%
Hoa Lu Ancient Capital	134,525	87,519	222,044	163,348	128,686	292,034	+21%	+47%	+32%
Bird Valley	62,166	16,874	79,040	65,559	4,353	69,912	+5%	-74%	-12%
Galaxy Grotto	11,302	3,250	14,552	13,085	3,828	16,913	+15%	+17%	+16%
Total	1,773,557	437,047	2,210,604	1,865,313	529,485	2,457,798	+5%	+21%	+11%

Table 1: Visitor numbers at the gateways of the property in 2015 and 2016.

Explanation:

1. Current visitor numbers

The results of visitor counts in the first two full years since inscription of the property are shown in Table 1. The data presented reveal the following:

- In 2016, approximately 2.4 million people visited the property, which was an increase of 11% above the previous year. This considerably exceeds the number of visitors reported at the time of inscription, due to under reporting of numbers in 2014 from incomplete counts, and to a marked increase in promotion and popularity of the property as a visitor destination since it became World Heritage.

- From 2015 to 2016 the largest increase in numbers (32%) was at the Hoa Lu Ancient Capital, which is the cultural hub of the property (and does not involve boat travel).
- Despite the overall increase in visitors between 2015 and 2016, at three gateway sites the number decreased. Numbers were lower by about half at Sunshine Valley where operations were scaled down, by about 40% at Tam Coc which appears to have lost visitors to the newer and more attractive Trang An site, and by 12% at the privately operated Bird Valley site.
- The distribution of visitors within the property is very uneven and heavily skewed to one site, the Trang An wharf and boat route, which receives some 70% of all visitors. The Hoa Lu Ancient Capital and the Tam Coc wharf are the other main visitor destinations. Galaxy Grotto and Bich Dong-Sunshine Valley have far fewer visitors with latter receiving less than 1% of the total.
- Foreign visitors now make up about 21% of all visitors. Tam Coc and Bich Dong-Sunshine Valley are distinctive in that foreigners considerably out-number domestic visitors. These are longer-established visitor sites and have been promoted and marketed internationally.
- Foreign visitor numbers grew about four times faster (21%) between 2015 and 2016 than domestic visitors (5%), which undoubtedly reflect the increased international exposure and interest in the property as World Heritage.

2. Predicted future visitor numbers

Should numbers of visitors increase at 10% per annum over the next three years, which on current trends is probably a maximum rate of increase, then by 2020 the property could be hosting approximately 3.5 million visitors annually.

Neither the current visitation level nor the three-year projected increase is of particular concern from the viewpoint of environmental, social or management capacity. No significant environmental or social impact occurs at present and none is anticipated beyond the ability or capacity of management to control it. The absolute numbers can be accommodated within existing and intended improvements in visitor infrastructure. Moreover, there is a very marked and constant pattern in the variability of visitor numbers throughout the year, with a very short peak season and a long period of low use. This makes it relatively easy to predict changes in levels of visitor use and to anticipate the level of management intervention required to minimise or avoid any undesirable developments or impacts. More details of this are provided in the following sections of the plan.

Actions taken:

Counting of visitors has improved markedly in the property since World Heritage inscription. Visitor numbers are now counted and recorded daily throughout the year at the principal gateways. The counts are based on boat and entry ticket sales and on periodic visual counts made by Company and Board staff together with independent counts by officers of the Department of Statistics. Counting now also distinguishes between domestic and foreign visitors.

Item VII.3.1.2

Regularly monitor popular tourist destinations and routes, especially at peak visitor times, to check for overcrowded conditions and environmental impacts.

Explanation:

There are six principal gateways into the property for tourist visitors: Hoa Lu Ancient Capital; Trang An wharf; Tam Coc wharf; Bich Dong-Sunshine Valley; Bird Valley and Galaxy Grotto (named Milky Way Grotto in the nomination dossier). Hoa Lu is visited on foot while the other sites give access to the property by boat. As noted above, visitors are very unevenly spread among the gateway sites, with the Trang An wharf receiving about 70% of the total while Bich Dong-Sunshine Valley has only about 1%. Visitor numbers also vary greatly during the year; with some 56% arriving during a three-month festival peak season (peak season management is discussed in further detail in section VII.3.1.5. below).



Figure 1: Visitors at Trang An wharf in the festival peak visitor season (photo: Xuan Lam)

The Management Board's monitoring programme gives attention to both environmental and social impacts. Environmental impacts are minimal and of little concern. Most visitors travel by boat. These are hand-operated sampans which are non-polluting. Management staff use small motorised boats occasionally. Destinations on boat routes all have paved surfaces, as does the Hoa Lu Ancient Capital site, so soil disturbance and erosion are not a problem. Overcrowding is the most likely social impact but it, too, is of little concern to date and evidence of crowding occurs only at the Trang An wharf and boat route during some days in the peak season. There is no problem with littering and boat operators ensure that it doesn't happen on the water.

Actions taken:

During the peak visitor season, monitoring officers are appointed and deployed to observe the numbers and behaviour of visitors at the most populated sites, especially the busiest

boat wharves and landing sites on boat routes. These officers carry hand-held radios and/or phones for communicating with the visitor centres and wharves.

Additionally, a new and innovate early warning system is in place to monitor for overcrowding on the routes operating at the Trang An wharf. This is the only place in the property that experiences some crowding during the peak festival season. The system uses fixed cameras at key locations monitored remotely from the visitor centre, thus giving managers real-time data on visitor numbers and behaviour. Remedial action, such as cessation of ticket sales or diversion of visitors to alternative sites, can be put in place quickly if potential problems arise.

Item VII.3.1.3

Impose limits on the number of boats licences to operate at each wharf of the major gateways and during the next three-year period place a cap on the total number of authorised boats at 4,000.

Explanation:

Apart from at the Hoa Lu Ancient Capital, access to the property for visitors is almost entirely by boat. Currently, there are 2,650boats operating in the property (see Table 2): 1,500 at the Trang An wharf; 1,000 at the Tam Coc wharf; 50 at Bich Dong/Sunshine Valley; 50 at Bird Valley and 50 at Galaxy Grotto. There has been no increase in boat numbers since the property became World Heritage in 2014. The number of boats operating at that time was slightly under reported, as it did not account for the boats operating at the Bird Valley privately operated resort.



