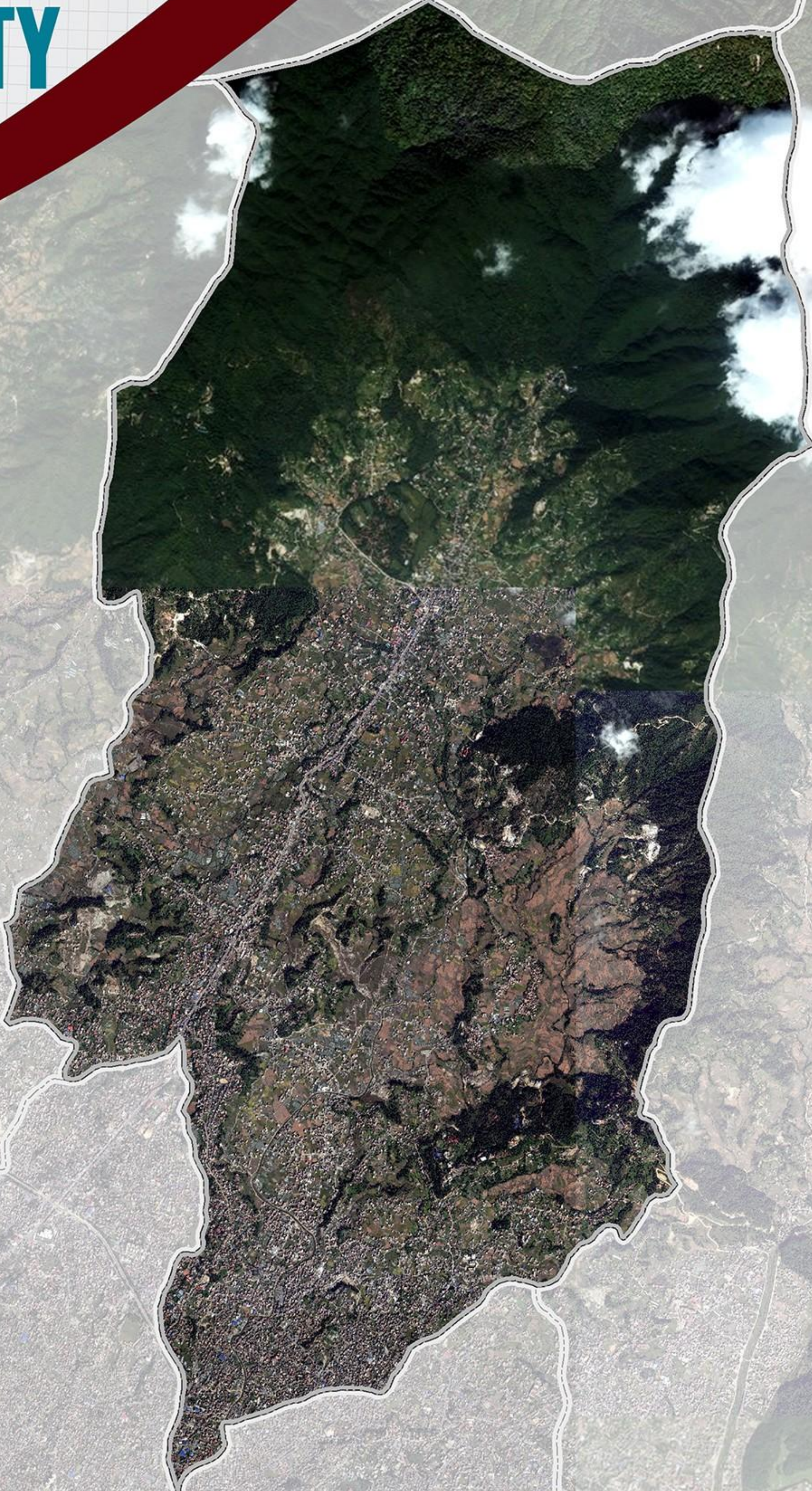
# BUDANILKANTHA MUNICIPALITY

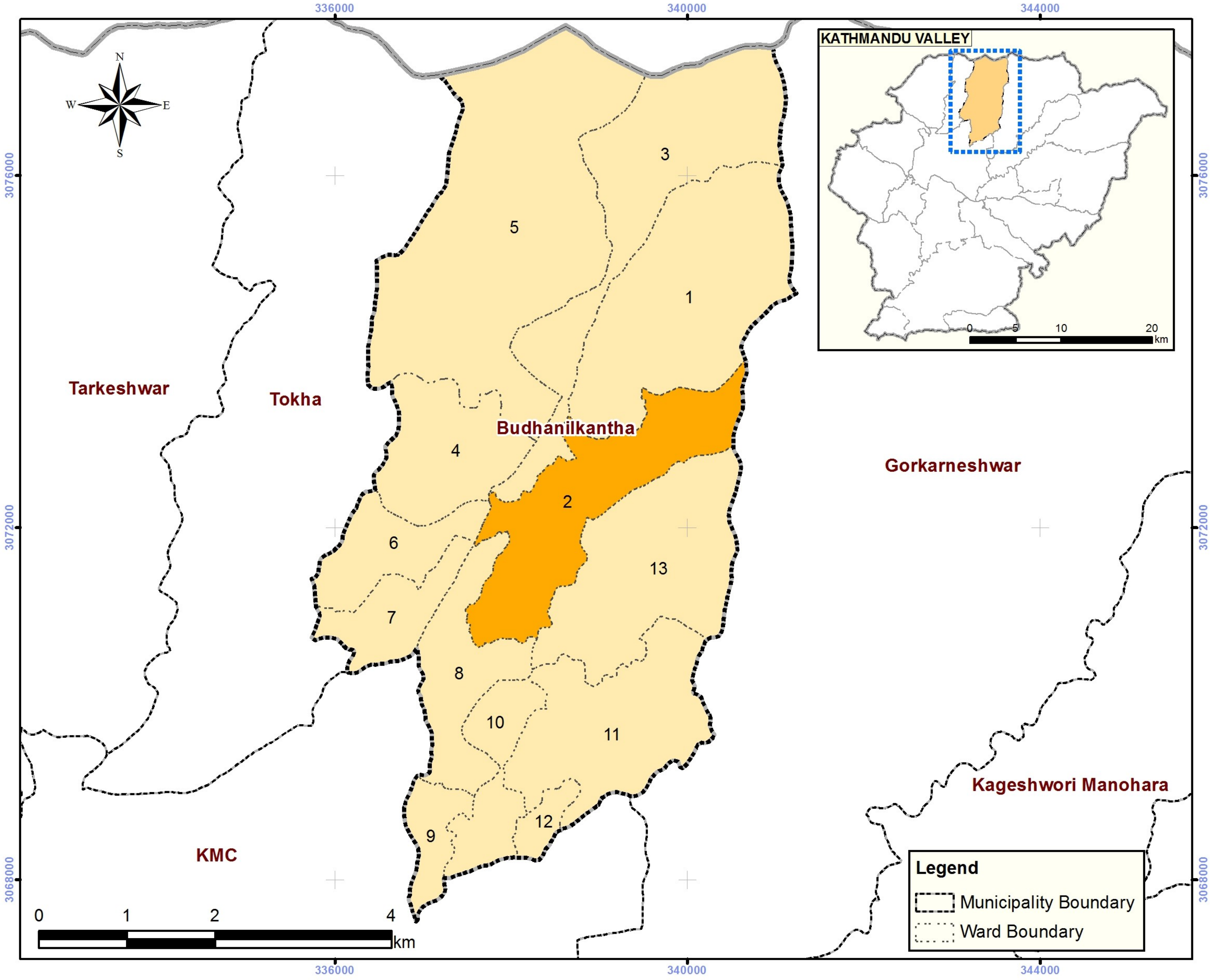
## MAP BOOK



The Project for Assessment of
**EARTHQUAKE DISASTER RISK**
for the Kathmandu Valley in Nepal

# Contents of Map Book

# A. Basic Conditions




# A-1

# Administrative Boundary

**Note:**

- Seismic hazard assessment has been conducted based on scenario earthquakes and detailed ground model have been prepared for this study area; seismic risk evaluation for a variety of socio-economic impacts due to scenario earthquakes such as damage of buildings and infrastructures, human and economic loss has been carried out.
- Budhanilkantha Municipality was selected as pilot municipality for formulation of BBB Recovery and Reconstruction Plan utilizing results of Seismic Hazard Assessment, Disaster Risk Reduction and Management (DRRM) plans based on the results of Seismic risk assessment , formulation of SOP for emergency response after an earthquake disaster and implementation of Community Based Disaster Risk Reduction and Management (CBDRRM) activities. Ward-2 was selected as Pilot ward for CBDRRM activities.

**Source:**

- Boundary of Municipality and Ward: DoS, MoFALD

WGS_1984_UTM_Zone_45N

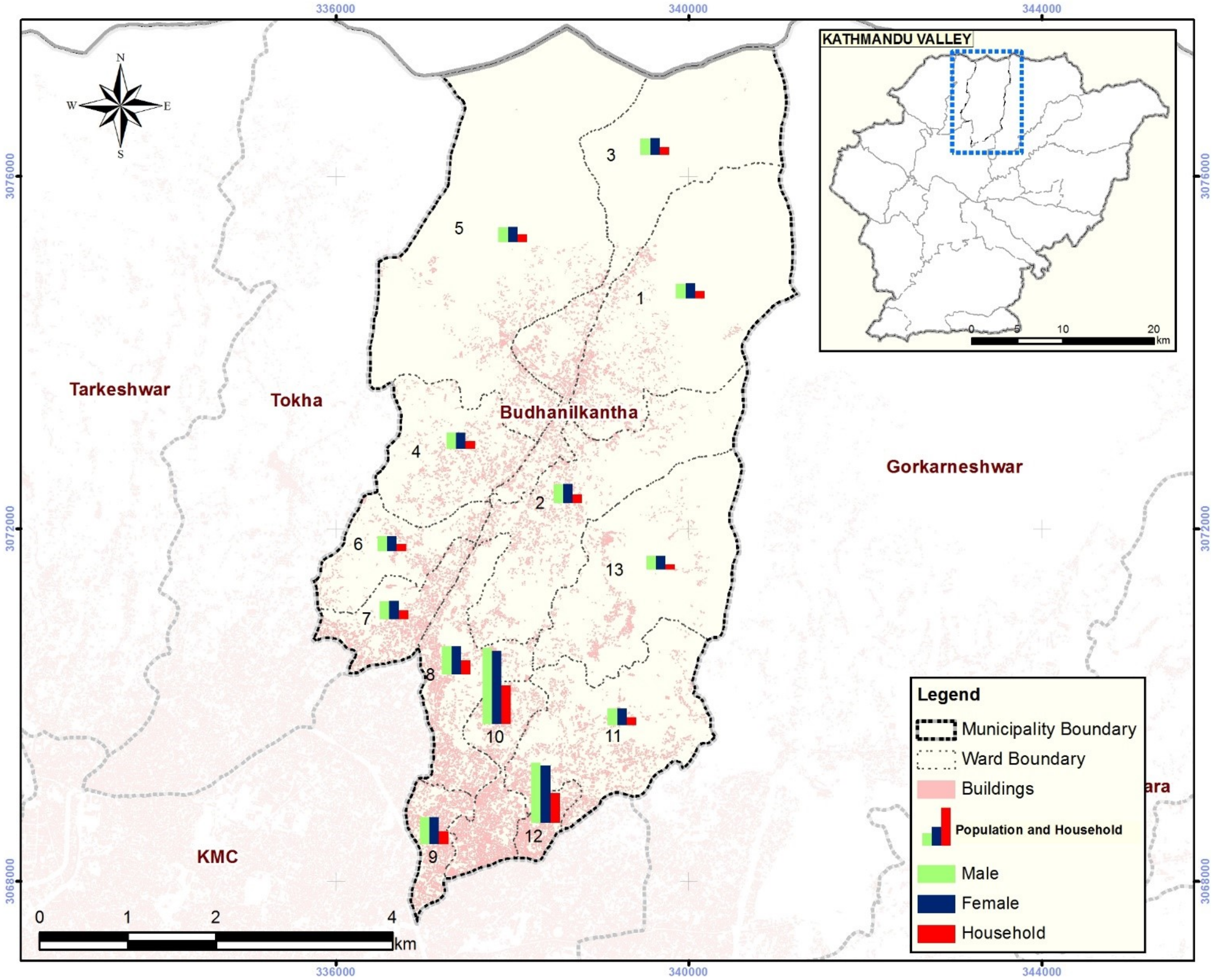
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

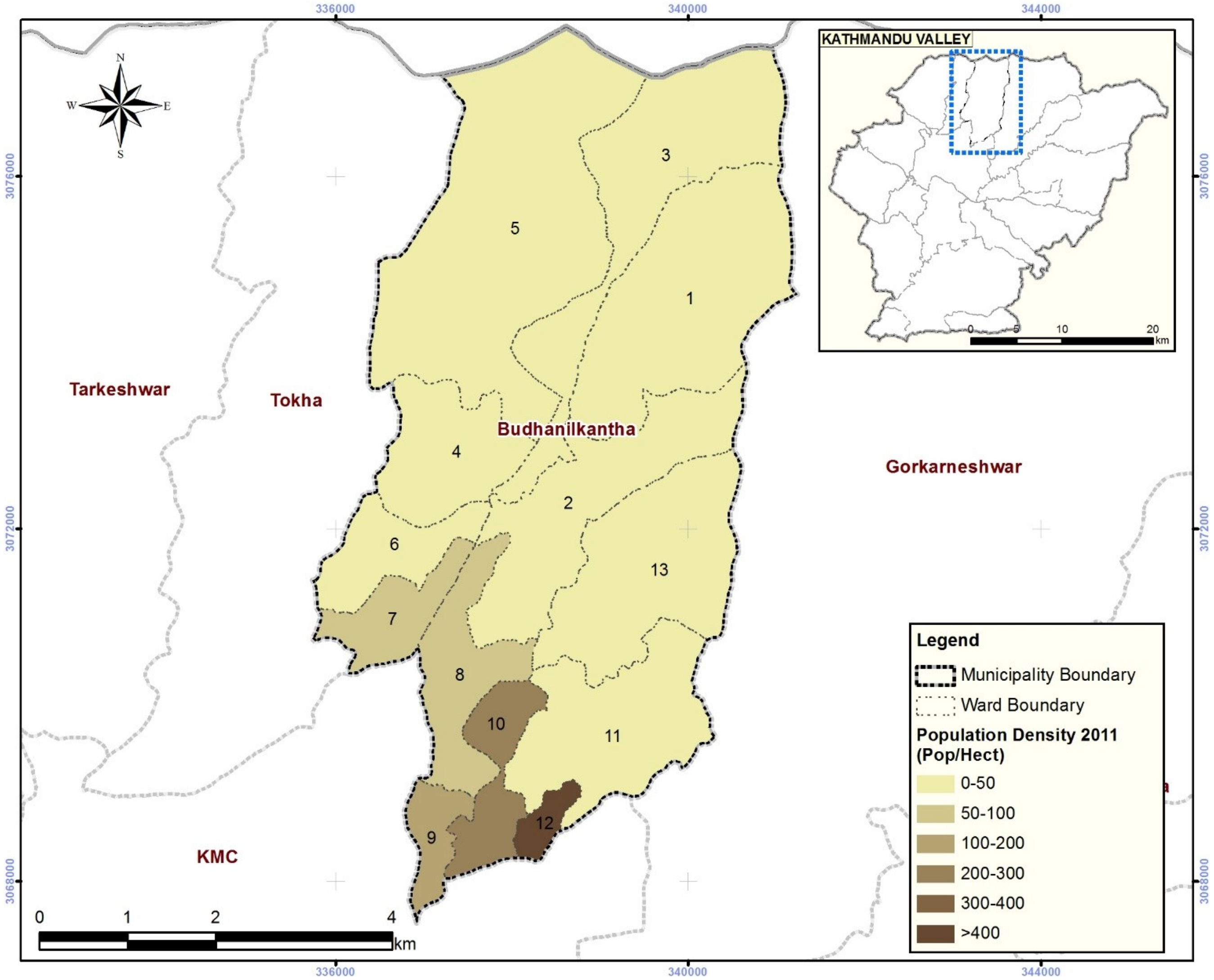
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# A-2
# Population Census 2011

## Population




## Population Density




| Ward | HH | Total | Male | Female | Ward | HH | Total | Male | Female |
|---|---|---|---|---|---|---|---|---|---|
| BUDHANILKANTHA-1 | 1121 | 4698 | 2305 | 2393 | BUDHANILKANTHA-8 | 2267 | 9171 | 4590 | 4581 |
| BUDHANILKANTHA-2 | 1453 | 6129 | 3032 | 3097 | BUDHANILKANTHA-9 | 2154 | 8826 | 4439 | 4387 |
| BUDHANILKANTHA-3 | 1231 | 5372 | 2637 | 2735 | BUDHANILKANTHA-10 | 6246 | 24050 | 12296 | 11754 |
| BUDHANILKANTHA-4 | 1230 | 5204 | 2591 | 2613 | BUDHANILKANTHA-11 | 1273 | 5382 | 2662 | 2720 |
| BUDHANILKANTHA-5 | 1264 | 4845 | 2376 | 2469 | BUDHANILKANTHA-12 | 4805 | 19031 | 9713 | 9318 |
| BUDHANILKANTHA-6 | 1171 | 4977 | 2496 | 2481 | BUDHANILKANTHA-13 | 859 | 4449 | 2208 | 2241 |
| BUDHANILKANTHA-7 | 1411 | 5784 | 2840 | 2944 | **Total** | 26485 | 107918 | 54185 | 53733 |

Source:
Boundary of Municipality and ward: DoS, MoFALD
Census Data: CBS 2011

Note: Old ward-wise population of Census 2011 was reorganized based on reconstruction of municipality in 2017.

WGS_1984_UTM_Zone_45N

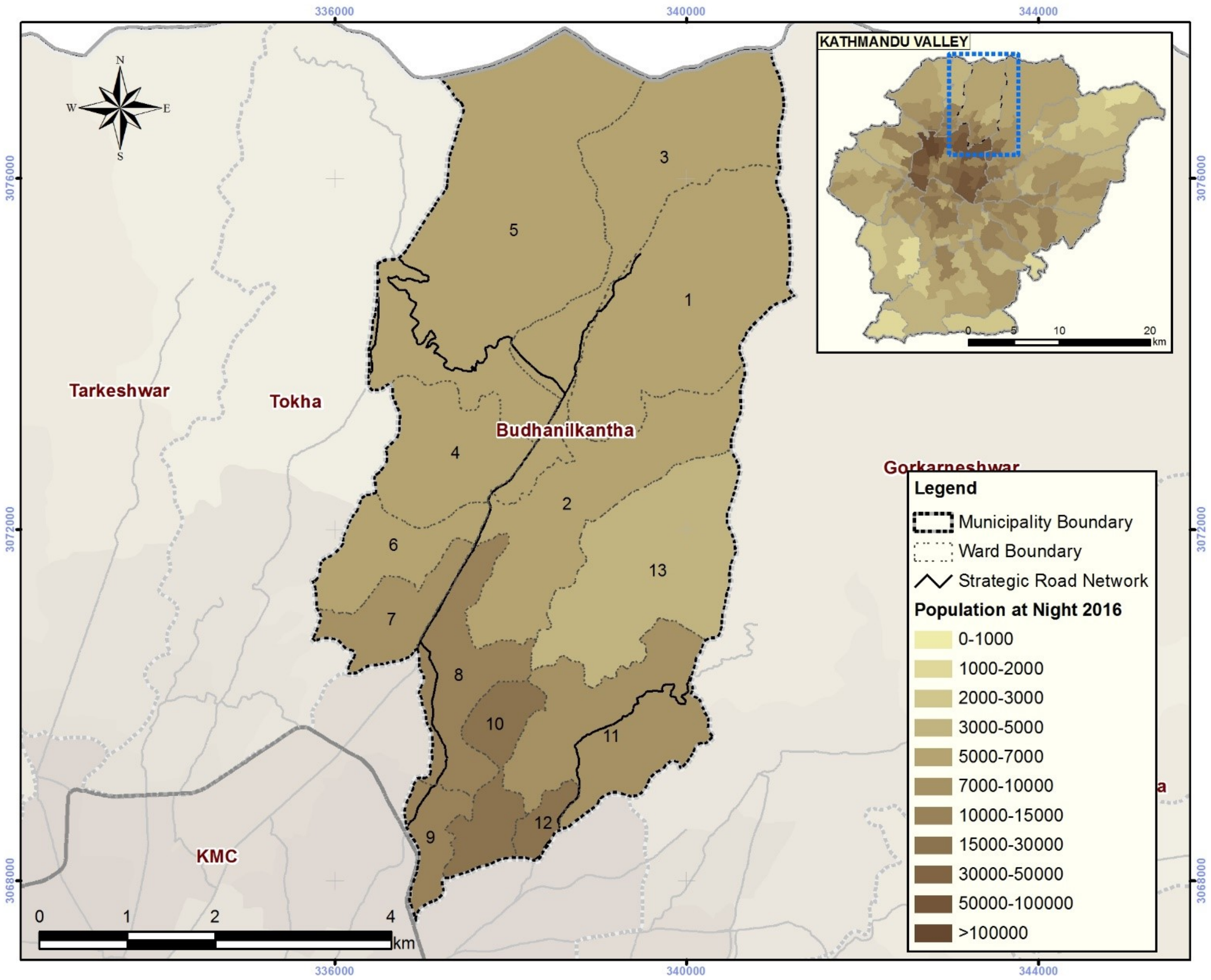
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

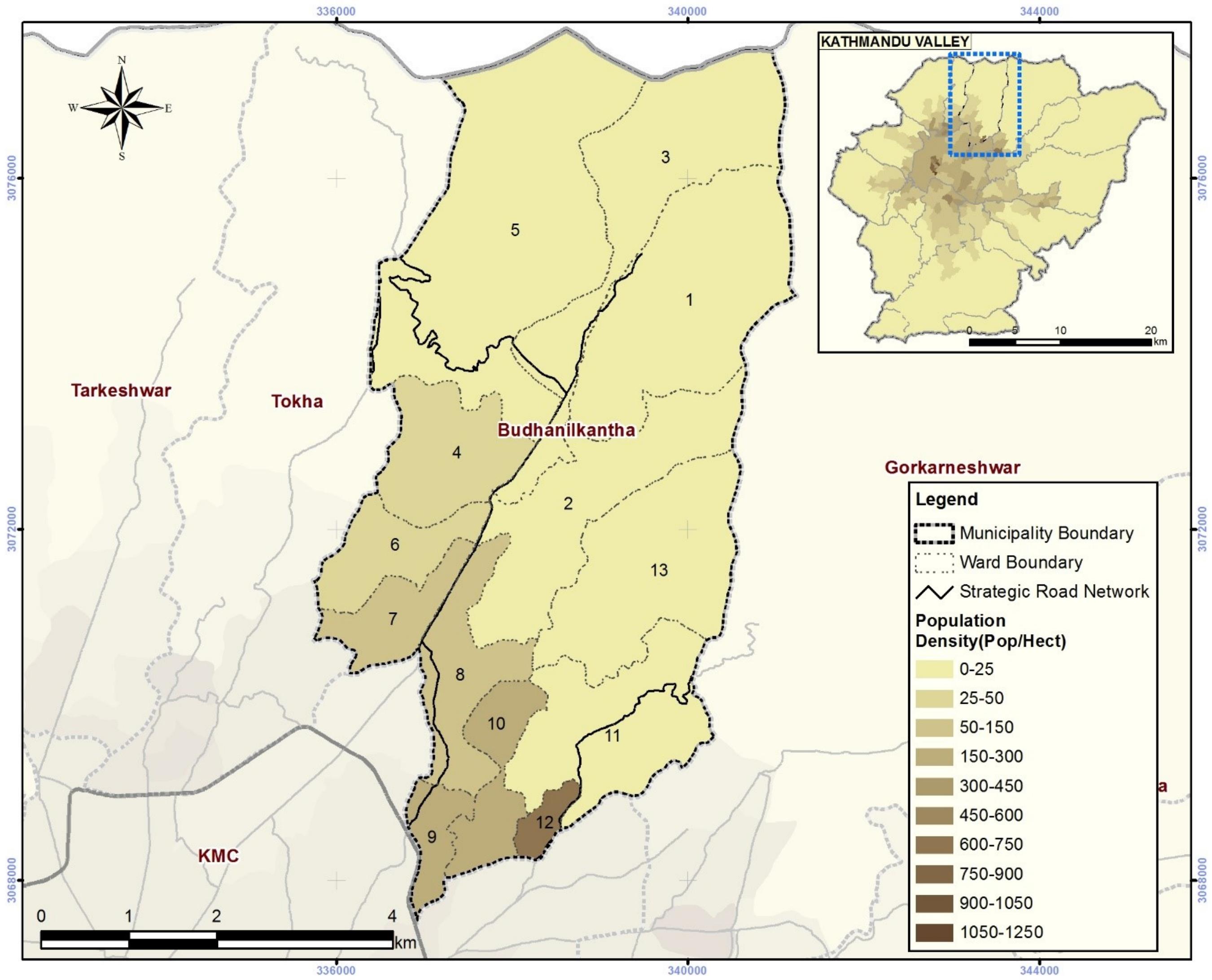
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

## A-3
## Distribution of Population in 2016 at Night

### Population




### Population Density




**Note:**

- The total population of the study area was estimated to be 129,708 in 2016.
- The estimation of ward-wise population in 2016 was carried out by JICA Project Team for the purpose of human casualty estimation based on the scenario earthquakes. The population in 2001 and 2011 according to National Censuses by CBS, the forecast result of the annual population growth rates by district every half-decade by 2016 and the result of prospective analysis for the decennial urbanization process by ward from 1990 to 2016 were used for this prediction.

**Source:**

- Ward wise predicted population in 2016: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

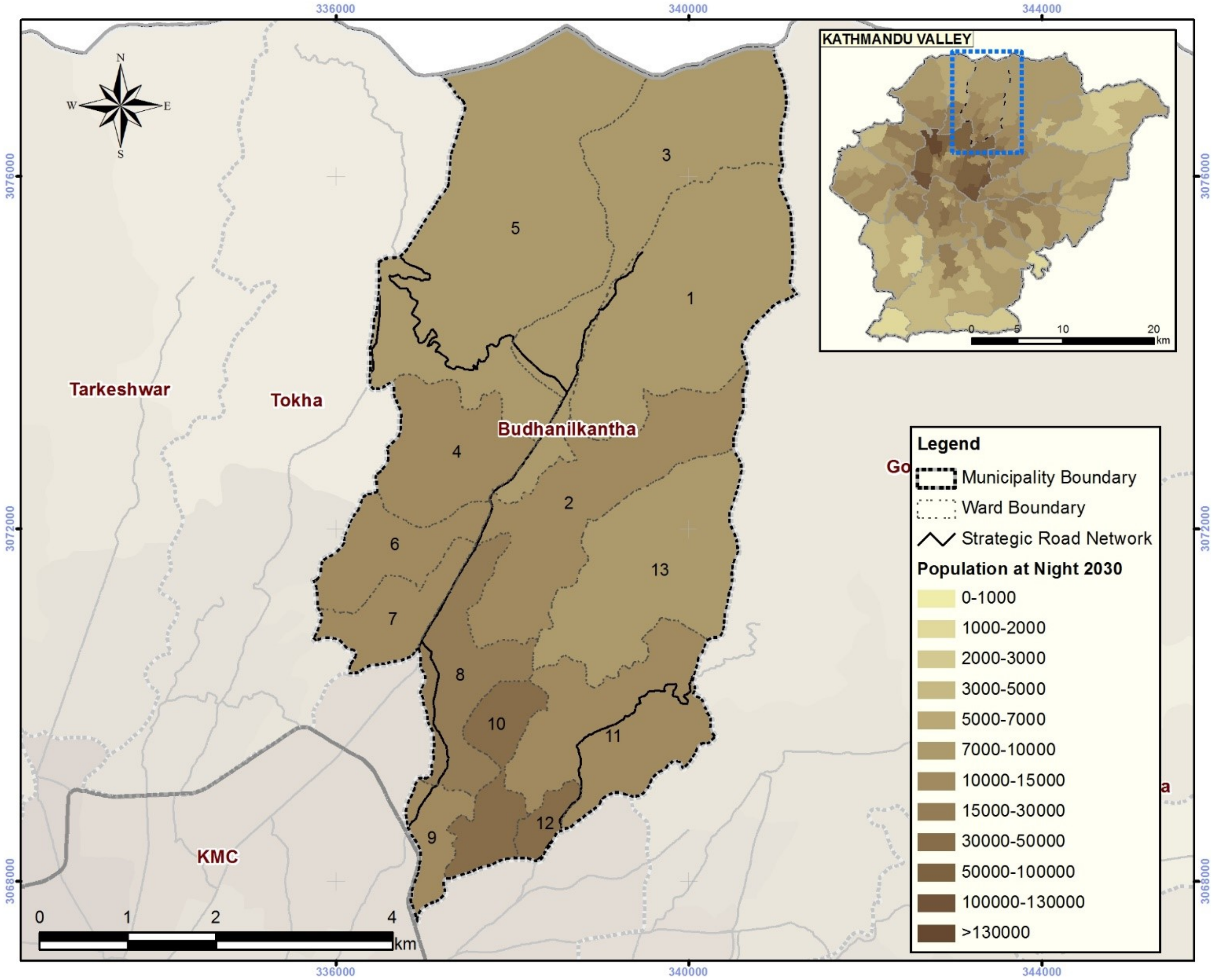
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: .........................................D_WGS_1984
Spheroid: .........................................WGS_1984

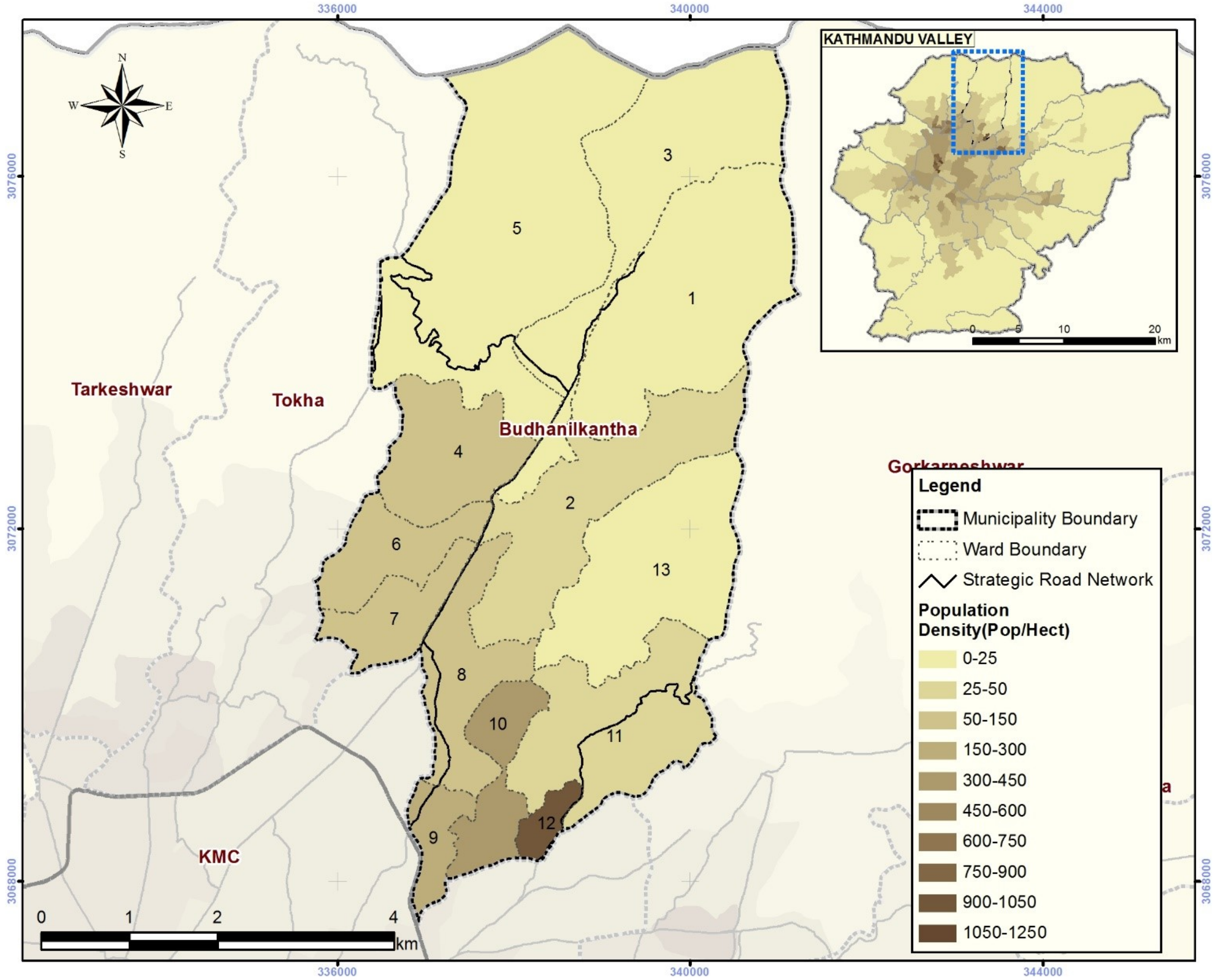
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# A-4
# Distribution of Estimated Population in 2030 at Night

## Population




## Population Density




**Note:**

- The total population in the study area in 2030 was estimated at 193,486
- The estimation of the ward-wise population in 2030 was carried out by JICA Project Team for the purpose of human casualty estimation based on the scenario earthquakes. The population in 2001 and 2011 according to National Censuses by CBS, the forecast result of the annual population growth rates by district every half-decade by 2031 and the result of prospective analysis for the decennial urbanization process by ward from 1990 to 2030 were used for this prediction.

**Source:**

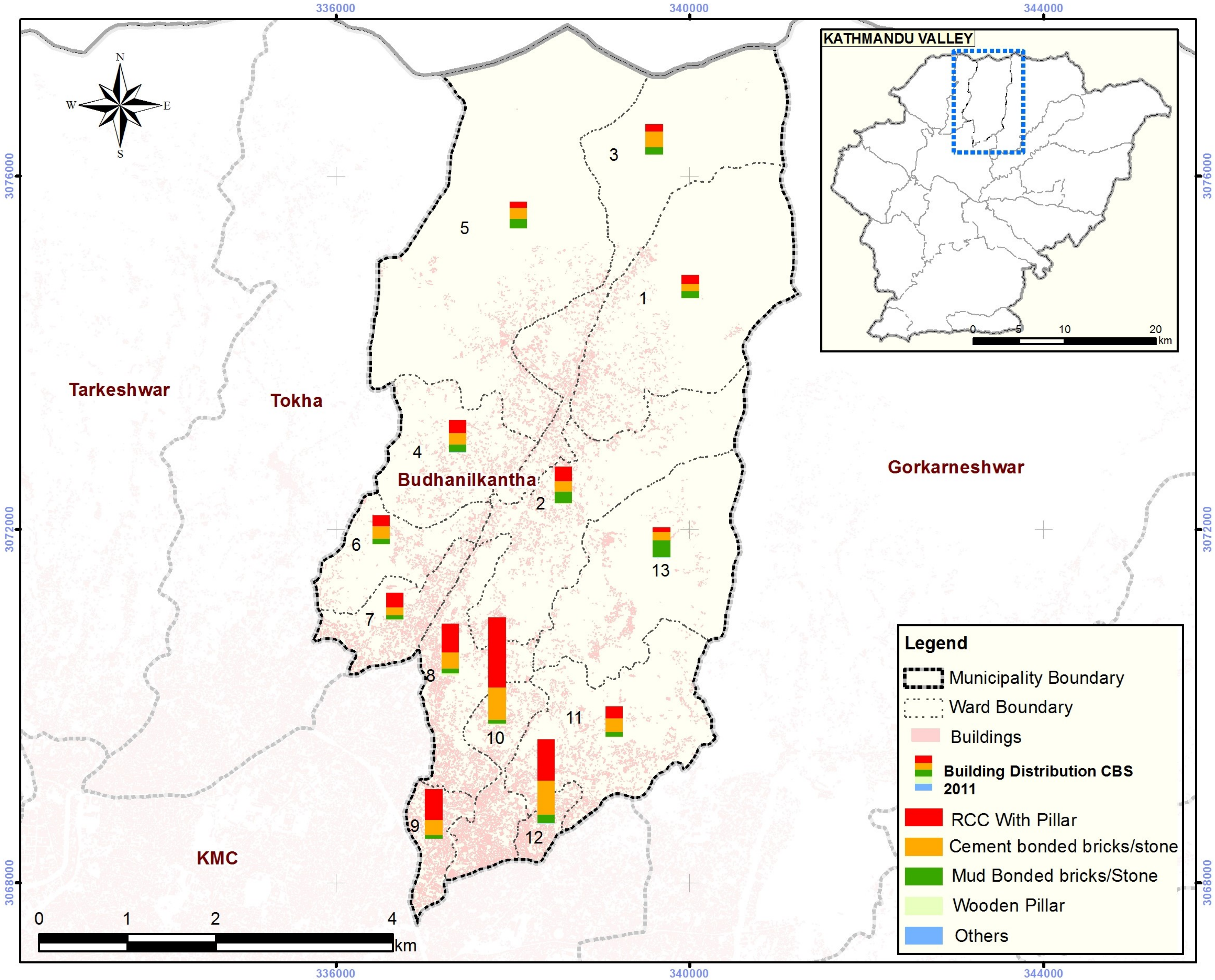
- Ward wise predicted future population in 2030: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal




# A-5

## Building Distribution in 2011

Note:

- Old ward-wise population of Census 2011 was reorganized based on reconstruction of municipality in 2017.

| Ward | MBBS | CBBS | RCCP | WP | Oth |
|---|---|---|---|---|---|
| BUDHANILKANTHA-1 | 173 | 178 | 233 | 6 | 0 |
| BUDHANILKANTHA-2 | 288 | 261 | 371 | 10 | 0 |
| BUDHANILKANTHA-3 | 177 | 399 | 174 | 2 | 0 |
| BUDHANILKANTHA-4 | 183 | 286 | 335 | 3 | 6 |
| BUDHANILKANTHA-5 | 229 | 276 | 151 | 0 | 1 |
| BUDHANILKANTHA-6 | 134 | 322 | 272 | 2 | 4 |
| BUDHANILKANTHA-7 | 113 | 193 | 366 | 4 | 3 |
| BUDHANILKANTHA-8 | 125 | 395 | 723 | 55 | 0 |
| BUDHANILKANTHA-9 | 94 | 380 | 769 | 6 | 1 |
| BUDHANILKANTHA-10 | 83 | 821 | 1742 | 38 | 2 |
| BUDHANILKANTHA-11 | 127 | 330 | 305 | 4 | 1 |
| BUDHANILKANTHA-12 | 213 | 852 | 1031 | 14 | 13 |
| BUDHANILKANTHA-13 | 419 | 216 | 109 | 8 | 9 |
| Total | 2358 | 4909 | 6581 | 152 | 40 |

MBBS-Mud Bonded Brick/Stone

CBBS-Cement Bonded Brick/Stone

RCCP-RCC with Pillar

WP-Wooden Pillar

Oth-Others

Source:

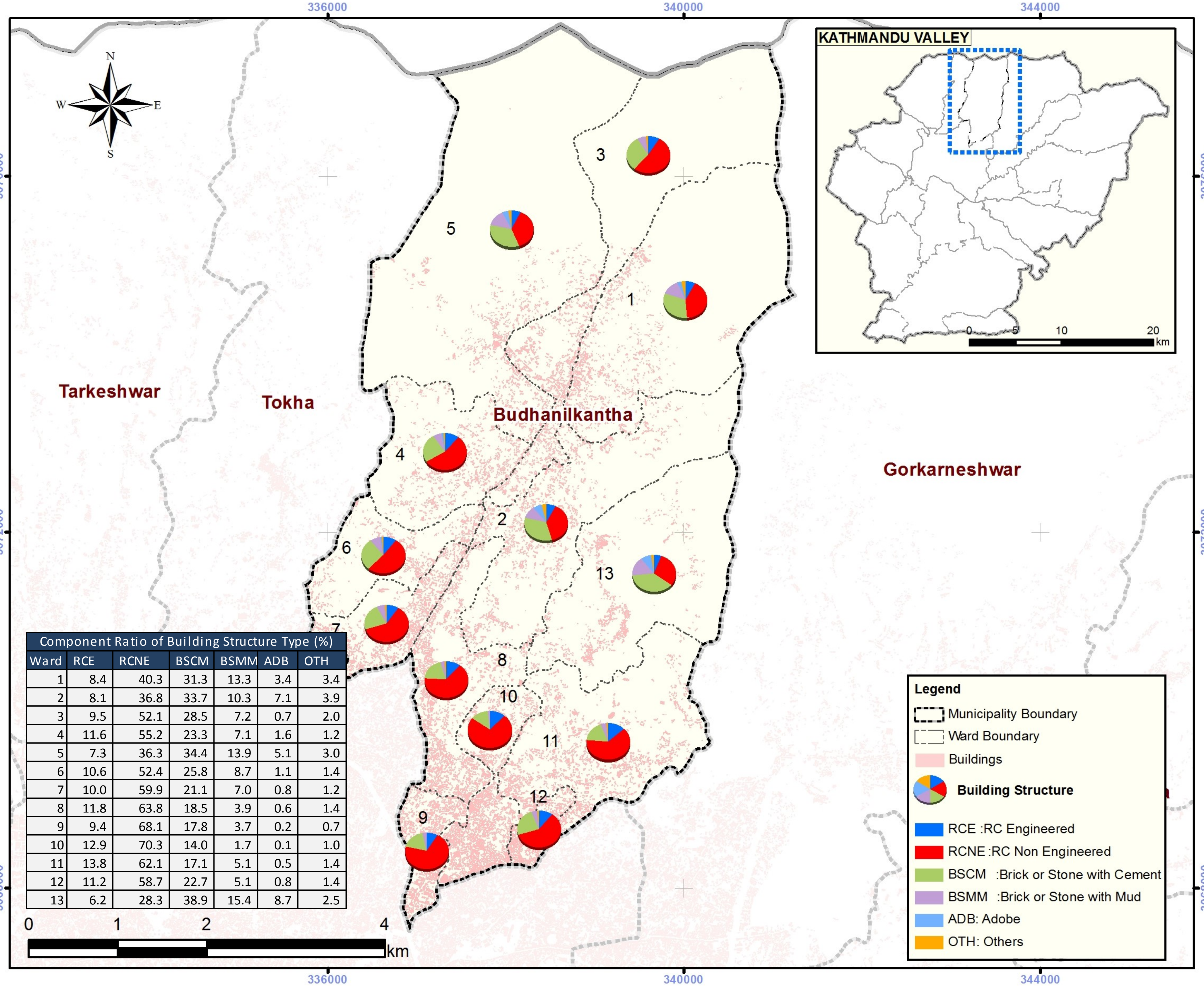
- Building Distribution in 2016: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




Component Ratio of Building Structure Type (%)

| Ward | RCE | RCNE | BSCM | BSMM | ADB | OTH |
|---|---|---|---|---|---|---|
| 1 | 8.4 | 40.3 | 31.3 | 13.3 | 3.4 | 3.4 |
| 2 | 8.1 | 36.8 | 33.7 | 10.3 | 7.1 | 3.9 |
| 3 | 9.5 | 52.1 | 28.5 | 7.2 | 0.7 | 2.0 |
| 4 | 11.6 | 55.2 | 23.3 | 7.1 | 1.6 | 1.2 |
| 5 | 7.3 | 36.3 | 34.4 | 13.9 | 5.1 | 3.0 |
| 6 | 10.6 | 52.4 | 25.8 | 8.7 | 1.1 | 1.4 |
| 7 | 10.0 | 59.9 | 21.1 | 7.0 | 0.8 | 1.2 |
| 8 | 11.8 | 63.8 | 18.5 | 3.9 | 0.6 | 1.4 |
| 9 | 9.4 | 68.1 | 17.8 | 3.7 | 0.2 | 0.7 |
| 10 | 12.9 | 70.3 | 14.0 | 1.7 | 0.1 | 1.0 |
| 11 | 13.8 | 62.1 | 17.1 | 5.1 | 0.5 | 1.4 |
| 12 | 11.2 | 58.7 | 22.7 | 5.1 | 0.8 | 1.4 |
| 13 | 6.2 | 28.3 | 38.9 | 15.4 | 8.7 | 2.5 |

# A-6

# Building Distribution in 2016

**Note:**

- The total building number in the study area was estimated to be 17,066 in 2016.
- The building distribution in 2016 was estimated on the basis of the following assumption:

  *Heavily damaged buildings due to Gorkha Earthquake were reconstructed of Brick Masonry with Cement mortar or RC Engineered.*
- As the first step of estimation of building distribution in 2016, the building distribution at the time of the Gorkha earthquake was estimated using several types of source data such as the result of building inventory & damage survey after Gorkha earthquake, the detailed building footprint map and the land use classification maps.
- Estimated heavily damaged buildings based on Gorkha earthquake model was approx. 4,200, and the proportion of heavily damaged buildings to total number of buildings was 8%
- The summarized component ratio of building structure type and the building number by ward in 2016 are shown in the map.
- The 250m gird wise building distribution in 2016 was estimated by the JICA Project Team only for the purpose of Building Damage Estimation based on the scenario earthquakes.

