International Participatory Training School

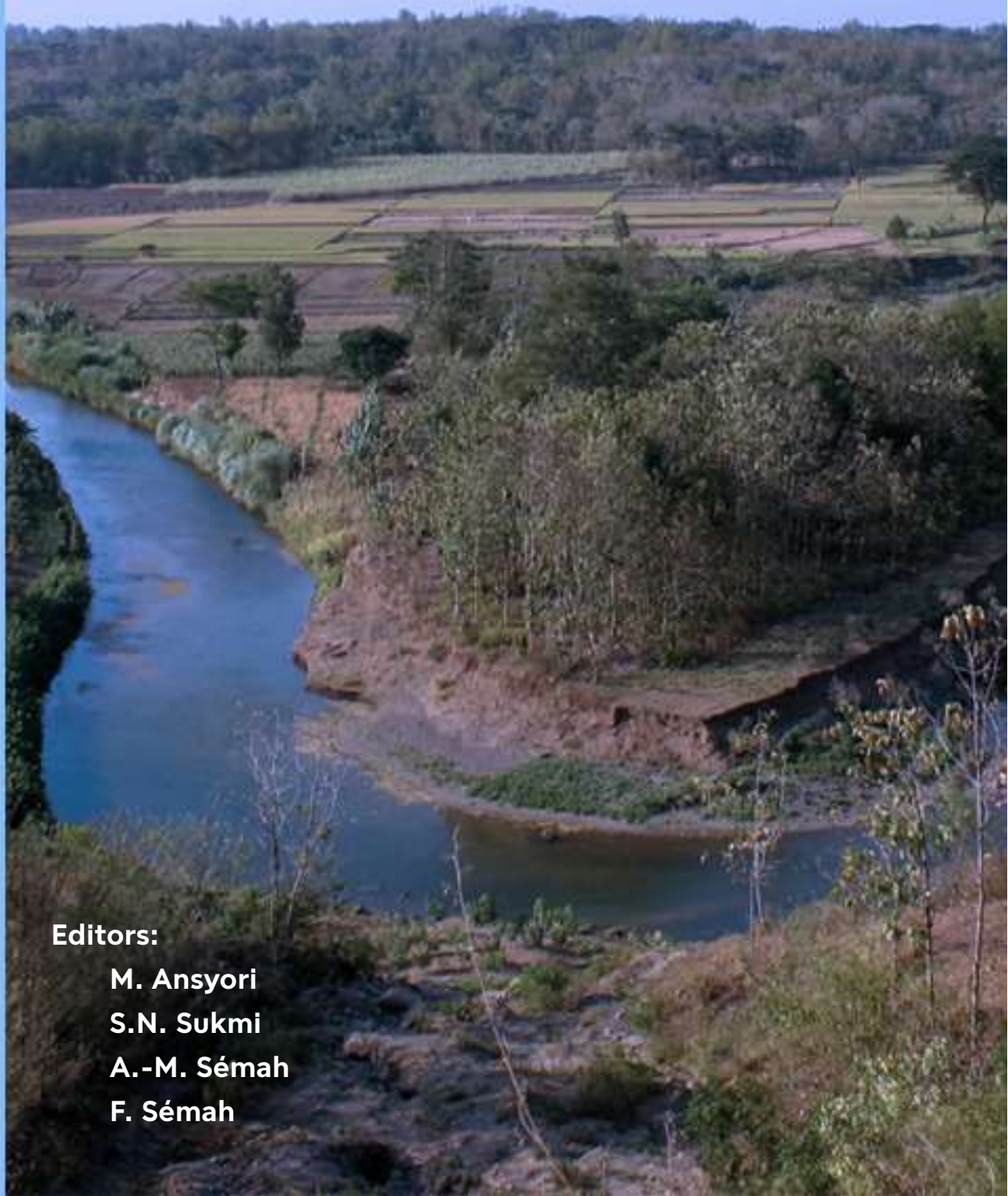
HUMAN ORIGINS HERITAGE

SANGIRAN INTERNATIONAL YOUTH FORUM

Human Origins Heritage

SIYF
SANGIRAN INTERNATIONAL YOUTH FORUM

# SANGIRAN TODAY II: Starring Heritage




**Editors:**

**M. Ansyori**

**S.N. Sukmi**

**A.-M. Sémah**

**F. Sémah**

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ISBN


HOH
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# Acronyms Used in the Text

**ASU**: Alliance Sorbonne Université

**CHEADSEA**: Center for Human Evolution, Adaptations, Dispersals in Southeast Asia (UNESCO Cat. 2 Center)

**IFI**: Institut Français d'Indonésie, Ambassade de France, Jakarta, Indonesia

**IHA (MCB)**: Indonesian Heritage Agency, Ministry of Culture, Indonesia

**IMQP**: Erasmus Mundus International Master in Quaternary and Prehistory

**IPT**: Instituto Politécnico Tomar, Portugal

**MCB (IHA)**: (Direktorat Museum & Cagar Budaya), Indonesian Heritage Agency, Ministry of Culture, Indonesia

**MEAE**: Ministère de l'Europe et des Affaires Etrangères, France

**MNHN**: Muséum national d'histoire naturelle, Paris, France

**POKDARWIS**: Kelompok Sadar Wisata (Association for Tourism Awareness)

**SIYF**: Sangiran International Youth Forum

**UISPP**: International Union of Prehistoric and Protohistoric Sciences

**UKSW**: Universitas Kristen Satya Wacana, Salatiga, Indonesia

**UMS**: Universitas Muhammadiyah Surakarta, Indonesia

**UNAND**: Universitas Andalas, Padang, Indonesia

**UNESCO**: United Nations Educational, Scientific and Cultural Organization

**UNHAS**: Universitas Hasanuddin, Makassar, Indonesia

**UNS**: Universitas Sebelas Maret, Solo, Indonesia

**URV**: Universitat Rovira I Virgili, Tarragona, Spain

**UNIFE**: Università Degli Studi di Ferrara, Italy

**WB**: (Direktorat Warisan Budaya), Directorate of Cultural Heritage, Ministry of Culture, Indonesia

**WH**: World Heritage

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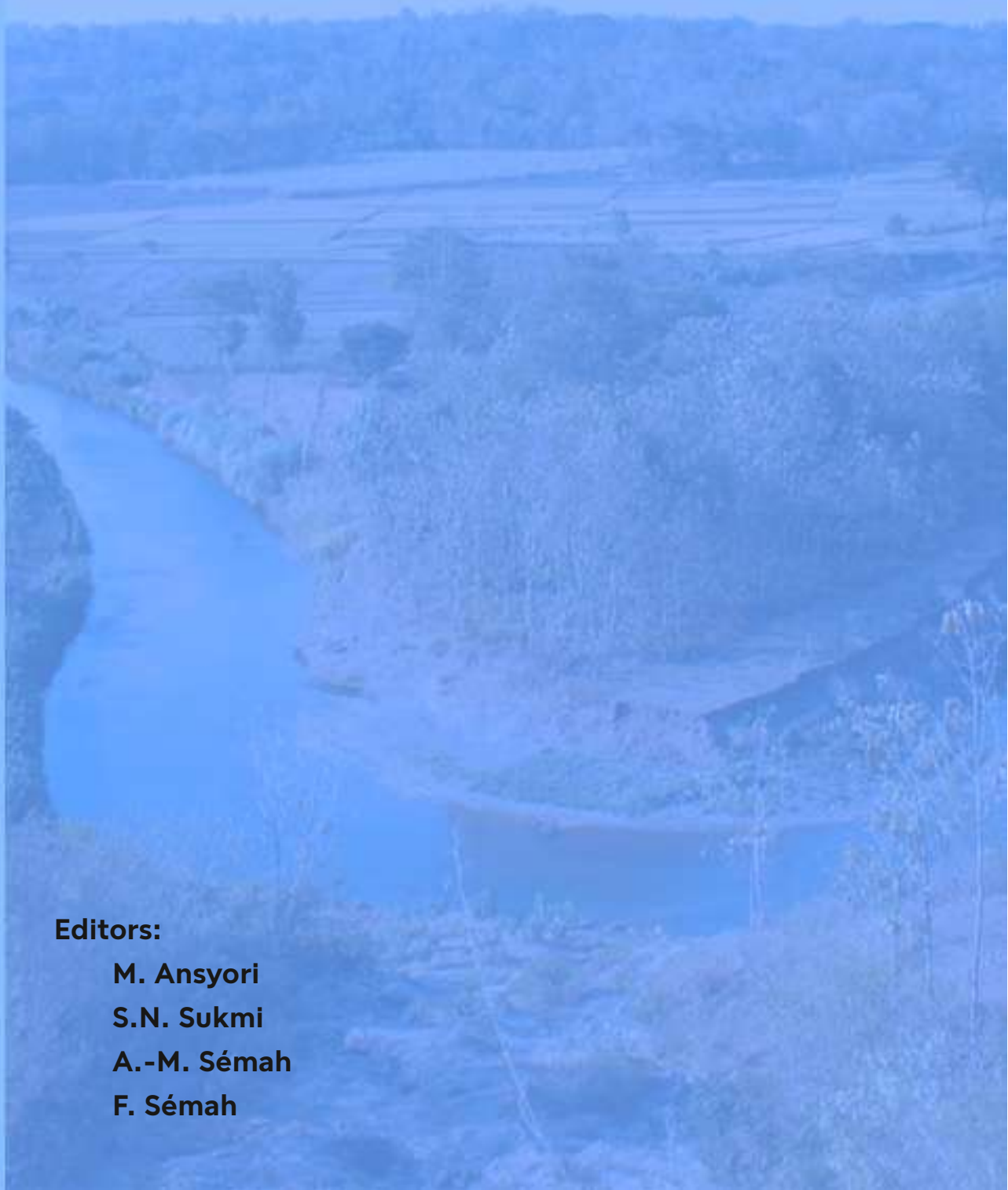


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# PART A


HOH
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Participants of Human Origins Heritage and Sangiran International Youth Forum Participatory School 2025

# Challenges and Opportunities in Managing Indonesia's Prehistoric Heritage

**By**

Ismunandar, FMIPA, Institut Teknologi Bandung, Indonesian Academy of Sciences & Ministry of Culture, Jakarta, Indonesia,
ismu0906@gmail.com

**Abstract**

Indonesia's prehistoric heritage spans an extraordinary I.5 million years, offering invaluable insights into human evolution and cultural development. From the early presence of *Homo erectus* to the advanced metal-age societies, these archaeological treasures provide a unique window into humanity's past. However, preserving and managing this heritage comes with significant challenges, including environmental degradation, human interference, and governance limitations. At the same time, emerging opportunities in digital preservation, international collaboration, and sustainable tourism offer promising solutions. This paper examines both the obstacles and potential strategies for safeguarding Indonesia's prehistoric legacy, emphasizing the need for improved conservation efforts, capacity building, and public engagement.

**Keywords:**

Prehistoric heritage management, governance, sustainable development

# 1- Introduction

Indonesia's prehistoric heritage stands as one of the most significant in the world, chronicling human history from the Pleistocene era to the dawn of recorded civilization. Key sites such as Sangiran in Java, Liang Bua Cave in Flores, and the megalithic traditions of Sulawesi reveal crucial evidence about early human migration, technological innovation, and cultural evolution. Despite this wealth of archaeological material, Indonesia's prehistoric heritage remains under-researched and insufficiently promoted. This paper explores the difficulties in preserving and managing these sites while identifying opportunities to enhance conservation, research, and global recognition.

# 2- The uniqueness of Indonesia's prehistoric heritage

Indonesia holds a distinctive place in the study of human prehistory due to several factors. The archipelago functioned as a critical crossroads for early human migrations, including the movements of *Homo erectus* and later *Homo sapiens*. This geographic position facilitated diverse cultural developments, from the production of Acheulean tools east of the Wallace Line to the creation of symbolic artifacts in Sulawesi. These discoveries challenge traditional Eurocentric narratives of cultural progression and highlight Indonesia's contributions to our understanding of human adaptation and creativity. Nevertheless, many prehistoric sites in Indonesia are still poorly documented, and public awareness of their significance remains limited.

# 3- Challenges in managing Indonesia's prehistoric heritage

## 3.1 Environmental and natural threats

Indonesia's prehistoric sites face numerous environmental hazards. Coastal and cave locations, such as those in Sulawesi containing ancient rock art, are particularly vulnerable to erosion and rising sea levels caused by climate change. Additionally, the country's high tectonic activity poses a constant risk to important archaeological sites, including the UNESCO-listed Sangiran Dome, which could be damaged by earthquakes or volcanic eruptions.

## 3.2 Human-induced pressures

Human activities further exacerbate the threats to Indonesia's prehistoric heritage. Rapid urbanization and agricultural expansion often encroach upon archaeological sites, leading to their destruction or degradation. Illegal excavations and the looting of artifacts for the black market also deprive Indonesia of valuable cultural property, disrupting scientific research and diminishing the nation's historical legacy.

Prof. Ismunandar's lecture

### 3.3 Governance and management issues

Effective management of prehistoric heritage is hindered by several systemic issues. The absence of a unified digital database results in fragmented records and inefficient tracking of artifacts. Many museums suffer from inadequate funding, outdated display methods, and a shortage of trained personnel, limiting their ability to preserve and present prehistoric collections. Furthermore, while Indonesia has established legal frameworks for heritage protection, enforcement remains inconsistent, allowing neglect and exploitation to persist.

## 4- Opportunities for improvement

### 4.1 Digital preservation and unified databases

One promising solution is the development of a centralized digital archive for prehistoric artifacts, linked with institutions such as BRIN, the Ministry of Education, and the Ministry of Culture. Such a system would facilitate better documentation, research access, and long-term preservation. Advanced technologies like 3D scanning and virtual reconstructions could also help safeguard fragile relics while making them accessible to a global audience.

### 4.2 Capacity building and research leadership

Strengthening Indonesia's role in prehistoric research requires enhanced collaboration with international organizations like UISPP and CHEADSEA. Investing in specialized training programs for archaeologists, conservators, and museum staff would improve the country's capacity to manage its heritage

From left to right: Harry Widianto, Anne-marie Sémah, Sadiman Subur (the head of Pokdarwis Wonderful Sangiran), Hernawan (Sangiran resident), Wakimin (Budi Karsa), Titi Susilowati Prabawa, Ismunandar

effectively. By fostering local expertise, Indonesia can take a leading position in global archaeological studies.

### 4.3 UNESCO world heritage and global diplomacy

Expanding UNESCO World Heritage nominations for Indonesian prehistoric sites could elevate their international profile and secure additional conservation resources. Sites currently at risk could benefit from inclusion in the List of World Heritage in Danger, which would mobilize urgent support and funding. Diplomatic efforts to highlight Indonesia's prehistoric significance can also strengthen its cultural influence on the global stage.

### 4.4 Sustainable tourism and public engagement

Adopting sustainable tourism models, such as the Historic Urban Landscape approach, can help balance visitor access with conservation needs. Museums and heritage sites should enhance their exhibitions with interactive and educational elements to engage the public more effectively. By making prehistory more accessible and appealing, Indonesia can foster greater appreciation and stewardship of its archaeological treasures.

## 5- Conclusion

Indonesia's prehistoric heritage is an irreplaceable part of human history, yet it faces mounting threats from environmental, human, and governance challenges. Addressing these issues demands a multifaceted approach, incorporating digital innovation, international partnerships, and sustainable tourism practices. By

improving conservation strategies, investing in education, and raising public awareness, Indonesia can protect its prehistoric legacy for future generations.

Preserving this heritage aligns with Indonesia's constitutional mandate to advance knowledge and promote global peace. Through coordinated efforts at local, national, and international levels, Indonesia can ensure that its prehistoric sites continue to inspire and educate, contributing to a deeper understanding of humanity's shared past.

# Sangiran Today II: Starring Heritage an International Participatory School in Sangiran World Heritage Site (Indonesia)

**By [Editors of the volume]**

François Sémah, Muséum national d'histoire naturelle, Paris, France & Universitas Kristen Satya Wacana, Salatiga, Indonesia, francois.semah@mnhn.fr

Mirza Ansyori, Universitas Kristen Satya Wacana, Salatiga, Indonesia, mirza.ansyori@uksw.edu

Sih Natalia Sukmi, Universitas Kristen Satya Wacana, Salatiga, Indonesia, sih.natalia@uksw.edu

Anne-Marie Sémah, Muséum national d'histoire naturelle, Paris, France, anne-marie.semah@mnhn.fr

**and [other Organizers]**

Anton Ferdianto, National Research and Innovation Agency, Jakarta, Indonesia, antonferdianto18@gmail.com

Titi Susilowati Prabawa, Universitas Kristen Satya Wacana, Salatiga, Indonesia, titi.susilowati@uksw.edu

Marisa Christina Tapilouw, Universitas Kristen Satya Wacana, Salatiga, Indonesia, marisa.tapilouw@uksw.edu

Marlia Yuliyanti Rosidah, Indonesian Heritage Agency, Ministry of Culture, Jakarta/Sangiran, Indonesia, marlia.yuliyanti@kemdikbud.go.id,

Harry Widianto, National Research and Innovation Agency, Jakarta, Indonesia, harrywidianto58@gmail.com

# I- From HOH to HOH/SIYF

The HOH International Participatory Training School began in 2018, stemming from the scientific, academic training and scientific dissemination cooperation between UKSW and MNHN (Figure I). We shall not repeat here all the characteristics of the project, advising the reader to refer to the previous published volume (Sangiran Today: a New Experience 2018-2019), easily accessible online at https://hoh.uksw.edu . We shall just remind

## a couple of 'founding' considerations:

- dealing with a heritage property is by essence inter- and trans-disciplinary, as the object is embedded in a landscape, a society and a nation;
- whatever the professional future of the involved students, they are likely to face situations needing to address a heritage-related challenge, and the various associated stakeholders, at the first rank local communities;
- dealing with such challenges must be in line with the World Heritage strategic objectives;

**and of academic objectives:**

- open the students to topics at the crossroads of research, conservation and development;
- allow them to face real world situations and all the associated complexity;
- provide them with a unique opportunity of international and intercultural opening;

without forgetting that a HOH-like project is supposed to open new practical horizons in terms of participatory sciences.

In 2024, the IHA/MCB successfully applied to the World Heritage Volunteers Initiative, presenting a project merging the so-called "Sangiran International Youth Forum" (SIYF) with the current HOH project. Selected students, originating from Sangiran area, hence representing the local rising generation, involved in various higher education programs, spent the whole HOH fieldwork period with HOH students and subsequently developed their own activities all year long in tight collaboration with IHA/MCB.

The experience proved to be a fruitful one for the project mode working process already established for HOH. For the 2025 edition, it was therefore decided to continue the tight collaboration between both the HOH academic program and the SIYF UNESCO supported initiative.


Figure I. The opening of HOH international participatory school by deputy rector Prof. Yafet Y. W. Rissy.

## 2- The HOH/SIYF 2025 Edition

This edition was assigned a specific mission, elaborated by IHA/MCB, UKSW (together with MNHN) and BRIN, main organizers of the forthcoming UISPP inter-congress conference in late October, 2025: "Asian Prehistory Today: Bridging Science, Heritage and Development" (APT2025). Part of the conference will take place in Sangiran. The objective is to organize a student-led scientific mediation event and to foresee this event through students' creativity: learning from a scientific topic and translate it into a mediation product involving a participatory approach.

27 students were enrolled in HOH: I2 master students coming from Europe (International Master in Quaternary and Prehistory), representing 8 countries (Brazil, China, France, India, Indonesia, Namibia, Peru, Spain), I4 from UKSW (6 study programs in 4 faculties: development studies, tourism, international relations, psychology, health, sociology) and I from UNAND. 6 groups were shaped by mixing institutions, country of origin and study programs (Figure 2).

I0 students, 9 originating from Sangiran area, joined as SIYF members, together with 9 members of local community organizations (Pokdarwis Wonderful Sangiran and Budi Karsa BUMS).

After the one-month long distance learning activities, the students met for 3 days in Salatiga (shorter exam, roadmap preparation, scientific mentoring … and the famous traditional HOH Wine and Cheese Party) then spent I0 days in Sangiran (one day being devoted to the visit of neighbouring Surakarta city for each group). Besides groups' researches, 3 milestone meetings with the teachers and on-demand mentoring, some sharing sessions with curators and local organizations responsible persons were organized. As usual, a seminar in

Indonesian was organized at the end of the field campaign, during which community members presented the early results.

The almost continuous presence of c. 12 teachers and curators (UKSW, MNHN, IHA/MCB and BRIN) was required during the fieldwork. All students were hosted together in Krikilan village, allowing them to immerse into the local society during the 10 days long field campaign. Four members from Bumiayu and Semedo Pokdarwis (sites located in the western part of Central Java) were invited to participate during 3 days. The Krikilan museum organized a "Night in the museum" event on the last evening.

The HOH students subsequently went back to Salatiga to prepare their report, teachers remaining available for consultation and organizing one or two more milestone meetings. They had the opportunity to visit the city, the Gedong Songo 9th century temple complex on the Ungaran volcano slope, and the Senjoyo spring.

A two days final seminar included lectures, students' projects final evaluation, students' evaluation of the project and two closing parties on the last evenings. Involved SIYF and community members joined again for these last two days.

## 3- The contents

As an introduction to this volume, several explanatory shorter chapters present the main dimensions of the HOH/SIYF project. The first one is from Prof. Dr. Ismunandar (Bandung Institute of Technology), former Delegate of Indonesia at UNESCO and presently Culture Minister's special advisor. Other articles include HOH pedagogical objectives, relation with the recently activated UNESCO Category 2 Center CHEADSEA, important issues re. communication, education and sustainable development in Sangiran. As the students, owing to the scientific mediation aim of the project, had to visit thoroughly the various Sangiran museums, an approach of those museums (purpose, history etc.) is also presented. Last, we added a short statement from one of the most experienced community members, founder of the Pokdarwis Wonderful Sangiran.

In a second part are the students' groups reports, whose structure and content significance is shortly analyzed in part 4 below. We'll just mention here the topics as they were sent to the students several weeks before the school. Explanations were purposely short as the topics must be considered in the framework of the challenge-based learning perspective (see further, Sémah et al., this volume).

Figure 2. HOH 2025' Opening ceremony

**Story telling topics**

**1- *Pithecanthropus erectus***

In a way, one can say that human palaeontology was born in Indonesia at the turn of the 20th century. This is a quite complex and fascinating story from several viewpoints, including science development, history, religion etc.

**2- The Sangiran Dome**

Sangiran site can be considered as a "window" open to understand and describe the history of central Java landscape, environment and climate during the last 2 million years, the period which witnessed the emersion of the area, then its colonization by continental fauna and by humans.

**3- Hominids**

Several kinds of hominids are found in Pleistocene sites in Java, including great apes. The complex story of their dispersals to the islands, their evolution, coexistence and extinction raises several major scientific questions.

**4- Adaptation**

During more than one million years, several *Homo erectus* forms settled in Java Island. How did they cope and adapt with the environment, from both the biological and cultural viewpoints? How did they survive?

**Site's narratives: the Ngebung area in the Sangiran dome**

**5- Preserving and displaying stratigraphy**

An easily accessible stratigraphical section in Ngebung begins with the Grenzbank and ends with the top alluvia, via the layers which yielded 0.8 million years old *Homo erectus* occupation floors and also important human fossils. After due cleaning of the section, we must signpost and explain the main stratigraphical milestones and discoveries along this section.

**6- A "site exhibition" in the Ngebung museum**

Grounding on the field evidence and also on all the major discoveries made in Ngebung, the purpose is to build in the existing Ngebung museum a smaller but sound exhibition fostering the dialogue between the site museum and the site itself.

## 4- The HOH/SIYF project's outcomes

### 4.1. The dynamic of the groups and the human keys for success

The HOH pedagogical objectives and methods are detailed in another part of this volume (see further, Sémah et al.). They can of course be considered as quite ambitious when confronted to the reality of the HOH/SIYF participants' diversity and to the dynamics needs of the groups.

Indeed, building inter-disciplinarity had to begin since the earliest stage of the school, i.e. one month before meeting in Salatiga, when the groups of students were formed and informed of their topic. Open mindedness must begin among 'classmates' before facing other stakeholder groups. Students who identified and shared early the difficulties they met to enter another discipline than their major and to acquire the necessary knowledge were those who proved to be the most pro-active to make their group project successful.

Not surprisingly, it therefore appears that the best results in terms of fieldwork project were reached by groups whose members were willing to develop an actual interdisciplinary atmosphere. This didn't happen without difficulties: several of their members got -even emotionally- confused when facing this challenge. They shared their doubts with the teachers, but those very doubts were in fact the demonstration of their constructive concern.

This concern, among a multidisciplinary group of students, has been the key towards success. The degree of 'interdisciplinary compactness' reached by the group of students determined to which extent they were able, not to 'integrate' new members in the group (i.e. SIYF local students and members of communities), but to actually form with the 'newcomers' a unique group able to synthetize various points of view.

From the fieldwork viewpoint, the success of a group also highly depended on the willingness of those 'new' members, the ones who are able to open the way towards a holistic, transdisciplinary approach of the complex local reality.

SIYF students who played an important role to enrich their group's project were those who feel pride re. their homeland and related heritage, grasping academic knowledge and actively developing contacts with a larger audience among the local communities, hence providing the project with new dimensions of local knowledge.

Members of local organizations (Pokdarwis Wonderful Sangiran and Budi Karsa BUMS) who did the same also proved to be the most efficient ones, while conveying also messages related to the daily socio-economical context in Sangiran. Their participation could sometimes result into the expression of latent conflicts or misunderstandings with other stakeholders (e.g. local government), but such viewpoints, as long as they were considered factually, became opportunities of common reflection and could also contribute to improve the projects' contents.

## 4.2. Structure of students' reports

Writing their reports, all groups were asked to follow the same template, indicating subtitles, approximative length and number of figures, precise questions to be answered:

- State of the art: how is the challenge dealt with presently in Sangiran?
- Scientific messages considered by the group (categorized and prioritized)
- Research activities, in relation with the selection above, explaining if they affected or refined the priorities.
- Considered project: choice of media, how do they match priorities and research results.
- Design of project, highlighting logical relations between elements.
- "Technical table" of what is needed to prepare each element.
- Potential impact (target audiences, World Heritage good practices, local development, indicators).
- References

Students did not meet major difficulties to follow it. The reports included in this volume underwent very light editing, and one must not forget that they were written by students who are still at least 18 months far from their graduation.

## 4.3. Reading students' reports

The reader who looks for an analytic or synthetic scientific paper re. the 6 topics assigned to the students will therefore inevitably be disappointed, as this is not the purpose of such reports. The considerations in part 4.I. above are simple guidelines in order to read the students' reports.

The evaluation of group's activity may appear quite interesting from various viewpoints, some of them beyond the current text:

- If the group undertook actual interdisciplinary exchanges, it should have reached clear and widely understandable description of the challenge and identification of the messages.
- Visiting the different museums (the school deals with scientific mediation) but also sites,
  - Did the group focus on the illustration of their topic (e.g. present or not in the displays), and especially to which point it matches the potential audiences?
  - Did they limit themselves to some evaluation of the museum, positive or not, or identified interesting, maybe missing dimensions useful for their topic?
  - Did they are actively conducted a dialogue involving group's local members (often local guides) and SIYF local students?
- Design of the project: does it include innovative ideas? Which parts reflect, without harming the scientific rigor, non-academic knowledge which documents the group's effort towards transdisciplinarity (e.g. an obvious dimension answering a community's need; the use of local culture in the media etc.)? A good, debated example, is that of the teak, present in Group 4 project (human adaptation during the early Middle Pleistocene): from the one hand we have no certain evidence of its presence during the Middle Pleistocene, but on the other one (i) it is emblematic of an open forest environment and (ii) teak plantations represent a strong extant reality to deal with when living in or visiting Sangiran; it was subsequently decided that the group may make use of a reference to that tree.
- Illustration and references: these last two points were supposed to help to assess the group's multidisciplinary cohesion and interdisciplinary approach. Unfortunately, they represent the weakest ones, for a large part related to the students' lack of experience. Very few paid attention to select (the case being, with the help of teachers) relevant references grounding their assignment, often delivering a more or less 'cosmetic' bibliographic list. The same observation applies for illustration, which quite often lacks of creativity or even relevance. Only a couple of contributions include carefully chosen pictures or some original artwork which is clearly complementing the argument and reflects the group's ideas.

## 4.4. Further dealing with students' reports

The above-described grid is not only intended to evaluate the academic outcome. Practically, it helps to assess the overall quality of the project, and subsequently to extract from it the best and feasible ideas which answer the HOH/SIYF 2025 project goals.

The APT2025 organizers and the IHA/MCB remain free to decide which parts of the projects can be implemented and to which extent for a student-driven event under the auspices of the Ministry of Culture, and subsequently involve the members of the groups in that implementation.

But their task of 'excavating' the students' reports is likely to be exciting, as attested by the shorter excerpts below:

**Group 1 (*Pithecanthropus* discovery)**

"... it was definitely agreed to use Wayang as our primary media [...], inscribed in 2008 on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity. Wayang serves to entertain, educate, and transmit messages [...]. As such, it demands a simplified narrative structure to ensure clarity and accessibility. It is an interactive and engaging medium, ideal for effectively delivering scientific information through light-hearted storytelling. This dual approach allows Wayang to simultaneously captivate the audience's attention and convey educational content."

**Group 2 (Geology)**

"The inspiration for our pop-up book emerged from a direct experience during a discussion activity focused on geological layers. One of our group members creatively bent his notebook into a dome-like shape to illustrate how geological layers can be compressed to form structures such as the Sangiran Dome. This simple yet effective visual demonstration significantly enhanced understanding, particularly for participants without a background in geology. "

**Group 3 (Hominids evolution)**

"[Our] inclusive approach can prove effective. Rather than refuting public beliefs, it is built on them—gently correcting misconceptions through logical reasoning and encouraging a scientific way of thinking. In doing so, we can create a space where science and faith could coexist in dialogue, rather than conflict."

**Group 4 (Adaptation)**

"So, a key innovation in our approach is that the scientific content will be delivered poetically. Rather than presenting technical data in a dry manner, we will weave scientific insights into poems that accompany the scenes. This poetic framing makes complex archaeological information more emotionally resonant and accessible, honoring the rigor of the research while engaging the audience's senses and imagination. "

**Group 5 (Ngebung section signposting)**

"We designed the signs with simple and concise text to attract the curiosity rather than making the visitors bored with too much information. [...] However, all these elements will purposely lack a detailed or very deep explanation, which will create the need for the visitor or observer to go to the museum or ask a local guide if they really want to fully understand what they are seeing and the overall relevance of the site."

**Group 6 (Ngebung museum lobby exhibition)**

"[...] This unit helps visitors see *H. erectus* not as distant relics but as real people who once lived, worked, and survived in this very landscape. The display invites understanding and emotional connection by combining fossils, body reconstructions, and storytelling. The message is clear: Java Man is not a myth but a genuine part of human history rooted in this land."

## 5- Acknowledgments

Editors and organizers express their sincere gratitude to all participants to the program, especially authors and actors who helped the preparation of this volume which depicts our collective reflections.

Other than the teachers and curators involved in the regular teaching and mentoring of students, including, besides the authors of this article and for IHA, Wulandari, Raiz Fathoni, Rindy Gita Wahyuni and Pipit Meilinda, thanks are extended to Prof. Dr. Ismunandar, Prof. Dr. Truman Simanjuntak, Prof. Dr. Harry Widianto (also involved in continuous mentoring), Dr. Herry Yogaswara, Dr. Thierry Goubier, and Dr. Sofwan Noerwidi for delivering formal lectures; to Prof. Dr. Eko Sediyono, Prof. Dr. Willi Toisuta, Dr. Toar Sumakul, Dr. Aldi Lasso, Dr. Yesaya Sandang, Dr. Ferry Karwur, Dr ST Prabowo, Prof. Dr. Thomas Ingicco, I Made Dharma Suteja S.S. M.Si and Abi Kusno M.E.M who contributed by their presence during part of the project to the success of the HOH/SIYF edition.

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museums in Krikilan, Dayu, Bukuran, Ngebung and Manyarejo and, of course our four efficient and patient drivers, Andika, Udin, Wahyu and Yadi.

Several institutions, whose acronyms are explained at the beginning of the volume, supported the implementation of the program. Beyond UKSW, MNHN, IHA/MCB and BRIN who organized, co-financed, and/or fully followed all steps of the action, beyond also the active participation of Pokdarwis Wonderful Sangiran and Budi Karsa BUMS, sincere thanks are due for their support to:

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- European Erasmus + program (E. Mundus International Master in Quaternary and Prehistory & Key Action KA 171)
- Institut Français d'Indonésie & Ministère de l'Europe et des Affaires Etrangères, France
- National Geographic Society
- UNESCO

# Human Origins Heritage: Meeting around Interdisciplinarity, Heading towards Transdisciplinarity

**By**

François Sémah, Muséum national d'histoire naturelle, Paris, France & Universitas Kristen Satya Wacana, Salatiga, Indonesia, francois.semah@mnhn.fr

Titi Susilowati Prabawa, Universitas Kristen Satya Wacana, Salatiga, Indonesia, titi.susilowati@uksw.edu

Marta Arzarello, Università Degli Studi di Ferrara, Italy, rzrmrt@unife.it

Anne-Laure Guieysse-Peugeot, Muséum national d'histoire naturelle, Paris, France, guieysse@mnhn.fr

**Abstract**

This brief article has no ambition to explore the immense world of teaching interdisciplinarity, although the latter is still far from being considered enough in the countries involved in the Human Origins Heritage participatory training school. In the framework of the 2025 HOH edition, deliberately oriented towards scientific mediation, it is intended to highlight the common pedagogical purposes and processes which ground the academic aspect of the school, to try to analyze how a multicultural and multidisciplinary group of students can develop an interdisciplinary approach of heritage and can involve members of communities living on a World Heritage site (as well as other stakeholders). By doing so, we explore to which extent they can integrate a part of transdisciplinarity in their project and, together with local stakeholders, deliver an outcome impacting heritage conservation, dissemination and development.