Figure 2: Most visitors access the property by small boats (photo: Bá Ngọc)

More boats are required to cope with the current and projected increase in the number of visitors. Experience to date shows that it would be possible to increase the volume of boat traffic considerably, including on peak days, without causing unacceptable environmental damage or loss. The major hurdle to be overcome is providing the necessary infrastructure

and services to avoid undesirable social impact from crowding. As explained in actions below, improved arrangements for ticket sales and boat access is helping to prevent congestion at wharf areas and better monitoring will reveal potential overcrowding at key sites., including within the cave passages. Moreover, adding new routes within the visitor use zone and directing more visitors to the relatively underused sites in the property is easing the pressure at the current hot spots.

Actions taken:

No more boats have been added in the past three years, and there is no pressure for an immediate increase in boat numbers. The Management Board has reached an agreement with all boat operators regarding the optimum number of boats at each of the major wharves, which takes account of reasonable visitor demand, and the need both to avoid environmental impact and to reduce crowding in the peak season. Accordingly, the management plan has been revised to set the cap on the total number of boats operating in the property by 2020 at 3,865 (Table 2). This would involve potentially adding 825 boats at the Trang An wharf, 300 boats at Tam Coc, 30 at Bich Dong/Sunshine Valley, 30 at Bird Valley and 30 at Galaxy Grotto. This increase in boats is considered to be adequate to cope with the projected increase in visitor numbers and is well within the upper limit of management capability given current and intended improvements in facilities infrastructure and services. The ratio of the number of boats to visitors would remain about the same as it is now. The property management plan has an extended vision to 2030, by which time it is anticipated that more than 4,000 boats may be operating to accommodate the number of visitors. However, it is difficult to accurately predict the situation that might exist more than a decade from now.

No	Gateway	Current Boats	Boat number by 2020	Boat number by 2030
1	Trang An Boat Wharf	1,500	2,325	2,500
2	Tam Coc Boat Wharf	1,000	1,300	1,500
3	Bich Dong and Sunshine Valley	50	80	120
4	Bird Valley	50	80	120
5	Galaxy Grotto	50	80	120
Total		2,650	3,865	4,360

Table 2: Existing boat numbers at wharves and proposed increase to 2020 & 2030.

Item VII. 3.1.4

Undertake assessments of the natural environment and conduct surveys of visitor satisfaction during the peak visitor season to identify any environmental or social impacts.

Explanation:

Environmental monitoring and reporting are fundamental aspects of the management monitoring programme within the property. Visitor satisfaction monitoring and

measurement are new elements in this programme and are still under development. The very low level of reported dissatisfaction or negative feedback from visitors' experiences means this has not been a priority need to date.

Actions taken:

The staff of the Management Board's Environment & Landscape Division undertakes field monitoring and reporting of the state of the environment and the behaviour of visitors every week, and more frequently during the peak visitor season. Details of this are in the property management plan.

Biodiversity survey work that the Board is currently undertaking with IUCN and research groups, including the use of camera-trap wildlife surveys, could become part of an improved park-wide environmental monitoring system.

Periodic surveys of visitor expectation and satisfaction have begun in August and September 2017. 300 to 450 questionnaires were distributed to Boat passengers in Vietnam, English, French, Chinese, Japanese languages. The results show that about 98% of Visitors expressed satisfaction with their experiences of the security, sanction, and boat operation. Only of 2% less satisfied. The most common comments were about the need for more drinking water outlets and more souvenir and food shops on the boat routes

Item VII.3.1.5

Impose controls such as limits on boat operations and sale of tickets if there is any evidence that visitor numbers are exceeding the desired conditions and carrying capacity.

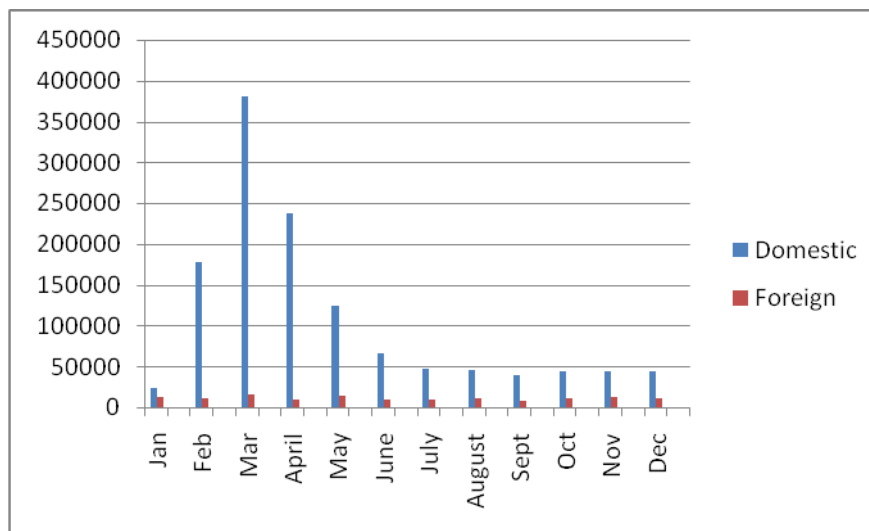


Figure 3: Annual distribution of domestic and foreign visitors at Trang An Boat Wharf in 2015

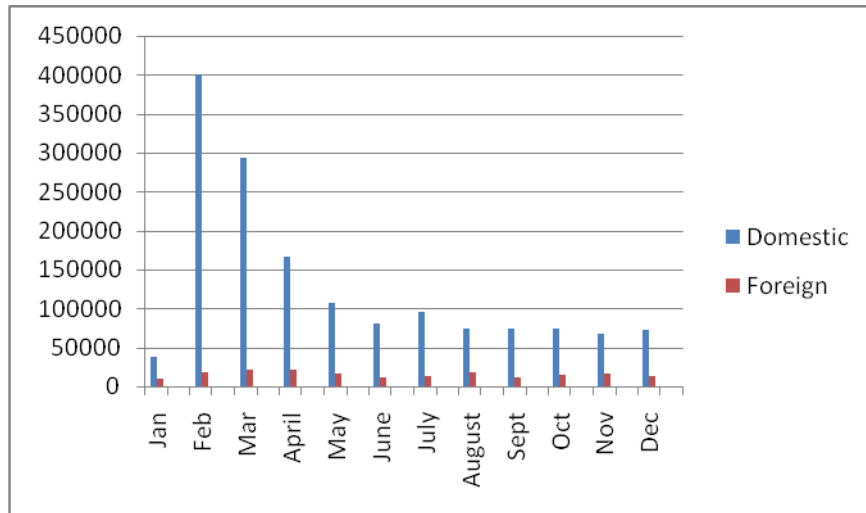


Figure 4: Annual distribution of domestic and foreign visitors at Trang An Boat Wharf in 2016

