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Preventive Conservation of the Kabayan Mummies: Surveying and Environmental Monitoring to Save the Mummies

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Abstract

The Kabayan mummies are culturally important to the indigenous Ibaloi peoples of Benguet, the Philippines. Within the last several decades, these mummies have increasingly begun to deteriorate. With the collaboration of the Ibaloi elders, this project gathered environmental data for ten months at seven identified burial rockshelters that contain mummies to better understand how the environments are contributing to their deterioration. Such knowledge can then inform conservation and preservation methods to minimise future deterioration of the mummies. Analysis of the environmental data revealed that the temperatures within the rockshelters are relatively stable, while the relative humidity levels are constantly high and inconsistent, which likely contributes to the deterioration of the mummies. This project fostered a relationship of trust and respect between the research team, the Kabayan community, and all concerned local and national government agencies, allowing this project to continue and expand in the future.

1. Introduction

1.1 Background

The Kabayan mummies, or *meking*, represent the ancestral remains of the Ibaloi peoples, one of the indigenous groups in the Cordillera region of the Philippines. Highly esteemed, uniquely mummified, and considered the enduring ancestors of the Ibaloi, the Kabayan mummies continue to play a significant role in community spirituality and ritual (Beckett, 2021). Regarded as valuable and irreplaceable, the Kabayan mummies were declared National Cultural Treasures (NCT) of the Philippines in 1973 under Presidential Decree No. 260. This designation acknowledges the importance of the mummies not only as the honoured ancestors of the Ibaloi people in Kabayan, but to the wider national cultural identity of the Philippines.

The distinctive mummification method used by the Ibaloi is also critical in a wider, more global context, as it provides insight into unique social structures and mummification processes in an isolated island chain with discrete flora and fauna that may have been used in preservation. Much of the information on the exact mummification methods that the Ibaloi employed has been lost (as the procedures were passed down solely through oral tradition and anecdotes) (Beckett et al., 2017); however, the knowledge that persists reveals that the mummification process likely involved cleaning a corpse and applying herbal extracts, sitting the body on a *sangadil* (death chair), and drying and dehydrating the human remains using the heat and smoke from a fire below (Balangcod, 2018). The Ibaloi peoples may have begun mummifying deceased individuals in this manner as early as 2000 BCE, with the peak period of mummification occurring between 1200 CE and 1500 CE, and the tradition ending around the late 19th century CE with increasing modernisation of the region (Beckett, 2021; Carascal et al., 2021). The mummification process could take up to two years to complete, with varying results; when successful, the practice was so effective that internal organs, nails, and skin displaying visible tattoos are still preserved on some individuals today (Beckett, 2017; Carascal et al., 2021).

Despite the significance of these mummies, they are at severe risk of disappearing due to decay, looting, and vandalism. Within the last several decades, the deterioration of the *meking* has accelerated, likely due to factors such as tourism, climate change, intensified vegetable farming, and the commercialisation of rural areas such as Kabayan. While previously the locations of many mummies were predominantly only known by locals, the increased activity around the rockshelters that accompanied the region's increased tourism and transformation led to foreign mountain climbers discovering the mummies in the 1980s (Balangcod, 2018). This activity has resulted in looting and repeated opening and closing of the coffins that contain the mummies (Balangcod, 2018). Such activity, coupled with climate change, has increased mould growth and insect infestations on the mummies and associated material culture–such as the wooden coffins and death blankets–furthering their deterioration. Consequently, the mummies are in dire need of preservation and conservation to prevent total loss (Datar et al., 2016).

1.2 Literature Review

Researchers worldwide have investigated the mummified remains of the Ibaloi, but varying accounts on the mummification practice and accompanying rituals and processes remain (Beckett et al., 2017; Carascal et al., 2021). Studies have been conducted to attempt to determine the species of plants used in mummification (Balangcod, 2018), and methods such as radiography, radio-carbon dating, endoscopy, and ethnography have been employed (Beckett et al., 2017). Many of these projects focused on the 'past' of the mummies, to uncover the methods involved in their mummification or to better understand the social contexts that initiated the practice. Despite these numerous projects, a scarcity of information persists, and only one study by the Geology and Paleontology Division of the NMP has focused on studying the rockshelters in which the mummies are presently housed. This study attempted to identify the type(s) of rock and the causes of leaks inside the rockshelters but did not record or monitor environmental conditions. Such environmental information is critical in determining the effects

of the environment on the mummies and thus developing potential methods to help preserve them for future generations.