**Source:**

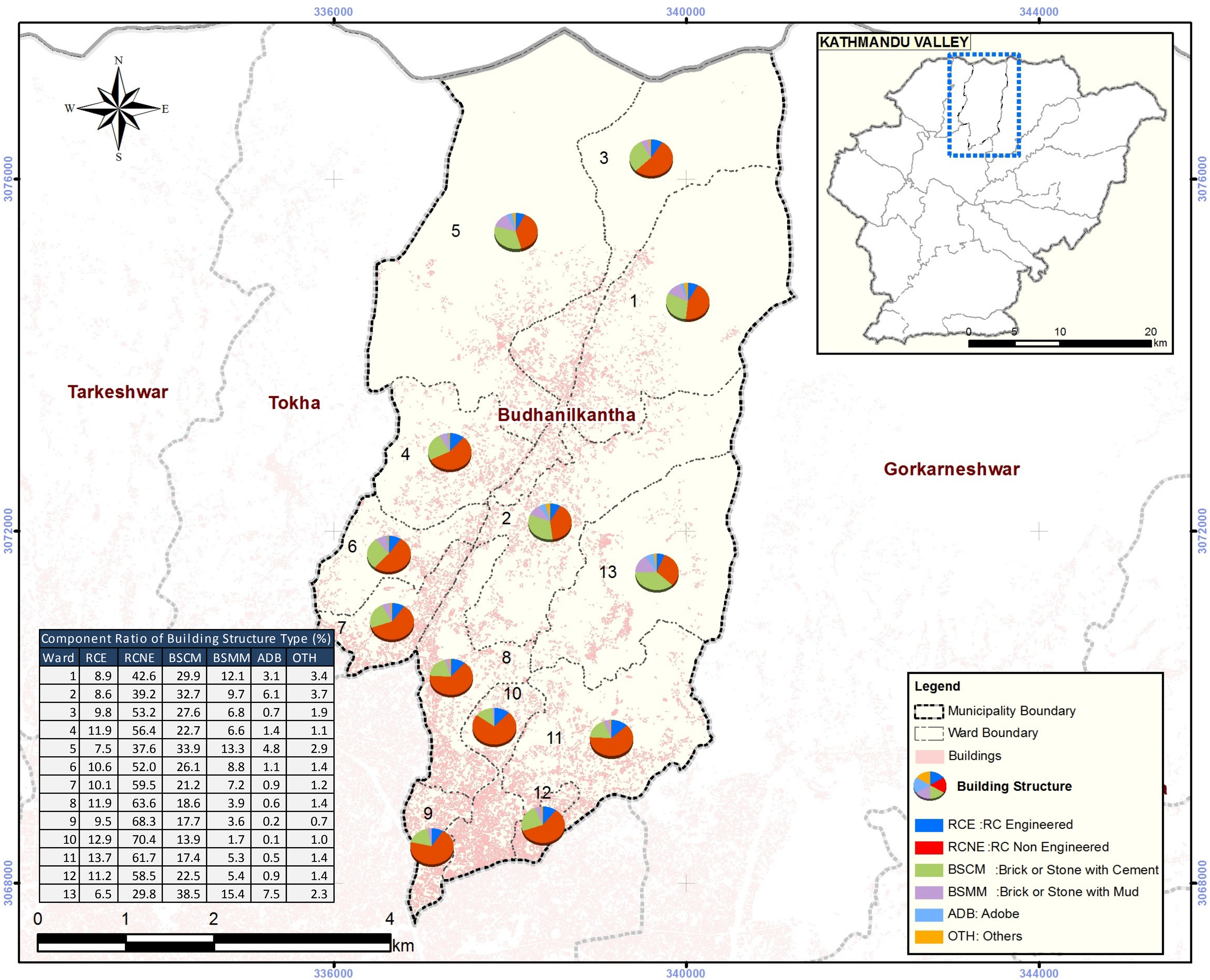
- Building Distribution in 2016: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




Component Ratio of Building Structure Type (%)

| Ward | RCE | RCNE | BSCM | BSMM | ADB | OTH |
|---|---|---|---|---|---|---|
| 1 | 8.9 | 42.6 | 29.9 | 12.1 | 3.1 | 3.4 |
| 2 | 8.6 | 39.2 | 32.7 | 9.7 | 6.1 | 3.7 |
| 3 | 9.8 | 53.2 | 27.6 | 6.8 | 0.7 | 1.9 |
| 4 | 11.9 | 56.4 | 22.7 | 6.6 | 1.4 | 1.1 |
| 5 | 7.5 | 37.6 | 33.9 | 13.3 | 4.8 | 2.9 |
| 6 | 10.6 | 52.0 | 26.1 | 8.8 | 1.1 | 1.4 |
| 7 | 10.1 | 59.5 | 21.2 | 7.2 | 0.9 | 1.2 |
| 8 | 11.9 | 63.6 | 18.6 | 3.9 | 0.6 | 1.4 |
| 9 | 9.5 | 68.3 | 17.7 | 3.6 | 0.2 | 0.7 |
| 10 | 12.9 | 70.4 | 13.9 | 1.7 | 0.1 | 1.0 |
| 11 | 13.7 | 61.7 | 17.4 | 5.3 | 0.5 | 1.4 |
| 12 | 11.2 | 58.5 | 22.5 | 5.4 | 0.9 | 1.4 |
| 13 | 6.5 | 29.8 | 38.5 | 15.4 | 7.5 | 2.3 |

# A-7

# Estimated Building Distribution in 2030 without BSPS

**BSPS: Promotion on Building Seismic Performance Strengthening**

**Note:**

- The total building number in the study area was estimated at 26,894 buildings in 2030. The estimated total building number increased by 57.6% from 2016.
- The rate of increase in building number from 2016 to 2030 by 250m-mesh grid defined as a minimum unit for seismic risk assessment in the project was estimated considering the future population growth rates (CBS) and the result of projection for future built-up area distribution (KVDA/UNDP).
- The building distribution in 2030 without BSPS was estimated on the basis of the following assumptions:

  *The building component ratio by 250m-mesh grid is same as 2016.*
- The summarized component ratio of building structure type and the building number by municipality are shown in the map.
- The 250m gird wise building distribution in 2030 without BSPS was estimated by the JICA Project Team only for the purpose of building Damage Estimation based on the scenario earthquakes.

**Source:**

- Building Distribution in 2030 without BSPS: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD

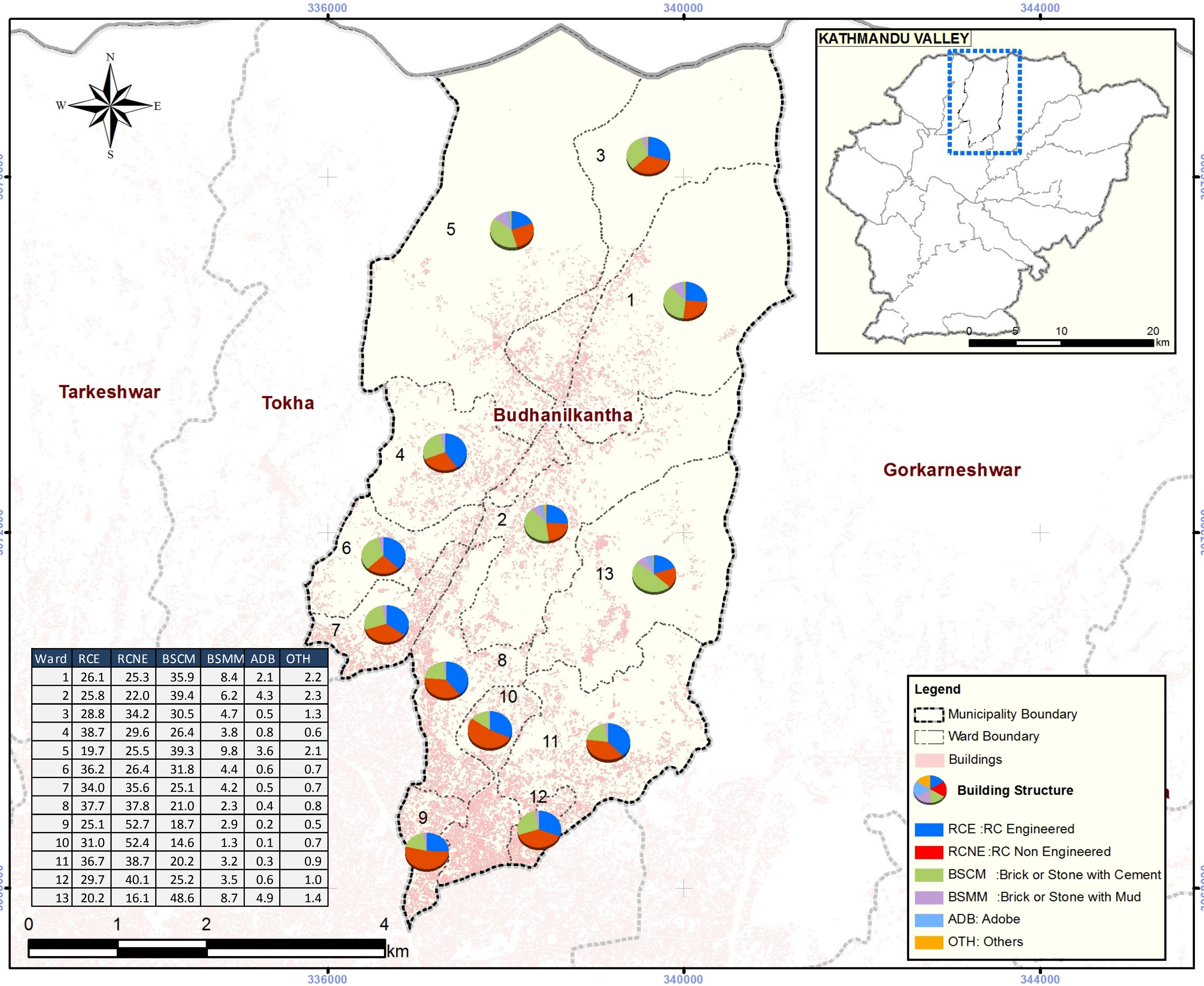
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

JICA




| Ward | RCE | RCNE | BSCM | BSMM | ADB | OTH |
|---|---|---|---|---|---|---|
| 1 | 26.1 | 25.3 | 35.9 | 8.4 | 2.1 | 2.2 |
| 2 | 25.8 | 22.0 | 39.4 | 6.2 | 4.3 | 2.3 |
| 3 | 28.8 | 34.2 | 30.5 | 4.7 | 0.5 | 1.3 |
| 4 | 38.7 | 29.6 | 26.4 | 3.8 | 0.8 | 0.6 |
| 5 | 19.7 | 25.5 | 39.3 | 9.8 | 3.6 | 2.1 |
| 6 | 36.2 | 26.4 | 31.8 | 4.4 | 0.6 | 0.7 |
| 7 | 34.0 | 35.6 | 25.1 | 4.2 | 0.5 | 0.7 |
| 8 | 37.7 | 37.8 | 21.0 | 2.3 | 0.4 | 0.8 |
| 9 | 25.1 | 52.7 | 18.7 | 2.9 | 0.2 | 0.5 |
| 10 | 31.0 | 52.4 | 14.6 | 1.3 | 0.1 | 0.7 |
| 11 | 36.7 | 38.7 | 20.2 | 3.2 | 0.3 | 0.9 |
| 12 | 29.7 | 40.1 | 25.2 | 3.5 | 0.6 | 1.0 |
| 13 | 20.2 | 16.1 | 48.6 | 8.7 | 4.9 | 1.4 |

# A-8

# Estimated Building Distribution in 2030 with BSPS Case-1

## BSPS: Promotion on Building Seismic Performance Strengthening

**Note:**

- The total building number in the study area was estimated at 26,894 buildings in 2030. The estimated total building number increased by 57.6% from 2016.
- The rate of increase in building number from 2016 to 2030 by 250m-mesh grid, defined as the minimum unit for seismic risk assessment in the project, was estimated considering the future population growth rates (CBS) and the result of projection for future built-up area distribution (KVDA/UNDP).
- The building distribution in 2030 with BSPS case-1 was estimated on the basis of the following assumptions:

  *The buildings of Brick Masonry with Cement (BMC) and RC Engineered (RCE) will be constructed as new buildings during the period from 2016 to 2030. The ratio of BMC and RCE for new buildings assumes same as the ratio of building number between Masonry*1 and RC*2 in 2016.*

  **1: Masonry structures include Adobe, Stone with Mud & Cement, Brick Masonry with Mud or Cement and Other materials.*
  **2: RC structures include RC Non-Engineered and RC Engineered.*

- The summarized component ratio of building structure type and the building number by municipality are shown in the map.
- The 250m gird wise building distribution in 2030 with BSPS Case-1 was estimated by JICA Project Team only for the purpose of building Damage Estimation based on the scenario earthquakes.

**Source:**

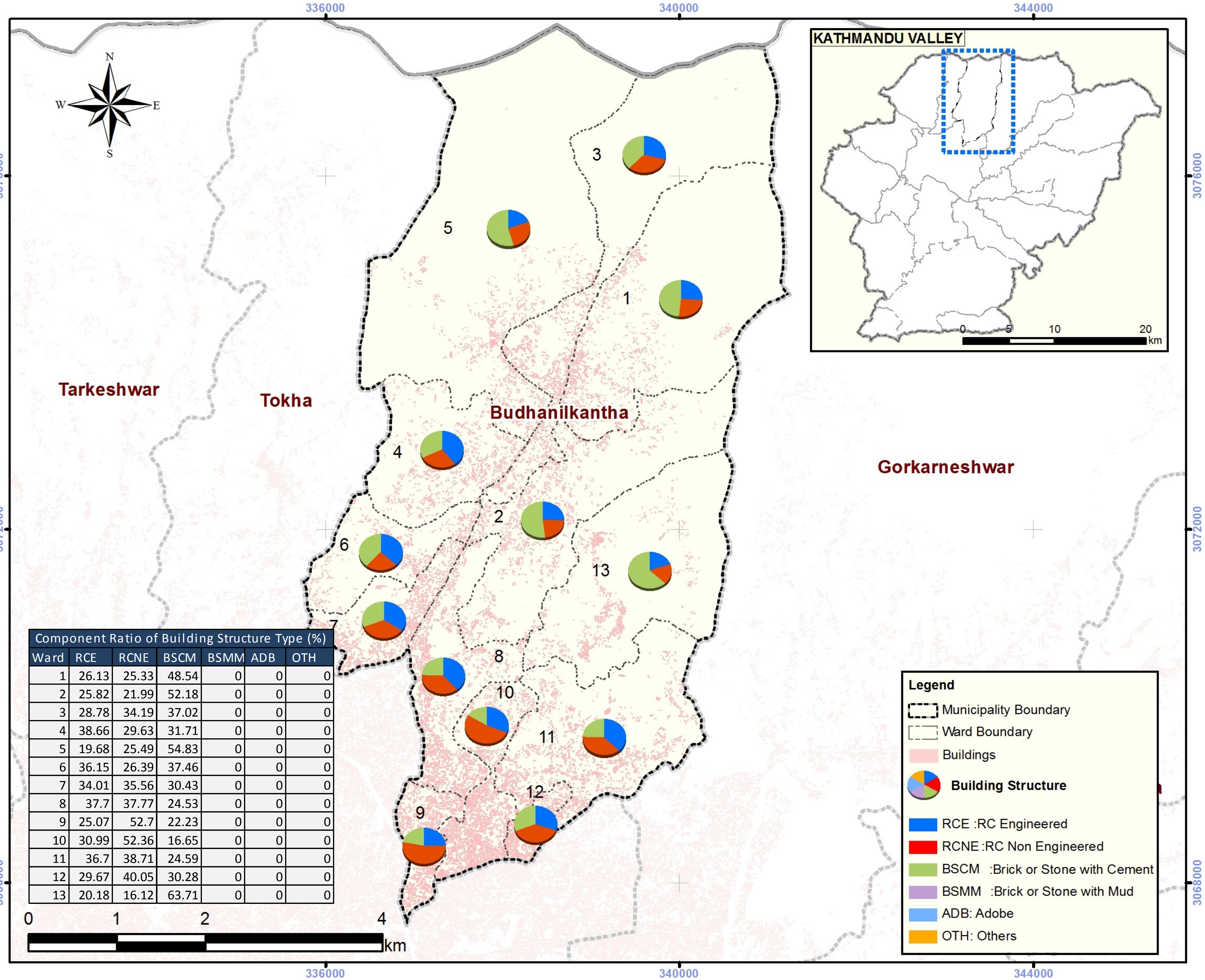
- Building Distribution in 2030 with BSPS C-1: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




Component Ratio of Building Structure Type (%)

| Ward | RCE | RCNE | BSCM | BSMM | ADB | OTH |
|---|---|---|---|---|---|---|
| 1 | 26.13 | 25.33 | 48.54 | 0 | 0 | 0 |
| 2 | 25.82 | 21.99 | 52.18 | 0 | 0 | 0 |
| 3 | 28.78 | 34.19 | 37.02 | 0 | 0 | 0 |
| 4 | 38.66 | 29.63 | 31.71 | 0 | 0 | 0 |
| 5 | 19.68 | 25.49 | 54.83 | 0 | 0 | 0 |
| 6 | 36.15 | 26.39 | 37.46 | 0 | 0 | 0 |
| 7 | 34.01 | 35.56 | 30.43 | 0 | 0 | 0 |
| 8 | 37.7 | 37.77 | 24.53 | 0 | 0 | 0 |
| 9 | 25.07 | 52.7 | 22.23 | 0 | 0 | 0 |
| 10 | 30.99 | 52.36 | 16.65 | 0 | 0 | 0 |
| 11 | 36.7 | 38.71 | 24.59 | 0 | 0 | 0 |
| 12 | 29.67 | 40.05 | 30.28 | 0 | 0 | 0 |
| 13 | 20.18 | 16.12 | 63.71 | 0 | 0 | 0 |

# A-9

# Estimated Building Distribution in 2030 with BSPS Case-2

## BSPS: Promotion on Building Seismic Performance Strengthening

**Note:**

- The total building number in the study area was estimated at 26,894 buildings in 2030. The estimated total building number increased by 57.6% from 2016.
- The rate of increase in building number from 2016 to 2030 by 250m-mesh grid, defined as the minimum unit for seismic risk assessment in the project, was estimated considering the future population growth rates (CBS) and the result of projection for future built-up area distribution (KVDA/UNDP).
- The building distribution in 2030 with BSPS case-2 was estimated on the basis of the following assumptions:

  *The buildings of Brick Masonry with Cement (BMC) and RC Engineered (RCE) will be constructed as new buildings during the period from 2016 to 2030. The ratio of BMC and RCE for new buildings assumes same as Case-1.*

  *Existing buildings made of Adobe, Brick Masonry with Mud and Other materials in 2016 will be reconstructed by Brick Masonry with Cement.*
- The summarized component ratio of building structure type and the building number by municipality are shown in the map.
- The 250m gird wise building distribution in 2030 with BSPS Case-2 was estimated by JICA Project Team only for the purpose of building Damage Estimation based on the scenario earthquakes.

**Source:**

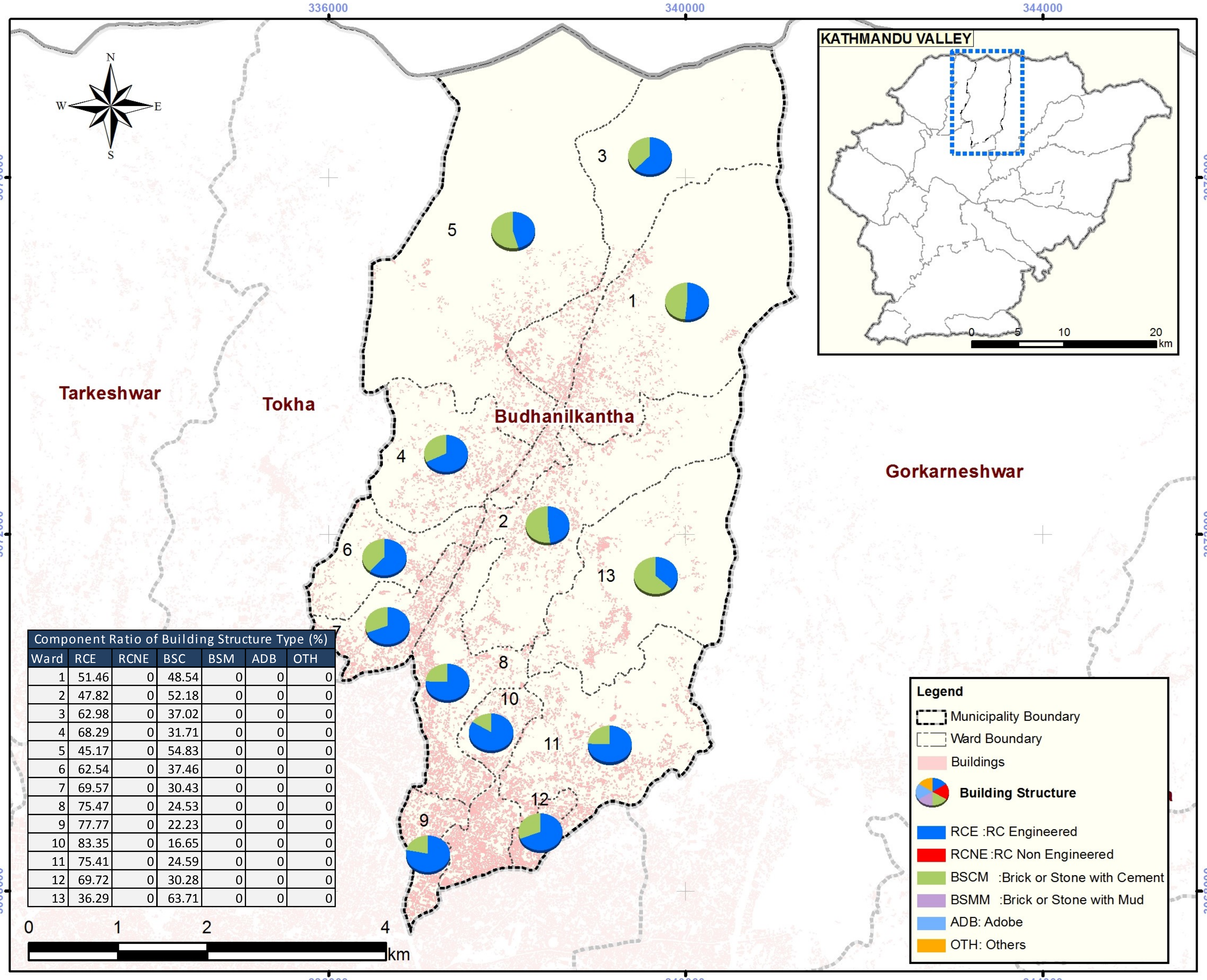
- Building Distribution in 2030 with BSPS C-2: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




Component Ratio of Building Structure Type (%)

| Ward | RCE | RCNE | BSC | BSM | ADB | OTH |
|---|---|---|---|---|---|---|
| 1 | 51.46 | 0 | 48.54 | 0 | 0 | 0 |
| 2 | 47.82 | 0 | 52.18 | 0 | 0 | 0 |
| 3 | 62.98 | 0 | 37.02 | 0 | 0 | 0 |
| 4 | 68.29 | 0 | 31.71 | 0 | 0 | 0 |
| 5 | 45.17 | 0 | 54.83 | 0 | 0 | 0 |
| 6 | 62.54 | 0 | 37.46 | 0 | 0 | 0 |
| 7 | 69.57 | 0 | 30.43 | 0 | 0 | 0 |
| 8 | 75.47 | 0 | 24.53 | 0 | 0 | 0 |
| 9 | 77.77 | 0 | 22.23 | 0 | 0 | 0 |
| 10 | 83.35 | 0 | 16.65 | 0 | 0 | 0 |
| 11 | 75.41 | 0 | 24.59 | 0 | 0 | 0 |
| 12 | 69.72 | 0 | 30.28 | 0 | 0 | 0 |
| 13 | 36.29 | 0 | 63.71 | 0 | 0 | 0 |

# A-10

## Estimated Building Distribution in 2030 with BSPS Case-3

### BSPS: Promotion on Building Seismic Performance Strengthening

**Note:**

- The total building number in the study area was estimated at 26,894 buildings in 2030. The estimated total building number increased by 57.6% from 2016.
- The rate of increase in building number from 2016 to 2030 by 250m-mesh grid, defined as the minimum unit for seismic risk assessment in the project, was estimated considering the future population growth rates (CBS) and the result of projection for future built-up area distribution (KVDA/UNDP).
- The building distribution in 2030 with BSPS case-3 was estimated on the basis of the following assumptions:

  *The buildings of Brick Masonry with Cement (BMC) and RC Engineered (RCE) will be constructed as new buildings during the period from 2016 to 2030. The ratio of BMC and RCE for new buildings assumes same as Case-1.*

  *Existing buildings made of Adobe, Brick Masonry with Mud and Other materials in 2016 will be reconstructed by Brick Masonry with Cement.*

  *Existing buildings of RC Non-Engineered at 2016 will be reconstructed by RC Engineered.*
- The summarized component ratio of building structure type and the building number by municipality are shown in the map.
- The 250m gird wise building distribution in 2030 with BSPS Case-3 was estimated by the JICA Project Team only for the purpose of building Damage Estimation based on the scenario earthquakes.

**Source:**

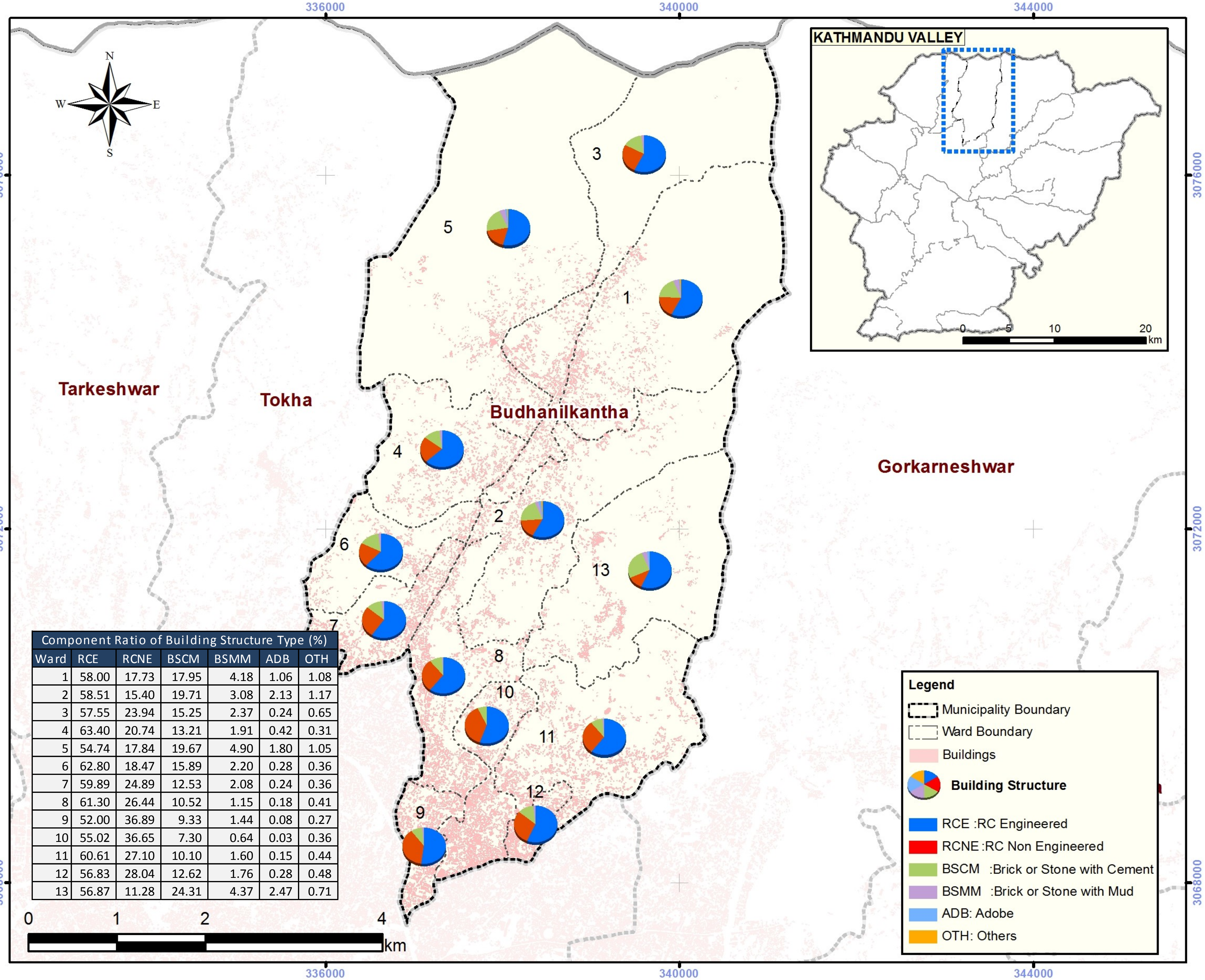
- Building Distribution in 2030 with BSPS C-3: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




Component Ratio of Building Structure Type (%)

| Ward | RCE | RCNE | BSCM | BSMM | ADB | OTH |
|---|---|---|---|---|---|---|
| 1 | 58.00 | 17.73 | 17.95 | 4.18 | 1.06 | 1.08 |
| 2 | 58.51 | 15.40 | 19.71 | 3.08 | 2.13 | 1.17 |
| 3 | 57.55 | 23.94 | 15.25 | 2.37 | 0.24 | 0.65 |
| 4 | 63.40 | 20.74 | 13.21 | 1.91 | 0.42 | 0.31 |
| 5 | 54.74 | 17.84 | 19.67 | 4.90 | 1.80 | 1.05 |
| 6 | 62.80 | 18.47 | 15.89 | 2.20 | 0.28 | 0.36 |
| 7 | 59.89 | 24.89 | 12.53 | 2.08 | 0.24 | 0.36 |
| 8 | 61.30 | 26.44 | 10.52 | 1.15 | 0.18 | 0.41 |
| 9 | 52.00 | 36.89 | 9.33 | 1.44 | 0.08 | 0.27 |
| 10 | 55.02 | 36.65 | 7.30 | 0.64 | 0.03 | 0.36 |
| 11 | 60.61 | 27.10 | 10.10 | 1.60 | 0.15 | 0.44 |
| 12 | 56.83 | 28.04 | 12.62 | 1.76 | 0.28 | 0.48 |
| 13 | 56.87 | 11.28 | 24.31 | 4.37 | 2.47 | 0.71 |

# A-11

## Estimated Building Distribution in 2030 with BSPS Case-4

### BSPS: Promotion on Building Seismic Performance Strengthening

**Note:**

- The total building number in the study area was estimated at 26,894 buildings in 2030. The estimated total building number increased by 57.6% from 2016.
- The building distribution in 2030 with BSPS case-4 was estimated on the basis of the following assumptions:

  *The buildings of Brick Masonry with Cement (BMC) and RC Engineered (RCE) will be constructed as new buildings during the period from 2016 to 2030. The ratio of BMC and RCE for new buildings assumes same as the ratio of building number between 50% of Masonry*1, and RC*2 plus 50% of Masonry*1 in 2016.*

  *50% of existing buildings of Masonry*1 in 2016 will be reconstructed of RC Engineered by 2030.*

  *30% of existing buildings of RC Non-Engineered in 2016 will be reconstructed of RC Engineered by 2030.*

  **1: Masonry structures include Adobe, Stone with Mud & Cement, Brick Masonry with Mud or Cement and Other materials.*
  **2: RC structures include RC Non-Engineered and RC Engineered.*
- The summarized component ratio of building structure type and the building number by municipality are shown in the map.
- The 250m gird wise building distribution in 2030 with BSPS Case-4 was estimated by the JICA Project Team only for the purpose of building Damage Estimation based on the scenario earthquakes.

**Source:**

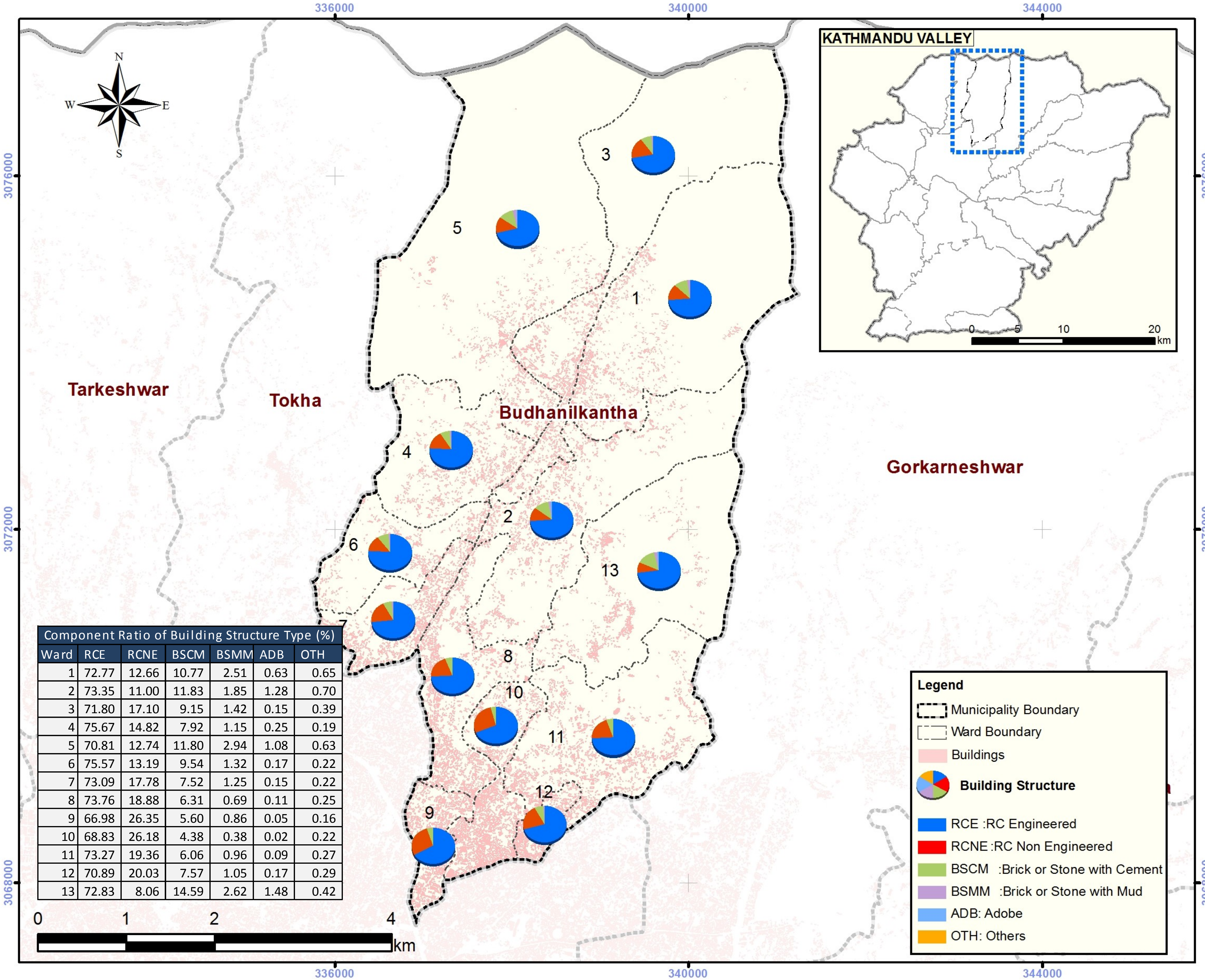
- Building Distribution in 2030 with BSPS C-4: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal




| Component Ratio of Building Structure Type (%) | | | | | | |
|---|---|---|---|---|---|---|
| Ward | RCE | RCNE | BSCM | BSMM | ADB | OTH |
| 1 | 72.77 | 12.66 | 10.77 | 2.51 | 0.63 | 0.65 |
| 2 | 73.35 | 11.00 | 11.83 | 1.85 | 1.28 | 0.70 |
| 3 | 71.80 | 17.10 | 9.15 | 1.42 | 0.15 | 0.39 |
| 4 | 75.67 | 14.82 | 7.92 | 1.15 | 0.25 | 0.19 |
| 5 | 70.81 | 12.74 | 11.80 | 2.94 | 1.08 | 0.63 |
| 6 | 75.57 | 13.19 | 9.54 | 1.32 | 0.17 | 0.22 |
| 7 | 73.09 | 17.78 | 7.52 | 1.25 | 0.15 | 0.22 |
| 8 | 73.76 | 18.88 | 6.31 | 0.69 | 0.11 | 0.25 |
| 9 | 66.98 | 26.35 | 5.60 | 0.86 | 0.05 | 0.16 |
| 10 | 68.83 | 26.18 | 4.38 | 0.38 | 0.02 | 0.22 |
| 11 | 73.27 | 19.36 | 6.06 | 0.96 | 0.09 | 0.27 |
| 12 | 70.89 | 20.03 | 7.57 | 1.05 | 0.17 | 0.29 |
| 13 | 72.83 | 8.06 | 14.59 | 2.62 | 1.48 | 0.42 |

# A-12

## Estimated Building Distribution in 2030 with BSPS Case-5

### BSPS: Promotion on Building Seismic Performance Strengthening

**Note:**

- The total building number in the study area was estimated at 26,894 buildings in 2030. The estimated total building number increased by 57.6% from 2016.
- The building distribution in 2030 with BSPS case-5 was estimated on the basis of the following assumptions:

  *The buildings of Brick Masonry with Cement (BMC) and RC Engineered (RCE) will be constructed as new buildings during the period from 2016 to 2030. The ratio of BMC and RCE for new buildings assumes same as the ratio of building number between 30% of Masonry*1, and RC*2 plus 70% of Masonry*1 in 2016.*

  *70% of existing buildings of Masonry*1 at 2016 will be reconstructed of RC Engineered by 2030.*

  *50% of existing buildings of RC Non-Engineered at 2016 will be reconstructed of RC Engineered by 2030.*

  **1: Masonry structures include Adobe, Stone with Mud & Cement, Brick Masonry with Mud or Cement and Other materials.*
  **2: RC structures include RC Non-Engineered and RC Engineered.*
- The summarized component ratio of building structure type and the building number by municipality are shown in the map.
- The 250m gird-wise building distribution in 2030 with BSPS Case-5 was estimated by JICA Project Team only for the purpose of building Damage Estimation based on the scenario earthquakes.