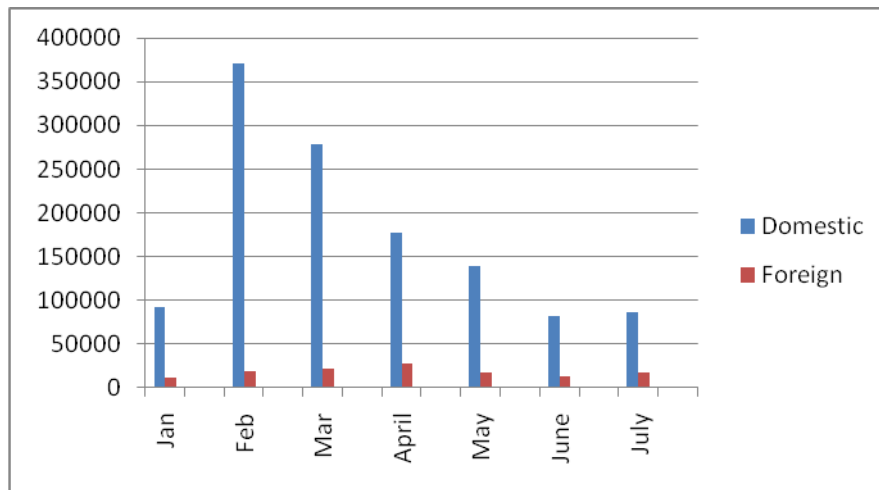


Figure 5: Annual distribution of domestic and foreign visitors at Trang An Boat Wharf in 2017 (January- July)

Explanation:

There is a markedly uneven distribution in visitor numbers during the week. Weekends are normally much busier than weekdays, reflecting the weekly pattern of holidays in Vietnam. The exception to this is at Tam Coc and especially Bich Dong-Sunshine Valley, which have a predominance of foreign visitors that tend to favour visits on week days.

There is also a marked imbalance in the numbers of visitor arrivals during the year (see Figures 1 – 3). During nine months of the year (May – January) visitor numbers are low, with only a few thousand arrivals per day. Lowest numbers are in the period from October, and especially in December when people remain home to prepare for New Year (Tet) celebrations. The peak visitor period is the three-month festival season from February to

April, during which the property receives about 56% of all visitors. At this time many thousand people arrive each day and more than 20,000 on some of the busiest days.

Data on visitor arrivals in Figures 1 - 3 reveal that there is trend toward a more even distribution of visitors throughout the year, with a lesser contrast between the volume of visitors in the peak and low seasons. This appears to reflect two things: 1) an increase in foreign tourists who avoid the peak season and 2) increased numbers of domestic tourists from further away in Vietnam who visit for reasons other than to attend the local festivals. This trend is welcome as it allows for a more uniform degree of management intervention throughout the year.



Figure 6: Crowding can occur on a few days in the peak visitor season (photo: P.Dingwall)

Currently, there is no observable environmental impact from visitors during the peak season, when festivals are the principal activity (see the following section VII.3.1.6 on respect that is shown by visitors). Beyond the boat rides, all visited sites in the property are hardened with concrete or stone paving or steps. Crowding can occur on the most visited days. The Foreign Affairs & Public Relations Division of the Management Board receives a small amount of negative feedback, via its hotline and internet site, about delays in queues for tickets and boat rides, especially at the Trang An wharf. Overall, the visitor satisfaction level is very high. Positive comment far outweighs negative feedback, with visitors praising the spectacular scenery, magical boat rides and friendly local guides, and expressing a wish to make a return visit. Thus, concerns about visitor impact mainly relate to exceeding the management capacity of the property (i.e. the number of boats and operators and other facilities and services) rather than exceeding the environmental or social carrying capacity of the property.

Actions taken:

Several measures are undertaken to ease the crowding, especially at the Trang An wharf, on peak days, as follows:

- Individual boats may make three trips per day.
- Sale of tickets is stopped when all boats are fully operational.

- Visitors are encouraged to arrive on week days, and to use either the less-visited boat wharf sites, such as Bich Dong-Sunshine Valley and Galaxy Grotto, or other non-boating sites such as the Hoa Lu Ancient Capital.
- Visitors are also informed about alternative opportunities to visit the Bai Dinh Pagoda in the buffer zone, and the neighbouring Van Long Reserve, which has fewer visitors.

Other crowd-reduction measures are being trialled or considered, particularly aimed at spreading the visitors more evenly among the gateways and throughout the year, as follows:

- Internet bookings and ticket purchases (possibly including use of cell phone apps.), allowing visitors to plan their arrival time and giving managers a prior indication of visitor numbers.
- Differential pricing of tickets between low and peak seasons.
- Shifting the ticket offices to the car park areas, to reduce crowding at boat loading/unloading sites.
- Opening of new boat routes (but not increasing boat numbers) to ease pressure on the few main routes, and establishing new wharf sites within the tourist/visitor zone of the property.

Management of visitors at the Trang An wharf and boat route in the peak season

There is an uneven geographical distribution of visitors at the various main gateways, with the Trang An wharf, which is the major hot spot, receiving some 70% of all visitors. Thus, the Trang An wharf and boat route are the only tourist operations experiencing some crowding in the three-month peak season. On busiest days about 20,000 people visit the site during this period. Currently, experience shows that this number of visitors can be adequately accommodated by the existing management facilities and services without undesirable environmental or social impact, but this situation could deteriorate if limits were not set on numbers and facilities and services improved. An optimum future carrying capacity has, therefore been set as follows:

At present 1,500 boats operate from the wharf. Each boat carries four adults, or up to six persons if two are children. Each boat can make three trips per day. Thus, assuming an average of five persons per trip, the maximum number accommodated in one day is **22,500** persons. Boats are, therefore, currently operating to maximum capacity on the busiest days. On a few occasions the demand is greater and boat tickets sales have to be suspended.