Over 40 years ago, conservator Federico Aromin of the National Museum of the Philippines (NMP) observed fungal activity on the skin of mummies (Datar et al., 2016). Accordingly, he recommended as far back as 1985 that climatological data be recorded and analysed to provide insight into the environmental conditions of the rockshelters (Datar et al., 2016). Unfortunately, such research was never conducted. As the caretakers of the Kabayan mummies, the NMP highlighted the issue of accelerated mould growth on many of the mummies in 2016 and further underscored the importance of collecting long-term environmental data in an effort to better understand the exact mechanisms and processes that are spurring the mummies’ deterioration (Datar et al., 2016). The NMP team attempted to gather these environmental data in 2017; unfortunately, the temperature and relative humidity (RH) levels were only collected during documentation and ocular inspections using a psychrometer, not continuously over long periods of time.

This project, therefore, aimed to fill a significant research gap by recording and analysing environmental data by installing environmental monitors, or data loggers, in seven rockshelters that house the mummies. By documenting the temperature and RH levels using these instruments, the research team endeavored to better understand how the mummies’ environments may be contributing to their deterioration. This knowledge can then be used with conservation science to develop treatment plans to better preserve the mummies.

2. Methodology

2.1 Project Management

Fieldwork for the project was planned to be conducted over the course of a week in September 2023. Three months before the fieldwork was intended to occur, members of the research team met with representatives of the National Commission on Indigenous Peoples (NCIP), a governmental organisation that strives to empower, equalise, and protect all indigenous peoples in the Philippines while preserving their customs, beliefs, and values (Republic of the Philippines Office of the President, National Commission on indigenous peoples). This initial meeting and continued collaboration with the organisation were an essential process in undertaking research with indigenous peoples in the Philippines in a respectful and ethical manner. Coordination with the NCIP before the proposed fieldwork allowed the research team to present their project and prepare for the required Free and Prior Informed Consent (FPIC). The FPIC process involved the conduct of a disclosure meeting with the community, discussion among the elders and members of the community to allow the research to be conducted, and the signing of the Memorandum of Agreement (MOA). It was further vital to begin discussions with the stakeholders during the early stages of the project to show respect to the community and demonstrate the team’s commitment to preserving the mummies. Such efforts were noted by the community and helped ensure the elders’ support for the project and possible future proposals.

Team members from the NMP Kabayan also paid a courtesy visit to the Office of the Municipal Mayor of Kabayan to inform them of the project and to ensure that all necessary requests and permissions were submitted. Team members from the Ethnology Division of the NMP in Manila further facilitated logistical aspects of the work, such as arranging meetings, translating conversations between different local languages, and providing local staff to aid in the installation, maintenance, and collection of data from the environmental monitors installed during fieldwork. NMP Kabayan personnel were particularly knowledgeable about how to confer with the elders and respectfully care for the Kabayan mummies, as their collection currently includes a mummified individual.

2.2 Instrument Used

When selecting an environmental monitor for this project, the harsh mountainous climate where the Kabayan rockshelters are located needed to be considered. Another crucial factor in choosing a data logger was ensuring that the device had a large Bluetooth range to allow data to be easily collected and downloaded without requiring repeated access to the interior of each rockshelter, which would have been disruptive and disrespectful to the mummies. The team began by studying how previous research projects successfully employed environmental monitors at open-air archaeological sites and then investigated the specific models of monitors used in these studies (Fernández-Navajas et al., 2013; Merello et al., 2014). Comparable models were then assessed. Ultimately, the Onset HOBO® MX2301A Outdoor Bluetooth Humidity Data Logger was selected as the most suitable and cost-effective option for a rugged, mountainous environment due to its weatherproofing, 100-foot Bluetooth capabilities, and small margin of error.

The monitors were programmed to record the temperatures and RH levels at 30-minute intervals for ten months from October 1st, 2023 through July 31st, 2024. Each monitor was given a specific numerical identifier and label that was determined by the rockshelter in which it was installed and the location within that rockshelter. Technicians from the NMP Kabayan visited each site monthly to collect the raw data via Bluetooth on a mobile device. Raw data were then uploaded to a shared drive to allow the overseas research team to access, process, and analyse the data.

2.3 Fieldwork

Fieldwork was conducted the week of September 18th, 2023. Before the sites were visited and monitors installed, the research team met with representative elders from the different *barangays*, or villages, of Kabayan to present the project and obtain consent. The NCIP helped facilitate this meeting. This community-wide assembly provided an opportunity for the elders and representatives to learn more about the project, ask questions, and negotiate terms. For the project to proceed, approximately 20 elders serving as indigenous peoples’ Mandatory Representatives (IPMRs) from the invited barangays needed to consent to the project. To formalise their approval, the IPMRs needed to sign a Memorandum of Agreement with the researchers that included a Kabayan-Ibaloi translation. Finally, the team also required a signed research agreement with the Mayor of Kabayan for the project to commence. This document served to further formalise the collaborative nature of the project and grant the team access to conduct research at specific sites within Kabayan. It was important to the research team that the local stakeholders partook in defining the terms and conduct of the project.