**Source:**

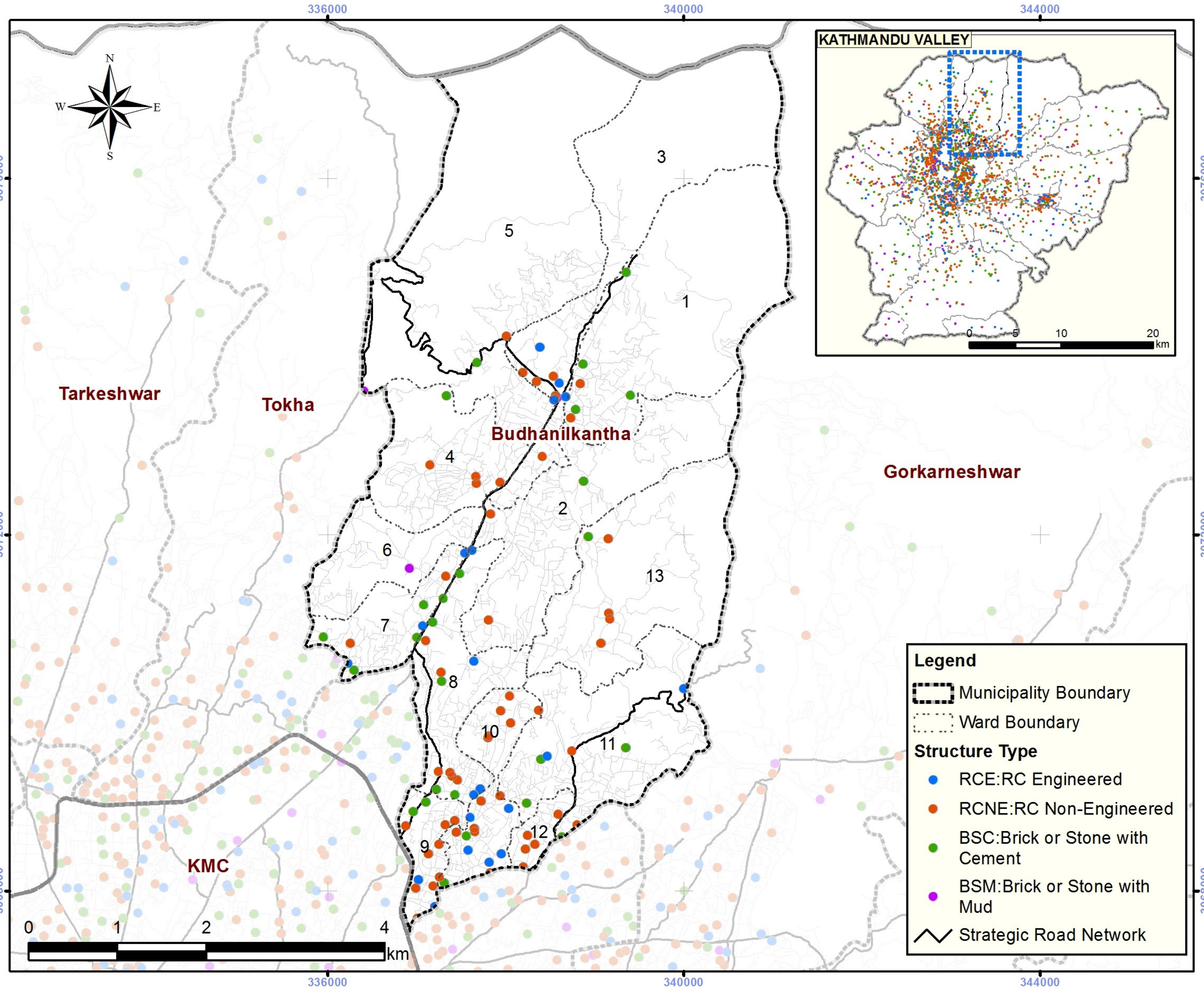
- Building Distribution in 2030 with BSPS C-5: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...................87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

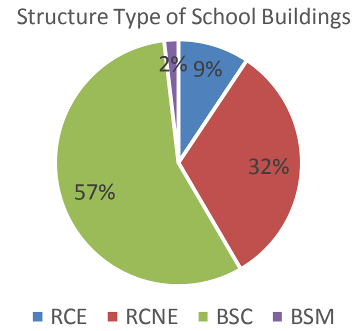



# A-13

## Distribution of School Building

**Note:**

- There are a total of 102 schools in the study area targeted for the seismic risk assessment. These are classified into Primary, Lower secondary, Secondary, Higher secondary, College, University and others. The total number of school buildings is 267.
- The component ratio of structure type of school buildings in the study area is as follows:




**Source:**

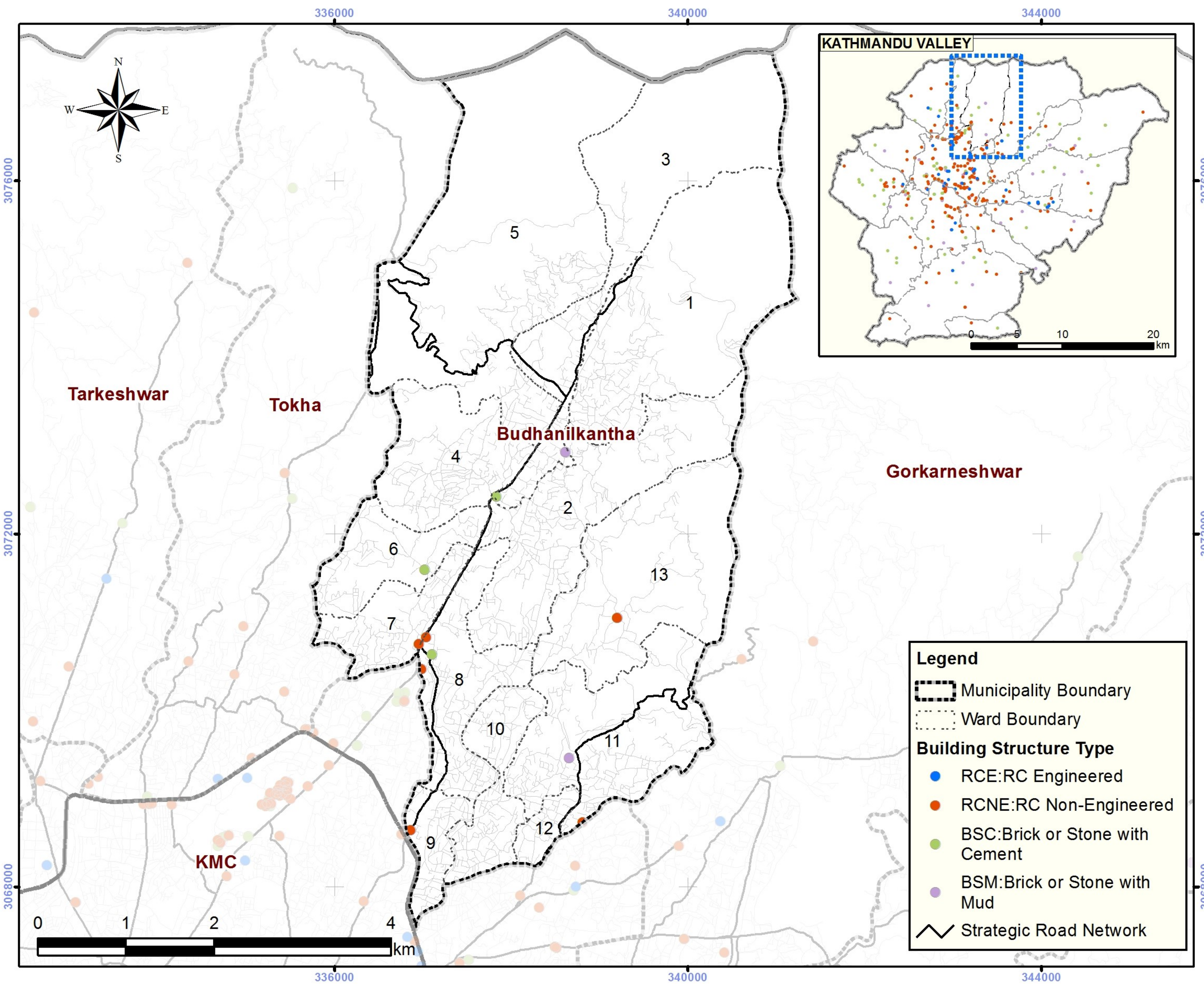
- School inventory data: DoE, Flagship 1 of NRRC.
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: .........................................D_WGS_1984
Spheroid: ........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

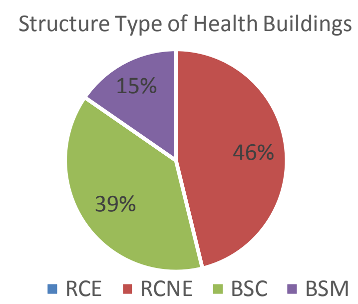



# A-14

## Distribution of Health Facility Building

**Note:**

- There are a total of 11 health facilities in the study area targeted for seismic risk assessment. These are classified into Hospital, PHCC, Health post and others which operators are divided into Government, Private and Community. The total number of health facilities' buildings is 13.
- The component ratio of structure type of health facilities buildings in the study area is as follows:




**Source:**

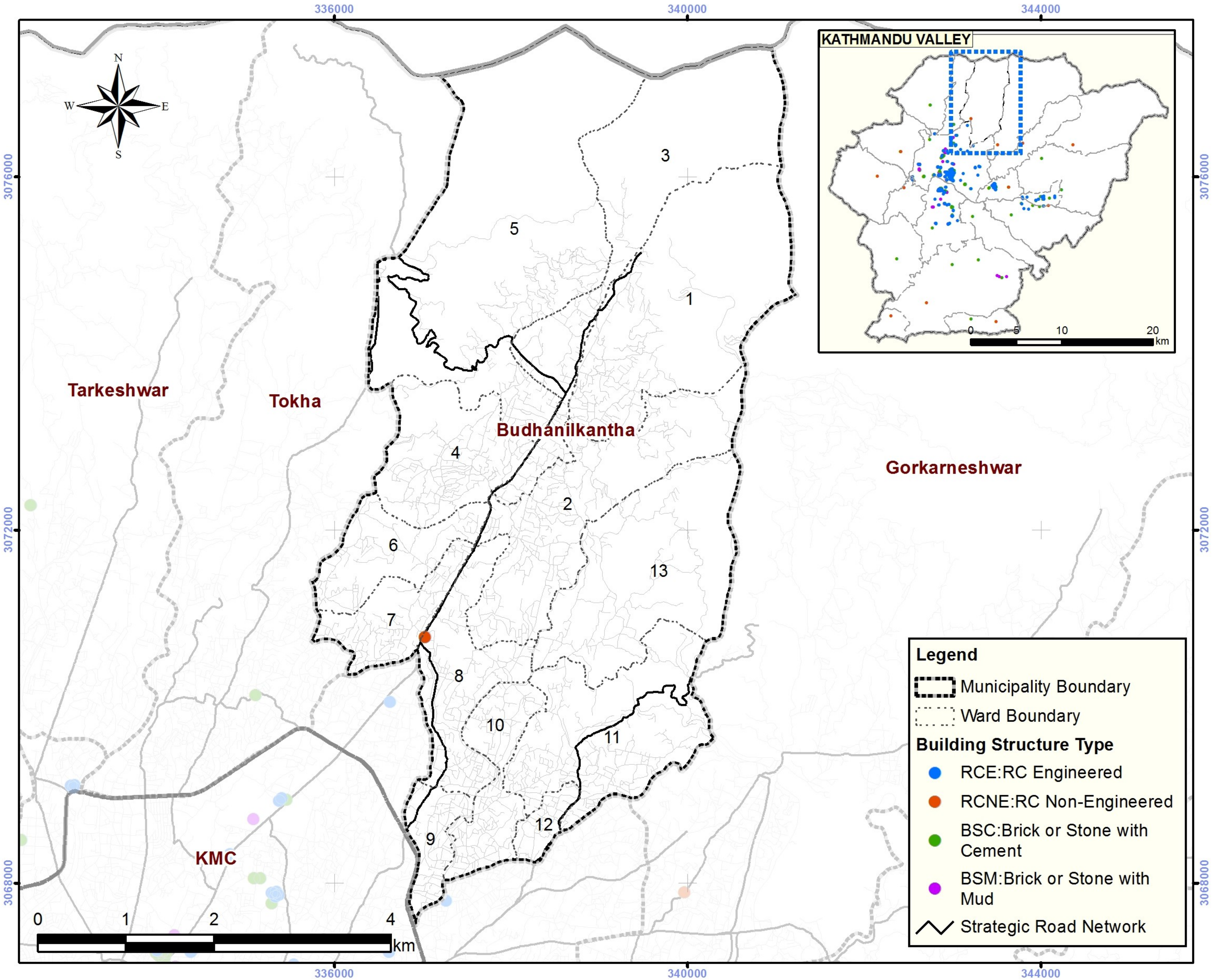
- Health Facility inventory data: DoH, Flagship 1 of NRRC.
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# A-15

## Distribution of Government Building

**Note:**

- One government building was targeted for seismic risk assessment in the study area. The targeted building is the Budhanilkantha Municipality Office.

**Source:**

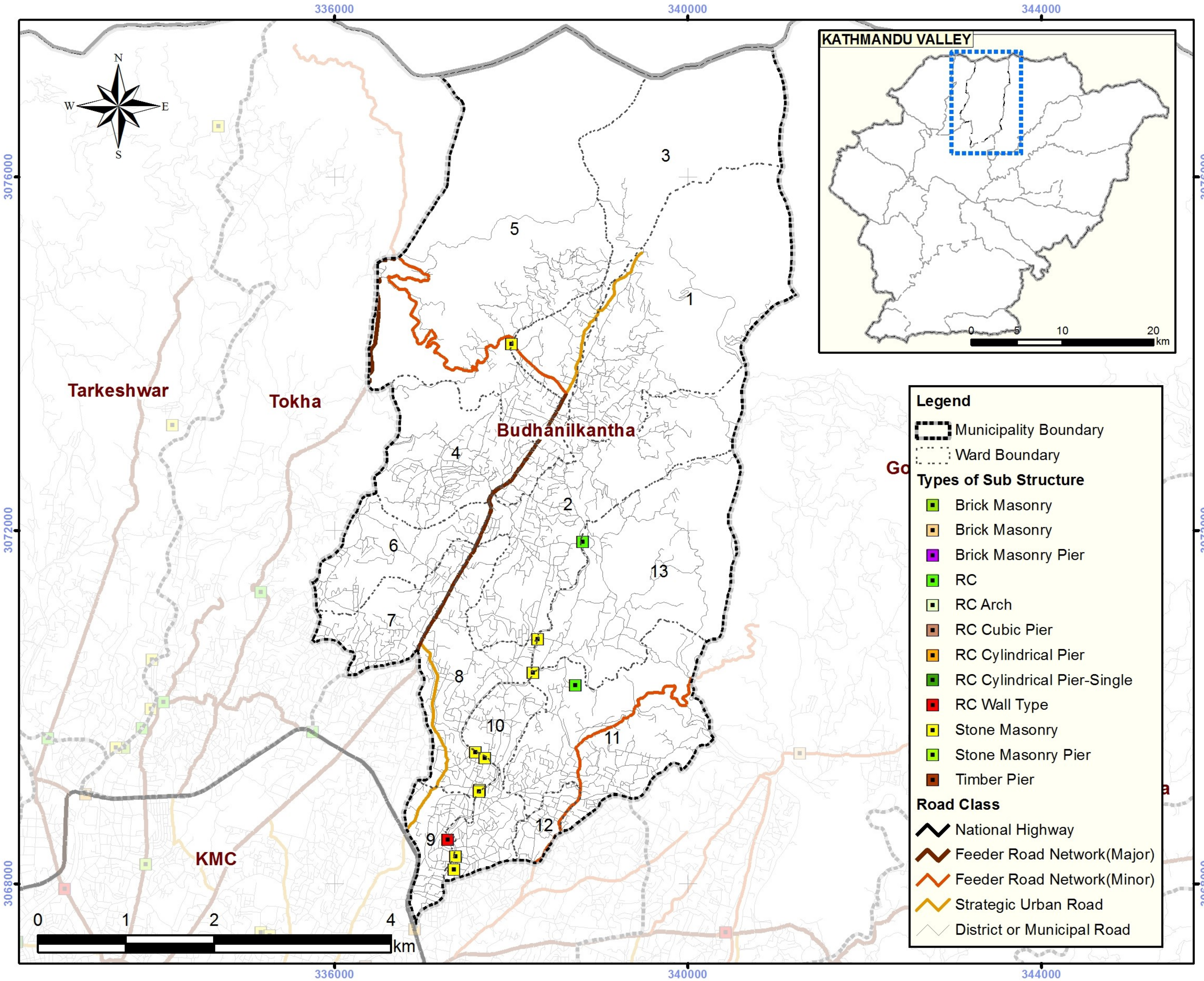
- Government building inventory data: DUDBC, ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# A-16

## Road Network and Bridge Distribution

**Note:**

- According to the SSRN2015-2016 (Statistics of Strategic Road Network 2015-16) published by DoR and Highway Management Information System (HMIS) managed by DoR, the total length of strategic road network (SRN) for Budhanilkantha are as follows

| Municipality | Class of Road | Road Length (Km) |
|---|---|---|
| Budhanilkantha Municipality | NH | 0 |
| | FRN,FRO | 14.1 |
| | SUR | 4.4 |

NH: National Highway
FRN: Feeder Road Network
SUR: Strategic Urban Road

- There are 12 bridges in the municipality area.- Targeted bridges are mainly located on the Strategic Road Network (SRN) but some bridges are located on district or village road network.
- The exact location of the bridges and structure types for each bridge were identified by visiting each bridge based on the inventory of the Bridge Management System (BMS), operated by DoR, and other available data.

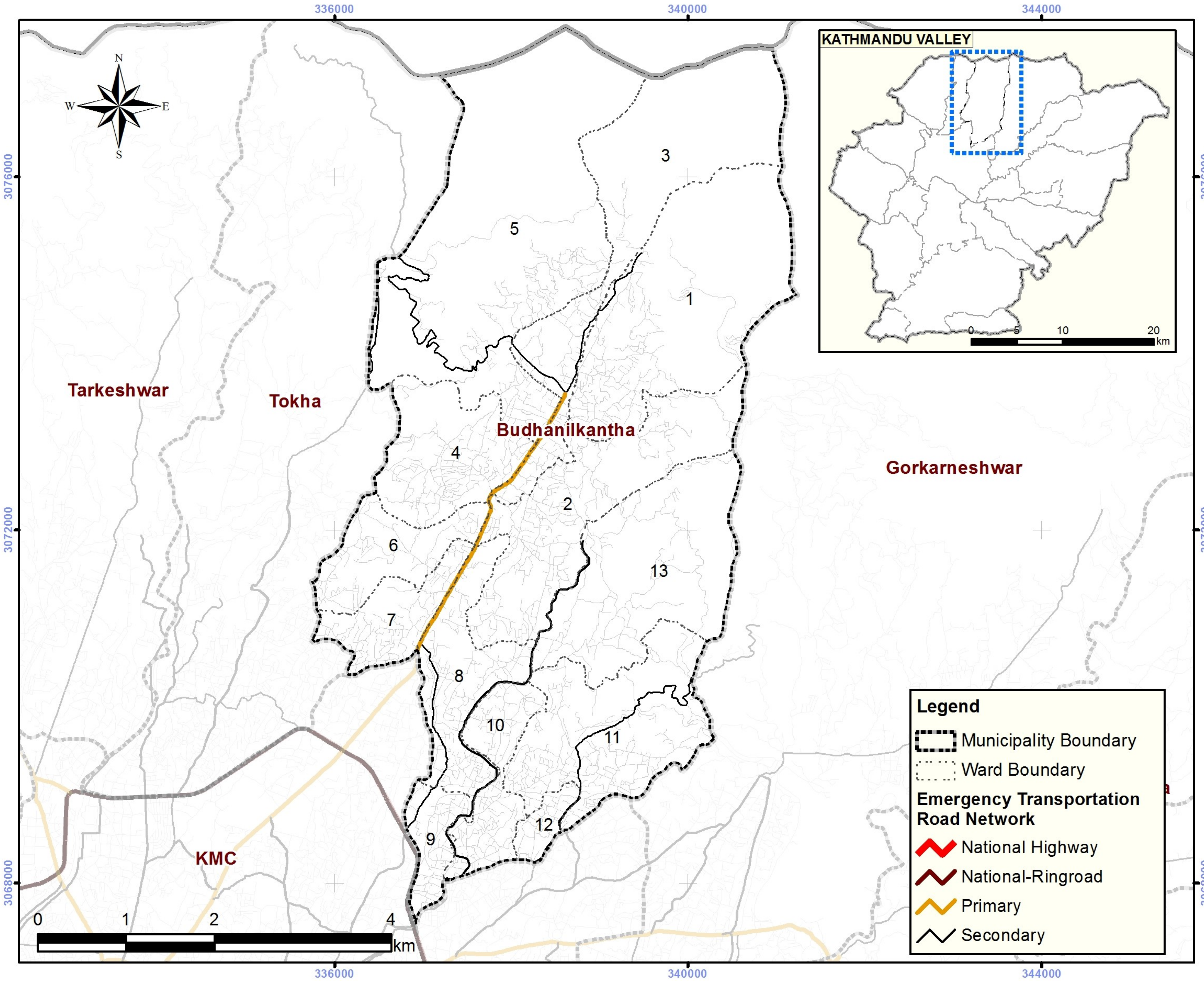
The structure types of bridges are divided as follows:

| Structure | Multi-Span (2) | Single-Span (10) |
|---|---|---|
| RC | 1 | 2 |
| Masonry | 1 | 8 |
| Timber | 0 | 0 |

**Source:**

- Road Network: DoR, DoLIDAR
- Boundary of Municipality and Ward: DoS, MoFALD
- Bridge inventory data: DoR, ERAKV 2016

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal




# A-17

## Emergency Transportation Road Network (ETRN) Proposed by JICA RRNE

**RRNE: Rehabilitation and Recovery from Nepal Earthquake**

**Note:**

- The Emergency Transportation Road Network (ETRN) in Kathmandu valley was proposed by the Project on Rehabilitation and Recovery from Nepal Earthquake (RRNE) through collaboration with the project on Urban Transport Improvement for Kathmandu Valley.
- ETRN was selected in consideration of locations of critical sites and facilities for disaster response and recovery such as government offices, major hospitals, evacuation places and other important facilities.
- National highway and Ring-road were designated for ETRN. And a part of strategic road network and district road network at the central Kathmandu valley were selected as primary or secondary of ETRN.

**Source:**

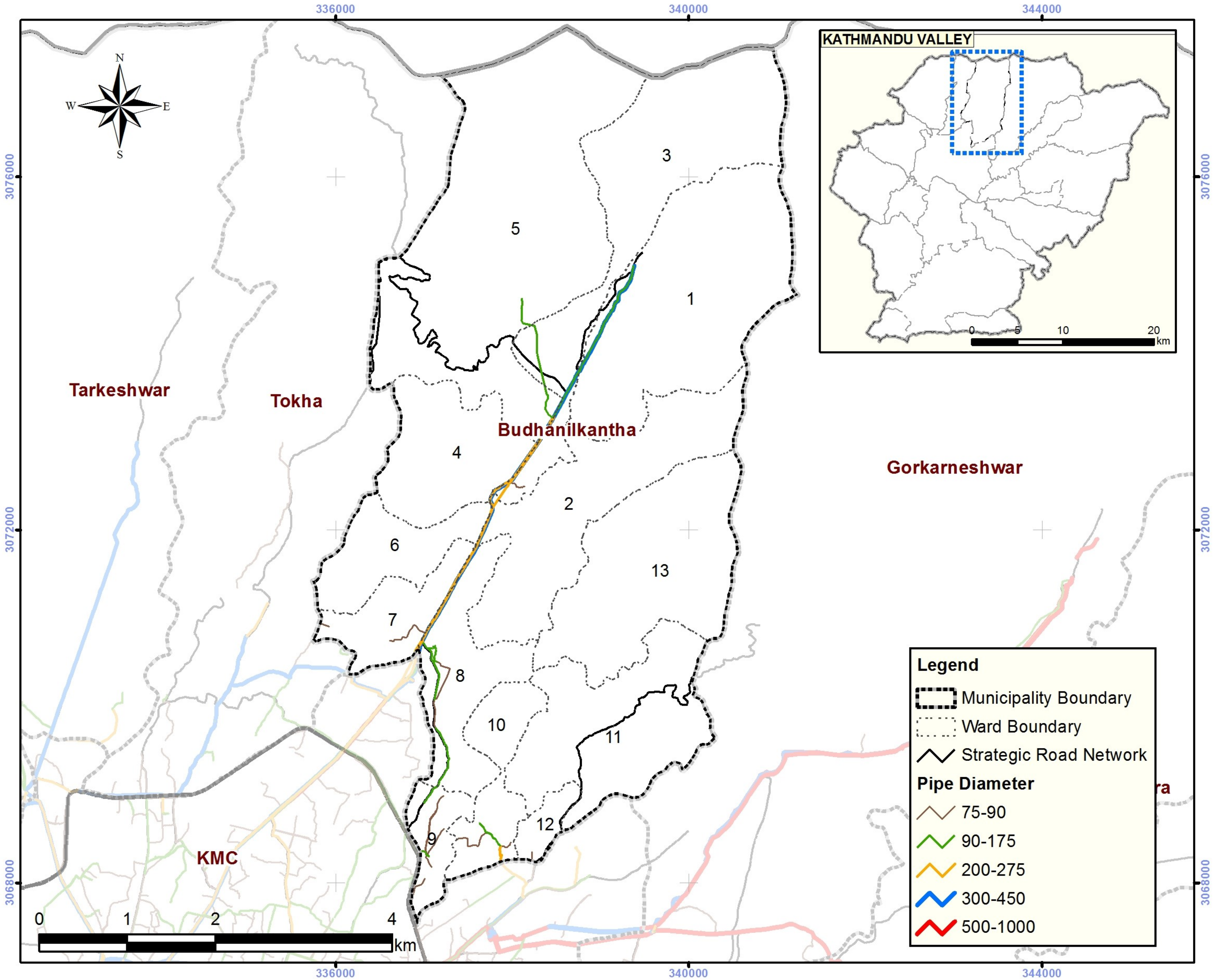
- Emergency Transportation Road Network: RRNE2017
- Road Network: DoR, DoLIDAR
- Boundary of Municipality and Ward: DoS, MoFALD
- River Network: 2002 JICA Project, UN OCHA Project

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal




# A-18

## Distribution of Water Supply Network (Existing)

**Note:**

- The spatial data of existing water supply distribution network was received from KUKL. This data contains the types of pipe materials, diameter of pipes (mm) and construction years by pipe node as attribute information.
- The six types of pipe materials such as cast-iron pipe (CI), ductile cast-iron pipe (DI), galvanized iron pipe (GI), high density polyethylene pipe (HDPE), polyvinyl chloride pipe (PVC), and stainless iron pipe (SI) are used for existing water supply distribution network.
- Existing water supply distribution network is shown in the map with color coding according to pipe diameter class.

**Source:**

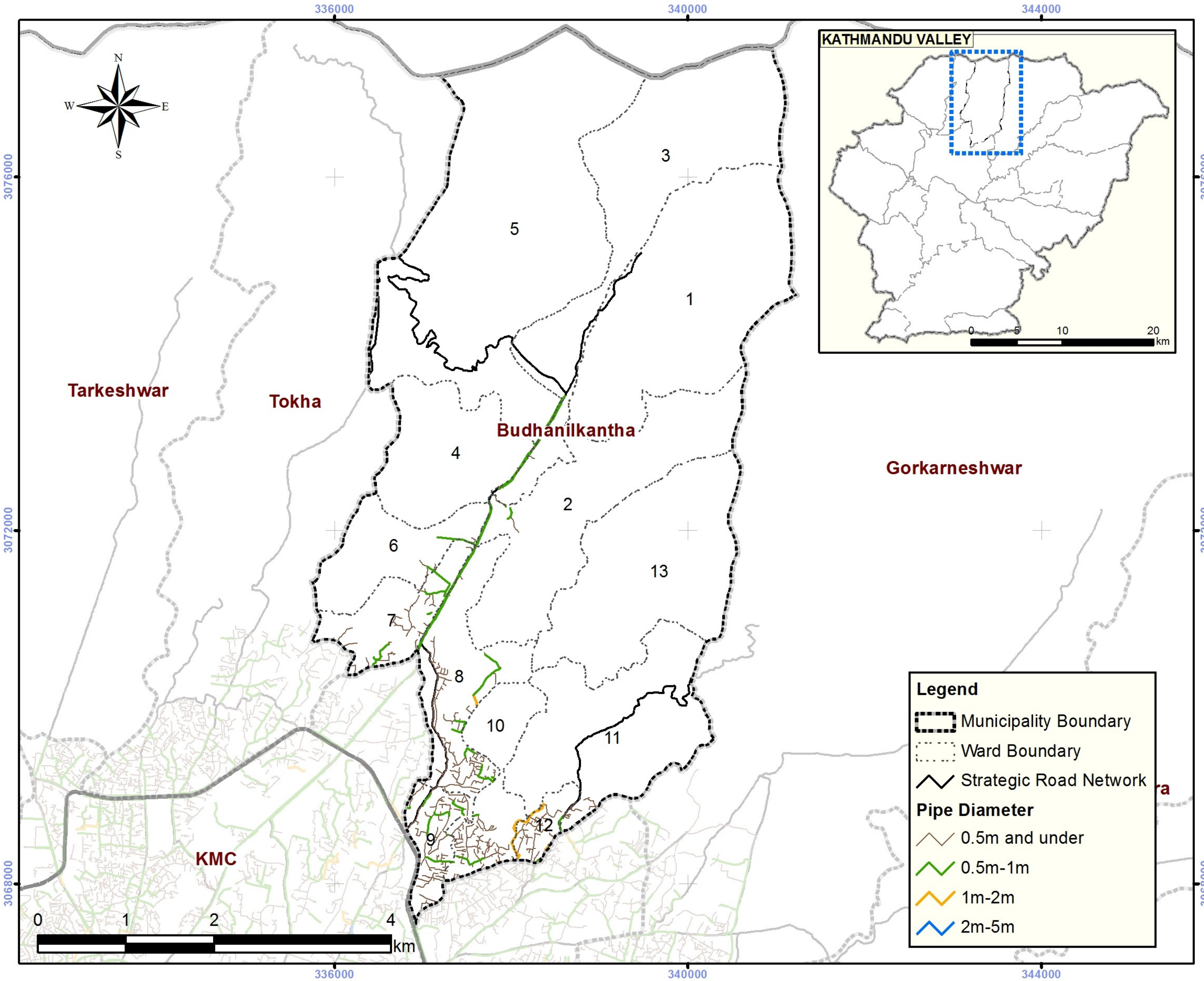
- Existing Water Supply Distribution Network: KUKL
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal




# A-19

## Distribution of Sewage Network

**Note:**

- The spatial data of existing sewage distribution network was received from KUKL. This data contains the types of pipe materials, pipes diameter (mm), depth of burial (mm) and construction years by pipe node as attribute information. The reinforced concrete is mainly used as the pipe material.
- Existing sewage distribution network is shown in the map with color coding according to pipe diameter class.

**Source:**

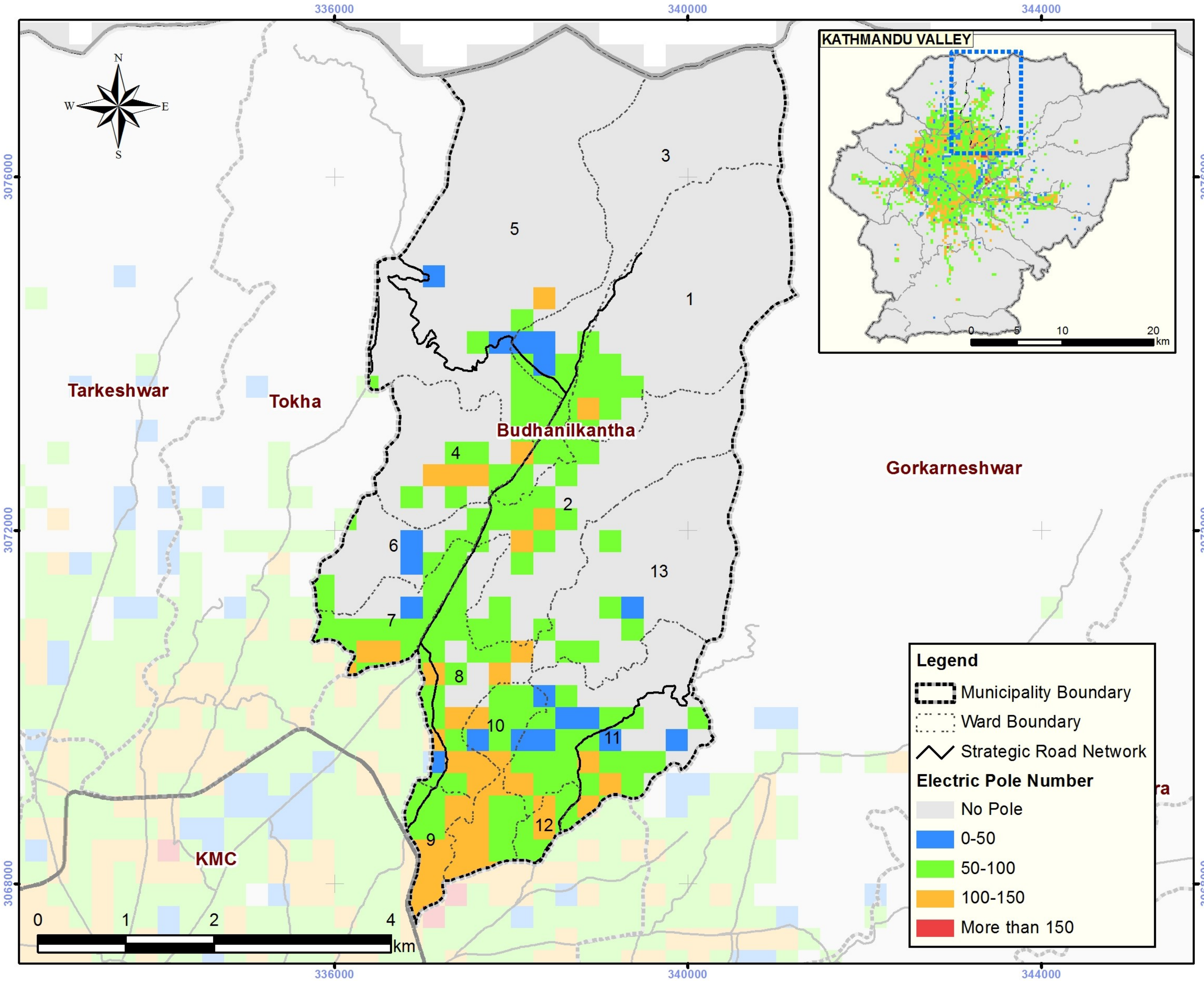
- Existing Sewage Distribution Network: KUKL
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ................87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# A-20

## Estimated Power Pole Distribution

**Note:**

- In this project, the ratio of electricity power outage due to electricity pole failures was supposed to be estimated as the risk assessment of electricity network, but a detail distribution network data is required as an input data for this estimation. However, there is no detail spatial data for the distribution network with locations of power poles such as GIS data. Therefore, JICA Project Team proposed an estimation approach to estimate the density of distribution lines and power poles using existing road network distribution as alternative method.
- According to Annual Summary Report of 2072/073 prepared by Kathmandu Regional Office of Nepal Electricity Authority (NEA), the total length of distribution network is 5,749km in Kathmandu Valley. On the other hand, the length of detailed road network located inside the urbanized area is 2533km. From both values and average distance between the poles, which was identified as 30.13m based on field survey for distribution poles installation in the study area, a formula to calculate pole number by 250m-mesh grid was defined as follows:

*Pole Number per 250m-mesh gird =*
*Total road length per 250m-mesh gird * 2.27/30.13*

- As a result, the total length of distribution network and power poles were estimated as 5,750km and 190,851 units in the Kathmandu Valley.
- 250m-mesh grid wise estimated power pole distribution is shown in the map.

