

METEOR: Ground Data Collection Using Protocols
Kathmandu, Nepal

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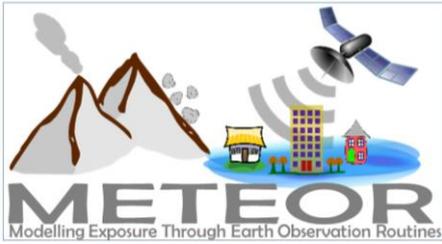


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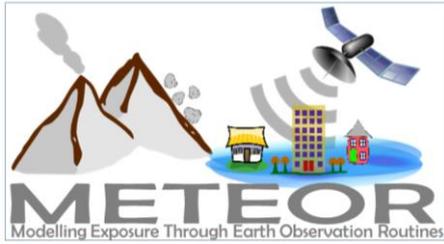


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Abbreviations

	Full Text	Description
BGS	British Geological Survey	An organisation providing expert advice in all areas of geoscience to the UK government and internationally
DE	Data Entry	
DMD	Disaster Management Department	Prime Minister's Office of Tanzania focused on disaster risk
DRM	Disaster Risk Management	
DRR	Disaster Risk Reduction	
EO	Earth Observation	
FATHOM		Provides innovative flood modelling and analytics, based on extensive flood risk research
GED4ALL	Global Exposure Database for All	An open global database for hosting exposure information for multiple-hazard impact assessment
GEM	Global Earthquake Model	Non-profit organisation focused on the pursuit of earthquake resilience worldwide
GFDRR	Global Facility for Disaster Reduction and Recovery	
GPS	Global Positioning System	
HOT	Humanitarian OpenStreetMap Team	A global non-profit organisation the uses collaborative technology to create OSM maps for areas affected by disasters
InaSAFE		Free open software that produces realistic natural hazard impact scenarios for better planning, preparedness and response activities



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ImageCat		International risk management innovation company supporting the global risk and catastrophe management needs of the insurance industry, governments and NGOs
IPP	International Partnership Programme	
JOSM	Java OpenStreetMap	Free Java software desktop editing tool for OSM data
KLL	Kathmandu Living Labs	
M	Milestone	Related to work package deliverables
Mapathon		Coordinated mapping event where individuals learn about OSM, and make edits to the map through remote digitising of satellite imagery
Maps.me		Free and open source mobile navigation application
METEOR	Modelling Exposure Through Earth Observation Routines	
NGO	Non Government Organisation	
NSET	National Society for Earthquake Technology	Non-governmental organisation working on reducing earthquake risk in Nepal and abroad
ODA	Official Development Assistance	
ODbL	Open Database License	
ODK	OpenDataKit	Mobile application questionnaire form for collecting data
OMK	OpenMapKit	Mobile application that works with ODK to collect data in OSM
OPM	Oxford Policy Management	Organisation focused on sustainable project design and implementation for reducing social and economic disadvantage in low-income countries



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OSM	OpenStreetMap	A collaborative project to create a free and open editable map database of the world
OSMCha	OpenStreetMap Changeset Analyzer	
OSMF	OpenStreetMap Foundation	
Osmose	OpenStreetMap Oversight Search Engine	
PDC	Pacific Disaster Center	
POSM	Portable OSM	
QA	Quality Assurance Specialist	
QGIS		Free open source desktop geographic information system
Ramani Huria		A community mapping project based in Dar Es Salaam, Tanzania
SDGs	Sustainable Development Goals	
TS	Team Supervisor	
UAV	Unmanned Aerial Vehicle	
UKSA	United Kingdom Space Agency	
WASH	Water, Sanitation and Hygiene	
WP	Work Package	
YAML		Human-readable data-serialisation language commonly used for configuration files



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1. METEOR Project Introduction

1.1. Project Summary

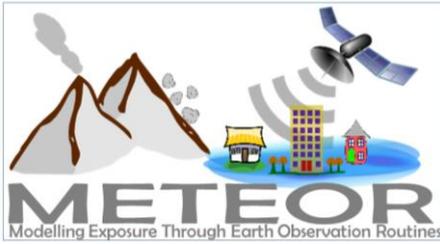
Project Title	Modelling Exposure Through Earth Observation Routines (METEOR): EO-based Exposure, Nepal and Tanzania
Starting Date	08/02/2018
Duration	36 months
Partners	UK Partners: The British Geological Survey (BGS) (Lead), Oxford Policy Management Limited (OPM), SSBN Limited International Partners: The Disaster Management Department, Office of the Prime Minister – Tanzania (DMD), The Global Earthquake Model (GEM) Foundation, The Humanitarian OpenStreetMap Team (HOT), ImageCat, National Society for Earthquake Technology (NSET) – Nepal
Target Countries	Nepal and Tanzania for “level 2” results and all 47 Least Developed ODA countries for “level 1” data
IPP Project	IPPC2_07_BGS_METEOR

Table 1: METEOR Project Summary

1.2. Project Overview

At present, there is a poor understanding of population exposure in some Official Development Assistance (ODA) countries, which causes major challenges when making Disaster Risk Management decisions. Modelling Exposure Through Earth Observation Routines (METEOR) takes a step-change in the application of Earth Observation exposure data by developing and delivering more accurate levels of population exposure to natural hazards. Providing new consistent data to governments, town planners and insurance providers will promote welfare and economic development in these countries and better enable them to respond to the hazards when they do occur.

METEOR is funded through the second iteration of the UK Space Agency’s (UKSA) International Partnership Programme (IPP), which uses space expertise to deliver innovative solutions to real world problems across the globe. The funding helps to build sustainable development while building effective partnerships that can lead to growth opportunities for British companies.



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1.3. Project Objectives

METEOR aims to formulate an innovative methodology of creating exposure data through the use of EO-based imagery to identify development patterns throughout a country. Stratified sampling technique harnessing traditional land use interpretation methods modified to characterise building patterns can be combined with EO and in-field building characteristics to capture the distribution of building types. These protocols and standards will be developed for broad application to ODA countries and will be tested and validated for both Nepal and Tanzania to assure they are fit-for-purpose.

Detailed building data collected on the ground for the cities of Kathmandu (Nepal) and Dar es Salaam (Tanzania) will be used to compare and validate the EO generated exposure datasets. Objectives of the project look to: deliver exposure data for 47 of the least developed ODA countries, including Nepal and Tanzania; create hazard footprints for the specific countries; create open protocol; to develop critical exposure information from EO data; and capacity-building of local decision makers to apply data and assess hazard exposure. The eight work packages (WP) that make up the METEOR project are outlined below in section 1.4.

1.4. Work Packages

Outlined below are the eight work packages that make up the METEOR project. These are led by various partners with a brief description of what each of the work packages cover. HOT is leading WP.4 Inputs and Validation, which focuses on the collection of exposure data in Kathmandu in Nepal and Dar es Salaam in Tanzania (Table 2). This data will assist with the validation and calibration of national exposure datasets created through the classification of building patterns from satellite imagery carried out by ImageCat in WP.3.

Table 2: Overview of METEOR Work Packages

Work Package	Title	Lead	Overview
WP.1	Project Management	BGS	Project management, meetings with UKSA, quarterly reporting and the provision of feedback on project deliverables and direction across primary stakeholders.
WP.2	Monitoring and Evaluation	OPM	Monitoring and evaluation of the project and its impact, using a theory of change approach to assess whether the associated activities are leading to the desired outcome.
WP.3	EO Data for Exposure Development	ImageCat	EO-based data for exposure development, methods and protocols of segmenting/classifying building patterns for stratified sampling of building characteristics.



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WP.4	Inputs and Validation	HOT	Collect exposure data in Kathmandu and Dar es Salaam to help validate and calibrate the data derived from the classification of building patterns from EO-based imagery.
WP.5	Vulnerability and Uncertainty	GEM	Investigate how assumptions, limitations, scale and accuracy of exposure data, as well as decisions in data development process lead to modelled uncertainty.
WP.6	Multiple Hazard Impact	BGS	Multiple hazard impacts on exposure and how they may be addressed in disaster risk management by a range of stakeholders.
WP.7	Knowledge Sharing	GEM	Disseminate to the wider space and development sectors through dedicated web-portals and use of the Challenge Fund open databases.
WP.8	Sustainability and Capacity-Building	ImageCat	Sustainability and capacity-building, with the launch of the databases for Nepal and Tanzania while working with in-country experts.

1.5. In-Situ Inputs and Validation

The project WP led by HOT is broken down into six deliverables, which are focused on the mapping of exposure data for the cities of Kathmandu and Dar es Salaam in OpenStreetMap (OSM). These involve importing existing data into OSM, the remote mapping of building footprints and road networks, drafting protocols for crowdsourcing exposure data, collecting detailed attribute information on the ground and producing a final report (Table 3).

Table 3: Overview of HOT Deliverables

Deliverable	Title	Overview
M4.1	Import Existing Data into OSM	Review and assess the suitability of existing open datasets for import into OSM for Kathmandu and Dar es Salaam.
M4.2	EO Mapping of Exposure Data	Remote mapping of building footprints and road networks in OSM for Kathmandu and Dar es Salaam.
M4.3	Protocols for Crowdsourcing Exposure Data	Draft protocols for the crowdsourcing of exposure data in OSM, covering data imports, remote mapping and ground data collection.
M4.4	Ground Data Collection using Protocols I	Collect exposure data on the ground for Kathmandu using a data model developed in line with the requirements for



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		WP.3
M4.5	Ground Data Collection using Protocols II	Collect exposure data on the ground for Dar es Salaam using a data model developed in line with the requirements for WP.3
M4.6	Final Report	Deliver a final version of M4.3 along with the resulting data from Deliverables M4.4 and M4.5.

2. OpenStreetMap

2.1. What Is It?

OSM is a crowdsourced geospatial database of the world built largely by volunteers and professionals digitising aerial imagery, collecting attribute information on the ground and liberating existing public sources of geospatial data. Known as the 'Wikipedia' of maps, the data is freely accessible to all under the Open Database License (ODbL)¹, meaning that it can be queried, used, manipulated, contributed to and redistributed in any form. OSM is the ideal database for humanitarian efforts and disaster management, as it is a great source of geographic baseline data for many cities around the globe, especially in countries with emerging economies that are not always on the map.

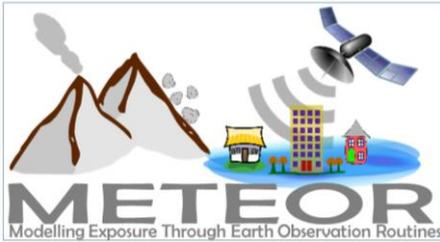
2.2. Open Data

The ODbL license is a copyleft ("share alike") agreement intended to allow users to freely share, modify, and use a database while maintaining this same freedom for others. Published by Open Data Commons, part of the Open Knowledge Foundation², the ODbL license enables OSM to be a source of powerful geospatial data to make change, particularly in ODA countries where a potential lack of internal funds and skill sets make it difficult to create up-to-date exposure data themselves. Such data is necessary to conduct hazard impact risk assessments and carry out informed appropriate disaster management decisions. One project may focus on creating data in OSM for a specific purpose, but this data can then be used by anyone for their area of interest. This freedom of use is outlined on the ODbL website³.

¹ <https://opendatacommons.org/licenses/odbl/>

² <https://okfn.org/>

³ <https://opendatacommons.org/licenses/odbl/summary/index.html>



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You are free:

- ❖ To Share: To copy, distribute and use the database
- ❖ To Create: To produce works from the database
- ❖ To Adapt: To modify, transform and build upon the database

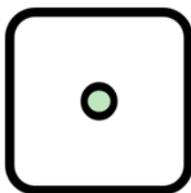
As long as you:

- ❖ Attribute: You must attribute any public use of the database, or works produced from the database, in the manner specified in the ODbL. For any use or redistribution of the database, or works produced from it, you must make clear to others the license of the database and keep intact any notices on the original database
- ❖ Share-Alike: If you publicly use any adapted version of this database, or works produced from an adapted database, you must also offer that adapted database under the ODbL
- ❖ Keep open: If you redistribute the database, or an adapted version of it, then you may use technological measures that restrict the work (such as DRM) as long as you also redistribute a version without such measures

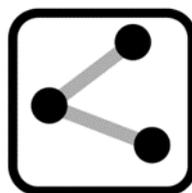
2.3. Data Structure

Geospatial data is stored in OSM as vectors, with three types of elements:

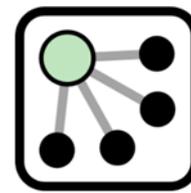
1. **Nodes**, which represent a point on the surface of the earth
2. **Ways**, which are sets of ordered nodes that can form lines or polygons
3. **Relations**, which are sets of nodes, ways and/or relations as members that are used to define logical or geographic relationships between other elements



Nodes



Ways



Relations

Each of these elements can have any number of `key=value` tags, that represents the attribute information for a given feature. For example, a post office may be represented with the tags `building=yes` and `amenity=post_office`, to help identify the purpose of the building.



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2.4. Why use it?

The most common question people ask is: Why would you use OpenStreetMap if there is Google Maps?⁴ These platforms have many similarities and address the same basic human of spatially knowing where things are. In short, OSM represents an open approach to how data is collected and distributed, which makes it fast, free, flexible and widespread; an ideal combination for development application among others.

In the case of Haiti, the OSM community needed just a few hours to remotely digitise earthquake affected areas from satellite imagery, in contrast to commercial maps that had no way of responding in such a short period. The thousands of active volunteers around the globe are what made this possible, and the fact that every update is immediately visible to all other users, and is also version controlled. In many cases, the OSM community has been able to achieve even higher detail than any other map source.

The very idea behind OSM was to solve the problem of data restriction by using a Wikipedia model. Each edit made in OSM is owned by the community, whereas each change made in commercial map is owned by the providers. Data in commercial maps is copyrighted and so it can be subject to licensing fees and contractual restrictions. OSM is, and always will be, available for free. This open access to geospatial data makes it easy for researchers, governments, disaster management agencies and policy implementers to work collectively from the same database.

OSM is also ready for any kind of operation. Many major organisations are choosing OSM for their maps because it allows for customisation based on need. It has been used to collect functioning and non-functioning water facilities in northern Uganda, to mapping hundreds of thousands of shelters in Bangladesh, to planning logistics for a Yellow Fever campaign in the Democratic Republic of Congo and mapping the exposure information of infrastructure for hazard impact. It allows access to all of the map offline and can be formatted in local languages, transcending national boundaries.

Most importantly, OSM emphasises local knowledge across the globe. The barrier to entry is low, and there are many ways to contribute that do not require access to the latest technology. The result is a map made by local experts. OSM provides global map data in a unified tagging schema, although there are some local variations, this allows for consistency from country to country, for a truly global map.

⁴ <https://welcome.openstreetmap.org/>



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3. Participatory Mapping

Participatory mapping is a phrase commonly used in the OSM community, which refers to the creation of maps by local communities. The maps are visual representations of what a community perceives as its environment and the significant features within it. Participatory mapping is based on the premise that local communities possess expert knowledge of their surroundings.

Often this process is supported by organisations, with a target goal and funds to assist with the research and direction, depending on the purpose of the data creation. The emphasis, however, is always on providing skills for the community to create the maps themselves in order to represent the spatial knowledge of local citizens. Participatory mapping, which is interchangeable with the term crowd-sourcing, is at the core of HOT as we believe that local teams are the experts needed to create the necessary data in OSM.