After prolonged discussions with the elders at the meeting, the research team recognised that the project plan needed to be amended. Originally, the research team planned to visit ten sites based on the NMP’s previous survey reports. However,

members of the community advised that several sites were inaccessible due to landslides or overgrowth of the surrounding forests. The elders also suggested that the research team include an alternative rockshelter in the project that the community thought could particularly benefit from gathering environmental information. By the end of the fieldwork period, the team was able to visit and install a total of 19 monitors across seven sites.

After the initial assembly, the research team performed a traditional *cañao*, an Ibaloi ritual that celebrates significant events, blesses future endeavors, and acknowledges ancestral spirits and local gods. The process is led by a *mangmadmad*, or local spiritual leader, who prays for the host and all those present at the cañao. The mangmadmad guides the community in ritual offerings of *tapey* (rice wine) and mountain pigs while men play gongs, drums, and metal bars, and pairs of men and women with blankets covering their extended arms dance to the music. It was particularly important for the research team to hold a cañao to demonstrate respect to the ancestral spirits represented by the mummies, which was vital due to the sensitive nature of the fieldwork. The cañao held for this project also served as an important social activity that welcomed community members to celebrate, eat, and learn about the project.

Over the following week, the team visited the seven burial sites with the help of local guides, who performed the proper rituals and prayers at each site before the team installed the environmental monitors. Personnel from the NMP Kabayan and Ethnology Division were also present to support the research team in this installation process.

To collect a comprehensive dataset, at least two data loggers were installed at each site: one or two to record the interior climate of the rockshelter and one to record the exterior climate. The data were collected for ten months to account for the wet and dry seasons, providing a more robust data set that allows for a more comprehensive analysis.

The research sites are located in four barangays in Kabayan. Each rockshelter can be reached by four-wheel drive vehicles followed by 30 to 45 minutes of hiking. Accordingly, the data loggers had to be calibrated and tested well in advance of hiking to the sites, and equipment used to install the environmental monitors had to be portable enough to be carried uphill for up to an hour. The data loggers were installed by securing the instruments in custom-made wooden boxes and then attaching these boxes to the surface of the rockshelters. A reversible cement and sand mixture was used to secure the monitors to the rockshelters to ensure best conservation practices were employed and to prevent damaging the rockshelters when the data loggers were to be removed at the end of the 10-month research period. After each data logger was installed, it was then tested to ensure that it was functioning correctly and to train the NMP Kabayan technicians who would be retrieving the data from each monitor monthly and sending them to the research team.

The following table summarises the number and location of environmental monitors installed at each site:

Site Name	No. of Monitors	Placement of Monitors
Bitoan	2	1 interior, inside cave shelter 1 exterior, attached to external rock face near entrance
Opdas 1	2	1 interior, centre near roof of rockshelter 1 exterior, attached next to entrance
Opdas 2	1	1 next to coffin (This rockshelter differed from the others included in this project in that it was not enclosed; accordingly, only one monitor was required because there was no internal/external divide)
Timbac 1	3	2 interior, one towards the centre of the rockshelter, another closer to the entrance of the rockshelter 1 exterior, attached to an external rock face near the entrance of the rockshelter
Timbac 2	3	2 interior, one deeper inside shelter and one central 1 exterior, attached to external rock face near entrance of the rockshelter
Tinongchol	5	4 interior, each in separate burial pockets/niches across the huge burial rock 1 exterior, attached to external rock face at the back area facing the river
Pongasan	3	2 interior, one towards the centre of the rockshelter and one near the entrance 1 exterior attached to the surface along the outside left side of the rockshelter

Table 1. The number and locations of environmental monitors installed at each of the seven rockshelter sites.

2.4 Challenges

The strategies, steps, and designs of this project remained quite dynamic throughout the course of the venture. This was anticipated, appropriate, and welcomed when working with indigenous communities and sensitive materials like human remains. The research team appreciated input from the Kabayan elders and mayor, as it ensured that all aspects of the project were culturally respectful and in adherence with the community’s customs and traditions.