**Source:**

- Estimated Power Pole Distribution: ERAKV 2017
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

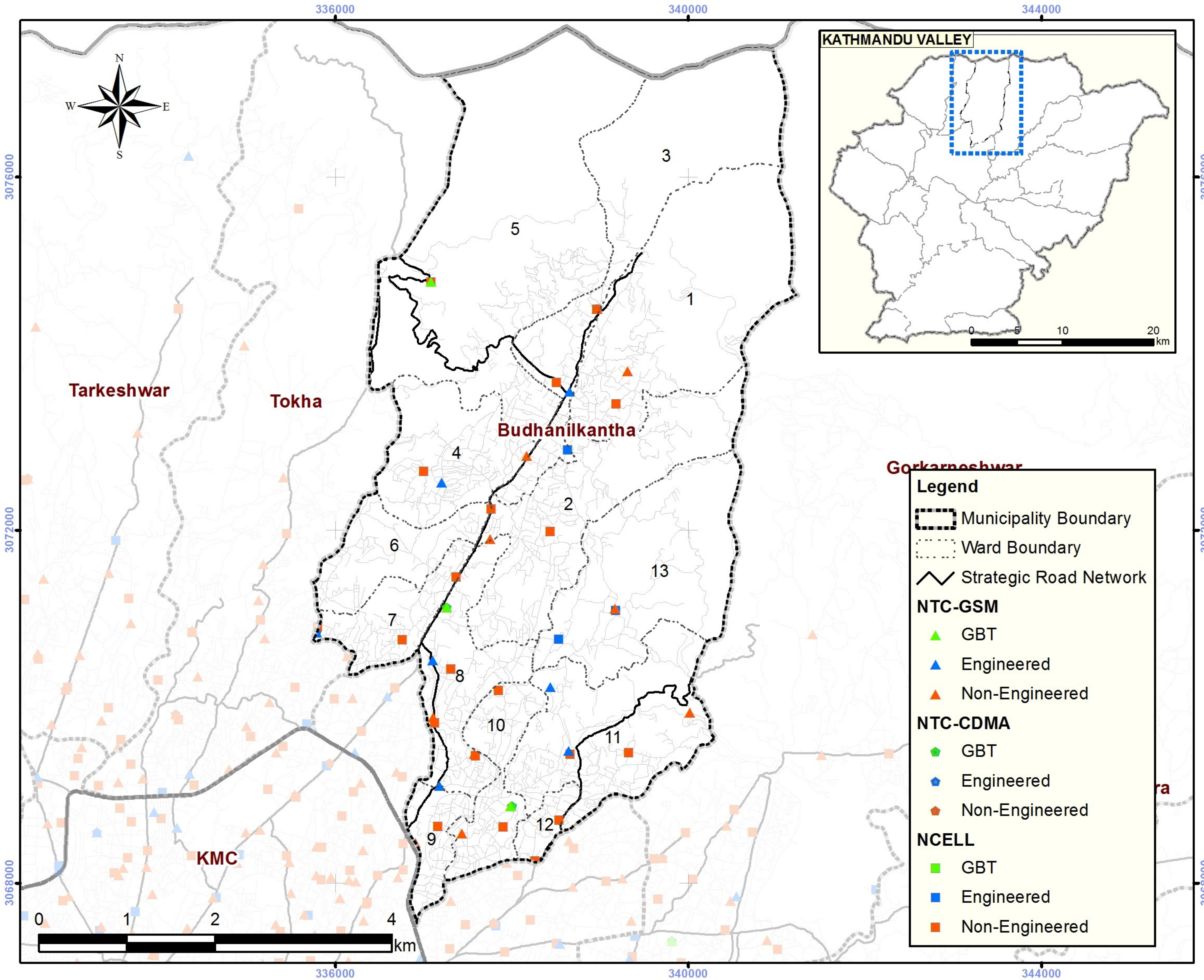
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ...............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

JICA




# A-21

## Distribution of Mobile BTS Tower

**Note:**

- Currently, mobile communication is the common telecommunication system in Nepal, with a total number of mobile subscribers exceeding 90% of the total telecommunication facility users. More than 90% share in the mobile communication market is taken by NTC (Nepal Telecom) and Ncell.
- Given the existing status of the telecommunication environment in Nepal, the damage assessment of the mobile telecommunication network is an important component of the earthquake risk assessment. In this project, it was decided to focus on the vulnerability assessment of the Base Transceiver Stations (BTS) which connects each mobile phone and mobile communication networks.
- With the cooperation of Nepal Telecommunication Authority (NTA), the latest data for locations of BTSs has been received from NTC and Ncell.
- The location map of current BTSs managed by NTC and Ncell in the study area is shown in the map.

**Source:**

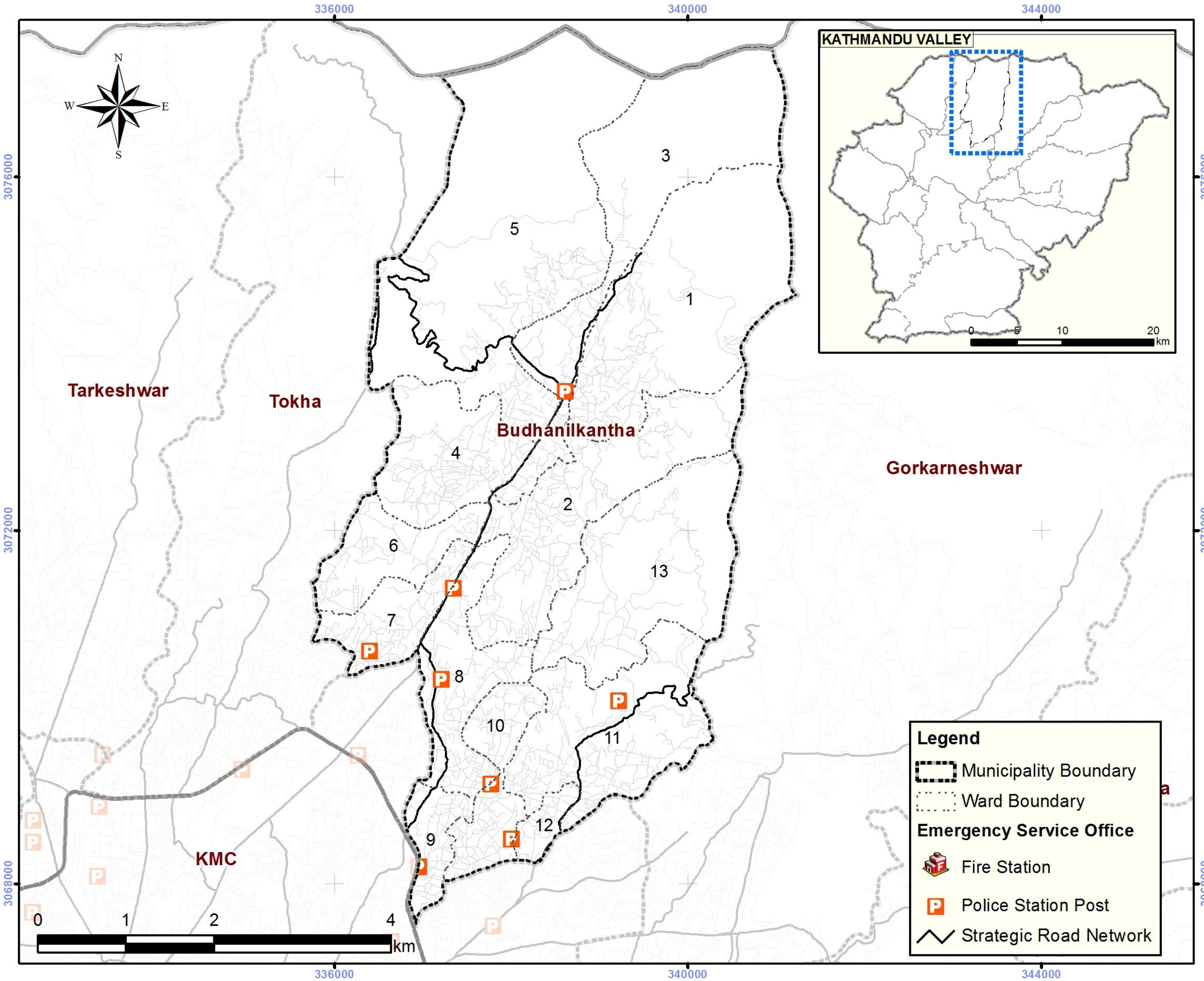
- BTS distribution Data: NTA, NTC, Ncell
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# A-22
# Emergency Service office Location Map

**Note:**

- New large-scale topographic maps were created using satellite image observed after Gorkha earthquake by the project on Rehabilitation and Recovery from Nepal Earthquake (JCIA RRNE) in 2016. There are two types of topographic maps, one is 1/10,000 scale for the Kathmandu valley and the other is 1/5,000 scale for four old municipalities area in 2015 including Lalitpur metropolitan city, Baktapur municipality and Budahanilkantha municipality.
- The location of buildings including fire stations and police station posts was surveyed by field surveys in order to ensure the accuracy of 1/5,000 scale topographic map. This location map of emergency service offices was created using point data of fire stations and police station posts in the 1/5,000 scale map.

**Source:**

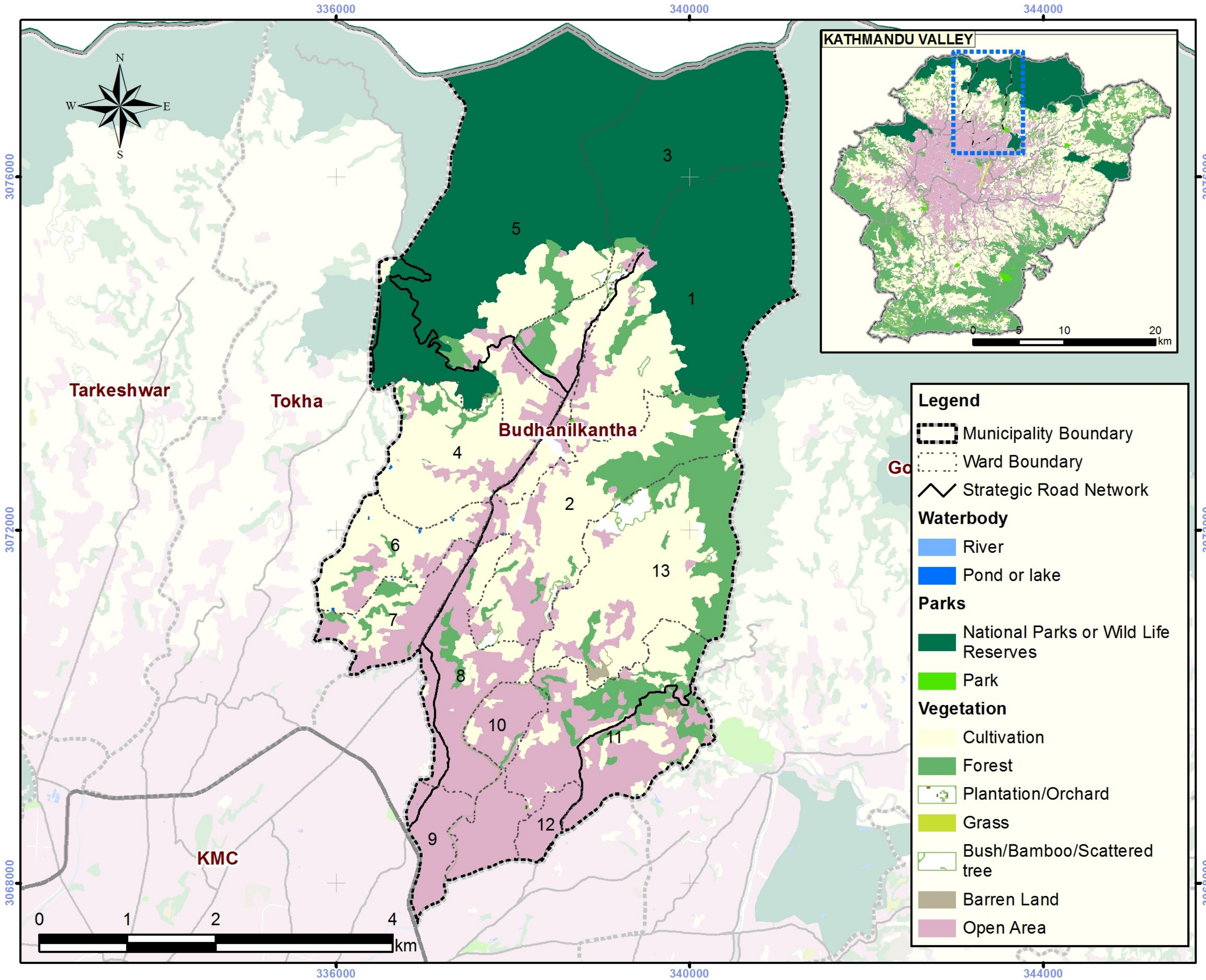
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- Emergency Service Office: JICA RRNE

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# A-23

## Landcover Map

**Note:**

- New large-scale topographic maps were created using satellite image observed after Gorkha earthquake by the project on Rehabilitation and Recovery from Nepal Earthquake (JCIA RRNE) in 2016. There are two types of topographic maps, one is 1/10,000 scale for the Kathmandu valley and the other is 1/5,000 scale for four old municipalities area in 2015 including Lalitpur metropolitan city, Baktapur municipality and Budahanil-kantha municipality.
- Landcover data in the Kathmandu valley was generated based on high resolution satellite image as one of contents of 1/10,000 scale topographic map. This landcover map was based on the data of 1/10,000 scale map.

**Source:**

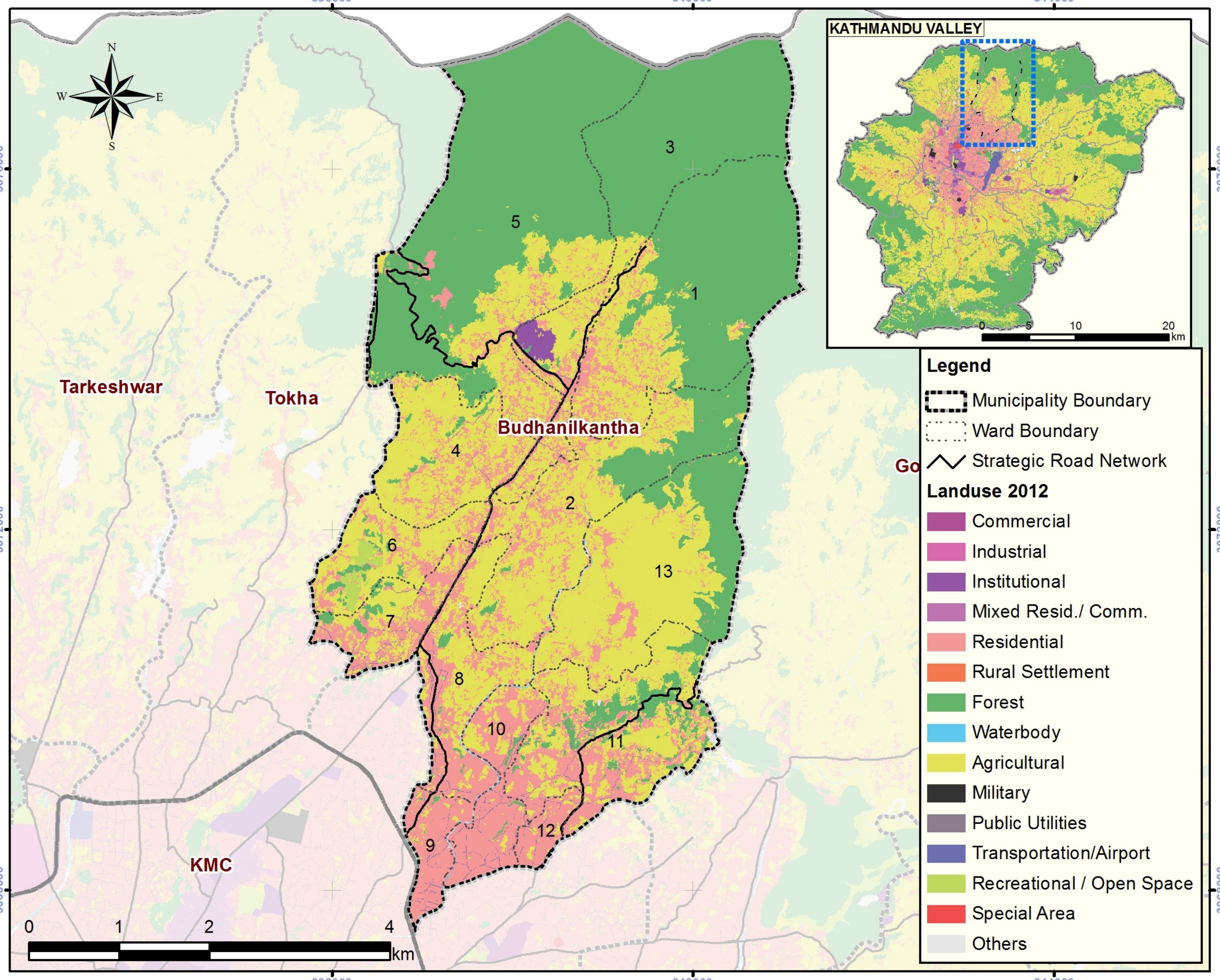
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- Topography: JICA RRNE

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal



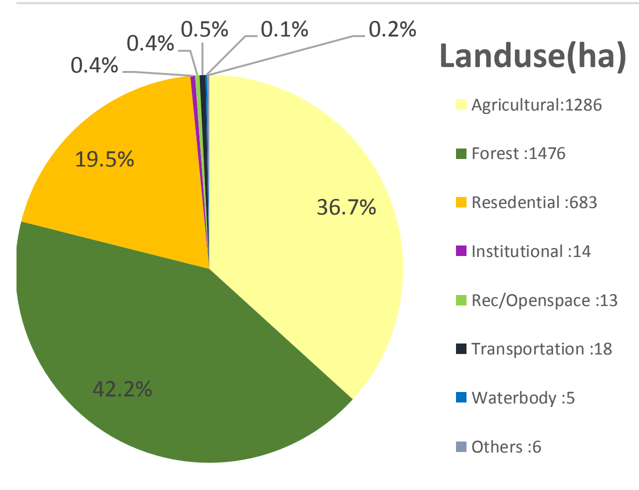

# A-24

## Landuse Map

**Note:**

- Based on the land use plan prepare by UNDP in 2012, It is classified into Agriculture, Forest, Residential ,Institutional, Recreational/Open space, Transportation, Waterbody and others.

The land use distribution is shown in pie-chart below




**Source:**

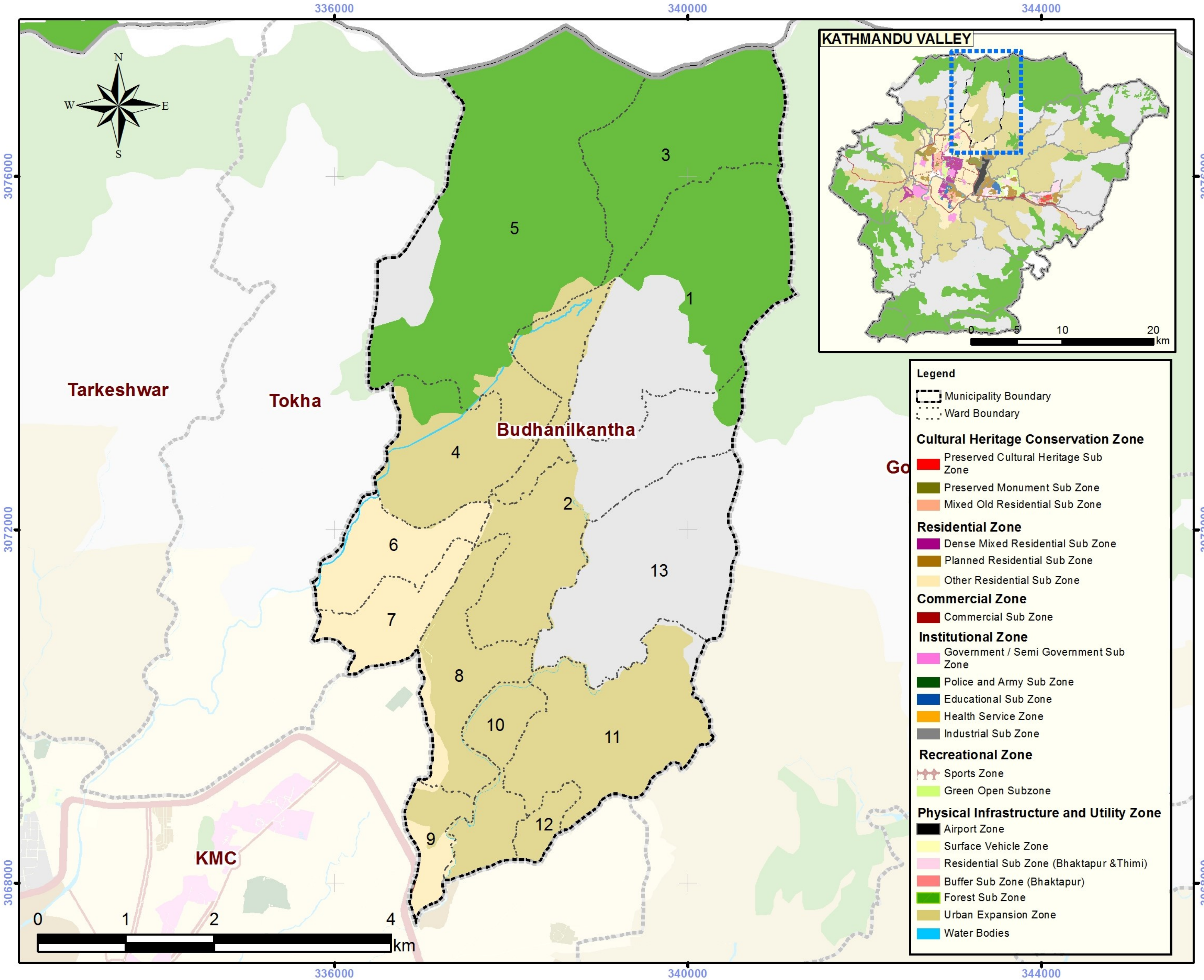
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- Landuse: UNDP, CDRMP 2013

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# A-25

## Zoning Map

**Note:**

- Budhanilkantha Municipality is classified into following zones according to the land use map:
  a) Cultural Heritage Conservation Zone
  b) Residential Zone
  c) Institutional zone
  d) Industrial zone
  e) Preserved zone
  f) Urban expansion zone
  g) Surface vehicle zone
  h) Airport zone
  i) Sports zone
- The zoning has been done in order to have planned urbanization and physical development along with conservation of the traditional and cultural heritage.

**Source:**

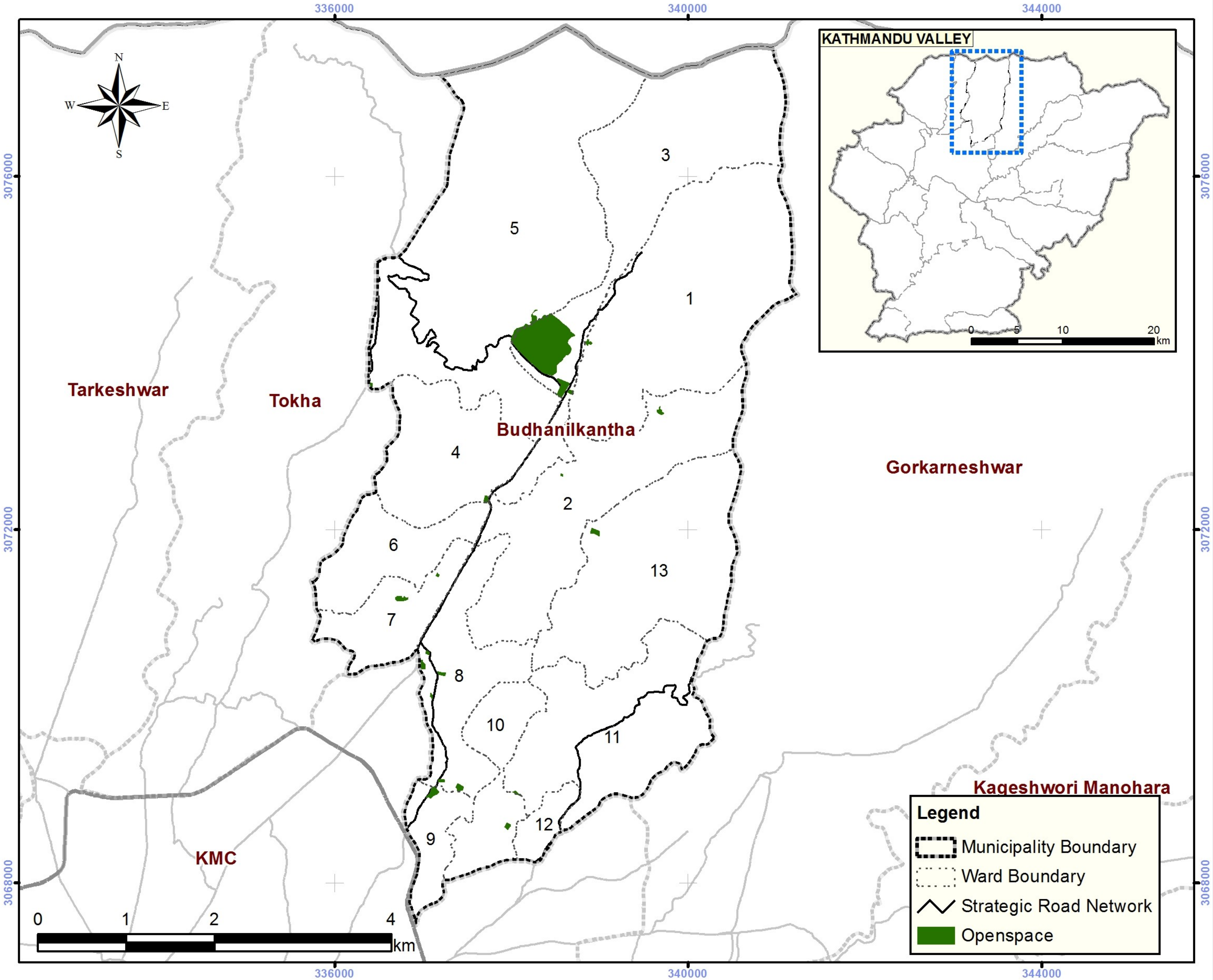
- Boundary of Municipality and Ward: DoS, MoFALD
- Zoning Map in 2007, KVDA

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ........................0.0
central_meridian: ...............87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# A-26

## Open Space

**Note:**

Open Spaces are necessary assets not only for the open and beautiful city but also for securing safe and accessible sites for emergency response and temporary shelter for citizens during disaster. These areas are places which are important for humanitarian assistance and work as evacuation and temporary shelters.

-Total Area of Open Space in Budhanilkantha Municipality is: 404,201 sq.m

Following table shows the details of identified open spaces in the municipality:

| Area Classification (sq.m) | No. of Open Space | Total Area (Sq.m) |
|---|---|---|
| Up to 5000 | 12 | 31,597 |
| 5000-10000 | 8 | 56,899 |
| Greater than 10000 | 2 | 315,705 |
| **Total** | **22** | **404,201** |

**Source:**

- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- Open Space: KVDA

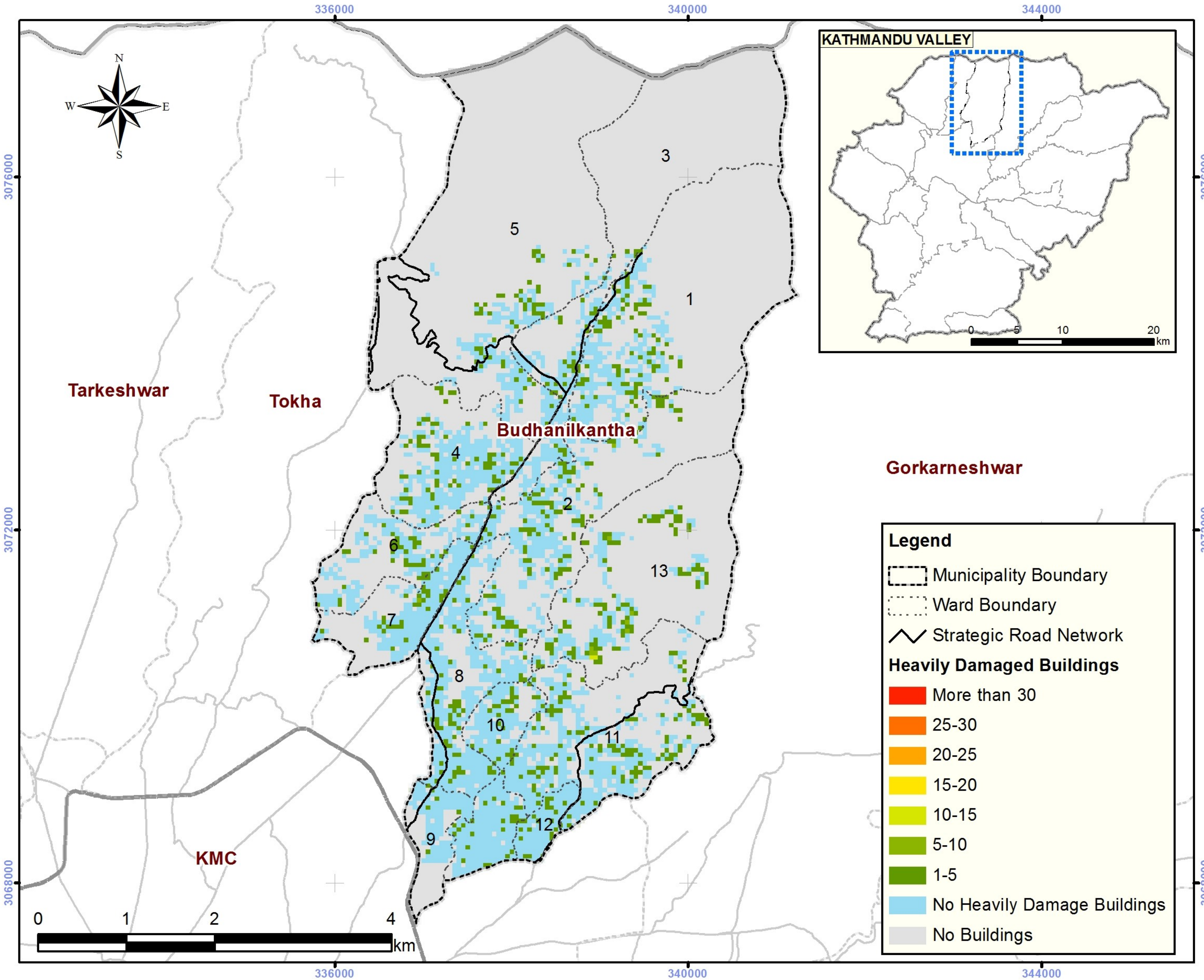
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal

JICA




# A-27

## Heavily Damaged Buildings by 2015 Gorkha Earthquake

**Note:**

- For the purpose of obtaining exact building damage status due to the Gorkha earthquake, this project conducted the entire building damage assessment survey in previous Lalitpur Sub-metropolitan City and Baktapur municipality area. Based on this survey result and another building damage assessment survey in Budhanilkantha municipality and previous Karyabinayak municipality conducted by NSET under "Public Private Partnership for Earthquake Risk Management (3PERM)" programme funded by USAID/OFDA, the project analyzed the trends of damaged buildings by structural type, construction year and others.
- This 50m mesh-grid heavily damaged building distribution was made from those survey results. "Heavily Damage Building" means a damaged building due to the Gorkha Earthquake evaluated as Damage Level 4 and 5 based on EMS 98.
- The total number of heavily damaged building in Budhanilkantha Municipality was 1188 buildings.

**Source:**

- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- Building Inventory Survey: ERAKV 2017, NSET/3PERM funded by USAID/OFDA

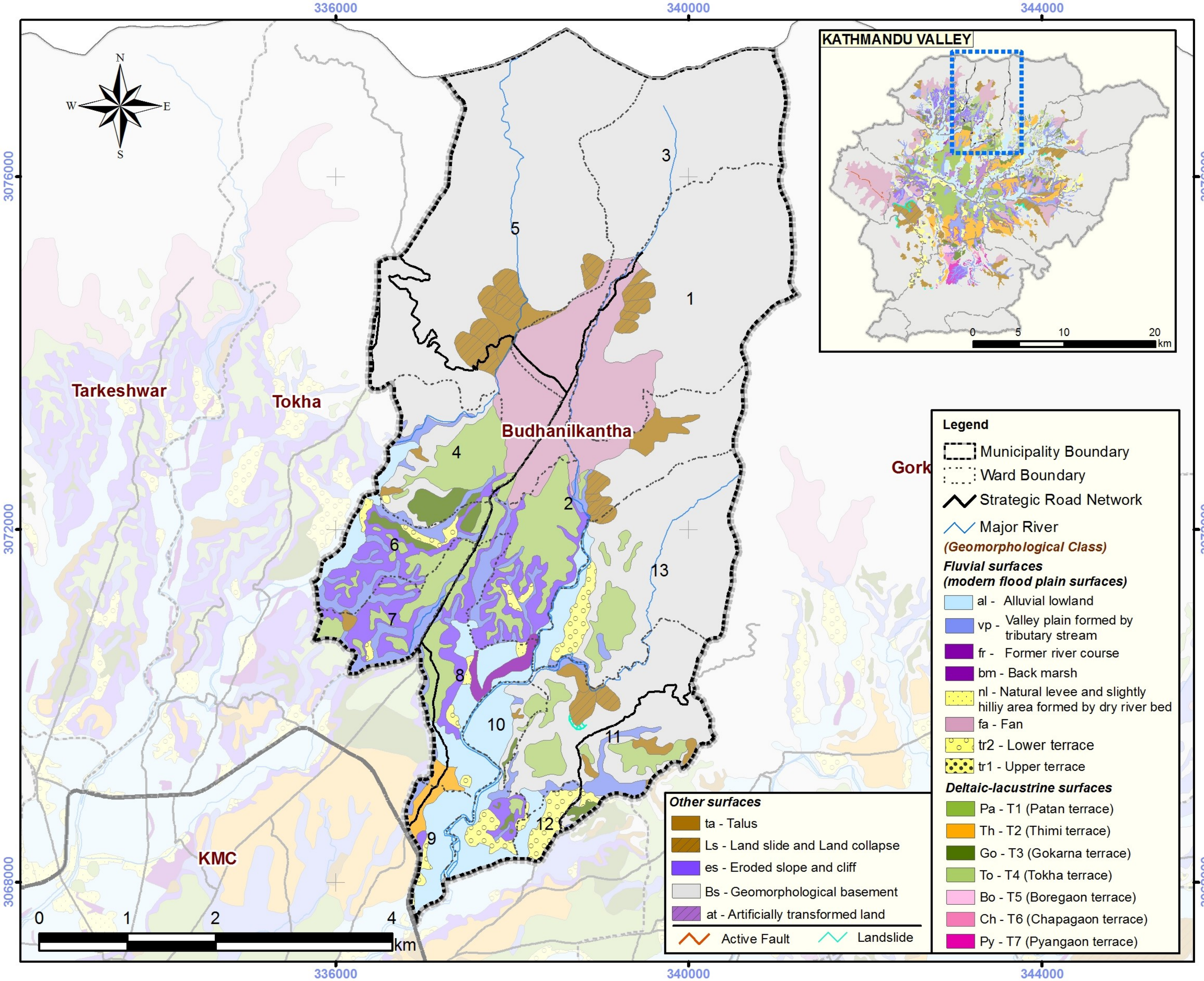
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# B. Seismic Hazard Estimation




# B-1

## Geomorphological Map

**Note:**

- For ground modelling, along with geological information, drilling data and topographical materials, geomorphological map which reflects detailed depositional environment plays an important role. Geomorphological interpretation and site reconnaissance survey were implemented, and a new detailed geomorphological map was prepared with DMG participation. Still site survey has not yet perfect, which will be supplemented by DMG, and then, DMG will be supposed to publicize after some further analysis.
- The detailed geomorphological classification was carried out by stereo-view of large-scale aerial photographs taken in December 1998 (scale about 1:15,000, by Department of Survey). Most areas of the Kathmandu Valley are covered by these aerial photographs taken in 1998, while large-scale photographs are not available in the western to southwestern margin of the Kathmandu Valley. Therefore, we used complementary small-scale aerial photographs taken in 1992 (scale about 1: 50,000, by Department of Survey).

**Source:**

- Geomorphological Map: ERAKV 2016
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- River Network: 2002 JICA Project, UN OCHA Project

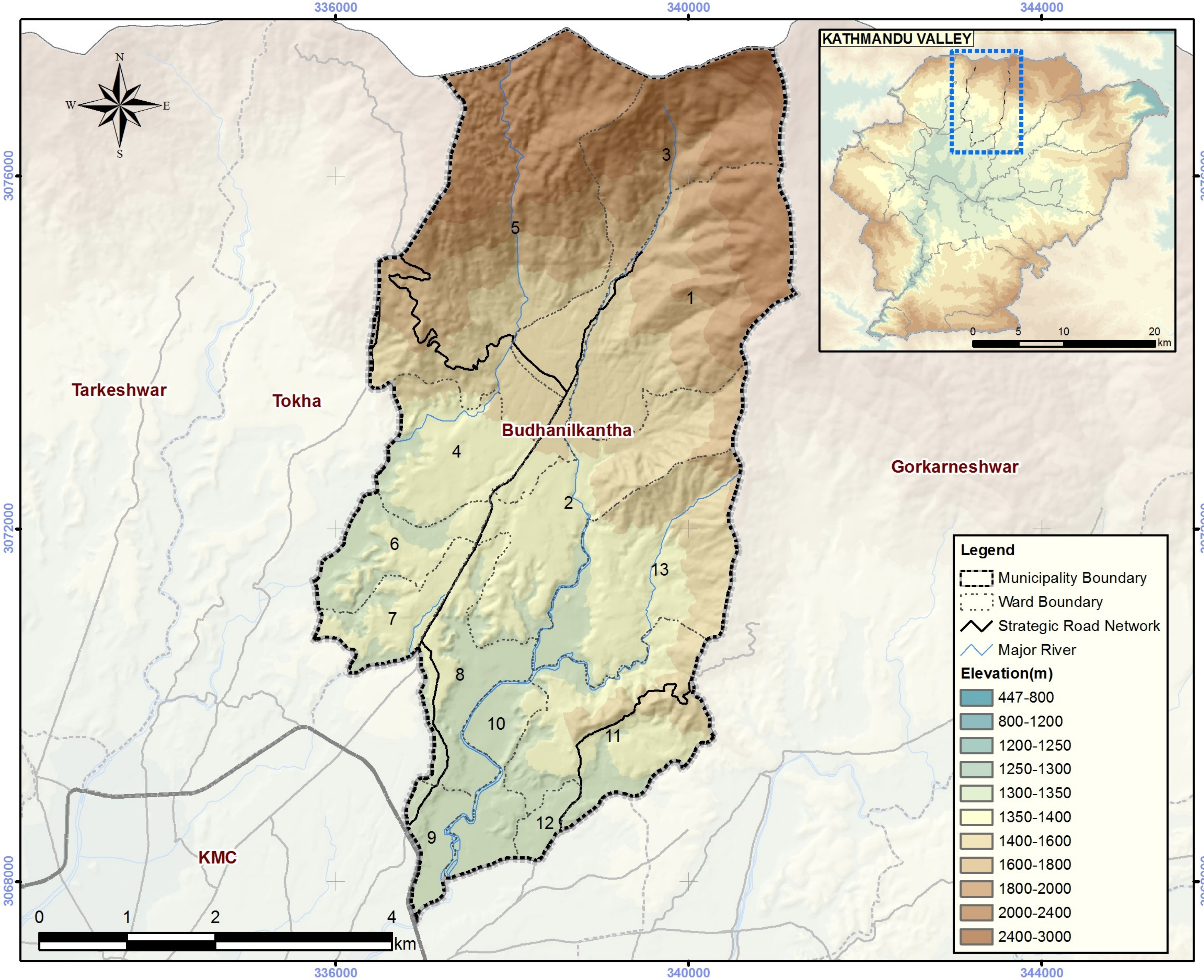
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ....................0.0
central_meridian: ..............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ...........................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

JICA




# B-2

## Altitude Distribution Map

**Note:**

- As one of ground information, altitude data were collected. The altitude data was obtained as a DEM (Digital Elevation Model) derived from recent satellite imagery data from UNDP.

**Source:**

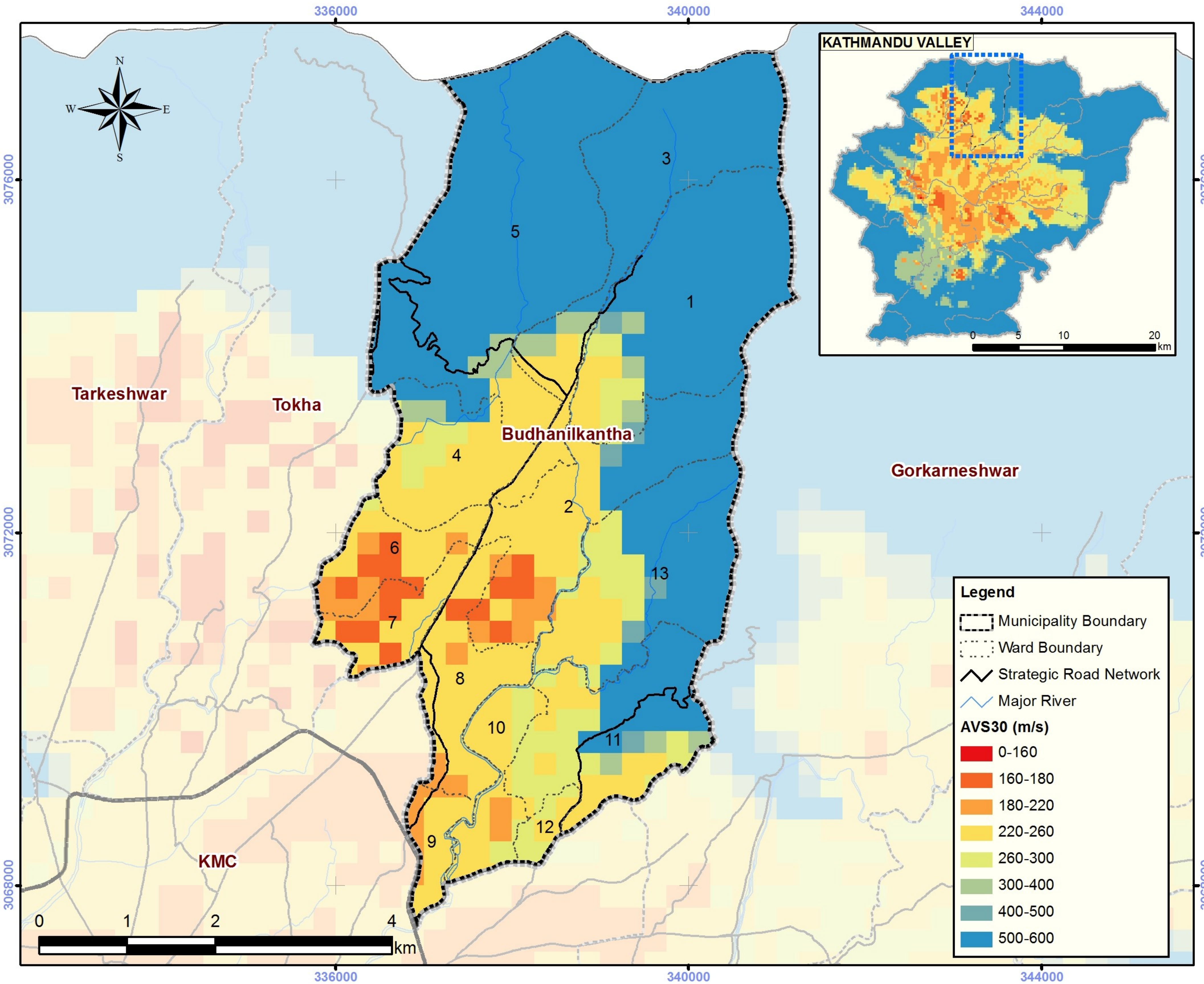
- Digital Elevation Model: UNDP/CDRMP
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- River Network: 2002 JICA Project, UN OCHA Project

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ...................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .......................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-3

## Estimated AVS30 from Ground Model

**Note:**

- The AVS30 (Average Vs over 30m from surface) of the ground are calculated from the ground model which is developed in this study.