Participatory mapping relates to fostering a collaborative approach. The primary ingredient in the success of an open mapping project is the cultivation and care of a strong network of partners across the range of communities and institutions that have a stake in the project. These partnerships are critical for the implementation, uptake, and sustainability of open mapping projects. They can lead to shared investment of resources and technical expertise, innovative use cases for open data, increased legitimacy for the project, and stability over time. Because the open mapping ecosystem is a global phenomenon, it is likely that at the start of any project, there will be a pre-existing group of individuals and organisations already mapping in the target area. With proper outreach and engagement, these groups can be a powerful resource. Including them early in the planning and design phases of a project will help increase their sense of ownership and improve the likelihood of successful collaboration.

Government agencies responsible for areas as diverse as national statistics, urban planning, transportation, public health, environment and natural resource management, and disaster response have all benefited from working with open mapping and can bring valuable resources, expertise, and authority to a mapping project. The OSM community is active globally and will, in many cases have a local presence with experience mapping in the area, technical knowledge about mapping, and a group of passionate volunteers who may be willing to participate.

As is the case for crowd-sourcing the regional exposure data in the cities of Kathmandu (Nepal) and Dar es Salaam (Tanzania) for the METEOR project. Kathmandu Living Labs (KLL) is a local company who has been involved with the OSM community for years, having worked on numerous projects with the Nepalese government. While Ramani Huria is a community-based mapping initiative that began in Dar es Salaam training university students and local community members to create OSM maps of the most flood-prone areas of the city, in an effort to help combat the impact.



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4. Ground Data Collection

The data collection in the city of Kathmandu was carried out by KLL following the outlined protocols in Deliverable 4.3: Protocols for Crowd-Sourcing Regional Exposure Data. The protocols focus on the addition of detailed attribute information of buildings observed from the ground to building footprints that were remotely digitised in OSM using aerial imagery. The methodology applied by KLL for the ground data collection is briefly outlined below and expanded through the following sections.

Table 4: Outline of KLL Ground Data Collection

No.	Step	Description	Date
1	Data Model	Development of localised data model for Kathmandu	November 2018
2	Mapping Team	Recruitment of a local mapping team	December 2018
3	Area of Interest	Generation of randomised sampling points per homogenous zone	December 2018
4	Survey Authorisation	Authorisation from district officials to survey areas of interest	December 2018
5	Tool Preparation	Preparation of data collection tools	January 2019
6	Team Training	Training with local structural engineers and use of data collection tools	January 2019
7	Data Management	Data management setup through dedicated online server	January 2019
8	Ground Survey	Collection of identified building attributes	February 2019
9	Data Validation and Quality	Data validation, spot checks and quality assurance	February 2019
10	Upload Data	Upload final data to OSM	March 2019

The first step of any ground data collection is to create a data model, which was localised for the context of Kathmandu with the assistance of local structural engineers who provided insight on types of commonly found building within the city. Once the data model was finalised, the mapping team was put together and the data collection tools prepared along with the creation of customised questionnaire forms following the localised data model. During this time, the team leaders



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determined the area of interest for collecting data through the generation of random sampling points within each of the homogenous development zones, as well as ensuring access with the appropriate authorities.

Training for the team on how to use the surveying tools to capture the data on the ground was then carried out, along with the establishment of a data management system where the completed questionnaires could be organised, hosted and backed through an online server. The data collection commenced on the ground once everything was in order, which was then followed by a series of data validation rounds, as well as random spot checks by team leaders. A final round of data validation and assessment of the data quality assurance was conducted before uploading the information to OSM.

In total, the various steps involved with the ground data collection in Kathmandu took around 5 months, with the development of the data model starting in November 2018, and the ground surveying taking place from 1st January to 1st March 2019. The final phase of the project, which focuses on data validation, spot checking, and uploading the final data to OSM took place from 15th February to 15th March 2019.

4.1. Data Model

The data model used for the collection of exposure information in Kathmandu was derived from the Global Exposure Database for All (GED4ALL) data model, which was initially conceived through the second round of the GFDRR Challenge Fund⁵. The Challenge Fund aims to decrease disaster risk management costs and increase resilience by developing frameworks that facilitates a multi-hazard view of risk, taking into account the effects of volcanoes, floods, tsunamis, storms and cyclones on the structural integrity of buildings. HOT, in collaboration with the Global Earthquake Model (GEM) and ImageCat, assisted with the integration of OSM data into GED4ALL at the building level, by aligning the appropriate data tags in OSM to the identified taxonomy attributes⁶.

Two versions of the GED4ALL data model were created, a core data model containing an exhaustive list of structural building features that can be impacted by the hazards listed above and a simplified version. The simplified version is based on the most common, relevant and easy to define features of buildings, which were selected to help reduce the comprehensive multi-hazard risk assessment taxonomy for less experienced surveyors. This is the version that was adapted and used for the METEOR project. Data collection efforts are much more effective when the attributes required are kept to a minimum, where possible. This allows the surveyors to focus on the quality rather than the quantity of information. Table 5 below outlines the simplified version of the GED4ALL building taxonomy OSM data model.

⁵ <https://www.gfdr.org/en/challenge-fund>

⁶ <https://wiki.openstreetmap.org/wiki/GED4ALL>



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Table 5: GED4ALL Simplified Building Taxonomy

SIMPLIFIED GED4ALL BUILDING TAXONOMY			
No.	GED4ALL	OSM Key	OSM Description and Values
1	Material of the Lateral Load Resisting System	building:lateral:material=*	Proposed lateral load resisting material tag (concrete_reinforced, concrete, concrete_steel, metal, masonry_reinforced, masonry, masonry_confined, earth, earth_reinforced, wood, other, unknown)
2	Lateral Load Resisting System	building:lateral:system=*	Identify structural system of buildings (moment_frame, infilled_frame, braced_frame, post_beam, wall, dual_framewall, flat_slab, waffle_slab ,infill_flatslab, infill_waffleslab, hybrid, unknown)
3	Height	building:levels=*	Number of above-ground levels of a building
		building:levels:underground=*	Proposed tag for number of below-ground levels of a building
		building:slope=*	Proposed tag for describing the slope of the building in degrees
4	Date of Construction or Retrofit	building:age=*	Proposed age tag, associated with buildings (pre_2000, post_2000, unknown)
		building:condition=*	Describe the condition of the building (good, average, poor, unknown)
5	Occupancy	building=*	Describe the building purpose (residential, commercial, public, mixed_use, industrial, agriculture, assembly, government, educational, unknown)
		capacity:persons=*	Describe the number of people a building can support
6	Ground Floor Hydrodynamics	ground_floor:openings=*	Proposed openings tag, associated with building ground floors (yes, no, unknown)
		ground_floor:height=*	Proposed height tag in meters, associated with building ground floors



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7	Roof	roof:shape=*	Well known roof shapes (flat, pitched, monopitch, sawtooth, curved, complex_regular, complex_irregular, unknown)
		roof:material=*	Outer material for the building roof (masonry, earth, concrete, metal, wood, fabric, slate, stone, clay, unknown)

As the GED4ALL building taxonomy is designed to be used around the globe, the OSM values in the simplified table are merely guidelines to commonly used entries for the identified attributes. These values were localised for Kathmandu, with the support of civil engineer experts from Resilient Structures Private Limited and Engineering Mantra Consultant and Associates Pvt. Ltd. Their input on structural aspects, such as commonly used building materials and lateral load resisting systems within Kathmandu Valley were incorporated into the METEOR data model, while those generally not found within the area were removed. The final localised data model used for the ground data collection in Kathmandu can be seen in Table 6 below.

Table 6: Kathmandu Localised Building Taxonomy

KATHMANDU BUILDING TAXONOMY			
No.	Attribute	OSM Key	OSM Description and Values
1	Material of the Lateral Load Resisting System	building:lateral:material=*	Proposed lateral load resisting material tag (concrete_reinforced, steel, steel-concrete_composite, brick, stone, adobe, timber/wood, bamboo, light_gauge_steel/cold_formed_steel, others)
2	Lateral Load Resisting System	building:lateral:system=*	Identify structural system of buildings (moment_resisting_frame, shear_wall, braced_frame, dual_frame_wall_system, masonry_wall, confined_masonry, hybrid, others)
3	Height	building:levels=*	Number of above-ground levels of a building
		building:levels:underground=*	Number of under-ground levels of a building
4	Date of Construction or Retrofit	building:age=*	Proposed age tag, associated with buildings (pre_2000, post_2000, unknown)
		building:condition=*	Describe the condition of the building (good, average, poor, unknown)



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5	Occupancy	building=*	Describe the building purpose (residential, commercial, public, mixed_use, industrial, agriculture, assembly, government, educational, health, unknown)
		capacity:persons=*	Describe the number of people a building can support
6	Roof	roof:shape=*	Well known roof shapes (flat, pitched, monopitch, double_pitch, sawtooth, curved, complex_regular, complex_irregular, unknown)
		roof:material=*	Outer material for the building roof (cgi, bamboo, thatch, mixed, masonry, earth, concrete, metal, wood, fabric, slate, stone, clay, unknown)
7	Neighbouring Condition	building:adjacency=*	Describe the neighbouring condition of the building (attached, free_standing)
8	Geological Site Condition	building:geological_site=*	Describe the geological site the building is built upon (flat_land, river_bank, slopy_land, landslide_prono)

4.2. Mapping Team

Once the data model was finalised, a team to conduct the data collection on the ground was put together. The structure of the team greatly influences the management, efficiency, quality and overall success of surveying on the ground, especially when working with large amounts of information. A tiered team structure ensures that the data collection can be carried out systematically, so that the line of responsibility and guidance is clear. As data collection is crowdsourced through OSM and focuses on the structural engineering of buildings, the surveying team for Kathmandu was composed of OSM community members, geomatics specialists and local engineers. This allowed for a range of specialised expertise combined with the local knowledge of residents from Kathmandu.

Recruitment of the team began in December 2018, which focused on the inclusion of recently graduated civil engineers with a sound understanding of building structures from the Himalaya College of Engineering⁷, Kathmandu Engineering College⁸, Universal Engineering and Science College⁹, Kantipur International College¹⁰, Aryan School of Engineering¹¹ and Sagarmatha Engineering College¹². The experience of a local engineering consultancy firm, Engineering Mantra, was enlisted by KLL to

⁷ <https://www.hcoe.edu.np/>

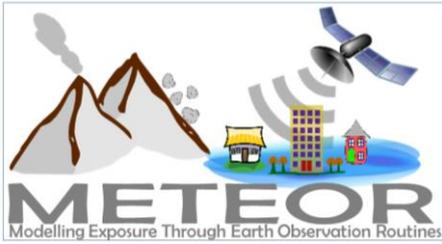
⁸ <https://keckist.edu.np/s>

⁹ <http://uesc.edu.np/>

¹⁰ <http://www.kantipurinternational.edu.np/>

¹¹ <http://www.thearyanschool.edu.np/>

¹² <http://www.sagarmatha.edu.np/>



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help select the ideal candidates from the recent graduates. Group interviews were conducted on 13th and 14th January 2019, with a total of 12 individuals chosen to be part of the mapping team (Figure 1). The team put together by KLL for the ground mapping consisted of a project manager, 2 quality assurance specialists, 12 data entry specialists, 1 mobile app developer for technical support and 1 senior engineer to oversee the whole data collection process (Table 7).



Figure 1: Group Interview with Civil Engineer Graduates

The team project manager was in charge of planning the whole mapping approach, from developing the workflow, setting up the tools, hiring the team, conducting the training and strategically dividing up the city, while the senior engineer oversaw all the data. Once the work was delegated down the line, the quality assurance specialists could focus on ensuring that the data was being collected correctly and to a high standard, while providing feedback both down the line to the data entry specialists, as well as to the project manager and senior engineer for reporting purposes.



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Table 7: Mapping Team Structure

No.	Name	Team Position	Connected Institute
1	Gaurav Thapa	Project Manager	Kathmandu Living Labs
2	Manoj Thapa	Quality Assurance Specialist	Kathmandu Living Labs
3	Roshan Paudel	Quality Assurance Specialist	Kathmandu Living Labs
4	Bhawak Pokhrel	Mobile App Developer	Kathmandu Living Labs
5	Sanjay Pandey	Senior Engineer	Kathmandu Living Labs
6	Aniket Rauniyar	Data Entry Specialist	Himalaya College of Engineering
7	Swagat Bhatta	Data Entry Specialist	Kantipur International College
8	Bipin Gc	Data Entry Specialist	Kathmandu Engineering College
9	Nabin Kadel	Data Entry Specialist	Universal Engineering and Science College
10	Rajesh Gyawali	Data Entry Specialist	Sagarmatha Engineering College
11	Sabrin Raj Gautam	Data Entry Specialist	Kathmandu Engineering College
12	Sameer Pandey	Data Entry Specialist	Himalaya College of Engineering
13	Santosh Kumar Mahato	Data Entry Specialist	Kantipur International College
14	Sishir Panthee	Data Entry Specialist	Kathmandu Engineering College
15	Sushant Parajuli	Data Entry Specialist	Aryan School of Engineering
16	Pradeep Kumar Rawal	Data Entry Specialist	Kathmandu Engineering College
17	Binod Rawal	Data Entry Specialist	Kathmandu Engineering College



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Figure 2: KLL Team Supervisors

Gaurav Thapa
Participatory Mapping Specialist

Gaurav Thapa currently is the Project Manager of Secondary Cities Pokhara, a field-based initiative of the Office of the Geographer of the State Department to map for resiliency, disaster management and emergency preparedness. He completed his Honours Bachelor of Arts degree from University of Toronto, Canada and his Master's of Applied Geography from New Mexico State University, USA where he was recognized as the Outstanding Graduate Student of the University for his academic and community work related to geography.

Gaurav leads a young team that is pioneering the use of OpenStreetMap (OSM) tools in the developing world. His current work has led him to help establish OSM communities in Neelkantha Municipality, Lalitpur Metropolitan, Nepalgunj Sub-metropolitan, Gulariya

Manoj Thapa
Data

Manoj brings Management Science perspective and several years of working experience to make sure that everyone at KLL gets whatever they need in order to achieve their goals. Also as the first choice goalkeeper of the KLL Futsal team, he keeps the opponents from scoring their goals during the matches.

Manoj was introduced to OpenStreetMap in August, 2012. Overcoming the fear of OSM jargons in the initial working days, Manoj has cleared his way to becoming a veteran mapper.

Manoj has already earned the title of OSM Guru according to OSM linifiniti.



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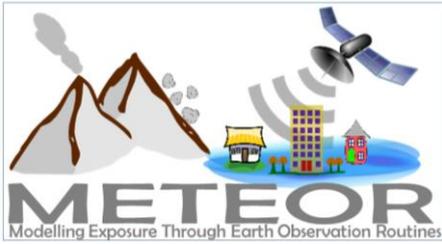
Roshan Paudel

GIS Analysis

Roshan is a Geomatics Engineer interested in the field of open data and open source software. In June of 2016, Roshan started working for KLL as an intern. After completing his bachelor's degree he joined KLL as its GIS Officer in December of 2016. He is an OSM volunteer and trainer who has introduced the concept of open mapping to hundreds of students of western Nepal.

His academic interests remain mapping using modern technologies such as Remote Sensing, Geographic Information System (GIS) and Photo Mapping. Roshan is interested in creating maps that accurately reflect the conditions and problems of the society in the simplest and easiest format. He strongly believes that maps like these will change the society for the better!





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4.3. Area of Interest

Dividing up and delegating target areas to the mapping team also plays a large role in successfully collecting data on the ground. How the area is split up is dependent on the type of mapping initiative, whether it is looking at the city or town as a whole, or whether it is isolated sections. For the METEOR project, Kathmandu was divided into homogenous development type zones making the area of interest a targeted portion of the city.