The dynamic nature of this project was not without obstacles, however. Coordinating and managing the logistics of this project was especially difficult, particularly as plans and dates changed often in attempts to accommodate the various stakeholders and groups involved. The most challenging aspect of this project, however, was obtaining the support and approval of the Kabayan elders. It was vital that the elders understood every aspect of the proposed project and had a chance to challenge its objectives and planned methodology. Despite months of discussions with the elders and the Mayor of Kabayan before the proposed September fieldwork, the research team still had to present the project to the community and defend its importance and benefit to the Kabayan people. Initially, the in-person presentation to the community before the start of the fieldwork was not well received, and there seemed to be little chance of the project progressing. However, open discussion, the team’s willingness to alter plans to accommodate requests and mitigate concerns held by the community, the support of the mayor, and the conduction of the cañao eventually helped the community and research team reach an agreement on how the project would be allowed to proceed. This process was essential to ensure that the Ibaloi peoples have agency over the remains of their ancestors and to respect the customs, traditions, and decisions of the community. Ultimately, all parties agreed on how the project would progress and were hopeful that the endeavor would prove beneficial in preserving the mummies.

Due to the research team being based overseas and the rural nature of Kabayan, establishing initial avenues for contact was difficult. The research team also had to propose the project through official channels of communication (i.e., via the NCIP and the NMP). If the research team had been able to make direct contact with the Kabayan elders at the beginning of the project, a more collaborative project may have been achieved.

Other challenges that arose during the course of the project centred on the data loggers. In three instances, the environmental monitors failed, resulting in the loss of a small subset of data. These technological issues were due to the batteries failing, despite using new environmental monitors with two-year battery lives. Additionally, there was an incident in which one data logger placed at the exterior of the rockshelter at the Pongasan site had its batteries removed, resulting in the loss of nearly one month’s worth of data. The research team wonders if this event could have been the result of a lack of communication between the research team and the community on the intended purpose of these environmental monitors. Within four weeks, the inoperative monitor was replaced with a new data logger, and no other similar incidents occurred during the remainder of the ten-month data collection period. Unfortunately, the remote nature of the rockshelters only permitted the technicians to access the sites once every month; consequently, issues with data collection could take up to four weeks to rectify.

3. Results

Raw data were analysed using the GCI Excel Tools system developed by the Getty Conservation Institute (Cosaert et al., 2022). Data were processed and examined using averages, ranges, cumulative relative frequencies, and medians. They were then converted into time-series graphs.

A consensus on ideal temperature ranges for outdoor heritage sites (specifically those in tropical Asian climates) has not yet been reached (Tse et al., 2018). Consequently, the research team referred to the standard Australian Institute for the Conservation of Cultural Materials (AICCM) Environmental Guidelines for humid environments as a general ideal for the temperature and RH ranges in the interior of each rockshelter. These guidelines set the ideal temperature at 15-25 °C with short-term fluctuations no greater than 4 °C and the ideal RH as 45-65% with short-term fluctuations no greater than 5% (Pagliarino, 2022). Typically, these ideal environmental conditions are most attainable in indoor spaces, such as museums and art galleries. It is important to note, however, that even within some of the most pre-eminent and distinguished public and private institutions worldwide, such ideal environmental conditions are difficult to achieve consistently.

4. Analysis

The results (Figures 1 and 2) indicate that, while on average the temperatures fell within ideal standards, the RH levels did not. Collecting and analysing the data over the ten-month period underscored not only the extreme fluctuations in RH over the course of several days but also across the wet and dry seasons. While the research team anticipated high RH levels, it did not expect a range consistently above 60% RH within the ten-month period or the high RH levels to persist throughout the dry season. These data also revealed how changes in the rockshelters’ exterior environments significantly affected their interior environments.

Figure 1. Average interior and exterior temperatures across all sites. The grey band indicates 15-25 °C, the ideal temperature range according to the AICCM’s Environmental Guidelines for museum interior environments in humid climates (Pagliarino, 2022).

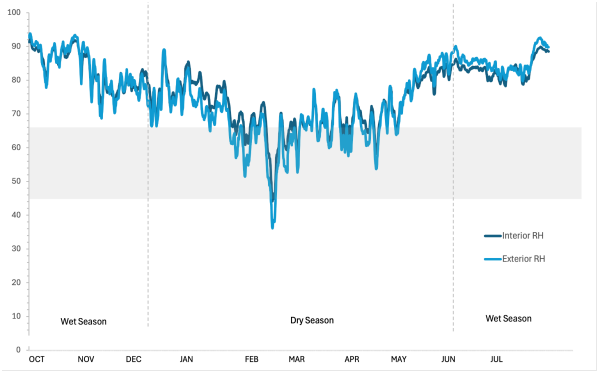

Figure 2. Average interior and exterior RH levels across all sites. The grey band indicates 45-65% RH, the ideal range according to the AICCM’s Environmental Guidelines for museum interior environments in humid climates (Pagliarino, 2022).