**Source:**

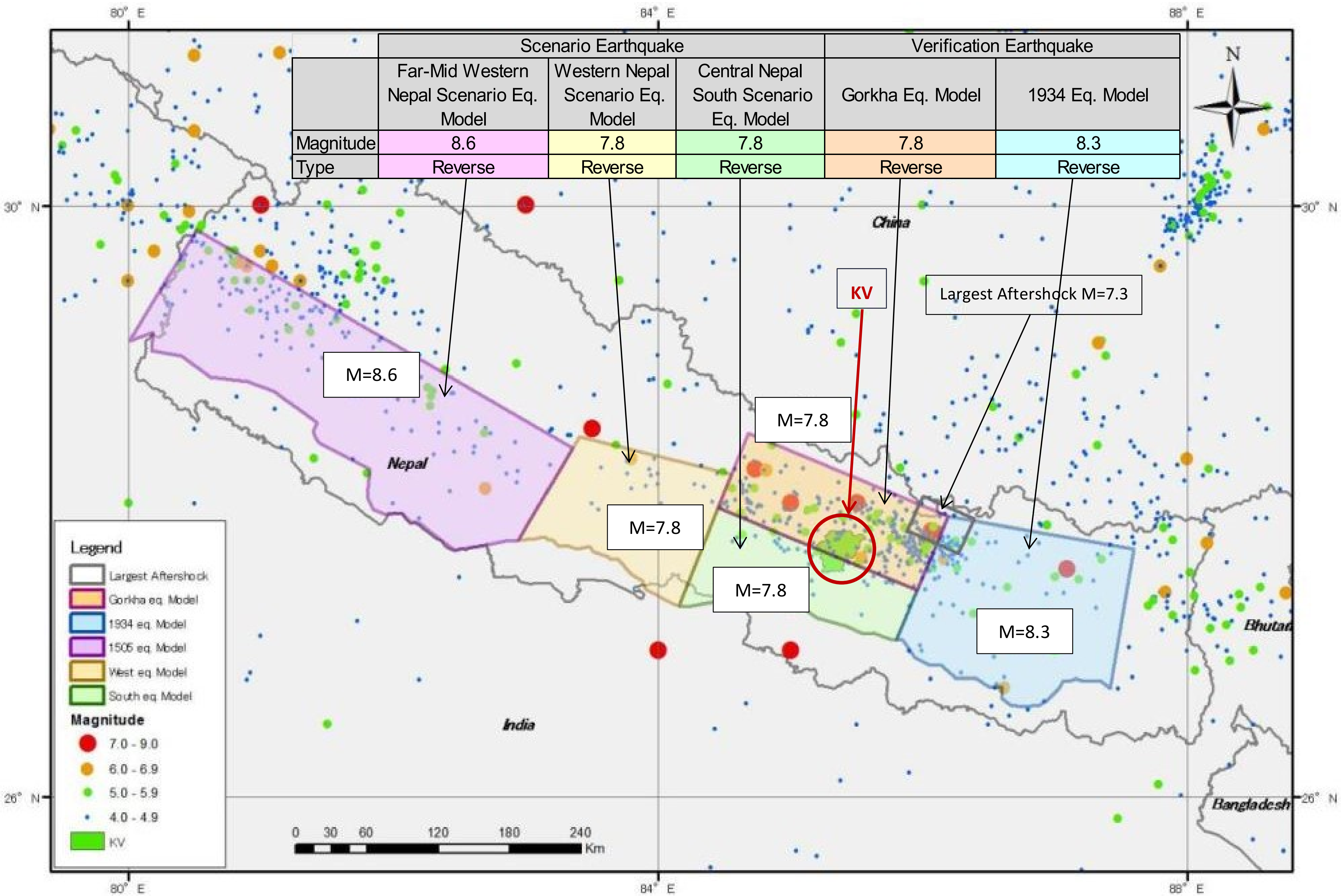
- AVS30 Data: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- River Network: 2002 JICA Project, UN OCHA Project

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .......................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




| | Scenario Earthquake | | | Verification Earthquake | |
|---|---|---|---|---|---|
| | Far-Mid Western Nepal Scenario Eq. Model | Western Nepal Scenario Eq. Model | Central Nepal South Scenario Eq. Model | Gorkha Eq. Model | 1934 Eq. Model |
| Magnitude | 8.6 | 7.8 | 7.8 | 7.8 | 8.3 |
| Type | Reverse | Reverse | Reverse | Reverse | Reverse |

# B-4

## Fault Model of Scenario Earthquake

**Note:**

- The scenario earthquakes were finalized and formally approved in 2nd JWG (April 11, 2016) and 3rd JCC (May 10, 2016), referring to the comments by SATREPS and National Scientific Community. The scenario earthquakes are three scenario earthquakes such as; "Far-Mid Western Scenario Earthquake", "Western Nepal Scenario Earthquake" and "Central Nepal South Scenario Earthquake" and two earthquakes for verification; the 1934 Bihar-Nepal Earthquake and the 2015 Gorkha Earthquake including largest aftershock.

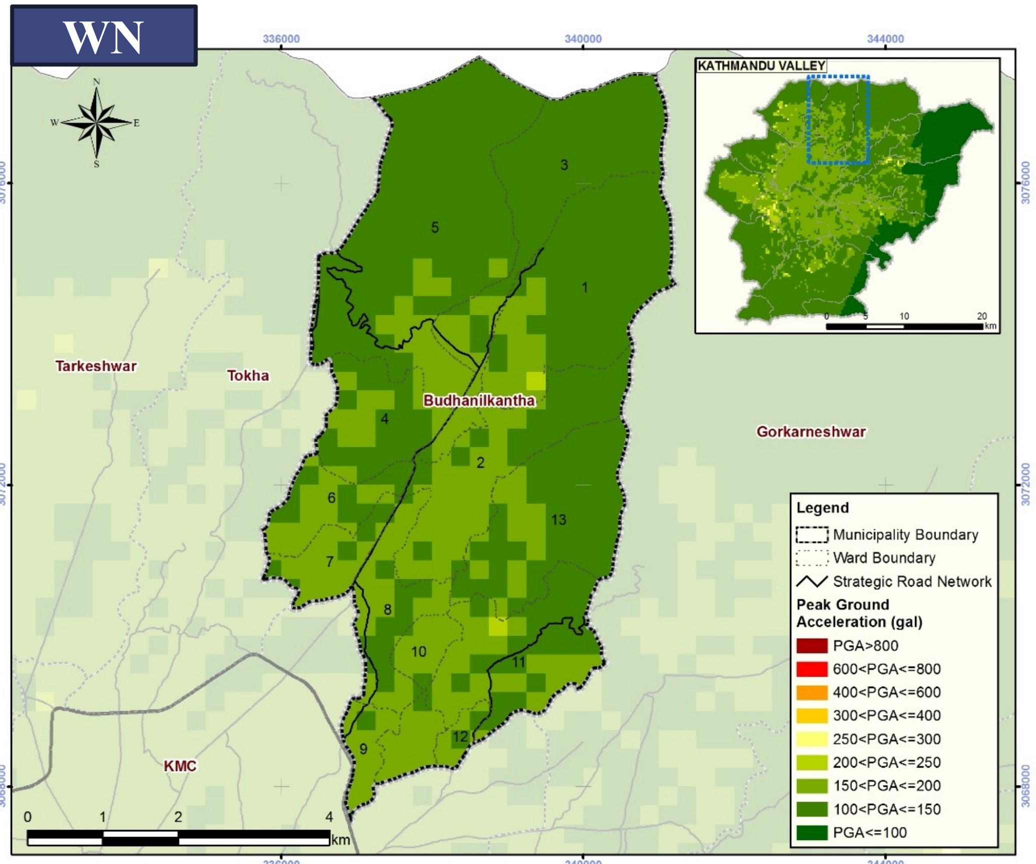
**Source:** ERAKV 2016

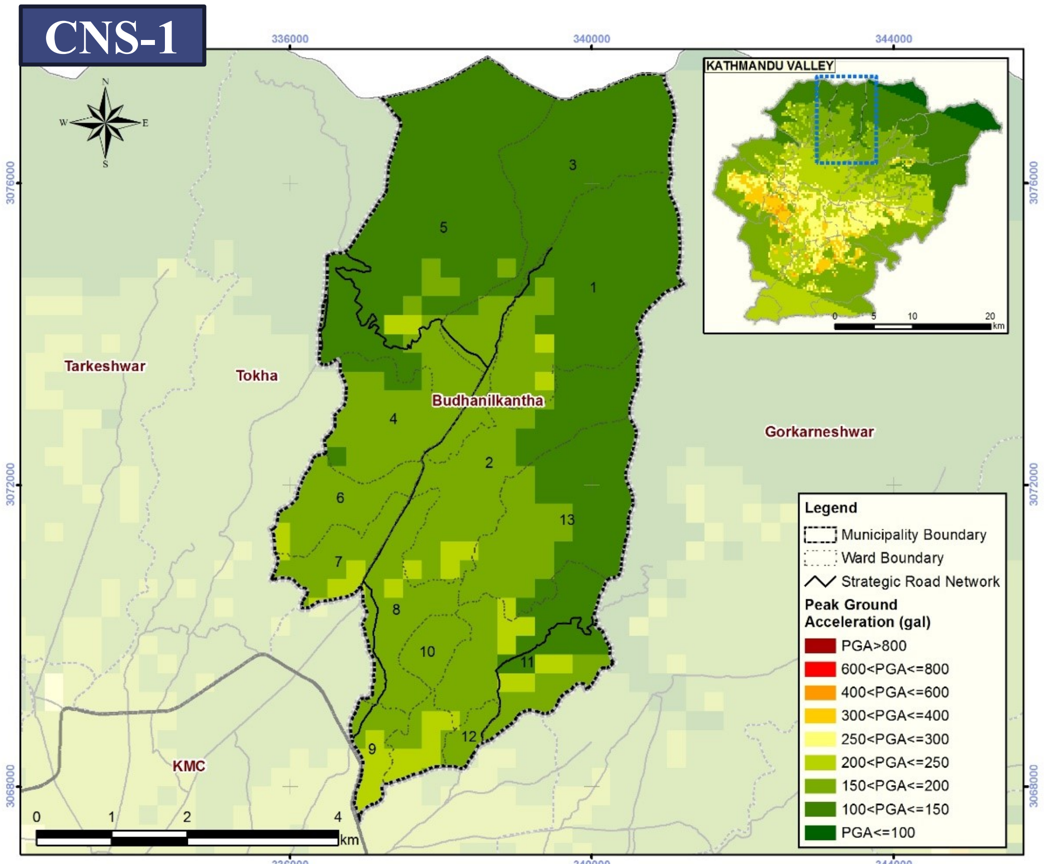
WGS_1984_UTM_Zone_45N

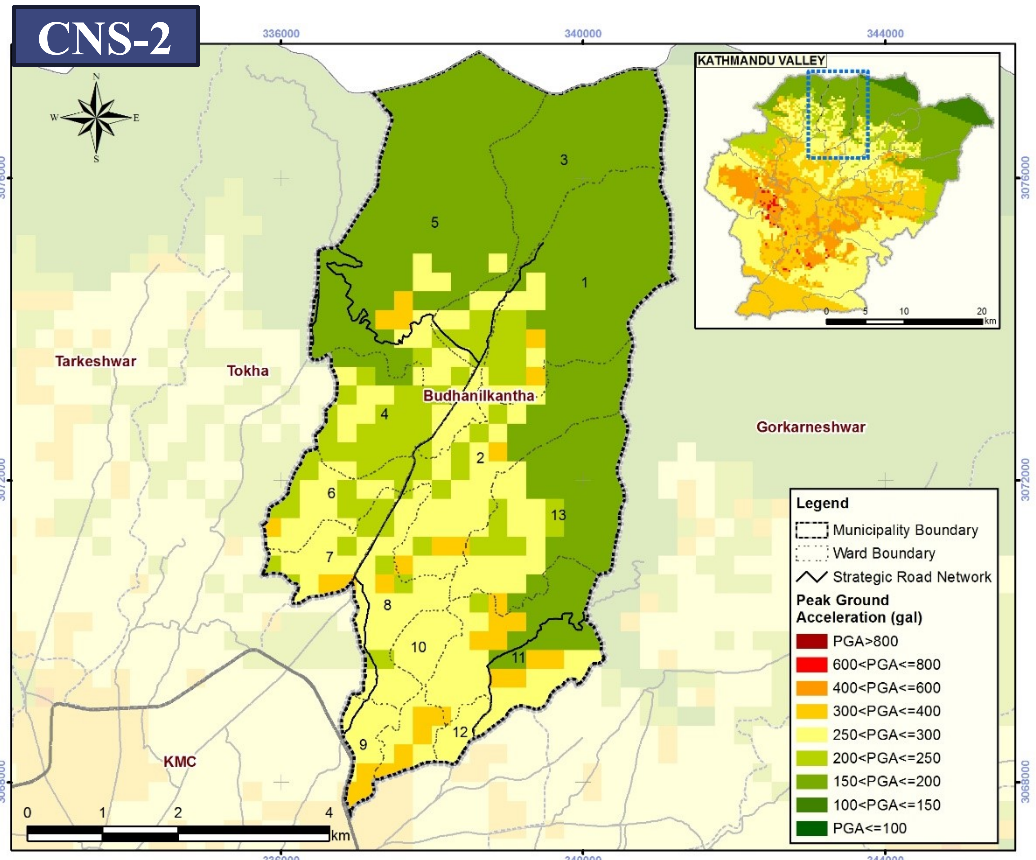
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

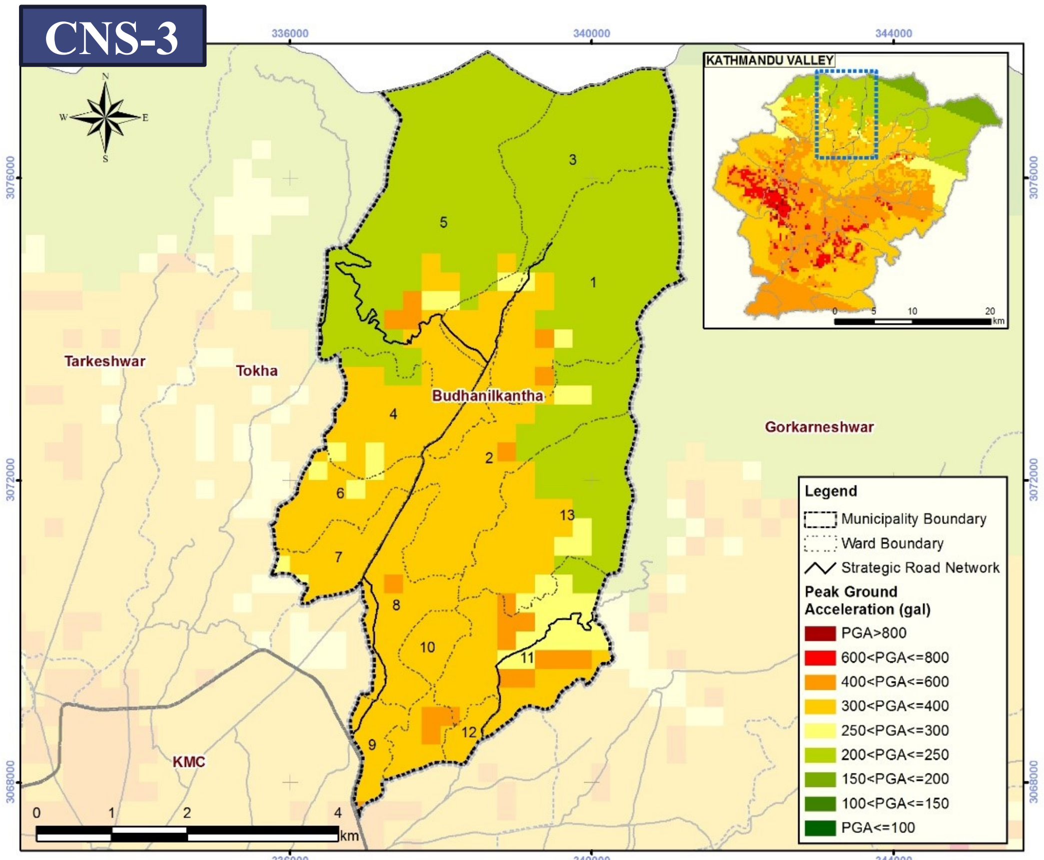
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ...........................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-5

# Peak Ground Acceleration Distribution

**Note:**

- First, the earthquake motion of scenario earthquake at bedrock (Vs=600m/sec) was calculated using existing Ground Motion Prediction Equation.
- Second, ground model for response analysis is constructed by drilling log, geomorphology map, microtremor survey, etc. in this project.
- Then, amplification of the ground is evaluated by one dimensional response analysis (SHAKE), based on the ground model above.
- PGA (Peak Ground Acceleration) is calculated by multiplying the bedrock motion by scenario earthquake and amplification of surface ground.

**Source:**

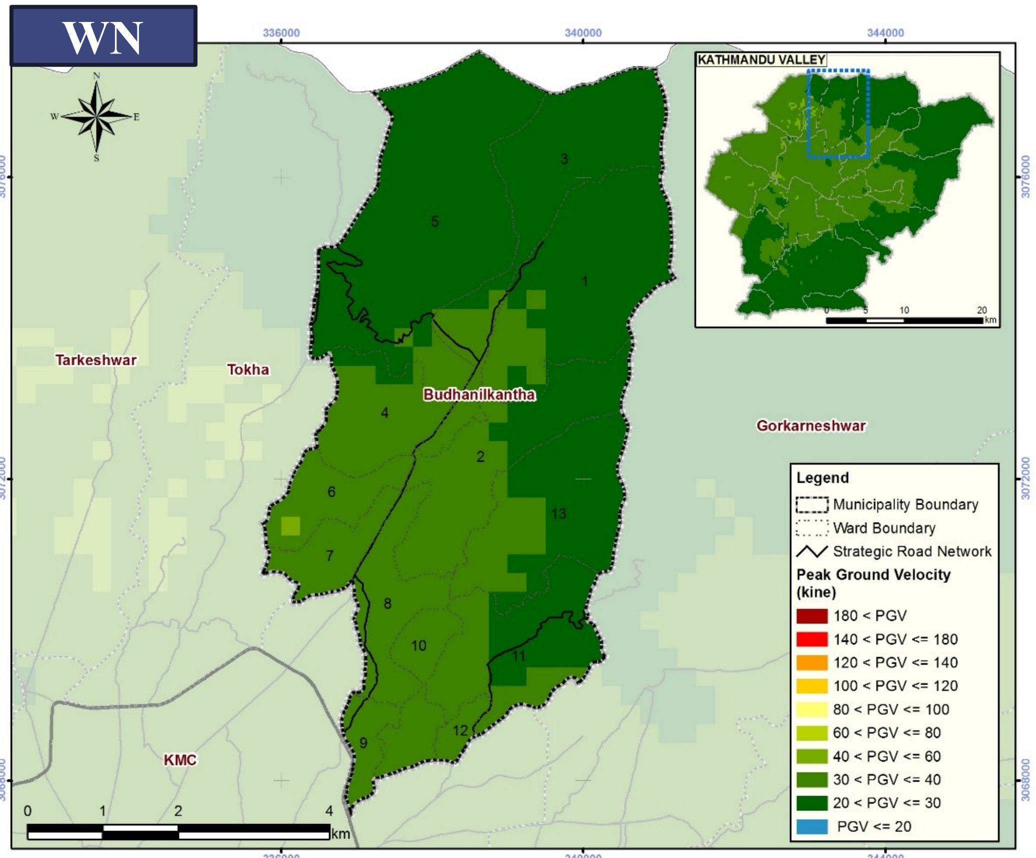
- Peak Ground Acceleration: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

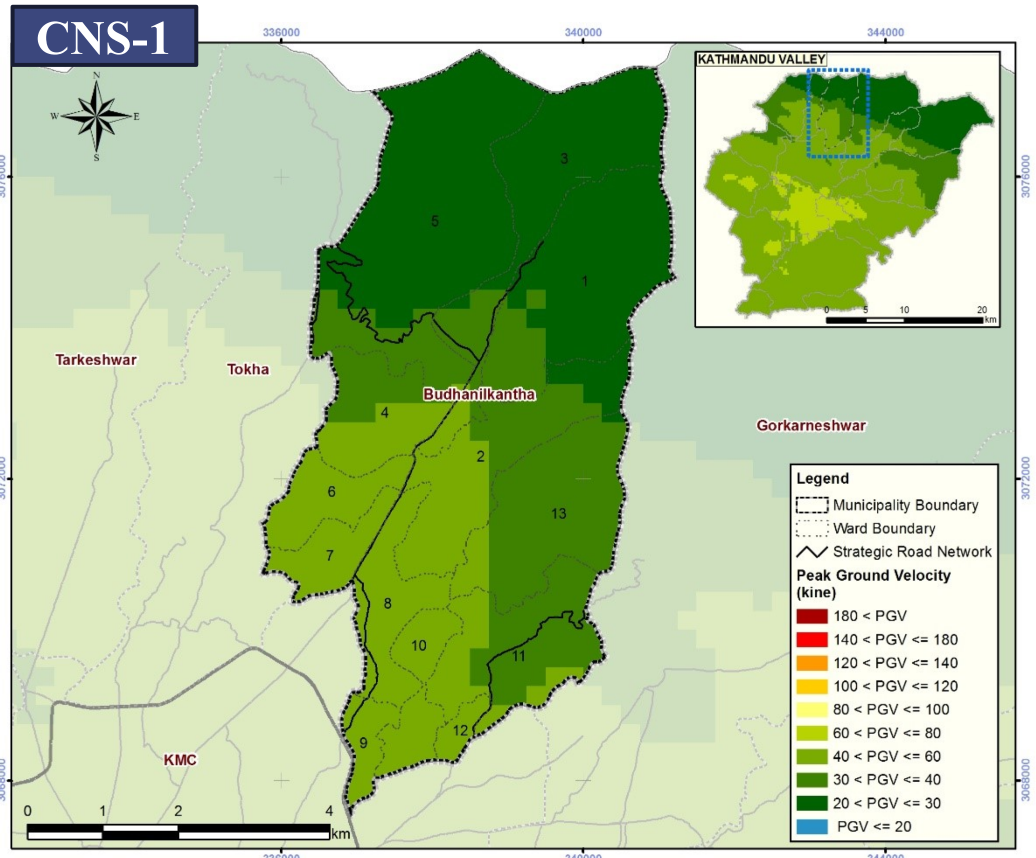
WGS_1984_UTM_Zone_45N

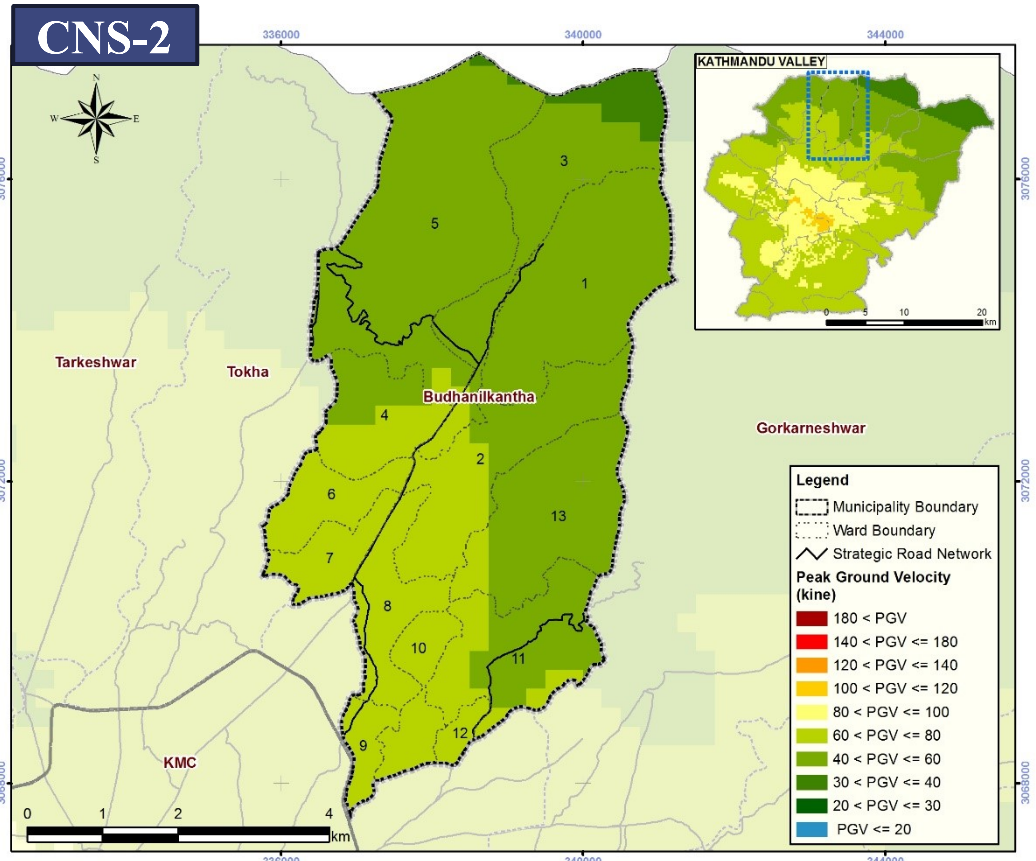
Projection: Transverse_Mercator
false_easting: ..............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

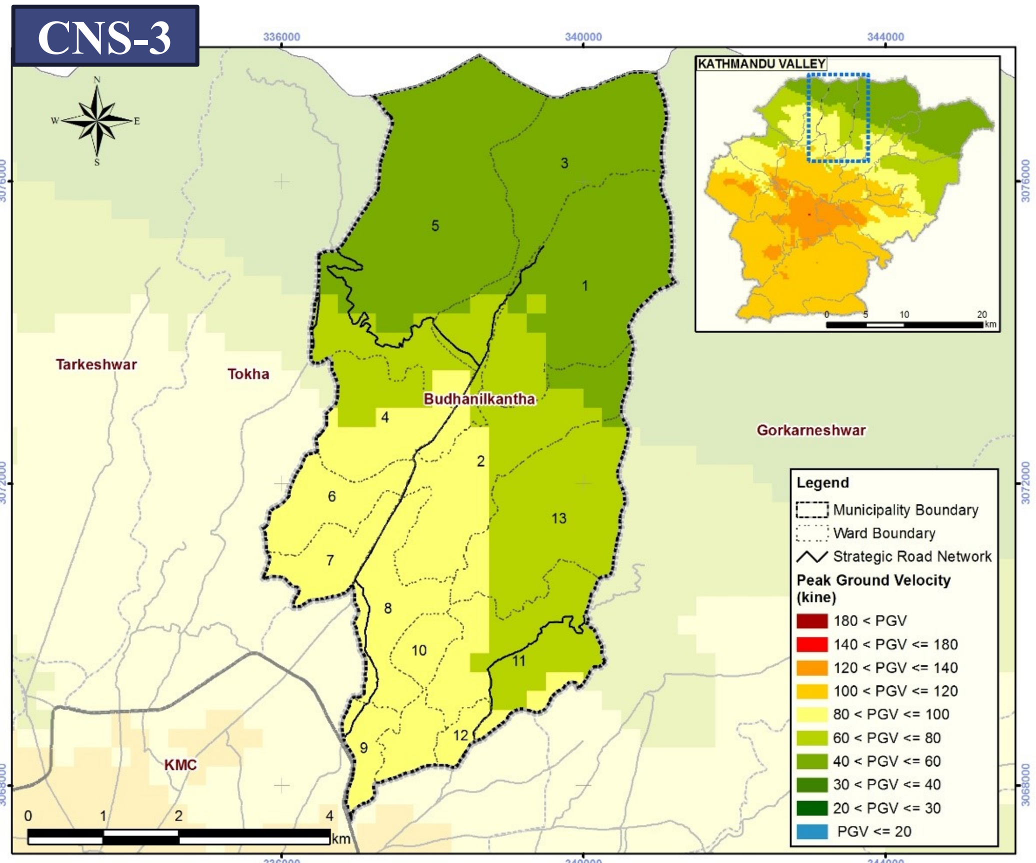
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-6

## Peak Ground Velocity Distribution

**Note:**

- First, the earthquake motion of scenario earthquake at bedrock (Vs=600m/sec) was calculated using existing Ground Motion Prediction Equation.
- Second, ground model for response analysis is constructed by drilling log, geomorphology map, microtremor survey, etc. in this project.
- Then, amplification of the ground is evaluated by one dimensional response analysis (SHAKE), based on the ground model above.
- PGV (Peak Ground Velocity) is calculated by integrating the surface acceleration waveform by response analysis.

**Source:**

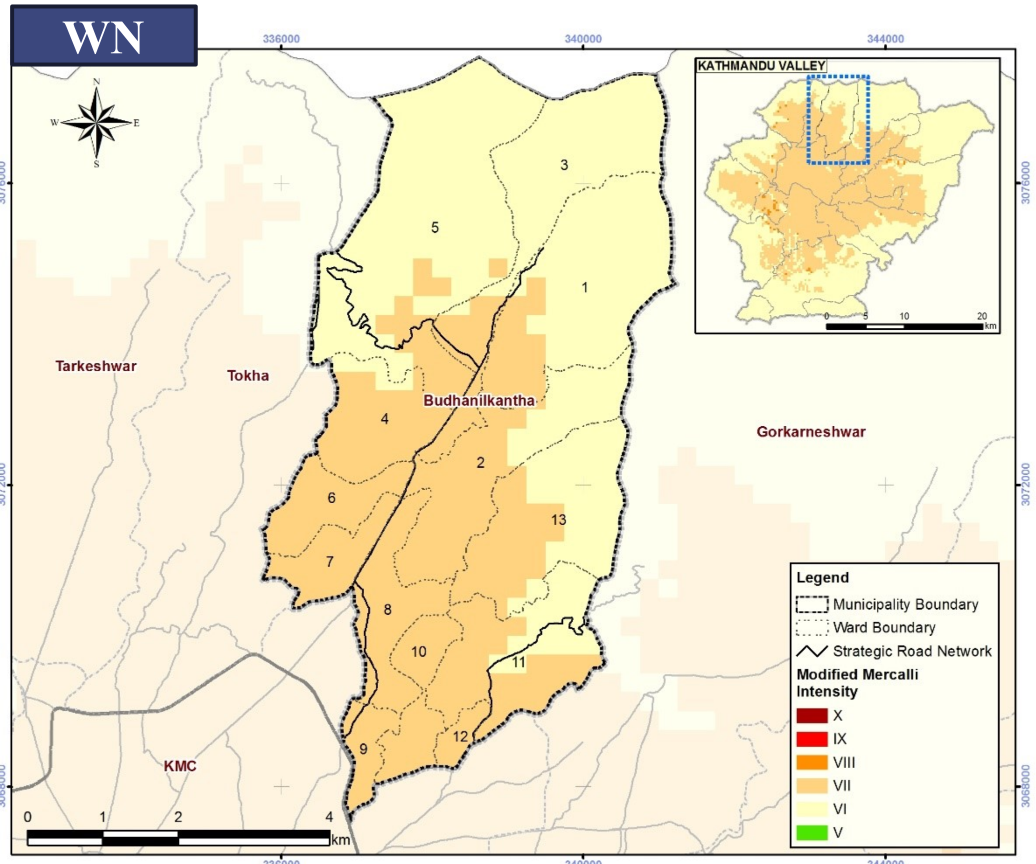
- Peak Ground Velocity: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

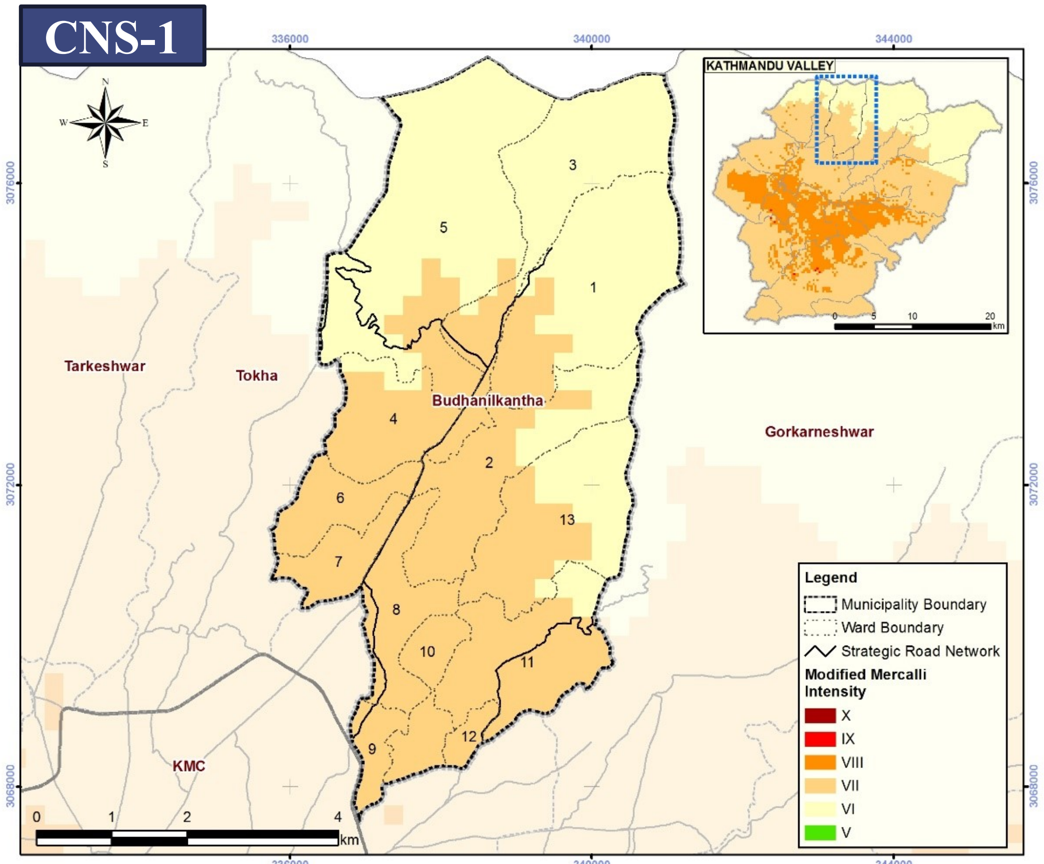
WGS_1984_UTM_Zone_45N

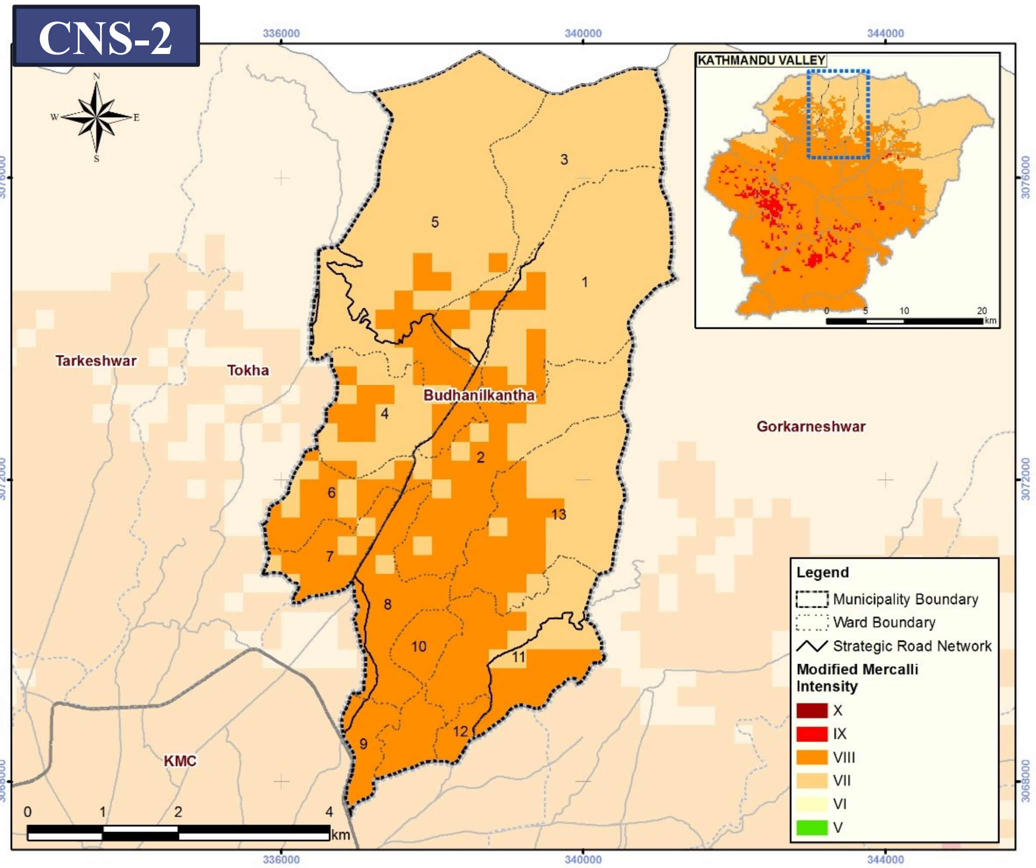
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

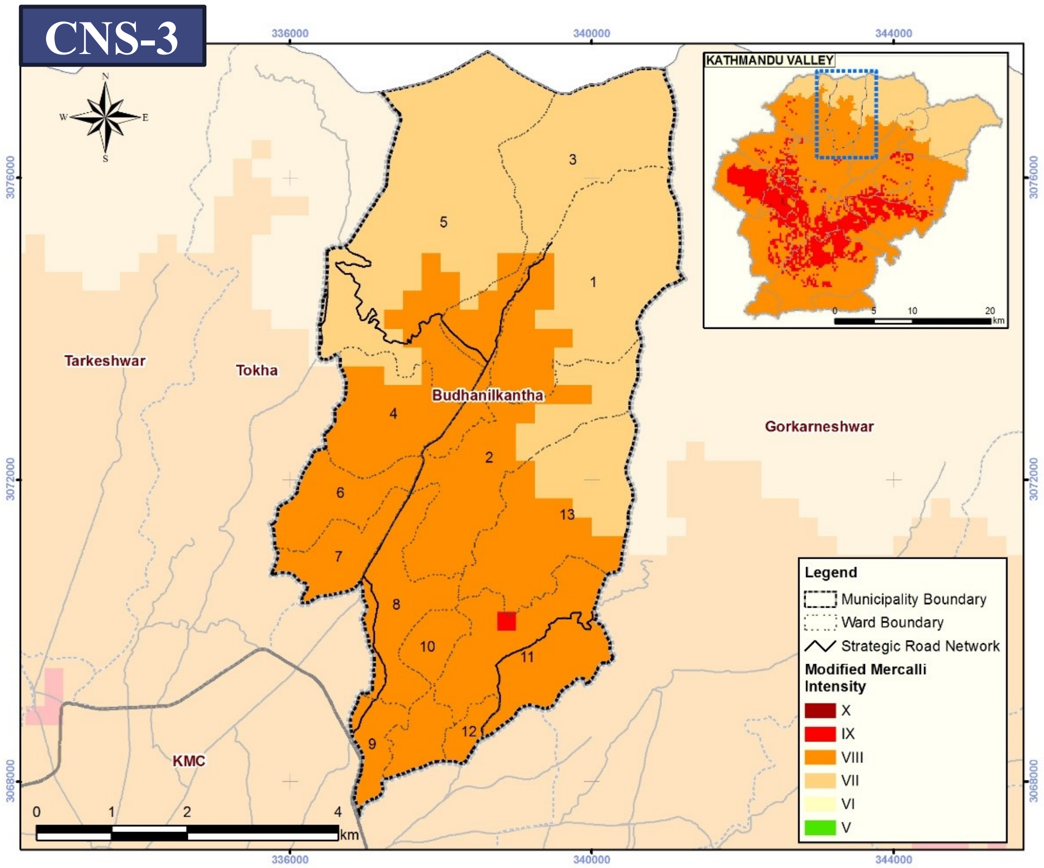
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree .......(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-7

# Seismic Intensity (MMI) Distribution

**Note:**

- First, the earthquake motion of scenario earthquake at bedrock (Vs=600m/sec) was calculated using existing Ground Motion Prediction Equation.
- Second, ground model for response analysis is constructed by drilling log, geomorphology map, microtremor survey, etc. in this project.
- Then, amplification of the ground is evaluated by one dimensional response analysis (SHAKE), based on the ground model above.
- Seismic Intensity in the MMI scale is estimated from existing empirical relation with PGA.