**Keywords:**

Prehistory, Challenge-based learning, Scientific mediation, Interdisciplinarity, Transdisciplinarity

## Preamble

*Arriving in Salatiga, before undertaking their fieldwork, all students who are enrolled in the Human Origins Heritage International Participatory Training School (HOH) have to pass a shorter multiple-choice exam about the basic, multidisciplinary knowledge they must have acquired before the school. We added a last, quite simple question, asking which answer totally fulfills the school's basic academic goal in terms of higher education training: (1) Being able to meet different cultures, languages and people or (2) Enhance student's transversal skills or (3) Learn a lot about Museology and Quaternary Geology.*

*Surprisingly enough, only half of the students chose the second answer, an observation that shows that paving the way towards interdisciplinarity in students' minds is not necessarily an easy task.*

## 1- Introduction

Referring to the volume published by Sukmi et al. (2021) about the Human Origins Heritage International Participatory School, the Sangiran Dome in Central Java, one of the few human evolution related sites inscribed on the World Heritage List, is also certainly the most populated one. As such, activities at the crossroads of science and conservation are particularly relevant there, including at the first rank those which are conducted in a participatory perspective.

Three of the strategic objectives of the World Heritage Center, respectively Capacity Building, Communication and Communities, are at the heart of the HOH school. In 2025, its purpose is to prepare a scientific mediation event to be presented in a forthcoming international conference, grounding on concrete projects designed by students (see previous article).

The project was also the opportunity, for teachers in charge of the design of the school at the international scale, to develop a deeper exchange about HOH pedagogical practices, and to observe the implemented processes and the concrete outcomes of the school. Such a reflection, which can also be applied for future editions of the project, enriches their appraisal of the impact of HOH on their institutional pedagogical objectives.

## 2- Institutions sharing a common goal

Although actual interdisciplinary or liberal arts academic programs are not that common in the countries of the higher educational institutions involved in the HOH program, for a long time interdisciplinarity represents a goal for them.


Figure I. Meeting with students in Salatiga before going to the field

In Satya Wacana University, the Tourism Destinations Study Program, the Master and the Doctoral Program in Sustainable Development Studies are implemented under the auspices of the Interdisciplinary Faculty with the aim of developing a more comprehensive and holistic scientific approach to development issues, including tourism which is a crucial issue for Indonesia. Such approaches stem from the obvious complexity of issues related to planning and practices oriented to sustainable development, which cannot be dealt with from a single disciplinary perspective. By introducing students to interdisciplinarity through learning, they are expected to be able to analyze development issues more critically, analytically and holistically.

The Muséum national d'histoire naturelle delivers a Master degree "Biodiversity, Evolution, Ecology", including 7 specialized cursi from "Museology of Sciences" up to "Environment and Health" via "Quaternary, Prehistory and Bioarchaeology". Such a diversity in an institution clearly positioned at the crossroads of earth, life, human and social sciences, implies an effort towards interdisciplinarity. Students have common courses and mixed group project assignments helping them to develop their skills beyond the classical disciplinary boundaries. In the perspective of their future professional life, most of them will have to be able to build, or at least facilitate, dialogues aiming at solving a problem by the conjunction of several approaches.

The Erasmus Mundus International Master in Quaternary and Prehistory (IMQP) is one of the very few schools related to archaeology at the European scale. Prehistory is by essence a multidisciplinary scientific domain. It trains young scientists who, for an important part of them, intends to specialize in a cutting-edge approach - e.g. radiometric dating of Quaternary sequences- but also future curators, museographers or site responsible persons. In all cases, they will have at one point to manage prehistoric heritage and the cursus must teach an interdisciplinary approach at the crossroads of science and conservation.

## 3- Developing specific pedagogical approaches: CBL & HOH

Developing critical thinking, group working aptitude, creativity, overcoming disciplinary boundaries, acquiring transversal skills are but a few keywords that guide our institutions in such an effort towards interdisciplinarity. Each of the above-mentioned higher educational program explores various, more or less innovative ways of developing interdisciplinarity, including mentored project mode working, hybrid teaching modules, etc.

The 2025 HOH Edition was basically oriented to challenge-based learning (CBL). We shall not repeat here the fundamental aspects of a pedagogical method quite widely described in the literature, although the term 'challenge-based' is sometimes understood in different ways, beyond the basic three steps approach: engaging-researching-acting (see for example the guidebook published by Apple Inc. 2011 or the literature review of Gallagher and Savage, 2020).

One relevant presentation of the method is that of Imanbayeva et al. (2023), which underlines some CBL dimensions which appear fully compatible with HOH goals as shown by the following examples:

| Imanbayeva et al. (2023) | Identified goals for HOH Program |
|---|---|
| Interaction with the real world | Making the students deal with situations comparable to those they will face in their professional life. |
| Developing reflection about existing knowledge | Acquiring basic knowledge about prehistory, communication, development and participatory sciences, but especially find, in a collaborative inter-students way, how these knowledges can be linked. |
| Role of the group for acquiring inter-disciplinary knowledge and soft skills | The basic learning approach, implemented before the practical school, involves a multitidisciplinary group intended to develop a first interdisciplinary dialogue. |
| Engaging in a wicked problem | Management of the Sangiran Early Man site (World Heritage) involves numerous stakeholders whose interests are quite different. Delivering a common message represents a complex task. |

Figure 2. Update with group 5 students in Ngebung site

Interestingly enough, Imanbayeva et al.'s approach discriminates several levels in CBL, which differ notably by the role of teachers/supervisors, the autonomy of the students' group, and the degree of impact (immediate or not) on the solution of the faced problem. From such a viewpoint, the HOH school enters the category of "moderate CBL", including some characteristics that will be developed below, e.g.:

- Students form a multidisciplinary group of co-learners and inter-disciplinary collaboration is fostered
- Semi-fixed learning in the real world
- Semi-fixed Learning and Teaching for the offered learning activities
- Flexible Learning and Teaching for self-regulated learning and group work

## 4- Learning and teaching during the school

The term "Semi-fixed" learning mentioned by Imanbayeva et al. (op.cit.) applies in our case, as it covers various didactic approaches converging towards our pedagogical aim.

The students receive, c. one month in advance, scientific multidisciplinary handouts that they are supposed to study before they meet in Salatiga. Their mixed project groups are already established, so that they can exchange and especially help each other depending on their cursus (e.g. prehistory vs. communication). This way of doing is, notably, intended to pave the way towards an actual interdisciplinary working method among each group.

More than a classical knowledge control, the short preliminary exam (see Preamble) is intended to help them to identify the requested level of knowledge that they should have reached in each discipline in order to be able to face their challenge. Obviously, individual weaknesses appear in several disciplines, which are supposed to lead the student to further discuss with the group's classmates (and with teachers), an 'osmotic' process fostering the interdisciplinary approach of the group.

Teaching sessions during the school's practical activities are maintained. Besides keeping the 'academic' atmosphere, they aim at reminding that in real world 'we can learn from anybody'. Formal and informal sharing sessions are organized together with different stakeholders involved the school, such as museum curators or experienced members of communities (local guides, members of local organizations having implemented scientific public displays or heritage celebration initiatives).

On-demand mentoring of groups remains available anytime (and organized in case the group doesn't regularly require it). Such mentoring can involve, whenever necessary, 'specialized' exchanges with a teacher re. her/his speciality (e.g. palaeoanthropology, communication etc.). But several milestone meetings are also organized with the group, analyzing their progress from all dimensions required by the challenge they deal with.

## 5- Attractive topics but wicked challenges

### 5.1. Students dealing with challenges

Dealing with scientific mediation, the 2025 HOH edition stems from topics that must be attractive by essence, e.g. "The impact of the discovery of *Pithecanthropus erectus* at the turn of the 20th century" (see Sémah et al., this volume).

Figure 3.
Instant mediation exercise on a specific object in Sangiran

Figure 4.
Evaluation of the program by the students

In line with their early multidisciplinary and multicultural composition, the groups of students are asked since the beginning of the distance-learning phase to undertake common reflection about the assigned challenge, undertake relevant literature research in their major field, and begin to identify the most important related questions to deal with during the school. These data are subsequently shared with the teachers upon arrival in Salatiga during a first milestone meeting in order to guide them to undertake the fieldwork together with other stakeholders.

During the first days of fieldwork, shorter oral exercises are also organized for the whole cohort on the basis of 'instant micro-challenges' in order to help the students in their approach. The process is for any participant to present in a couple of minutes, after short preparation and in an attractive scientific but widely understandable way, the meaning of an heritage object (e.g. a site, a fossil, an artefact) she or he approached during the fieldwork. Such very short exercises prove to be very useful for the students to feel the difficulty to deal with a mediation challenge, although they sometimes can appear painful-even emotionally.

## 5.2. Group composition and stakeholders

Diversity among students' groups represent a richness: experience shows that mixing up disciplines and even, for a part, academic levels (part of the participants are undergraduate) fosters the quality of intra-group relationships.

Integrating other stakeholder groups within the students' working groups needs specific attention:

- No problem appears from the viewpoint of authorities in charge of heritage (e.g. museum curators, who take part in program supervision or can be asked to provide sharing sessions); the same observation is valid for local authorities (e.g. Regency officers) whom the students meet on several, already framed, opportunities.

- Members of communities are involved in the project during the whole fieldwork period. Among those who become members of students' groups, we find people who are for a long time working together the scientists associated to the project, and/or prominent members of local tourism awareness community organizations. They play an important part in the students' contacts with a larger community. Nevertheless, some groups also include 'new' local members, implying an attentive follow-up of their integration by the teachers, so that their full contribution can be expected.

- Since 2024, the HOH program is, to a certain degree, merged with the new Sangiran International Youth Forum (SIYF) initiative conducted by the Sangiran Conservation Office. This kind of project, encouraged by UNESCO, was implemented in Sangiran by involving young people originating from the very site area and engaged in undergraduate studies. They subsequently were integrated in the students' groups during the whole fieldwork period. Depending on their intellectual appetite, their role as members of the local rising generation can be complemented by a deeper involvement in the students' group project.

## 5.3. Towards trans-disciplinarity: the multiple dimensions of a wicked challenge

Looking at the composition of the local socio-cultural environment, the above-mentioned diversity of involved actors appears as a necessary constrain. It nevertheless clearly contributes to the difficulty to implement any participatory project on the site, including and also beyond the challenges identified for the HOH 2025 edition. Among the various aspects to be taken into account are the constraining regulations linked to the World Heritage status of the site, the economic situation of the villagers, the quality and intensity of the relation they develop with the several museums established throughout the property, sometimes the conflicts that may appear with the authorities etc.

But it is clear that knowledge and awareness about heritage, whatever the form it takes, becomes the meeting point of all participants, maybe the only one that is able to open a constructive way, provided the conception of heritage is broadly considered (i.e. beyond prehistory, including its natural, historical and living aspects).

Such an assertion may appear quite simple in principle, but it encompasses a quite complex multi-dimensional reality. Obviously, it doesn't seem possible to ask the students, facing this real-world complexity, to find in a short time all the mandatory keys that allow to deal with their challenge in a fully holistic way. However, realizing this complexity itself and its components already represents for them a significant step towards an actual trans-disciplinary approach.

From the single pedagogical aspect, this step dealing with transdisciplinarity is probably the one that requires the most the attention from the teachers, as any bias in the implementation of the program can harm its scientific rigor.

For example, it is mandatory to consider how and to which extent the local, traditional or legendary knowledge, part of the above-mentioned multi-dimensional reality, is taken into account. In the case of a mediation project, such knowledge can help a lot to identify and select the most attractive aspects of the topic. However, the final mediation product has to keep its scientific rigor, and pay attention not to deliver a vague, not fully scientific storytelling mixing up various kinds and levels of knowledge.

From another point of view, the teachers must take care, especially during the milestone meetings of each group, that each stakeholder group conserves its own identity and its own word in the process, without accepting automatically another (internal or external to the group) stakeholder category's opinion. The risk always exists that one category becomes dominant, either because of its authority or because its scientific skills, preventing the 'dominated' one to elaborate an original opinion.

## 6- Conclusion

The HOH participatory training school is, basically, an academic training module awarding credits within the teaching programs involved in its design and implementation. It is also a useful smaller experimental pedagogical laboratory for the related institutions, fostering, notably, the development of interdisciplinarity.

While dealing directly with three of the World Heritage strategic objectives (see Introduction) it is also related to the two remaining objectives of Credibility and Conservation. HOH is in fact part of a much more general program addressing research, conservation and management of prehistoric heritage in Island Southeast Asia.

In the framework of this general objective, it directly documents the importance of the role of the students. Considered as 'apprentices', as trainee scientists, they often elicit the trust of community members, who are keen to learn from them but also, more important, to teach them. This role significantly triggers the disclosure of local information, and therefore appears crucial in the perspective of the development of participatory approaches in local prehistory, especially here in the context of the fourth most populated country in the world.

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# Scientific Mediation: a Scaffolding Communication between Science and the Public

**By**

Sih Natalia Sukmi, Universitas Kristen Satya Wacana, Salatiga, Indonesia, sih.natalia@uksw.edu

Marisa Christina Tapilouw, Universitas Kristen Satya Wacana, Salatiga, Indonesia, marisa.tapilouw@uksw.edu

Rizki Amalia Yanuartha,Universitas Kristen Satya Wacana, Salatiga, Indonesia, rizk.amalia@uksw.edu

**Abstract**

This paper explores the transformation of scientific knowledge into accessible public media within the framework of the 2025 Human Origins Heritage (HOH) Program. Central to the program is the concept of scientific mediation, which serves to engage the public particularly through student-led activities in understanding the research and conservation value of prehistoric heritage. The initiative brought together 27 students from interdisciplinary fields and eight countries, fostering a collaborative process of co-constructing and translating scientific knowledge for broader audiences. Through participatory science conducted via engagement with the Sangiran International Youth Forum (SIYF), interactions with local communities, and immersion in the Sangiran World Heritage Site, participants internalized and re-articulated complex scientific themes. This collaboration resulted in the creation of six educational media outputs: a wayang performance, pop-up book, board game, opera, interpretive signage at Ngebung, and interactive exhibition at the Ngebung Museum. These outputs demonstrate how scientific narratives can be effectively communicated to the public, contributing to wider heritage awareness and education.

Keywords:

Scientific mediation, communication, education

# I- Introduction

In recent years, the challenge of effectively communicating science to the general public has become a topic of debate. While most scientific journals primarily cater to researchers and specialists, research findings are often shared at academic conferences and symposia, which are typically attended by professionals. This creates a gap in access to complex scientific knowledge, widening the divide between the scientific community and the non-academic public.

Additionally, recent reports indicate a decline in young people's interest in science. Although this has often been viewed as a secondary concern in scientific advancement, efforts to engage the public in research have grown steadily. One notable development is the rise of participatory science, where structured protocols enable local communities to contribute to data collection. Examples include initiatives like Particip-Arc, where citizens share cultural knowledge, and Vigie-Nature which involves the public in biodiversity monitoring.

In terms of archaeological research and conservation, the public archaeology proposed in the early 1970s reflects a scope from acknowledging communities' interest to meaning-making processes of heritage through open dialogue with professionals . In other words, this field ranges from public curiosity into archaeology in a popular culture context to its role in Cultural Resource Management practices. Moreover, public engagement is vital for both researchers and citizens, especially in archaeological sites like the Sangiran Early Man one. With around 200,000 people living within this World Heritage Site, local livelihoods directly influence the preservation of its prehistoric heritage. Thus, effective strategies to communicate the site's value through education and public outreach are essential.

In 2025, the Human Origins Heritage (HOH) had 27 students from interdisciplinary backgrounds encompassing archaeology, prehistory, communication science, sociology, development studies, international relations, tourism, and nutrition. They developed an idea from six scientific topics regarding prehistoric heritage value in Sangiran Dome into a medium for the audience. The task was different from the seven former HOH editions because in about 20 days in Indonesia, including 10 days of field school in Sangiran, they faced challenges to gather, cultivate, and analyze scientific messages in the first step(see. Afterwards, they collaborated with the Sangiran Youth Forum and local people (the Pokdarwis Wonderful Sangiran and 2 members of Budi Karsa BUMS), transforming it into a popular medium. The works are purposed to share, inform, build awareness, and increase knowledge for society in terms of scientific mediation.

Scientific mediation contains two perspectives: education and communication. Education refers to a stage that covers the cognitive, affective, and psychomotor domains. The educational process in the Human Origin Heritage program happened between students (archaeological & non-archaeological background) and the local community in the Sangiran site, and their collaboration to prolong the scientific knowledge to a wider public. The goals of education are to gain knowledge about the prehistoric value of the Sangiran site and to raise awareness about conserving the Sangiran site.

Communication strategy, then, is needed to bridge the process of education due to the diverse public background. In order to encourage "voluntary participation" of the public in prehistoric heritage conservation, this program proposes two ways of communication to approach the target rather than top-down communication. The reciprocal process is embodied through listening and respecting the local people's knowledge and perspective. However, it has a challenge in obtaining a similar meaning because each actor in heritage management has diverse interests. Therefore, creating a medium as a tool to reach public awareness and understanding becomes a concern in this program.

## 2- State of the art

Science communication is not as simple as translating science into easy language for public comprehension. It comprises communication design strategies that begin by learning deeply the scientific messages, deciding the target audience, finding appropriate content and medium, and designing the prospective impacts as the communication result. A scientific mediation mechanism is needed to serve as an intermediary to transform scientific discourse into a form that is more easily understood by the general public. Efforts to popularize science through the right media not only aim to enhance public science literacy but also contribute to breaking down the boundaries of scientific exclusivity, making science more inclusive, participatory, and transformative.

The diverse background of the participants, whether interdisciplinary and multicultural, increases challenges to embody the media. It means the distinction of interpretation, expectation, skills, and knowledge of understanding heritage value becomes more complex in the construction of scientific messages, even among participants in the group. The second footstep, then, focuses on creatively transforming the messages into a medium based on a target audience (out-group) in a specific project.

Therefore, this writing aims to elaborate on the process of co-creation and co-construction of scientific communication media of the six groups of the Human Origins Heritage Program 2025.

## 3- Scientific mediation in the scaffolding perspective

The scientific mediation revolves around the social learning idea that allows the student to evolve through observation, experience, and experimentation. Vygotskydepicts the learning process as a scaffolding from prior to advanced knowledge (Figure I).


Figure I. A scaffolding approach to understand science and society

In order to dismantle and reshape the relationship between science and society, Vygotsky's scaffolding approach provides a relevant pedagogical framework. In this framework, scientific mediation can be positioned as a scaffolding structure that allows non-experts to move from the zone of actual development (the knowledge they already possess) towards the zone of potential development, which is the understanding of more complex scientific concepts. Through the assistance of popular narratives, visualizations, analogies, and interactive dialogues, in Burner (I986)the scaffolding process supports the gradual and contextual internalization of scientific concepts. Thus, scaffolding not only explains how science is adaptively communicated to the public but also serves as a conceptual foundation for the development of effective mediation strategies in the process of the popularization of science. The following are some steps in student activities in HOH:

I. Internal group learning process to exchange knowledge.

2. External group learning through interaction with the local people.

3. Creating a scientific medium.

Figure 2. Interview of pupils and teachers

The HOH program conducted a participatory approach to reach advanced knowledge. It refers to mixing all the participants in the melting pot to be involved in overall activities, from establishing scientific messages to designing the medium. This approach recognizes the knowledge and role of each party, whether the contribution of students or the local community.

In order to elucidate the scientific mediation processes, the paper is constructed by a qualitative approach with participatory observation methods to examine the dynamics of interaction in the HOH program. Observations were conducted directly on six working groups, each consisting of students from various disciplines (both international and local), local students involved in SIYF and representatives of the local community organized through Pokdarwis Wonderful Sangiran (Kelompok Sadar Wisata) and Budi Karsa BUMS. The focus of the observation was directed towards communication patterns, the formation of shared knowledge, and the social role of each actor in the process of scientific mediation. Data collection related to how interactions between students, teachers, local students, and the community occur within the context of educational activities, both formal and informal, to understand how the processes of scaffolding and co-construction of knowledge take place in cross-social and cultural contexts. This observation technique was chosen to capture the authentic dynamics that emerge in natural situations, as well as to explore the meaning behind each form of interaction that contributes to the collaborative delivery and reception of scientific messages.

## 4- Analysis of students' media initiation

The process of scientific mediation not only occurs linearly between educators and learners, but also through collaborative and multi-party social interactions. The HOH program provides an interactive space that allows for collaborative exploration of archaeological knowledge, communication, and education,

involving relationships between teachers and students, among students, students with the local community, and students with local students. Sharing activities can initiate knowledge exchange between participants. The following table is the result of the scientific medium created by the student groups.

**Table Media initiation**

| Group | Media initiation |
|---|---|
| *Pithecanthropus erectus* | traditional javanese art, *wayang* |
| The Sangiran Dome | Pop-up book |
| Hominids Adaptation | boardgame opera |
| Preserving and displaying stratigraphy | sign-posting |
| A "site exhibition" in Ngebung Museum | "Site exhibition" in the Ngebung museum |

**The first group** elaborates on the topic of *Pithecanthropus erectus*. Their task was simplifying the knowledge about human evolution that could be scrutinized by science development until the discourse about history and religion. According to their observation, the pictures of human evolution obscure the understanding. It is more complex when the characteristic of Indonesians tends to be religious. Therefore, their target audience is the general public. After gathering information during the field study, this group was convinced that wayang or Javanese shadow puppet is the appropriate medium to deploy their scientific message. Wayang is chosen for three reasons: I) it has proximity with the local people as part of Javanese culture, 2) the art of wayang has an aesthetic side that entertains the public, and 3) there is a dalang (a person who plays the shadow puppet) in the Sangiran area. It was a good idea to promote sustainability by involving the local inhabitants in the transfer of knowledge based on their potential.

**The second group** talked about the Sangiran Dome to comprehend the history of the paleoenvironment, including the colonization of continental fauna and humans. The group has specifically focused on children as a target. The idea of a

Figure 3. Lithic making training

pop-up book appeared during the group presentation. Once the group member presented the stratigraphical layers with small book demonstration, he got attractive response from the other students. It means their experience inspires the group to create the medium. During the program, the group also gathers inspiration scientifically and creatively by interviewing the educators and teachers, and also the children, to know their interests and points of view (Figure 2).

**The third group** worked on the topic about hominids. The group found several panels represents human evolution that yield a misconception. The debate about great apes and humans inspired them to make a game that invites the public to gain knowledge and understanding through fun activities. Their idea came up after they conducted the survey to respondents to see their worldview and looking for references from previous board games. Their medium targeted the general public because the topic could be related to children and adults.

**The fourth group** worked on adaptation topic. They challenged to deliver message about how the *Homo erectus* survived in the Java Island. General public becomes their communication target. They proposed theatrical perform to show the interaction between the human with their environment. The idea immersed from the "prehistoric body" group that turn into opera. However, they more reconstruct from the scientific knowledge to build the storytelling. For instance, to gain the illustration of the ancient culture of *Homo erectus*, the students learned how to make and use a stone tool or cracking bones through the simple experience that was conducted by scientist (Figure 3). After discussion and confirmation by the scientists, they chose art show since designing costume until opera narratives. The insight to create costume also inspired the materials that were used by *Homo erectus* and still exist today such as bamboo tree.

**The fifth group** focuses on preserving and displaying stratigraphy. Their task was explaining the main stratigraphical milestones and discoveries of the Ngebung site to preserve the area and communicate the scientific value to the public. To reach their objective, the group cleaned the section to expose the layer or landscape. They chose the sign-posting because it also aligns the museum authorities' master plan that designs the area as a tourism destination, the heritage trail. General public becomes their target, including the local inhabitants because this land is owned by the local people and part of the road route. The signpost could be a marker and trigger for everyone who passes the sites which are crucial for the human evolution.

**The sixth group** focused on creating a "site exhibition" in the Ngebung museum. Their work does not aim to establish a new museum but complements the dialogue between the site and the museum. They tried to bridge the display of the museum to highlight the richness of the site, mirroring in a way the project prepared, in situ, by the fifth group.

## 5- The challenge and strategies of scientific mediation

Different from the process of creating another medium, scientific mediation emphasizes the comprehension of the public about science. The challenge of media production is not merely about making creative media to attract the interest of the target, but it is more about mastering the scientific knowledge as a main resource at the first stage and reaching a similar meaning for the target as the final goal. Collaboration is the key that enables students to draw perspectives from each other in order to solve problems .The student will be a scientific mediator. Hence, ensuring the rigorous angle of the scientific message took the longest time during the program. The interdisciplinary background, then, could be beneficial on one hand because it enriches the abilities to produce creative media, but it becomes a burden in the process. It is because mastering the message or "product knowledge" is mandatory in the

Figure 4. Discussion with supervisors

communication process before creating media. In the HOH program, the scientific message focuses on prehistoric heritage value, particularly in the Sangiran Dome. So that, the non-archaeology discipline students need more effort. However, through intensive communication and discussions through a social and participatory learning approach, the students could pass the challenge.

Determining the target audience is another challenge. In fact, the medium cannot reach the entire audience at the same time in the same way. The students need to learn the characteristics of their target to find an appropriate medium for them. In this situation, the social science students play an important role. Therefore, the collaboration with the local people also becomes crucial. According to the observation, the local students and community help to link the student to society and the environment. For example, after meeting the local musician, the students are inspired to include traditional music in their concept. The student, then, considers the religious aspect that influences the way of thinking and way of life of Indonesian society.

In scientific mediation making, the scientist's position as supervisor becomes critical. Popular media production in advertising or mass and new media usually uses market or public surveys as a basis to construct product knowledge before creating media. However, in scientific mediation, scientific legitimation is fundamental to avoid misguidance or misconception. Finding the angle to approach the value of the prehistoric heritage is a task that needs students' initiative, then evaluation and re-evaluation by the supervisors to ensure that the goal is reached (Figure 4).

According to that explanation, the scaffolding process not only occurs in the stage of constructing scientific knowledge but also in the creation of scientific messages, where the content of science is packaged communicatively according to the cognitive capacity of the audience. Next, at the stage of creating media, the selection of formats and channels for delivering the message also follows the principles of scaffolding to ensure the accessibility of meaning to the public. This process culminates in scientific message transfer, which is the delivery of scientific messages to the wider public in an inclusive and participatory manner. Thus, scientific mediation in the pedagogical realm functions not only as a mechanism for knowledge transfer but also as a social practice that builds an epistemic bridge between science and society.

## 6- Conclusion

The scaffolding process in scientific mediation serves as a vital bridge between expert knowledge and public understanding, transforming complex ideas into accessible insights without sacrificing accuracy. By fostering interactive dialogue, simplifying concepts strategically, and encouraging active cognitive engagement, mediators empower audiences to navigate scientific topics with greater confidence. This two-way effort requiring both skillful communication from experts and openness to learning from the public ensures that scientific knowledge is not just transmitted but meaningfully integrated into societal discourse. Ultimately, effective scaffolding strengthens science communication, cultivates critical thinking, and fosters a more informed and engaged public whichis essential for addressing the challenges of an increasingly science-driven world.

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# Sangiran World Heritage Site Facing Sustainable Tourism Development Challenge

**By**

Titi Susilowati Prabawa, Universitas Kristen Satya Wacana, Salatiga, Indonesia, titi.susilowati@uksw.edu

Aldi Herindra Lasso, Universitas Kristen Satya Wacana, Salatiga, Indonesia, aldi.lasso@uksw.edu

**Abstract**

The Sangiran site, one of the largest and most important Prehistoric Sites in the world was granted the status of World Heritage Site (WHS) status by UNESCO in I996. Five prehistoric museums were established in the site to attract tourists and connect science with the community. However, the site is currently struggling to achieve sustainable tourism development objectives. This article discusses several challenges faced by the Sangiran site in implementing sustainable tourism practices including poverty, tensions among stakeholders, and environmental problems. Although different parties collaborate to achieve sustainable tourism development objectives at the Sangiran World Heritage site, the results are still far from ideal. Despite the potential for the Sangiran Site to become a tourism destination, current development practices lack extensive and meaningful community participation and hardly improve the living standards of the impoverished population.

**Keywords:**

Sangiran, World Heritage Site, sustainable tourism development, challenges, community participation.

# I- Introduction

Sangiran site, as one of the largest and most important Prehistoric Sites in the world, lies 15 kilometers in the north of Solo city in Central Java, Indonesia covering an area of 5600 hectares. Administratively, Sangiran Site is located in Sragen and Karanganyar Regencies, Central Java Province. UNESCO granted the status of World Heritage Site (WHS) in 1996 due to its outstanding universal value for the huge discovery of *Homo erectus* fossil findings in the sites. At Sangiran site, around 100 prehistoric human fossils (*Homo erectus*) have been found or more than 50% of fossil findings in the world, and more than 60% of those found in Indonesia (https://whc.unesco.org/en/list/593/; Hidayat, 2012; Wildan, 2016). In Sangiran Site, since 1996, the Indonesian Government through the Directorate General of Culture has gradually established five prehistoric museums, the Krikilan, Ngebung, Bukuran, Manyarejo and Dayu Museums.

Prior to the establishment of prehistoric museums, one traditional museum has been introduced by Toto Marsono. Toto Marsono was the village chief of Krikilan between 1939-1975. He met Von Koenigswald, a German paleontologist and hosted Koenigswald in his house and supported him during his research by coordinating local workers to help with the excavations. In his absence, Toto Marsono continued coordinating fossil collection in his house and gave financial compensation to the locals who collected fossils (Biets, 2025). In 1974, the Central Java Provincial Government built the first museum next to the Village Meeting Hall of Krikilan Village after the house of Toto Marsono was overloaded with fossils. The establishment of the museum was also meant to serve the needs of the tourists flowing to the site (Wildan, 2016). From then on, the development of museums in Sangiran Sites has experienced expansions and the latest development is the establishment of site museums in five different locations. In addition to the Krikilan museum, tourists can also visit other archaeological museums in Bukuran, Ngebung, Manyarejo and Dayu.

Each museum has specific thematic collections. As mentioned earlier, the oldest and biggest museum of all is the Krikilan Museum. Krikilan Museum is divided into three main exhibition sections. The first area displays the geological and biological richness of Sangiran. The second section exhibits the process of nature formation and the human evolution. The third one presents the golden age of *Homo erectus*. This museum stored more than 22,000 fossil collection. The second one is Ngebung Museum. Ngebung Museum displays particularly, the pictures of main national and international researchers to commemorate their hard work and achievement in contributing to the development of archaeological researches in Sangiran. The third is Bukuran museum which focuses on evolution process of *Homo erectus* archaic, typical to progressive. Visitors can also enjoy the visible storage collecting prehistoric fauna fossils in the museum. The fourth one is Manyarejo museum. This museum exposes excavation box with original fossil inside it. Here, visitors can learn about the relationship between researchers and locals, and also about unique myths

Figure I. Traditional Javanese House - Joglo Style

Figure 2. Traditional Javanese House - Limasan Style

regarding the fossils. The last one is Dayu Museum. Different from other museums which are administratively located in Sragen regency, Dayu Museum is located in Karanganyar regency. At Dayu museum, visitors can learn about prehistoric stratigraphy showing the changing environment from time to time. Dayu is also the place where the oldest stone tools were discovered.

With the recognition from UNESCO for its unique heritage value, Sangiran Site has been expected to attract both domestic and international tourists. The establishment of the museums is meant to boost the number of visitors and to link science to the community. The archaeological site museums not only function as the storage of excavation findings but also a place for both research and education. The site museums employed the modern display techniques for the audience, but were equipped with storage, laboratories, workshops, audio-visual rooms, seminar rooms, and researchers' housing (Widianto et. al., 2023).

Around the world, heritage tourism is gaining its momentum as a tool of development due to its fastest growth compared to other types of tourism activities. The heritage tourism development is expected to bring economic support and improve communities' quality of life by providing a source of income and also better infrastructure. However, the introduction of heritage tourism as a new tool of development to a community is not without challenges. Just like any other types of tourism development, the development of heritage tourism may bring negative environmental and sociocultural impacts. The consequences of tourism development in heritage sites depend on its implementation and management. Both researchers and international organisations such as UNESCO World Heritage Center emphasize the importance of applying sustainable heritage tourism development in order to minimize the negative impacts of tourism on local communities and environment while maximizing its benefits (Ghanem & Saad, 2015). In other words, to meet the sustainable development objectives, tourism development

should go beyond economic efficiency. Without taking into account societal and environmental aspects, the development will result in destructive and hazardous outcomes (Hosseini et. al., 2021).

This article is meant to discuss the challenges of developing sustainable tourism in Sangiran as one of the world heritage sites. The Brundtland Report defined "sustainable development" as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". To operationalise the concepts, Landorf (2009) noted that two key principles of sustainable practice encompass a planning process that is long term and holistic, and multiple stakeholder participation in that planning process. In the following sections, we will discuss a number of challenges faced by Sangiran site to develop sustainable tourism development practices, starting from the problem of poverty, tensions among different stakeholders, and environmental problems. Despite the potential of the Sangiran site to be developed as a tourism destination, the current development performance hardly meets the sustainable development objectives. This is particularly evident in the lack of extensive and meaningful community participation and the failure to improve the living standards of the impoverished population.