Current rules allow for an increase of boat numbers here to **2,325** by the year **2020**. This would increase the maximum daily boat passenger numbers to almost **35,000** persons, and would undoubtedly give rise to some level of overcrowding on the existing route. For this reason, a second boat route has been opened for use in the peak season. This will allow the numbers of visitors on the primary route to be held to a maximum of approximately 20,000 per day, while the secondary route caters for the balance of about 15,000 per day.

Item VII.3.1.6

Establish standards of respect for cultural and natural features, codes of conduct and penalties for violations, and make all visitors aware of these through documents, signs and verbal means.

Explanation:

Most visitors arrive in the peak season, which is dominated by festivals. During this period the majority of people come on a personal pilgrimage to worship in temples and pagodas, in veneration of Gods and ancestors, and to celebrate nature. Visits are mostly quiet and orderly. People are normally very considerate of nature and of each other. Pilgrims also know how to behave in a respectful manner in temples and observe traditions in sacred places. There is a general absence of environmental harm, littering, and offensive or bad behaviour.

Actions taken:

Only minimal management intervention is required to maintain control of visitors and avoid undesirable impacts. Some information leaflets are distributed and others are in preparation. Signs advising of rules and regulations regarding behaviour are posted in the visitor centres and temples. Guides are available at Hoa Lu and all other visitors are accompanied by boat rowers who also act as guides (see further details below).

Item VII.3.1.7

Undertake patrols by rangers especially during peak visitor periods to ensure maintenance of standards and compliance with rules for protection of cultural and natural features and report any violations, which will be penalised.

Explanation:

Supervision of compliance with rules and regulations is conducted by security staff and forest rangers as part of the monitoring programme in the property. Violations of rules and the imposition of penalties are very rare events. Existing staff numbers are considered adequate for the present and the foreseeable future.



Figure 7: Rangers are stationed on boat routes for monitoring and security
(Photo: P.Dingwall)

Actions taken:

Security staff are strategically positioned throughout the visitor-use zone of the property at all times. Approximately 30 full-time officers are employed on the tourist routes at Trang An, with lesser numbers at the more lightly uses sites. In the Hoa Lu Special Use Forest, which occupies a considerable area of the property, forest rangers from the Department of Agriculture and Rural development are employed to conduct weekly patrols. They co-operate closely with Management Board staff and security officers elsewhere in the property.

Item VII.3.1.8

Adequately train all boat operators and require them to encourage necessary standards of behaviour among visitors and report any unacceptable conduct.

Explanation:

Everywhere, except at the Hoa Lu Ancient Capital, boat rowers accompany visitors in the property.

Actions taken:

All boat rowers have received some environmental training and English language instruction (some can also converse in other languages). They are able to tell visitors about the plants, animals, aquatic life and the geological landscape, and they keep order on the boats. At Trang An the boat rowers are well organised, being split into 27 teams each of which has a leader who reports immediately by phone to site managers about any environmental damage or bad behaviour, such as refusal to wear lifejackets.

Item VII.1.3.9

Adopt and rigorously enforce visitor safety standards at all times.

(See section on visitor safety below)

Item VII.3.1.10

Place limits on development of visitor facilities infrastructure, and allow any new developments only after careful consideration of the need and full assessment of environmental and social consequences.

Explanation:

There are strict rules and regulations regarding the development and operation of visitor facilities infrastructure in the property, which are supervised by the Management Board in collaboration with the Department of Construction, Department of Planning and Investment, Department of Agriculture and Rural Development and Department of Natural Resources and Environment. Privately owned and operated facilities, especially home stay accommodation, are subject to comprehensive building regulations, which specify the allowable locations, types of use, building heights and number of floors, among others. Additionally, health and hygiene standards are administered by the Department of Health and inspected by the Police and Security authorities.

Actions taken:

The Management Board has collaborated closely with all relevant authorities to control and manage facilities within acceptable legal limits. There have been several instances where restrictions have been placed on home owners wanting to extend their houses as hotel accommodation. Many improvements have been made over the past three years including better roads and parking lots; cleaner public toilets; more shops and improved retail standards at visitor gateways; improved supply and quality of potable water; a more extensive electric power network and introduction of modern facilities such as ATM machines. In villages there is still a need for more improvement of rubbish collection and disposal, and sewage and waste water treatment, but local authorities are currently attending to these matters.

Two significant facilities developments have occurred that are of major benefit to the visitor management programme in the property.

- A second boat route has been introduced in the visitor use zone, operating from the Trang An wharf in the peak season, thereby alleviating the crowding at this site.
- A youth education centre has been established in the conservation zone of the property, to provide for training of students from Vietnam and surrounding countries in ecology, environmental management and conservation.

These innovative developments are consistent with objectives for visitor management and education, respectively, in the management plan. To date they have had no detrimental impact on the protection and integrity of the cultural and natural values of the property.

Item VII.1.3.11

Require owners of private retail facilities such as shops, cafes, restaurants and souvenir and handicraft stalls to meet acceptable building codes, and observe high standards of cleanliness and hygiene.

(See actions above regarding facilities infrastructure)

Item VII.1.3.12

Collaborate with authorities and operators to promote a regional tourism strategy that eases the visitor pressure on the property.

Explanation:

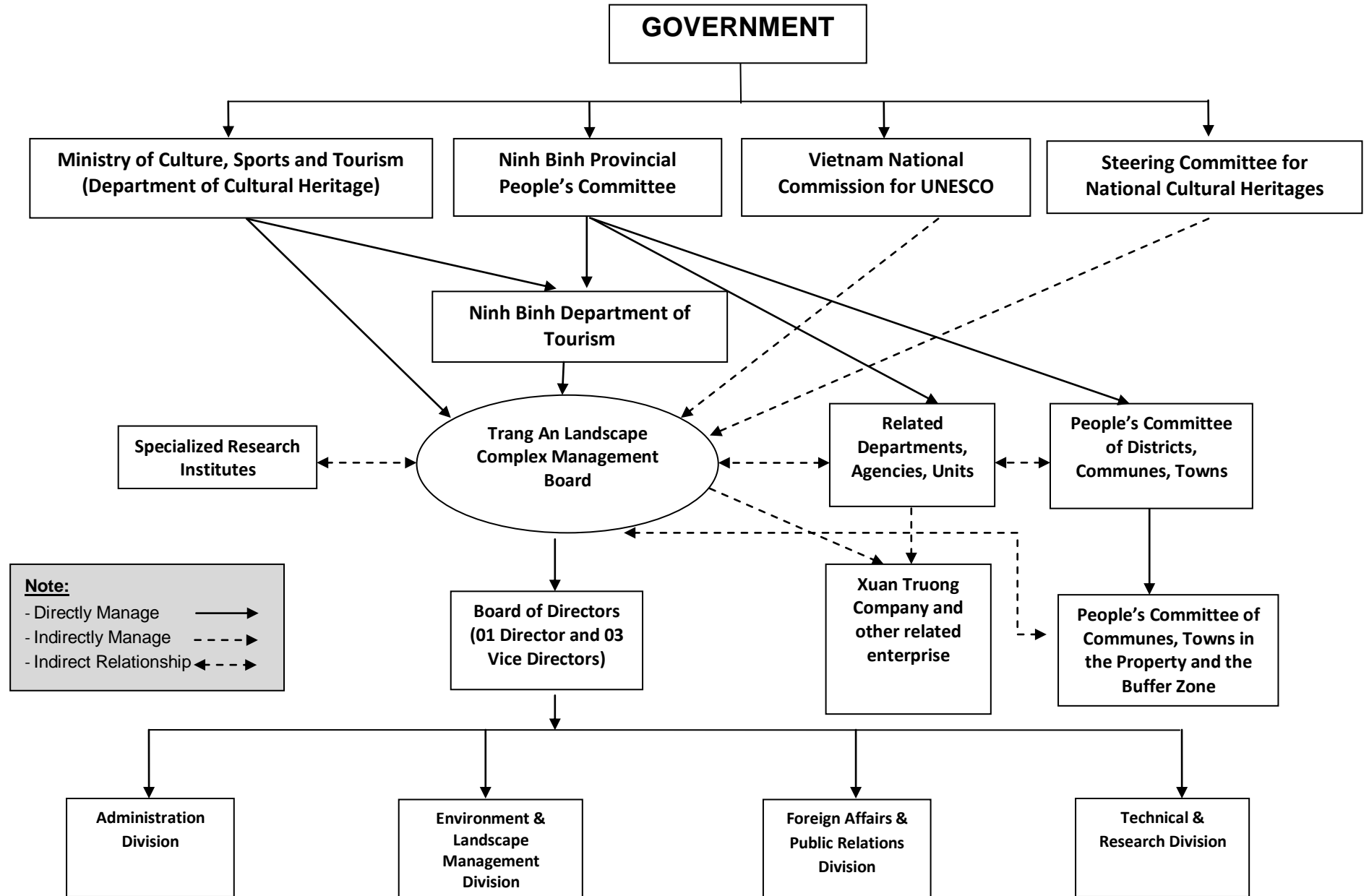
Tourism in Ninh Binh Province is guided by a Tourism Master Plan, prepared by the Department of Tourism, which provides a long-term vision and strategic objectives for tourism development, accompanied by an assessment of resources needed and benefits to be derived. Account is taken of the need for the Trang An management plan and the Tourism Master Plan to be compatible, and for both to recognise the authority of World Heritage standards and requirements. Within the property the management plan has precedence.

Actions taken:

During 2017, as part of Government administrative reform in Ninh Binh Province, the Trang An Landscape Complex Management Board was transferred to the newly established Department of Tourism. A vice-director in the Department of Tourism now has responsibility for supervising and controlling the activities of the board (see Figure 8). The key roles are to cooperate with all relevant agencies and the local district People's Committee, and to report to the Director of the Department of Tourism and to the chairman of the Provincial Steering Committee for Conservation and Development of the Trang An Landscape Complex. The Board itself has a director and up to three vice-directors and is composed of four divisions, responsible respectively for administration, environment and landscape management, foreign affairs and public relations, and technical and research matters.

The Management Board, and its role in strategic planning of tourism, have been considerably strengthened by this change. The Board retains its identity and independence, but is now founded more securely within the provincial Government framework. It is also able to conduct its general operations and strategic planning more efficiently through having direct access to officials in the Tourism Department and all other relevant agencies, especially the new Department of Culture and Sport. The Board also now reports directly to the head of a principal Government Department in the province, and through that office to the Provincial People's Committee. By locating the board within the Tourism Department, the links between tourism and conservation in management of the Trang An property have been strengthened and harmonized. The provincial authorities have issued a resolution and specific regulations requiring the protection of the Trang An Landscape

Figure 8: Organization chart of Trang An Landscape Complex Management Board



complex as a World Heritage property, and development of sustainable tourism to support protection of the property and to benefit the local community.

VII.3.2. Recreation

Item VII.3.2.1

Carefully monitor existing recreational activities to ensure compliance with protection requirements.

Explanation:

Trang An is not suited to a wide range of recreational activities. Virtually all access to the core areas of the property is by boat, except at the Hoa Lu Ancient Capital and at several other temples and pagodas. Currently, recreation activities are limited to sight-seeing, walking, hiking and cycling. The principal cycle trail is on a paved road from Tam Coc wharf to Bich Dong pagoda, Sunshine Valley and Bird Valley. Walking routes, some with steps, are also paved or constructed with flagstones. Recreation activities are essentially passive and to date there has been little evidence or any incidents of undesirable impacts on the environment. There is no demand for additional recreation activities and the Management Board has no plans to introduce them.



Figure 9: Cycling is a popular recreation activity (photo: Nguyen Loan)

Actions taken:

All visitors including recreationists are monitored by security staff and forest rangers while in the property, who check that everyone observes the rules regarding environmental protection and behaves in an orderly manner. The boat rower/guides also advise visitors about responsible behaviour, and monitor their activities.

Item VII.3.2.2

Provide essential facilities such as toilets and shelters and services such as rubbish collection to meet the demand.

Explanation:

Only minimal basic facilities are required to meet the needs of recreationist visitors in the property.

Actions taken:

Toilets, rubbish bins, food, water and shelter are provided and regularly maintained on visitor routes throughout the property. All paved routes are well maintained.

Item VII.3.2.3

Ensure that recreational uses do not have a detrimental impact on the primary cultural and natural values of the property and do not infringe upon the activities of other legitimate visitors.