Typically, the RH levels at the exterior of the rockshelters were slightly higher than those inside the rockshelters. In January and February 2024, however, the RH levels inside the rockshelters were markedly and consistently around 5% higher than those at the exterior of the rockshelters. This discovery is particularly concerning, as it suggests that moisture may be trapped in the rockshelters, possibly due to a lack of air movement inside the shelters.

Organic materials such as mummified human remains are particularly susceptible to increased microbial, fungal, and insect activity (DeAraujo et al., 2016). Such organic materials are also prone to swelling and contracting as RH changes (Heritage Collections Council Australia, 1998). As earlier reports detailed the presence of fungal and insect activity, the data gathered in this project that revealed the elevated and inconsistent RH levels in the rockshelters suggest that the RH is undoubtedly contributing to the recent accelerated deterioration of the mummies by creating a detrimental microclimate where agents of biodeterioration can thrive. As such, intervention to decrease humidity levels inside the rockshelters is vital in decelerating these processes of deterioration.

5. Presentation of Results to Community

After the ten-month data collection period, the team organised and analysed the data for presentation. Another meeting was scheduled with the community and representatives of the NCIP, as indicated in the MOA. In August of 2024, members of the research team returned to Kabayan to present the findings of the project and discuss how the community wanted to proceed with additional phases of the project. The elders appreciated that the findings were presented in person, as they were aware of the effort and days of travel that were required to revisit the rural community. With their previous experiences with researchers studying the Kabayan mummies, the elders were pleased that the team informed and engaged the community in the plan for future aspects of the project. Some members of the community who are knowledgeable in environmental studies even expressed their willingness to aid in the research and conservation efforts. This further engagement encouraged other members of the community to agree to allow the data loggers to remain installed in the rockshelters and continue to collect data even after the 10-month period of data collection had ended.

During the course of the project, Australian Geographic interviewed the research team and published a video. This video was shown to the community at the forum, and the elders were pleased that their heritage was not only being shown and discussed in other countries, but also that the entire conversation was based on how such precious material culture needed to be preserved.

The steps taken during the forum further built upon the trust that the research team began to develop with the elders over a year earlier. This relationship proved particularly fruitful, as it led to the community approving continued environmental monitoring of the sites for an indefinite period of time. Ongoing monitoring will allow the research team to collect additional data that will help mitigate data loss from the initial ten-month period and provide a more comprehensive picture of the rockshelters’ environmental conditions. This long-term monitoring will likely prove particularly helpful in capturing how less regular weather patterns (such as La Niña, which tends to bring higher rainfall) may affect the environments of the rockshelters.

Significantly, the conference also discussed possible actions to address the deterioration in a more practical sense. While this project’s dataset represents an important and crucial step in conserving the mummies, the question of how to conserve them remains. The research team hopes that they can continue to pursue this work with the Ibaloi to develop ways to improve the environmental conditions of the rockshelters in which the mummies are housed.

6. Conclusion

The results of this project have highlighted the problematic environments in which the Kabayan mummies are housed. While the temperatures appear largely stable and close to ideal standards for enclosed indoor spaces, the RH levels are concerning, as they were predominantly higher than the ideal range and fluctuated greatly over short-term intervals. Such marked variations pose a substantial risk to the Kabayan mummies and their associated material culture.

The data collected provide a better understanding of how the environment affects the Kabayan mummies and thus can help inform how the environment may be altered and/or treatments may be performed to minimise future deterioration of the mummies. Now that the community has approved ongoing environmental monitoring of the sites for an indefinite period of time, a more thorough understanding of the rockshelters’ environmental conditions can be achieved. Such information will prove beneficial to further informing preservation and conservation measures.

The exact treatment plan (which may include dehumidification techniques, creating microclimates for the mummies, and/or reforesting the areas around the rockshelters) will be developed with the close involvement of the Kabayan community. So far, the research team has established a relationship of trust and collaboration with the Kabayan community. It is essential to build on this foundation and ensure that the community is involved in every aspect of this project going forward, as the Ibaloi must have agency to determine if and how their ancestral remains are to be treated. Hopefully, the continuation of this project can assist the Ibaloi in developing and, eventually, independently managing a program to care for the mummies that aligns with the community’s beliefs and values.

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Appendix

These graphs detail the average interior and exterior RH and temperatures for each rockshelter. Where the data loggers failed, missing data is visible as gaps. Viewing the individual environment for each rockshelter is particularly valuable, as each rockshelter is unique and may require a different conservation plan.