## 2- Poverty and tourism development in Sangiran as UNESCO world heritage site

The status as one of the world heritage sites and the establishment of the modern museums in Sangiran have attracted quite a number of tourist visits to the site but the number has fluctuated from time to time. The updated statistical records of visitors as presented in table 1, showed that in 2019 the number of domestic tourists declined compared to the previous year. Then, during the Covid Crisis 2020 and 2021 the number of tourists drastically declined. However, even though starting from 2022 tourist visits slowly started to grow, the number is still much lower than that before the Covid Crisis. The management of Sangiran struggles hard to increase the number of visitors. The visitors' number was only 1 % of the number of the whole tourist visits to Central Java (Dewi & Ristianti, 2021).

The tourism development in Sangiran site is expected to support not only the funding of heritage conservation but the heritage tourism development becomes an alternative source of income for the local community. The cultural heritage should be employed as a revenue generation strategy in the context of developing countries (Nhamo & Katsamudanga, 2019). In the case of Sangiran, we find that the earning from tourism development is still limited and the majority of the local people still can not reap benefits from the tourism development despite the fact that in order to ensure the contribution of heritage tourism to sustainable development, community participation is at stake.

**Table I. Number of Visitors to Museum Sangiran**

| Year | Number of Domestic Tourists | Number of Foreign Tourists | Total |
|---|---|---|---|
| 2018 | 222,748 | 588 | 223,336 |
| 2019 | 188,702 | 1,121 | 189,823 |
| 2020 | 44,771 | 236 | 45,007 |
| 2021 | 28,253 | 5 | 28,258 |
| 2022 | 97,724 | 49 | 97,773 |
| 2023 | 114,940 | 628 | 115,568 |

Source: adapted from the *Central Java in Figures 2018-2023* (Buku Statistik Pariwisata Jawa Tengah Dalam Angka 2018-2023).

Poverty is still a pressing issue in the area of Sangiran world heritage sites. Ironically, all the heritage museums are located in areas with a high level of poverty. The households at Krikilan, Bukuran, Ngebung Museums, at the Kalijambe subdistrict, and Manyarejo at Plupuh sub district in Sragen regency and Dayu Museum at Gondangrejo sub district in Karanganyar regency are those with the highest beneficiaries and food social assistance budget in 2023 (Sragen and Karanganyar Regencies in Figures 2024). Majority of the population make a living as rain-fed rice field farmers. Those who do not own land work as labour for batik industry, farm workers, construction workers and other informal jobs in the surrounding areas, earning low income. Meanwhile, others decided to migrate to big cities hoping to earn better lives and went back to the village after saving some money.

## 3- Capacity of local community to respond to tourism development

With the development of the Sangiran Site as a tourism destination, local initiatives to respond to the development emerged through a number of both economic and socio-cultural activities. However, for the majority of the population, the initiatives still can not bring significant economic benefits. Some may experience livelihood improvement due to the increasing popularity of the sites but many are still struggling to meet their daily needs and the tourism development still does not affect their livelihood positively.

## 4- Emerging economic and socio-cultural activities

There are members of the community who are recruited by the museum management as tourist guides. During the Human Origin Heritage Programme in which we were involved as project supervisors, we met a number of tourist guides who are members of Pokdarwis (Tourism Awareness Group) Wonderful Sangiran. From our discussions and observation, we were assured that they had comprehensive knowledge about the collection in the museum, and the scientific value of the fossils. They also have a good understanding about the environment in Sangiran. They are very motivated to make sure that the fossils are preserved because they were aware about the infinite value of the site in understanding human evolution.

Others who live close to the Krikilan Museum, owning spacious houses with some spare rooms, decided to run homestay businesses. Most of the houses are built in concrete, some are two storey buildings. The fact that the number of houses with traditional javanese architecture in Sangiran, shown in Figures I & 2 have gradually declined is really alarming. As it has been stated in the document published by UNESCO, that the traditional wood and bamboo architecture, besides the traditional lifestyle, folk arts and practices of the local community can elevate the Outstanding Universal Value of Sangiran as the World Heritage Site. The traditional architecture together with other cultural resources in the community will undoubtedly bring added value to the site, if the tourism activities are the choice for development and source of alternative income for the community (UNESCO World Heritage Committee, 2008). In the International Participatory Training on Human Origin Heritage 2022, one group was exploring the perception, barriers and challenges faced by the local community in maintaining the traditional houses. From the interviews conducted with the locals, generally they expressed that maintaining traditional houses is very costly. If they had to maintain the traditional houses, they expected to get supports from the government. According to their experience, when there was a government program for house improvement, they got cement, and bricks, instead of bamboo or wood. This policy may also affect the willingness of the community who own traditional houses to maintain the traditional houses.

Another business is roducing and selling souvenirs for the consumption of tourists. Tourists can find different types of souvenirs sold by the locals in the surroundings of Krikilan Museum such as stone jewellery and statues, T-shirts and batik materials and others. Some products are produced locally and others are ordered from different areas. For example, some stone handicrafts are produced by local craftsmen. However, due to restrictions of stone mining in many parts of the Sangiran site, it was getting more and more difficult to get the materials in the area. The price of production was getting more expensive as the result. Therefore, the sellers would rather order stone handicrafts from outside Sangiran. Meanwhile Batik materials are still produced locally in Plupuh. The problem with the souvenirs sold in Sangiran, they lack of authenticity of the

Figure 3. Field visit for lantern park feasibility study

Figure 4. Lantern park planning and design process

sites and consequently, they fail to convey the authentic meaning and scientific value of the heritage to the public. For the tourists, souvenirs represent the place they visited. Therefore, providing authentic souvenirs reflective of the regions and not the generic ones is prominent (Milman, 2015).

Besides the local initiatives discussed above, additional measures have been undertaken. To distribute tourism revenues more equitably, the local tourism awareness group Pokdarwis Wonderful Sangiran has proposed idea of developing a new, resident managed attraction. This project is meant to be a long term project due to the big fund needed to implement it. Situated approximately 500 m from the Krikilan Museum, this site is planned as a "lantern park" in which illuminated structures depict ancient flora and fauna. Through the Human Origin Heritage (HOH) program in collaboration with the Center for Sustainable Development Studies (CSDS) at the Faculty of Interdisciplinary Studies, Satya Wacana Christian University and MNHN (Muséum National d'histoire naturelle) in Paris. Pokdarwis Wonderful Sangiran received expert

Figure 5. *Hexaprotodon sivalensis* lantern

Figure 6. *Rhizophora* lantern

guidance in both the planning and conceptual design of the park. Figures 3 & 4 show the process of developing the planning and conceptual design of the park.

As the initial actions to realize the park, they start with an incubator project in which the Pokdarwis Wonderful Sangiran opened an exhibition site with scientific posters (Figure 4) and lanterns representing the ancient Hippo (*Hexaprotodon sivalensis*) (Figure 5) and *Rhizophora* (Figure 6). The lanterns were created in the real size visualising the real *Hexaprotodon sivalensis* and *Rhizophora* supervised by archaeologists. Taking into account aesthetic considerations, the lanterns are made of attractive colorful materials to attract school children who are the main market for the museums in Sangiran. From the information in the posters, visitors can learn about the lives of the *Hexaprotodon sivalensis* in the swamp environment. The exhibition site is located strategically near the the Krikilan Museum, the museum with the highest

number of visitors. Even though they still struggle to attract visitors, efforts to convey scientific value to the public are there. They provide a box of appreciation, in which visitors can voluntarily contribute for the continuation of the project.

## 5- Tensions among different stakeholders

Sangiran is one of the heritage sites with high population density as more than 200,000 inhabitants live in the area. Sangiran covers an area of 56 km² but only I percent of the area belongs to the government (Sukronedi & Haryono, 2016). Therefore any policies issued regarding the heritage site affect the locals significantly. The situation is more complex because the majority of the inhabitants depend on cultivating the rain-fed farms or for their living.

Undoubtedly, living in the heritage sites has brought a number of consequences on the livelihood of the locals due to the application of a number of restrictions in order to manage and protect the fossils and maintain the environment. Prior to the designation of the site as the world heritage, the Indonesian government has implemented a number of policies with the intention to protect the fossils at the site. The first was when the Ministry of Education and Culture of the Republic of Indonesia issued the decree number 070/1977 declaring Sangiran area as a nationally protected cultural site of human evolution during the Pleistocene. Later on, in 1992, Law Number 5/1992 was issued and then revised with Law Number II/2010 to equip the Sangiran heritage site with a comprehensive protection including protection from illegal trading of the fossils and area maintenance after the designation of the site as a world heritage (whc.unesco,or/en/list/593/).

Despite a number of positive actions such as reforestation to avoid erosion and landslides, tensions among the community members and also between the community and the government is unavoidable. The enforcement of Law II/2010 brings the consequences on the land management including the private land belonging to the community. Based on the Law, the Sangiran site is divided into different zones for management and conservation purposes. The residents can not easily cultivate the land or change the landscape freely after the implementation of the Law. Before they execute their plan, residents have to report to Indonesian Heritage Agency first and the institution will do assessment to make sure that the activities do not affect the heritage negatively (Suparno, et. al., 2021). These circumstances created significant obstacles for residents seeking to utilize their land for agriculture, which remains their principal source of livelihood.

Consequently, sometimes rivalries among different groups of communities are also heard as the consequences of development policies. Some may consider that others get more benefits or opportunities from the development. During

the field program of Human Origin Heritage, we also observed some emerging tourism initiatives from different community groups. The initiatives are appreciated, however, fragmented communities may trigger frictions and conflicts if communication among the groups is not well maintained. Eventually the social tensions may affect the sustainability of the heritage site as a tourism destination.

## 6- Degrading environmental condition

Good quality of environment is a prominent selling point in tourism industry, meanwhile Sangiran as a world heritage site struggle with the environmental issues which may affect the resources. Although for the moment, the environment of Sangiran including the areas where the most important fossil discoveries were made not optimally promoted as tourist attractions, the environmental challenges in Sangiran have been obvious. Experiences in other more established destinations as shown by Gaughan et al. (2008) in their study in Angkor Vat, Cambodia; the study of Staiff, R., & Ongkhluap, S. (2012) at the Historic City of Ayutthaya, Thailand; the study of Thinh et al. (2019) in Hoi Anh, Vietnam among others showed that tourism activities can either put more burden to the environment or intensify the existing problems. Therefore, environmental management system should be pursued to systematically manage the current environmental problems and anticipate the potential problems caused by tourism development.

The degradation of quality in Sangiran site is mainly caused by water pollution, waste, and illegal construction material mining. The major water pollution in the rivers (Figure 7) come from the batik industry waste. For more than a decade, liquid waste from batik cloth production in Pungsari Village, Plupuh District, Sragen Regency has been flowing to the river, despite the fact that the area is within the protected zone under national law and international regulations (Sugiyanto, 16 Feb. 2025). Apart from water pollution, another alarming issue is the illegal littering. In some places, piles of waste are found in the surrounding. Unmanaged waste can potentially damage the underground artefacts, and affect the aesthetic and image of the world heritage site. Another serious environmental problem is with the illegal construction material mining such as sand, pebbles and stones done illegally at the Sangiran site. As reported in the media, an illegal mining area was found just two kilometers away from the Krikilan Museum. A number of community members expressed their concerns about the negative impact of the mining on the the ecology of the archaeological site (Widjadjadi, 2024).

Figure 7. Water pollution in the river

## 7- Conclusion

This article is exploring the potentials of Sangiran World Heritage Site as Tourism Destination and the challenges faced by the destination in order to meet the sustainable development objectives. Earlier studies showed that tourism development had the potential to become alternative source of income for communities living in the area of world heritage site. The population who live in the Sangiran site live in poverty and depend on the nature for their living by cultivating the land for growing crops and growing teakwood or did construction material mining such as sand, pebbles, and stones prior to the issueing of heritage protection Laws. However, with the issuance of Laws protecting the fossils in the sites, access of the local community to the natural resources is more limited. Therefore tourism development can be a good alternative source of income especially after the designation of Sangiran site as a World Heritage Site.

As a world heritage site, the tourism activities in Sangiran need to comply with the world heritage convention and its operational guidelines issued by UNESCO. The tourism development is implemented in coherence with the principles of sustainable tourism and guaranteeing the conservation of the site's Outstanding Universal Value. And sustainable economic development in the heritage site should be achieved in order to meet the needs of the people without undermining the resource itself (Nhamo & Katsamudanga, 2019).

A number of business initiatives and community engagement in tourism have emerged in Sangiran heritage site, but for some reasons, only limited number of people can benefit from the development. First, the most frequently visited museum is the Krikilan museum which is the oldest and biggest museum among others. Therefore the tourism related business development happens mainly in this area. Second, some locals work as tourist guides for the museums. However,

because the number of tourist visits are limited, only small percentage of locals can be recruited.

Apart from economic issues, the sustainability of the site is also challenged by tensions due to the law enforcement to protect the site and rivalries among different groups in the community due to the imbalance benefits from development.

Despite the importance of sustainable environment for tourism, we found that another significant threat to sustainability in Sangiran is related to the environmental challenges. In addition to the naturally unstable condition of the land in Sangiran, the area also suffers from anthropogenic effects ranging from illegal mining to illegal industry waste management.

Different stakeholders including government, academics and local community have put efforts to ensure the sustainability of the Sangiran world heritage site. Without undermining the long term collective efforts done, to make sure that sustainable tourism development can be achieved, a comprehensive sustainable tourism development planning needs to be defined in Sangiran world heritage site. Ideally, the sustainable planning model should combine three inter-connected dimensions of economy, environmental conservation and social equity into a single, intertwining framework (Padin, 2012).

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# Museums at Sangiran Early Man World Heritage Site

**By**

Harry Widianto, National Research and Innovation Agency, Jakarta, Indonesia
harrywidianto58@gmail.com

**Abstract**

The Indonesian archipelago hosts a rich array of prehistoric sites, spanning from the arrival of *Homo erectus* approximately I.8 million years ago to the Austronesian dispersal in the late Holocene. These sites offer invaluable insights into past human life, culture, and environmental interactions. Among them, Java Island, particularly the Sangiran Dome, stands out as a key region for understanding *Homo erectus* and early human evolution. To communicate these important scientific findings to the broader public, the Indonesian government has established five site museums in Sangiran. These museums serve to bridge the gap between archaeological research and public engagement by bringing the knowledge uncovered at the sites into accessible and educational spaces. In this way, site museums function as vital links between science and society.

**Keywords**

Sangiran Dome, World Heritage, Museum, *Homo erectus*, Pleistocene, Dissemination of Knowledge

## 1- The relation between the value of the sites and the establishment of museums

Prehistoric sites in Indonesia archipelago range from the arrival of *Homo erectus* as the oldest humans 1.8 million years ago (Widianto, 2020; Husson et al., 2022), to the Austronesians dispersal in the second half of the Holocene (Jacob, 1967; Simanjuntak et al., 2016; Widianto & Noerwidi, 2020a). Numerous sites have been studied through surveys and excavations, providing information about human past life, culture and environment (see Soejono, 1993).

Presumably, Java Island should indeed be the main magnet for the study of the life of *Homo erectus* because hominid remains were found in various places (Widianto, 2009), at the first rank Trinil (Dubois, 1924), then Sangiran (Sragen and Karanganyar, Central Java, in 1934), Perning in Mojokerto (East Java, 1936), Sambungmacan (Sragen, 1974), Selopuro (Ngawi), Patiayam (Kudus, Central Java, 1979), Semedo (Tegal, Central Java, 2005), and more recently at Bumiayu (Brebes, Central Java, 2018; Widianto & Noerwidi, 2020b). This distribution of *Homo erectus* sites is representative of the oldest period in Indonesian prehistory, which began 2 million years ago and ended around 100,000 years ago. *Homo erectus* was skilled at making stone tools in the form of chopper-chopping tools referred to as the chopper-chopping tool complex, which is widespread in many parts of the world. So far, the Indonesian archipelago is one of the few centers of human evolution in the world, apart from Africa, Europe, Front Asia, and East Asia.

This extraordinary scientific information, especially that from the Sangiran Dome, had to be conveyed to the public and the Government of Indonesia, through the Directorate General of Culture (Ministry of Education, Culture, Research and Technology), has established five site museums in Sangiran. The purpose is to bring information from the site to the museum, that will make public enjoy it. In this sense, the museum site is a link between science and community.

The site museums are realized in accordance with the provisions of a modern museum, with public displays modern techniques, accompanied by other facilities such as storage, laboratories, workshops, audio-visual rooms, seminar rooms, researchers' housing, and souvenirs shops. Thus, the public can comfortably enjoy the information displayed in the museum, an efficient transfer of knowledge process, and feel happy in visiting the museum.

## 2- Reminder about the value of Sangiran World Heritage property

The long story of human evolution in the world cannot be completely separated from the existence of a barren stretch of hilly land located in the middle of the

border of Sragen and Karanganyar regencies in Central Java. Sangiran covers an area of 8 × 7 square kilometers, and the land is now known as the Sangiran site, whose story has echoed loudly worldwide. One of the world's centers of human evolution emerged at least I.5 million years ago in this location.

Today, the Sangiran site is a giant dome that has eroded its top, resulting in a large basin at the center of the dome, characterized by undulating hills. The soil material, mainly black clay and fluvio-volcanic sand, is less fertile and can be very arid in the dry season. Nevertheless, Sangiran's potential as one of the world's leading sites of human evolution is clear. In terms of paleoanthropological, archaeological, paleontological, and geological aspects, the Sangiran site is the most complete and important Pleistocene early human site in Indonesia and Asia. Since its discovery by G.H.R. von Koenigswald through the discovery of a concentration of flake tools in Ngebung in I934, the site has painted a long picture of human evolution over the last I.5 million years, represented by the evolution of *Homo erectus*. *H. erectus* is the most important taxon in the history of human life before reaching the stage of H. sapiens. *H. erectus* fossils were found sporadically and continuously in the 8x7 kilometer site area from I936 until the last decade.

The Sangiran site not only provides a picture of human physical evolution since I.7 million years ago, but it can even provide a clear picture of cultural evolution since I.2 million years ago, faunal evolution for 2 million years, and environmental evolution for 2.4 million years. Fossils and stone tools of excellent quantity and preservation have been found at the site in stratigraphic series deposited uninterruptedly over 2 million years, with environmental changes ranging from marine, marshy, and terrestrial environments. Therefore, the site has emerged as a site of great importance for understanding human evolution in general, not only for national interests, but has also been regarded as one of the world's centers of human evolution.

## 3- Designing and establishing museums

From the essence of archaeological information shown by Sangiran, the question arises: how can the scientific information be delivered to the public, as well as understood clearly? For example, the Sangiran site's management concepts demand a clear, conceptual, and comprehensive description of the site's substance. As with many other paleoanthropological and palaeontological sites, the field situation at Sangiran ''reflects nothing'', merely an expanse of arid land, and is utterly incapable of telling us much about the evolution of humans, culture, and their environment, which is very rich and powerful. Such a situation is in stark contrast to the millions of years of extraordinary archaeological information. It is almost certain that Sangiran is of interest only to scientists and specialists, especially to experts in archaeology, history, geology, and other earth sciences, and not at all to the lay public. In the eyes of this latter group, the

Figure I. Reconstruction of Sangiran I7 & *Homo floresiensis* (scientific collaboration: Elisabeth Daynes, Harry Widianto, Dominique Grimaud-Hervé (pictures H. Widianto)

Sangiran site only appears as an arid land, with hot air that causes sweating and very heavy to explore. Ordinary people are very reluctant to come to Sangiran, so the scientific information it unusually possesses has yet to be discovered to them. The greatness of Sangiran for human evolution is what the public should see, feel, and own. Then, how can the public also enjoy and understand the information of past life, as the scientists and specialists have also obtained? What is the endeavor to undertake so that the information can be accessed quickly and clearly by ordinary people? There is only one way to make the messages of the past accessible to the public: establish a representative information center in the site area in the form of a site museum with a modern, explanatory, and comprehensive display, bringing information about past lives. This way, people do not have to go to the field if they want to know information about a site but can visit the site museum. In this case, the process of transferring scientific information from a site to the community will be bridged by a site museum. The site museum is a facilitator for scientific information to be understood by the community. Scientific information from the field will reach the community through it.

The establishment of these potential site museums started in 2004 when (at that time) the Directorate General of History and Antiquities (now the Directorate General of Culture, Ministry of Education and Culture, Research and Technology) finished preparing the Sangiran Development Master Plan, which contains site development policies. During the two years of preparation, the Master Plan also involved regional stakeholders and experts (including from universities) before finally being declared complete in early 2005. The publication of the Sangiran Site Master Plan was followed by preparing a Detail Engineering Design (DED), which also involved experts and stakeholders. The

Figure 2. Reconstruction of a *Stegodon* (left), of Ngebung excavations (upper right) and front entrance of Ngebung museum (lower right) (pictures H. Widianto)

manuscript was completed in 2007 so that with the publication of the Master Plan and DED, there was an apparent reference for the development of the Sangiran site, both based on the concept of site preservation and its utilization for cultural tourism purposes.

## 4- Five museums in the Sangiran Dome

The Sangiran site presents excellent information on human evolution over I.7 million years, faunal evolution over 2.0 million years, cultural evolution over I.2 million years, and environmental evolution over 2.4 million years. *Homo erectus* was first present on Java Island I.7 years ago, evolving into archaic *Homo erectus* and typical *Homo erectus*. In a vast swamp environment, they coexisted with various fauna from the early Lower Pleistocene. They started making stone tools as early as I.2 million years ago. Over time, the swamp environment at Sangiran changed into a terrestrial environment through the deposition of volcanic rocks of the Kabuh and Notopuro Formations in the Middle Pleistocene period, coupled with the increase in animal species number in the Middle Pleistocene. Flake tools, and chopper-chopping tools were found in this set of volcanic rock layers. The Sangiran site represents a phase of life from the Pliocene to the Upper Pleistocene. The Sangiran site, as a vast grand site (56 square kilometers) with a past chronology of 2.4 million years, gets privileged with the construction of the site museum at 5 cluster points. The clusters are Krikilan as the visitor center, Ngebung, Bukuran, and Dayu as its satellites.

- Krikilan Cluster is a visitor center, an information center about early human life in Indonesia, the Homeland of the Java Man. This cluster is the umbrella of the other clusters and the source of information about other ancient human sites in


Figure 3. Bukuran Museum (top) and reconstruction of various Indonesian hominin forms (*Homo erectus* and *H. floresiensis*) (pictures H. Widianto)

Indonesia (such as Trinil, Kedungbrubus, Ngandong, Sambungmacan, Mojokerto, Ngawi, Patiayam, Semedo, and Bringin). The presentation of this information is also linked to international information, namely Sangiran's position in the context of human evolution in the world (Figure I).

- Ngebung Cluster specifically presents information about the historical discovery of the Sangiran site, especially since the discovery by von Koenigswald in 1934. Von Koenigswald's travels with W.F Tweedie in the Ngebung hills uncovered several flake tools associated with vertebrate faunal fossils characterized by the Trinil Fauna of the Middle Pleistocene Period. These tools, which would later become known by the famous name Sangiran Flake Industry, led von Koenigswald to declare his conviction more than 70 years ago: "These are flake tools, ancient

Figure 4. . Reconstruction of game hunting in swamp environments by archaic *Homo erectus* (picture H. Widianto)

human culture. Here, someday, fossils of ancient humans will be found, just like in Trinil and Ngandong...". His astute prediction was proven two years later (Figure. 2).

- Bukuran Cluster This cluster is explicitly dedicated to information on the discovery of ancient human fossils, along with a brief account of human evolution (as the whole story is presented at the visitor center Krikilan Cluster). The presentation model and facilities of the Bukuran information center are equivalent to the Ngebung Cluster (Figure 3).

- Dayu Cluster was developed to inform the latest research results, as it is the site of the discovery of the oldest stone tools in Sangiran and even in Indonesia, derived from an ancient river deposit that flowed between swamp environments I.2 million years ago. Therefore, visitors can descend to the excavation site to observe the I.2 million-year-old ancient river deposits, along with the stratigraphy and artefact findings in their stratigraphic context (Figure 4).

- In addition, Manyarejo excavation spot, a site excavated by Truman Simanjuntak, which yielded a layer of *Homo erectus* habitation 700,000 years ago, is a museum site in its own right. This spot shows the relationship between the soil layer and the culture, which at the time of excavation, showed a life event in the early Middle Pleistocene (Figure 5).

Figure 5. Excavation that yielded Middle Pleistocene cultural layers at Manyarejo (pictures H. Widianto)

## 5- Conclusion

The construction of modern museums, notably in Sangiran, has changed the face of museums in Indonesia. Today, there are more than 450 museums in the archipelago, divided into museums owned by the central government, local governments (provincial, district and city) and the private sector. Museums owned by the central government are usually good and comfortable to visit because they are in accordance with the museums desired by the public and funded by the state budget. Similarly, many private museums have also met the expectations of the public because their displays are tailored to the public's desires: spacious rooms, optimal climatization, supported by modern techniques, information provided briefly but clearly and efficiently. Visitors feel comfortable with private museums, even though the entrance ticket is quite expensive. In contrast, many museums owned by local governments receive minimal funding from their regions, due to limited local funds. As a result, it is not uncommon for the museum to appear as it is, so it is unable to attract visitors.

That is why the construction of site museums and other museums by the Central Government prioritizes modern museums that are fun to visit. Some of these museums were eventually handed over to local governments for ownership and management, allowing them to disseminate the information displayed in a museum more efficiently. On the other hand, visitors soon increased dramatically, as visitor statistics soon showed a significant increase. For example, since the construction of the 5 site museum clusters in Sangiran, in 2

years, visitors have increased by 400%, and have continued to increase in following.

This is one of the positive impacts of the construction of modern museums by the Directorate General of Culture. The information of an extraordinary site has been displayed well and attractively in a site museum. The community is immediately close to the museum and its scientific content, and vice versa, the museum becomes less distant from the community and information from the site can be displayed and absorbed by the public easily. In the future, it is hoped that similar site museums can still be built, so that the process of transferring knowledge can be obtained by the community more freely and easily.

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# Developing Activities in Line with the World Heritage Strategic Objectives in Indonesia: the CHEADSEA Unesco Category II Center and the Human Origins Heritage Project

**By**

Harry Widianto, National Research and Innovation Agency, Jakarta, Indonesia, harrywidianto58@gmail.com

Anton Ferdianto, National Research and Innovation Agency, Jakarta, Indonesia, antonferdianto18@gmail.com

François Sémah, Muséum national d'histoire naturelle, Paris, France & Universitas Kristen Satya Wacana, Salatiga, Indonesia, francois.semah@mnhn.fr

**Abstract**

We briefly introduce here the UNESCO Category II Center CHEADSEA (Center for Human Evolution, Adaptation, and Dispersals in Southeast Asia), intended to serve, notably, as a regional and international hub for advancing collaborative research, heritage conservation, and educational outreach focused on the ancient history of humankind in Southeast Asia. The Center's objectives match well with those of the HOH program, which was coupled in 2025 with the Sangiran International Youth Forum (SIYF) UNESCO-supported initiative. Overall, this synergy results in activities that foster the image of CHEADSEA, and the reached outcomes represent good practices at the crossroads of scientific dissemination and celebration of prehistoric heritage.

**Keywords**

UNESCO, Prehistory, Southeast Asia, Sangiran Dome, World Heritage

## 1- A Unesco Category II Center devoted to Southeast Asian Prehistory

The UNESCO Category II Center (C2C) CHEADSEA (Center for Human Evolution, Adaptation, and Dispersals in Southeast Asia) was founded stemming from the dynamism of the Indonesian Government's efforts to protect, preserve and disseminate the rich country's heritage re. prehistory, anchoring very deep in time (almost 2 million years for the oldest remains).

During the last 15 years, this dynamism is documented through the major role played by the country in the Southeast Asian region re. numerous aspects of prehistoric heritage which are currently at stake, such as:

- the rapid development of significant research programs on a national, Asian-wide and international scale (e.g. hominid fossils, rock art discoveries or early agricultural practices);
- the protection of sites (often facing heavy risks under tropical climates) and that of the indissociable moveable heritage (artefacts, fossils and associated documentation);
- the necessity to secure public access to the heritage and also to make use of this cultural asset in terms of sustainable development (specific initiatives re. tourism etc.)

CHEADSEA, under the auspices of the Directorate General of Culture then subsequently the National Research and Innovation Agency, serves as a regional hub for advancing collaborative research, heritage conservation, and educational outreach focused on the deep history of human presence, behaviours, and environmental interactions in Southeast Asia.

## 2- CHEADSEA and HOH's synergy

Central to CHEADSEA's vision is the Human Origins and Heritage (HOH) program, a collaborative academic initiative that brings together higher education institutions such as the Muséum National d'Histoire Naturelle (MNHN), Universitas Kristen Satya Wacana (UKSW) and the International Master in Quaternary and Prehistory consortium. The Indonesian ministry of Culture is, for its part, responsible for the Sangiran Youth International Forum (SYIF, an initiative supported by UNESCO, involving young people from around Sangiran site), grouping young students from Sangiran who followed a large part of the participatory school's activities.

HOH embodies CHEADSEA's mission by fostering integrative, site-based approaches that connect archaeological research with participatory education and sustainable heritage management. Through activities at key sites like

Ngebung within the Sangiran World Heritage property, the program promotes inclusive practices that build local capacity, support site preservation, and significantly engage communities and diverse stakeholders. This was especially the case during the HOH 2025 edition, which aimed at co-creating narratives re. human history and at highlighting the importance of Ngebung site.

CHEADSEA as a UNESCO C2C and the HOH school share a strong strategic synergy, grounded in mutual goals that align closely with UNESCO's priorities and the World Heritage strategic objectives. Their collaboration supports research, education, heritage stewardship, and sustainable development.

That synergy advances UNESCO's objectives of capacity building and education by offering hands-on training to students from the European International Master in Quaternary and Prehistory, from various cursi of Indonesian universities, and also local residents, while actively involving young researchers through an immersive participatory program. This work reflects the strategic priority of developing effective capacity-building initiatives, especially for students.

In support of multi- but especially inter-disciplinary collaboration, HOH brings together archaeology, geology, anthropology, heritage studies, communication, tourism and sustainable development studies, promoting both local and international institutional partnerships that echo UNESCO's goals of fostering global cooperation and intercultural dialogue. SIYF, for its part, is open to any student originating from the site's area who is willing to engage in the above-mentioned objectives.

Furthermore, HOH prioritizes community engagement and heritage stewardship by developing participatory site programs with local residents and co-managing educational heritage projects at active archaeological sites. These initiatives directly contribute to the World Heritage objective of enhancing the role of communities in the conservation and sustainable use of heritage.

## 3- Matching the World Heritage Convention criteria

Therefore, by acting as a model for collaborative heritage governance in a culturally diverse region, HOH and CHEADSEA together embody the vision of a UNESCO C2C, including but also going beyond the World Heritage strategic objectives.

The HOH school implemented this year, as reflected by the students' reports published in this volume, has directly contributed to the protection, interpretation, and educational use of heritage that meet UNESCO World Heritage criteria, with a strong focus on the Sangiran Early Man Site—recognized as a World Heritage Site since 1996.

In accordance with Criterion (iii), which highlights the importance of preserving exceptional testimony to cultural traditions or civilizations that have disappeared, the program provided educational and scientific insights into early human lifeways. Addressing Criterion (v), the program explored the evolution of human-environment interactions, adaptation strategies, and land-use patterns from the Pleistocene through the Holocene. Furthermore, in support of Criterion (vi), HOH engaged in participatory preservation and public education efforts that strengthen the living cultural relevance and collective memory of human origins, linking scientific understanding with identity, heritage and history of science. By aligning its activities with these criteria, the 2025 HOH program supported the goals of the UNESCO World Heritage Convention to safeguard cultural and natural heritage of Outstanding Universal Value (OUV), while fostering community engagement and stewardship of this legacy.

One interesting initiative of the 2025 school, as mentioned above, is the participatory co-creation of narratives related to a quite long human history. Such projects implemented by students in collaboration with communities are at the crossroads of scientific dissemination and celebration of heritage, hence merging two categories of good practices.

## 4- Conclusion

Overall, the previous HOH participatory training schools (since 2018) and the subsequent HOH-SIYF implementations (2024-2025) have demonstrated the vital role that inclusive, research-based, and community-oriented initiatives can play in safeguarding World Heritage sites. By integrating scientific research, heritage education, and participatory engagement, the program not only reinforces the Outstanding Universal Value of the Sangiran Early Man Site but also fosters a deeper connection between local communities and their shared human past, which can have fruitful outcomes in terms of sustainable development.

These efforts fully justify the close collaboration undertaken this year with the recently activated CHEADSEA UNESCO C2C. Together, they underscore the importance of continuing collaborative, interdisciplinary approaches to heritage preservation that bridge the gap between global significance and local meaning, ensuring that such major sites as the Sangiran Dome remain protected, understood, and valued for generations to come.

# The value of Ngebung site

**By**

Sadiman Subur, founder of the Pokdarwis Wonderful Sangiran

The following statement originates from an interview transcript by Leonard Fernando, UKSW, then edited together with the author.