Explanation:

It is considered fundamentally important that visitors of all kinds, including recreationists, cause no damage or disruption to the cultural and natural values of the property, and do not detrimentally affect the activities or enjoyment of other visitors. To date there has been little evidence of such impact or behaviour. Visitors are usually carried in boats as family groups or with friends, so there is no conflict among different age or ethnic groups.

Actions taken:

(See actions above related to compliance with protection requirements.)

Item VII.3.2.4

Refuse to authorise those recreational uses or activities considered to be contrary to the other values and protection objectives of the property.

Explanation and actions taken:

As noted above, all current recreation activities are compatible with the protection and integrity of the property, and there is no demand or intention to add new activities. Should the introduction of additional activities be considered then they would be subjected to rigorous assessment of their potential environmental and social impacts, or effects on protection and integrity of cultural and natural values.

VII.3.3 Privately owned accommodation facilities

Item VII.3.3.1

Issue all private operators with operational licences that require strict observance of all laws, regulations and plans applying to them.

Explanation:

The residential zone in the property has a variety of small privately owned resorts, hotels and home-stays. The number of homestays inside the property and in the buffer zone has increased markedly since World Heritage inscription (discussed further below). The homestay businesses are run under licences from the District and other local authorities who collaborate with relevant Government Departments. Most licences are supervised by the Department of Tourism, which collaborates with the health, police and tourism agencies and the local authorities. Licences cover matters such as building types, construction materials and standards, size of building and number of floors, health, hygiene, waste management and fire prevention.



Figure 10: A privately owned resort in the property (photo: P. Duy Linh)

Actions taken:

The Management Board, which is now administered within the Department of Tourism, is able to collaborate closely with tourism officials and also with officials of other relevant agencies that conduct inspections of properties at intervals of every week..

Item VII.3.3.2

Monitor and inspect compliance with relevant laws, regulations and plans, penalise offences and prosecute any illegal actions or activities.

Explanation and actions taken:

Regular monitoring and inspection occurs, as noted above. To date there have been very few instances of non-compliance or illegal activities, and no significant prosecutions have been required.

Item VII.3.3.3

Assess new building structures and architecture and major repairs, restoration alteration or change of use for their cultural or environmental impact and harmful effects. Exercise approval rights of the Management Board and of other State agencies.

Explanation:

Historic and sacred buildings such as temples and pagodas are subject to strict regulations regarding repair, restoration, alteration and changes of use. New buildings are required to comply with building regulations, some of which are designed to ensure the adoption of appropriate standards for World Heritage.



Figure 11: Temples are important cultural sites in the property (photo: Ba Ngoc)

Actions taken:

The Management Board primarily has monitoring, inspection and reporting roles in these matters, while approval and regulatory roles are exercised by other relevant Government agencies. To date, the principal concerns have been the increased number of residential owners wishing to open homestay businesses. Prior to June 2014, when the property became World Heritage, there were 13 homestays in the property and 26 in the buffer zone. By June 2017 there were 36 in the property and 60 in the buffer zone. Additionally, there were 17 others under construction in the buffer zone. All homestay construction in the property is within the residential zone.

Any change of land use and all new applications are carefully assessed, especially to ensure compliance with the rules about the allowable size of buildings and number of floors - currently set at a maximum of two floors (eight metres) in the property and three floors (12 metres) in the buffer zone. Environmental effects of any new construction or

change of use are also assessed. The Management Board is also giving consideration to the appropriate total number of homestays and hotels that should be allowed in the property, and is taking account of the relevant regulations in the Trang An Master Plan.

VII.3.4. Cultural and religious tourism and festivals

Item VII.3.4.1

Co-operate with festival organisers and provide the necessary infrastructure and services.

Explanation:

Festivals are the main activities during the peak visitor season. There are three main annual festivals held in the property: Truong Yen Festival in the Hoa Lu Ancient Capital; Thai Vi Festival in Tam Coc Scenic Area; and Trang An Festival. Another festival is held at Bai Dinh Pagoda in the buffer zone. The festivals are celebrated over one to three days and involve worship, games, contests, song and dance, processions on foot and by boat, and feasting.

Actions taken:

The Management Board collaborates closely with the Department of Culture and Sport, which is the agency responsible for organising festivals, and with local authorities and residents to arrange and supervise the conduct of festivals. Festivals involve thousands of people who require costumes, flags and banners etc, food and drink, and the use of boats and other transport. The Board also arranges security services.



Figure 12: Festivals are the main activities in the peak visitor season (photo: Xuan Lam)

Item VII.3.4.2

Keep festivals under continual surveillance to observe any undesirable social or physical impacts, and control any problems that may arise.

Explanation and actions taken:

Festivals are routine annual events held at the same time each year. They are well organised and orderly, and are conducted collaboratively by the Management Board and all relevant authorities. Apart from some occurrence of crowding (discussed in detail above) there are no problems or impacts from noise, litter, environmental damage or pollution of any kind.

VII.4.1. Visitor centres

Item VII.4.1.1

When resources allow, improve the visitor centre at Trang An Scenic Area by replacing the display area with new interpretation and education facilities, and possibly a small museum. Give consideration to shifting the existing car/bus park to a more convenient and safer location in the buffer zone.

Explanation:

The major visitor centre operating in the property is located at Trang An wharf. It comprises staff offices, a ticket office, a restaurant, a few souvenir stalls, toilets and a large communal room for general public use and for holding traditional music and dance performances. This room also has some cabinets for display of information and a collection of archaeological artefacts. A large car/bus park is located across the road from the centre, and at crowded times there is some disruption of pedestrian and vehicle traffic flow.



Figure 13: The Trang An visitor centre (photo: Bá Ngọc).

Actions taken:

The display area has been up-graded. Construction of a small museum with an information/interpretation centre is currently under consideration. Guidance from within Vietnam and the UK is being sought for establishing artworks, dioramas and interactive

displays to illustrate and explain geological evolution, landscapes and natural features of the property and the life of ancient inhabitants, among others.

Several options for improving traffic flow are being considered, including construction of a pedestrian bridge, and moving the car park to a nearby location in the buffer zone, linked to the visitor centre by the use of electric-powered carts.

Item VII.4.1.2

Plan for the establishment of visitor centres at the other four main gateways to the property in consultation with owners and operators of tourist facilities.