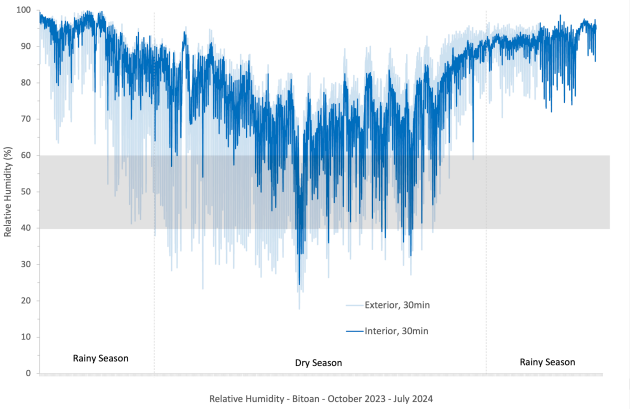

Figure 3. Average interior and exterior RH for the Bitoan Site from October 2023 to July 2024. The grey band indicates 45-65% RH.

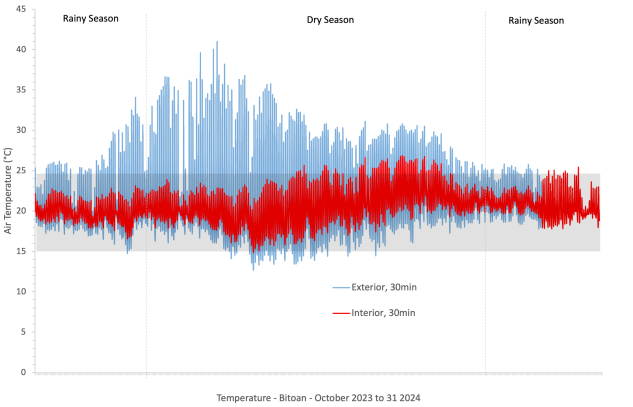

Figure 4. Average interior and exterior temperatures for Bitoan Site from October 2023 to July 2024. The grey band indicates 15-25 °C.

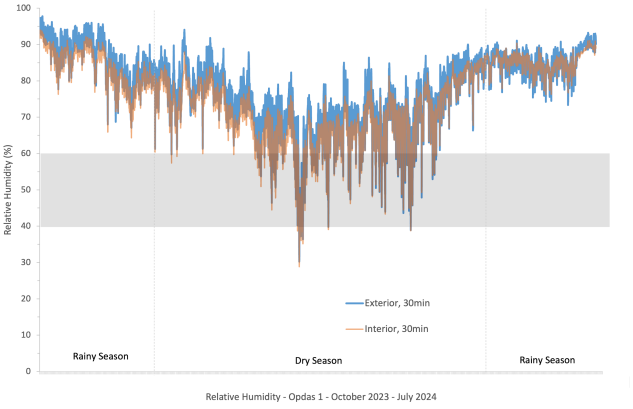

Figure 5. Average interior and exterior RH for the Opdas 1 Site from October 2023 to July 2024. The grey band indicates 40-60% RH.

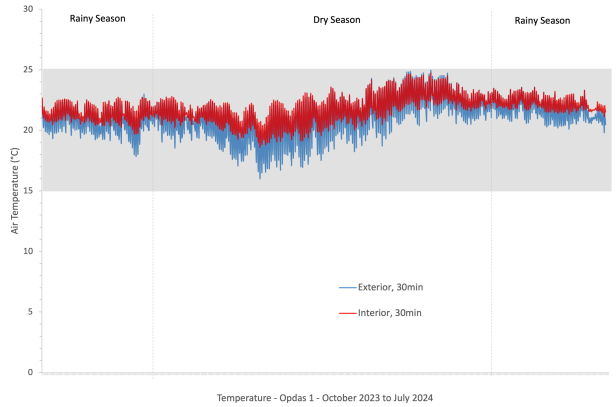

Figure 6. Average interior and exterior temperatures for Opdas 1 Site from October 2023 to July 2024. The grey band indicates 15-25 °C.

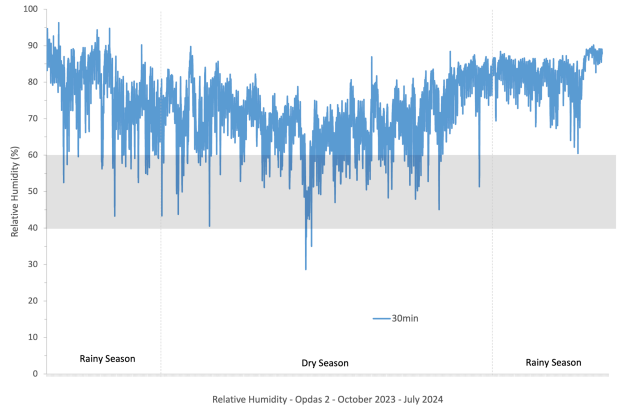

Figure 7. Average interior and exterior RH for the Opdas 2 Site from October 2023 to July 2024. The grey band indicates 40-60% RH.