These areas were classified into homogenous zones by ImageCat, based on structural development patterns identified remotely. There were 8 zone types identified in Kathmandu, which include dense residential, high urban, industrial, informal, new industrial, residential, urban and rural. The rural development pattern was ignored for the purposes of this project as the area of interest was within the city of Kathmandu, which left 7 homogeneous zones where buildings would be surveyed (Figure 3 and Table 8).

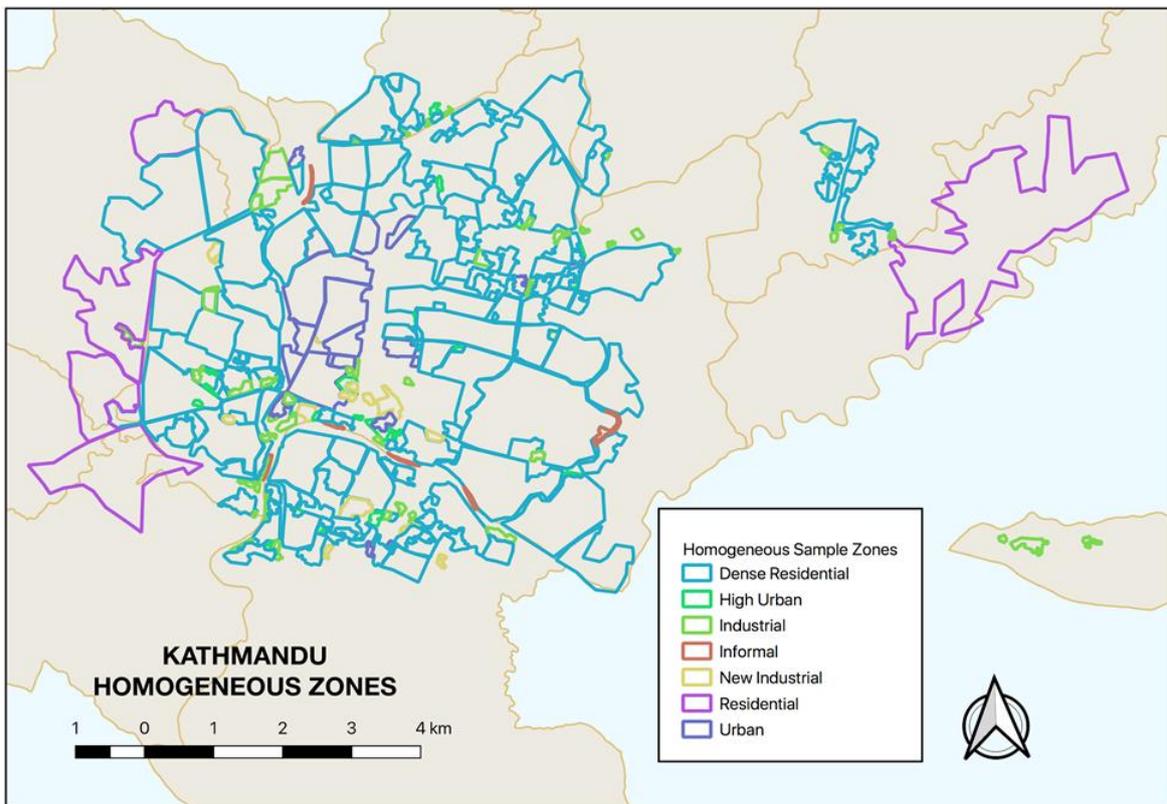


Figure 3: Kathmandu Homogeneous Zones



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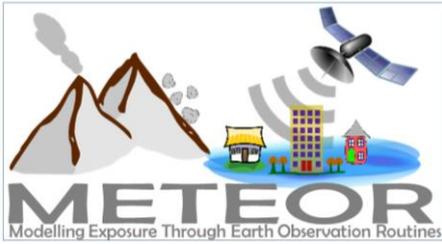
Table 8: Kathmandu Homogeneous Zones

No.	Homogenous Zone Type	No. Zones Identified
1	Dense Residential	143
2	High Urban	23
3	Industrial	51
4	Informal	7
5	New Industrial	13
6	Residential	5
7	Urban	19
	Total	261

ImageCat requested that a randomised sampling strategy be applied to the homogenous zone types, so that there are 40 randomised points per development type, with 10 buildings surveyed around each of the points. These sampling points were used as coordinates on the ground, from which the mappers randomly selected 10 buildings to survey and collect data for, following the project data model. As there are 7 homogenous zone types in Kathmandu, ideally a total of 2,800 buildings were to be surveyed keeping the error margin at 5%.

The randomised points were selected from a shapefile created by ImageCat containing 53,000 randomised points, which were then clipped to each development type, sorted based on their ID number and then using the top 44 points. The extra 4 points per development pattern were included as a backup, in case it was not possible to map around the first 40. However, during the clipping process it was only possible to select 20 sampling points for the new industrial homogeneous zone, due to the limited area actually covered by this type.

This means that roughly 2,600 buildings were to be surveyed in total. However, several of the sampling points fell within military and government complexes, where ground surveying is prohibited and in such cases, where possible alternative points were chosen. When it was not possible to select an alternative point, they were ignored. In the end, there was a total of 2,701 buildings surveyed around 284 sampling points across the 7 homogeneous zones (Figure 4 and Table 9).



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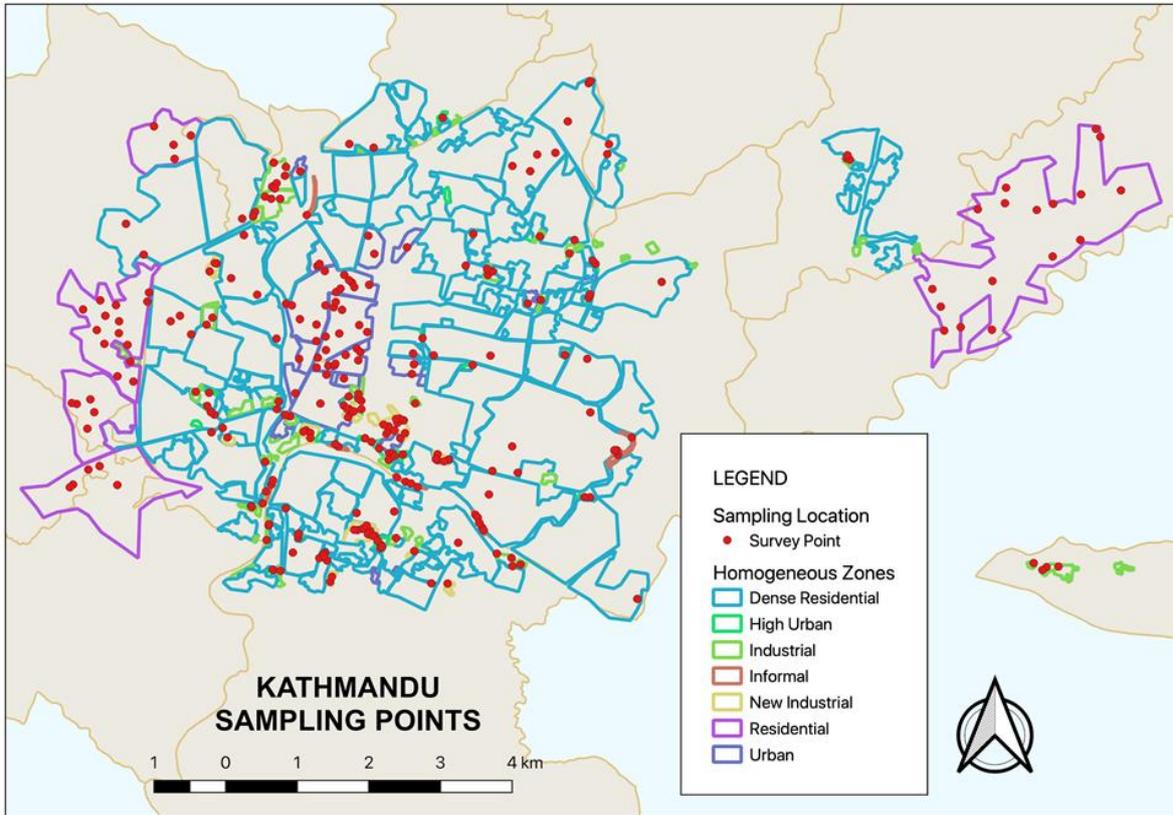
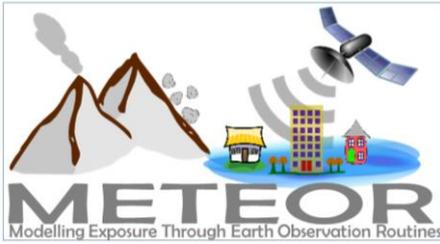


Figure 4: Kathmandu Sampling Points

Table 9: Kathmandu Surveyed Buildings

No.	Homogenous Zone Type	No. Sampling Points	No. Buildings Surveyed
1	Residential	44	450
2	Dense Residential	44	856
3	Urban	44	505
4	Industrial	20	370
5	Informal	44	60
6	High Urban	44	285
7	New Industrial	44	175
	Total	284	2,701



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4.4. Survey Authorisation

No official authorisation was required as the surveying team did not enter any private property or restricted areas, nor interview anyone. Therefore there was no formal request made by the teams to survey. Instead the mappers informed the local government of their intended activities in the area before carrying out the ground data collection. This was done at the ward level, and was accompanied by a letter of intention composed by KLL, Engineering Mantra, HOT and the local government (Figure 5).

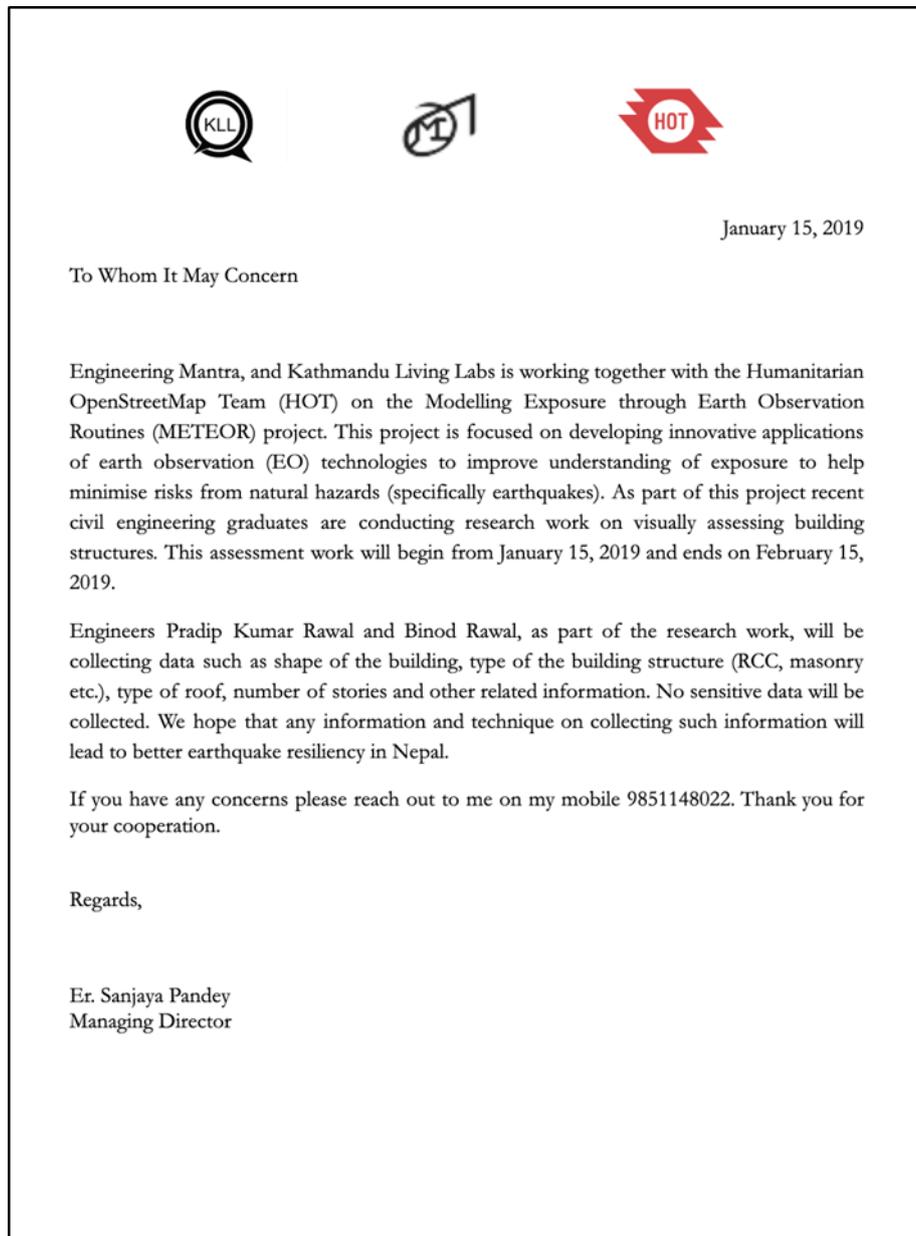


Figure 5: Surveying Letter of Intention



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The team was also very conscious of their behaviour and overall code of conduct, carrying out their data collection in a respectfully appropriate manner. For example, the surveyors did not enquire about the details of building attributes from individuals who did not independently volunteer to share this information.

4.5. Tool Preparation

Surveyors can choose from a number of free and open OSM tools that facilitate on-the-ground data collection in both online and offline settings. The tools used by the mapping team in Kathmandu included the mobile applications OpenDataKit (ODK), OpenMapKit (OMK) and Maps.me. ODK¹³ is an Android application that replaces paper forms used in survey based data gathering, allowing users to easily author, field, and manage mobile data collection solutions. It supports a wide range of question and answer types, which can be managed by a set of rules in order to help reduce the occurrence of errors during data collection. It is also designed to work well without network connectivity. Once forms have been downloaded, it does not depend on the internet again until the collected data needs to be uploaded to a server, or not at all if the data is transmitted directly to a desktop.

The biggest portion of preparing ODK for use, is the creation of the customised questionnaire that will be read by the tool and presented to the surveyors through their mobile application. The questionnaire was created by KLL with the use of a spreadsheet (Figure 6) and the localised OSM data model outlined in the previous section. Once the spreadsheet is complete, it can be converted into a form for consumption by ODK using XLSForm¹⁴ or by loading it onto OMK Server, which is detailed in the 4.7 Data Management section below.