**Source:**

- Seismic Intensity (MMI): ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

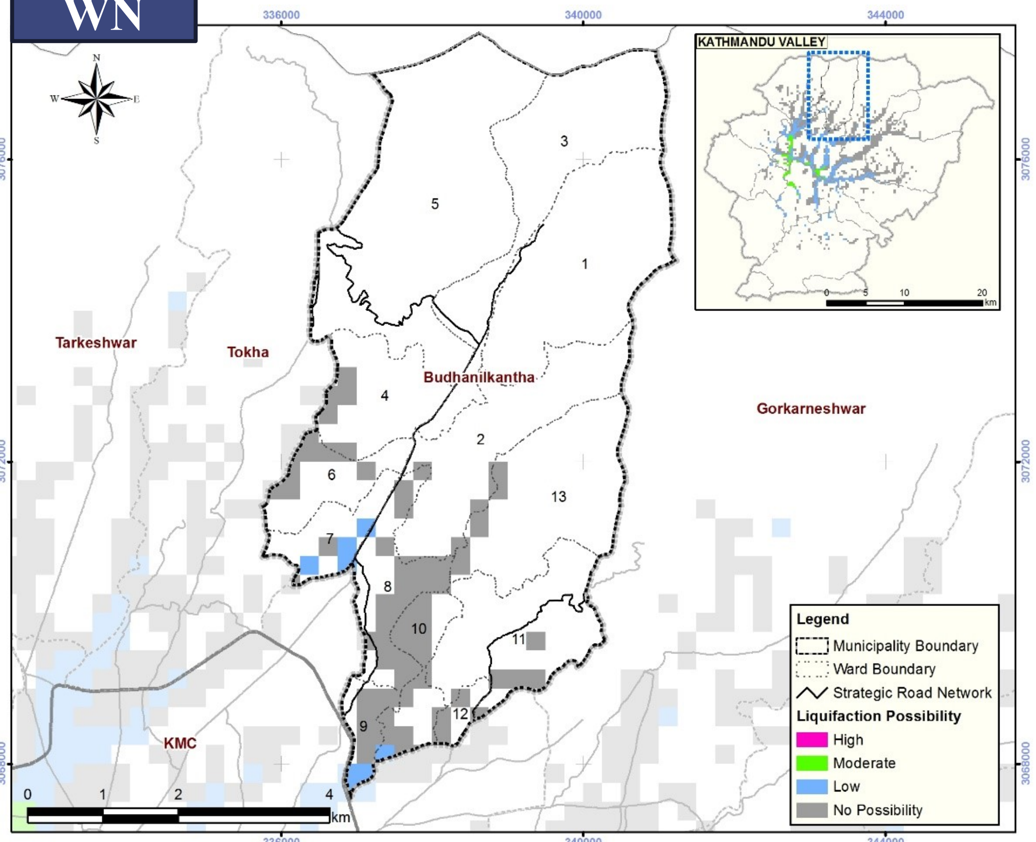
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

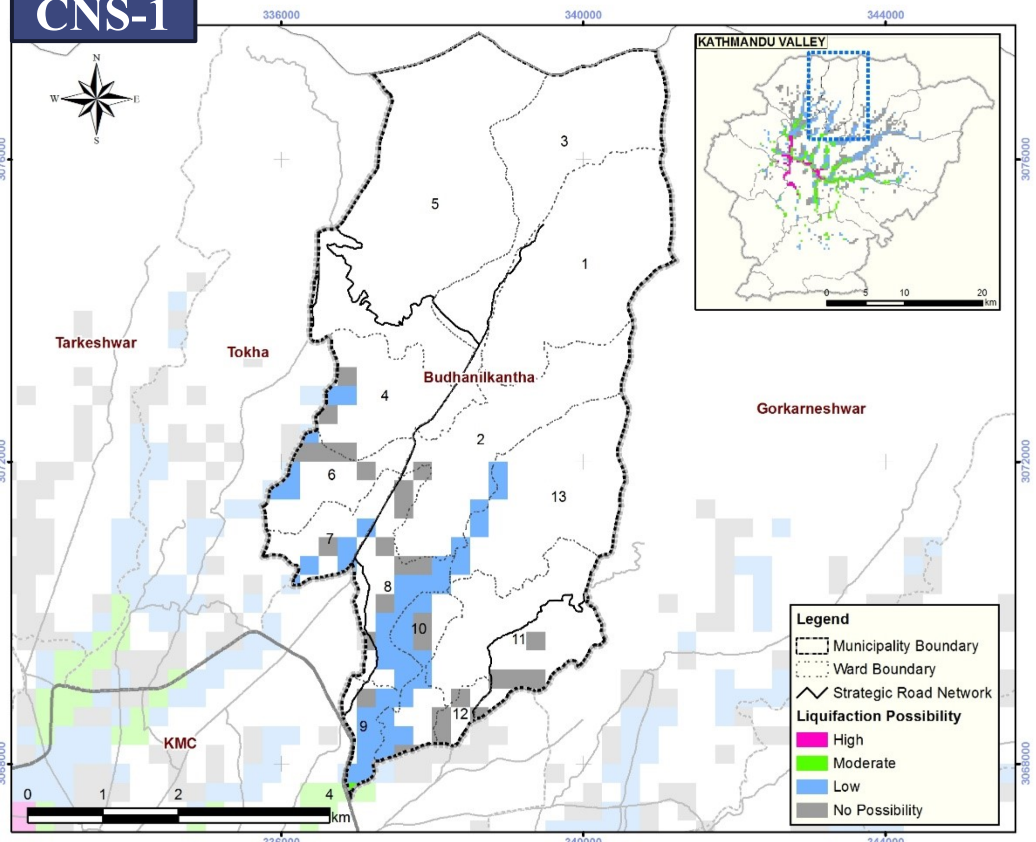
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree .......(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

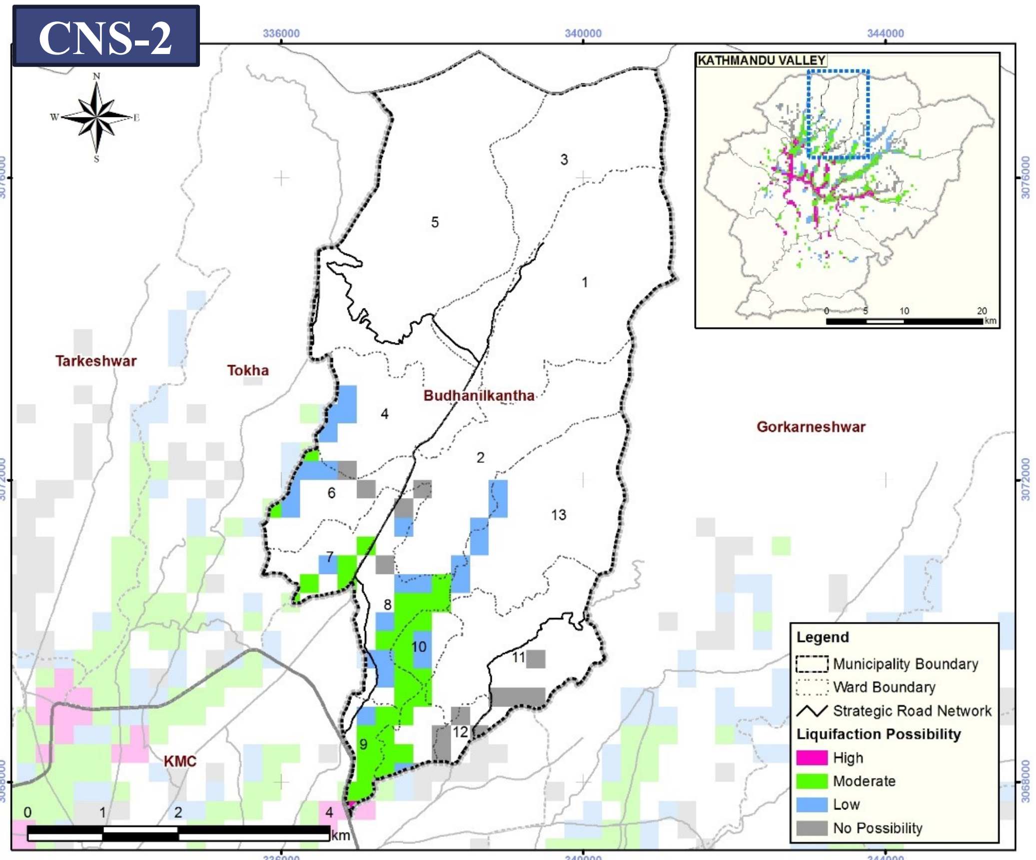
WN



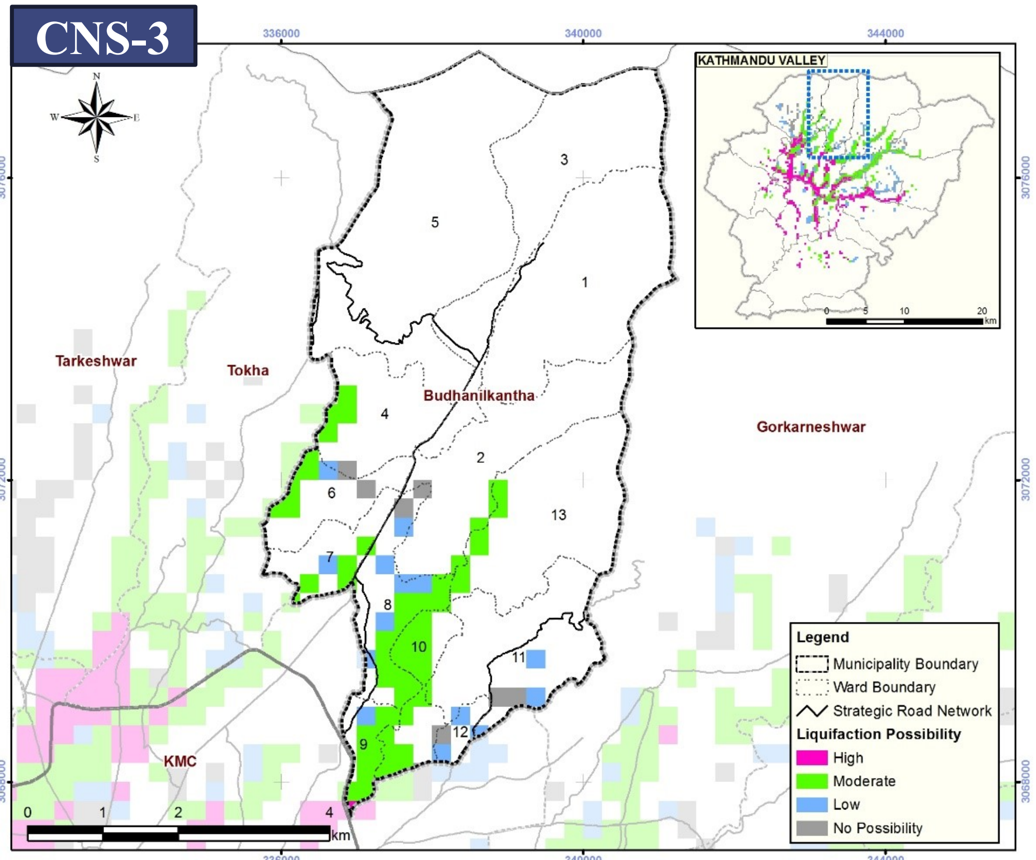

CNS-1




CNS-2




CNS-3




# B-8

## Distribution of Estimated Liquefaction in Rainy Season

**Note:**

- The liquefaction was evaluated using geomorphological map, boreholes with N values, groundwater level, and results of J-RAPID, and also taking into consideration of the history of liquefaction.
- These maps show the liquefaction possibility in Rainy Season, namely ground water level is high.

**Source:**

- Assessment Result of Liquefaction: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

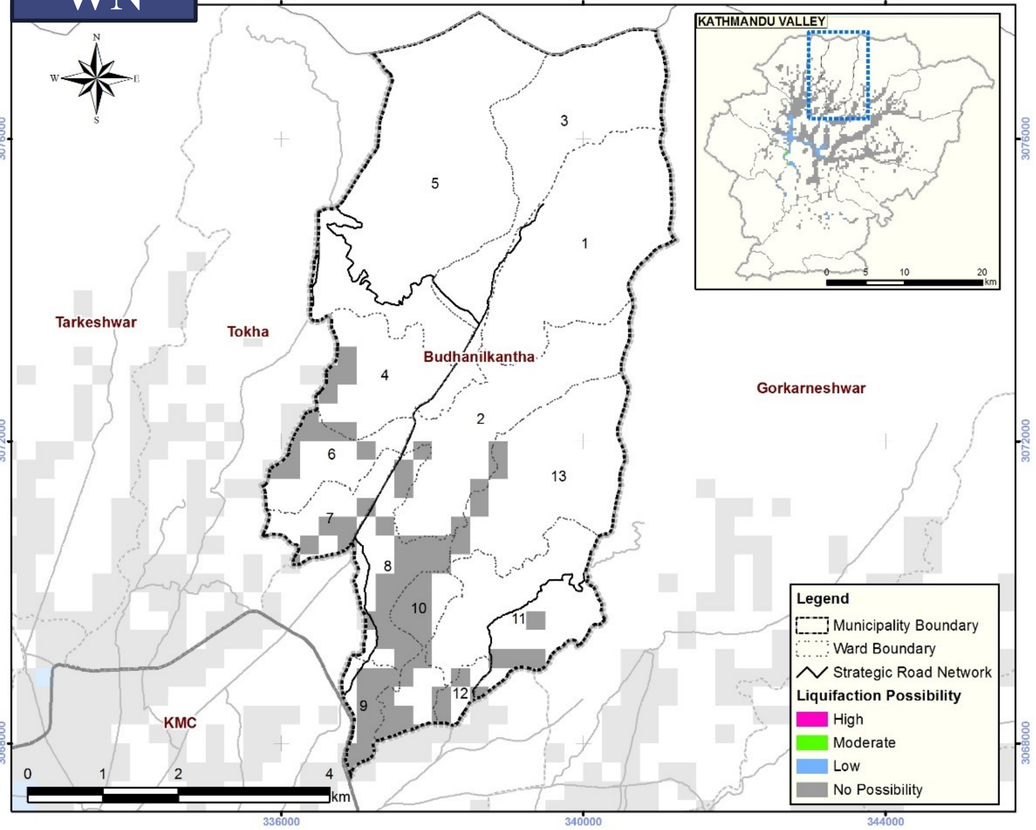
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

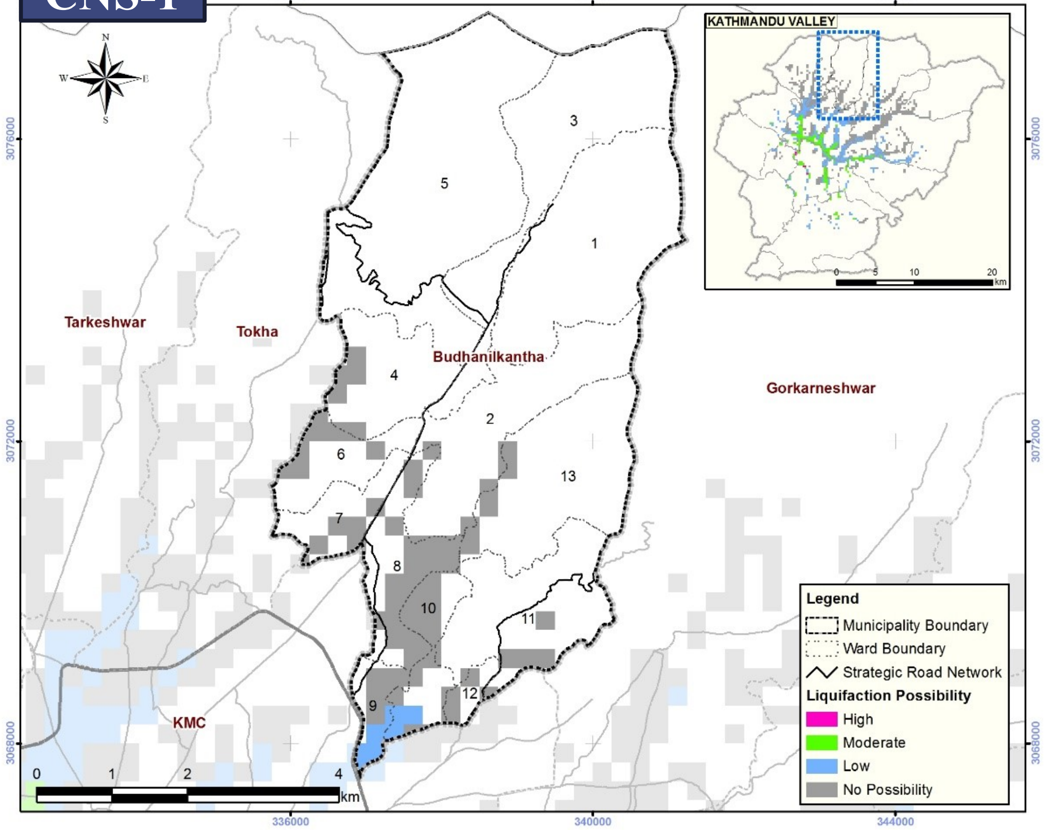
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ............................................D_WGS_1984
Spheroid: ............................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

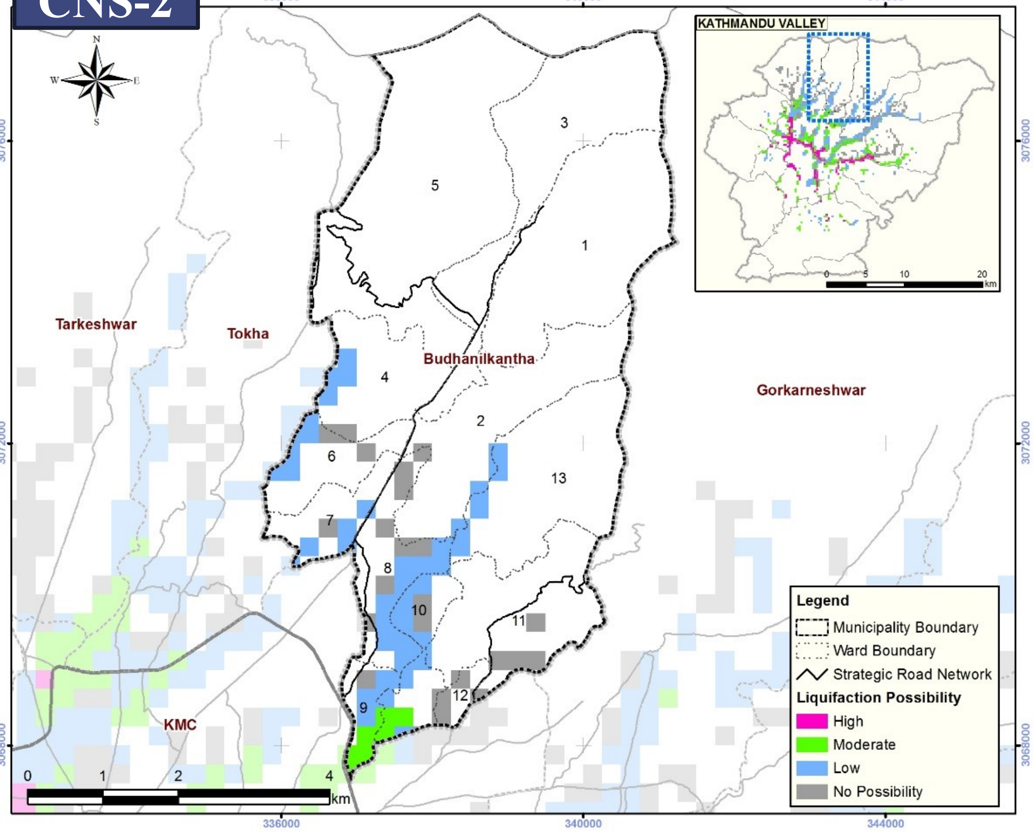
WN



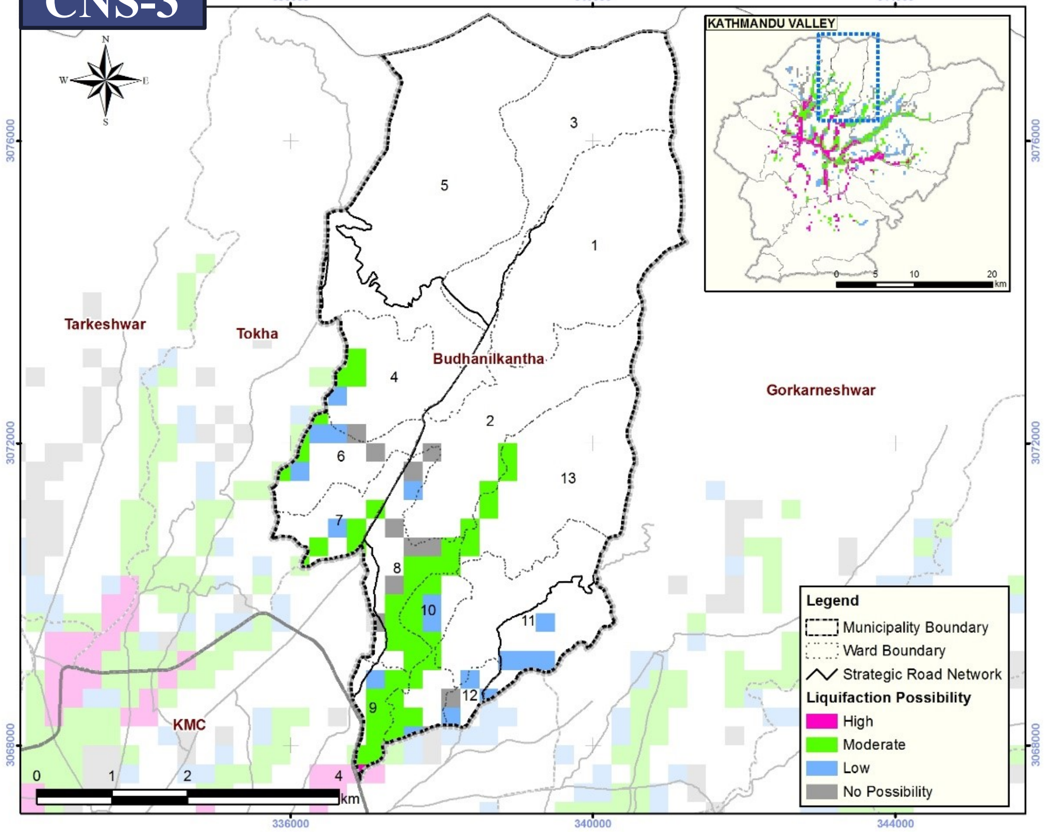

CNS-1




CNS-2




CNS-3




# B-9

## Distribution of Estimated Liquefaction in Dry Season

**Note:**

- The liquefaction was evaluated using geomorphological map, boreholes with N values, groundwater level, and results of J-RAPID, and also taking into consideration of the history of liquefaction.
- These maps show the liquefaction possibility in Dry Season, namely ground water level is low.

**Source:**

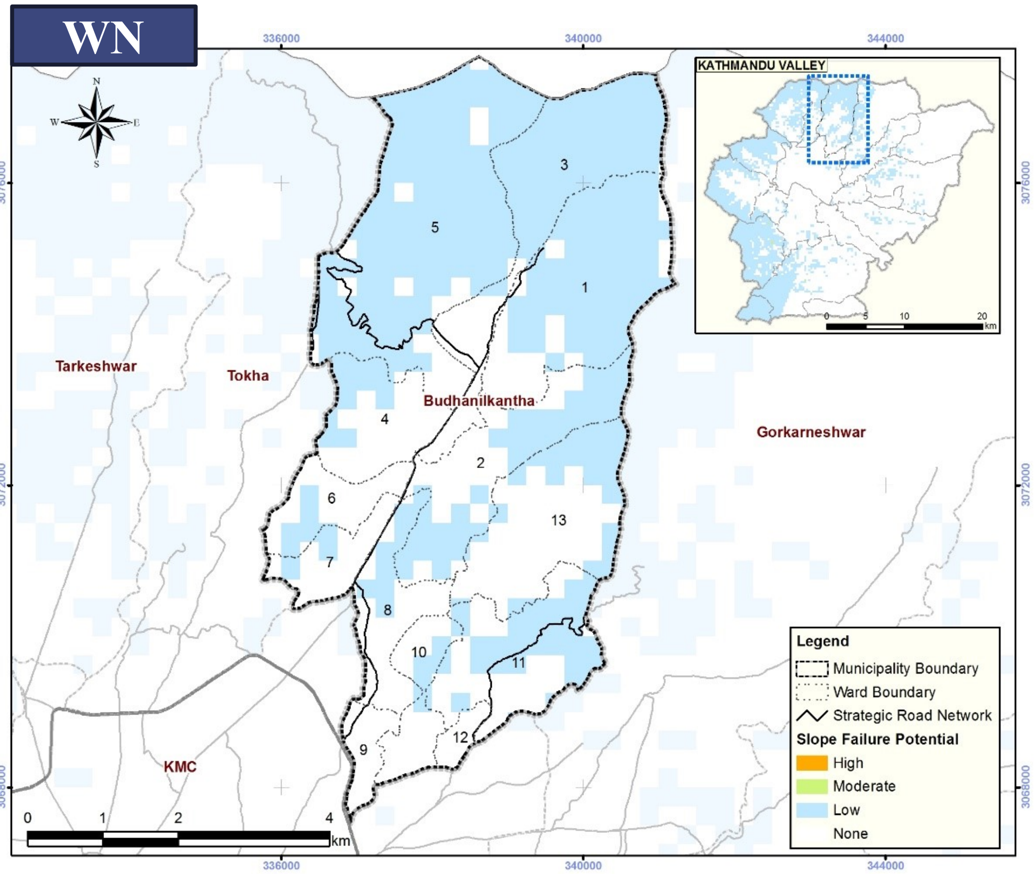
- Assessment Result of Liquefaction: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

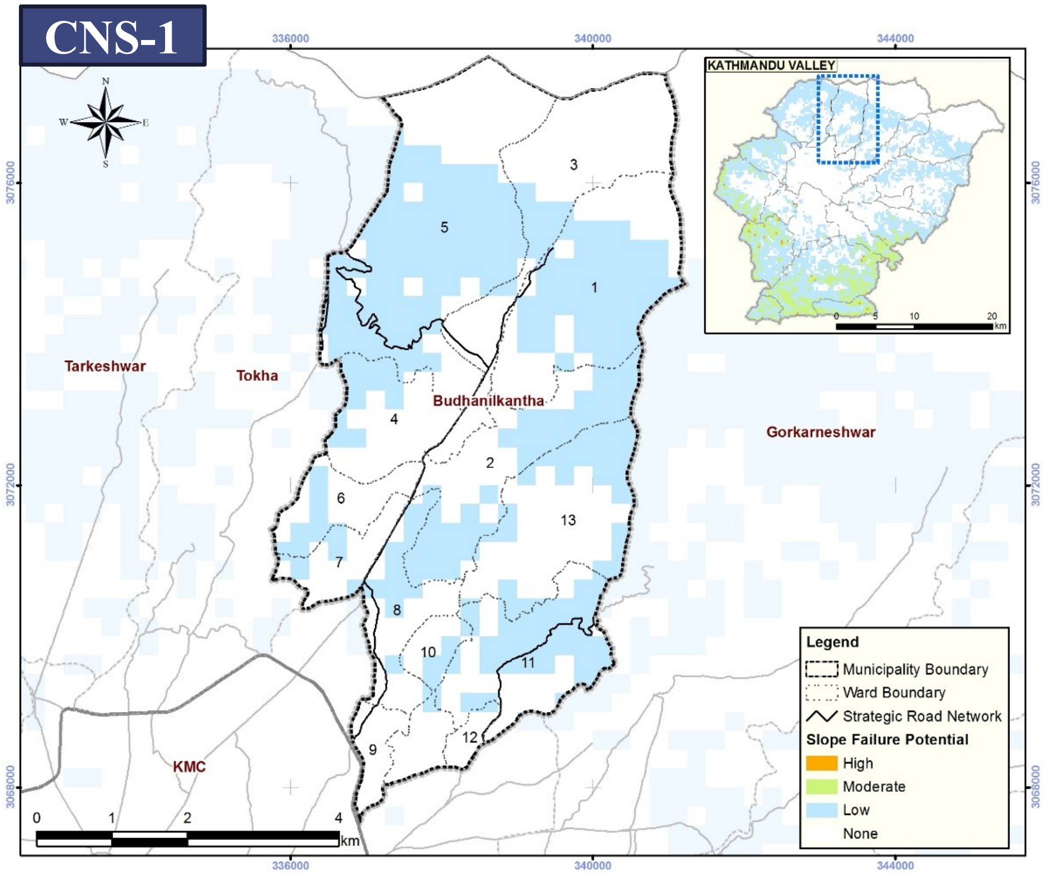
WGS_1984_UTM_Zone_45N

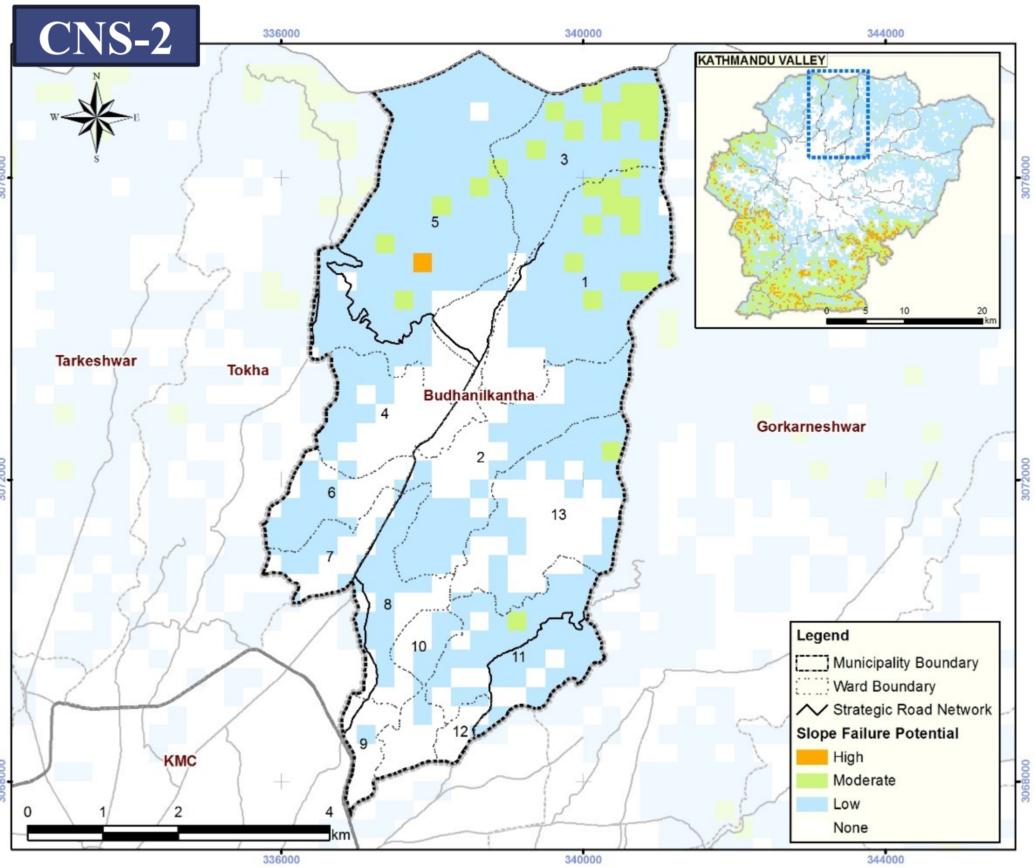
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .....................0.0
central_meridian: ...............87.0
scale_factor: ...................0.9996
latitude_of_origin:.................. 0.0
Linear Unit: Meter (1.0)

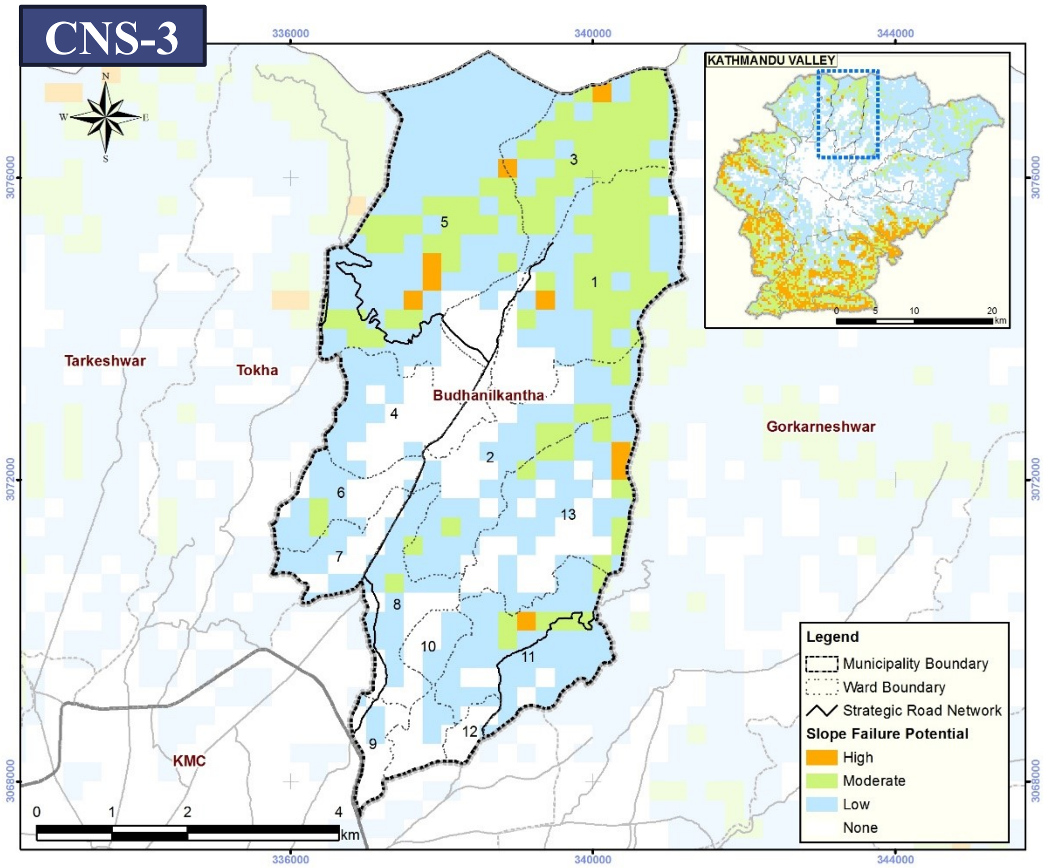
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...............................................D_WGS_1984
Spheroid: ..............................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-10

# Distribution of Estimated Earthquake Induced Slope Failure

**Note:**

- For the evaluation of the earthquake induced slope failure, slope angle, geology, history of slope failure are taken into consideration and the peak ground acceleration is used. The physical soil properties of slopes are estimated.

**Source:**

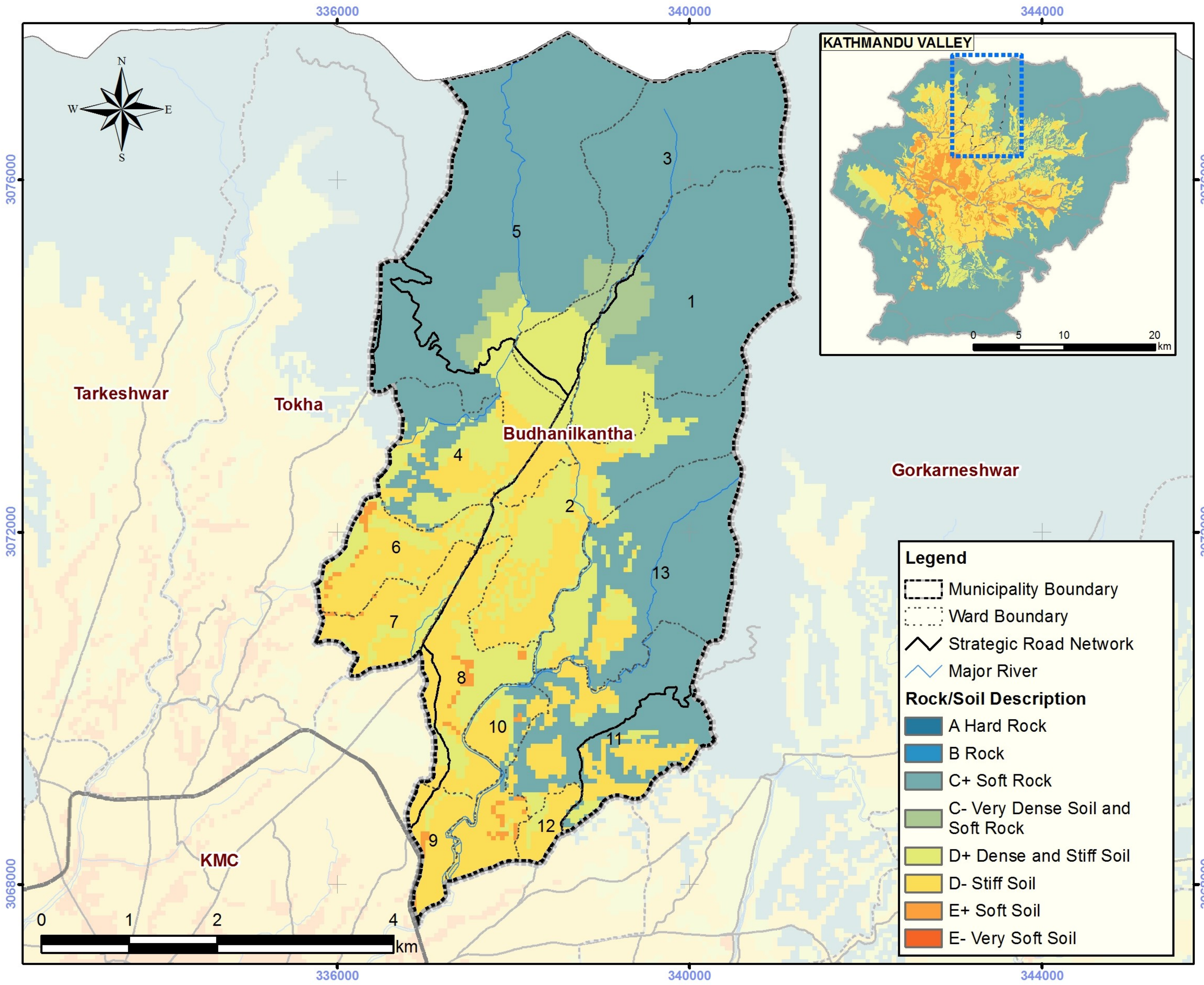
- Assessment Result of Slope Failure: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-11

## AVS30 Map based on Geomorphological Unit

**Note:**

- The geomorphological map has significantly contributed not only to the ground modelling, but also to the understanding of origin, process and distribution of ground formation. In this project, by combining the geomorphological map and a variety of survey results, the maps were developed that show the softness of ground, vulnerability related to liquefaction and slope failure.
- Specifically, to organize the results of AVS30 obtained from the L-shaped array measurement of microtremor described below (where AVS30 is the average value of the S-wave velocity to a depth of 30m from the surface) for each geomorphological unit, together with the relationship with altitude, AVS30 map or the surface soil softness map, namely "Shakability" map, was developed.