Explanation:

A substantial visitor centre is established at Trang An wharf, which currently receives about 70% of visitors to the property. Smaller visitor centres are required at the other main gateways, which at present generally have only a car park, ticket office, toilets and some cafes and small souvenir stalls.

Actions taken:

The Department of Tourism is planning to develop a visitor centre at Tam Coc wharf, along with a new car park about 100m away in the buffer zone. The Management Board is discussing new developments for the roadside wharf at Bich Dong-Sunshine Valley and at Bird Valley with the private operators who run these two facilities. At the Galaxy Grotto gateway, which at present has a restaurant, toilets and some information displays, the Provincial Government is planning to establish a new car park in the buffer zone.

Item VII.4.1.3

Operate the visitor centres either under the direction of the Board or through licence agreements or concessions monitored and supervised by the Board.

Explanation:

Visitor centres, or their equivalent, are currently run as commercial operations by private companies or individuals. All operations are run under licences from the provincial Department of Planning and Investment, supervised by the Management Board. At Trang An and Tam Coc the licence agreement is for 70 years, while at the other gateways the licences are valid for a period of 49 years.

Actions taken:

The Management Board has all licences under active supervision and control, and reports on a regular basis to the Provincial People's Committee through the Department of Tourism. The Board considers that no further action is warranted at this stage.

Item VII.4.1.4

Encourage, and support where possible, private land and business owners and operators to upgrade residences, businesses and facilities in the vicinity of the visitor centres.

Explanation:

Some visitor gateways are surrounded by private residences and businesses such as shops and small hotels. At Tam Coc in particular there is a need to up-grade some of these residences and facilities, which have high exposure to visitors including foreigners and fall below the desirable standards of World Heritage.

Actions taken:

The Management Board is collaborating with the Department of Tourism and with local businesses and residents with a view to up-grading the quality and appearance of buildings in the vicinity of visitor gateways. There are plans to provide new cleaner and better located toilets, and improved retail outlets, for example. New parking lots are also planned. This work will take time as it largely relies on the good will of the private owners and there are few resources available to provide incentives. The Board conducts an active awareness-raising campaign to encourage co-operation from local stakeholders.

VII.4.2 Education and interpretation

Item VII.4.2.1

Welcome the use of the property for educational purposes and activities and allow them to occur subject to normal protection requirements.

Explanation:

Trang An is recognised as being strategically located and well equipped as an important study site and educational centre, and schools and other higher education institutes are encouraged to use it for this purpose.

Actions taken:

An environmental education and training centre has recently been established in Trang An. Located in the north-western part of the property, and accessed from the vicinity of the Bai Dinh Pagoda in the buffer zone, the site covers 20 ha, of which 12 ha is a lake. This area, which is second-growth forest and wetland, is within the conservation/sustainable management zone of the property that allows for some limited visitor use and associated facilities development. The Centre comprises three accommodation houses built in traditional architectural style, toilets, and a lake with a surrounding paved walking track. The purpose of the centre is to provide opportunities for students drawn from throughout Vietnam and some surrounding countries to learn about forest and wetland ecology, and for training in conservation. Walking access only is allowed but there may also be some

limited provision for disabled visitors to be transported by electric-powered cars. Establishment of this new facility is consistent with policies for promotion of education and training in the property contained in the management plan (Sect.VII.4.2).



Figure 14: The centre for ecological study and conservation education (photo: Duy Linh)

Item VII.4.2.2

Promote the educational use of Trang An with relevant education authorities and institutions, especially for studies in the subjects of pre-history, history, culture, religion, natural landscapes, geology, geomorphology and heritage conservation.

Explanation and actions taken:

The Management Board interacts regularly with the provincial Department of Education and Training to implement programmes such as the “Friendly Schools Active Students” campaign focused on Trang An. Students from schools, colleges and universities are frequently hosted in the property. In addition to their learning programmes, the students sometimes assist with small environmental management tasks such as tree planting, and may also learn new skills, e.g. in forest fire prevention, control and rescue.

Item VII.4.2.3

Progressively develop and implement the property interpretation plan.

Explanation:

Interpretation is regarded as an important adjunct to visitor management to advance the knowledge and understanding of the cultural and natural values of the property and to enhance the enjoyment of visitors. The property management plan provides for on-going development of a thematic interpretation plan, using a wide range of methods and tools.

Much of the effort is to be focused on visitor centres with a secondary emphasis on the progressive development of signage and information panels.

Actions taken:

The interpretation plan is a work in progress. The principal Trang An information booklet has been revised and reprinted. Some new signs and panels have been established and others will be introduced continuously in future. Improved interpretation facilities at visitor centres are still under consideration (see above).

Item VII.4.2.4

Enhance staff capacity and capability in educational studies and interpretation through training and skills development, and supplement these with appropriate resources.

Explanation:

Management Board leaders and staff are academically well qualified. In 2016 there were 11 staff with post-graduate qualification, 30 with undergraduate qualification and six educated to college level. The broad range of specialist subjects covered includes archaeology, cultural heritage, environment and resources, forest conservation and management, tourism, Government management, law, business administration, accountancy and statistics. Several Board staff are capable of communicating in English and other foreign languages. Staff are encouraged to undertake further studies and to gain professional experience from participating in workshops and conferences (both domestic and international) and working with scientists in the property. The Board also organises its own training programmes, and it encourages schools and universities to conduct education programmes in the property.

The Board also conducts an education and awareness raising programme for the local community. This covers subjects such as heritage protection and conservation, resource management, restoration and promotion, including knowledge of World Heritage.

Actions taken:

The numbers of staff with post-graduate qualification has increased by six in the past two years. Five staff are actively participating in the SUNDASIA Project in the property, a major multi-year archaeological research programme funded by UK and local sources, based at Queen's University Belfast, Bournemouth and Cambridge University, and utilising experts from several other institutions (e.g. Oxford University Museum of Natural History), including in Vietnam (e.g. Vietnam Institute of Geosciences and Mineral Resources, Institute of Archaeology, Cuc Phuong National Park). Board staff are also currently assisting in geological, biological, historical, and cultural heritage studies in the property.

Staff have continued to attend conferences, and training workshops and courses both in Vietnam and elsewhere. As discussed above, an educational facility has been established in the property for Vietnamese and foreign students to study natural and cultural heritage conservation.