¹³ <https://opendatakit.org>

¹⁴ <https://opendatakit.org/xlsform/>



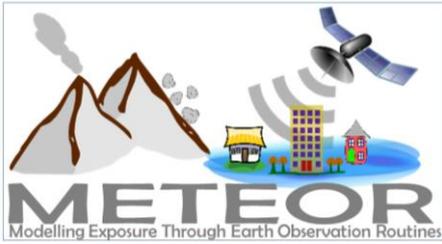
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Figure 6: OpenDataKit Spreadsheet

type	name	label	hint	required	required_n	appearance
start	start					
end	end					
today	today					
username	username					
phonenumber	phonenumber					
deviceId	deviceId					
note	title	MODELLING EXPOSURE THROUGH EARTH OBSERVATION ROUTINES: METEOR KATHMANDU				
osm_building_tags	osm_buildings	Building	Tag attributes about this building			
begin_group	building_photos					field-list
image	image_1	Building Image 1	Building must best fit the image viewport	TRUE		Please capture the building image
image	image_2	Building Image 2				
image	image_3	Building Image 3				
image	image_4	Building Image 4				
image	image_5	Building Image 5				
end_group						field-list
note	end_001	You have reached the end of this form.				

list name	name	label
building_tags	building:lateral:material	Lateral load resisting material
building_tags	building:lateral:system	Structural system of building
building_tags	building:levels	Number of above-ground levels of a building
building_tags	building:levels:underground	Number of below-ground levels of building
building_tags	building:age	Age of building
building_tags	building:condition	Describe the condition of the building
building_tags	building	Describe the building purpose
building_tags	capacity:persons	Describe the number of people a building can support
building_tags	roof:shape	Shape of roof
building_tags	roof:material	Outer material for the building roof
building_tags	building:adjacency	Neighbor condition
building_tags	building:geological_site	Geological/Site condition
building_tags	fixme	Description of a possible error in the map
building:lateral:material	concrete_reinforced	Concrete reinforced
building:lateral:material	steel	Steel
building:lateral:material	steel-concrete_composite	Steel-concrete composite
building:lateral:material	brick	Brick
building:lateral:material	stone	Stone
building:lateral:material	earth	Adobe (earth)
building:lateral:material	wood	Timber/Wood
building:lateral:material	bamboo	Bamboo
building:lateral:material	light_gauge_steel or cold_formed_s	Light Gauge Steel/Cold Formed Steel
building:lateral:system	moment_resisting_frame	Moment Resisting Frame
building:lateral:system	shear_wall	Shear Wall
building:lateral:system	braced_frame	Braced Frame



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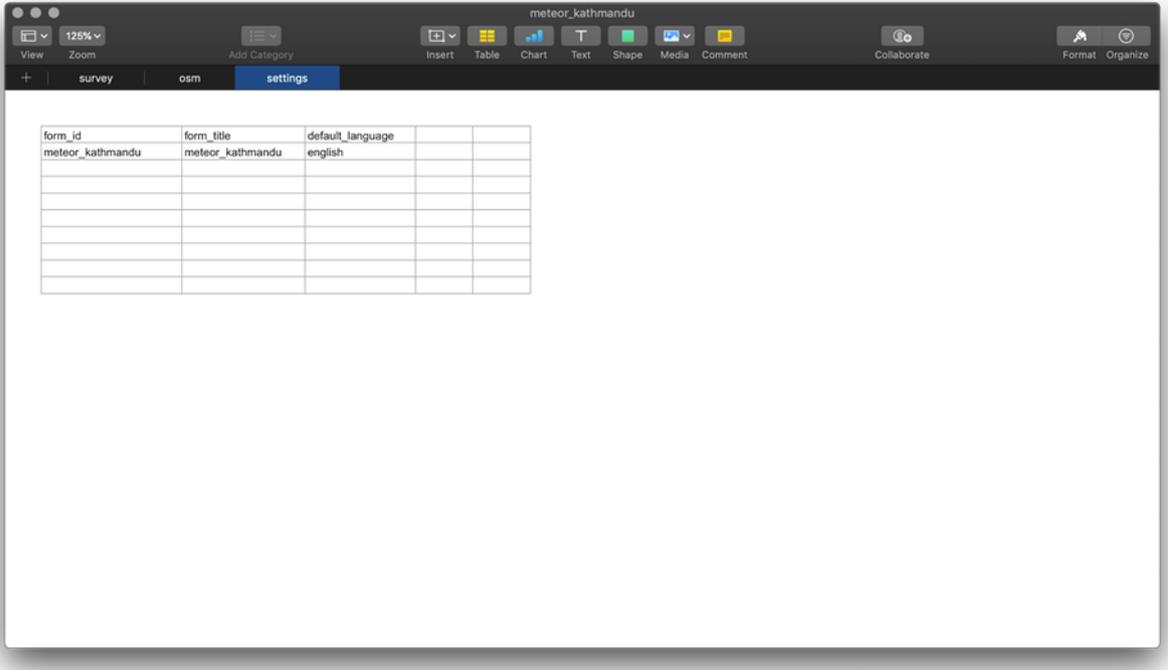
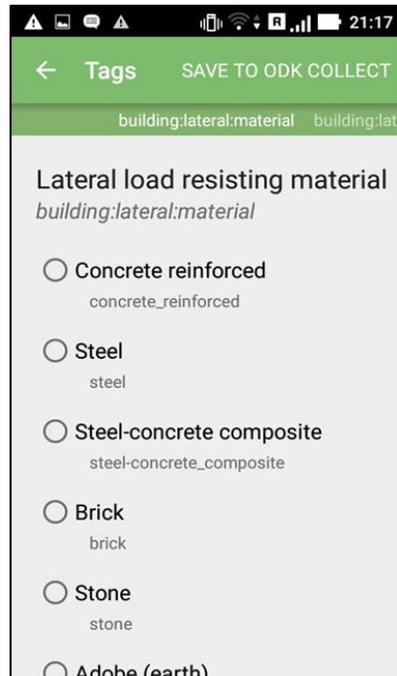
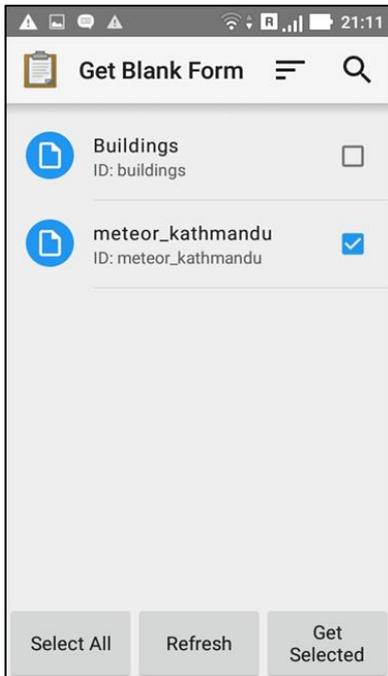
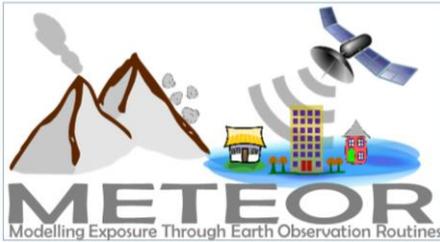


Figure 7: OpenDataKit Questionnaire





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OMK¹⁵ (OMK) is a free and an open source tool that is used to create professional quality mobile data collection surveys on the ground in OSM. OMK launches directly from ODK and allows users to add points of interests and attribute information in the form of tags for OSM, following the customised survey questionnaire. This allows detailed information to be securely collected, saved, and uploaded to the server of choice. OMK is an extension that launches directly from within ODK, when the OSM question type is enabled in a standard survey. It allows the user to browse OSM features, and to create and edit OSM tags. Therefore ODK must also be installed on the Android phone in order to use OMK to collect and edit data in OSM. Preparation for this tool included the creation of an OSM baselayer, containing the footprints of the buildings that were selected for surveying on the ground. This allows the mappers to easily identify and select a specific building geometry to add structural details. Other useful baselayers created by KLL for OMK included the boundaries of the homogenous zones identified across Kathmandu.

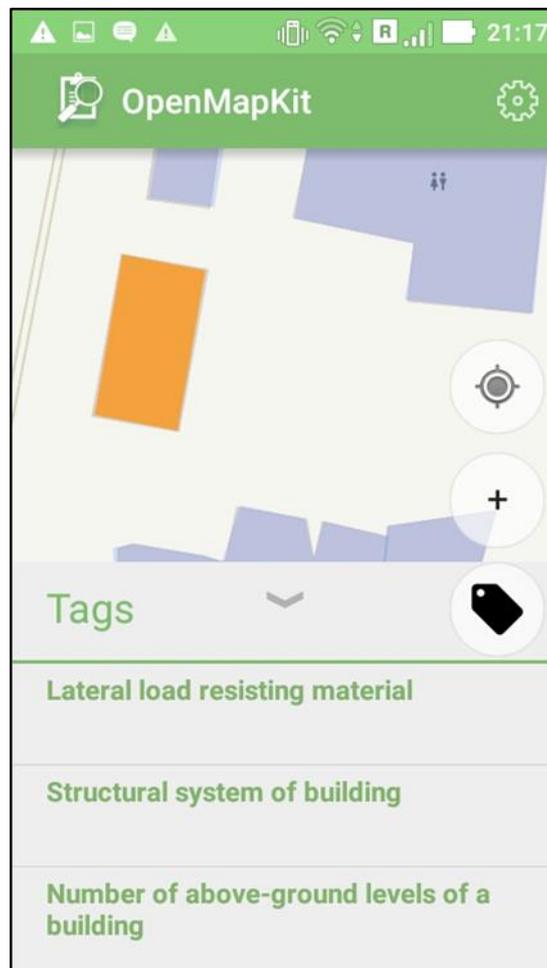
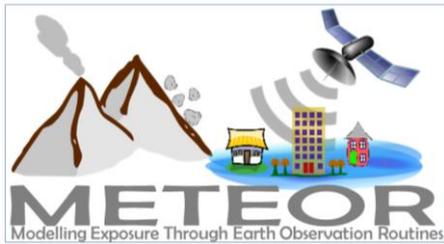


Figure 8: OpenMapKit Interface

¹⁵ <http://openmapkit.org>



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The surveyors used the navigation application Maps.me¹⁶ to help orientate themselves on the ground. Maps.me is a free and open source mobile application that can be used with both Android and iOS operating systems. Based on OSM data, the application provides offline maps, which is especially useful for navigating in areas with no network coverage. All that is needed is the GPS in the mobile device and the map data downloaded for the area of interest, prior to heading out on the ground for mapping. A bookmark layer containing the randomised sampling points was prepared for the surveyors prior to heading out on the ground (Figure 9). From each of these points, 10 buildings were surveyed ensuring that they did not overlap with the area of interest of another point.

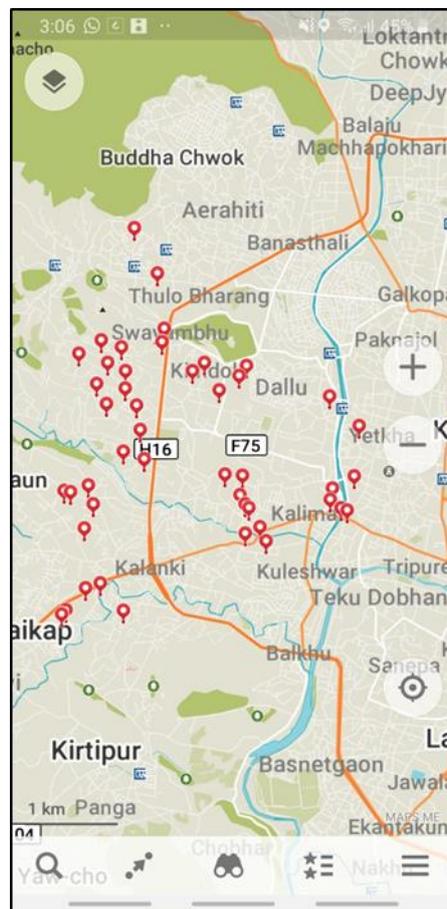


Figure 9: Randomised Sampling Points on Maps.Me

¹⁶ <https://maps.me/>



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4.6. Team Training

A two-day training session was conducted at the KLL office by two senior civil engineers from engineering firm Resilient Structures. Resilient Structures, is a pioneering firm of Nepal, that focuses on minimizing potential risk factors of buildings that exist in any severe hazardous events. Training the mapping teams took place on 16th and 17th January 2019 at the Kathmandu Living Labs office. The first day was dedicated to the structural engineering training, where two senior civil engineers from Resilient Structure lead the session and provided details on building structures, materials commonly used in Kathmandu and the challenges of visually inspecting buildings from the ground. The second day of training focused on the use of surveying equipment. This training covered the use of the ODK, OMK and Maps.me applications on the mobile phones of the surveyors. For this portion of the training, the surveyors were taken out to the field where they collected real world data on the ground to simulate the actual data collection process (Figure 10). The data that was collected during training, was then evaluated to provide feedback to the surveyors, as part of the learning process.



Figure 10: OpenMapKit Training in the Field



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4.7. Data Management

After surveying, the data needs to be retrieved from the devices. This can be done simply by manually copying the data directly from the mobile phone devices over to a computer, however, this does not scale well when there are large numbers of people collecting data. It also means the data is generally not backed up until the surveyors return to the office, and if the devices are lost, then all the collected data is also lost. KLL decided to use a data collection server as their central repository for managing the hosting of their questionnaire forms, deployments, collection and aggregation of responses.

KLL setup an online OpenMapKit (OMK) Server¹⁷ to help manage their data flow and backup their submissions (Figure 11). A surveyor can retrieve blank questionnaire forms directly from the server, and as long as there is internet connectivity, the completed questionnaires can be submitted back to the server from the field. The submitted data is then immediately backed up by the server, greatly reducing the chances of loss. In addition to the deployment of forms to ODK, overall data management and automatic backing up of submitted forms, OMK Server also provides the ability to view all the surveyed features on a map (Figure 12), as well as filter and export selected data.

meteor_kathmandu		Start	End	Username	Submission Time	Image	Download
Total submissions: 2754		Jan 17, 2019 10:08 PM	Jan 17, 2019 10:31 PM	nabin kadel	Jan 18, 2019 3:45 AM	Download image	OSM File
ODK Data OSM Data		Feb 1, 2019 1:38 AM	Feb 1, 2019 1:40 AM	Santosh kumar mahato	Feb 2, 2019 1:50 AM	Download image	OSM File
Manage		Jan 17, 2019 10:39 PM	Jan 17, 2019 10:44 PM	nabin kadel	Jan 18, 2019 3:45 AM	Download image	OSM File
From: YYYY-MM-DD To: YYYY-MM-DD		Jan 31, 2019 12:28 AM	Jan 31, 2019 12:36 AM	Sishir Panthee	Jan 31, 2019 5:27 AM	Download image	OSM File
Username: Choose an item...		Jan 18, 2019 1:22 AM	Jan 18, 2019 1:25 AM	Sishir Panthee	Jan 21, 2019 4:00 AM	Download image	OSM File
Filter Clear		Jan 25, 2019 1:50 AM	Jan 25, 2019 1:54 AM	Santosh kumar mahato	Jan 25, 2019 9:06 PM	Download image	OSM File
Page Size: 200 Page: 1		Jan 21, 2019 7:33 PM	Jan 21, 2019 7:36 PM	Sabrin Raj Gautam	Jan 21, 2019 9:46 PM	Download image	OSM File
Switch to Map view		Jan 19, 2019 9:27 PM	Jan 19, 2019 9:33 PM	Binod Rawal	Jan 21, 2019 4:04 AM	Download image	OSM File
		Feb 2, 2019 11:59 PM	Feb 3, 2019 12:09 AM	nabin kadel	Feb 6, 2019 1:55 AM	Download image	OSM File
		Feb 8, 2019 12:05 AM	Feb 8, 2019 12:07 AM	Binod Rawal	Feb 8, 2019 3:01 AM	Download image	OSM File
		Jan 30, 2019 12:20 AM	Jan 30, 2019 12:22 AM	Aniket Rauniyar	Feb 1, 2019 9:06 AM	Download image	OSM File
		Jan 26, 2019 12:52 AM	Jan 26, 2019 12:52 AM	Binod Rawal	Jan 26, 2019 5:04 AM	Download image	OSM File
		Feb 9, 2019 11:11 PM	Feb 9, 2019 11:14 PM	Sabrin Raj Gautam	Feb 10, 2019 10:58 PM	Download image	OSM File
		Jan 30, 2019 11:12 PM	Jan 30, 2019 11:14 PM	Sishir Panthee	Jan 31, 2019 5:24 AM	Download image	OSM File
		Jan 18, 2019 9:54 PM	Jan 18, 2019 9:57 PM	Santosh kumar mahato	Jan 20, 2019 8:38 PM	Download image	OSM File
		Feb 9, 2019 9:52 PM	Feb 9, 2019 9:59 PM	Sabrin Raj Gautam	Feb 10, 2019 10:56 PM	Download image	OSM File