**Source:**

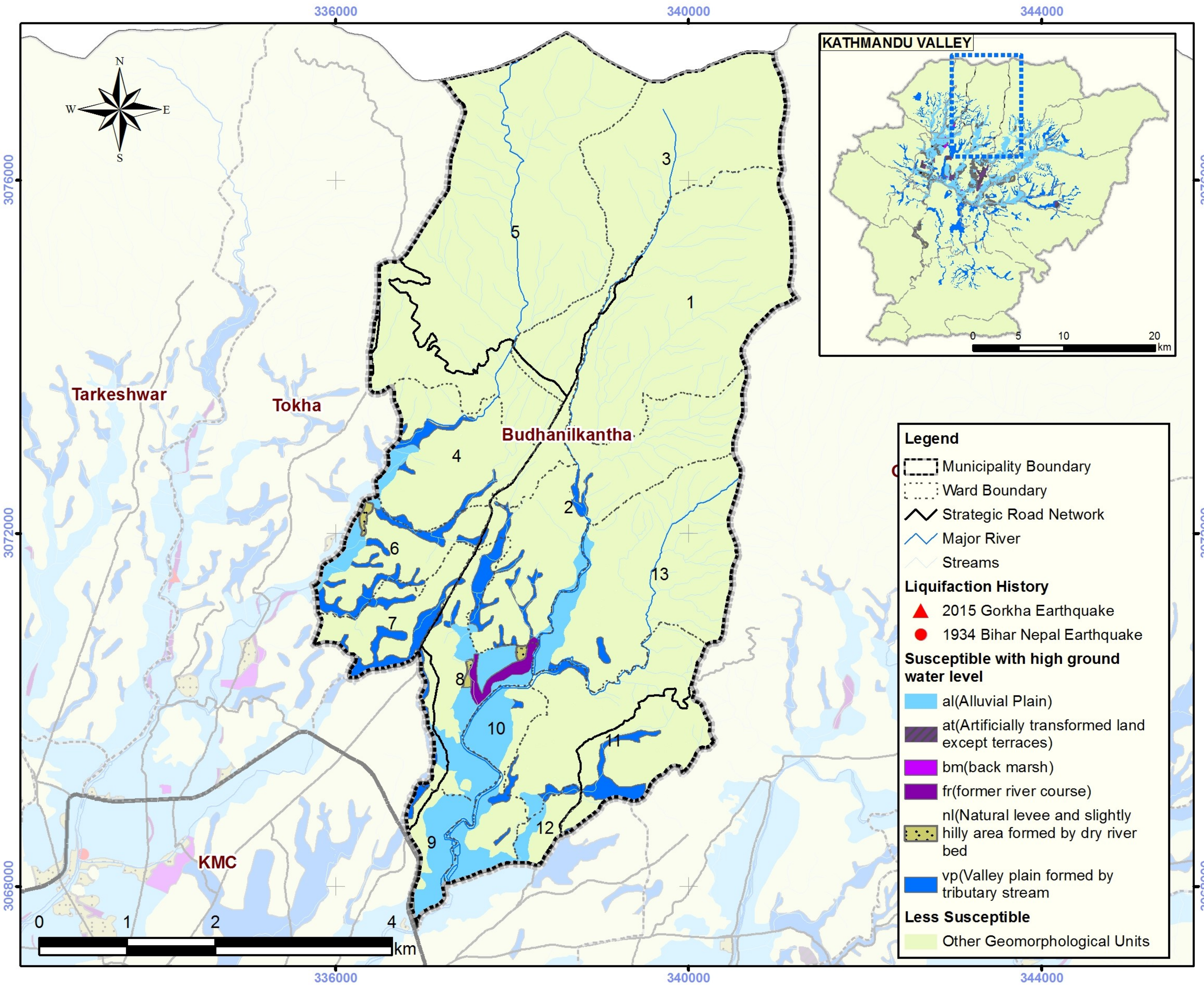
- AVS30 map base on geomorphological unit: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- River Network: 2002 JICA Project, UN OCHA Project

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:.................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ............................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-12

# Liquefaction Susceptibility Map

**Note:**

- The geomorphological map has significantly contributed not only to the ground modelling, but also to the understanding of origin, process and distribution of ground formation. In this project, by combining the geomorphological map and a variety of survey results, the maps were developed that show the softness of ground, vulnerability related to liquefaction and slope failure.
- The liquefaction susceptibility map with the past liquefaction history was prepared. This susceptibility map should be valid map for taking advantage as basic information at the time of grasping the ground situation of the entire Valley, or development planning, setting land use unit.

**Source:**

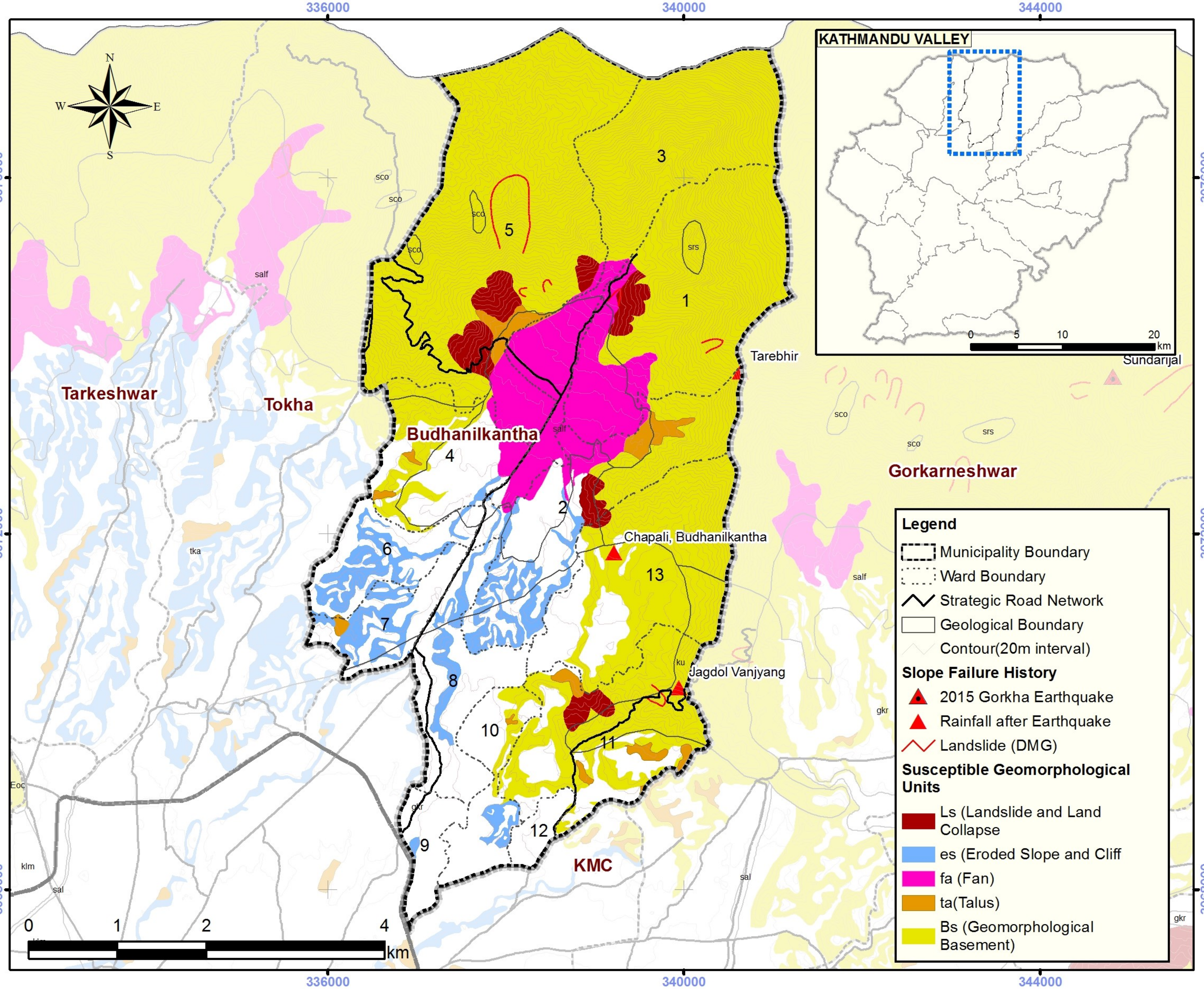
- Liquefaction Susceptibility Map: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- River Network: 2002 JICA Project, UN OCHA Project

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: .............................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-13

# Earthquake Induced Slope Failure Susceptibility Map

**Note:**

- The geomorphological map has significantly contributed not only to the ground modelling, but also to the understanding of origin, process and distribution of ground formation. In this project, by combining the geomorphological map and a variety of survey results, the maps were developed that show the softness of ground, vulnerability related to liquefaction and slope failure.
- Earthquake induced slope failure susceptibility map considering slope angle, geomorphological unit, the history of slope failure and the inclination was developed. This susceptibility map should be valid map for taking advantage as basic information at the time of grasping the ground situation of the entire Valley, or development planning, setting land use unit.

**Source:**

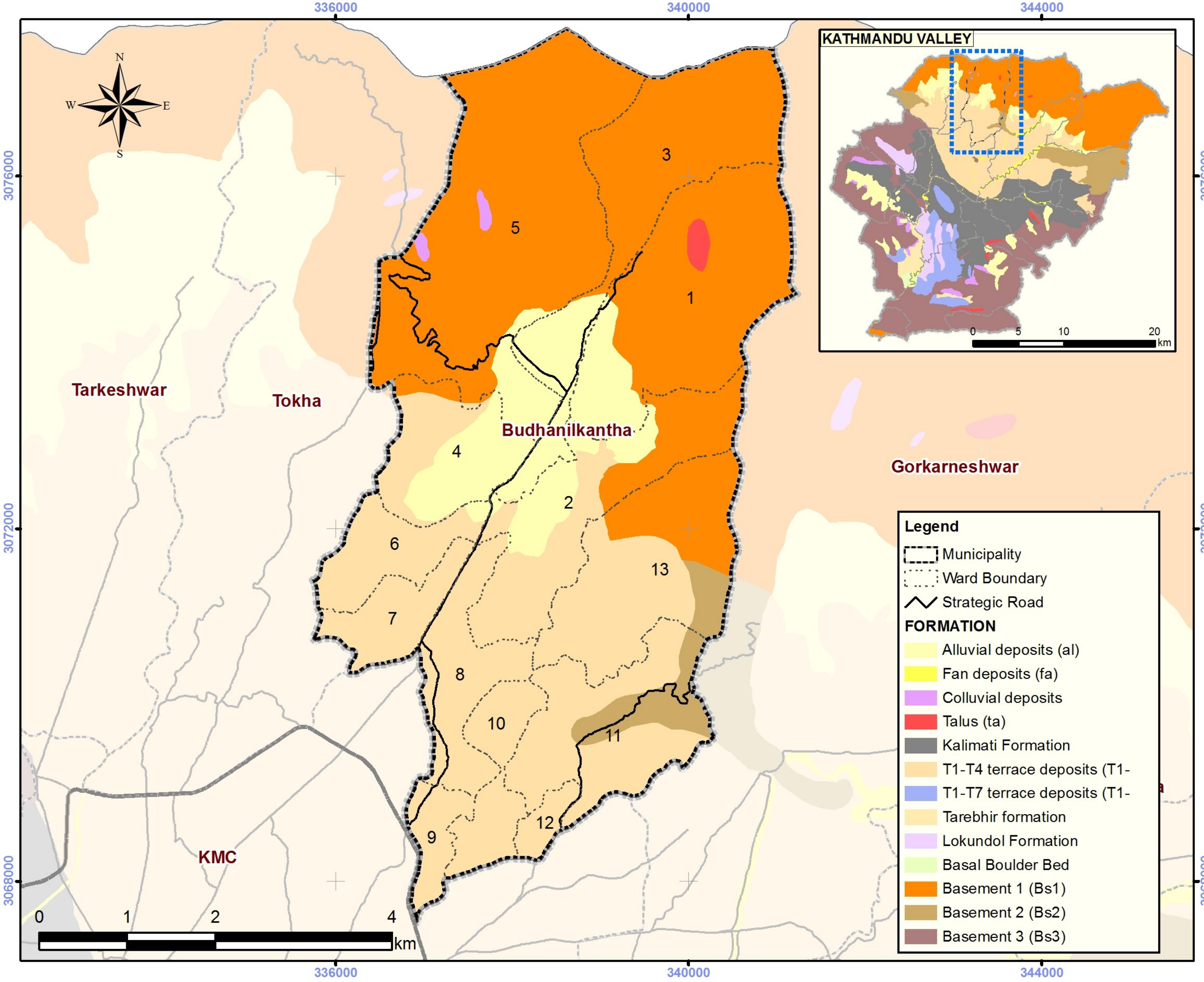
- Earthquake induced slope failure Susceptibility Map: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- River Network: 2002 JICA Project, UN OCHA Project

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ............................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal




# B-14

## Geology Map

**Note:**

- This geology map of Kathmandu Valley was created by UNDP/CDRMP by modifying engineering and environmental geology map by DMG in 1998.

. According to the report of Comprehensive Study of Urban Growth Trend and Forecasting of Land Use published by UNDP/CDRMP 2013, the geology of Kathmandu valley is classified into two categories: hard basement rocks and soft sediments. The Kathmandu Valley has formed a basin where the peripheral hilly area comprises low to medium grade metamorphic rocks and intrusive rocks belonging to Lesser Himalayas as well as sedimentary rocks equivalent to Tibetan Tethys Zone.

**Source:**

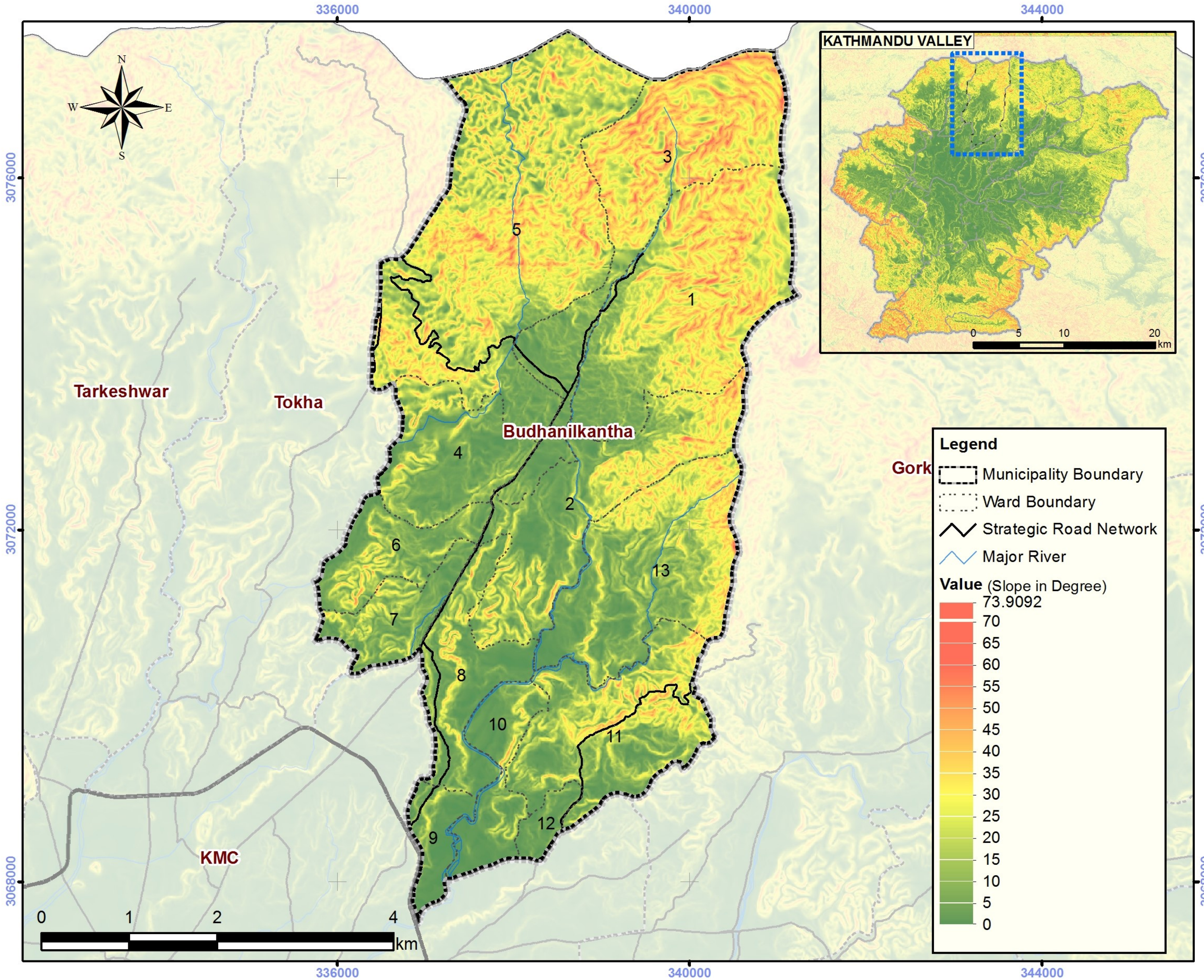
- Geological Map: UNDP/CDRMP 2013
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- River Network: 2002 JICA Project, UN OCHA Project

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ............................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# B-15

## Steep Slope Map

**Note:**

- As one of ground information, steep slope map was analyzed based DEM (Digital Elevation Model) derived from recent satellite imagery data from UNDP/CDRMP.

**Source:**

- Digital Elevation Model: UNDP/CDRMP
- Steep Slope: ERAKV 2016
- Boundary of Municipality and Ward: DoS, MoFALD
- Road Network: DoR, DoLIDAR
- River Network: 2002 JICA Project, UN OCHA Project

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:.................. 0.0
Linear Unit: Meter (1.0)

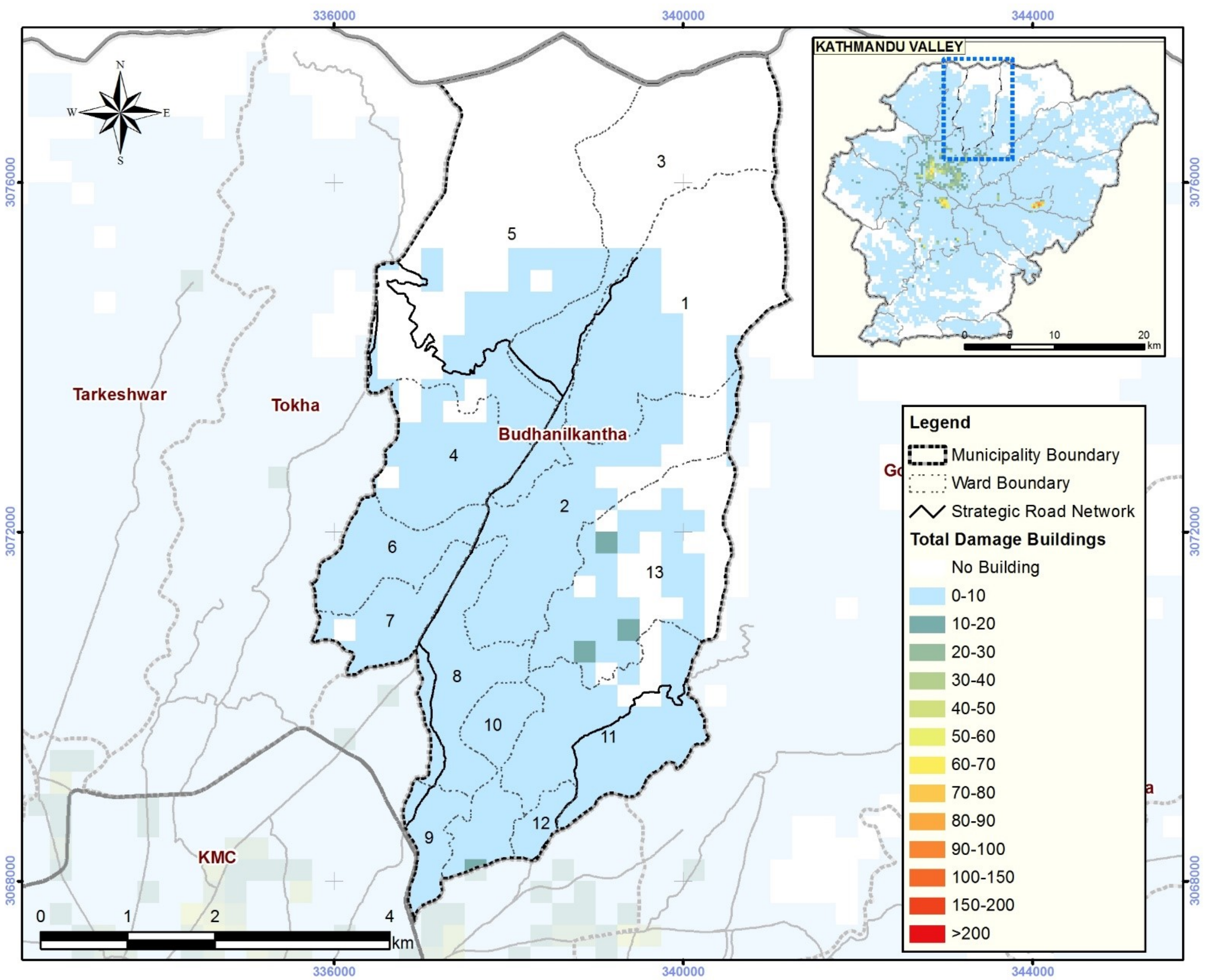
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ............................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

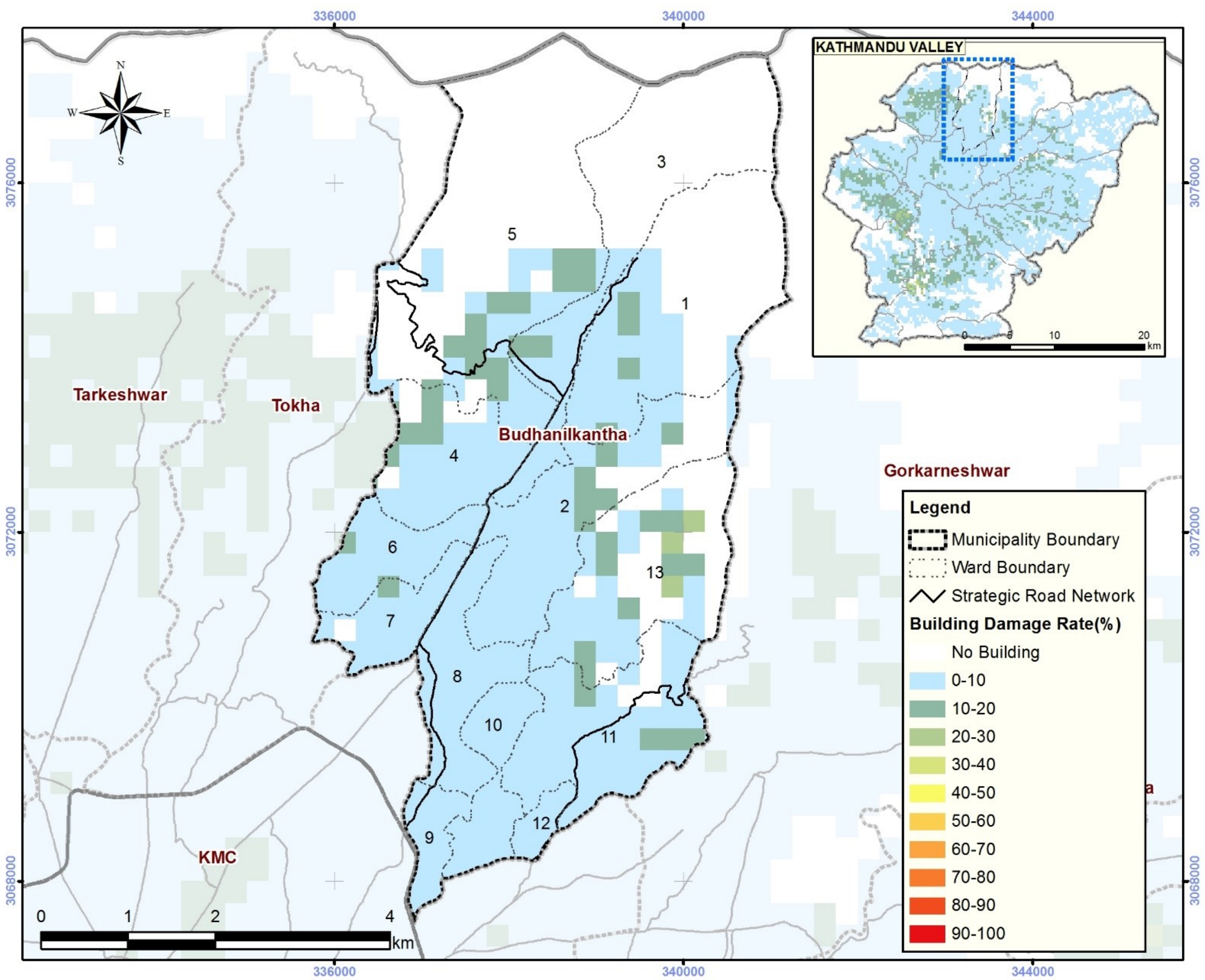
# C. Seismic Risk Assessment

# C-1
# Distribution of Heavily Damaged Building Number & Ratio in 2016
# Scenario Ground Motion: WN

## Number of Damaged Building




## Ratio of Damaged Building (%)




**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number, and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total number of heavily damaged buildings in the study area in 2016, based on WN scenario ground motion, was estimated to 550 and the proportion of damaged buildings to total no. of buildings defined as 17,066 was 3.2%.

**Source:**

- Grid wise damaged building distribution in 2016 based on WN scenario ground motion: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

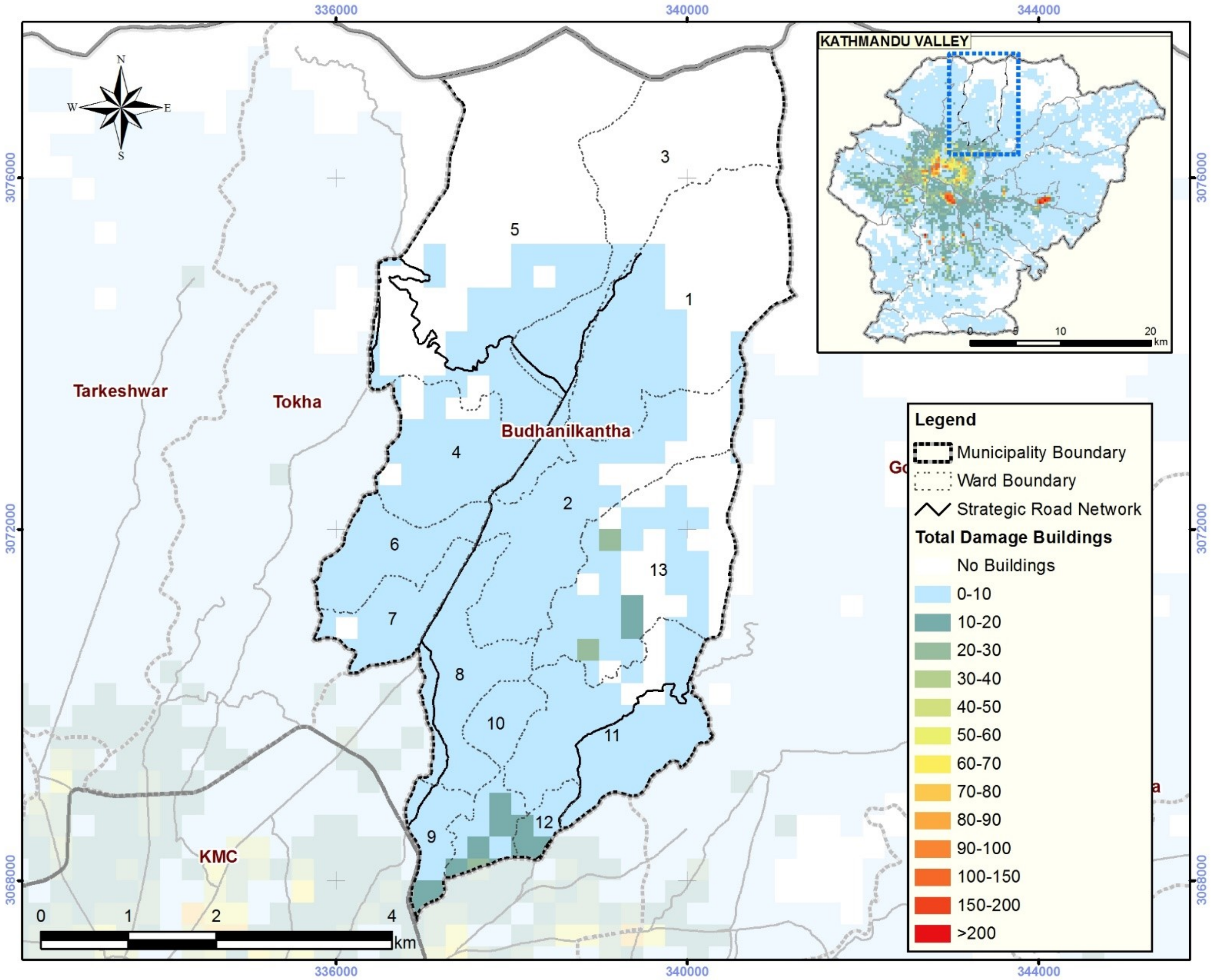
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ...................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

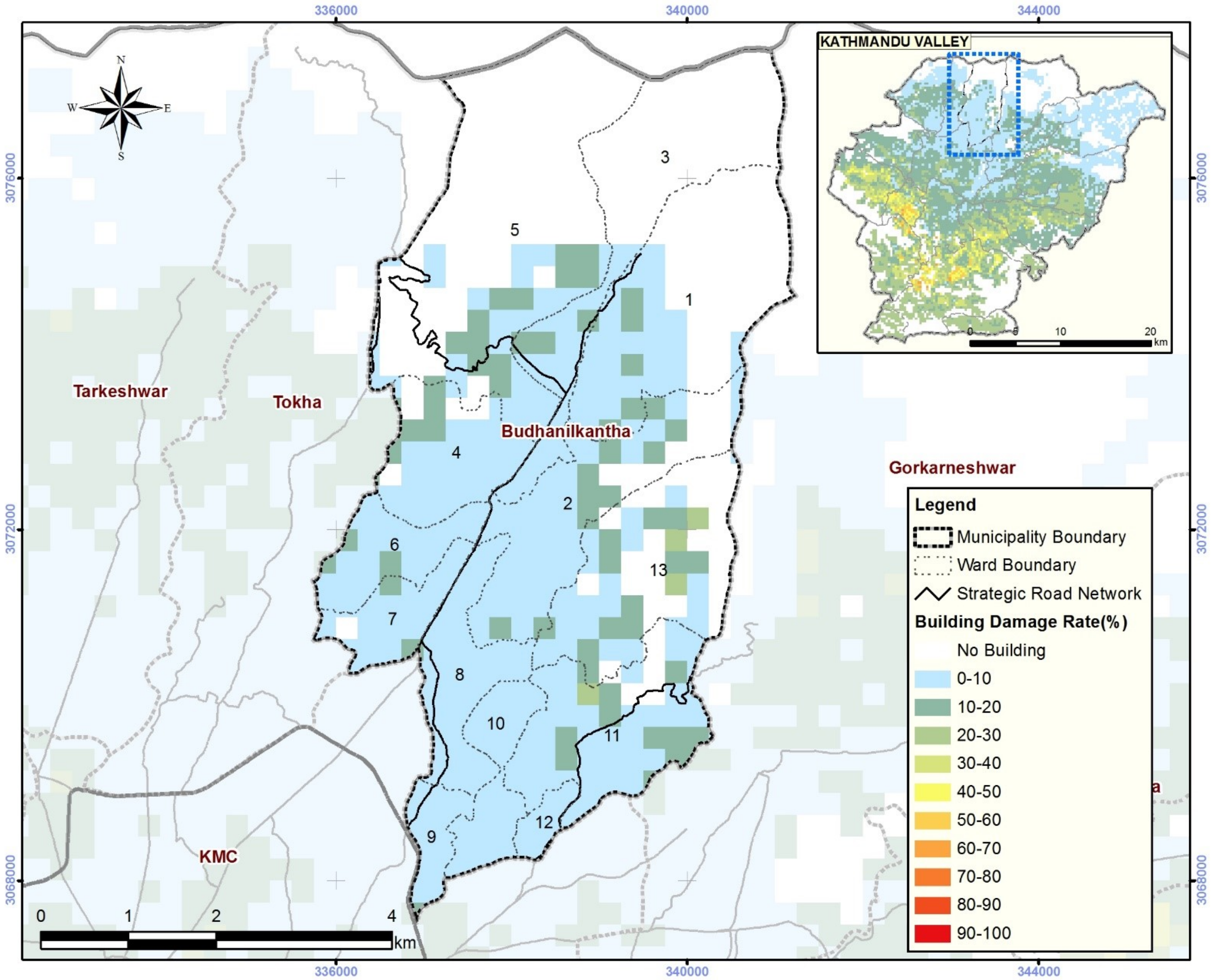
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# C-2
# Distribution of Heavily Damaged Building Number & Ratio in 2016
# Scenario Ground Motion: CNS-1

## Number of Damaged Building




## Ratio of Damaged Building (%)




**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number, and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total number of heavily damaged buildings in the study area in 2016, based on the CNS-1 scenario ground motion, was estimated to be 881 and the proportion of damaged buildings to total buildings defined as 17,066 was 5.2%.

**Source:**

- Grid wise damaged building distribution in 2016 based on CNS-1 scenario ground motion: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

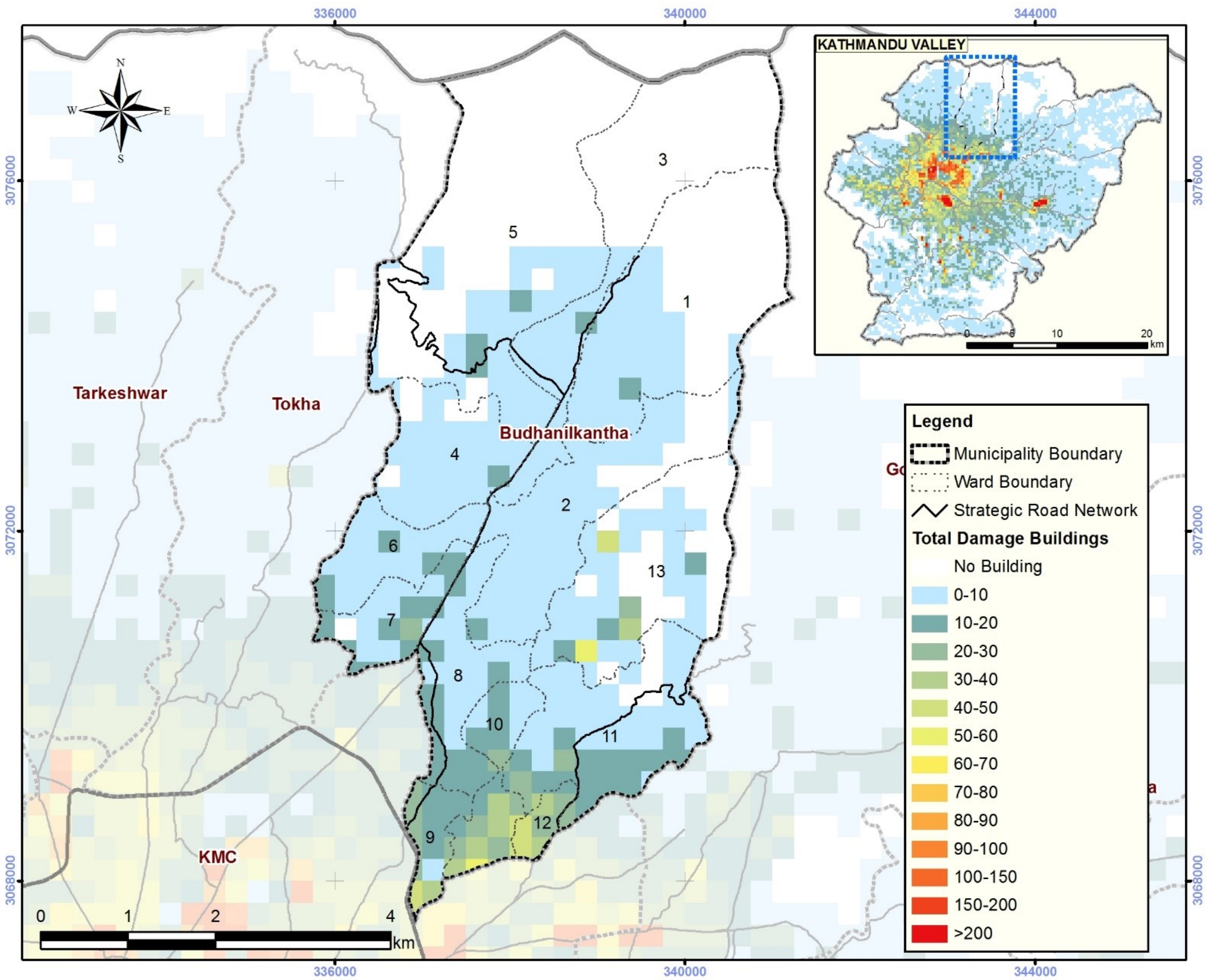
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

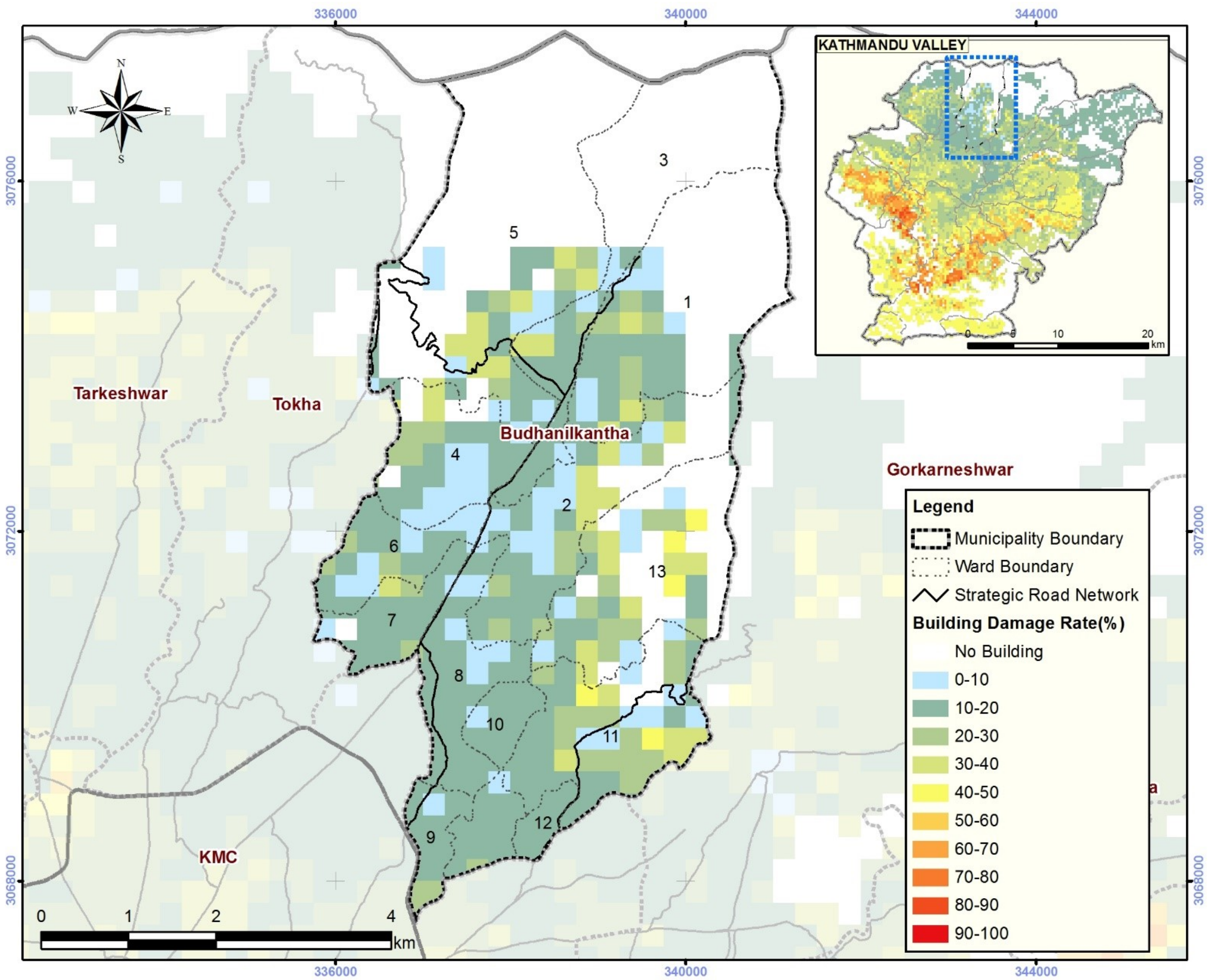
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

## C-3
## Distribution of Heavily Damaged Building Number & Ratio in 2016
## Scenario Ground Motion: CNS-2

### Number of Damaged Building




### Ratio of Damaged Building (%)




**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged building by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number, and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total number of heavily damaged buildings in 2016, based on the CNS-2 scenario ground motion, was estimated to be 2,640 in the study area and the proportion of damaged buildings to total buildings defined as 17,066 was 15.5%.