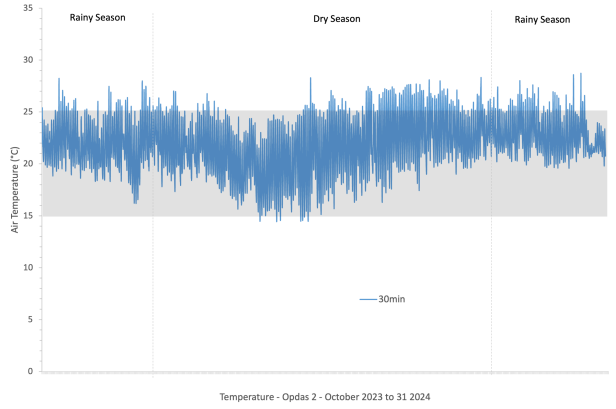

Figure 8. Average interior and exterior temperatures for Opdas 2 Site from October 2023 to July 2024. The grey band indicates 15-25 °C.

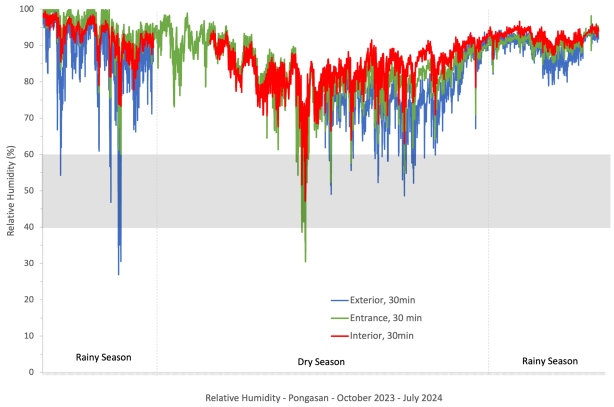

Figure 9. Average interior and exterior RH for the Pongasan Site from October 2023 to July 2024. The grey band indicates 40-60% RH.

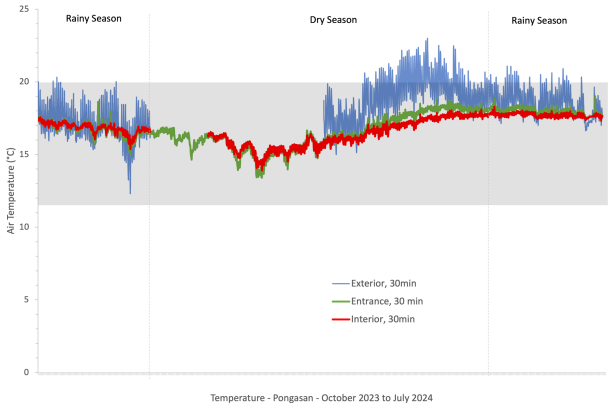

Figure 10. Average interior and exterior temperatures for Pongasan Site from October 2023 to July 2024. The grey band indicates 15-25 °C.

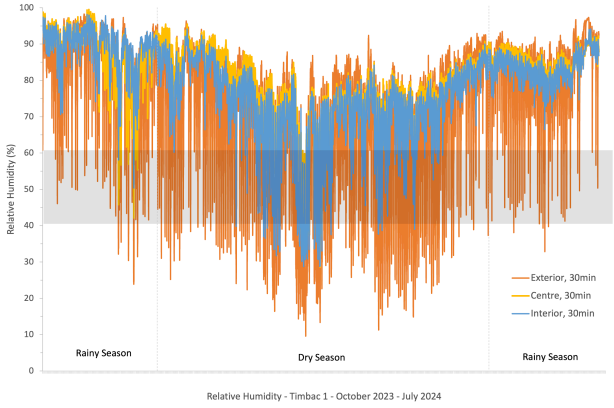

Figure 11. Average interior and exterior RH for Timbac 1 Site from October 2023 to July 2024. The grey band indicates 40-60% RH.