Figure 11: OpenMapKit Server Table View

¹⁷ <https://github.com/hotosm/OpenMapKitServer>



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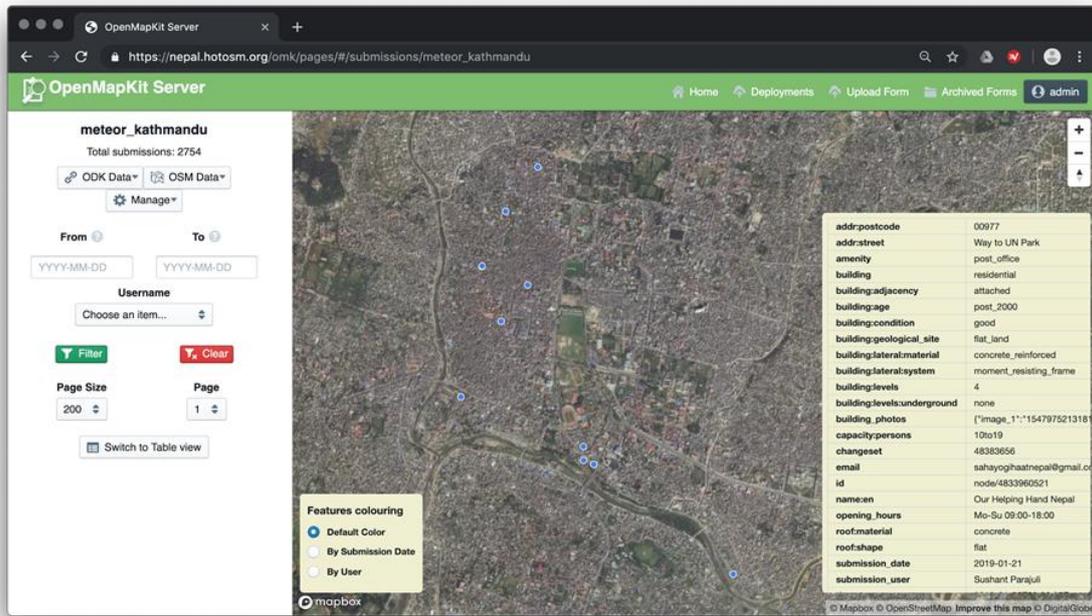


Figure 12: OpenMapKit Server Map View

4.8. Ground Surveying

Once the data management system was set up through OMK Server, a physical paper map allocating the sampling points was created to help organise the mapping teams as to which areas they would be surveying (Figure 13). A clustering method was applied to the allocation of sampling points to help make the mapping time on the ground as efficient as possible. Based on the spatial layout of the roads within the areas of interest, it made sense to group the sampling points into six clusters, containing 45-55 points each. Based on these clusters, six groups of two surveyors each was created. Groups that had longer travel times were assigned fewer points.

Physical maps of the surveying areas were printed and given to each group, to ensure that there were no overlapping areas and preventing the duplication of collected data in the field. The teams headed out into the field to commence their ground data collection with the paper maps, as well as the sampling points saved as a bookmark layer on the Maps.me mobile phone applications, which was used for offline navigation. Their OMK mobile applications would also contain a baselayer of the sampling points, as well as the OSM building footprints for their allocated area of interest, so that the surveyors could download the customised questionnaire form from OMK Server for a particular building, fill out the attribute information following the localised data model observed from the ground, and submit it back to the OMK Server once it was successfully completed (Figure 14).



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Figure 13: Printed Field Map

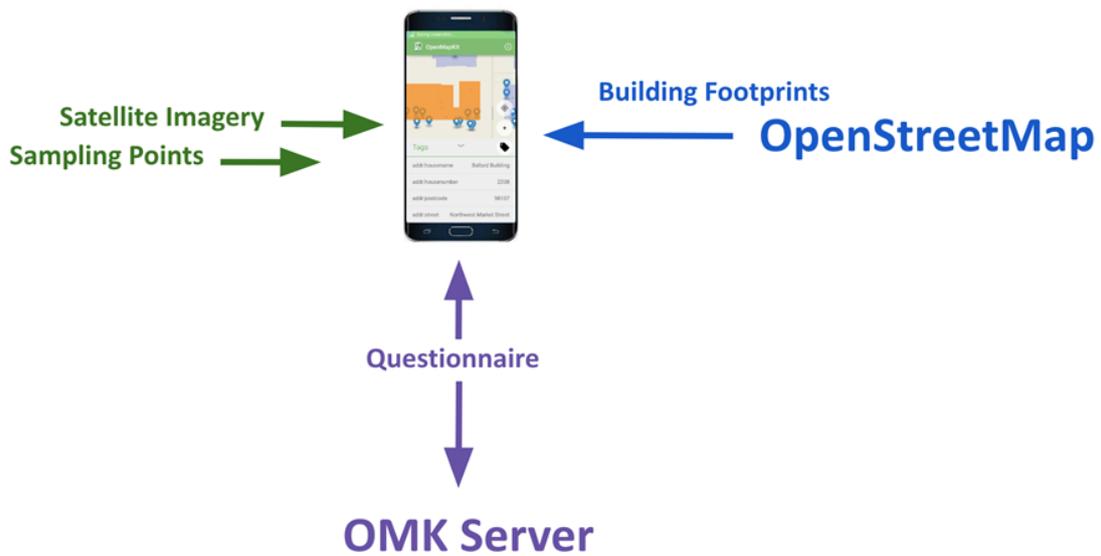


Figure 14: OMK Mobile Application



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Ten houses around each sampling point were chosen and visually inspected by the surveyors. The field surveyors were given discretion on how far or near from the specific coordinate they could move and were advised not to infringe on the 20 metre buffer of another point. Surveyors were asked to ignore any points that fell inside restricted zones, such as military compounds. Any surveyors encountering difficulties with accessing particular directions of a point were asked to collect data in another direction where possible.

Throughout the data collection period, weekly meetings were held and used as a place for the surveyors to discuss and address any challenges faced. This provided them with the opportunity to ask any specific technical questions, learn more about OSM, OMK and OMK Server, as well as get feedback on the quality of the data being collected to help iron out any issues before continuing on with the data collection. At the end of the data collection, a total of 2,701 buildings were surveyed. Some of these buildings had pre-existing attribute information following the tags identified in the localised data model such as `building`, `building:adjacency`, `building:levels`, `roof:material` and `roof:shape`, while the other tags were not present at all. Table 10 shows how the data surveyed through this project has added to and enriched the pre-existing attribute information in OSM for the selected buildings in Kathmandu.

No.	Tags	Before	After	Change
1	<code>building</code>	2589	2701	4%
2	<code>building:adjacency</code>	118	2694	96%
3	<code>building:age</code>	0	2689	100%
4	<code>building:condition</code>	0	2701	100%
5	<code>building:geological_site</code>	0	2682	100%
6	<code>building:lateral:material</code>	0	2701	100%
7	<code>building:lateral:system</code>	0	2701	100%
8	<code>building:levels</code>	146	2701	95%
9	<code>building:levels:underground</code>	0	2694	100%
10	<code>capacity:persons</code>	0	2701	100%
11	<code>roof:material</code>	65	2701	98%
12	<code>roof:shape</code>	685	2701	75%
13	<code>source</code>	119	2701	96%

Table 10: Before and After Survey Attribute Information

Looking at the breakdown of the data values collected for the key attributes, it can be seen that the lateral system found in the structural materials used for buildings surveyed within the areas of Kathmandu are roughly 67% for moment resisting frame, 30% masonry wall, 2% hybrid, and 1% braced frame (Figure 15). The values for the structural materials are roughly broken down as 64% reinforced



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concrete, 29% masonry, 4% steel and 1% for earth, bamboo and wood (Figure 16). There is a high percentage of reinforced concrete found as the structural materials for buildings as the survey was carried out in the city. Please see Appendix 2 for a break down of the other attribute values collected during the survey.

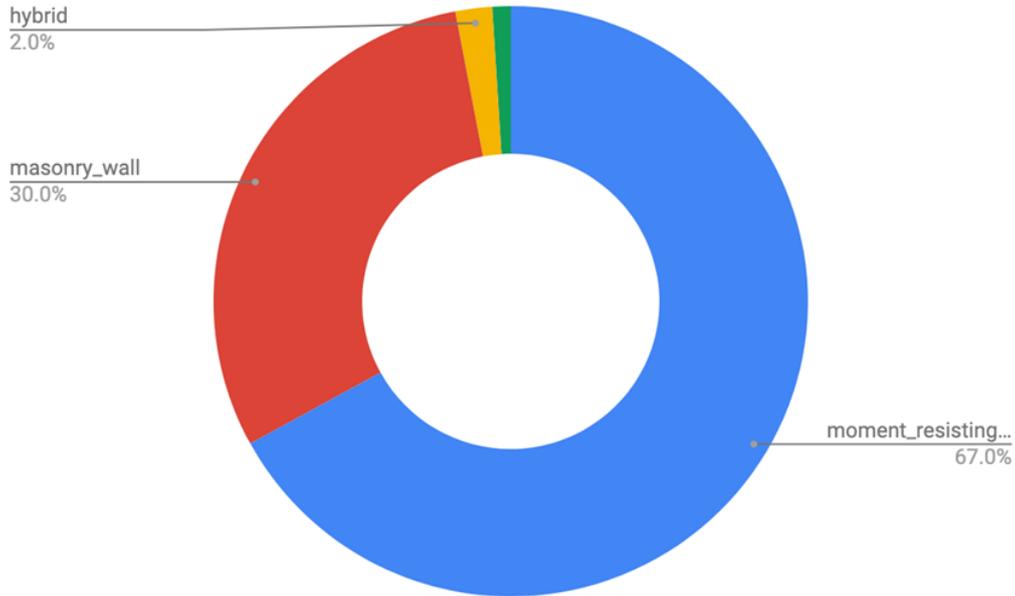


Figure 15: Lateral System Attribute Breakdown

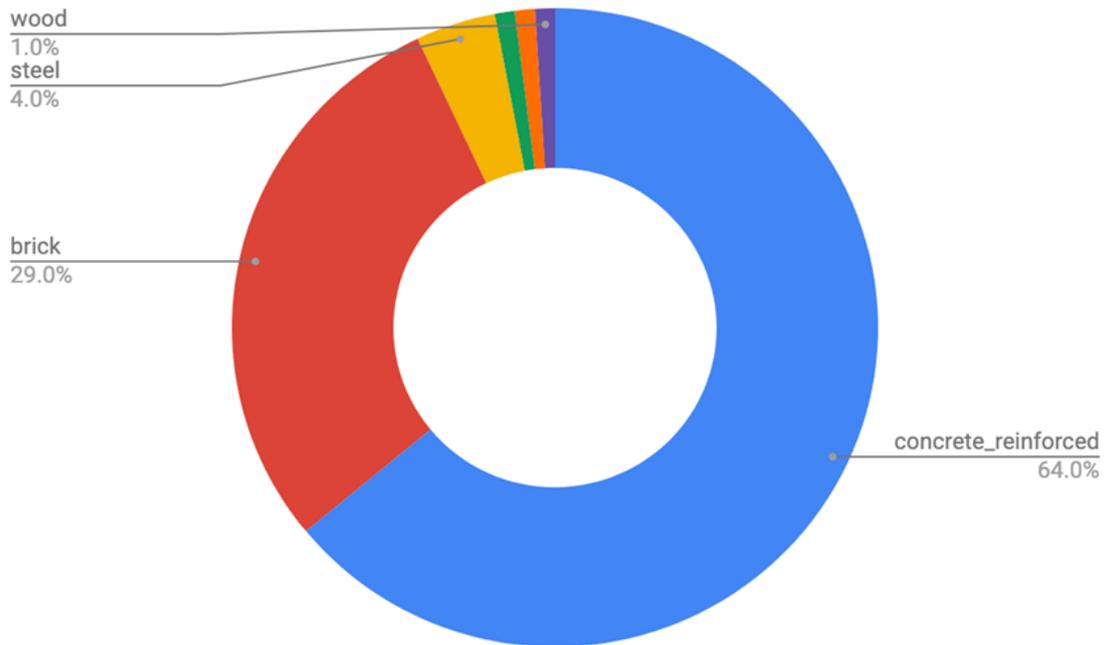


Figure 16: Lateral Materials Attribute Breakdown



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4.9. Data Validation

Validating the data to ensure that it is complete and correct is a key part of the ground data collection process. The main objective is to catch any mistakes in the data before uploading it to OSM, so that anyone using the information can be confident of the data accuracy. Data validation was carried out at four stages by KLL during the ground data collection process. The first phase of data validation is when the DE specialists are cleaning up the information they collected on the ground. There are several tools that can be used to assist with data validation, but the tool generally used the most, which was also applied by KLL is the use of JOSM (Figure 17).

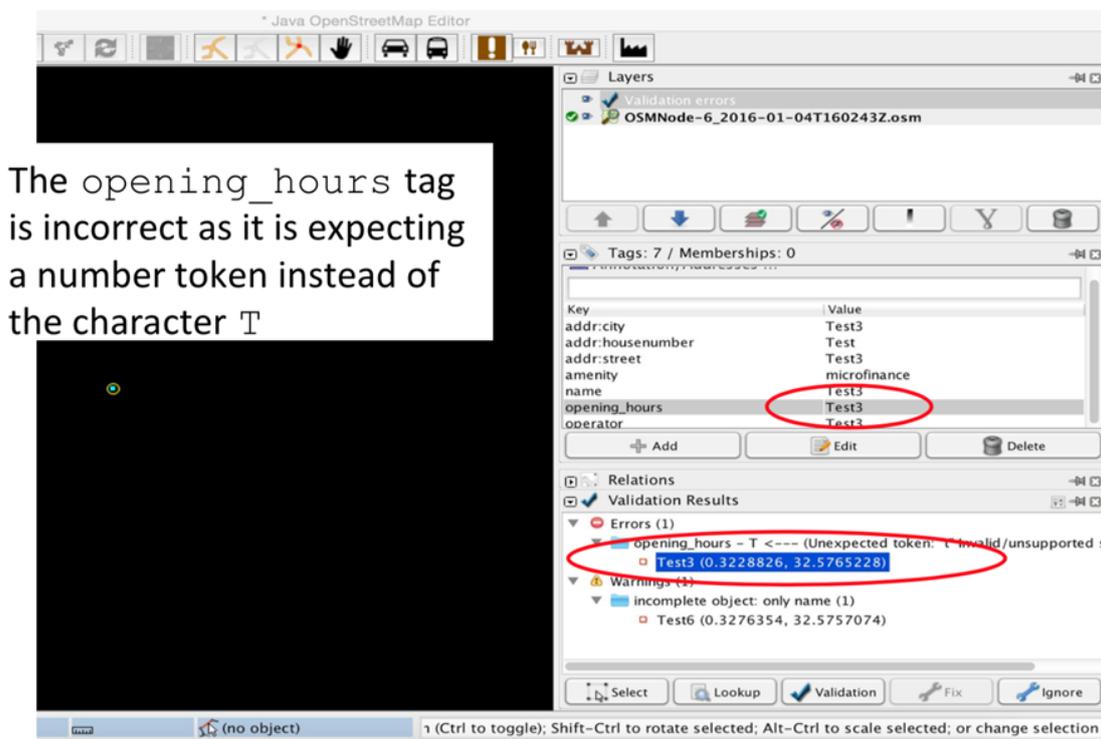


Figure 17: JOSM Validation Tool

This desktop GIS tool is specifically designed for OSM data and can help highlight any errors and warnings in the data with the 'Validation' tool. Geospatial errors detected include intersecting geometries and unconnected nodes, while attribute information errors include missing tags, misspelled tags, and incorrectly assigned tags. The 'TODO' tool, which is also available in JOSM, allows the user to select all the features in a layer and organise them so that they can be reviewed systematically one by one, so that none of them are missed.

