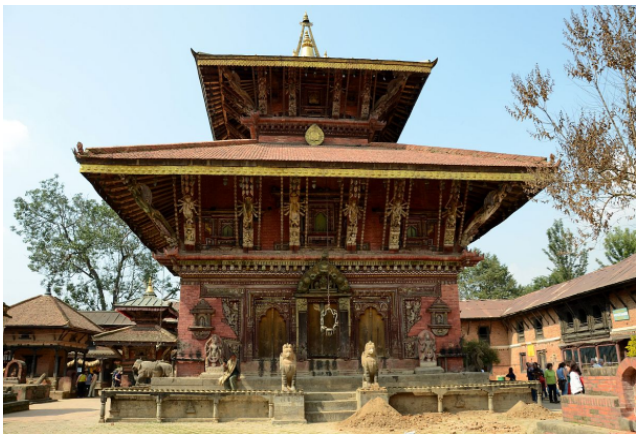
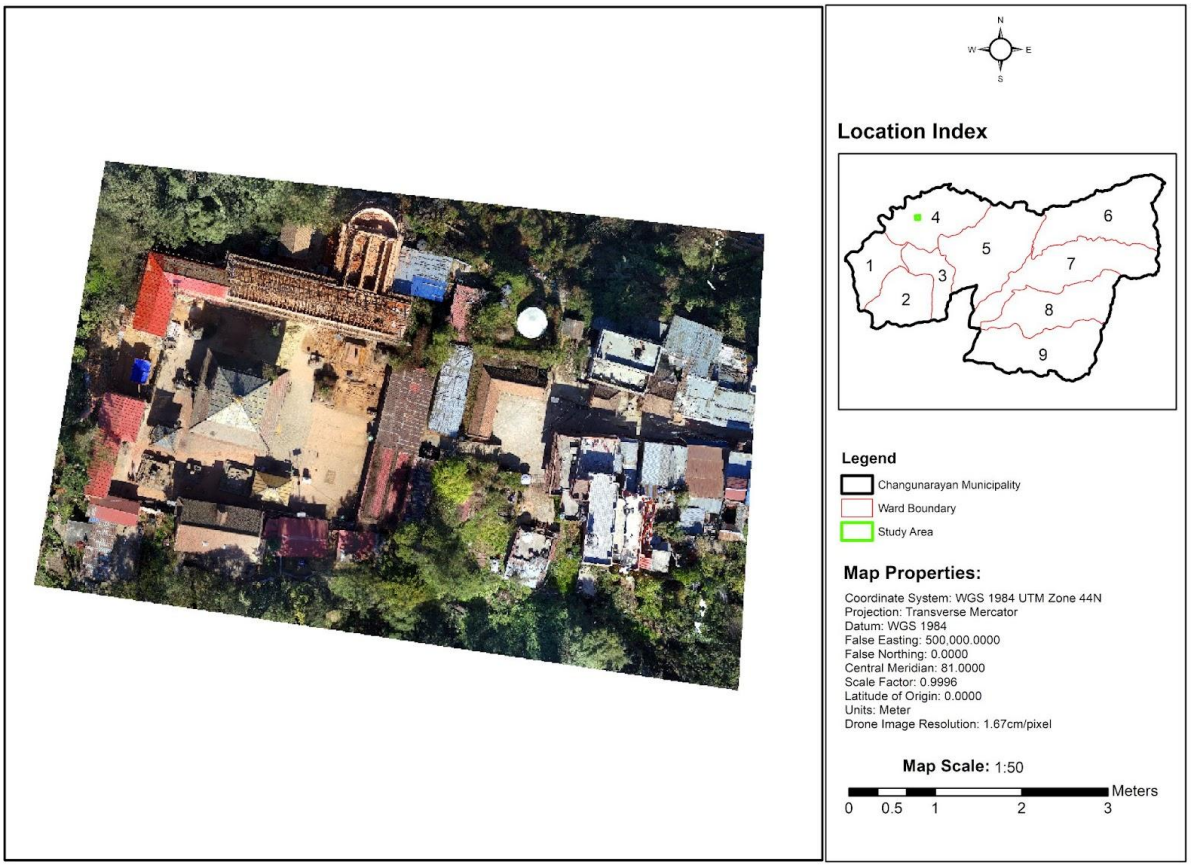
# Drones for Heritage Conservation: 3D Modelling of the Changunarayan Temple, the oldest temple in Kathmandu Valley

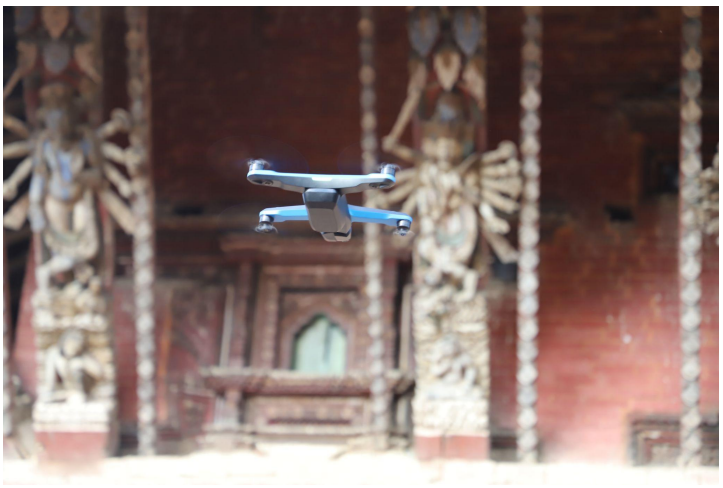
*3D Model of Changunarayan Temple*



*Changunarayan Temple*




*Orthophoto map of Changunarayan and its periphery*



*Skydio 2 in action executing 3D scan*

| OVERVIEW | |
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| **Flying Labs** | Nepal Flying Labs |
| **Geographic area** | Changunarayan, Province-03, Bhaktapur |
| **Date range** | December 2021 to March 2022 |
| **Sector program** | AidRobotics |
| **Main SDGs** | GOAL 9: Industry, Innovation and Infrastructure<br>GOAL 11: Sustainable Cities and Communities |