VII.4.4 Visitor safety

Item VII.4.4.1

Assess the degree of hazard risk through regular survey and inspection, and mitigate or avoid any known hazards.

Explanation:

The two natural hazards of principal concern are rock fall and flash flooding. Rocks could fall from overhanging cliffs and from cave ceilings. Flash flooding from very heavy rainfall could lead to a sudden rise of water level in the property potentially trapping boats. Remarkably, despite the millions of visitors to the property in the past three years, there have been no medical emergencies and no reported deaths or serious injuries from accidents or incidents.

Actions taken:

Members of the security staff undertake patrols to inspect for hazards every morning before boat operations commence, and every evening to ensure all boats have returned safely to the wharf.

Item VII.4.4.2

Maintain all visitor facilities and routes in a safe condition.

Explanation:

Routes requiring safety measures are waterways, cave passages, paved paths and steps. Boats may be obstructed and visitors may fall from boats, though these rarely occur. In cave passages it is possible (but unlikely) for visitors to be injured by falling rocks, or from making contact with the roof, especially during times of high water level. Paved paths and steps can be slippery at rainy times.

Actions taken:

Waterways are kept clear of weed through regular cleaning operations. Cave passages are well lighted and are regularly inspected, with any potential hazards being removed. Paths are well maintained and secure handrails are installed on steps where required.



Figure 15: Weed clearing is important for safe use of waterways (photo: Sinh Khánh).

Item VII.4.4.3

Station rangers along key access routes to monitor safety conditions, record breaches of rules, report any incidents or accidents and assist those requiring help.

Explanation:

It is an essential requirement of the property management plan that safety conditions are monitored continually in all parts of the property used by visitors.

Actions taken:

Security staff are strategically located along all visitor routes throughout the operating day. They are equipped with radios or phones to report any safety incidents or accidents. They also have motorised boats available if necessary for recovery and transport of injured or unwell visitors.

Item VII.4.4.4

Establish well-equipped and fully maintained first-aid stations at key points on popular tourist routes, and make available rescue equipment and capability in cases of emergency.

Explanation:

There are requirements in the property management plan for provision of first aid and search and rescue services.

Actions taken:

First aid stations, caches of rescue equipment and designated medical evacuation points and procedures have not yet been established but are included in a comprehensive visitor safety plan now being developed.

Item VII.4.4.5

Provide first-aid training for boat operators, who will be required to carry basic first-aid supplies.

Explanation and actions taken:

Some staff with first aid knowledge are deployed in the property during busy visitor times. However, as noted above, first aid supplies and services are yet to be fully developed as part of the evolving visitor safety plan. That plan includes the establishment of well-equipped first aid stations at visitor centres and wharves, and basic first aid training for all boat rowers.

Item VII.4.4.6

Advise visitors about safety requirements through appropriate signs, information brochures and verbal messages from boat operators.

Explanation and actions taken:

Boat rowers advise all passengers about safety requirements such as the wearing of life jackets and appropriate behaviour while in the boats, and they take particular care to avoid dangers for visitors while travelling through caves passages.

SUMMARY OF THE EXISTING SITUATION REGARDING VISITOR MANAGEMENT IN THE PROPERTY

The Management Board of the Trang An Landscape Complex already operates a sophisticated visitor management programme, guided within a comprehensive property management plan and supported by substantial financial and staff resources.

The visitor management plan is carefully designed to take account of requirements for ensuring protection and integrity of cultural and natural values, while allowing for appropriate visitor use aimed at optimising enjoyment while minimising undesirable impacts.

Currently, approximately 2.4 million visitors use the property annually and it is projected that numbers will rise to about 3.5 million by 2020.

The level of visitor use is highly variable both in time and space: one of the six major gateway destinations in the property receives about 70% of all visitors; weekends are favoured visitor times; and some 56% of visitor use is concentrated in a 3-month peak season when traditional festivals are held. Predictable use levels allow for more effective management intervention.

The great majority of use by visitors is of the passive type – visitors mainly seek enjoyment and relaxation from experiencing the natural world and/or appreciation of cultural values and traditions. Most visitors travel by boat and all key destinations are paved.

At current levels and types of use there is no observable undesirable environmental or social impact apart from some crowding on a few festival days in the peak season.

The Management Board is highly confident that present and planned infrastructure and services are capable of ensuring this desirable situation will continue, despite anticipating a substantial increase in visitor volume.

Among the key operational provisions introduced or planned to reduce crowding, especially in the peak visitor season, are:

- Increasing the number of trips per boat, while suspending ticket sales when all boats are operational;
- Opening a new boat route in the visitor-use zone;
- Encouraging visitors to select less busy arrival times, less crowded sites, and alternative destinations outside the property;
- Internet ticket sales, and differential pricing to encourage more low-season use; and
- Improved parking and ticketing arrangements at the gateways to avoid congestion.

A cap has been placed on the total number of boats permitted to operate by 2020, and a maximum daily carrying capacity has been established at the busiest gateway, to reflect current and projected visitor numbers and ensure avoidance of any overcrowding or environmental impact.

A strict visitor monitoring programme is in place, including staff stationed at key sites, together with an innovative early warning system using remotely monitored cameras for real-time observation and effective response should potential overcrowding occur.

Standards are set and codes of conduct are applied regarding visitor behaviour, with rules strictly supervised by rangers, boat rowers and other staff.

Interpretation and information services are greatly improved, along with visitor centre developments and establishment of a student educational facility within the property.

Improved infrastructure and services are in place for better support to recreational activities, and the Board has introduced a comprehensive visitor safety programme.

Close collaboration has been established for constructive partnership between the Board and private owners and operators of visitor accommodation and facilities, and with organisers of festivals.

Shifting of administration of the Management Board to the Provincial Department of Tourism has greatly strengthened the strategic planning and operation of visitor management in the property.

Priorities have been identified for future development and improvement of visitor management including:

- Further expansion of visitor centres and development of interpretation and information products and services;
 - Improved parking and access provisions at some gateways;
 - On-going staff training and capacity development;
 - Continued strict monitoring of the volume and trend of visitor numbers, along with visitor behaviour and impacts;
 - Increased survey and recording of visitor experiences, satisfaction levels, requirements and demands;
 - Surveillance of visitor safety with more equipment and services; and
 - Strengthened partnerships with private operators and close collaboration with tourist business owners in the property and the local community generally.
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