The second phase of data validation took place when 50% of the overall data was collected, while the third data validation phase took place when 90% of the data was collected. Both of these phases were conducted by the QA specialists. To do this, a CSV file of all the surveyed information was downloaded, which was then divided into six groups based on the mappers name or the mobile device ID through which the data was uploaded. Once the data was sorted into groups, every tenth row was validated



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by a QA specialist based on the images gathered by the surveyors of the building in question. This process was carried out, so that 10% of all data surveyed was validated at the office.

Spot checking was also carried out by visiting the locations of the buildings that fell within the 10% of the data that had been validated (Figure 18). The building information was checked by the QA specialists to ensure that the information on the ground matched the images and data collected by the field surveyors (Figure 19). The fourth and final data validation phase took place after 100% of the data was collected through peer reviews. This process involved the surveyors reviewing the data of one another and leaving comments where they felt potential errors had been made, on a shared spreadsheet (Figure 20).



Figure 18: Spot Check Points on Maps.me



Figure 19: Building Photos



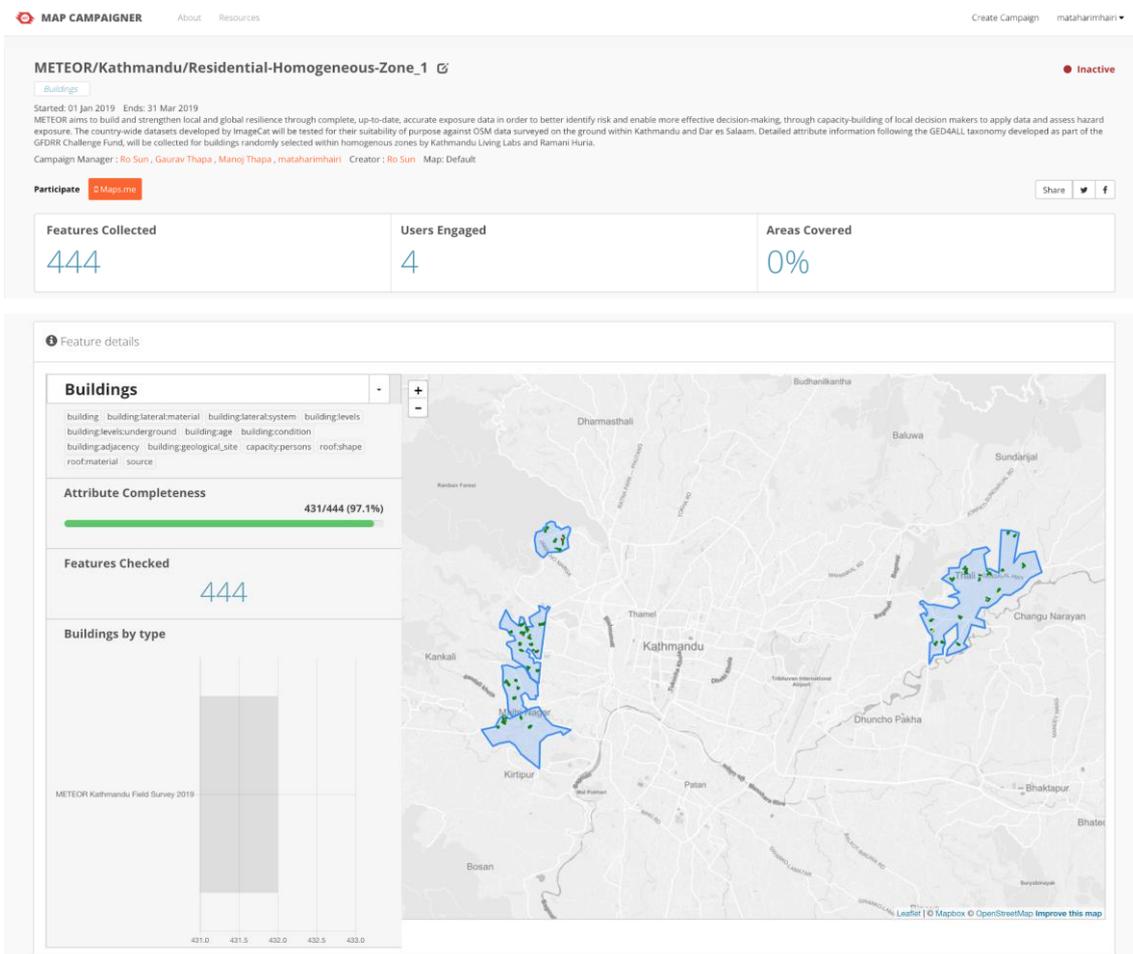
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No.	Homogenous Zone Type	MapCampaignter Project
1	Residential	https://campaigns.hotosm.org/campaign/88900da88213470e97a437f2399161db
2	Dense Residential	https://campaigns.hotosm.org/campaign/085a2322e33a4b1b9c2101744c15db48
3	Urban	https://campaigns.hotosm.org/campaign/2ec9f24a5dbe49df8d75161932af948f
4	Industrial	https://campaigns.hotosm.org/campaign/c4b1cdf329894306aa90369adff32770
5	Informal	https://campaigns.hotosm.org/campaign/d685b725bee24051b10f95a7c7d53d37
6	High Urban	https://campaigns.hotosm.org/campaign/969eca6207b849f482a416f9bb4a412
7	New Industrial	https://campaigns.hotosm.org/campaign/880541fb5cb24fcd48e2c0106358775

Table 11: Kathmandu MapCampaignter Projects

Figure 21: Residential Homogeneous Zone on MapCampaignter





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Errors

13

Status	Name	Date	Comment
error	way:206890292	2019-02-28	Errors: building:lateral:material not found, building:lateral:system not found, building:levels not found, building:levels:underground not found, capacity:persons not found, roof:shape not found, roof:material not found, source not found
error	way:208833536	2019-02-28	Errors: building:age not found
error	way:342323765	2019-02-28	Errors: building:lateral:system not found, building:levels not found, building:levels:underground not found, capacity:persons not found, roof:shape not found, roof:material not found, source not found
error	way:506418186	2019-02-28	Errors: building:lateral:material not found, building:lateral:system not found, building:levels not found, building:levels:underground not found, building:geological_site not found, capacity:persons not found, roof:shape not found, roof:material not found, source not found
error	way:517209665	2019-02-28	Errors: building:levels:underground not found, capacity:persons not found, roof:shape not found, roof:material not found, source not found
error	way:540791175	2019-02-28	Errors: building:lateral:material not found, building:lateral:system not found, building:levels not found, building:levels:underground not found, capacity:persons not found, roof:shape not found, roof:material not found, source not found
error	way:543053903	2019-02-28	Errors: building:lateral:material not found, building:lateral:system not found, building:levels not found, building:levels:underground not found, building:age not found, building:condition not found, building:adjacency not found, building:geological_site not found, capacity:persons not found, roof:shape not found, roof:material not found, source not found
error	way:547958635	2019-02-28	Errors: roof:shape not found, roof:material not found, source not found
error	way:549497765	2019-02-28	Errors: building:levels:underground not found, capacity:persons not found, roof:shape not found, roof:material not found, source not found
error	way:549814826	2019-02-28	Errors: building:lateral:material not found, building:lateral:system not found, building:levels not found, building:levels:underground not found, building:condition not found, building:geological_site not found, capacity:persons not found, roof:shape not found, roof:material not found, source not found

Previous 1/1 Next

Download

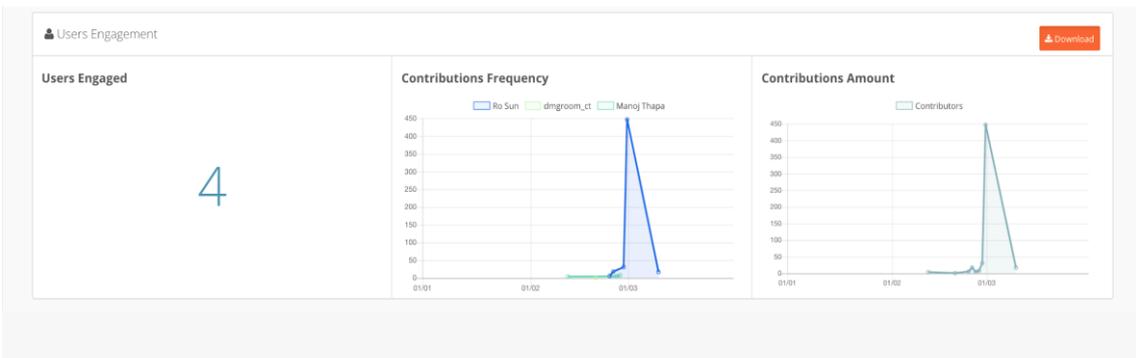
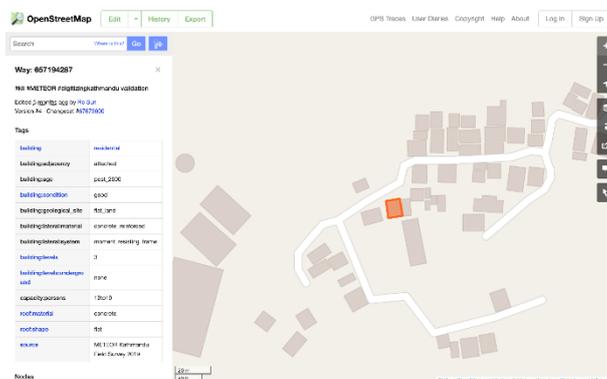
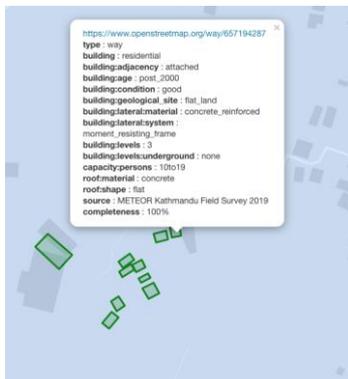


Figure 22: Attribute Information in MapCampaigner (Left) and OSM (Right)





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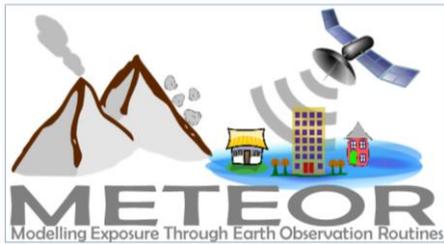
5. Open Access

5.1. Data Extracts

The final collected and validated Kathmandu data, is now hosted on OSM and available for anyone to access and use. There are multiple ways to extract data from OSM such as the use of Overpass Turbo or JOSM, but for those with little to no experience with OSM, the Export Tool¹⁹ is recommended. The Export Tool was created by HOT as a way to provide individuals with low technical skills to easily extract data from OSM through a user friendly interface and straight forward process. The Export Tool allows users to create custom OSM data extracts for anywhere in the world, simply by selecting an area of interest (Figure 23), map features (Figure 25) and file formats to convert the data into (Figure 24). Within minutes, up-to-date OSM data is exported (Figure 26).

Figure 23: Describe Tab – Create Export Tool Function

¹⁹ <https://export.hotosm.org/>



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Figure 24: Formats Tab – Create Export Tool Function

Figure 25: Data Tab – Create Export Tool Function



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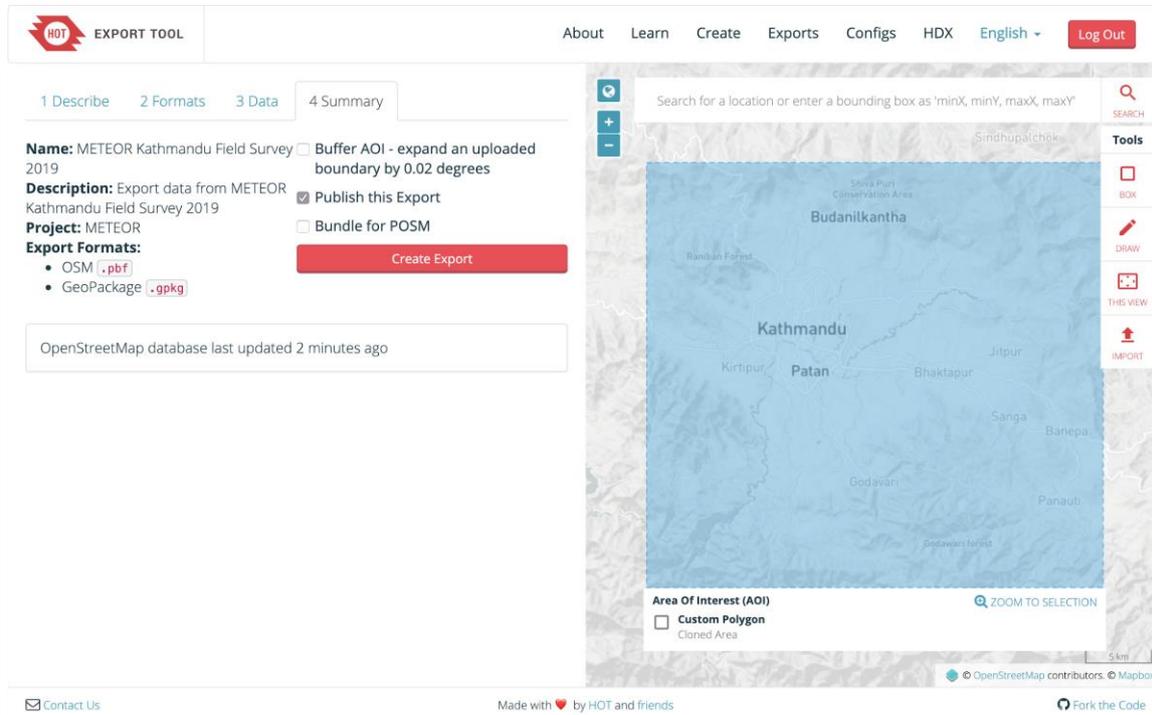


Figure 26: Summary Tab – Create Export Tool Function

The only requirement to use the Export Tool is to sign in with an OSM username and provide an email address, which is used to send a link of completed jobs in case the connection is lost, the export will still run and notified the user once it is ready.

A job has already been set up on the Export Tool for the Kathmandu data (Figure 27), which can be found in Table 12. The data is extracted from OSM using the source = “METEOR Kathmandu Field Survey 2019” tag, which was applied to each of the buildings surveyed by the team. This selects the specific buildings within the area of interest, and then filters the attributes based on those identified in the YAML syntax in the ‘Feature Selection’ tab of the Tool.

There are multiple file formats to choose from, but only the geopackage and pbf formats have been selected. If other formats are desired, the job can be ‘Cloned’ and the settings changed before running the job again. The file can be downloaded by clicking on the highlighted link on the export page once it has finished running.