## History of Ngebung sites

First, Ngebung is according to me an historical place. The story began when von Koenigswald, at the top (triangulation point) of the hill, found flakes made by ancient humans. He subsequently, together with Totomarsono, chief of Krikilan village, organized surveys and collects with local inhabitants, including my late mother (who washed von Koenigswald garments, full of "sediment" and my name is Sadiman), Satina, Tanu, Citro and others. It is here, near the triangulation point, and in the little ravine nearby, that the story began.

Then von Koenigswald brought his disciples there: Teuku Jacob, who was to become Professor at Gajah Mada University, and S. Sartono, who became Professor at the Institute of Technology in Bandung. Professor Soejono, archaeologist, came here also. Altogether with local inhabitants, they organized surveys and many artefacts and fossils were discovered. All this happened before I was born. When I was a kid, the landscape here was covered by patches of forest and grassland.

As a little boy, I learned how to find fossils, especially after heavy rains when the land is subject to erosion, and I brought the fossils I found to Totomarsono. I remember with nostalgy, when I was in high school, the day when Totomarsono (Mbah Toto) asked "Bur, bring me to the triangulation point", and I drove him on


Figure I. Map of Sangiran Dome locating Ngebung area

my motorbike. This is the day he taught me the history of the people who worked in Ngebung (Figure I). I also often collected stone bolas in the field and brought them to him, but he paid no attention to such things, convinced they were natural stones. Only at the end of his life, after having seen the result of the excavations in Ngebung, was he convinced that these bolas were stone tools.

Figure 2. The 1990s: The Kabuh layers at Ngebung (photo F. Sémah)

Figure 3. The 2000s: Discovery of Sendang Klampok fragmentary skull (photos F. Sémah & Kasman Setiagama)

Figure 4. The 2010s: Excavation at Pucung PCTS site (photo A-M. Sémah)

At the time I was a teenager, Totomarsono introduced me to François Sémah and Tony Djubiantono, still students at the time, and I helped surveys until they organized excavations in 1989-90 (Figure 2). François' excavations in Ngebung continued every year, and in between excavations campaigns the site was covered with plastic bags and protected by sand. During their absence, I regularly came to monitor the site, especially after heavy rains. This is how I found the Kresna femur, in the yellow silts at the basis of Kabuh, just above the Grenzbank. The fossil could be lost if not collected, and this discovery complemented the finds of human teeth and stone tools on the site.

## From Ngebung to other sites in Sangiran

But the story doesn't end here. During the early 2000s, I found a human cranial fragment (part situated near the ear) in the Grenzbank at Sendang Klampok, very near to Ngebung (Figure 3). The Grenzbank here is heavily eroded, not compact, but contains fossils and even a big flake from an elephant tusk. At the time the site was studied also by Boris, a French student who slept in my house (there was no mess in Sangiran at the time).

These studies led me to better understand the fossil-bearing sites in Sangiran, from Ngebung to Sendang Klampok and Glagah Ombo, and even further away, on a land I own in Pucung we found human teeth and very small bolas, and made excavations in the 2010s (Figure 4).

At this time I had also the opportunity to work with Prof. Sartono, it was the time of the discovery of Sangiran 22 near Sendang Klampok, he organized excavations and I helped in the field: discoveries were artefacts and one lower left mandible fragment of *Pithecanthropus*. I suppose Prof Sartono appreciated my help because he often came to me after; he worked also with the American researcher Donald Tyler. I worked also with Prof Harry Widianto and also very often with Prof Truman Simanjuntak, who very often asked me to help surveys, to identify sites where to organize excavations.

All these sites, during 40 years, became place to train young researchers, Indonesian and foreigners, who studied in Indonesia or in Europe. Continuous and detailed research appears to be the key to accumulate important data about Sangiran, and all these sites are actual assets. Though, they are for some endangered, especially by erosion, and it is the task of the government to protect them, who has to work in close collaboration with the inhabitants.

# PART B


HOH
Human Origins Heritage


SIYF
SANGIRAN INTERNATIONAL
YOUTH FORUM

# Narrating the History of the Discovery of *Pithecanthropus erectus* through Traditional Javanese Art

**By:**

Gabriela Krismendia Aponno, Tourism Destinations, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 73202402l@student.uksw.edu

Mauricio Fernando Gastello Morales, International Master in Quaternary and Prehistory, Instituto Politécnico de Tomar, Portugal, aluno27740@ipt.pt

Chaterina April Philia, Sociology, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 352022022@student.uksw.edu

Riski Rosmayda, Tourism Destinations, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 732024006@student.uksw.edu

Julia Shilume, International Master in Quaternary and Prehistory, Muséum national d'histoire naturelle, Paris, France, ndapewajuliandeendelago.shilume@edu.mnhn.fr

**Other members of the project**

Dita Pradiva Juliyanti, Historical studies, Universitas Negeri Semarang, Indonesia pradivadita@gmail.com

Nadila Tita Alfiana, English Education, Universitas Sebelas Maret, Solo, Indonesia nanadila3@student.uns.ac.id

Santoso, Pokdarwis Wonderful Sangiran, Indonesia

**Abstract**

At the beginning of the 20th century, the discovery of *Pithecanthropus erectus* (now *Homo erectus*) in Indonesia marked a milestone in human paleoanthropology. The discovery of these fossils by Eugène Dubois not only provided tangible evidence of an evolutionary "missing link" but also sparked debates in scientific, historical, and religious circles. Initially classified as an "ape-man," its subsequent reclassification to the genus *Homo* reflects a great advance on the history of science. This multifaceted history encompasses scientific endeavors, indigenous traditions, and challenges to Darwinian theory at the beginning of the 20th century. Within this framework, this project aims to explain this scientific milestone in simple language through Wayang art for a general audience. The project was developed by exploring Sangiran, the most important region in the studies of the *Pithecanthropus erectus* and analyzing the information presented. Furthermore, the design of the Wayang story was carried out with the active participation of an expert in this type of art and the idea of exposing scientific knowledge. This project seeks to generate a better understanding of the importance of *Pithecanthropus erectus*, promote local art, offer new media for tourist guidance, and educate in a way that enhances community engagement with museums and projects.

**Keywords:**

*Pithecanthropus erectus*, palaeoanthropology, history of science, *Homo*, Wayang, Sangiran

# A- THE CHALLENGE AND RELATED SCIENTIFIC MESSAGES

## AI- State of the art

### Krikilan museum

Krikilan museum is one of the largest in the region. This museum offers extensive displays related to *Pithecanthropus erectus*. It provides a wealth of background information, contains numerous panels, skull replicas, and stone tools that illustrate the material culture of *Pithecanthropus erectus*. The museum's exhibitions help visitors develop a foundational understanding of *Pithecanthropus erectus* such as the discovery, characteristics and its role in human evolution (Figure A.I).

One significant oversight is the lack of an explanation for the renaming of *Pithecanthropus erectus* to *Homo erectus*, a key transition in the scientific understanding of human evolution. On the other hand, we have different terms such as Java men, missing link, *Pithecanthropus erectus* or *Homo erectus* to refer to the same individual.

Figure A.I. Reconstruction of the *Pithecanthropus erectus*

Figure A.2. Bola: Material culture of *Pithecanthropus erectus*

Despite these drawbacks, Krikilan Museum has considerable potential. Its strategic location and size give it the ability to attract a diverse local audience and international visitors. To enhance the visitor experience, the museum could transform its educational model by offering more interactive and engaging exhibits. The Krikilan museum could provide immersive experiences that allow visitors to actively engage with the material culture of *Pithecanthropus erectus* (Figure A.2).

**Bukuran museum**

Bukuran museum excels in interactivity with the users. Its exhibits are designed to engage visitors of all ages, with educational displays that provide dynamic and interesting ways of learning about *Pithecanthropus erectus*. The museum's focus on interactive experiences helps foster a deeper understanding of the scientific and cultural narratives surrounding human evolution.

**Manyarejo museum**

Manyarejo museum stands out for its unique narrative focus on the Balung Buto myth (see below Part B), offering a culturally rich perspective of how the original communities interpret the presence of fossils in Sangiran. This mythological framing provides a distinctive storytelling element that can engage local communities, creating a bridge between scientific understanding and cultural heritage.

To enhance its scientific credibility, the museum could further develop its exhibits by incorporating more information on the scientific processes that follow excavation, such as laboratory analysis and the publication of research findings.

**Ngebung museum:**

Ngebung museum provides a focused educational experience on the fauna of the *Pithecanthropus erectus* era. The museum's educational displays are both attractive and informative, but it falls short in addressing the cultural and behavioral aspects of *Pithecanthropus erectus*. While the exhibit's focus on fauna provides a solid understanding of the ecological context in which *Pithecanthropus erectus* lived, it doesn't explore the cultural, social, and technological advances made by these early humans.

## A2 - Scientific messages

**Information display**

According to our visit we can affirm that crucial data such as the discovery of *Pithecanthropus erectus*, characterization of the species, material culture and behavior are displayed in the different exhibitions at Sangiran.

From understanding our state of the art, we could determine how our project could reach all kinds of different audiences, from young kids to academics. And through scientific mediation, we can hope that simple medias could deliver scientifically accurate messages presented below.

**I. Discovery**

Retelling the discovery of *Pithecanthropus erectus* with integral figures in the discovery of the human fossils in Sangiran and why the name *Pithecanthropus*


Figure A.3. The arrival of Dubois in Indonesia and the discovery of *Pithecanthropus erectus*

Figure A.4. Balung Buto myth tapestry

Figure A.5. Skull replica of Sangiran I7

*erectus* was settled for. The discovery of *Pithecanthropus erectus* (later reclassified as *Homo erectus*) at Sangiran marked a pivotal moment in paleoanthropology.

Eugène Dubois first identified the species in 1891 in Trinil, Java. His discovery was based on a skullcap, a molar, and a femur. He initially named it *Anthropopithecus erectus* ("upright man-ape") and later *Pithecanthropus erectus* (Dubois, 1894). reflecting contemporary debates about human evolution (Figure A.3). Later, the paleontologist Gustav Heinrich Ralph von Koenigswald expanded on the discoveries in the 1930s at Sangiran, uncovering more than 50 *Homo erectus* fossils, and also at Mojokerto (East Java).

These finds cemented Indonesia, especially Java Island, as a crucial place for human evolutionary studies. The reclassification to *Homo erectus* by Ernst Mayr in 1950 unified the Asian and African specimens under a single species, emphasizing anatomical continuity.

**2. Misconceptions**

The misconception of *Pithecanthropus erectus* being an "ape-man" and rectifying this through the cultural and behavioural attributes that have been attributed to it, and led to its ultimate classification into the Genus *Homo* with the full binomial name of *Homo erectus*.

**3. Traditional myths and science**

Integrating the early traditional understandings of fossils through the myth of the Balung Buto (Figure A.4) and reiterating that although these are legends, it is these legends that laid the foundation for scientific research in Sangiran, together with the already active local population engaging in fossil collecting.

**4. Birth of Paleoanthropology and World Heritage status**

Including how the studies in Sangiran catapulted to the development of Paleoanthropology as a scientific discipline and such studies led to Sangiran obtaining the UNESCO World Heritage status due to its outstanding universal value for Prehistory (Figure A.5).

The stratigraphic layers of Sangiran preserve more than one million years of hominid activity, yielding remains of over one hundred *Homo erectus* individuals and a large part of the world's known hominin fossils. Its UNESCO World Heritage status recognizes its unparalleled contribution to the understanding of human dispersals, technical innovations, and adaptations.

# B- RESEARCH

## Activities

To address on how and what to present for our subject, one of the initial activities that we conducted was to observe the data and information in regards to the *Pithecanthropus erectus* in the five museums found in Sangiran. We analyzed the data and narrowed it down to what was generally lacking and what was present in museums so that we can use these elements to convey our messages which have been addressed in Part A above.

Extensive literature review (Alink et al.,2016; Dubois, 1894; Shipman and Storm, 2002; von Koenigswald 1956) was conducted to implement the characteristics of

Figure B.I. Wayang at Java residence © Keraton Surakarta Hadiningrat

Figure B.2. First meeting with Mr. Joni

*Pithecanthropus erectus* so that they can be applied to our narrative that will be adapted to the scientific messages we would like to convey. Subsequently, we targeted the following important elements:

- discovery of the *Pithecanthropus erectus*,
- cultural and behavioural attributes that make *Pithecanthropus erectus* human,
- the change of the name of *Pithecanthropus erectus* to *Homo erectus*,
- the emergence of paleoanthropology and the UNESCO World Heritage status.

Throughout our time in Sangiran, our guide and group member Mr. Santoso has been extremely informative on the knowledge about *Pithecanthropus erectus* and its discovery. He has especially made the effort to understand the history of study of *Pithecanthropus erectus* and of Sangiran in general. Furthermore, we have had several exchanges with Mr Santoso in regards to his experience and thoughts about the discovery and the reactions he receives from visitors.

During the initial Google call meetings held among our group on April I2 and 22, 2025, the idea of conveying the scientific message through an artistic medium was proposed. Following visits to several museums on May I and 2, 2025, and a subsequent visit to the residence of the Javanese royal family in Solo on May 3, 2025, the traditional performance art of Wayang was identified as a potential medium for message delivery (Figure B.I).

Further group discussions were conducted, during which the suggestion of using Wayang prompted one of our team members, who resides in Sangiran and is actively engaged in the local arts community, to recommend contacting a master puppeteer named Mr. Joni. Mr. Joni is a local schoolteacher who also devotes part of his time to Wayang performance. He has demonstrated a strong commitment to storytelling, particularly narratives centered on the life of ancient humans from the Sangiran area. As a result, a meeting was scheduled with Mr. Joni on May 5, 2025, to learn more about his storytelling approach and discuss the potential collaboration (Figure B.2).

**Priorities in conveying the message**

Through these activities we have understood how important it is to put emphasis on the role and the history of science, notably using the role of Eugene Dubois in his journey of finding what he dubbed the "missing


Figure B.3. An old map displayed at Ngebung museum showing fossils discoveries in Java

Figure B.4. The Myth of balung buto tapestry

link". This is an aspect that is exhibited in the museums we visited (Figure B.3).

One of the principal challenges of our research question is to reconcile the scientific fact that *Pithecanthropus erectus* was human vs. religion and tradition, which offer a completely different perspective of the origins of humans. This appeared especially after hearing from Mr Santoso's experience with museum visitors who challenged him on the origins of humankind referring to religion. Additionally, he also stated that while he reiterates aspects of scientific research to visitors, explaining about *Pithecanthropus erectus* and evolution in general, visitors are often not convinced by these facts. To address this, we chose to illustrate this challenge through the cultural and behavioral attributes of *Pithecanthropus erectus*, for example toolmaking, hunting etc. in order to highlight its humanity.

We recognize how substantial this topic is, challenging religious beliefs. Consequently, this has encouraged us to incorporate characteristics of Javanese culture in our narrative. This will be shown by including myths such as the Balung Buto (Figure B.4) which is a traditional Javanese myth explaining that the fossils found in Sangiran were that of giants. While these legends are understood as myths and are not directly linked to our topic, they can help to illustrate the nature of humans and specifically the ancient

Javanese people's attempt to explain natural phenomena (in this case the occurrence of fossils), just like Eugene Dubois' description of the ape-man, which was eventually corrected to being fully human. This also helps communicate one of our scientific messages (history of science), using an aspect that is familiar to the public.

During our meetings with Mr Joni, he shared with us his larger Wayang Purba project (see part CI below) about the prehistory of Sangiran. He explained his process of doing research with books and museums and how his performances are based more on what could have been the daily life of *Pithecanthropus erectus*, ambitioning through his long play to deliver a moral lesson. Mr Joni also tends to include myths and fantasy-like components to his work which is not really based on scientific knowledge dissemination. Through these discussions regarding the possible complementarity of our and his project, we realized how the theme of "History of Science" is important and were encouraged to make it a priority.

Figure C.I. Discussion regarding the technical aspect of Wayang Purba with the local puppet master

FIgure C.2. Wayang Purba puppets of the local puppet master

Figure C.3. Consulting Mr. Joni for conducting the performance

# C- THE PROJECT

## CI- The media

Following initial consultations with Mr. Joni, it was definitely agreed to use Wayang as our primary media. Wayang is defined as the portrayal of figures using puppets or dolls in theatrical performances (Sulastuti and Rianto, 2025). The puppets are operated by a shadow puppet master, known in Bahasa Indonesia as a Dalang. The use of puppetry is deeply rooted in Javanese culture and it holds significant cultural value throughout Indonesia. This importance was internationally recognized when Wayang was inscribed in 2008 on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity.

Wayang serves to entertain, educate, and transmit messages to the audience (Sulastuti and Rianto, 2025). As such, it demands a simplified narrative structure to ensure clarity and accessibility. It is an interactive and engaging medium, ideal for effectively delivering scientific information through light-hearted storytelling. This dual approach allows Wayang to simultaneously captivate the audience's attention and convey educational content.

The project seeks to build upon the existing cultural foundation in Sangiran and to include as many collaborators from the local population as possible. Following our initial meeting, we proposed to Mr. Joni to take the role of Dalang for our narrative—a proposal he enthusiastically accepted (Figure C.I). Mr. Joni is an ideal collaborator not only because of his membership in the community but also due to his expertise in Wayang performance and his commitment to public education through this medium. He specializes in a more specific form of Wayang he calls Wayang Purba, which incorporates narratives about prehistoric humans, an identity closely associated with the Sangiran region and distinct from traditional Wayang performances that revolve around recurring mythological characters (Figure C.2).

In our second meeting with Mr. Joni, we presented the concept in further detail. While he expressed strong interest in the narrative and overall vision, he emphasized the importance of incorporating humor to enhance the entertainment value of the performance. We presented him with a draft manuscript of the narrative, which he approved. One challenge we encountered was the traditional length of Wayang performances, which typically ranges from one to three hours. However, after reviewing the script, Mr. Joni agreed to adapt the performance to approximately ten minutes in length. Furthermore, although the script was originally presented in Bahasa Indonesia, Mr. Joni expressed a preference for performing in Javanese. We are thus committed to prepare a Javanese version of the script.

## C2- The design

| ELEMENT | DESCRIPTION | OPERATIONAL TASK | PRIORITY |
|---|---|---|---|
| *Dalang* (Puppet master) | The puppet master in charge of conducting the performance. | Consulting Mr Joni on conducting the performance and opinion on the storyline provided (Figure C.3). | High |
| Script | This dialogue that will be recited throughout the entire play. | Creating a script both in Bahasa Indonesia and English highlighting our scientific message (See Annexes). Creating a script in Javanese language. | High |
| Characters of the play. | The figures that will be represented in the performance. | While Mr Joni has puppets there is a proposal for a redesign of the *Pithecanthropus erectus* for a more accurate representation (Figure C.4) and the addition of figures such as Eugene Dubois (Figure C.5) and Toto Marsono (Figure C.6). | High |
| *Wayang* Screen (*Kelir Wayang*) | Screen backdrop made out of rectangular white cloth. | This includes the overall stage area that will be used for the performance. Additionally looking into having a screen projecting translations in English and Bahasa Indonesia. | Medium |
| Music | In *Wayang* music is often included to enhance the emotion to the scenes that are being portrayed. | Incorporate traditional rhythmic music such as *Gamelan* that could align with work with a local group involved in creating the music and collaborate with the *Dalang* according to the scenes playing out. | High |

# D - IMPACT

With respect to Sangiran heritage, dissemination efforts mainly focus towards the archaeological and prehistoric value. In our case, however, our project aims to incorporate the traditional and cultural Javanese attributes, to insist on the rich local culture and on how prehistoric heritage also serves as an important aspect of Sangiran's identity. Our media aims to achieve these goals through the Wayang Purba performance which is expected to reach an audience of all ages, bridging scientific knowledge and the wider public. Through a scientific mediation approach, complex information can be transformed into knowledge that is easily understood by various audiences, including students, the general

public, and stakeholders. This can enhance awareness, understanding, and active participation in scientific and cultural issues (Figure D.I).

As mentioned before, through our chosen media, we expect that our project would contribute to showcase strategies and approaches that are both effective and collaborative in terms of the World Heritage Centre good practices implementation. Wayang as a media is familiar not just to the local Javanese people, but also to the majority of people in Indonesia and also attractive for

Figure C.4. Representation of *Pithecanthropus erectus* puppet

Figure C.5. Eugene Dubois puppet design

Figure C.6. Toto Marsono puppet design

Figure D.I. Wayang as a scientific mediation © wayang purba Mr. Joni

tourists. Combining a tradition that has been passed down for generations, we intend to merge cultural heritage and empirical knowledge. A mediation done through these methods comprises aspects that promote sustainability and is carried out by considering participatory approaches, ensuring that all actors that participate, like stakeholders and local communities, are actively involved in the development, decision-making and implementation process of the project.

Through our process of development, one thing that comes to mind is how we have to engage directly with the community and work at a grassroots level. Knowing that the concept of Wayang Purba is present in the local community and comes from the people themselves, we feel that by learning with the person in charge and understanding better regarding the concept of Wayang Purba, the latter could match with our purpose of scientific mediation, simplifying the story of *Pithecanthropus erectus*, making it understandable for all ages.

This project has the potential to drive local development by enhancing community skills, strengthening identity, and fostering a sense of pride in local products. In addition, it can boost sustainable tourism and promote the local economy through active community involvement in the preservation and promotion of cultural and natural heritage.

Through an ethical collaboration carried out with the peers of Sangiran, we hope that we might help maintain and develop the local communities' creativity and also help the concept of Wayang Purba to reach a wider audience, both

locally and internationally, knowing that it has the potential to become one element of Sangiran identity, as is its rich prehistoric heritage. At a larger scale, Wayang Purba performances have also the potential to boost the economy of the Sangiran local community, bringing income in a sustainable way.

Additionally, this project is expected to enhance the development Sangiran not only as a touristic but also an educational destination, hence supporting preservation of the heritage and conveying ealily understandable knowledge regarding *Pithecanthropus erectus*.

Our collaboration with local stakeholders allowed us to expand a once small-scale performance project into a more elaborate production, making it sustainable by incorporating other actors who share the same interest in preserving cultural and scientific heritage, engaging them to involve in other components of a Wayang performance such as puppet making, ensemble of Gamelan, and continuing the tradition of becoming a Dalang.

We can also propose to further develop the media we use in order to reach a wider audience. Sustaining past live performances, we could utilize other medias like animation or video records to promote our product through social media, providing subtitles of different languages so that our outcome can reach an international audience.

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# Illustrating the Natural History of the Sangiran Dome

**By:**

Larissa Docal Spina, International Master in Quaternary and Prehistory, Università Degli Studi di Ferrara, Italy, larissa.docalspina@edu.unife.it

Care She Eklesia Polii, Universitas Kristen Satya Wacana, Tourism Destinations, Salatiga, Indonesia, 732024005@student.uksw.edu

Putra Hudlinas M., International Master in Quaternary and Prehistory, Muséum national d'histoire naturelle, Paris, France, muhammad.putrahudlinas@edu.mnhn.fr

Bunga Suci Pertiwi, Universitas Andalas, Litterature, Padang, Indonesia, bungasucipertiwi@gmail.com

Kania Bening Rahmayna, Universitas Kristen Satya Wacana, Sustainable Development Studies, Salatiga, Indonesia, 092024011@student.uksw.edu

**Other members of the project:**

David Eko Nazhir S., Geography, Universitas Muhammadiyah Surakarta, Indonesia, m.davideko@gmail.com

Raida, Pokdarwis Wonderful Sangiran

Wahyuda Pradana Santosa, Pokdarwis Wonderful Sangiran

**Abstract**

The Sangiran Dome is a particular geomorphological structure, shaped by many environmental factors, such as tectonic and volcanic activity and subsequent river erosion. Exposed layers reflect various successive landscapes along a more than 2 million years history. We develop here a communication proposal for school children regarding these geological aspects. Our focus on this target group is due to an analysis of the present exhibition and exchanges with locals, teachers and guides at the museum. We were able to assess that children do know about the fossils found, but do not understand the unique formation that allows these archaeological discoveries. We intend to address this gap by producing a pop-up book which tells the story of an elephant that travels back in time to reveal the history of Sangiran land, coupled with a sticker game and digital tools. Among the potential implications, we focus on fostering a connection between the new generation and the site heritage, encouraging them to engage in conservation and other activities at the site. Furthermore, the book may transport Sangiran's value beyond its visitors and immediate area, being used in other places of Indonesia to increase cultural knowledge and feeling of identity. Lastly, although focused on children, the project has the potential of transmitting the message to other audiences, especially if adapted in one large version of a single page to be exposed in the museum.

**Keywords:**

Sangiran, Geology, Palaeoenvironment, School education, Pop-up book

# A- THE CHALLENGE AND RELATED SCIENTIFIC MESSAGES

## AI- State of the art

### The Sangiran Dome: archaeological museum and living area

Sangiran is an archaeological site located in Central Java, Indonesia, occupying an area of approximately 56 square kilometers (7 km x 8 km), some I5 kilometers north of Surakarta, nestled in the valley of the Bengawan Solo River. The Sangiran region is administratively divided between two regencies: Sragen Regency and Karanganyar Regency. The Sangiran dome presents an unique stratigraphy, spanning horizontally in the landscape, which can be studied through a number of vertical sections. These layers are structured in key geological ‘formations’, namely Kalibeng, Pucangan, Grenzbank, Kabuh and Notopuro, concentrically visible from the center to the periferia of the Dome. In those, many fossils of extreme significance are found, comprehending local changes and evolution from 2,4 million years ago to 250,000 years ago.

The site also presents an unique perspective from the relation to the locals, an integral part for the discovery of fossils, long before the beginning of archaeological research. The Balung Buto, a local myth, tells the story of giant's

Figure A.I. Explanation from Bu Raida about museum

Figure A.2. Image of Sangiran stratigraphy at Dayu Museum

Figure A.3. The environmental reconsruction in Dayu Museum

bones found in the area, which in reality refers to the fauna in the layers. This intangible cultural aspect illustrates the particular relationship between Sangiran inhabitants and the discoveries. Although raising different opinions, the site's establishment as an UNESCO World Heritage property came with great expectations for the social development of the area.

**The Sangiran Dome in the museums: geological and formation aspects**

The museums of Sangiran are divided into clusters, comprehending indoor and field museums, exhibiting the stratigraphy, fauna and excavation areas. The Krikilan museum presents a more comprehensive exhibition and other more particular aspects. The cluster in Dayu focuses on geology aspects, Bukuran on human evolution, Manyarejo on landscapes and Ngebung on history of research and Sangiran flake industry (Figure A.I).

Regarding the geological aspects, the Krikilan and the Dayu museum communicate about the different layers and the formation of the Dome, influenced by tectonic and volcanic activity. Entering the Krikilan museum, the visitor can see a video with an interactive panel, explaining the process for the

geological configuration of the site, each formation through the click of a button. Visitors can also see samples from each layer, presented vertically, and connected to the associated fossils representative of the landscapes (Figure A.2).

The Dayu museum focuses on stratigraphy, since the museum is built down hill with a sequence of formations from Pucangan to Grenzbank, Kabuh and Notopuro. The exhibition rooms highlight the actual stratigraphy through window glasses. A video illustrates the folding process due to magmatic activity and the subsequent erosional cutting of the Dome by the Cemoro river.

Overall, the exhibitions are very visual and interactive: environmental reconstructions synthesizing data from geology, palynology and paleontology; displays of fossils and stratigraphy, often simplified in a continuous vertical position. While a valuable tool, this simplification can be misleading if not combined with other materials that clarify the geological processes (Figure A.3).

The Dome's formation is much more particular, and we wondered if visitors would understand it without a guide's explanation. Stones and soil samples are very attractive, but their value is not obvious for inexperienced eyes. A medium communicating their significance is necessary to replace the explanation from guides who are not employed by all visitors. The current explanations are much concentrated in posters, which may not be absorbed by visitors that do not read extensively or are not familiar with this type of text. Furthermore, the material displayed in the museum is not specifically aimed at children. Although the visual presentation used is interesting, the complex sequence of geological and environmental events often appears difficult for children.

## A2- Scientific messages

From our observations, the geological scientific messages are not communicated contextually as part of landscape evolution. This is due not only to the level of complexity of the information but also to the lack of efforts to relate geological concepts to everyday experiences and understanding. There is a lack of emphasis on the importance of geological formations, as a result, the information presented can sometimes feel boring and irrelevant, especially for children.

We aimed at identifying scientific aspects regarding the Sangiran Dome, considering where they overlap for our communication. From these considerations, reading articles, the HOH classes and guided visits with Ibu Raida from Pokdarwis, we selected what is most important to understand the shape and structure of the land, as well as its variations through time. Thus, the following points are highlighted as communication goals:

Figure A.4. Landscape of kabuh formation in Manyarejo

Figure A.5. Cold volcanic mudflow of Sangiran

Figure A.6. Fossils in Bukuran Museum storage

Figure A.7. Interview with local visitors

•I. The folding of the Dome and its geological layers, influenced by tectonic and volcanic activity.

•2. The subsequent erosion of the Dome by the river, exposing the older layers.

•3. The evolution of the landscape through time: from sea to swamp, continent, open and dry environment.

The evolution of landscape in particular may connect different types of data, associating geology to the changes in environment and the subsequent fauna arrivals and adaptation. There is a combination of data which allows for reconstruction, such as geological and geomorphological aspects, palynology, malacology and paleontology. These pieces of a puzzle tell a rich and compelling story, part of Sangiran's natural heritage.

Knowing these scientific messages is knowing the history of the land, which can communicate the complexity and value of its development. Understanding it may foster a connection and sense of belonging, especially for local populations that already interact and experience the land in their daily life. Likewise, nurturing local knowledge about the site is a way of reinforcing the links to the heritage (Figure A.4).

Arriving at Sangiran, the exchanges with the local group's members proved to be fruitful for us to understand other issues related to our topic, but not so obvious from an outsider's perspective. Ibu Raida and Mas David have a clear familiarity with the site and its visitors which we, the other students, would not have time to acquire. Mas David highlighted the feeling that there is not enough information and nothing new in the Krikilan museum, in spite of the number of posters. Ibu Raida, frequently a guide in Sangiran museum visits, brought up a common visitors' question about why so many fossils are found in Sangiran, and not in other places of Java or Indonesia. We considered it a significant curiosity and added it as a fourth scientific message.

•4. Sangiran Dome is an unique place to find fossils due to its particular geological formation.

A priori, the question does not seem to be connected to geological aspects. However, one of the main factors in the explanation is the exposure of older sediment layers through the uplifting and erosion of the terrain. Understanding changes in the landscape influenced by volcanic and river activity is crucial to explain the presence of fossils. Thus, by approaching scientific message number 4, other messages may be encompassed, but geomorphological processes (I and 2) clearly remain necessary for an adequate answer (Figure A.5).

Communicating this is also emphasizing the value of Sangiran Dome, related to the unique fossils found in its layers and the geological history recorded in its formations. As such, the scientific message may be framed in a way that answers this visitors' question, explaining geological aspects while at the same time justifying its value and the necessity of this knowledge (Figure A.6).

Consequently, scientific message number 4 takes precedence due to its significant potential to enhance the overall understanding of the site, promote a deeper appreciation for its cultural and historical significance, and encourage active participation in its preservation efforts. By starting our interpretation with a topic that resonates with visitors, we align our messaging with their interests and emotional responses, thereby increasing the narrative's relevance and impact. This approach not only prompts reflection on the profound meanings of heritage but also fosters a personal and emotional connection between the visitors and the site (Figure A.7).

Without a narrative that connects geological processes, landscape formation, and archaeological findings, visitors will have difficulty understanding the importance of Sangiran as a World Heritage site. Therefore, a more inclusive and interactive educational approach is needed, such as the use of simple analogies, educational games, or digital technology that can visualize geological processes in a more easily digestible and interesting way for visitors and especially children, as we highlighted the gap in dissemination material for them. Through immersive experiences and meaningful interactions with the site's values—historical, social, or symbolic—we aim to evoke curiosity, empathy, and a sense of responsibility. In this way, the scientific message transcends mere information; it becomes transformative, inspiring a lasting commitment to the protection and transmission of heritage for future generations.

## B - RESEARCH

The experience at Sangiran enriched our perspective on landscape transformation in the region . Each visit opens up space for internal dialogue within the group about how historical knowledge is conveyed and revived in public spaces. We also witnessed an interesting geological phenomenon in the form of a mud volcano, which is a marker of the tectonic and geological dynamics of the Sangiran area to this day (Figure B.I).

After these activities, our group held in-depth discussions with several key figures and resource persons who have extensive understanding and experience in the fields of education and culture, namely Dr Yesaya Sandang and Dr Marisa from UKSW, Ibu Rindi from the museum, Ibu Raida and Ibu Darmi from the Pokdarwis (Figure B.2). We documented the entire series of activities through field notes, activity photos, and audio-visual recordings. This documentation plays an important role for in-depth reflection in the process of preparing the final report, as well as being basic material in the production of creative media that depicts our findings during the activity.