| SCOPE | |
|---|---|
| **Project stakeholders** | Changunarayan Municipality Office, Nepal Archaeological Department, Skydio |
| **People impacted** | Changunarayan Municipality Heritage Development Committee |
| **Number of people impacted** | Not applicable |
| **Challenge** | Nepal is a rich country in terms of natural and cultural heritage, however, protecting these heritages is a major challenge as the country is highly vulnerable to disasters. During the aftermath of the 2015 earthquake in Nepal, hundreds of heritages were destroyed all over Nepal. In the absence of preserved digital data of these historical and cultural monuments, the reconstruction of such important heritages was badly affected. In that regard, having a proper digital record that can store the data regarding the intricate details of the heritages can not only speed up the reconstruction process but also ensure proper restoration. |
| **Scope** | Within our project we captured high-resolution images of the Changunarayan heritage site with the assistance of municipal representatives and residents of the community. Then a 3D model and orthomosaic of the Changunarayan Temple and surrounding Heritage area was prepared. Finally, the data and |

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| | high-resolution images of the site were handed over to the municipal officials and the local heritage development committee which ought to serve in protecting and reconstructing its values in case any natural calamities deteriorate the Changunarayan site. |
| **Outcome** | High-resolution orthophoto maps and building methodology for 3D modelling for conservation of heritage data for future reconstruction purposes.<br><br>Sensitization on the need and importance of creating digital data of heritage sites that will aid future reconstruction and renovation efforts. |
| **Impact** | This project has played a significant role in sensitising the government bodies and enhancing local awareness regarding preparation of digital dataset to support reconstruction and maintenance of heritages. Besides, this project has proven that high-resolution models and maps generated using Skydio 2 drones can be used for any sorts of future conservation and tourism promotion activities. |
| **Next steps** | A digital database of preserved data will be prepared, using which authorities can visualise the output model and maps that will assist in future reconstruction work. |

| **COMMUNITY ENGAGEMENT AND STAKEHOLDER SUPPORT** | |
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| **Consent for data acquisition** | First and foremost, the consent letter was secured from the District Administrative Office,Bhaktapur with the help of recommendations and support documents from Changu Narayan Municipality Office for the consent for data acquisition. Changunarayan Temple being in the World Heritage Site, the final permission for data acquisition was granted by Nepal Archaeological Department (NAD) with the help of support letters from DAO, Municipality Office and relevant authorities. The project team also liaised with the District Administrative Office, Bhaktapur the Changunarayan Temple Preservation Committee, the Armed Police Force and the local stakeholders to ensure the data collection and drone flights were conducted with the consent of all the stakeholders involved. |
| **Activities to engage with the community** | Interaction at the local government office.<br>Interaction with local heritage development committee |
| **Community groups engaged with** | Changunarayan Municipality<br>Changunarayan Municipality Heritage Development Committee<br>Department of Archaeology |

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| **Community attendance** | As the project location was a world heritage site, there were a lot of people travelling to the area . There was always a group of around 9-10 people always watching the mapping work with curiosity. |
| **Community feedback** | As the project location was a world heritage site there were many people at the site, most of whom showed concerns regarding the purpose of the mapping activity and how it was going to contribute to the ongoing reconstruction activities. |
| **Stakeholder support** | We have not been able to handover the datasets to the local government and other stakeholders yet. However, we are planning to organise a one day data dissemination and output sharing session together with the department of Archaeology and then also invite other relevant stakeholders during the session. This will first help to sensitise the relevant stakeholders regarding the need of maintaining a digital data archive of heritage sites. |

| DATA ACQUISITION | |
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| **Size of area** | 3D model: 0.3 ha (3000 $m^2$)<br>Orthomosaic: 14.8 ha (0.148 $km^2$) |
| **Drone** | Skydio 2 |
| **Sensor(s)** | RGB sensor |
| **Flight plan software** | Skydio 3D Scan, Skydio Mission Planner |
| **Flight height** | 3D model: 6 metres above ground level<br>Orthomosaic: 40 metres above ground level |
| **GSD (Accuracy)** | 3D model: 0.38 cm/pixel<br>Orthomosaic: 1.67 cm/pixel |
| **Number of images acquired** | 3D model: 1047<br>Orthomosaic: 61 |
| **Number of flights** | 3D model: 3 flights<br>Orthomosaic: 2 flights |
| **Time invested in data acquisition** | 3D model: 2 days<br>Orthomosaic: 1 day |
| **Georeferencing** | Drone survey with PPK was carried out.<br>No GCP installed. |

| DATA PROCESSING & ANALYSIS | |
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| **Processing software** | Agisoft Metashape, PIX4Dmapper, Bentley ContextCapture |
| **Processing time** | 4 hours for the 3D model, 50 minutes for the orthomosaic |
| **Data products** | 3D model and orthomosaic |
| **Analysis tools** | N/A |
| **Analysis outputs** | N/A |
| **Final outputs shared with stakeholders** | Raw datasets and 3D model of the temple were shared with the Changunarayan Municipality and Department of Archaeology |
| **Data sharing** | The 3D model was shared with the Skydio team to seek technical support. Data protection policy and an NDA were prepared. |