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The screenshot shows the HOTOSM EXPORT TOOL interface. At the top, there is a navigation bar with links for 'About', 'Learn', 'Create', 'Exports', 'Configs', 'HDX', 'English', and a 'Log Out' button. The main content area is divided into three columns. The left column displays details for an export job: 'Export #c1f46025-6f93-4957-925d-83fed720a51b', 'Description: Export data from METEOR Kathmandu Field Survey 2019', 'Project: METEOR', 'Area: 1097 sq km', 'Created at: Tuesday, July 2nd 2019, 2:40 pm', 'Created by: mataharimhairi', 'Published: Yes', 'Export formats: OSM (.pbf), GeoPackage (.gpkg)', and 'OSM Analytics: View this area'. Below this are 'Features' buttons: 'Re-Run', 'Clone', and 'Delete'. The middle column shows job status: 'Run #758c0093-db9a-4972-9785-7af0829668b8', 'Status: COMPLETED', 'Started: Monday, July 29th 2019, 5:01 pm', 'Finished: Monday, July 29th 2019, 5:01 pm', 'Duration: a few seconds', and lists two export files: 'OSM (.pbf) meteor-kathmandu-field-survey-2019_export_pbf.zip (155 kB)' and 'GeoPackage (.gpkg) meteor-kathmandu-field-survey-2019_export_gpkg.zip (555 kB)'. The right column shows a map of Kathmandu with a blue rectangular area highlighting the survey region. At the bottom, there is a footer with 'Contact Us', 'Made with ❤️ by HOTOSM and friends', and 'Fork the Code'.

Figure 27: Export Page – Completed Job

Table 12: Export Tool Data Extract

Kathmandu Data Extract
https://export.hotosm.org/en/v3/exports/c1f46025-6f93-4957-925d-83fed720a51b

5.2. Methodology

Creating data in OSM is not the only aim of HOTOSM led projects, but providing open access to the methodology and tools applied is also at the core. Sharing knowledge is the best way to increase awareness of the issues and goals at hand, which also allows for the sustainability of the data in the years to come.

One of the ways in which the project methodology is shared with the greater community is through the OSM wiki²⁰ (Figure 28, Table 13). The wiki is a common place for documenting projects related to creating data in OSM. It is also the first place that should be checked for similar projects conducted in the targeted area of interest. This way the processes and lessons learned can be reviewed and built

²⁰ <https://wiki.openstreetmap.org/>



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upon. It is also common to provide the details of the project manager who can be contacted for further discussions regarding the work and provide feedback.

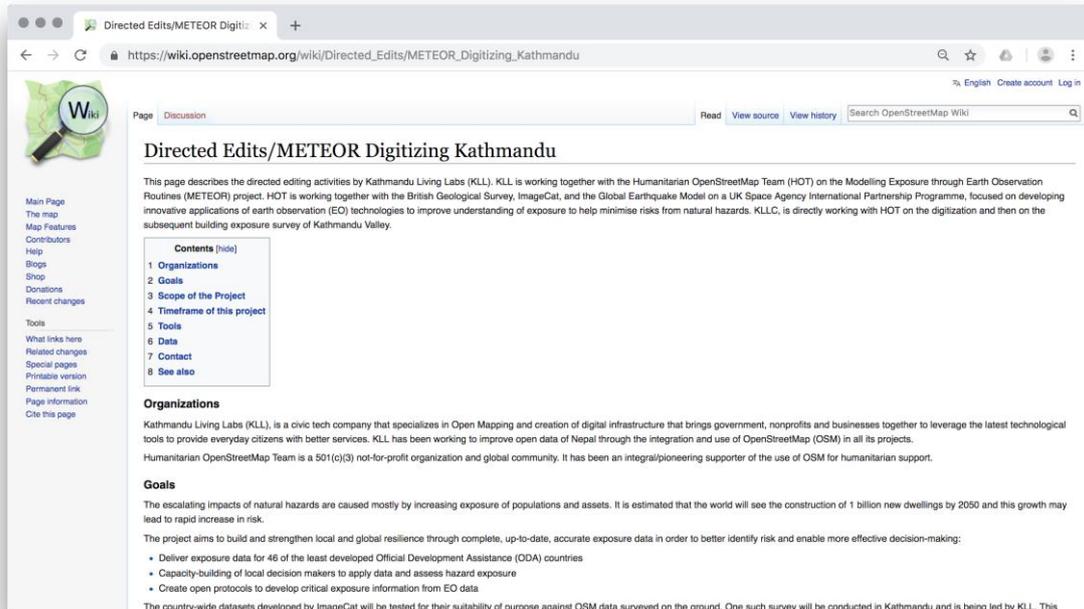


Figure 28: Kathmandu METEOR Wiki Page

Table 13: Kathmandu METEOR Wiki Page Link

Local Partner Organisation	Link
Kathmandu Living Labs	https://wiki.openstreetmap.org/wiki/Directed_Edits/METEOR_Digitizing_Kathmandu

The OpenStreetMap Foundation provides an overview on the expectations for organised editing efforts in OSM through their ‘Organised Editing Guidelines’ page²¹. Their goal is to provide a framework to both organised mapping initiatives and the communities to encourage good organised mapping, which will assist with the sustainability and usability of the data created. The organised editing guidelines apply to any edits that involve more than one person and can be grouped under one or more sizeable, substantial, coordinated editing initiatives. One of the key sections of the guidelines focus on the creation of a wiki page, to assist with the recording and sharing of activities with the rest of the OSM community for constructive feedback.

²¹ https://wiki.osmfoundation.org/wiki/Organised_Editing_Guidelines



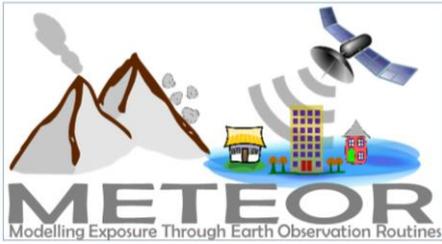
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A page for the METEOR project has been set up on the HOT website²², with contact details for the project manager, as well as links to news update blogs and other key pages related to the work. KLL have set up a project page on the OSM wiki for the created in Kathmandu, as part of the METEOR project following the OSM Foundation 'Organised Editing Guidelines'. The main sections of the wiki page includes an overview of the project (manager, contact details, timeframe, etc), the purpose and goal, as well as details of the data creation process. This includes links to the Tasking Manager projects, imagery used, building statistics before and after the digitisation stage (quantity and quality), as well as before and after maps of the homogeneous zones for the remote digitisation phase. The localised OSM data model derived from the GED4ALL schema, tools used for the data collection, statistics of attribute completeness before and after data collection, statistics of data quantity and quality before and after surveying are also provided through the wiki page.

While the wiki page provides more of an overview to the METEOR project aim, methodology, tools and results, it does not go in depth on how to set up a mapping project and apply the appropriate tools. Outlining the steps in *METEOR Deliverable 4.3: Protocols for Crowd-Sourcing Regional Exposure Data* report is not the most effective way to reach a larger audience, as HOT has seen in the past and are currently developing an open online 'HOT Toolbox' that will host all of the methodologies applied for setting up and executing mapping projects (Figure 29, Table 14). The site includes presentation, videos and the ability to export materials as PDFs. It covers a range of topics spanning from designing and coordinating a mapping project, to data use and analysis. This will continually evolve as the methodologies applied by HOT also change to reflect the lessons learned and the emergence of new better equipped tools are developed.

²² <https://www.hotosm.org/projects/modelling-exposure-through-earth-observation-meteor/>



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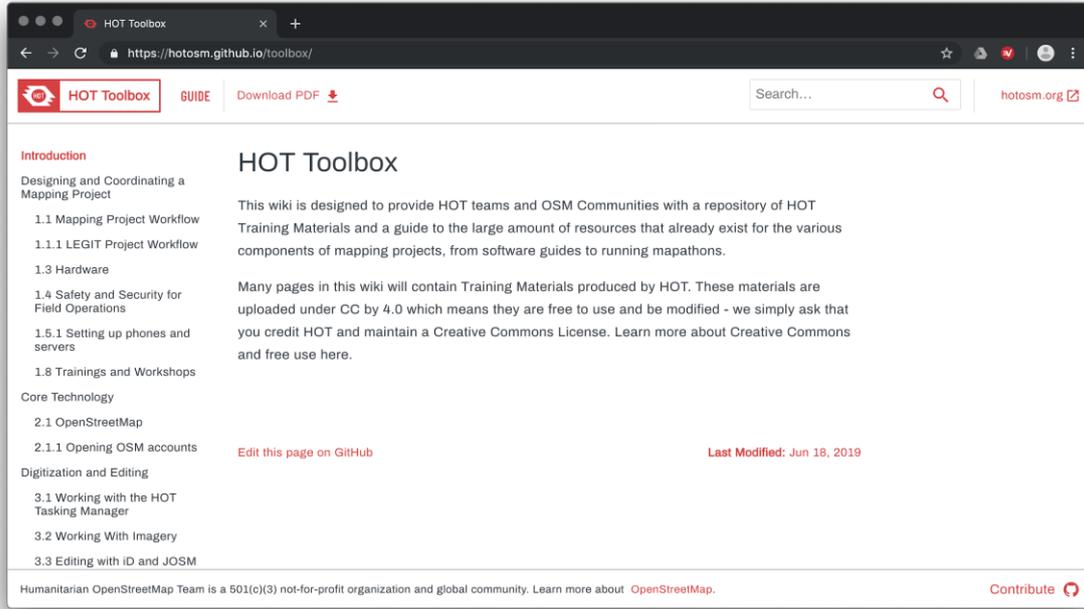


Figure 29: HOT Toolbox

Table 14: HOT Toolbox Link

Open Access Training Material	Link
HOT Toolbox	https://hotosm.github.io/toolbox/



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6. Sustainability

A common concern about crowd-sourcing mapping initiatives is their ability to have a sustainable impact after the end of the project cycle. In this case, sustainability can take on multiple meanings, including continuing use and maintenance of the data, continued activity of the local mapping community, or ongoing investment in the project by new participants. Defining at the start of the process, what goals are the most relevant to help the sustainability of the data will more likely achieve them. It is also important to take stock at the end of a project of what was learned during the implementation, in order to guide continued work or new efforts in other locations. Key goals for the sustainability of the METEOR ground data collection was the creation of open access information on the project itself, including the aim, methodology, tools and results through the OSM wiki page, as well as the HOT Toolbox where interested parties can access more detailed steps on how to set up their own mapping projects.

Other aspects of the data collection focused on the sustainability of the project, includes the use of the 'source=METEOR Kathmandu Field Survey 2019' tag, which allows user to see and reference how the data was created. Reading the open access documents and protocols on the mapping project can work as a guide to support similar mapping activities in the area to enhance the data or to simply keep it up-to-date. Similarly the 'fixme=*' tag was also applied to the data collected. This tag was used to describe any mapping errors discovered by the surveyors on the ground. For example, the "north side of the building is attached to a neighbouring wall" or "the building complex is actually 4 separate buildings evenly divided". This tag was included in the ground data collection model to maximise the improvement of OSM. It has also made it easier for the OSM Nepal community to continue improving OSM beyond the project period.

Since KLL is a local organisation based in Kathmandu, they plan to monitor the data uploaded to OSM. They work on several OSM related projects throughout the year, and will continue to do so in the future as they are an integral part of the OSM community across all of Nepal, and act as a point of contact and reference for related mapping projects in the country. MapCampaigner was a new tool introduced to KLL on the METEOR project, which they hope to continue to utilise going forward as it helps the teams to monitor specific data in OSM.



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7. Conclusion

Overall the ground data collection effort was successful, providing OSM data at the building level for randomly selected structures within the 7 homogeneous development type zones. The OSM data will then be used by ImageCat to aggregate and smear for the rest of Nepal to create exposure datasets at higher levels. However, no data collection project is ever perfect, and this one is no exception. There were many lessons learned along the way that should be noted here going forward and striving to continually improve in the way that data is created in OSM based on its intended purpose.

Feedback from discussions with ImageCat, GEM, KLL, Resilient Structures, Engineering Mantra and HOT, look at how some aspects would be beneficial to consider from the start of the project. These include taking multiple photographs of the structure being analysed from all angles, as the side and back views are less likely to be hidden behind a non-structural facades and can expose the materials and structural system for easier identification from outside of the field. In line with taking more images, it was also suggested that a higher resolution camera should be used in the future for post-assessment review, as the details are often blurry when zoomed in. The cameras used are generally dependent on the mobile phone used for the data collection itself which also contains the surveying applications. It would be good to keep this in mind for future data collection efforts, so that the purchase of mobile phones with better cameras and internal GPS units are built into the budget.

It should also be kept in mind that the data collection methods applied for the METEOR project are by no means an exhaustive and comprehensive reference for all the processes and tools that can be used for collecting data in OSM. No one solution fits all, and an approach should be formulated based on the data collection focus, the local community and the targeted area of interest. Approaches that work in one country might not work in another, and newer more appropriate tools for data collection may become available.

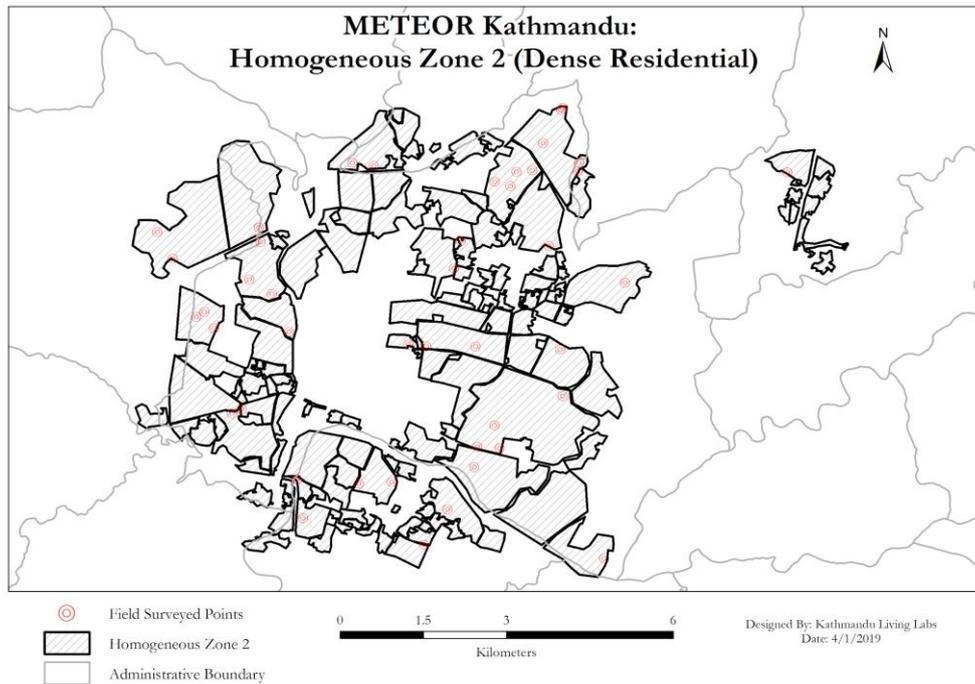
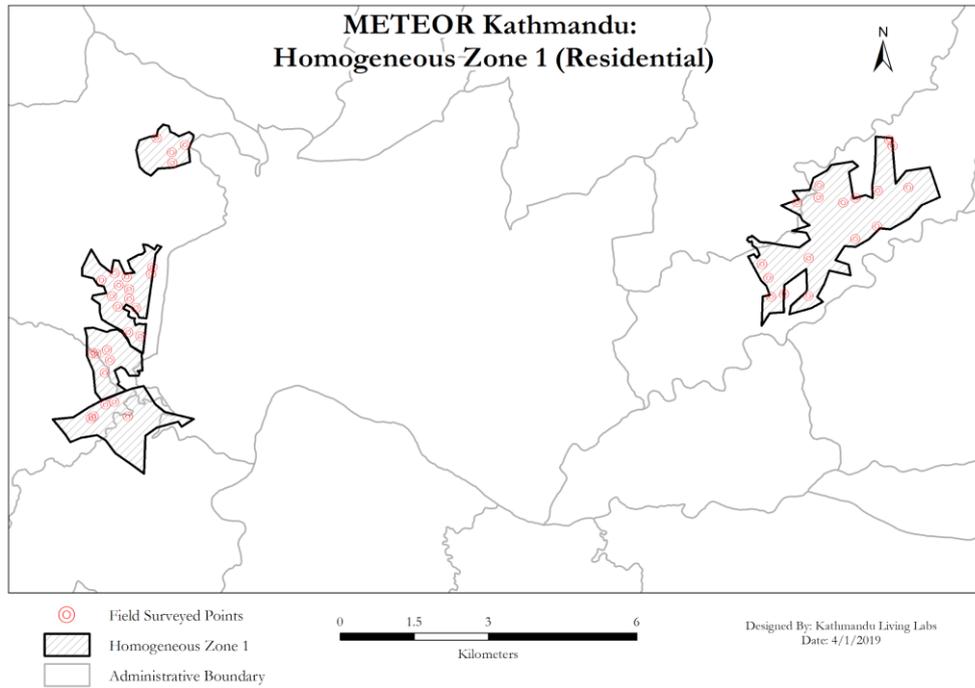
HOT has been conducting OSM data collection for over five years, and the methodology is continuously evolving as lessons are learned, and processes become more streamlined. Many of our software development projects are focused on assisting the creation, extraction and analysis of OSM data. Helping provide the tools to empower local citizens with the capacity to place themselves on the map, is one of the biggest contributions we can make towards the OSM community as we work towards the Sustainable Development Goals (SDGs) together.