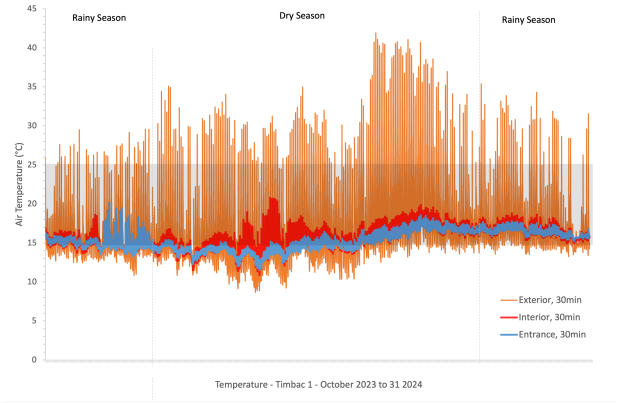

Figure 12. Average interior and exterior temperatures for Timbac 1 Site from October 2023 to July 2024. The grey band indicates 15-25 °C.

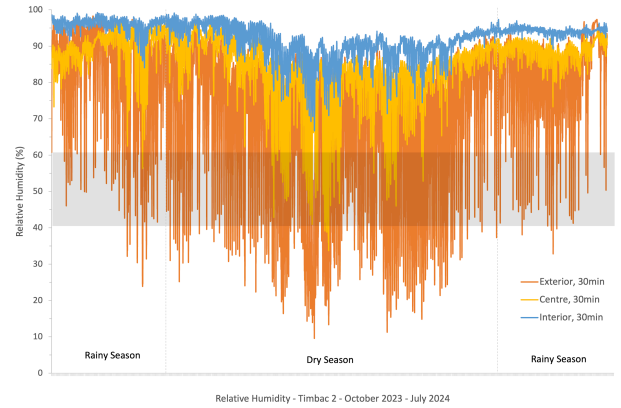

Figure 13. Average interior and exterior RH for Timbac 2 Site from October 2023 to July 2024. The grey band indicates 40-60% RH.

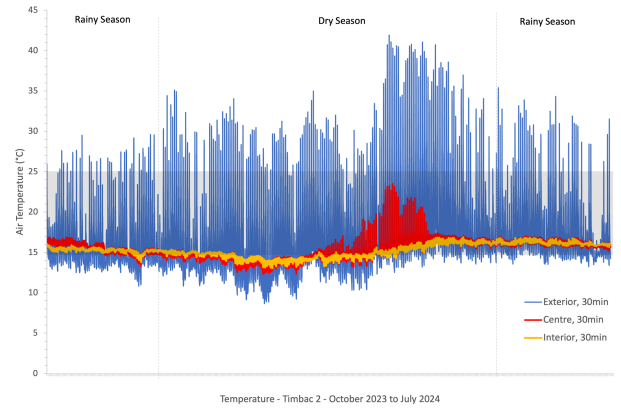

Figure 14. Average interior and exterior temperatures for Timbac 2 Site from October 2023 to July 2024. The grey band indicates 15-25 °C.

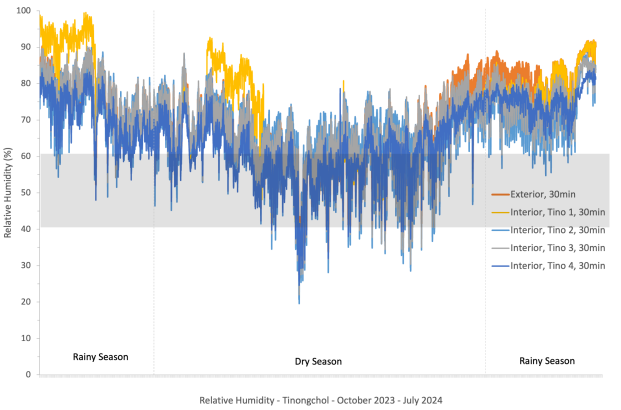

Figure 15. Average interior and exterior RH for Tinongchol Site from October 2023 to July 2024. The grey band indicates 40-60% RH.

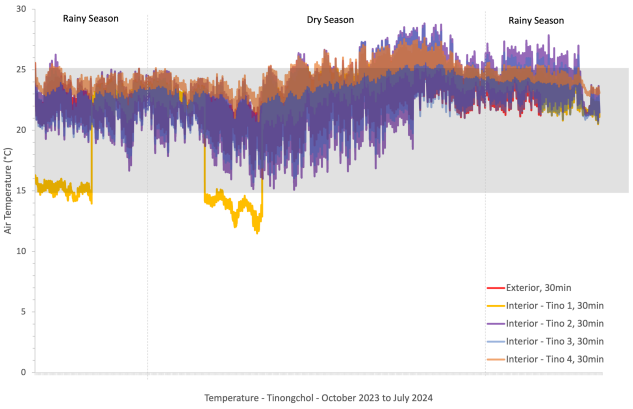

Figure 16. Average interior and exterior temperatures for Tinongchol Site from October 2023 to July 2024. The grey band indicates 15-25 °C.