### The choice of a target group

From our visits and field trips we had noticed a possible gap concerning the comprehension of Sangiran's stratigraphy as a horizontal structure, in particular for children. Further inquiries were necessary to confirm this hypothesis. The conversations with Ibu Raida offered strong indicators due to her experience as a guide to school's children. She emphasized the difficulty in explaining stratigraphy and geology to this age group, mainlyfor the lack of material in the exhibition targeting them. In a meeting with Ibu Darmi, a Pokdarwis member who also works in education projects of local children, she corroborated Ibu Raida's perspective, saying the children do know about the fossils, but have no knowledge about geological formations and the complex interactions that produce it. We decided to conduct interviews with the visitors to ascertain the gap and explore how to approach it. (Figure B.3)

Figure B.I. Figures of volcanic Activity in Sangiran

Figure B.2. Discussion with Ibu Rindy about educational aspects

Figure B.3. Discussion with Ibu Raida from POKDARWIS

The interview with visitors was the first step adopted, talking to twelve people on Sunday 04th May, 2025. We were positioned at the end of the Krikilan museum, meaning the visitors had already crossed the complete exhibition path when we met them. We found out that, even though at the end of the parcours, interviewees from all age groups didn't know the geological formation of the Dome, its significance or why fossils are found there. A young, local boy said he only knew about fossils; another woman, accompanied by her child, expressed that, even though she didn't know anything about prehistory, she would like her daughter to learn.

These dialogues indicate potential for the communication of a scientific message that is not being absorbed. Furthermore, they express an interest in the prehistoric archaeology universe that could be fruitful if associated with geological formations, framing them as a record as valuable as fossils. Here is an opportunity to engage the visitors and encourage preservation efforts by presenting science and value. By focusing on school age children, from 7 years old to 12 years old, we can foster the connection between the future generation and their heritage, hopefully making them active in several local organisations.

Figure B.4. Pucung river filled with garbage

Figure B.5. Interview with school children

**Identifying the Narrative**

Part of the research is the development of a narrative for the scientific message. Instead of delivering a lecture-like communication, we approach daily life of local people and familiar elements to most visitors. In one communication exercise, our group was asked to explain in simple words the fossil diversity in Sangiran Dome. When talking about the formations that hold these fossils, we were faced with the challenge of translating scientific jargon into a visual and easily comprehended message. Thus, identifying the elements that would allow this translation is essential, grounding the future design of the project.

The river may work as that connection element, since it is both part of daily life of the inhabitants and also the major erosive factor. In fact, water is the main element in cutting through the uplifted Dome and exposing the older layers at

its center, so exploring its role in the present seems a reasonable path. When we discussed it with Dr Yesaya, he brought up the hydrosocial cycle of water, a two-way road: our habits influence the river environment and we are at the same time influenced by it (Figure B.4).

In practical terms, the river is important for transportation and domestic use, but it is nowadays severely impaired by pollution and chemicals related, among others, to agriculture practices, to such a degree that wells are necessary for potable water. But cultural aspects are also inherent to the relationship between humans, nature and spiritual beliefs. Walking along the Pucung branch of the Cemara river we observed at its margins offers of food, flowers and incense for the protection of nature. As a symbol of the Javanese culture, it indicates an effort to demonstrate gratitude and respect, placing the river at the heart for this symbolic communication. Moreover, for their fossil bearing banks, the watercourses in Sangiran present a particular scientific value. Since a long time ago, archaeological materials are frequently found by locals, who nowadays work with archaeologists. Such is the case of Sangiran 17, a worldwide famous *Homo erectus* skull that was discovered by locals and delivered to the museum. Hence, by combining science with cultural and practical aspects, the bodies of water are at the core of the narrative, binding past and present, scientific and local knowledge.

**Communicating the narrative for our target group: educational aspects**

An attractive narrative is essential for the project success, so the aim of our research was to narrow the language and framework for our scientific message, adequately for our target audience, school age children. Persuasion of the readers is achieved by Thurley's heritage cycle (Thurley, 2005), in which an enjoyable experience brings understanding, which makes them value, and consequently care about their heritage. In order to accomplish it, we conducted several interviews. Through this held in-depth discussions, we explored the importance of involving children in educational spaces such as museums. Their perspective opens our horizons of thinking about how children interpret the experience of visiting a museum—not just as a recreational activity, but also as a contextual and enjoyable learning process (Figure B.5).

From the conversations with Dr Marisa and Ibu Rindi we benefited from their experience in education to design the language and visual elements to be used. Presenting our pop-book idea to Ibu Marisa, she emphasized the development of literacy abilities, in particular by suggesting the inclusion of digital resources in QR code. This nurtures reading and brings familiarity to the use of technology. As such, our project is a tool for teachers in the development of their classes. For this reason, one important step was the interview with the headmasters from local elementary schools, SDN Manyarejo and SDN Bukuran I. We talked about the current projects promoting book exchanges and reading habits, confirming the pop-up book could be actually implemented. Likewise, digital

tools could be an asset, in accordance with the school's resources and other types of activities already conducted. They further encouraged us to write an explorer story with a character from which the children could learn.

All these activities shaped the idealization and design of our project, intending to highlight the value of the Sangiran formation as a record of geological and environmental changes. Through the pop-up book we communicate to children notions related to landscapes, volcanoes and river activity, all parameters creating an unique area for fossil finding.

## C - THE PROJECT

### CI- The media

The inspiration for our pop-up book emerged from a direct experience during a discussion activity focused on geological layers. One of our group members creatively bent his notebook into a dome-like shape to illustrate how geological layers can be compressed to form structures such as the Sangiran Dome. This simple yet effective visual demonstration significantly enhanced understanding, particularly for participants without a background in geology. It highlighted the importance of visual and interactive methods in conveying complex scientific concepts. Consequently, we conceived the idea of developing a pop-up books—three-dimensional, interactive volume that is not only visually captivating but also capable of explaining geological topics in an accessible manner for a wide audience, including children, students, and the general public.

Such books create an interactive experience particularly beneficial especially for children aged 7-12 who are still very unfamiliar with scientific words, as they engage visual and tactile senses, fostering curiosity and enhancing the comprehension of abstract concepts. Nila Rahmawati (2014: 3) emphasizes that pop-up book media is an effective three-dimensional teaching aid that stimulates children's imagination, enriches vocabulary, and bolsters their understanding of shapes and objects. Through a vibrant visual approach, children are encouraged not just to observe but to actively engage with the material, making the learning experience more dynamic and meaningful.

The narrative invites readers on a fascinating journey through time, traversing the geological layers of Sangiran much like flipping through the pages of Earth's history. In the context of the Sangiran site, pop-up book media emerges as a valuable tool for conveying intricate geological information in a straightforward and captivating manner. This book empowers children to visualize the formation of the Sangiran dome, identify the types of fossils embedded in various soil layers, and grasp the extensive history of ancient life in this area. Its interactive format not only broadens children's knowledge but also cultivates a passion for geology and highlights the importance of preserving our cultural heritage from an early age.

The story culminates with a reflective moment along the banks of the Cemara River, where researchers and residents collaboratively discover a new fossil. They stand in awe of their discovery, recognizing these fossils as vital pieces of human history—essential clues that prompt profound questions such as: who are we, and where do we come from? Ultimately, this book transcends mere knowledge delivery; it invites young readers to contemplate their connection to the past, nature, and the scientific world, nurturing a thoughtful and inquisitive mindset. Not limited to children, pop up books will also appeal to adults, as we already know that interest in reading in Indonesia has declined due to current technological advances that are growing rapidly .

We have chosen to utilize this medium because of its proven ability to boost children's interest and curiosity in complex subjects. According to the article "Developing the Local Wisdom-Based Pop-Up Book for Fifth-Grade Students" by Budiyanto Satrio and Fatmawati Laila (2024), pop-up books have demonstrated effectiveness in improving educational outcomes through various methods. Firstly, they present an engaging narrative enhanced by dynamic illustrations that introduce an element of surprise, increasing student involvement and enthusiasm in the learning process. Secondly, research indicates that incorporating local wisdom into pop-up books can deepen students' understanding of scientific concepts by linking lesson material to their cultural backgrounds, thereby making learning more relatable and impactful. Third, We will use pop-up books as our educational tool, enabling children to explore and understand geological layers in an interactive and engaging way. With vibrant illustrations and dynamic 3D elements, these books simplify complex concepts, making learning more enjoyable and memorable.

## C2. The design

### Pop-up book design: imagetic content and folding techniques

Based on an interview with the teacher and some students from elementary school and group discussion, there are some points we can elaborate, such as colour, language, design, interactive elements and the pedagogical aspect (Figure C.I). Since our target is children, first, we will not use very scientific language; we can use words that they are familiar with. Second, we will use the combination of primary colours to attract and make it more interesting for the children (Figure C.2). Third, the design we will use will be with a more realistic image, not cartoon-like, an interesting preference from 10-12-year-old children we talked to. Each theme will have depictions of fauna and flora from the sea, swamp, open and dry environments. Fourth, the interactive element is the 3D aspect of the pop-up book itself, as the reader can also interact to increase motoric activity and not be bored when reading the story (Figure C.3). We chose the elephant as our main character because the proboscidean or ancient elephants appear in almost all the periods of the Sangiran dome stratigraphy and the students near the museum are familiar and fascinated with the quite long-tusked Stegodon.

Figure C.I. Interview with headmasters of Manyarejo elementary school

Figure C.2. Interview with teacher at Bukuran elementary school

Figure C.3. Example of popup book

Figure C.4. Walking in the Pucung river

There are a few techniques of the pop-up book we can implement, for instance, to show the conversation we can use text boxes with pull-tabs, so we hide some text boxes, then when the children pull the paper it will show the other texts. Also, we can use sidebars and annotations which when they are pulled extend to show more added spaces for texts. For the animal pop-up we can use the pull tab technique, in which the children pull some paper and then the animal pops-up. Another simpler option is to pop-up all the animals in the same opening. For the folding and the erosion from the river, when opening the book the land is flat and by pushing the left and right side the dome will fold (Figure C.4). By pulling some paper in the middle, the river will come out.

Because we are not given the names of animal species, but just describing their main characteristics, we are adding on the last page a sticker game. It means that after reading the book, the children put the fossil sticker on a specific kind

Figure C.5. Example of what will appear in QR code

Figure C.6. 360 Photo that will appear after open QR code

Figure C.7. Interview with local children

of animal. For example, there is the sticker of the Dayu Stegodon skull and then they have to stick that to the correct environment.

Regarding the education aspects, both in school and with the parents, we will use digital resources to involve them. The QR code brings them to the link as an interactive 3D and 360° view of the formation layers with sounds of the environment to make them experience the situation in the past. We think it will be effective as we already had an interview with a teacher who mentioned the students already know how to scan the QR code. For a prototype of our idea, we did one example at the Pablengan river for mud volcanoes and another at Manyarejo outcrop for the Kabuh formation. We would like to present a description of the layer and give links to some references for further understanding (Figure C.5). The applications we use are Lapentor (https://app.lapentor.com) web app to put the 360° images, sound, descriptions and Sketchfab sketchfab.com to upload the 3D models of the outcrop (Figure C.6).

Apart from the pop-up book, we also want to have a bigger version of the dome formation process. We would have at the museum one large page exhibited, where the layers are folded by the push of a visitor, associated with volcanic activity. On the same page, at the fold of the dome, a river would appear beneath it, indicating the water flow that erodes the layers. Placing such a large

interactive pop-up would be attractive for visitors due to unexpected media, communicating the scientific message beyond the school age children, targeting to the book. Although our main product is focused on children, the adaptation of one of its pages can be presented in the museum for a wider audience.

**The storyline**

Based on our conversations with educators and school children, the idea of the storyline is to put adventure and exploration missions (Figure C.7). So our main character, the young elephant called Septian, is on a journey through the past of his land. Through fictional elements, we communicate the scientific message about the land, Sangiran Dome from present to the past and back to present, highlighting the educational aspect to our story. It will bring them to unforgettable imagination as the children prefer exploration or puzzle stories. We decided that the title was "The Secret of the Sangiran Dome", or "Rahasia Kubah Sangiran".

The book is divided into eight pages. The first one presents Septian, the elephant, who is at Cemara river that cuts Sangiran. Like many locals, he finds a fossil in the river bank, but when he touches it he is transported back in time. In the second page he arrives at the sea (Kalibeng), where he receives a riddle from an old sea turtle: to get back home, Septian must travel through the history of his land, following the volcano as the key.

On the third page he is finally on the continent again, but this time in a swamp environment (Pucangan). On the fourth page, he reaches the open environment (Kabuh), where he meets a familiar figure, the *Stegodon*. The fifth presents a very dry environment (Notopuro), where Septian is alone. He cries and wishes to go home, when he listens to the volcano one last time. On the sixth page the land trembles, the volcano is stronger and he witnesses the folding of the Dome and the river coming back. On the seventh page he is again at the river bank, but this time he can see two persons on the other side, one archaeologist and one local, who comment on the uniqueness of Sangiran for fossil finding.

The eighth page brings the stickers and the mission: to connect the fossils to the living animals in each environment. The goal is to demonstrate the variation of contexts in which different animals have lived in the same Sangiran spot. We can also include a few quizzes about the association between fauna and landscape, encouraging own reflection and perception, since we are only depicting these changes through our elephant's eyes.

| ELEMENT | DESCRIPTION | FAUNA AND FLORA | GENERAL TOOLS |
|---|---|---|---|
| Cover | Title and images of Septian and the Sangiran dome showing the Solo depression. | | Printed Design, 160 minimal grams of paper, glue or duct tape, ruler, compass (to make a perfect circle), scissors and a handicraft knife |
| Prologue | The Cemara river is surrounded by trees. Septian, the elephant is at the river margin and he is touching with his trunk an elephant skull-like fossil. | Elephant (Septian)<br><br>The fossil he touches | |
| Sea | Septian was surrounded by the sea and met with Tatharuga and the Sheriff at the **sea.** | Turtle (Tatharuga), Shark (Sheriff), and Elephant (Septian) | |
| Swamp | A hippo appears from the swamp and scares Septian with the pop-up of volcanic rock falling. | Elephant (Septian), Crocodile (Croco) and Hippo . | |
| Open Forest | Septian wakes up in Open Forest by the river and sees a deer hiding in the bush With the pop-up of the group of animals. Volcano mountain eruption pop-up. | Dicotyledon tree, grass, river, *Stegodon* (Stego), Elephas, *Panthera tigris* , Rhino, Wild Boar Buffalo, Bull, Deer | |
| Dry and barren | Septian is crying in the dry and barren land. | Red to orange background, Dry and reddish tree leaves, cracked land, Rivers drying up | |
| The folding of the Dome | The main drawing is the **layers of the Dome** presented in the book (Kalibeng, Pucangan, Kabuh and Notopuro), presenting fossils inside them, reflecting animals from each environment. For example, Kalibeng may show shark fossil, Pucangan *hexaprotodon* and Kabuh *stegodon*. Pop-up of the **folding process and the river** appear in the middle of folding. | Sangiran formation layers in vertical position, to be transformed when folding. Shark teeth fossils image inside the layer, *hexaprotodon* and *stegodon* . | |
| Present environment | Cemara river with Septian, the elephant on one side, archaeologist and local person on the other. They are finding a *Stegodon* fossil. | Elephant (Septian), archeologist and local people, *Stegodon* fossil. | |
| Games & QR code link | Images or drawing of the layer with the environment indicator like sea, swamp, terrestrial to place the sticker QR code of the link: https://app.lapentor.com/sphere/grup-2-hoh | Stickers with fossil photos. | |

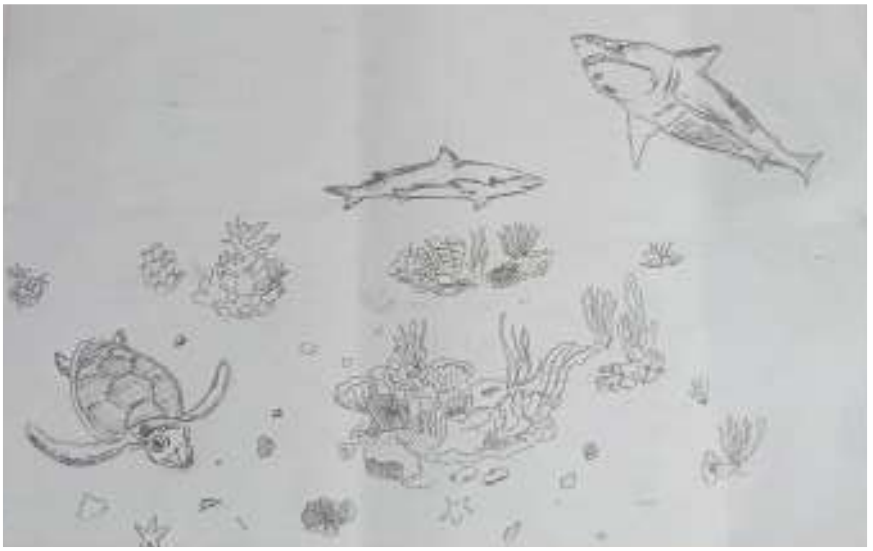

Figure D.I. Sketch of the sea (drawings by Wahyuda Pradana Santosa)

Figure D.2. Sketch of the swamp (drawings by Wahyuda Pradana Santosa)

## D - IMPACT

### The impact on the target audience

The use of educational media such as pop-up books has a significant impact not only on elementary school children but also on broader segments of society. It effectively simplifies complex scientific concepts, making them accessible to the general public. Through its visual and interactive approach, the pop-up book serves as a strategic tool for disseminating value for the site, allowing the key significance of Sangiran as a cultural and scientific heritage site to be more widely understood and appreciated (Figure D.I).

Moreover, this approach fosters an emotional connection between the local community, particularly children, and the site, as they engage with it in a way that stimulates curiosity, imagination, and a sense of belonging. Consequently, awareness and a sense of responsibility to protect and preserve the Sangiran site can emerge organically as part of the community's collective identity.

In addition, the pop-up book contributes to communicating universal values such as the importance of cultural preservation, respect for scientific inquiry, and the interconnectedness between humanity's past and the sustainability of its future. Through these three dimensions, the pop-up book functions as both an educational and cultural medium that is not only informative but also transformative in strengthening the relationship between communities and world heritage sites.

**The development process: a participatory experience and book distribution**

Key for this project is the participation of locals. Together we defined the scientific issues and our approaches, based on the needs presented by them. For instance, Ibu Raida spoke about her difficulty in explaining the geology for children and the common question about why fossils are found in Sangiran. Her experience in the museum indeed guided our discussions, in an effort to address these matters in our communication project (Figure D.2).

This participation strengthens their relationship with the heritage, increasing the consensus, since everyone's concerns are taken into account, both from a scientific, cultural and daily perspective. There are limitations, since the community around the museum is not homogeneous, they diverge in their needs and feelings about Sangiran. Thus, the book may have a distinct reception, even if we are considerate of this diversity and intend to persuade about Sangiran's value.

Despite that, we planned to engage as much of the local population as possible. For the creation of the drawings, we requested the aid of Mas Yuda, a local inhabitant already experienced in designing other communication projects for the museum. By this collaboration we counted with his perspective about the landscape and geological evolution of the site and engaged a local artist, valuing his skill and contribution to the heritage. For these reasons, we also explore the possible impacts according to the book's intended distribution.

Libraries can offer accessibility, but the public is mainly the regulars, who already have reading habits. As we would like to encourage literacy, it is preferable to distribute the book where it can reach a wider audience. In local schools the book is an educational tool, as we previously discussed possible implementation with local elementary school teachers. It aligns with the curriculum, as they already do social studies about heritage, but brings a new perspective. The students already learn about fossils, but have no classes on the geological history of the area or about why Sangiran is so unique in its fossil assemblage. The proposed book intends to address this gap, offering an educational resource.

Beyond the Sangiran area, the distribution in schools and libraries across Indonesia fosters a sense of identity and pride of the nation's heritage. Besides,

we aim to sell the pop-up book also as a souvenir, promoting awareness of Sangiran among tourists and the general public. This initiative supports the local economy by empowering small enterprises and engages with Sangiran cultural heritage and archaeological importance. Ultimately, we want the book to be both a learning resource and a promotional asset for sustainable cultural destinations.

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# Hominids and Hominins in Java, with Special Reference to the Sangiran Dome

**By:**

Ezio Anton, Quaternary, Prehistory and Bioarchaeology, Muséum national d'histoire naturelle, Paris, France, ezio.anton@gmail.com

Chandan Kumar Rajak, International Master in Quaternary and Prehistory, Muséum national d'histoire naturelle, Paris, France, chandansjs01@gmail.com

Dita Veronica Aula,Nutritional Sciences, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 472021014@student.uksw.edu

Yolanda Dewi Indraswari, Psychology, Universitas Kristen Satya Wacana, Salatiga, Indonesia yolandaswari.ys@gmail.com

**Other members of the project:**

Eldina Nurdiana, Accounting education, Universitas Muhammadiyah Surakarta, Indonesia, eldinanurdiana@gmail.com

Valentsia Galuh Nirmala Malika, English littérature, Universitas Sebelas Maret, Solo, Indonesia, valentsiaa@gmail.com

Darmi, Pokdarwis Wonderful Sangiran

**Abstract**

This project explores first how human evolution and the relationship between humans and great apes are presented in museums around Sangiran, Indonesia. We identified common misconceptions, such as linear evolution models and limited representations of hominid diversity and dispersal. To address this, we developed an interactive trivia game designed for museum visitors, especially children. The game focuses on three key themes: hominid dispersals in Java, the evolutionary relationship between humans and other great apes, and their differences. The research includes surveys and interviews with locals, revealing limited awareness of human-ape evolutionary links, shaped in part by religious beliefs. The project emphasizes respectful science communication, bridging scientific facts with cultural context. The final media aims to make evolutionary science accessible and engaging and foster conservation interest, especially regarding the now-extinct orangutan population in Java.

**Keywords**

Hominids, Hominins, Great Apes, Sangiran, Java, Evolution, Trivia game

# A - THE CHALLENGE AND RELATED SCIENTIFIC MESSAGES

## AI- State of the art

In order to create a project around our topic, we made several museum visits as a mean to understand how the different hominid taxa and the relationship between them is depicted in the region.

We decided to focus on 3 points which are central to our project:

- the way the relationship between human and other great apes is represented
- the way hominids' dispersals are shown
- how the difference between humans and apes is represented and explained

We visited Krikilan, Bukuran and Ngebung museums for their exhibitions related to our topic.

Regarding the biological/paleontological relationship between hominin hominids and non-hominin hominids we observed different representations with a common point.

In the Krikilan museum, a huge panel represents human evolution (Figure A.I). This panel takes up the famous "March of Progress" which is perhaps the most recognizable representation of evolution. This panel shows a linear evolution, as

Figure A.I. The "March of Progress" displayed at Krikilan Museum

Figure A.2. A display at Krikilan Museum showing dispersal of *Homo erectus* and *Homo sapiens*

Figure A.3. A panel at Krikilan Museum showing unique characteristics of the human genus

if humans were the culmination of an evolutionary race which includes other great apes as our lesser ancestors. This depiction is misleading and might give the visitors a false idea of the dynamics of human evolution.

Krikilan museum chose to include Tarsier and Lemuria in the panel (probably to highlight the most basal primates separation: between Strepsirrhini and Haplorhini), and a casual visitor could think that our species descends from extant lemurs.

In a similar fashion, Bukuran museum presents an animated movie showing different hominids' locomotion, from knuckle walking to complete bipedalism. This movie, depicting a linear sequence could give the idea of the human lineage as a straightforward process, from apes to modern humans.

In this museum, a representation differs from the other two, in the first room of the museum animal taxonomy is represented on a mural and all primates are here represented as being related, in the same circle, without linear evolution.

Our project could focus on giving a more accurate, but still simple representation of hominid bushy evolution.

Different maps in Krikilan and Ngebung museums show hominins dispersal routes and flows around the world. These maps only show human dispersion and no data is provided regarding the dispersal of other hominids throughout the world. The map in Krikilan museum (Figure A.2), presenting *Homo erectus* and *H. sapiens* dispersals, is very simple and offers no timescale. In Ngebung museum a panel is illustrating the dispersal of *H. erectus* s.l. with species such as *H. neandertalensis* and *H. ergaster*. We also noticed that these maps focus on a global level, the dynamics of human dispersals from continental Asia to Southeast Asia are not shown in detail. For the creation of our media we could focus on showing regional dynamics.

Regarding the difference between humans and other great apes, four panels in Krikilan museum are emphasizing what makes humans unique (Figure A. 3).

• motricity: humans' opposable thumb enables human species to perform complex and precise tasks.

• speech ability: unlike apes, human physiology allows complex speech and better information transmission. In this panel the development of cultures is linked to humans' better speech ability.

• brain development: according to the panel, humans' bigger brain capacity and complexity compared to other apes let us remember and think better than any other animals.

• bipedalism: human bipedalism is presented as one of the reasons behind their success, allowing us to be more alert about threats and to create and use tools.

Earlier in the museum itinerary, another panel presents human characteristics: "Being humans means having to keep learning, being creative and not repeating the same mistakes".

The topic of the difference between humans and apes has been kind of handled by the Krilikan museum. According to it, the difference seems to be related to biological facts (higher motricity, more complex speech ability and brain development) as well as cognitive ability. We take into account how the difference between hominin hominid and non-hominin hominid has been highlighted by the museum to build our project.

## A2- The messages

We considered three categories of scientific messages for our project, one related to the history of hominids dispersals in Java and one regarding the effects of the landscape and paleoenvironments on said hominids dispersals and evolution. The last category revolves around the paleontological/biological relationship between humans and other great apes, the distinction between those two groups as well as the perceived difference by society.

For the first category we considered three different aspects:

- Hominids dispersal history in Java.
- The coexistence of humans and other great apes in Java.
- The extinction of non-hominin hominids in Java.

We've seen that in Sangiran museums, non-hominin hominid dispersal is not showcased, and we think that emphasizing that point could be interesting for knowledge dissemination. The coexistence of humans and their Pleistocene living hominid relatives in Java (*Pongo, Gigantopithecus,* or even *Meganthropus*) could also be considered for our project. Also, the extinction of all non-hominin hominids in Java before the Holocene can be addressed, maybe in relationship with the coexistence topic.

These points could be interesting for every visitor, highlighting the variety of hominids in nature, time and space.

Also, we thought about describing the environment the Java Pleistocene hominids would have lived in. We considered two issues to support the previous points: landscape evolution and paleoenvironments.

To talk about the landscape evolution of Java, we would have to consider volcanic, tectonic as well as sea level variation history. These issues might be difficult to showcase but sea level changes are important to understand migration flow, dispersal dynamics are related to glacial and interglacial cycles, leading to connection between Java, other islands and mainland Asia. Describing the paleoenvironments of Java by taking into account fauna and flora diversity through time and space for all the Pleistocene might make us face the same challenge as the landscape evolution: being able to simplify a lot of complex data. We still considered these ideas for our project because of their importance to understand the life of hominids in Java. Such topics related to the change of environmental conditions and landscape through time, if presented correctly, can be interesting for all potential public.

Additionally, we wanted to explore the parallel between hominin hominids and non-hominin hominids, considering both the relationships and also the differences between humans and other great apes.

We might explore the taxonomic relationship between human species which have been present in Java (*H. erectus* and *H. sapiens)* and other fossil hominids on the island (*Gigantopithecus, Pongo, Meganthropus*) - as well as extant hominids living outside of Java such as extant orangutan, or even hominids present outside of Asia like gorillas and chimpanzees. Communicating on the shared ancestry of all hominids can be a focus point of our project, the

relationship between these species being sometimes misunderstood or even completely denied. Our media can shed light on this matter by communicating on the relationship between humans and other great apes.

Also, we noticed that the difference between humans and, for example, orang-outan or gorillas are often emphasized in Sangiran's museums, the blurry line between humans and our closest cousins seeming to be a matter that raises questions. This topic is different from the other we were considering to include in our project, it is based on more subjective considerations, going beyond the scope of scientific data alone.

We decided to select some of those issues, exploring in our project :

- Hominids dispersal history in Java.
- The relationship between humans and other great apes.
- The difference between humans and other great apes.

For the hominids dispersal history in Java, we decided to implement part of the data regarding the landscape evolution of Java, related to the changes in sea level through the Pleistocene.

Through these three messages, we want to highlight our shared history with other great apes, extant and extinct, that we are related to them but not their direct descendants.

## B - RESEARCH

Through our project, we aim at convey a central message: "Humans share a common history with great apes. We are related to current great apes, but we're not their direct descendants." We intend to deliver this core message, along with three additional key messages detailed in Part A2.

To better tailor our communication to our main audience—local communities and children—we took several steps to understand how these messages might be received. Our activities included:

- Engaging in discussions with professors from various fields such as prehistory, communication studies, and sustainable development
- Survey in the village of Sangiran
- Looking for references on trivia games in five museums at Sangiran

These efforts helped us gain insight into how narratives about human evolution

Figure B.I. Discussion with Prof. Harry Widianto

circulate in the public sphere, acknowledging the fact that prehistoric research has been conducted in Sangiran for more than 80 years, and how children, in particular, interpret and respond to such questions.

The discussions helped shape our approach in addressing the fundamental question —"Where do humans come from? and our central message"—in a way that would resonate with the public. We held a discussion with Prof. Harry Widianto, an expert in human evolution in Indonesia (Fig. B.I), which helped us understand how to bridge the gap between science and public belief. He emphasized the importance of connecting scientific ideas with people's existing religious and cultural frameworks. For example, when individuals refer to Adam and Hawa as the first humans, we can explain that they may represent the first *Homo sapiens*, but the human story stretches back much further in time—well before the appearance of *Homo sapiens*. Given the strong influence of religious beliefs in many communities regarding human origins, we recognized the importance of approaching the topic with sensitivity. While designing our survey questions, we intentionally avoided direct or confrontational language. Instead, we framed them in a way that allowed participants to respond within the context of their own beliefs, including religious perspectives. This approach not only encouraged open dialogue but also helped us explore effective ways of communicating our message through accessible and respectful media.

We tried to find references for trivia game in all the five museums at Sangiran-Krikilan, Dayu, Ngebung, Bukuran and Manyarejo. We obtained some ideas from the game displays at the Dayu Museum (Figure B.2).

**Challenges in conducting the survey**

While planning the survey, one of the key challenges we faced was to deal with the issue of the "obvious"—that is, the influence of prevailing religious beliefs on


Figure B.2. References trivia game at Dayu Museum

people's understanding of human origins. We were aware that the majority of the residents in Sangiran practice Islam, and that their responses would likely reflect religious faith. Despite this, we chose to move forward with the survey for the following important reasons:

- to assess the extent to which religious beliefs shape public responses
- to identify effective strategies for communicating our scientific message
- to explore a neutral and respectful way of addressing the relationship between science and religion

The story of Adam and Hawa (Eve) is deeply rooted in the local communities around the world, often perceived as the origin of humankind. Through discussions with professors, we developed an approach that allowed us to walk a middle path—one that communicated our core message without directly challenging people's beliefs. For example, during conversations with the public, we can position Adam and Hawa as the first *Homo sapiens*, and then introduce the idea that human history stretches even further back in time, with the evidence available through scientific inquiry.

This inclusive approach can prove effective. Rather than refuting public beliefs, it is built on them—gently correcting misconceptions through logical reasoning and encouraging a scientific way of thinking. In doing so, we can create a space where science and faith could coexist in dialogue, rather than conflict.

**The survey**

For the survey, we formulated a set of five questions. The questionnaire consisted of closed-ended as well as open-ended questions, consisting of two

and three questions for each type respectively. We interviewed altogether 26 people around the vicinity of the Krikilan museum in Sangiran (Figure B.3). The respondents included men, women, and children, with the majority (around 62%) falling within the 18–40 years age group.

**Results of the survey**

This exercise proved to be valuable in multiple ways. Not only did it help us meet our research goals, but it also offered insightful observations. We noticed that individuals who had exposure to researchers or museum staff at Krikilan museum tended to demonstrate a better understanding of human origins. For instance, during one of the conversations, a respondent referenced the term "missing link"—a phrase historically connected with Eugene Dubois's 1890s search for human fossil ancestors though scientifically inaccurate today (Shipman and Storm, 2002). It indicated how informal educational exposure shapes people's understanding of scientific questions related to human origins.

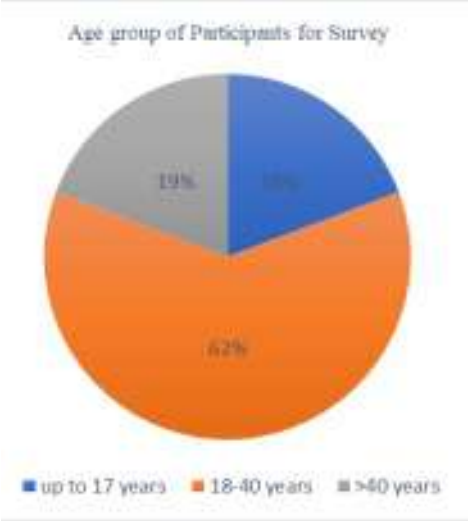


Figure B.3. Pie chart showing the age group of the participants

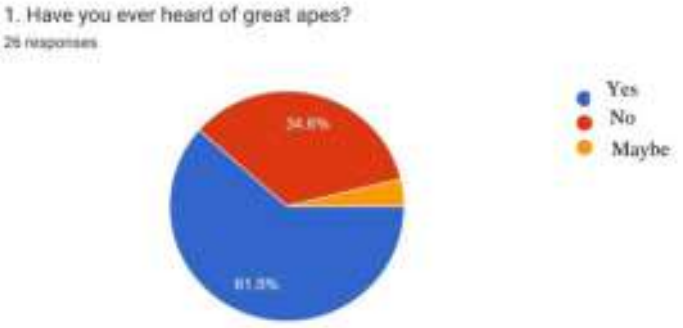


Figure B.4. Pie chart showing the result for Question 1

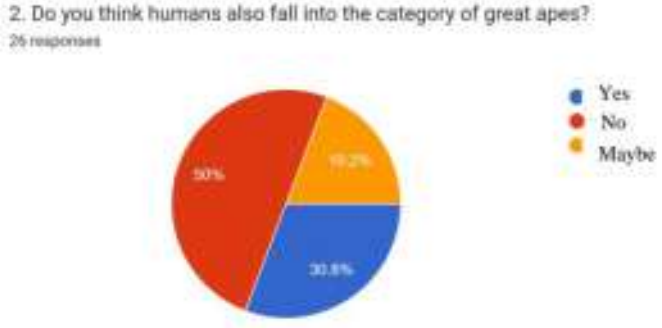


Figure B.5. Pie chart showing the result for Question 2

Approximately 61.5% of the respondents were familiar with great apes—referred to locally as *Kera besar*—while 34.6% were not (Figure B.4). Among those who were aware, most mentioned is the orangutan, which is the most widely recognized great ape in Indonesia, native from the islands of Sumatra and Borneo.