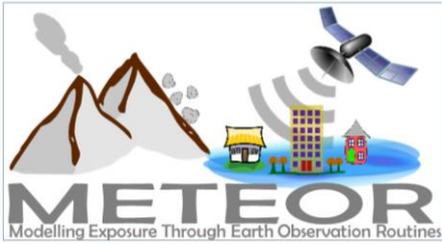


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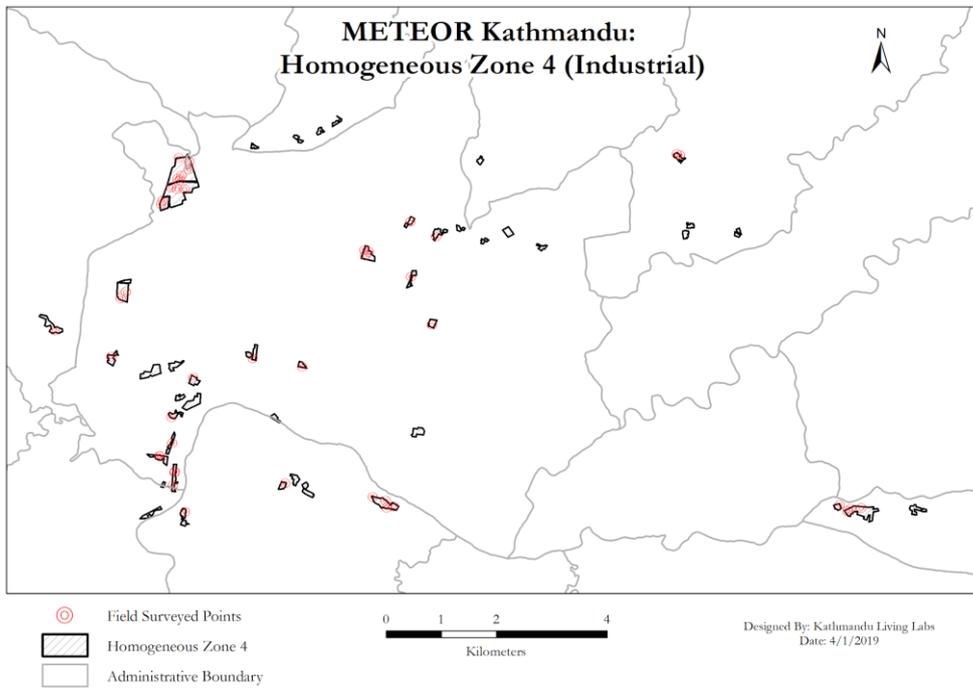
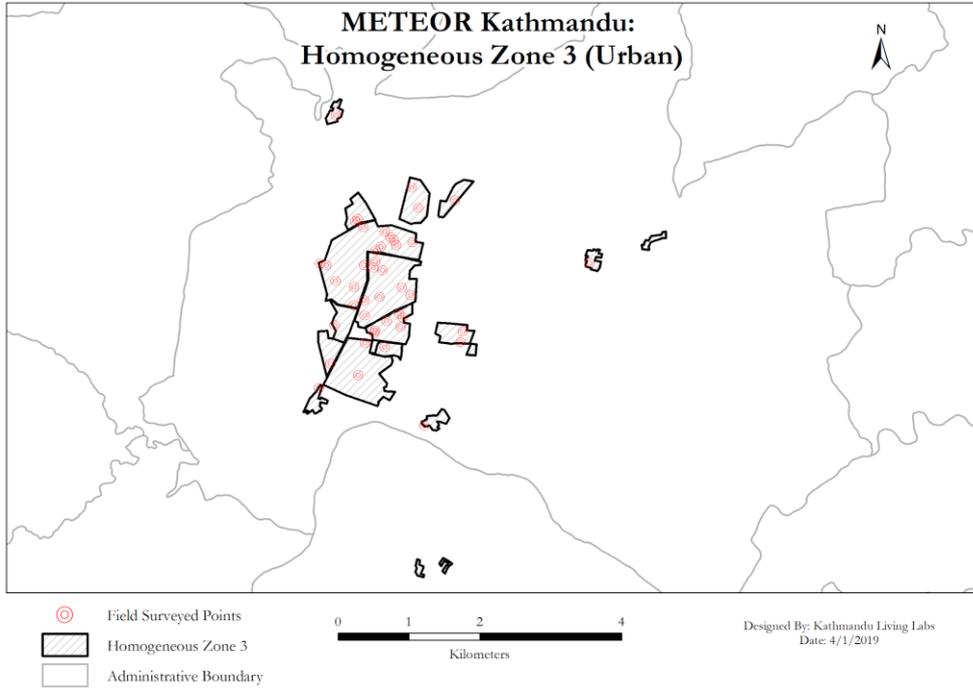


Appendix 1: Homogeneous Zone Maps



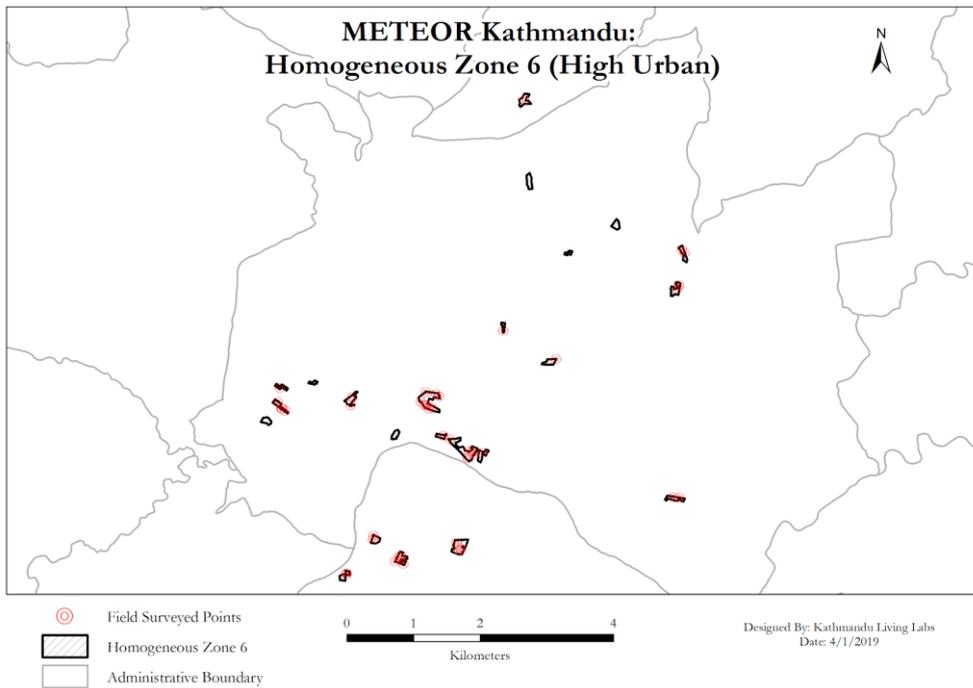
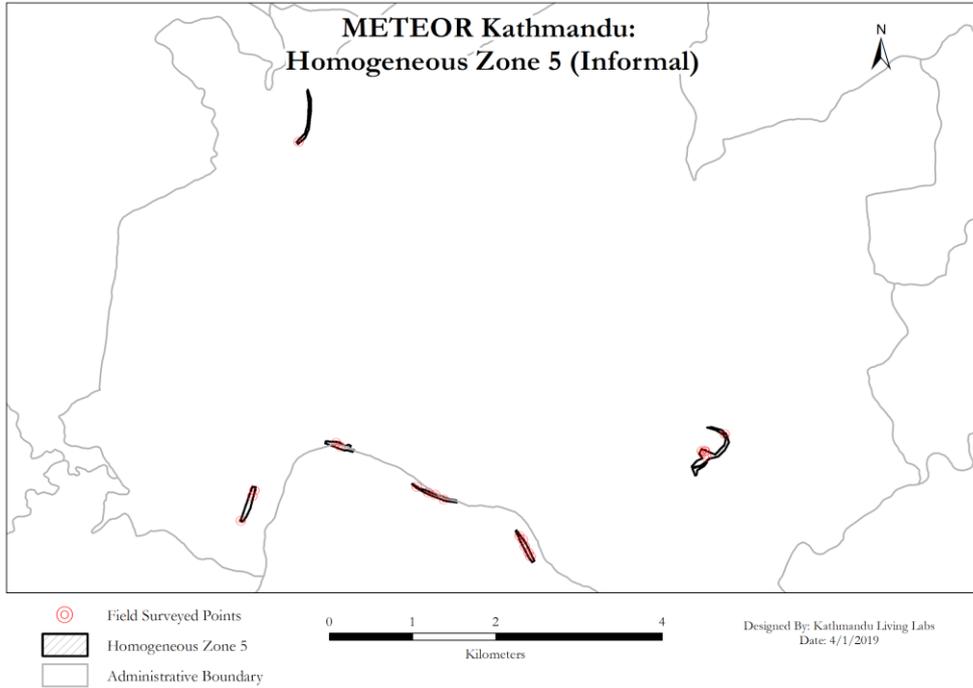


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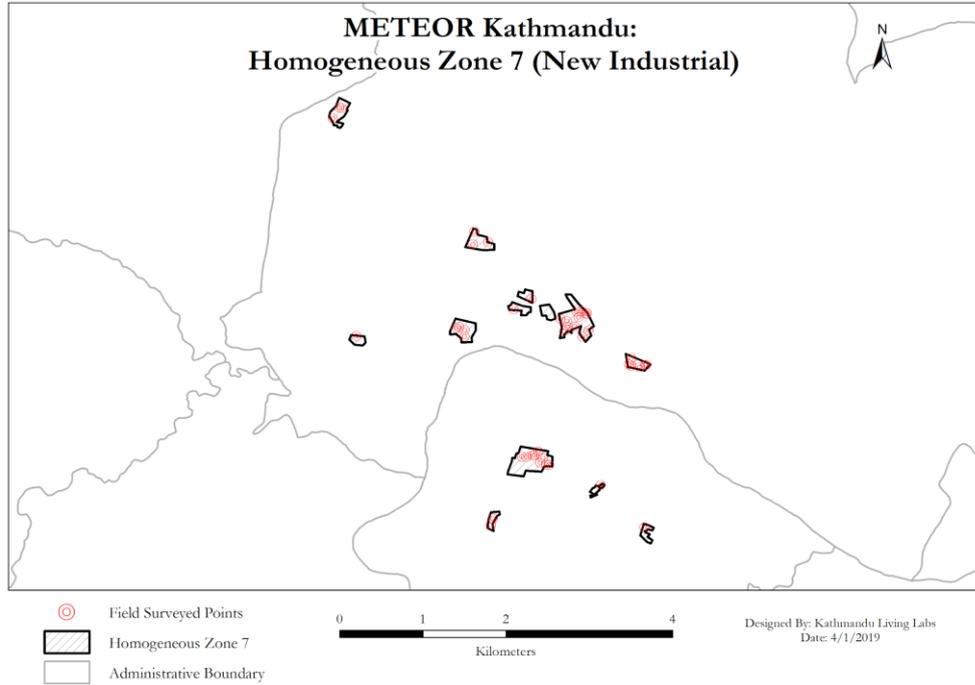


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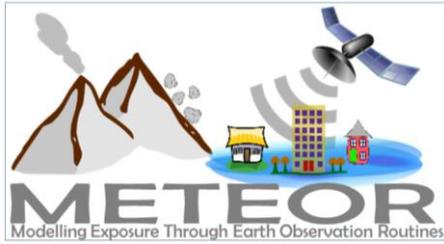
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Appendix 2: Attribute Value Breakdown

No.	Lateral Materials	Count	Percentage
1	concrete_reinforced	1729	64%
2	brick	779	29%
3	steel	97	4%
4	earth	33	1%
5	bamboo	15	1%
6	wood	14	1%
7	steel-concrete_composite	7	-
8	stone	3	-
9	brick-steel_composite	2	-
10	hybrid	2	-

No.	Lateral System	Count	Percentage
1	moment_resisting_frame	1821	67%
2	masonry_wall	801	30%
3	hybrid	47	2%
4	braced_frame	21	1%
5	dual_system (frame wall)	4	-



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No.	Building Levels	Count	Percentage
1	3	790	29%
2	4	600	22%
3	1	431	16%
4	2	355	13%
5	5	315	12%
6	6	121	4%
7	7	52	2%
8	8	15	1%
9	9	10	1%
10	10	6	-
11	11	2	-
12	13	2	-

No.	Building Levels Underground	Count	Percentage
1	none	2523	93%
2	1	161	6%
3	0	10	1%
4	2	5	-

No.	Building Age	Count	Percentage
1	post_2000	1465	54%
2	pre_2000	1224	46%



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No.	Building Condition	Count	Percentage
1	good	1266	47%
2	average	1156	43%
3	poor	276	10%
4	unknown	3	-

No.	Building	Count	Percentage
1	residential	1176	44%
2	mixed_use	811	30%
3	commercial	278	10%
4	government	96	4%
5	educational	89	3%
6	industrial	67	2%
7	office	66	2%
8	public	30	1%
9	hotel	27	1%
10	health	17	1%
11	temple	9	1%
12	school	6	1%

No.	Building Capacity	Count	Percentage
1	10to19	1109	41%
2	20to49	656	24%
3	5to9	475	18%
4	50andabove	331	12%
5	lessthan5	130	5%



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No.	Roof Shape	Count	Percentage
1	flat	1952	72%
2	monopitch	225	8%
3	double_pitch	223	8%
4	complex_regular	205	8%
5	pitched	34	1%
6	unknown	32	1%
7	complex_irregular	15	1%
8	curved	10	1%
9	sawtooth	5	-

No.	Roof Material	Count	Percentage
1	concrete	1666	62%
2	cgi	700	26%
3	mixed	204	8%
4	masonry	44	2%
5	unknown	37	1%
6	slate	25	1%
7	fabrick	10	-
8	metal	8	-
9	clay	5	-

No.	Building Adjacency	Count	Percentage
1	attached	1406	52%
2	free_standing	1288	48%



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No.	Geological Site	Count	Percentage
1	flat_land	2469	91%
2	slopy_land	182	7%
3	river_bank	11	1%
4	slopy_land;flat_land	9	1%
5	flat_land;river_bank	7	-
6	slopy_land;river_bank	4	-