When asked whether they were aware that humans are also classified as great apes, 50% of respondents said they were not aware, while 30.8% said yes and 19.2% were unsure but believed it might be possible (Figure B.5).

In response to the first open-ended question—what they knew about the relationship between great apes and humans—fewer than 50% of participants were able to provide an answer, indicating limited understanding of this connection. When asked about the ancestors of humans, nearly 40% of respondents referred to the religious narrative of Adam and Hawa, reflecting the strong influence of cultural beliefs.

When we asked whether they were aware of the differences between great apes and humans—a follow-up to the previous question—responses varied widely. Some shared scientifically informed views, while others relied on non-scientific or traditional explanations, which was expected given the open nature of the question.

Most people were familiar with great apes—especially orangutans, or *Kera besar* in Bahasa Indonesia—since they are the only extant apes native to Indonesia. However, when it came to understanding the evolutionary connection between apes and humans, or identifying human ancestors, it became clear that there is a significant gap in public knowledge. This highlighted the importance of effectively communicating our core message in a way that is accessible, respectful, and engaging.

# C - THE PROJECT

## CI - The media

Our media is a multilevel trivia game that tests knowledge by providing several questions. An interactive game can be an attractive way to deliver our messages in an engaging way. We hope to attract every public with this media design, moreover, we know that children might be attracted by the interactive aspect of the game and we wish to appeal to them.

Based on the results of the research we conducted, the public's understanding of hominids is not developed, therefore we chose this media so that the public can get information about hominids based on scientific data, and this media is considered attractive enough for museum visitors and the general public.

## C2- Project design

Our media will be presented through a touch screen in a dedicated area that still needs to be defined. The game will be divided into three levels :

I. Hominid dispersal into Java

2. The relationship between humans and other great apes

3. The differences between humans and other great apes

For each level, YES/NO questions will be asked to the player, the player can try to answer the question as many times as he wants until the correct answer is found. Each question will be displayed in a tile inside of a box, after the right answer is found, the tile will flip revealing part of a picture (Figure C.I). After all the tiles of a box are flipped, an image related to the topic will be revealed, this image will have an educational value and will deliver knowledge. Below the image a short, simple and accessible text will also give information related to the topic (Figure C.2). The goal is to make the pictures and text as simple as possible for everyone to understand (especially for the children who will play the game) while being attractive for all.

For each level, the number of questions will increase: 2 questions for the first topic; 3 questions for the second topic, 4 questions for the third topic.

After designing the basic mechanics of the game, we tried to render an idea of what the game could look like (Figure C.3). We used bright colour and an appealing design, and the picture displays the first two levels (one with two tiles, the other with three tiles). After the level is completed, the picture will appear next to in place of the brown tiles. We also designed an example of gameplay (Figure C.4), with the two questions of the first level, related to hominid dispersals in Java.

We decided to design very simple trivia questions for our game:

**Level I**: Hominid dispersals into Java

- Was Java always an island during prehistory? (Ans. No)
- Did hominids arrive on Java Island through the sea? (Ans. No)

**Level 2**: The relationship between humans and other great apes

- Did humans evolved from current great apes (orangutan for example)? (Ans. No)
- Are we closely related to great apes / *Kera besar* (chimpanzee, gorilla and orangutan) or not? (Ans. Yes)
- Do humans share genetic similarity with great apes or not? (Ans. Yes)

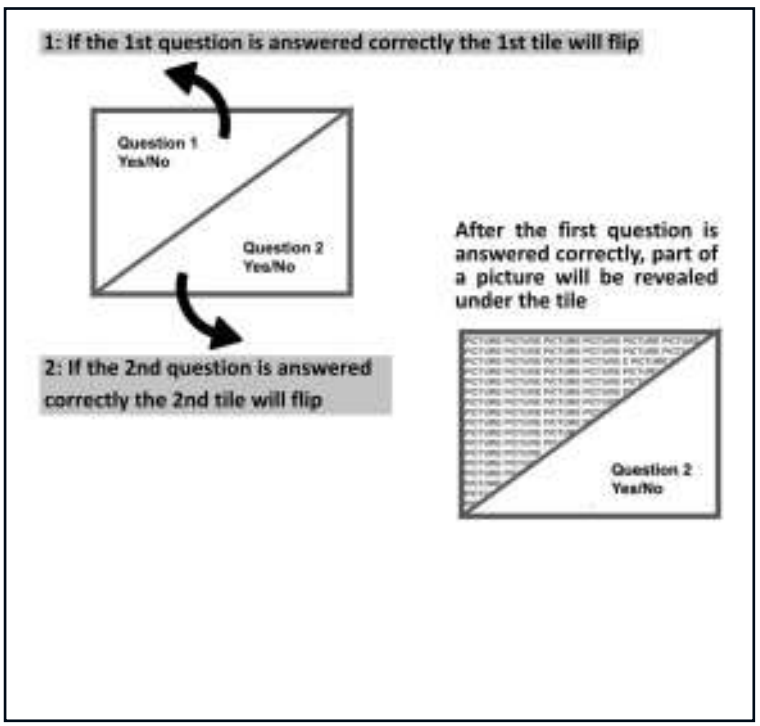


Figure C.I. Basic working of the game

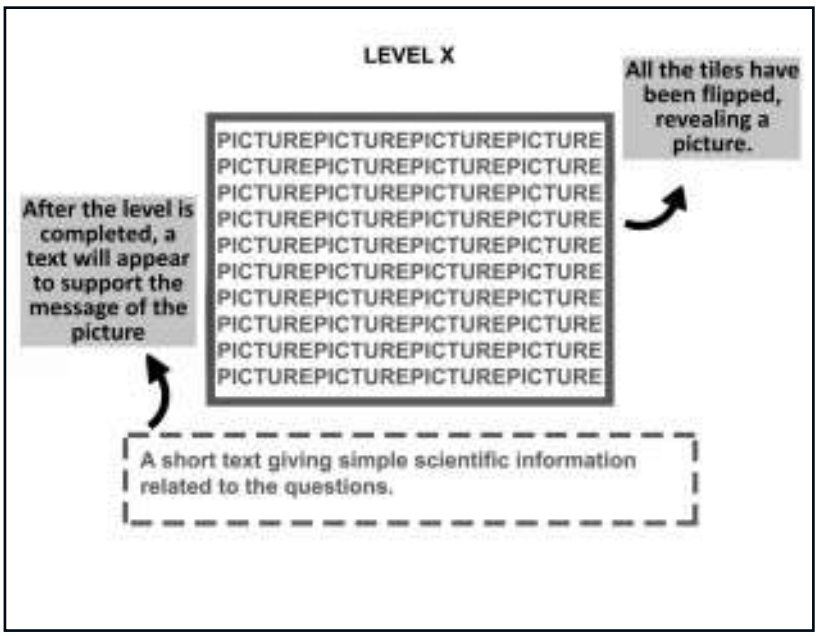


Figure C.2. The Final working of the game is shown once all the questions for a level are answered displaying a picture containing the message and short text

**Level 3** : The differences between humans and other great apes

- Can Great Apes (*Kera besar*)/ orangutans walk on two legs in the same way that humans do? (Ans. No)

- Can Great Apes (*Kera besar*) make stone tools or not? (Ans. Yes)

- Can we consider brain size as a marker of difference between great apes and humans? (Ans. Yes)

- Will the other great apes become humans like us through time? (Ans. No)


Figure C.3. A prototype of the game showing Level I and Level 2


Figure. C.4. A prototype of Level I with 2 questions (in Bahasa Indonesia) on two tiles

As said before, after all questions of a level are answered correctly a picture will be unveiled and a short text will appear below said text. Unfortunately, because of the limited time available, we haven't had a chance to design the images that will be placed under the tiles. However, all of the explanatory texts have been written, and will be displayed as shown in Figure C.2.

Level I : In the past, Java was part of a larger landmass called Sunda, formed during glacial periods when sea level dropped. Land bridges connected Java with Sumatra and Borneo. It allowed animals—and later human ancestors—to migrate to Java from mainland Southeast Asia.

Level 2 : Humans did not evolve from living great apes but we share a common ancestor. The most recent common ancestor of all hominids (us, orangutan, gorillas...) lived roughly 14 million years ago!

Level 3 : Humans are different from great apes in various ways. They can walk on two legs, make complex stone tools, and have a larger brain size compared to our body size. Still, we share so many similarities that it's hard to define what's properly human.

**Technical implementation**

We are providing the game structure, its design, its gameplay as well as the trivia questions. In order to implement our project, the support of a game development service will be needed. The structure of the game is provided by the technical drawings (Figures C.I & C.2), the proposition of design (Figures C.3 & C.4) can be altered by the game development service according to their expertise. A touch screen will also be needed to implement the game.

## D - IMPACT

The Hominids tiles and trivia game are designed as an engaging, visual learning tool to communicate complex topics such as the dispersal of hominids in Java, the evolutionary relationship between humans and great apes, and their differences. This interactive format helps translate scientific knowledge into accessible experiences, especially for audiences that might otherwise find such topics difficult or intimidating.

**Making science accessible across audiences**

For educators and students, this game offers a refreshing alternative to traditional teaching methods. Where textbooks often present information in a static, one-way format, the game fosters active learning through interaction, storytelling, and strategy. It encourages curiosity about evolutionary history by introducing key topics such as the migration of early hominins and their fossil evidence in Java in a way that is both fun and informative.

For the general public, especially those without a background in science, the game breaks down barriers to understanding. Evolutionary concepts like the shared ancestry of humans and great apes are often hard to grasp through text alone. This game uses images, narratives, and intuitive gameplay to make these concepts more relatable. It allows players of all ages and backgrounds to learn about our shared human past without needing to read academic papers or technical language.

By embedding local elements such as Java fossil sites and extinct orangutan populations in Java, the game not only teaches science but also cultivates cultural pride. Players discover that the very land they live on holds a significant place in the global story of human evolution. This kind of place-based learning can foster a sense of ownership and responsibility toward heritage preservation.

### Bridging science, culture, and community

It strengthens awareness of Java's unique prehistoric significance, helping local communities understand their role in protecting cultural heritage. The project also opens doors to collaboration between scientists, game designers, museums, and local storytellers. This creates opportunities for the co-creation of content that is both scientifically rigorous and culturally resonant. For example, integrating local folklore or archaeological discoveries into the game enhances authenticity while preserving intangible heritage.

Furthermore, this initiative supports the development of creative economies and heritage-based tourism. By involving local artists, educators, and small businesses, the game can evolve into a locally-produced educational product with real economic impact. Museums, schools, and tourism centers could use the game as part of exhibitions or outreach programs, making it a valuable tool in public education and conservation efforts.

### Sensitization towards conservation of orangutans

Orangutans, a group of great apes currently found on the islands of Sumatra and Borneo, once inhabited Java during the Pleistocene epoch, a fact supported by fossil evidence. However, they should have disappeared from Java around 12,000 years ago, near the Pleistocene-Holocene boundary (Spehar et al., 2018). Today, orangutans are listed as critically endangered on the IUCN Red List of mammals. They continue to face serious threats in the modern world, and this presents an opportunity to raise public awareness: without urgent conservation efforts, they would also join the extinct ranks of *Hexaprotodon* and *Stegodon*.

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# Adaptation of *Homo Erectus* in Sangiran: Between Ecological Constraints and Lithic Technology Innovation

**By:**

Noémie Bertrand, Quaternary, Prehistory & Bioarchaeology, Muséum national d'histoire naturelle, Paris, France, noemie.betrand@edu.mnhn.fr

Daniel Burel, International Relations, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 372023086@student.uksw.edu

Gaston Lienhard, Quaternary, Prehistory & Bioarchaeology, Muséum national d'histoire naturelle, Paris, France, gaston.lienhard@edu.mnhn.fr

Robetrin Serumena, Sustainable Development Studies, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 092024007@student.uksw.edu

Dewi Ayu Kherina Try, Nutritional Sciences, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 472021012@student.uksw.edu

**Other members of the project:**

Octaviana Dian Angraini, Environmental and soil sciences, Universitas Sebelas Maret, Solo, Indonesia, octasvia17@gmail.com

Ika Aldila Putri Jalasenastri, Pokdarwis Wonderful Sangiran

**Abstract**

This study explores the adaptations of *Homo erectus* in Sangiran during the Middle Pleistocene, focusing on their interactions with local fauna, flora, and lithic tools. As one of the earliest hominins in Java, *Homo erectus* faced a dynamic environment that required innovative survival strategies.

We analyzed the museography at the Krikilan, Ngebung and Manyarejo cluster museums, which provided valuable context for the archaeological findings. Additionally, visits of stratigraphic sections with volcanic layers, Grenzbank, and Kabuh layers helped us understand the various environments encountered by *Homo erectus* and the challenges they faced.

By examining the ecological context of Sangiran, we highlight the region's rich biodiversity, including animal species and vegetation that influenced the subsistence patterns of *Homo erectus*. The analysis of lithic tools reveals their technological advancements and adaptability to changing conditions.

To understand the fauna, flora, and lithic tools used by *Homo erectus*, this project aims to produce a play and poetry as a cultural mediation tool whose objective is to engage with a broad audience. This multidisciplinary approach aims to illuminate the complex relationship between *Homo erectus* and their environment, contributing to a deeper understanding of human evolution and adaptive strategies in diverse ecological niches.

**Keywords**

Adaptation, *Homo erectus*, Fauna, Flora, Stone implements, Middle Pleistocene, Theater play

# A – THE CHALLENGE AND RELATED SCIENTIFIC MESSAGE

## AI- State of the art

The Sangiran Site in Central Java stands as one of the most significant places for the study of human evolution and has been recognized as a UNESCO World Heritage Site since 1996 (Widianto & Setiawan, 2012). Its importance lies in key discoveries such as *Homo erectus* fossils, lithic artifacts, and well-preserved geological layers that document environmental changes across the Pleistocene, particularly the Middle Pleistocene. These stratigraphic sequences provide exceptional opportunities to reconstruct the dynamic relationships between volcanic activity, climate change, and the evolution of early human culture and technology (Figure A.I). Despite this scientific richness, efforts in science

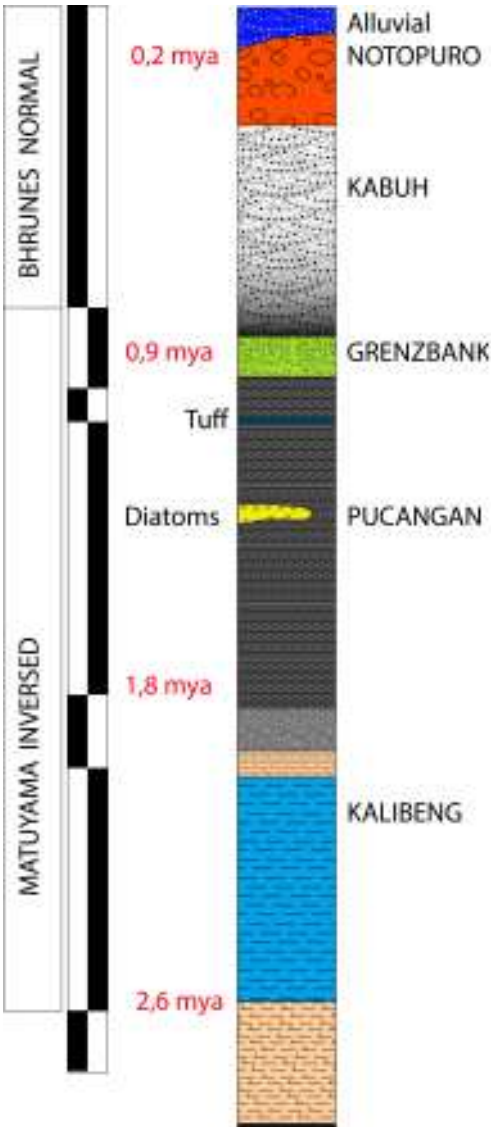


Figure A.I. Sangiran's stratigraphic sequences (various authors)

communication at critical field locations such as Air Asin, Mud Volcano, the Pucangan and the Kabuh layers remain somewhat inadequate. These areas could serve as direct educational platforms for understanding stratigraphy and geological processes, yet they suffer from poor maintenance and limited access due to land ownership by local communities rather than the state. Consequently, the general public is deprived of firsthand engagement with these valuable scientific records, which, if better managed, could become powerful open-air learning spaces illustrating the chronology of human evolution and ancient environmental shifts (Figure A.2).

Moreover, the interpretive quality of the main museum spaces, such as the Krikilan museum, reveals several shortcomings. While the initial exhibition rooms are thoughtfully designed with modern layouts that guide visitors through the evolutionary timeline, subsequent sections partly lack thematic coherence. The use of unsuitable props, such as stuffed rabbits, diminishes the scientific atmosphere, and there is no clear visual comparison between the Archaic, Typical, and Progressive stages of *Homo erectus* (Figure A.3). Similarly, the open-air museum in Manyarejo, which has immense potential for experiential learning through direct observation of excavation sites, could clearly improve infrastructure and facilities, as well as indoor explanatory exhibit arrangements helping visitors to grasp the significance of the collections. Compounding these challenges is the poor environmental condition surrounding the Sangiran area, where waste pollution in rivers and unmanaged landfills compromise both the ecological context and the visitor experience of an ancient, scientifically rich landscape.

Figure A.2. Science communication at critical field location Air Asin remains somewhat inadequate

Figure A.3. Unsuitable props

Despite these issues, Sangiran still holds great promise as an educational and cultural resource. The broader natural landscape is home to unique features such as saline springs, mud volcanoes, lahar remnants, and sedimentary layers, which offer direct insights into prehistoric geological phenomena. These geological markers, if properly maintained and integrated into interpretive educational programs, can significantly enhance public understanding of environmental change and human adaptation. To bridge the gap between academic research and public comprehension, innovative strategies such as interactive installations, scientific-based musical performances, or visual theater could be employed to narrate the complex processes of human evolution in engaging ways. The integration of science, art, and technology helps not only strengthens Sangiran's role as a research center but also transforms it into a dynamic, inclusive educational space capable of addressing contemporary challenges in science communication and heritage preservation.

## A2- The message

The scientific message that we raised after directly visiting the Sangiran area, was to focus on the dynamics of *Homo erectus*' adaptation to the environment during the Middle Pleistocene period, especially in the Sangiran area. This adaptation can be seen from the interactions of *H. erectus* with biotic and abiotic elements in the surrounding environment that form their survival strategies. A striking adaptation is the use of local vegetation, such as bamboo (*Bambusa spp.*), possibly the teak (*Tectona grandis*), and acacia (*Acacia spp.*), which not only serve as a source of building materials, food, and tools, but also reflect the resilience of the ecosystem that can still be found today (Figure A.4)

Figure A.4. *Acacia* as a local vegetation

Figure A.5. Past environmental conditions displayed at Krikilan museum

(Dhanang Puspita et al., 2020). The use of these plants suggests a close connection between ancient humans and their environment, as well as their knowledge of the potential natural resources available around their habitats. The sustainability and distribution of this flora makes it an important indicator in palaeoecological studies, as it allows a direct trace of the past environmental conditions inhabited by *Homo erectus* like grassland in the Middle Pleistocene for example (Figure A.5) (Bettis et al., 2009).

The vegetation in the Sangiran area shows frequent presence of bamboo and from another viewpoint dense teak plantations. The tracing of this vegetation through time can help to reconstruct the climate and ecological changes that occurred during the Middle Pleistocene period. The flora in Sangiran, which has been identified since prehistoric times, provides an idea of how *H. erectus* adapted its lifestyle to seasonal changes and the broader influence of climate change. The existence of fauna such as *Bibos palaesondaicus* (ancient banteng) and ancient hyenas in the Sangiran area provides important insights into the complex ecological relationship between humans and the large animals that existed at that time (Figure A.6) (A. Bouteaux et al., 2006 ; Fathoni., 202l). The interaction between *H. erectus* and the large fauna not only shows their role in the food chain, but also reflects their adaptability and technological innovation. Analysis of 636 bone fragments showed that some bones underwent modifications, including traces of marrow extraction, meat cutting, and bone tool formation (Abdullah & Mahirta., 2022). These findings indicate that *H. erectus* likely used the carcasses of large animals either naturally found or as a result of interventions against other predators. This resource is a valuable source of nutriment and could be a good raw material for tools. This adaptation reflects

Figure A.6. Ancient buffalo


Figure A.7. Bola as a lithic technology

the response of *H. erectus* to the Sangiran environment which is rich in megafauna as well as their ability to develop efficient survival strategies (Abdullah & Mahirta., 2022).

Lithic technology in the Middle Pleistocene period shows the cognitive ability of early humans to design tools as needed (Abdullah & Mahirta, 2022). They chose local raw materials (stone) as well as they imported allochtonous rocks from tens of kilometers away and applied production techniques that are in accordance with environmental characteristics (Widianto, 2020). These tools reflect an ecological heritage, as their use continues for a long time (Rohman et al., 2020). The sustainability of lithic technology shows that stone tools are a key element in *H. erectus* survival strategy when facing climate change, volcanic activity, and faunal changes (Figure A.7) (Yuliyanti & Anggraeni, 2017). Through the integration of three essential elements: flora, fauna, and lithic technology, this scientific message aims to provide a holistic understanding of how *H. erectus* adapted in the Middle Pleistocene environment. Human adaptation is not only biological, but also includes cultural and technological aspects (Abdullah & Mahirta, 2022). With this approach we want to show that the study of human evolution requires an interdisciplinary perspective, which includes archaeology, paleontology, geology and ecology. Comprehensive knowledge delivery to the public is also an important goal, so that the results can be widely understood and appreciated. This message can also generally remind us that human sustainability on earth is inseparable from the ability to adapt to the environment and that the traces of evolutionary history are not just stories of the past, but can enrich an understanding of the importance of conservation, sustainability, and how interdisciplinary science can provide solutions to modern challenges, such as climate change and environmental degradation (Rohman et al., 2020).

Figure B.I. Evidence of soil layer location in Pucangan Formation

Figure B.2. Blue clay deposit

Figure B.3. Mud volcano

## B - RESEARCH

We visited the main museum at Krikilan, followed by the Ngebung and Manyarejo museums. The Krikilan museum presents an in-depth explanation of the layers of soil found at the Sangiran site, which are very important in understanding the process of human evolution and the dynamics of environmental change over millions of years. Information is presented through dioramas, interactive panels, geological maps, and replicas of land cross-sections that show the stratigraphic sequence and environmental changes from the sea, land, to volcanic activity. In addition to visiting the museum, we also conducted direct observations at the location of the soil layers, which provided a more concrete understanding of the geological structure and evidence of physical environmental change (Figure B.I). The differences in color and texture between layers indicate significant environmental transitions, reflecting the adaptive challenges faced by ancient humans. This observation supports the topic of adaptation, because it shows how ancient humans adapted to climate change, geographical conditions, and resource availability through survival strategies.

On the second day, we visited Air Asin, one of the proofs of changes in the physical environment in the Sangiran environment. This salt water is useful for those of us who discuss human adaptation because it can help identify soil layers through the differences in color and texture between layers. Blue clay refers to the shallow sea deposits (part of the Kalibeng formation). Black clays refer to mud and soils rich in organic or volcanic ashes (part of the Pucangan formation) which means that Sangiran area became a swamp that recorded also volcanic activity (Figure B.2) (Faylona et al., 2022). We visited the Mud Volcano which is also an important part to understand about the geological and

Figure B.4. Bola in Manyarejo Museum

Figure B.5. flakes in Ngebung Museum (Flakes industry)

Figure B.6 An experiment of marrow extraction using stone tools

environmental processes (Figure B.3). These field trips helped us to better understand the earliest part of the Sangiran stratigraphy and related environmental changes faced by the earliest humans who settled in the area.

At the Ngebung and Manyarejo museums, we studied stone tools which are clear evidence of ancient humans' adaptation to their environment. Tools such as hand axes, flakes, and other cutting tools show the ability of early humans to utilize natural resources effectively, process food, and survive like bolas (Figure B.4). We visited the Ngebung site which is also known as the flakes industry site because of the large number of smaller stone implements that were found (T. Simanjuntak and F. Sémah, 1996) (Figure B.5). One of *H. erectus*' forms of adaptation is how to select raw materials and manufacturing techniques that show the process of thinking and planning. After leaving the Ngebung site, we continued our journey to the Ngebung museum not to visit the contents of the museum but to learn in general how *H. erectus* got marrow from inside the bones by experimentally breaking bones and making flakes and bolas (Figure B.6). This reminds that early humans' cultural adaptations played an important role in their evolution and survival.

Discussions conducted with lecturers and supervisors resulted in the idea that human adaptation to the environment can be studied through observation of environmental conditions around the Ngebung site. Based on the discovery of the pollen, types of flora that have existed since prehistoric times and still survive today are Poaceae, Asteraceae, Fabaceae and Mimosaceae (A.M. Sémah., 2004). We choose the acacia (Mimosaceae), and grass (Poaceae) to represent the continuity of ancient vegetation into the actual environment. Furthermore, we chose to implement bamboo, and also teak, even though we haven't found any teak evidence for the middle Pleistocene, because it is a

quite well adapted taxon under the long dry season climate that possibly dominated at the dawn of the Middle Pleistocene. In addition, fossil finds of fauna in Sangiran such as bones from ancient banteng and teeth from ancient hyenas (A. Bouteaux et al., 2006) were also included in our project, as these two animals represent a group of species that still exist today, so they can provide an idea of the continuity and changes of the ecosystem from the past to the present.

# C – THE PROJECT

## CI – The media

The medium we chose to represent our theme, "Adaptation," is a play. We were especially influenced by the Prehistoric Body Theater, actors' embodiment of *Homo erectus* and their nuanced use of lighting and atmosphere. Prehistoric Body stages scenes with dim, carefully controlled light that shapes immersive environments guiding the audience's emotional response and conveying profound meaning without words (Figure C.I). This aesthetic approach felt perfect for exploring the complex and fascinating topic of early human adaptation.

By opting for a play, we focused on a clearly defined era: the early Middle Pleistocene. Our group set out to examine the adaptation of *Homo erectus*, and to make our subject more concrete we chose to portray one specific form, the Trinil-like *H. erectus* as found at Sangiran. Rather than getting lost in distinctions like archaic, typical, or progressive forms, we decided to highlight the variant directly tied to the numerous discoveries made in Sangiran at this geological period.

We designed this theatrical project with a strong emphasis on local involvement and sustainability. The intended audience includes not only tourists and students from around the world, but also and above all local communities. For these communities is an opportunity for training and active participation in the creative process through workshops focused on scenography, costume-making (Figure C.2), and traditional music or acting. This participatory approach allows local people to engage deeply with the project, contributing with their knowledge and creativity, and preserve all the costumes, sets, and materials after the performances for future use or transmission.

The scientific narrative will be delivered in Indonesian in order to reach and empower local audiences, while the musical elements will be based on traditional music from Manyarejo, further rooting the play in its cultural context (Figure C.3). To ensure accessibility for international visitors, an English-language display panel will summarize each act and scene along with the key scientific content, making the play comprehensible and enriching for tourists, researchers, and students alike.

Figure C.I. Performance illustration reference from prehistoric body Theater

Figure C.2. *Gejog Lesung*, a traditional musical instrument

Figure C.3. Gambus Bambu music, from Manyarejo which will be used to accompany the performance

So, a key innovation in our approach is that the scientific content will be delivered poetically. Rather than presenting technical data in a dry manner, we will weave scientific insights into poems that accompany the scenes. This poetic framing makes complex archaeological information more emotionally resonant and accessible, honoring the rigor of the research while engaging the audience's senses and imagination.

## C2 - The Design

This performance titled "Adaptation in Sangiran" is a play regrouping together dancing, poetry and music exploration as a way to express *Homo erectus* adaptation during the Middle Pleistocene. The play is structured into four acts, each depicting a facet of early human life, from environmental engagement to technological development and cultural transmission. The general ambiance of the performance will be gloomy. We choose this atmosphere to represent the fact that everything that will be represented is only hypotheses. However, we will sometimes choose to highlight some important scientific aspects of the act

such as the use of stone tools using a light to focus on the hand of *H. erectus* or the tools that are represented. The totality of the stage will be covered with synthetic grass and flowers reminding of early Middle Pleistocene environment.

The fauna and the flora will be represented by living humans, except for the grass and flowers. The costumes for the flora will be made of local resources from the Sangiran area such as bamboo (Figure C.4), teak (Figure C.5) and acacia (Figure C.6). This will enable the local people to create and reproduce the costumes easily and will help the audience to understand the ancient flora more easily. The choice of no fixed background but living actors to represent the flora is to illustrate the constant change of climate and environment at the time, living bodies representing climate impermanence. For the fauna we will do the same thing. We chose one animal that is close to a well-represented one in the area, the ancestor of banteng (*Bibos palaesondaicus*) (Figure C.7). One skull and two fragments of the ankle bone were found on the site of Tanjung in the Sangiran area (A. Bouteaux et al., 2006). This attests the presence of bovids at the time. We also decided to represent carnivores, such as hyenas, as predators and even competitors of humans. One inferior tooth of *Pachycrocuta brevirostris* was found on the site of Bukuran (A. Bouteaux et al., 2006), but the taxon is well described in the rest of the Asian continent. The costume will be one mask for each animal. For the body we decide to do bodypainting for the hyenas and a cape for the bovid. The costumes will be easily made by non-professional people (Figure C.8).

For the stone tools we will represent the searching of raw materials, we chose not to talk about the chaîne opératoire of the tools because it seems to be too much hypothetical. In Sangiran, stone tools in different materials have been found, such as pebbles for the bolas (F. Sémah et al., 2002), flakes, polyhedrons and cleavers for andesite and quartz interpreted as a hammer stone (F. Sémah et al., 1992). Although andesitic pebbles can be found in the Sangiran dome, quartz seems to come from a much far away place. We will illustrate the searching for raw materials from short distance, for pebbles and andesite, to long distance for quartz, because this is an example of adaptation. Then we will show the different hypotheses about the use of these stone tools. Breakage of the bone with the bolas (Figure C.9), cutting the flesh with the small flakes (Figure C.10) and then collect the marrow from the inner part of the bone. We will also illustrate the throw of the bolas as a way to frighten the carnivores.

Sound and light in our production will be very important. Every sound cue and lighting change has a narrative purpose: to immerse the audience in the era's atmosphere and reinforce themes of change and adaptation. For instance, cooler, harsher lighting evokes the Middle Pleistocene's challenging environment, while strategic silences or sound effects suggest isolation or tension. As the play progresses, evolving light schemes mirror *Homo erectus* gradual transformation as they adapt to their surroundings.

| ELEMENT | CONTENT DESCRIPTION | PRACTICAL NEEDS | INFORMATION |
|---|---|---|---|
| **Script and Narrative** | Scientific narrative of *Homo erectus* adaptation: environmental conditions (flora & fauna) use of stone tools, inheritance | - Manuscript writer with an archaeological or anthropological background<br>- Scientific consultation<br>- Dramaturgy script | Integrating scientific knowledge in the form of opera (theatre) narrative |
| **Cast (Actors and Extras)** | A Portrait of *Homo erectus* , fauna (buffalo, hyenas), and flora (bamboo, teak trees, and acacia) | - Physical theater cast<br>-Choreography of ancient human movements<br>- Costumes according to the times (already made) | The cast must be trained to express the non-verbal communication of *Homo erectus* |
| **Musical Instruments** | Background music from bamboo (bamboo gambus, stone friction) as an expression of the environment | - Bamboo Musical Instrument Craftsman<br>- Ethnomusicological composer<br>- Traditional instrument players | Music reflects the atmosphere of the environment, life, and ancient rituals |
| **Visuals and Stage Sets** | Representation of the Middle Pleistocene environment: savannas, bamboo forests, volcanic slopes | - Set designer<br>- Thematic lighting | Focus on the immersion of the past Sangiran environment |
| **Costumes and Makeup** | Appearance of *Homo erectus* and ancient flora and fauna | - Prehistoric costume designers<br>- Special effects make-up artist | Natural costumes and realistic look of *Homo erectus* |
| **Props Stone Tools** | Replica of shale tools and core stones | - Lytic replicas of local resin or stone<br>- Usage guide for actors | Actively used in hunting and environmental survival scenes |
| **Environmental Sound Effects** | Natural sounds (wind, water, wildlife, volcanic eruptions) | - Sound engineer<br>- Natural sound effects recording<br>- Surround stage speakers | Giving a sensory dimension to the setting of time and place |
| **Supporting Educational Media** | Contextual explanations for the audience (mini-exhibitions, booklets, interactive displays) | - Scientific curation team<br>- Educational graphic design<br>- Visual translator (iconography) | Provided before or after the performance as learning material |
| **Consultant Team** | Validation of archaeological and ecological information in the show | - Archaeologist, paleologist, expert on ancient flora and fauna | Ensure the scientific integrity of the narrative presented |

Figure C.4.
Bamboo costume

Figure C.5.
Teak costume


Figure C.6. Acacia costume

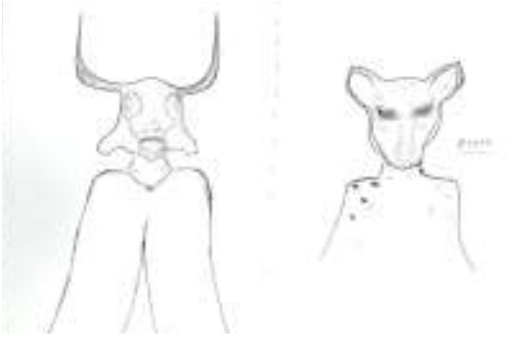

Figure C.7. Costume for bovid and hyaena

What is important to consider is that the creation of this project is really cheap and easy (see Table above). The only significant cost would be the spotlights and the rent of a proper place to do the play, although different structures, such as the Sangiran museum, could easily be a place to perform. In that way, the cost of the play will only depend on the light materials.

## D – IMPACT

Our project uses play as a powerful tool of scientific mediation to make the prehistoric site of Sangiran and its lithic tools heritage accessible to a wide and diverse audience. By staging the daily life and adaptation strategies of *Homo erectus*, the play breathes life into archaeological data and transforms complex scientific concepts such as tool-making techniques and paleoenvironmental dynamics into emotionally engaging narratives. Performance allows for the personification of past human experiences, making history tangible and relatable (Figure D.I). The use of lighting, soundscapes, and physical expression creates an immersive atmosphere that foster understanding even without spoken language, thus broadening accessibility across age groups, literacy levels, and cultural backgrounds.

Figure C.8. Illustration of a bull mask for a show

Figure C.9. Marrow extraction experiment using stone tools

Figure C.10. Cutting meat using stone tools_ flakes

This project aligns with the World Heritage Centre's good practices by promoting inclusive cultural heritage education and engaging local communities in the protection and valorization of a UNESCO World Heritage site. The play can be performed in museums or schools, making it adaptable to different local contexts. It encourages the audience not only to learn but to feel the significance of Sangiran as one of the cradles of human evolution.

In terms of local development, the project can support cultural tourism by offering an innovative format of heritage interpretation. It creates opportunities for local artists, educators, and students to collaborate, reinforcing local identity and pride (Figure D.2). Through partnerships with local cultural and educational institutions, it can also inspire the development of new educational programs or community-driven cultural events. Adaptation in Sangiran, can also be a promotional medium related to the uniqueness of Sangiran itself, which aims to attract tourists to visit the site and its museums and, of course, have an impact on improving the economy of the community.

The play can show off some of the actual problems such as the environmental one that occur in the Sangiran area. During our field studies in several villages in Sangiran, we saw multiple rivers polluted due to human activities. Thus, Adaptation in Sangiran displays a rich flora that can also be interpreted as a symbol of life and that it is important to live with. Local people can remember the many benefits in everyday life of these resources such as building houses, souvenirs, preventing floods and others. For this reason, the message that we want to convey is that for the sustainability of a good community, it is necessary to maintain a good environment.

Figure D.I. Personification of past human experiences from Prehistoric Body Theater

Figure D.2. Local Development for the local artist (Mbah Maimo)

Finally, for local people, this play will be an introduction to contemporary artistic creation which is often less accessible in rural areas. It will be an introduction to contemporary art from the point of view of the audience and also from the actors because of the participative aspect of our project. At the same time, it empowers access to scientific knowledge with fauna, flora and lithics tools directly connected to the community's own cultural and archaeological heritage.

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# Preserving and Displaying Stratigraphy in Ngebung Area (Sangiran Dome):

## *The humans' ancestors who survived behind the volcanoes 900,000 - 800,000 years ago*

**By:**

Tamara Angela, International Relations, Universitas Kristen Satya Wacana, , Salatiga, Indonesia, 372021056@student.uksw.edu

Leonard Fernando, Sustainable Development Studies, Universitas Kristen Satya Wacana, , Salatiga, Indonesia, 092024008@student.uksw.edu

Ahmad Fitra, Tourism Destinations, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 732024018@student.uksw.edu

Miguel Subires Mérida, International Master in Quaternary and Prehistory, Universitat Rovira i Virgili, Tarragona, Spain, migazsm@gmail.com

**Other members of the project:**

Sultan Khasan Falfila, Sport Coaching Education, Universitas Tunas Pembangunan, Surakarta, Indonesia, sultankhasanf@gmail.com

Oktaviola Wahyu Nuraini, English Education, Universitas Sebelas Maret, Solo, Indonesia, oktaviolawahyu7@student.uns.ac.id

Sadiman Subur, Pokdarwis Wonderful Sangiran

Iwan Hernawan, Krikilan inhabitant

Wakimin (Tekle), Budi Karsa BUMS

Sumanto, Budi Karsa BUMS

Karyadi, Pokdarwis Wonderful Sangiran

Wahyuda Pradana Santosa, Pokdarwis Wonderful Sangiran

**Abstract**

More than 1.5 million years ago, *Homo erectus* arrived in Java, most concretely in the Sangiran area. They adapted and survived to the new environment, making this new place their home. It is this trace of our ancestors and their lives that we intend to bring to the present and give life to the soil they walked on and where they died. To achieve this, we have designed a multi-interdisciplinary group whose common objective is to bring archaeology and its most scientific side closer to a global and neutral language, where everyone can learn and feel a direct connection with their ancestors and the land they inhabited, in the Ngebung area. At the same time, the project's objective involves different sectors, seeking to have a direct impact or at least be the seed that will eventually foster the need to preserve the heritage site and the history, culture, and work associated with it. Therefore, it acts as a vector between culture, science, education, tourism, economy, sustainability and politics. Created from an archaeological excavation and its stratigraphic arrangement, a place where the spark of adventure and intrigue for knowledge is born for locals and non-locals, while also being able to boost the local economy, culture and education. To this end, a series of activities have been developed involving locals along with students from different disciplines, creating a multicultural and interdisciplinary project that can continue growing.

**Key Words:**

Stratigraphy, Sangiran, Ngebung, Conservation, Tourism, Local Heritage, *Homo erectus*

# A – THE CHALLENGE AND RELATED SCIENTIFIC MESSAGES

## AI- State of the art

Sangiran is a quite rich archaeological site area, where we can study and reconstruct the life of our ancestors since they arrived in Java more than 1.5 ma. In this chronological frame we find the area of Ngebung which counts as one of the main spaces to understand the behavior and life of our ancestors between 900 to c. 200 ka. In other words, Ngebung works as the chest that contains the human fossils of *H. erectus* and their link to the environment thanks to rich context of vertebrate fauna fossils (Irawan, 2016) and lithic assemblage called 'Sangiran flake Industry' (Widianto et al., 2001). So, through the study of the area it is possible to find the living floors of the *Homo erectus* and study environmental changes (Sémah et al., 1992; Puspaningrum, 2024) as well as the adaptation of our ancestors and other animals.

**The route to the museum, the monument and the heritage trail**

Ngebung is a locality within the Sangiran Dome that features its own museum, a monument and an heritage trail. It encompasses archaeological sites where important fossil remains have been discovered. However, an issue arises due to the lack of a direct and clear connection between the museum and these sites. Currently, the museum does not provide signs, maps, brochures, or posters that inform or invite visitors to explore the surrounding archaeological field, where the remains originated from. Similarly, the directional signage leading to the site is quite small and easy to overlook, which may cause visitors to miss the Heritage Trail entirely as well as the monument, ultimately limiting their understanding of the area's significance (Figure A.I). As a result, many may leave the museum unaware of the actual locations where the fossils were found, missing the opportunity to connect with the landscape and context of the discoveries.

Creating a direct and well-marked route from the museum to the archaeological sites integrated into the Heritage Trail and including the Triangulation Monument could offer a more immersive experience. Visitors would gain a deeper appreciation of the Ngebung area and its historical importance, as the fossils

Figure A.I. Heritage Trail path


Figure A.2. Heritage Trail connecting museums to archaeological sites and the Triangulation Monument.

and tools on display represent various stratigraphic layers and reflect different stages of human adaptation and lifestyle. Part of these remains are preserved in the museum, but a stronger connection to their original discovery sites would enhance their educational value (Figures A.2 & A.3).

**The challenge found at the site**

The Ngebung area displays a critical part of Sangiran stratigraphy, related to major palaeoanthropological, palaeontological and archaeological discoveries, together with a beautiful landscape that clearly illustrates the external part of the Sangiran Dome tectonic shaping. The presence of the trail path near the museum is fully conducive to learn about geology, fossils and archaeology as well as to 'feel' the stratigraphy and learn how was the environment in which *Homo erectus* lived. On the other hand, much remains to be done to highlight Ngebung richness, especially in the field, to make the stratigraphical record and the landscape understandable and meaningful for the visitor and to reinforce the relation between the sites themselves and the site museum.

Building on the issue mentioned earlier, the absence of signs leading visitors to the archaeological field is closely connected to another problem: there are only a few boards or explanation at the site itself to help people understand what they're looking at or why the area is important. As a result, the site may seem like just a quiet, natural space while in fact, it holds global significance for understanding human evolution. Visitors might need further information about the fascinating history of archaeological work here, and the crucial role Ngebung plays in revealing an important part of the stratigraphy of Sangiran and of the life of *Homo erectus*. It's in the Ngebung area that we find key stratigraphic layers linked to the presence of *H. erectus*, showing how this species adapted to environmental changes such as intense volcanic activity and dry periods (Satyana, 2008; Brasseur et al., 2014). These shifts forced our ancestors to develop new ways to survive and their footprints, tools, and remains are still found in the soil where they once lived. Traces of both the environmental changes and human presence are preserved in different layers of earth, although they aren't clearly visible at the site today.

Even though the stratigraphy is still accessible, it's not easy to see from the main road. The recent construction of a heritage trail path from the museum is a great step forward but making the stratigraphy easier to understand on-site remains a challenge. The tropical climate adds difficulty: fast-growing vegetation and frequent landslides often cover important sections of the outcrops, making them hard to observe. That's why one of the main goals should be to bring the story of the stratigraphy to life for visitors. Helping them see how the landscape of Ngebung changed over thousands of years shaped by

Figure A.3. The Grenzbank layer after cleaning

tectonic forces and volcanic activity (Satyana, 2008; Purnomo & Sémah, 2013; Brasseur et al., 2014) would create a more meaningful and memorable experience. After all, this is a place where the lives of our early ancestors became part of the land itself.

## A2- The messages

With the goal of exposing (bring to the life in the present) how was and changed the environment where the *H. erectus* lived and adapted in Java Island more than 800,000 years ago, reflected by the stratigraphy, we decided to work under the scientific message of "The humans' ancestors who survived behind the volcans 800,000-900,000 years ago"(Figure A.4);

- where humans ancestors refer to the *H. erectus* and the different fossils of this species that have been found at the site of Ngebung, as the Sangiran 2I jawbone (e.g. Kaifu et al.,2005);

Figure A.4. Stone bolas (max. diameter 8 cm.)

Figure A.5. Fossil in the Kabuh section

- survived, for its part, allegories the way in which these *Homo erectus* adapted to the environment that surrounded them and how they modified their survival strategies according to the changes in the environment, and all the remains related to their activities and life presence as the artifacts (flakes or bolas) or the fauna fossils;

- volcanoes refer to the environment and conditions under which our ancestors lived in this area;

- finally 800,000-900,000 years ago indicates the ages/chronology of the

Figure A.6. Arjuna I3 skull fragment (found just below the Grenzbank)

Figure A.7. Kabuh layers

sedimentological layers in which the presence and activity of *Homo erectus* has been preserved in the area, known today as Grenzbank and Kabuh layers (Figures A.5 & A.6).

The importance of the message lies in the need to awaken a common interest in all audiences about knowing how our ancestors adapted to perhaps not very favorable conditions, turning environments that today we would consider as dangerous into their home, leaving the trace of their presence and activity stored in the soil they inhabited and today the ground we walk on. For this we have the Ngebung area which is a unique site where we can study, connect and

expose the aforementioned elements, since we have the presence of at least three different stratigraphic layers (Grenzbank, Kabuh, and alluvial terraces), where two of them (Grenzbank and Kabuh) collect a large number of the human fossils discovered at Sangiran. The lithic industries together with butchered animal bones, may explain how *H. erectus* adapted or at least were able to survive in the environment that surrounded them. At the same time, animal fossils help to describe both the environment and also the biostratigraphical evolution in Sangiran around the Early to Middle Pleistocene period.

The final goal of our proposal is to involve the project in different sectors as our priorities are to preserve and highlight the importance of stratigraphy in archeological sites, educate the local and global community about the history and value of the site to understand the human evolution, impulse the local economy of the area and create new political and cultural links throughout the area of Sangiran which can be exposed in future collaborations, works, studies and activities. We aim to deliver our message in a way that is as easy to understand as possible to all the public. The chosen message can be understood at different levels depending on the audience's age, where younger visitors may grasp the basic idea of ancient human life, while older audiences may explore the deeper scientific meaning behind it. We hope that this simple, yet powerful message helps the public to connect early human life with the earth sciences, foster the value of sedimentary records at Sangiran, and understand how the past has been preserved through fossils and stratigraphy (Figure A7).

## B- RESEARCH

### Sangiran Krikilan museum

Activities at the Krikilan Museum involved discussions with lecturers, to develop project plans according to group topic divisions. Discussions were held regarding "State of the art" to design mediation strategies that are adaptive to the needs of local communities while ensuring the accessibility of scientific information for everyone. Discussions were held via focus group discussion (participatory FGD), involving the community in the program "The Humans who survived behind the volcanoes 900.000 years ago" (Figure B.I).

### Puren River

Group field activities with partners of the Pokdarwis (Karyadi, Tekle, and Manto) focused on observation of stratigraphic formation in the Puren River. Field analysis identified three main layers, Kalibeng, Lower Lahar and Pucangan, which contain several significant geological findings such as deposited saltwater mollusk fossils, as well as rock variations including nodules, clayball, quartz, and black clay. This activity aims to analyze the stratigraphic characteristics of the

Figure B.I. Field group discussion

area as a basis for comparison with the geological conditions of the Sangiran Site, as well as strengthening group understanding regarding the sedimentation dynamics that underlie the formation of soil layers in the observation area. It is hoped that the observation results can become an empirical reference in designing adaptive stratigraphic preservation strategies at the Ngebung Site (Figure B.2).

**Manyarejo museum and site**

Activities at the Manyarejo museum and Site are conceptually similar to observations at the Puren River, but the Manyarejo museum displays stratigraphy along with excavation findings such as mammal leg bone fragments, bull skulls (Cranium of *Bibos*), elephant ribs and pelvic bone. The Manyarejo excavation box has an attraction that shows fossils that are still in the Kabuh layers. Observations at the Manyarejo site focused on analyzing the condition of the soil layers, the context of the findings in the excavation box, and the sedimentation characteristics of the Kabuh layers, so that we can understand and learn before we finally study the layers in Ngebung site (Figure B.3).

**Archaeological practice, museum observation and community engagement at the Ngebung Site**

Archaeological activities at the Ngebung site focus on preserving and presenting the stratigraphy of the Kabuh and Grenzbank layers, as well as the alluvial terraces. These efforts involved our group and its Pokdarwis members. The team began with initial observations and site mapping, followed by cleaning activities in areas designated by the supervisors, and held discussions with local residents to understand the current condition of the site. The Ngebung Site

Figure B.2. Pucangan layer in Puren river

Figure B.3. Kabuh layers in Manyarejo site

Figure B.4. Grenzbank section in Ngebung site

Figure B.5. Yellow silty layers just above the Grenzbank at Ngebung

consists of three main areas: (I) the triangulation monument on Ngebung Hill, Ngebung Village, Kalijambe District, Sragen Regency; (2) the Heritage Trail, aimed at educating the public, involving the community, promoting sustainable tourism, and displaying archaeological findings (e.g., fossils and stratigraphy) in an accessible manner; and (3) Ngebung I and Ngebung 2, which feature Kabuh

stratigraphy but are difficult to access. Local awareness remains low, and the site is covered with teak trees, with land belonging to community members.

Observation activities at the Ngebung museum identified that a number of fossils in the storage warehouse came from excavation findings at the Ngebung site, such as deer antlers (characteristic of the Ngebung environment), bulls, turtles, stone balls, and others. These findings were chosen as visual icons in the design of information signs to highlight the significance of the Ngebung site as a locus for findings on a national and international scale. Through the integration of these cultural heritage symbols, this project aims to increase local community awareness of the importance of the Ngebung site and ensure that scientific messages can be effectively conveyed. The overall goal is to strengthen the identity of the Ngebung site within the broader narrative of world cultural heritage conservation (Figure A.3).

Excavation was permitted on local land, and the group was divided into two teams, one carried out excavation to clean and display the Grenzbank layer during 3 days, and the other handled documentation, media, analysis, and observation. Two additional locals assisted in presenting the Kabuh layers and alluvial terrace. Thus, from top (departure of the Heritage Trail) to bottom, we find:

- A thin gravelly layer (alluvial terrace) deposited during early erosion of the dome of Sangiran, which yielded the 'Sangiran Flakes' discovered by von Koenigswald.

- The Kabuh layers, formed around 800,000 years ago. The upper age is unknown, but in Sangiran it is often uncomformably covered by the c. 250,000 years old Notopuro breccia. It is a a volcano-sedimentary series, mostly fluvial consisting of sandstones, siltstones, and claystones deposited by ancient rivers, where were discovered human remains (e.g. Grogol Wetan skull by Widianto and Sofwan, 2020), mammalian fossils (e.g *Stegodon* and cervids one can see in Ngebung repository) and which yielded human occupation floors (Sémah et al., op.cit.).

- The Kabuh layers cover the so-called Grenzbank layer, dating back to approximately 900,000 years ago (Figure B.4). Its composition is characterized by a surface made up of pebbly sand layers in which clasts of marine and continental elements are mixed and locally cemented. Numerous fossil remains have been found in this layer, among which we can highlight those corresponding to *H. erectus*, such as the recent calvarium discovery published by Widianto et al. (2023) or Sangiran 2I jawbone (e.g. Kaifu et al., 2005) found in the Ngebung area itself. It is important to note that the uppermost party of the Grenzbank in Ngebung presents fine-grained yellow clayey silts, in which was discovered, among others, the Kresna II femur (Figure B.5).

- Below the Grenzbank appear the top of the Pucangan 'black clays', where the oldest fossil remains of *H. erectus* were found (Von Koenigswald, 1954; Widianto, 2001; cited in Brasseur et al., 2015). In Ngebung, the Ardjuna 13 fragment of human skull comes from these layers (Figure A.6). However, Pucangan clays are not visible along the Heritage trail.

After cleaning, both teams mapped fossil coordinates and measured the excavation area. Team 2 drafted plans for Grenzbank and Kabuh, while Team 1 profiled the Kabuh layers, a planning that took two days, delayed by rain. Data collection involved community discussions and expert input through FGDs, lecturer consultations, participant observation with Pokdarwis, and interviews with Pokdarwis leaders, SIYF, and locals. The main reason for cleaning is to make the stratigraphy more visible and learn the importance of each layer since each layer has its own discoveries. Group 5's discussions emphasized the importance of making stratigraphy more visible, improving site information (e.g., boards and signage), and preserving the site's uniqueness. Such discussions often addressed the shared responsibility in protecting the cultural heritage. The group proposes that scientific mediation (to be discussed in the next section) can be a potential solution to address community needs at Ngebung.

# C- THE PROJECT

## CI- The media

We chose a media that we believe can support our goals which are to educate, to preserve, and to make the scientific aspects of the Heritage Trail in Ngebung for the public to feel the importance in the historical and archeological aspect, and can be explained in 3 steps:

The first media are signposts. These signposts are going to be placed along the trail to guide visitors and to introduce the discoveries. We designed the signs with simple and concise text to attract the curiosity rather than making the visitors bored with too much information. There will be a sign placed near the museum to inform people that the heritage trail exists and is only 200 meters away. Other signs will be placed along the trail to highlight the important archaeological findings such as fossils, tools or stratigraphy layers but we will only give hints rather than detailed stories, as more details about the findings will be told by the tour guides. Some signs also include helpful reminders about what visitors are allowed or not allowed to do while walking the trail. Plus, the signpost will be placed in the Grenzbank section with fences to avoid the entrance inside the excavation. We tried to make the sign not as the main attraction but just as a small reminder so that the visitor would still focus more on the stratigraphy rather than on the signs (Figure C.I).

The second media is a paving of sandbox filled with Grenzbank material, which will be installed in front of the existing Grenzbank section. Similarly,


Figure C.I. Signpost examples

Figure C.2. Grenzbank sandbox paving

cobblestones will be created under the same requirements for the section encompassing the main profile of Kabuh and for the one located at the top, related to the alluvial terrace. This allows visitors to safely feel the different textures of these layers using their hands or bare feet, without risking damage to the original site. This display approach will help people to understand better about the soil changes (stratigraphy), turning learning into a physical and memorable experience. With the same objective that the paving of sandbox fulfils in the Grenzbank section, we propose the arrangement of a sediment box next to the Kabuh section and another next to the alluvial terrace section, where can be found real sediments recovered during the work in these sections and which also provide visitors with the experience of feeling with their hands. (Figure C.2).

The third media are three information site-boards, one for each one of the main layers (Grenzbank, Kabuh and upper alluvia) where we will display visual-informative information about each layer. The board will count with the presence of a general stratigraphy draw plus and arrow giving an increased image of the main exposed layer, with name and chronology of the layer, a background based on a reconstruction of the environment related with the animals and plants that inhabited this soil and a QR code where the people could find additional information (references), pictures and videos about the site, the stratigraphy, reconstruction and the work developed on it. To promote this we collaborated with the group designing an exhibition in Ngebung museum, so that people will be invited to follow the Heritage Trail and from the Heritage Trail to the museum, since signs that plan to be placed will be in both the trail and also the museum (Figure C.3).

## C2- The design

The project itself bases its objective on connecting the field elements and archaeological excavation with the tourism, educational, economic and museum sectors, while preserving the state of the archaeological space and the remains found there. To this end, a series of elements have been designed to connect the museum with the sites, and we focused on the three that we have considered most relevant and urgent to develop, keeping others as proposals for the future. As mentioned, the main element on which our project focuses are the signposts, as these themselves respond to several of our needs, such as preserving, attracting in a striking and visual way, informing and educating, and connecting the museum with the archaeological field and workspace. This is possible since there are multiple designs that we have developed, some of which are warning, prohibition and regulatory signs, more focused on the preservation and education of the value of the space; others for their part act as a guide for passers-by and visitors, helping them and at the same time connecting the countryside with the museum in a striking and didactic way; and finally those focusing on the scientific message of each layer (Grenzbank, Kabuh, and alluvial terrace), exposed in a message accessible and understandable by the public in the form of a signboard, which includes the name of the stratigraphic level, the dates (chronology), accompanied by a drawing of the stratigraphic profile where an arrow leads to a real image of the layer, a collection where the environment has been recreated during this period, and a QR code that includes bibliographic references, images and videos of the place and the archaeological excavation carried out in it.

| ELEMENT | Qty | NEEDED-MATERIALS | NOTES |
|---|---|---|---|
| Signpost Heritage Trail in Ngebung Site | I | Information about Heritage Trail, Ngebung Sites, Rules, Prohibitions, and Map Directions. Materials: Design / Metal plate /- 2 Iron poles (sticks) /4 bolts | The aim is to make it easier to find out about the Ngebung Site and involve visitors in the value of the site and the need of preserving it. |
| Site Boards | 3 | Stratigraphic formations drawing, recreation of the environment as an image, name and chronology of the layers, the logos of the associated institutions and a QR with additional information. Materials: 3 Acrylic Board / 3 Design printed in the Acrylic / 3 Wood board to fix the acrylic plate / 6 sticks / I2 bolts | QR with additional information as references, pictures, videos and draw of the excavation and the site, in different languages. |
| Show a Grenzbank boulder is Im long and - 0.5m wide | I | Recreate a fragment of the excavation with original sediment on which visitors can set foot. Materials: Grenzbank sediment / Cement Plate / Gate /Lock | Visitors can experience the Grenzbank section with a sediment boulder without damaging the real excavation. |
| Prohibition Sign in Grenzbank Section + wood fences | 3-4 | Prohibition signs + barriers such as fences to protect and preserve the Grenzbank section. Materials: Designs / Metal plates / 8 Iron poles (sticks) / I6 bolts /Wood fences | Preserve and protect the Grenzbank section. |
| Direction signposts | 6 | Signposts with images of archaeological remains found in the related layers with the name of the layer to which they belong and their chronology. Materials: Discovery images (bolas, fossils etc.) / Chronology of the remains / Layer of discovery / Guide arrows (indicators) / Metal plate / I2 Iron poles (sticks) / 24 bolts | Facilitate access to knowledge about discoveries and the life and evolution of the stratigraphic layers. |
| Do and Don't | I | Signs explaining what is permitted and what is not. Materials: Wood board to fix the acrylic plate /Design printed in the board / 2 sticks /4 bolts | Encourage visitors to protect and preserve the site and help them to know about the importance of the place |
| Sandbox (sediment box) | 2 | Give the visitor the opportunity to feel the layers without damaging them. Materials needed: 2 Acrylic boxes with open gate + locker / Sediments of each layer (Kabuh and alluvial terrace) / 4 Iron poles / 2 Iron or cement plates to fix the iron poles | Make visitors feel with their own senses what the land where their ancestors lived was like |


Figure C.3. Site boards examples


Figure C.4. Planned signpost site disposition

With the intention of giving life to the place and preserving it, we introduce the idea of making paving boxes and sediment boxes that collect real sediment from the place, extracted during the archaeological intervention and which provide the opportunity to the visitor to touch, feel and analyse the ground where their ancestors lived without causing any damage to the excavated


Figure C.5. Planned signpost rules

space. Finally, to guarantee the preservation, security and value exposure of the place, especially the section referring to the Grenzbank layer, it is proposed to have a wooden fence (bamboo) around it, which would make it impossible to directly enter the archaeological area and would provide it with a vision of the importance or value that must be protected. However, all these elements will purposely lack a detailed or very deep explanation, which will create the need for the visitor or observer to go to the museum or ask a local guide if they really want to fully understand what they are seeing and the overall relevance of the site (Figures C.4, C.5,).

## D- IMPACT

The main objective of the project is to bring the scientific work and message to the general public, trying to avoid a too much scientific terminology. For this reason, we strive for direct, largely visual communication that can attract and captivate the attention and interest of any audience, regardless of age, education, or nationality. We simply aim to create a seed of interest and curiosity to know what the images, numbers, and names they see refer to, while also creating a connection between the audience or public and the land and space beneath their feet. The aim is to provide open scientific communication to the general public about the importance of understanding and preserving stratigraphy, in order to understand the space and life of our ancestors, who left

Figure D.I. Grenzbank excavation as World Heritage site

Figure D.2. Project potential impacts

their mark. Thus, we intend to show how humans always leave a mark and presence of life and how it was, which remains encapsulated in the soil they inhabit.

The ideas we implement can create a bridge between archaeological and scientific work and the growing world of tourism, seeking a sustainability that does not alter or damage the heritage and, in turn, allows the public to enjoy it firsthand, feeling part of it. Thus, we seek not to neglect the importance that the world of tourism has on the value of heritage, but at the same time we intend to ensure that it does not exploit heritage in an uncontrolled manner, leaving aside the local people and the preservation of the space considered as world heritage. Therefore, our project can contribute as an example of how the world of archaeology and scientific research can be linked and integrated with the tourism, education, and preservation sectors of local culture and tradition, without damaging the space, its heritage, or exploiting the local people. Our aim

is to demonstrate how those spaces within the framework of the World Heritage and those that do not yet belong to it but have the potential to bridge past, present, and future. (Figure D.I).

The project includes multiple potential impacts on local development. Firstly, it can boost the local economy by being a tourist attraction, where tourists can spend their money on the museum, local guides or transportation, souvenirs provided by local shops or on food offered by locals. It also offers a need to create new jobs related to the continuation of work and its preservation. Secondly, linked to the cultural impact, it can give local people a greater feeling of the history of their land and its antiquity, as well as making them see its value and the need to preserve it, creating a stronger link between the local individuals and the history, traditions and values of their locality. From an educational perspective, it can encourage local young people to learn about their ancestors. It would provide any local person the opportunity to learn and understand the global value of their land and its relationship with the outside world, providing a globalized view of human evolution and the current equality of humankind. From a political perspective, the project can lead to connections with neighboring towns and nearby entities. This provides opportunities to connect museums, roads, local communities, and, in fact, policies related to the preservation or development of the area. Finally, the social component is the broadest in scope, as any social value can be linked to the project, such as connections between locals and even non-locals; the implementation of new political and social strategies for the development and benefit for the locality and its inhabitants; the creation of a seed of curiosity about the importance of caring for and preserving the land, its traditions, and culture, within a framework of collaboration and equality for the mutual benefit of local community and other stakeholders (Figure D.2).

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# A "Site Exhibition" in the Ngebung Museum: Life in the Deep Past

**By:**

Devi Ayu Aurora Nasution, International Master in Quaternary and Prehistory, Università Degli Studi di Ferrara, Italy, deviayuauro.nasution@edu.unife.it

Yuxin Ning, International Master in Quaternary and Prehistory, Muséum National d'Histoire Naturelle, Paris, France, yuxin.ning@edu.mnhn.fr

Matias Espanet, History of Art and Archaeology, Sorbonne Université, Paris, France, espanetm@gmail.com

Valiza Salsabila, Tourism Destinations, Universitas Kristen Satya Wacana, Salatiga, Indonesia, 732024020@student.uksw.edu

**Other members of the project:**

Marwah Nur Fitri, Archaeology, Universitas Hasanuddin, Makassar, Indonesia, marwahnurfitri973@gmail.com

Berliana Noviyanti, English Language Education, Universitas Sebelas Maret, Solo, Indonesia, berliananoviyanti2002@gmail.com

Sumanto, Budi Karsa BUMS

**Abstract**

The Sangiran site in Central Java is a crucial location for studying human evolution, with a record spanning over 1.5 million years. This site documents physical human evolution and the development of culture, fauna, and past environments. This project focuses on the Ngebung Museum and aims to design an exhibition that connects archaeological discoveries in the field to the visitor experience. The exhibition conveys key scientific messages, including stratigraphy, paleoenvironmental context, *Homo erectus* hominin fossils, faunal remains, lithic artifacts, as well as cultural values and community involvement. Using interactive media and accessible narratives, the exhibition seeks to enhance diverse audiences' understanding of the Ngebung site's significance in human history and cultural heritage preservation. The project emphasizes the active participation of the local community in site conservation, strengthens the link between the museum and the archaeological site, and supports Sangiran's status as a UNESCO World Heritage Site. The outcomes are expected to raise public awareness and engagement, reinforce local cultural identity, and promote sustainable regional tourism development.

**Keywords**

Sangiran, Ngebung, Site museum, Human fossils, Lithic implements, Fossils, World Heritage

# A – THE CHALLENGE AND RELATED SCIENTIFIC MESSAGES

## AI- State of the art

The Sangiran site in Sragen and Karanganyar Regencies is essential in studying human evolution. For over 1.5 million years, this site has recorded many crucial events in humanity's history (Widianto, 2008). Sangiran provides insight not only into humans' physical evolution but also into the development of culture, fauna, and the environment in the past. Recognizing the extraordinary potential of this site in deepening the understanding of human evolution, in 1996, Sangiran was designated a World Cultural Heritage by UNESCO.

The Sangiran site has five museum clusters: Krikilan, Ngebung, Manyarejo, Bukuran, and Dayu. According to Widianto (2008), when planning the construction of these museums, it is essential to create an in-depth experience for visitors about the journey of ancient humans during the Pleistocene era. The goal is for the information to engage visitors and leave a lasting impression on their memory and awareness.

## Challenges in managing Sangiran

Nevertheless, managing the Sangiran site faces various challenges. According to Wiyono (2008), one major challenge is the natural conditions prone to landslides and erosion, especially during the rainy season, due to the high sand or clay content. Landslides often result in the discovery of new fossils. For example, when we visited the Puren River to observe the stratigraphy, we easily found mollusk fossils (Figure A.I) with Mr. Manto, Mr. Kariyadi, and Mr. Tekle, members of POKDARWIS.

Land ownership is another challenge, as many fossils are located on private property, creating tensions between local communities and the government. In response, authorities have introduced several regulations, including construction restrictions, industrial development bans, and prohibitions on harmful chemicals (Wiyono, 2008). While these policies are steps in the right direction, enforcement remains weak, particularly in areas at risk of illicit activity. Educational initiatives have been launched to raise awareness of land-use rights and heritage protection. These tensions raise critical questions about how local landowners can be motivated to engage in shared heritage stewardship. One promising initiative is forming the POKDARWIS or Budi Karsa Bums tourism awareness groups, which involve residents in preservation and education efforts.

## Ngebung Museum

Our group focused on the Ngebung Museum (Figure A.2) and collaborated with another team on a stratigraphy project at the Ngebung site. Our project aims to design a small yet impactful exhibition that links the site's archaeological

Figure A.I. Fossilized mollusk was found in sedimentary rock at the Puren River, uncovered by natural erosion


Figure A. 2. Front view of the Ngebung Museum, Sangiran

discoveries to the museum visitor experience. From our observations, several issues were identified: no clear information about the site's history or significance, few authentic exhibits of fossils and artifacts, lack of presentation of heritage values, difficult access to the site, and inadequate signage and infrastructure.

We found that the Ngebung Museum does not fully convey the site's story effectively (Figure A.3). However, archaeological findings from the area provide a solid foundation for future exhibition development. The museum has also taken steps to raise public awareness through workshops with students and local communities. One of its ongoing initiatives is a Heritage Trail program developed with various stakeholders. This program allows visitors to explore the site with guided tours, strengthening the connection between displayed content and the site's material history.

In conclusion, despite its management challenges, the Sangiran site is crucial in understanding human evolution. While the Ngebung Museum has made progress in education, further development of its exhibitions and improvement of site access are needed. Our project seeks to enhance the visitor experience, strengthen the connection between the museum and the site, and contribute to preserving Sangiran's cultural heritage.

## A2- The messages

In this project, we developed exhibition concepts that highlight stratigraphy and paleoenvironmental contexts, key archaeological findings—including hominin remains, faunal fossils, and lithic artifacts—cultural values, and aspects of social development. The exhibition also presents historical narratives that underscore


Figure A.3. One example of an exhibit display at Ngebung Museum *Stegodon* skeleton reconstruction

the significance of the Ngebung Site and its role in reinforcing its status as a World Heritage Site.

We selected scientific messages that aim to understand the Ngebung site comprehensively. Each message is carefully crafted to cover a range of interconnected scientific perspectives, presenting knowledge in a way accessible to a broad audience, from children to adults. We prioritized messages that are easy to grasp and enhanced through interactive media, visuals, and engaging narratives. Below are the details of the scientific messages we selected:

### I. Stratigraphy and paleoenvironmental context

We aim at clearly understand the stratigraphy at the Ngebung site (Figure A.4), demonstrating how geological layers reveal periods and environmental changes. Layers such as Grenzbank and Kabuh provide essential context for visitors to comprehend the depth of time and the relative position of archaeological finds. This message is crucial in encouraging visitors to observe the well-preserved layers at the Ngebung site directly.

### 2. Key archaeological findings

Hominin fossils: The discovery of hominin fossils, such as *Homo erectus* (Figure A.5) remains at the Ngebung site, is crucial for understanding the evolution of early humans. Specifically, the archaic and typical *H. erectus* findings at Ngebung highlight the site's significance and diversity. Displaying these fossils can evoke curiosity and an emotional connection. For children and the general public, seeing these ancient human fossils helps bridge the gap between the

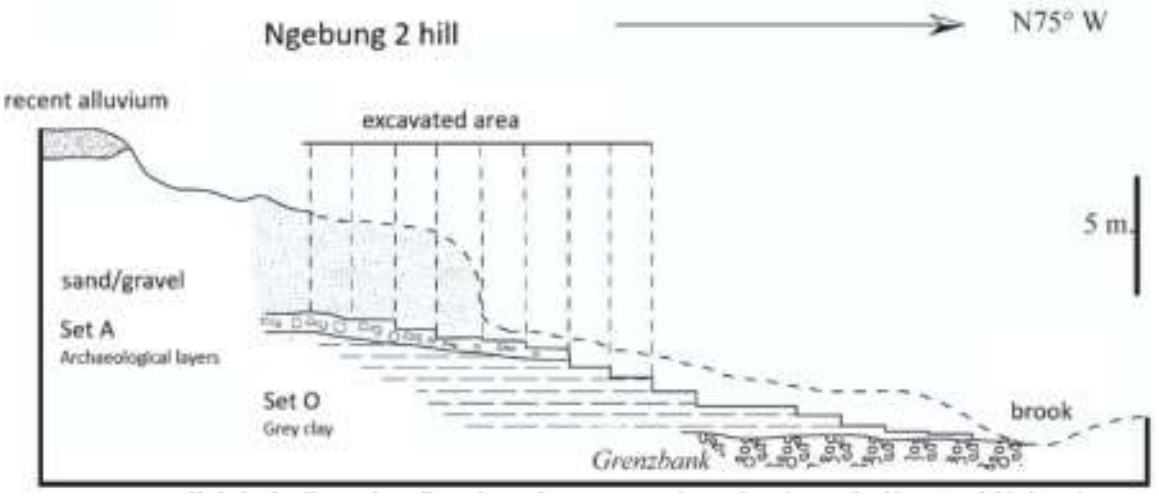


Figure A. 4. Stratigraphic profile of the Ngebung 2 excavations (Sémah et al. 1992)

Figure A. 5. One of the hominin fossil discoveries at Ngebung is Sangiran 21 (mandible of *H. erectus*)

Figure A. 6. A bola found at the Ngebung Site

distant past and the present, making the concept more relatable and emotionally impactful.

Faunal fossils: fossilized remains of extinct animals provide valuable insights into past ecosystems and the adaptation of early humans to their surrounding environments. At the Ngebung site, fossils of *Stegodon*, bovids, and the newly identified small deer species, *Axis lydekkeri ngebungensis*, illustrate how both large and small fauna coexisted within the forests and unique island fruit-bearing trees. These discoveries show how *H. erectus* interacted with open environments and hunted these animals. The exhibition will aim to help visitors understand how early humans adapted to environmental changes influenced by mainland and island factors.

Lithic artifacts: We also present stone tools and artifacts (Figure A.6), highlighting their functions, production techniques, and cultural significance. This display aims to showcase the development of technology and culture in early human societies. Additionally, we seek to build observational skills and promote scientific thinking, particularly among children and adults, who benefit from tactile, comparative, and interactive learning. This approach also

Figure A. 7. Discussion with local people around Ngebung site

encourages visitors to recognize what makes a stone "special," fostering an appreciation for early human intelligence and adaptation.

### 3. Cultural values and social development

This exhibition will also emphasize the importance of community involvement in preserving the site. We focus on how institutional frameworks and the ongoing interaction between local culture and social practices shape heritage value. Community engagement is crucial in strengthening pride and ownership of this cultural heritage (Figure A.7). By making the Ngebung site a part of the community's daily life, we aim to foster emotional connection and a deeper understanding of the importance of preserving the site.

### 4. History and significance of the Ngebung site and confirmation of World Heritage status

The Ngebung site, part of Sangiran, holds significant historical value, including *H. erectus*, faunal fossils, and evidence of stone tool industries essential for understanding human evolution. Therefore, Ngebung represents a major place to explain why Sangiran is a World Heritage Site, enhance its global recognition, and underscore the need for sustainable protection. This exhibition will highlight the role of Ngebung in understanding human history and explain why the site

must be preserved for future generations while also introducing visitors to its scientific and cultural significance.

**Prioritizing Messages**

These messages have been prioritized based on their educational value and ability to engage a broad audience. Ngebung is central in securing Sangiran's status as a World Heritage Site by providing a comprehensive record of stratigraphy and paleoenvironmental context. It allows visitors to understand the geological processes and environmental changes that have shaped human evolution. Without Ngebung, Sangiran would not have achieved this prestigious recognition. The discovery of hominin fossils, faunal remains, and lithic artifacts at Ngebung provides a complete picture of early human life, illustrating how these hominins interacted with their environment and demonstrated technological advancements. It makes Ngebung scientifically significant and underscores its pivotal role in human history.

The message regarding cultural values and community involvement is also a priority, as it emphasizes the importance of engaging the local community in preserving and appreciating this cultural heritage. Community involvement is essential for safeguarding the site and ensuring that future generations understand and value its cultural significance. This approach ensures that the heritage is preserved with pride and responsibility, especially by those most closely connected to it.

Finally, the message regarding the historical importance of Ngebung and its confirmation as a World Heritage Site is critical. It highlights the need for long-term protection and recognition of the site. Ngebung is at the core of Sangiran's World Heritage status, providing valuable insights into human evolution and past ecosystems. Understanding Ngebung's role helps visitors appreciate the importance of preserving the site for scientific research and as a cultural heritage for humanity. These priorities align with our goal to make Ngebung accessible and relevant to all visitors while emphasizing its scientific, cultural, and historical significance.

## B – RESEARCH

The research conducted at the Ngebung museum and site aims to integrate scientific findings with an accessible experience for many visitors. During field activities, we observed the site's stratigraphy, engaged in discussions with experts, and interacted with the local community, which plays a crucial role in conserving the site. Collaboration with stakeholders such as POKDARWIS, Budi Karsa BUMS members, and Ngebung Museum staff deepened our understanding of the historical and scientific context of archaeological findings.

Figure B.I. The Grenzbank layer in Ngebung Site

Figure B.2. The Kabuh layer in Ngebung 2 Site

Our initial approach involved direct observations of the stratigraphic contexts near Ngebung, particularly along the banks of the Puren River and at the Grenzbank Layer and Ngebung II sites (Figures B.I to B.3). Accompanied by members of communities, specifically Mr. Manto, Mr. Kariyadi, Mr. Tekle, and Mr. Subur, we identified various geological formations in the area, including the marine clays of Kalibeng, the fluvio-lacustrine deposits of Pucangan, the fossil-rich transitional layers of Grenzbank, and the volcano-fluvial layers of Kabuh. Stratigraphy is the guiding thread of all archaeological analysis in Sangiran. These observations taught us that each sedimentary layer is a natural archive formed by geological and hydrological processes over thousands of years. While these formations are observable at or near Ngebung, not all stratigraphic layers are continuously exposed in a single location. This variation must be considered when interpreting the site's geological and archaeological contexts.

At Ngebung, several key formations provide essential context for understanding the artifacts and fossils discovered. For example, the Grenzbank Layer is an intermediate formation composed of gravels and carbonate concretions containing continental and reworked marine fossils and Arjuna 9 *Meganthropus*-like mandible, then limy silts including notable specimens such as the Kresna II human femur (Figure B.4). The overlying Kabuh Formation consists of volcano-fluvial deposits. In Ngebung, evidence of intense volcanic activity alongside

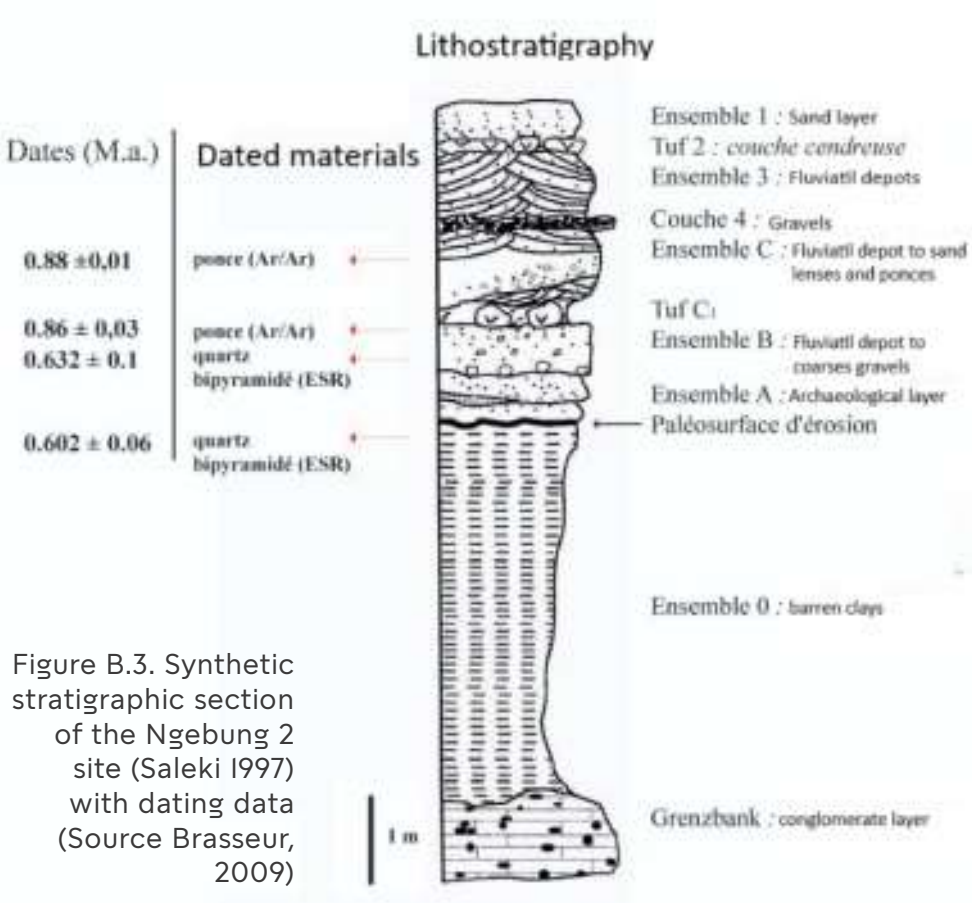


Figure B.3. Synthetic stratigraphic section of the Ngebung 2 site (Saleki 1997) with dating data (Source Brasseur, 2009)

essential archaeological human occupation floors and faunal remains is revealed, including the small deer species Axis lydekkeri ngebungensis (Moigne et al., 2004). Significant hominin fossils, such as the Sangiran 2I mandible, have been discovered within these layers (Kaifu et al., 2005), underscoring their importance in understanding the region's paleoenvironment and human evolution. The stratigraphic section is capped by younger, coarser alluvia (in which were discovered the first "Sangiran flakes").

These stratigraphic insights provide a solid geological framework for interpreting the archaeological record at Ngebung and form the foundation for developing effective scientific messages. Understanding the complexity and significance of these stratigraphical sequences enables us to design an exhibition content that accurately reflects the site's history and enhances visitors' comprehension of human evolution in this unique landscape.

In addition to field observations, our group engaged in extensive discussions with several experts and conducted a literature review to deepen our scientific understanding. These included Mr. Harry Widianto, Mr. Rais, and Mrs. Pipit, who contributed valuable knowledge on hominin fossil discoveries at Ngebung; Mr. Anton, who provided insights on the lithic industry; Mr. Mirza, who advised on faunal fossils; and Mr. Sémah and Mrs. Sémah, who shared expertise on Ngebung's geology and paleoenvironment concerning the location of actual

Figure B.4. Kresna II (shaft femur)

archaeological horizons. These consultations gathered detailed scientific information that significantly informed and strengthened our project framework.

Hominin fossils attributed to *Homo erectus* discovered at Ngebung, such as Sangiran 2I (mandible), Arjuna 9 (mandible), Ngebung 9I/92 teeth found in excavations, Kresna II (femoral diaphysis) or even the skull fragment Ardjuna I3 from the underlying Pucangan series have contributed to refining regional paleoanthropological models. Faunal and floral discoveries allow the reconstruction of past environments, revealing a mosaic of wetlands, grasslands, and open forests that supported diverse fauna. Large mammals include *Stegodon*, cervids (notably *Axis lydekkeri ngebungensis*), *Hexaprotodon*, bovids, and feline. Flora, identified through fossil pollen analysis, mainly consists of grasses, Poaceae, and Cyperaceae.

Alongside human fossils, the site has yielded numerous lithic artifacts mainly linked to the famous "Sangiran flake" industry. However, Ngebung is also renowned for being the first site to document Acheulean-like implements in Java. These tools demonstrate *Homo erectus*'s skill in transforming raw materials using techniques such as direct and indirect percussion and pressure retouching. Made from local smaller pebbles of stones like chalcedony and larger imported materials such as quartzite, these artifacts reflect deliberate resource selection throughout a large territory, serving practical and cognitive functions and offering insights into early human gestures, techniques, and adaptations.

We also conducted detailed examinations of the displays within the Ngebung Museum to evaluate how scientific information and artifacts are currently presented to the public. Our observations revealed that the exhibitions do not provide detailed narratives about the Ngebung site itself nor showcase authentic finds from Ngebung, despite the significant potential these original artifacts have to enhance the visitor experience. These findings highlighted substantial gaps between the site's rich archaeological heritage and its current public presentation, underscoring the need to develop an exhibition that more effectively connects the scientific narrative with the authentic material culture of Ngebung, thereby serving as a meaningful bridge between the museum and the Ngebung site itself.

Through semi-structured interviews with residents, students, museum staff, and members of the Sangiran International Youth Forum, and with the valuable assistance of Dr. Titi and Dr. Marisa in conducting the interviews, we identified a shared desire for an exhibition that communicates the scientific importance of the site, features authentic artifacts, and offers an immersive experience. Many noted the disconnection between the museum and the archaeological site, highlighting the need to bridge this gap. This insight shaped our exhibition design and deepened our appreciation of Ngebung's significance, enriched by the local community's archaeological knowledge. As part of Sangiran's UNESCO World Heritage status, recognized for its exceptional testimony to human history and its association with universal cultural values, Ngebung embodies these criteria through its rare fossils, stratigraphic continuity, and dense discoveries. Effective mediation must, therefore, engage local communities as active contributors to the scientific narrative, incorporating their stories, memories, and preservation efforts into the exhibition.

**Principles of message delivery**

In crafting our scientific messages, we prioritized clarity, accessibility, and engagement to reach diverse audiences, including children, the general public, and scholars. Recognizing the complexity of stratigraphy and archaeological data, we aimed at presenting these topics using clear visuals, interactive displays, and relatable narratives. We also emphasized authenticity and community involvement, integrating local knowledge and stories to create an emotional connection and foster a sense of ownership over the heritage.

**Reflection on our approach**

Our research and engagement process revealed the importance of involving local communities and experts throughout the project. Feedback from interviews and fieldwork guided us to refine the exhibition narrative, ensuring it resonates with visitors and bridges gaps between scientific research and public understanding. We adapted our communication methods by incorporating interactive elements and accessible language, acknowledging that successful scientific mediation relies on accurate data and effective and inclusive presentation.

## C – THE PROJECT IMPLEMENTATION: MEDIA AND DESIGN

**Module I: Step to the reality – Bridging the exhibition and the site**

**Display media:**

At the entrance, visitors will see a 3D cross-section model showing Ngebung's topography, sediment layers, and important fossil discovery points (like the Grenzbank layer and Ngebung teeth discovered in actual archaeological


Figure C. I. Color cross-section of Ngebung sedimentary layers with fossil markings. Used for educational illustrations (Image generated by OpenAI_s DALL·E 3 tool).

Figure C.2. Fossil evidence to reveal the intertwined lives of ancient humans and animals. Used for educational illustrations (Image generated by OpenAI_s DALL·E 3 tool).


Figure C.3. Color cross-section of Ngebung sedimentary layers with fossil markings. Used for educational illustrations (Image generated by OpenAI_s DALL·E 3 tool).

horizons). Lights or projections highlight each location. Pressing a button lets visitors see real site photos with short messages like: "Welcome to the site."

Next to the model, a "Field Site Visit Guide" panel explains how to visit the real archaeological site. It shows the walking route, how long it takes (about 10 minutes), and what to look for—like exposed layers, excavation spots, ancient riverbeds, and traces of volcanic activity.

Visitors are free to choose where to begin their visit. The whole experience includes the museum exhibition, the on-site archaeological area, and a walk of approximately 10 minutes between the two. The order of visit is entirely flexible —starting at either location will not affect the completeness of the experience.

Visitors can start their experience at the museum or the field site; the order does not matter. To support outdoor learning, they will receive a digital QR map or printed brochure with an "Observation Task Card" to help them find soil layers, color changes, or fossils in the field, making stratigraphy easy to understand through honest exploration.

**Logic:**

This module connects the museum with the real site from the very beginning. The message is clear: the museum is not just a room of objects but a gateway to a real prehistoric landscape. By linking the display to real landforms and discoveries, visitors see that the site and the exhibition are one story. Without the site, the museum has no meaning.

**Module 2: Reading the layers through time – Ngebung stratigraphy**

**Display media:**

A large, colorful cross-section diagram of Ngebung's strata will greet visitors (Figure C.I), with clear labels of each formation and the age in millions of years marked on the side. Important find spots (e.g., where a human tooth or animal bone was found) are highlighted on the layers, like pins on a timeline. Besides, it has a short message: "These layers are like pages in a book of time."

Touchable sediment blocks representing different layers (e.g., river sand and volcanic tuff) allow visitors to feel the texture changes over time. A digital interactive could let students "dig" down through virtual layers: as they swipe, the landscape and animals of that time appear, showing how Ngebung's environment changed. A simple stratigraphy puzzle with stackable transparent plates can invite kids to place fossil replicas (fish, shell, *Stegodon* bone, stone tool) in the correct layers. Through these displays, visitors of all backgrounds can understand that deeper layers are older and appreciate how Ngebung's rich finds are embedded in context, literally in the layers of time beneath their feet.

**Logic:**

Each layer of soil at Ngebung is like a page in Earth's history. By studying these layers—a method called stratigraphy—scientists can understand how the environment changed over millions of years. At Ngebung, only part of the stratigraphy is exposed, from the upper Pucangan layers (but difficult to access in the field for the visitors) up to the most recent alluvia capping the stratigraphy via the Grenzbank and Kabuh layers.

**Module 3: Traces in fossils: identity, movement, survival**

- **Unit I: Ancient animals and environments – A prehistoric ecosystem**

**Display media:**

This unit reconstructs the ecological world in which *Homo erectus* once lived, using fossil evidence to reveal the intertwined lives of ancient humans and animals (Figure C.2). At the center of the display stand selected fossil remains of other prehistoric fauna excavated from Ngebung. These remains are more than just remnants of extinct creatures—they are environmental indicators, telling us

what kinds of landscapes existed, how the climate changed, and how early humans adapted to survive.

Real ancient fossils of the *Stegodon* fossils which are already in the lobby of Ngebung Museum, will be complemented with a big drawing picture of the paleo-environment background in Ngebung, where *Homo erectus* used to live. Semi-transparent window films display ancient vegetation from the site's paleoenvironment.

A "microfossil marvels" station can showcase the tiniest fossils – mounted photographs from the scanning electron microscope showing plancton looking like intricate grains of sand or fossil pollen grain magnified to show its spiky surface. We might include a magnifying glass interactive which visitors can move over a long, flat glass case containing a layer of soil with remains (e.g. mollusks) from the real stratigraphy, hence entering the 'microscopic world'. Another engaging display is a fauna touch screen, where visitors tap an animal's silhouette (*Stegodon*, Rhino, Crocodile, etc.) and see where its fossils were found at Ngebung.

**Logic:**

The exhibition emphasizes two key ideas: first, that animal fossils are critical evidence for reconstructing ancient habitats, and second, that these animals were also central to the subsistence strategies of early humans. Large herbivores like *Stegodon*, deer, and bovids likely served as important food sources, while the presence of cut marks on bones near stone tools hints at hunting or scavenging behavior. Through these interactions, we see early humans as part of a dynamic ecosystem, both observers of and participants in the web of life.

Visitors are invited to imagine the challenges faced by *Homo erectus*: reading animal behavior, tracking prey, sharing resources, and adapting to seasonal changes. The fossils thus become scientific specimens and narrative traces of movement, survival, and identity across deep time.

- **Unit 2: Follow the footprints of Java Man – Human fossils**

**Display Media:**

This unit introduces visitors to *Homo erectus*, the early human species historically known as "Java Man." A life-size mural of 2 *Homo erectus* skeleton figures will be put on the wall, hand-drawn in motions—one bent slightly forward, holding a chopper tool prepared for hunting or butchering, another is preparing to knap a stone nucleus from a block collected in the river. These will connect to the next unit about stone tools.

Onto these illustrated skeletons, authentic fossils or high-quality casting replicas are precisely mounted at their anatomical positions: skulls, mandibles (with labels Sangiran 2I, Arjuna 9), the teeth (Ngebung excavations), and femur shaft (Kresna II). Each bone is accompanied by a clear, visually engaging label that explains its anatomical function and scientific significance—for instance: "Thick brow ridge – helped protect the eyes; a typical feature of *Homo erectus*." This approach grounds the fossils in real anatomy and helps visitors visually reconstruct Java Man as a living being rather than just an isolated set of remains.

To deepen tactile engagement, we provide a touchable replica of a *Homo erectus* jaw or skull fragment, allowing visitors—especially students—to explore the morphology of early humans physically. The wall mural extends beyond the human figure, including illustrative reconstructions of the surrounding activity, such as butchered animals, cracked bones, and discarded flakes. This contextual layer highlights *H. erectus*' adaptive behavior and ecological intelligence—as a species that hunted, scavenged, and collaborated.

**Logic:**

Meet *Homo erectus*, the early human species who once lived at Ngebung. Also known as "Java Man," they walked upright and used stone tools over a million years ago. Fossils found in the Sangiran area show that they lived here between I.5 million and 500,000 years ago (UNESCO World Heritage Centre).

This unit helps visitors see *H. erectus* not as distant relics but as real people who once lived, worked, and survived in this very landscape. The display invites understanding and emotional connection by combining fossils, body reconstructions, and storytelling. The message is clear: Java Man is not a myth but a genuine part of human history rooted in this land.

- **Unit 3: Ancient Technology – Stone Power**

**Display media:**

Fundamental stone tools from Ngebung, flakes, choppers, and bolas are displayed in a lit case. Labels clearly point out marks made by human hands. A backlit panel shows a flake's sharp edges and ripple marks. A large photo shows a tool next to a cut-marked animal bone, with a magnified view of the cut.

Because we still do not fully know how bolas were used, possible functions are shown in hand-drawn illustrations, such as throwing, striking, or combining with wooden tools. Visitors can hold selected replica bolas to feel their shape and weight. Guiding questions like "Could this work like a hammer?" encourage imagination and learning.

Wall drawings explain how early humans collected stones, shaped them with strikes, and crafted useful tools. Enlarged diagrams highlighting striking points and flake scars will help visitors distinguish between natural stones and human-made tools. Future additions may include a small outdoor workshop, where guests can watch or try simple tool-making with guidance.

**Logic:**

Stone tools are the most direct evidence of how *Homo erectus* survived and adapted. Though they may look like regular rocks, they are the earliest known human technology. This unit helps visitors understand how and why these tools were made and why they matter today.

**Module 4: Heritage and Community – Ngebung's Legacy and Future**

**Display:**

This section introduces Ngebung's local story and the people behind it. It starts with a short history of discoveries, such as how local villager Pak Toto Marsono helped Dutch scientist von Koenigswald find fossil-rich spots (von Koenigswald found the 'Sangiran Flakes' in 1934). A visual timeline shows major excavations, international research visits, and milestones in the journey toward World Heritage status.

A Local Viewpoints Photo Wall will feature photos of students and villagers visiting the site, paired with their reflections—for example: "This is the first time I saw the place where Sangiran 21 was found. It is just next to our village." A sound station will let visitors hear recorded stories from local people about the site, their memories, and its meaning in daily life.

In the participatory mapping area, visitors might use magnetic tokens to mark "where I come from" and "my relationship with the site," linking schools, farms, and homes to local heritage. These interactive experiences show how archaeological heritage is not just ancient history but deeply connected to people's lives today.

**Logic:**

Ngebung is more than an archaeological site—it is a source of pride and shared identity. It is part of the Sangiran World Heritage Site, which was listed by UNESCO in 1996. This unit shows that local communities have played an important role in discovering, protecting, and interpreting the site. Encouraging participation helps people better understand and protect their cultural heritage.

## Technical Table

To provide a clear overview of the practical needs for each part of the project, the table below outlines the key modules or units, the types of display media involved, essential materials and equipment, and the primary technical requirements. This detailed breakdown will guide the planning and execution phases, ensuring that every component is adequately supported for effective implementation.

| MODULE UNIT | DISPLAY MEDIA | ARCHAEOLOGICAL CASTING | ESSENTIAL MATERIALS AND EQUIPMENTS | KEY TECHNICAL REQUIREMENTS |
|---|---|---|---|---|
| **Module I: Step to the Real** | *Interactive 3D Map & Site Connection* | Archaeological sketches of bones and tools, photos of sites. | 3D digital display, projector(s), interactive system, screen, audio, printed panel, brochure/digital file, magnifying glasses. | Design a 3D map with interactive points linked to visuals/audio. Include site photos, descriptions, a route guide, and a task card. Requires 3D/graphic design, interactive tech. |
| **Module 2: Reading the Layers of Time** | *Stratigraphy Displays (Diagram, Tactile, Interactive, Puzzle)* | Sediments of Kabuh & Grenzbank, replicas of Kresna II, Arjuna 9, Sangiran 2I, and Ngebung teeth | Large format print, secured containers and supports, touch screen, simulation software, puzzle base/pieces, transparent plates. | Stratigraphic diagram (ages/finds). Touchable sediment samples. Interactive digital "digging" simulation. Stratigraphy puzzle for correct fossil placement. Requires graphic design, geological data, conservation for samples, and interactive/software development. |
| **Module 3: Traces in Fossils** | ***Unit I: Ancient Animals and Environments*** | *Stegodon* casting, Real fauna/flora fossils (shells, wood, etc) | Display cases, fossil supports, labels, holographic projector, large screen, video playback, printed SEM photos, display panels, touch screen, and mapping software. | Selected fossil remains with contextual info. Integrate real fossils with holographic paleoenvironment projection and continuous scene videos of ancient life—showcase microfossils with SEM photos. Develop an interactive magnifying glass for microfossils and a touch screen map of fossil locations by species. Requires paleontology, hologram/video production, and microscopy. |
| **Module 3: Traces in Fossils** | ***Unit 2: Follow the Footprints of Java Man*** | Fossils/replicas (skulls, mandibles, teeth, femur) are replicas made of sturdy material. | Mural materials, anatomical mounts, labels. | Create a life-size *Homo erectus* mural with anatomical mounting points for fossils/replicas and illustrations of activities. Provide a touchable replica of a jaw/skull fragment. It requires illustration and paleoanthropology knowledge for anatomy/behavior, conservation (for fossils), and fabrication of replicas. |
| **Module 3: Traces in Fossils** | ***Unit 3: Ancient Technology*** | stone artifacts (flakes, chopper, bola), raw stone. | Display case, lighting system, backlit panel, high-res prints with annotations, illustrations, secure mounts, and printed diagrams. | Stone artifacts, lit/secured case. Backlit panel (flake features). Comparative photos of tools/bones magnified cuts. Illustrated bola uses with touchable examples. Diagram for tool manufacturing process. Future: outdoor stone tool workshop. Requires conservation, photography, illustration, fabrication, experimental archaeology, and logistics. |
| **Module 4: Heritage and Community** | *Community & Heritage Engagement Displays (Photo Wall, Memory Places, Participatory Mapping)* | Photos of the discoveries by the local community | display system, caption holders, recording equipment, mapping tools/software, large printed maps, magnetic tokens/markers. | Photo wall with community pictures and personal captions—document and display information on local memory places related to the site. Set up a participatory mapping area for visitors to mark their connection to the site. Requires photography, community engagement, ethnography, and cultural geography. |

Our exhibition design carefully considered the spatial limitations of the Ngebung Museum lobby. The layout shows how the four modules—3D Map, Stratigraphy, Fossil Traces, and Community Wall—fit into the physical space without obstructing circulation.

## D- IMPACT

This project can bridge science and local people and link the museum and the site in Ngebung. This exhibition acts as a scientific mediation that disseminates knowledge so that audiences with diverse backgrounds can understand it. The anticipated impacts are as follows:

**Scientific mediation for diverse audiences**

- Students and youths: this exhibition will interactively present scientific information about stratigraphy, archaeological findings (hominin fossils, fauna fossils, and lithic artifacts), and their heritage value. Through the media used, the exhibition will increase understanding of the value of cultural heritage while encouraging a sense of pride in local identity.

- Visitors (domestic and international): this exhibition can enhance visitors' experiences, both domestic and international, by using easy-to-understand informative media.

- Local community: this exhibition certainly involves the participation of the local community, which can raise local awareness of the importance of knowing, maintaining, and conserving heritage.

- Researchers and academics: this exhibition communicates research results openly to the public. It also encourages cooperation between scientific fields and opens future joint research and educational opportunities.

**Indicators of success:**

- Number of visitors increases as an indicator of the attractiveness of the exhibition.

- Level of audience understanding, measured through simple post-visit surveys or quizzes.

- Positive feedback from visitors on the quality of information and exhibition presentation.

- Local communities, such as guides or cultural resource persons, will participate in the exhibition.

**Contribution to World Heritage good practices**

This exhibition project aligns with the World Heritage Centre's good practices. It will involve various stakeholders, including the museum staff, the local community, and academics, to ensure the content is accurate and inclusive. The involvement of local communities enriches the exhibition with lively cultural narratives while at the same time encouraging a sense of ownership over the heritage, thus supporting the sustainability of conservation.

**Indicators of success:**

- Academics and experts assess scientific accuracy and cultural representation according to world heritage preservation standards.
- Multi-stakeholder involvement (museums, communities, academia) in exhibition planning and implementation.
- Sustainability of preservation is supported by local community participation post-exhibition.

**Contribution to local development**

This project is expected to encourage the development of visits to the Ngebung museum and sites. Tourism can positively impact local economic growth, including guides, homestay managers, food vendors, transportation service providers, and souvenir artisans.

However, one important impact is that the exhibition may strengthen the bond between the community and the museum institution. By providing a space for the community to participate, it is hoped that the community will develop a sense that museums and sites are part of their lives. This strong relationship between the museum and the community supports efforts to sustain and preserve heritage.

Indicators of success:

- Increased local economic income from tourism sectors such as homestays, culinary, tour guides, and handicrafts.
- Increased community involvement in the tourism sector and museum management, including participation in decision-making and collaborative activities.
- Changes in perception and increased community pride in cultural heritage and museums, measured through surveys or interviews.

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