**Source:**

- Grid wise damaged building distribution in 2016 based on CNS-2 scenario ground motion: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

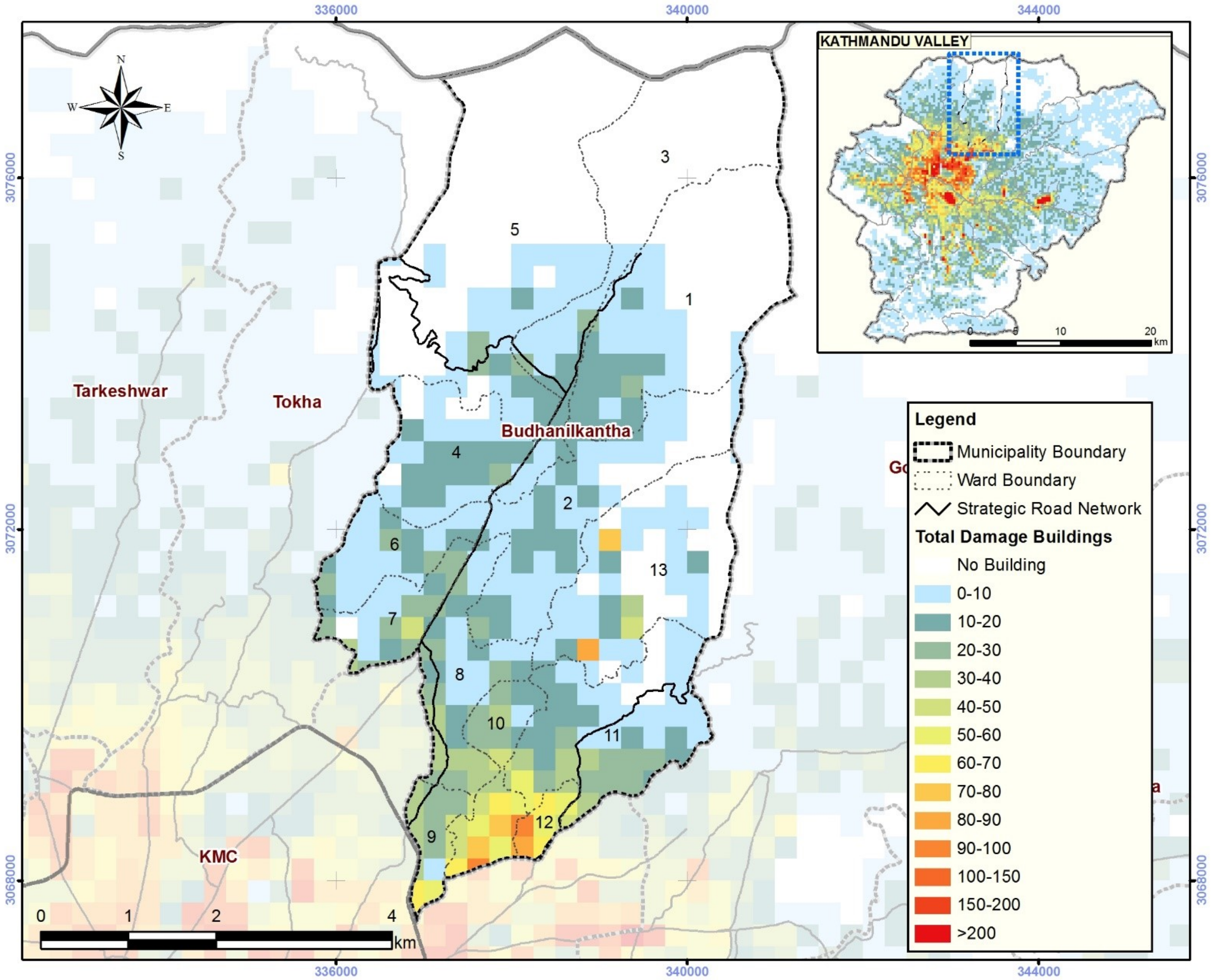
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

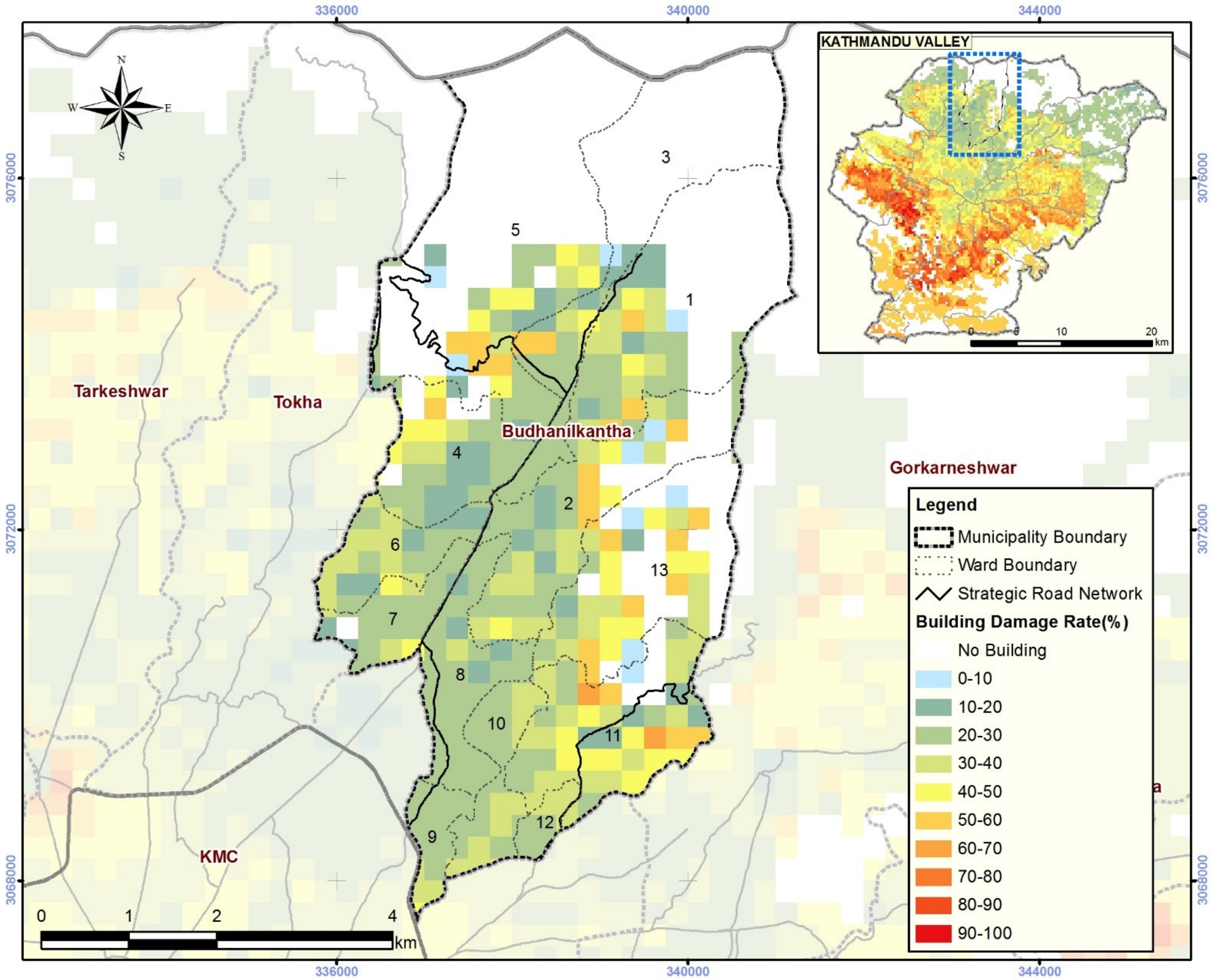
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# C-4
# Distribution of Heavily Damaged Building Number & Ratio in 2016
# Scenario Ground Motion: CNS-3

## Number of Damaged Building




## Ratio of Damaged Building (%)




**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged building by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total number of heavily damaged buildings in the study area in 2016, based on CNS-3 scenario ground motion, was estimated to be 4,883 and the proportion of damaged buildings to total buildings defined as 17,066 was 28.6%.

**Source:**

- Grid wise damaged building distribution in 2016 based on CNS-3 scenario ground motion: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

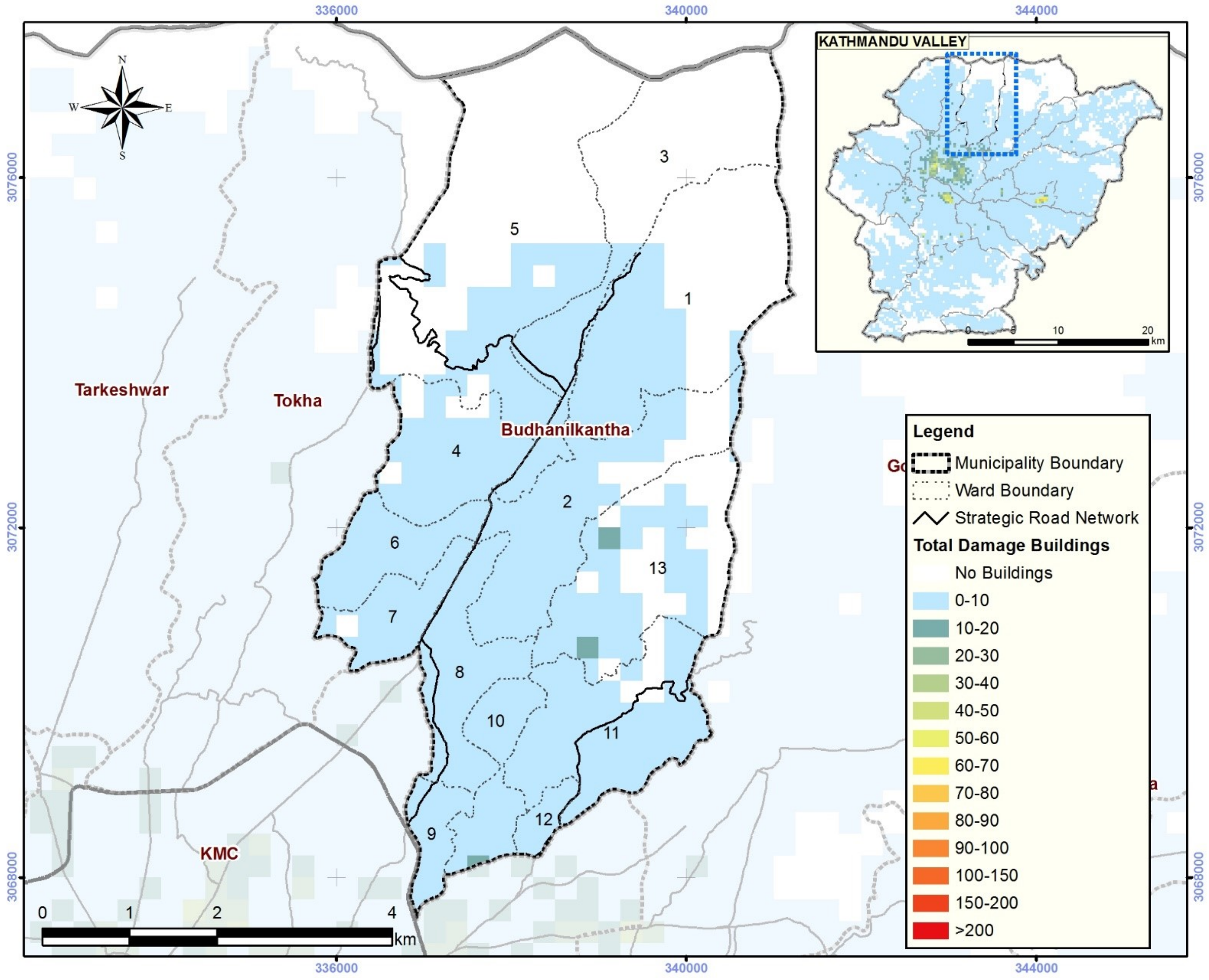
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

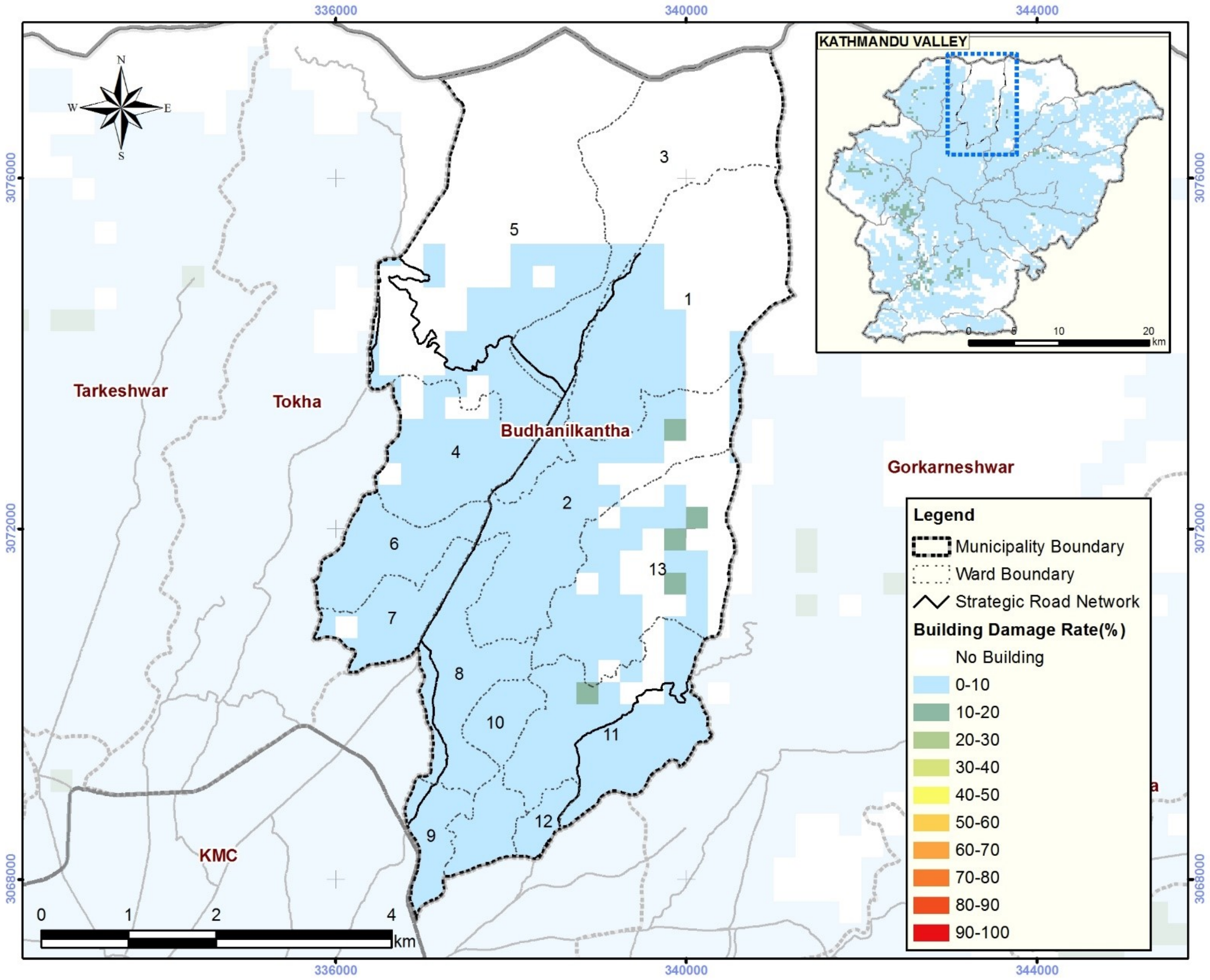
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

## C-5
## Distribution of Moderately Damaged Building Number & Ratio in 2016
## Scenario Ground Motion: WN

### Number of Damaged Building




### Ratio of Damaged Building (%)




**Note:**

- "Moderately Damaged Building" means a building classified as Damage Level 3 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total number of moderately damaged buildings in the study area in 2016, based on WN scenario ground motion, was estimated to be 587 and the proportion of damaged buildings to total buildings defined as 17,066 was 3.4%.

**Source:**

- Grid wise damaged building distribution in 2016 based on WN scenario ground motion: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

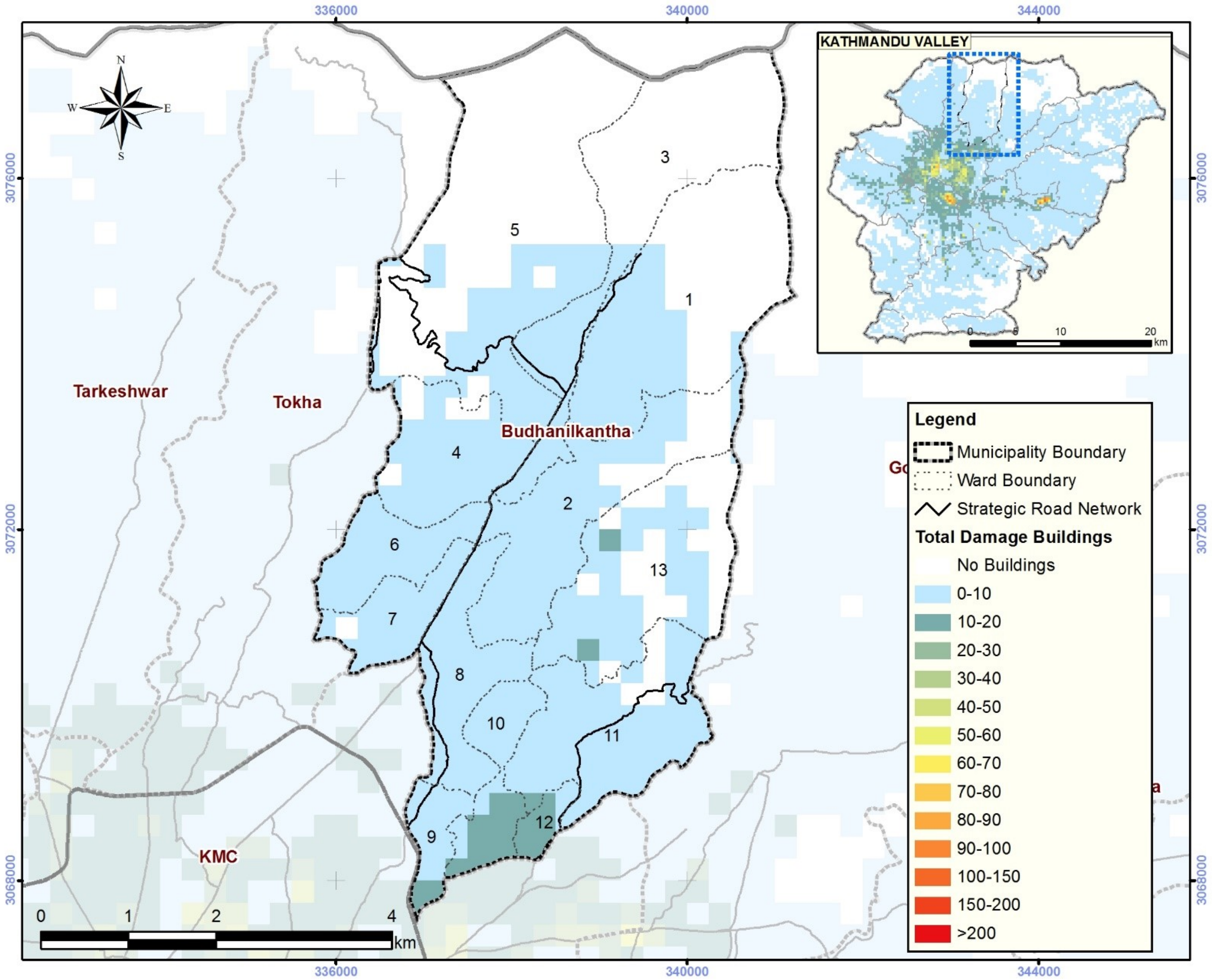
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

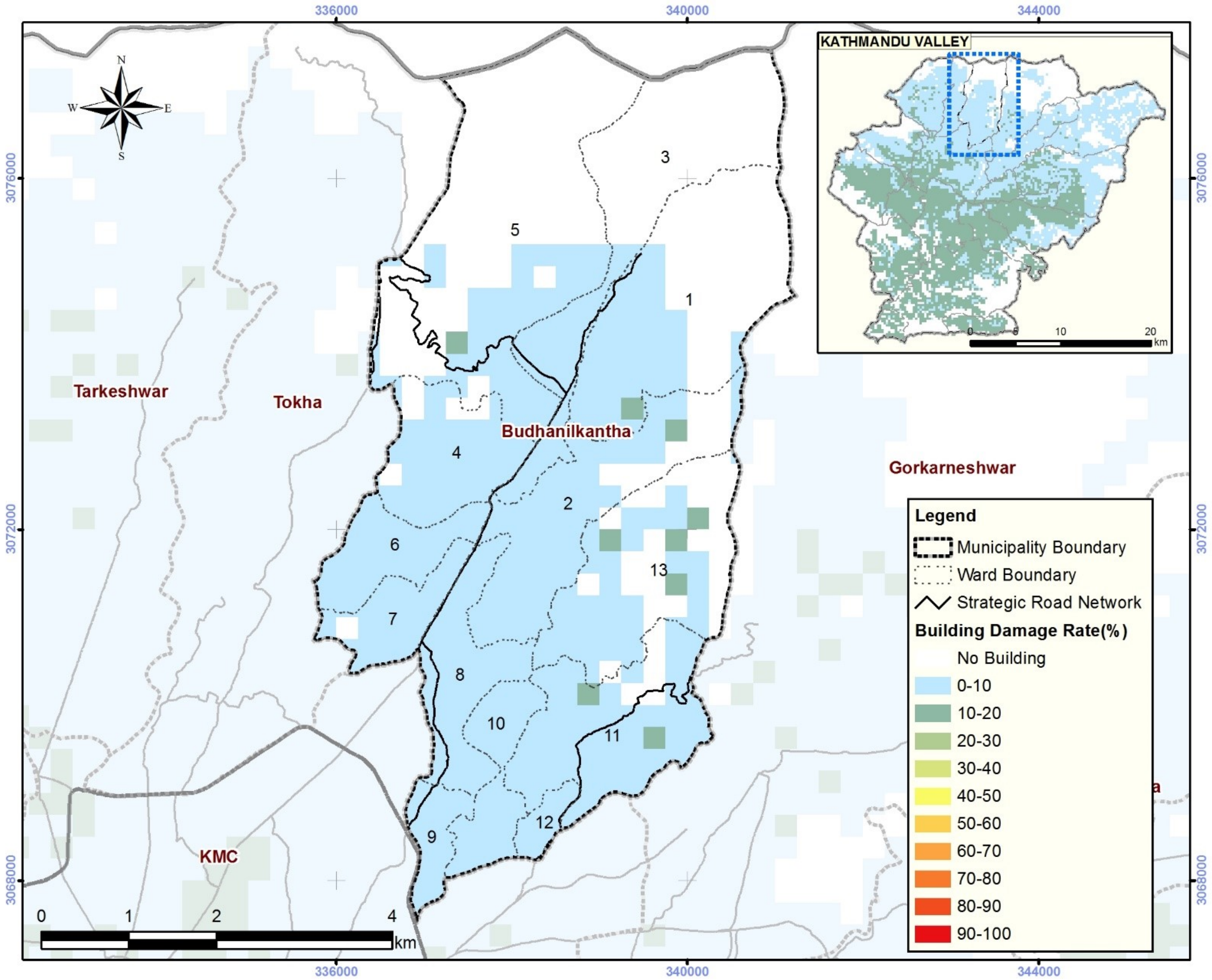
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# C-6
# Distribution of Moderately Damaged Building Number & Ratio in 2016
# Scenario Ground Motion: CNS-1

## Number of Damaged Building




## Ratio of Damaged Building (%)




**Note:**

- "Moderately Damaged Building" means a building classified as Damage Level 3 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total number of moderately damaged buildings in the study area, in 2016, based on the CNS-1 scenario ground motion was estimated to be 904 and the proportion of damaged buildings to total buildings defined as 17,066 was 5.3%.

**Source:**

- Grid wise damaged building distribution in 2016 based on CNS-1 scenario ground motion: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

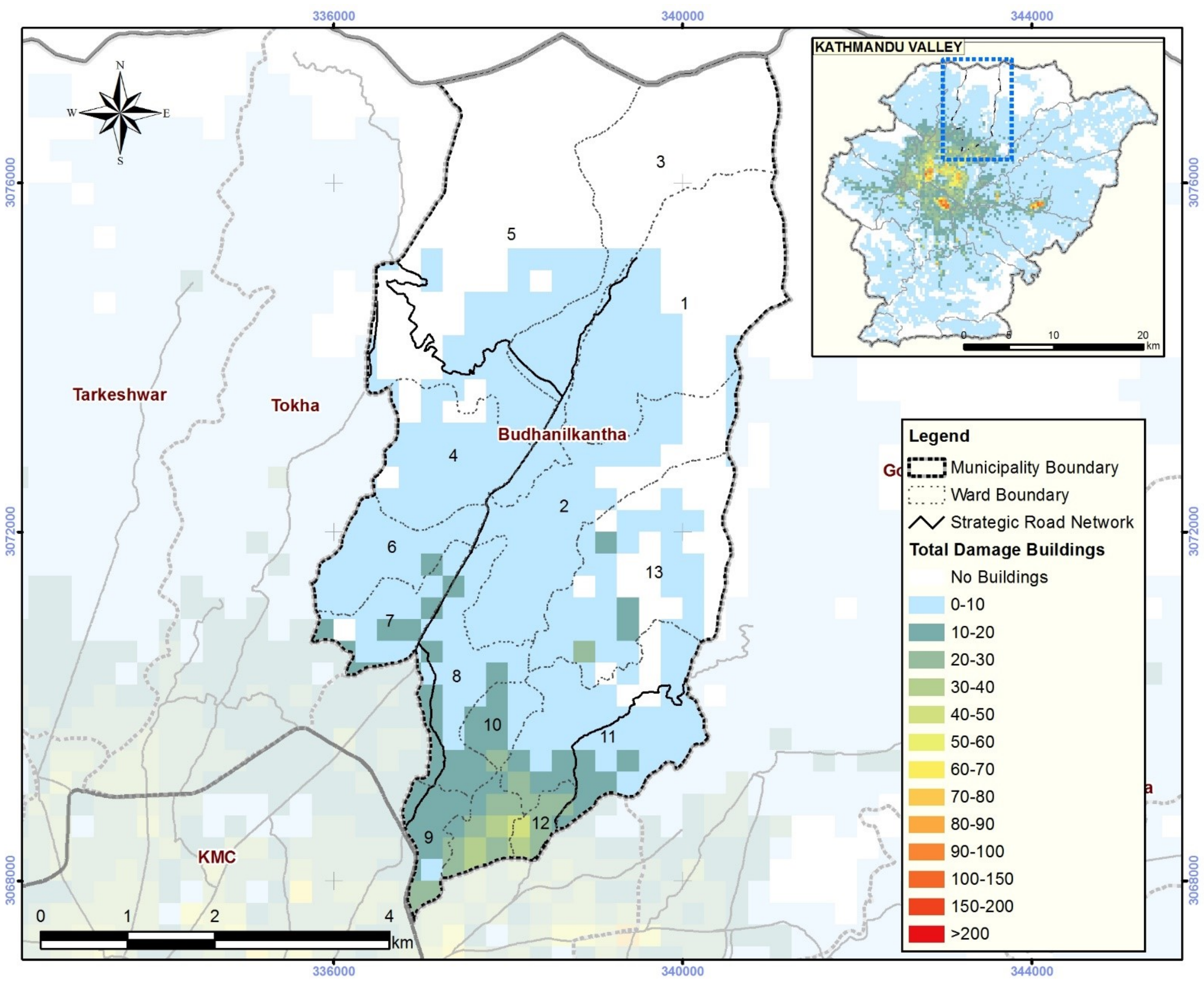
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

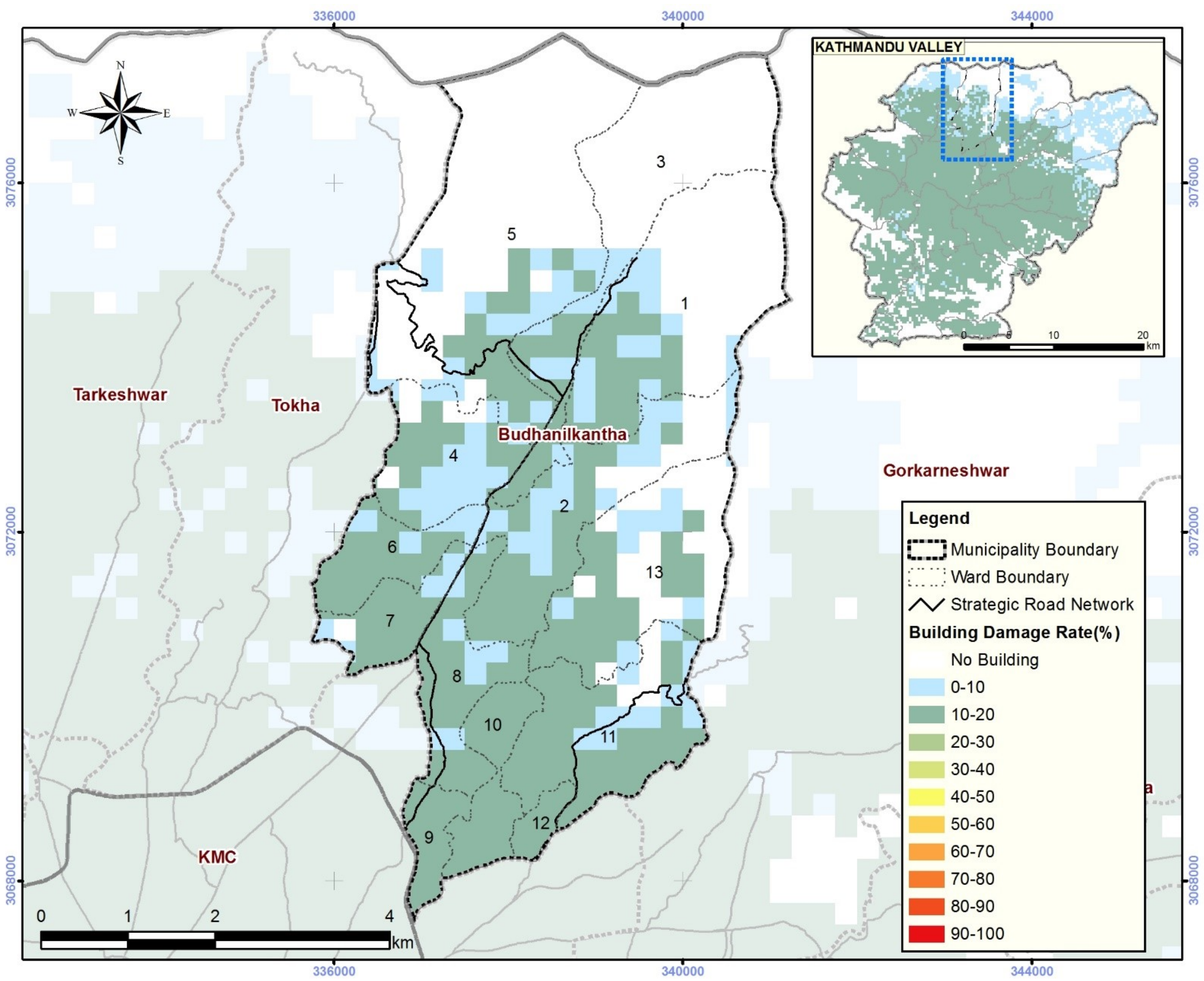
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# C-7
# Distribution of Moderately Damaged Building Number & Ratio in 2016
# Scenario Ground Motion: CNS-2

## Number of Damaged Building




## Ratio of Damaged Building (%)




**Note:**

- "Moderately Damaged Building" means a building classified as Damage Level 3 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total number of moderately damaged buildings in the study area, in 2016, based on CNS-2 scenario ground motion was estimated to be 1,984 and the proportion of damaged buildings to total buildings defined as 17,066 was 11.6%.

**Source:**

- Grid wise damaged building distribution in 2016 based on CNS-2 scenario ground motion: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

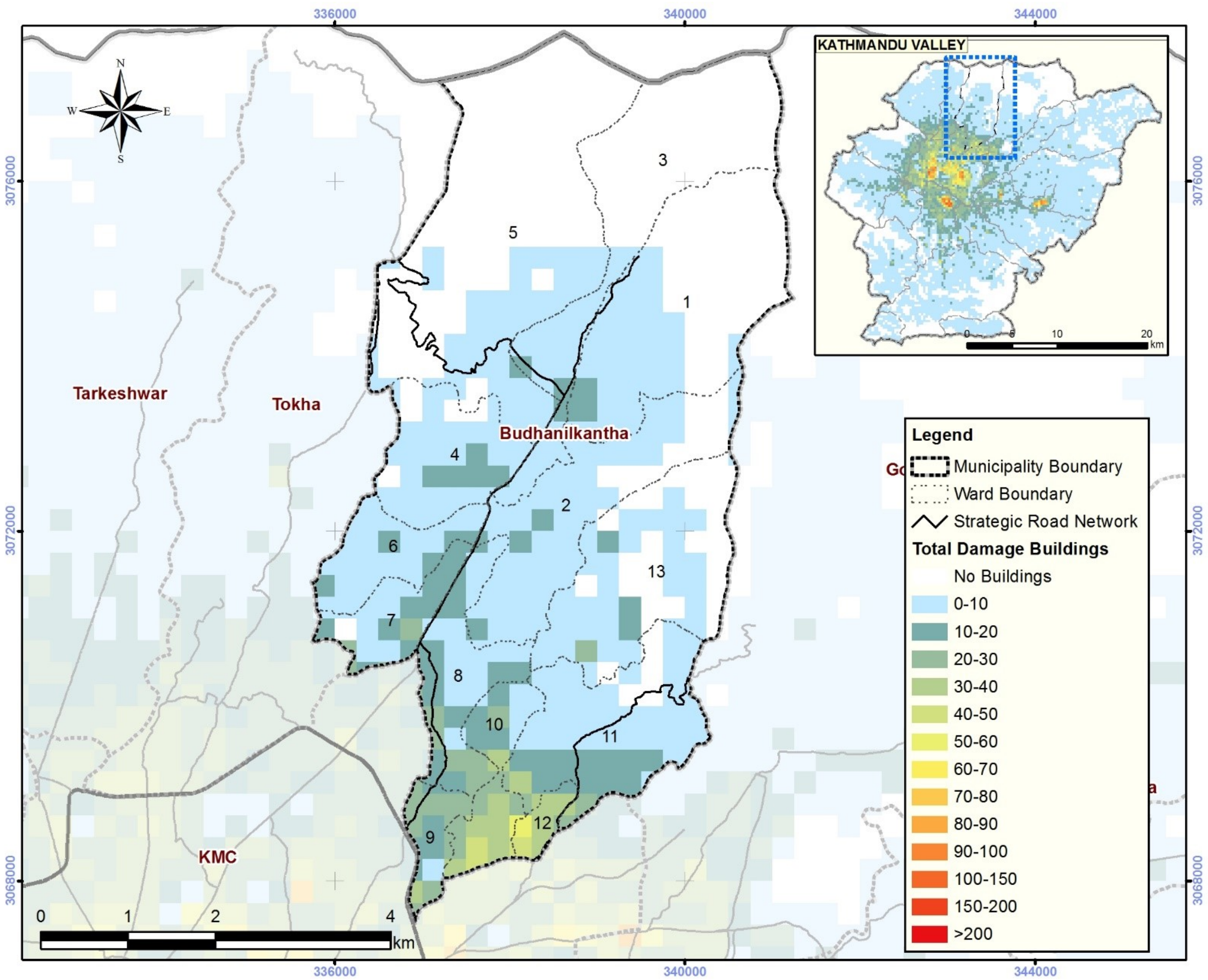
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

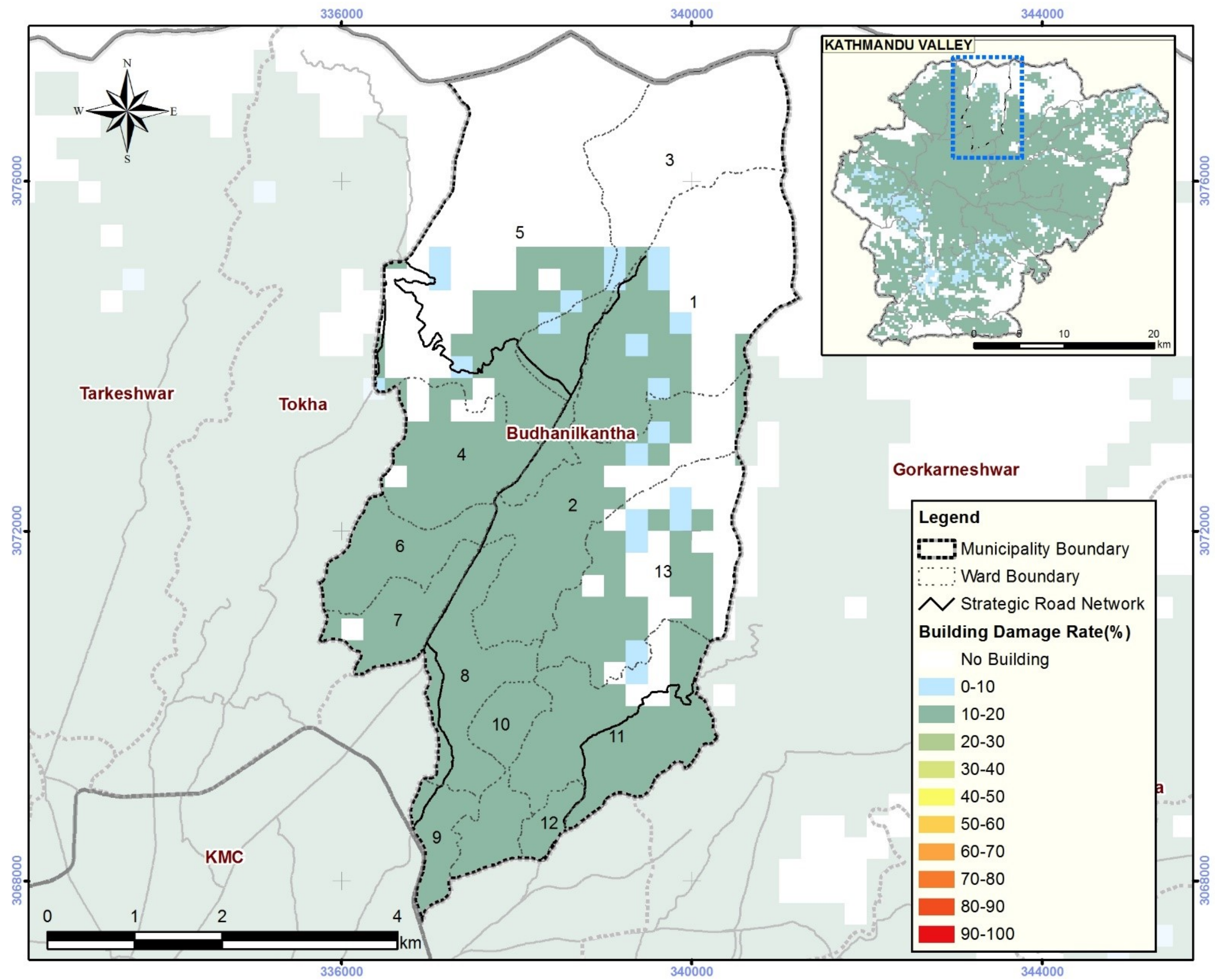
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# C-8
# Distribution of Moderately Damaged Building Number & Ratio in 2016
# Scenario Ground Motion: CNS-3

## Number of Damaged Building




## Ratio of Damaged Building (%)




**Note:**

- "Moderately Damaged Building" means a building classified as Damage Level 3 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total number of moderately damaged buildings in 2016 based on CNS-3 scenario ground motion was estimated to be 2,670 in the study area and the proportion of damaged buildings to total buildings defined as 17,066 was 15.6%.

**Source:**

- Grid wise damaged building distribution in 2016 based on CNS-3 scenario ground motion: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

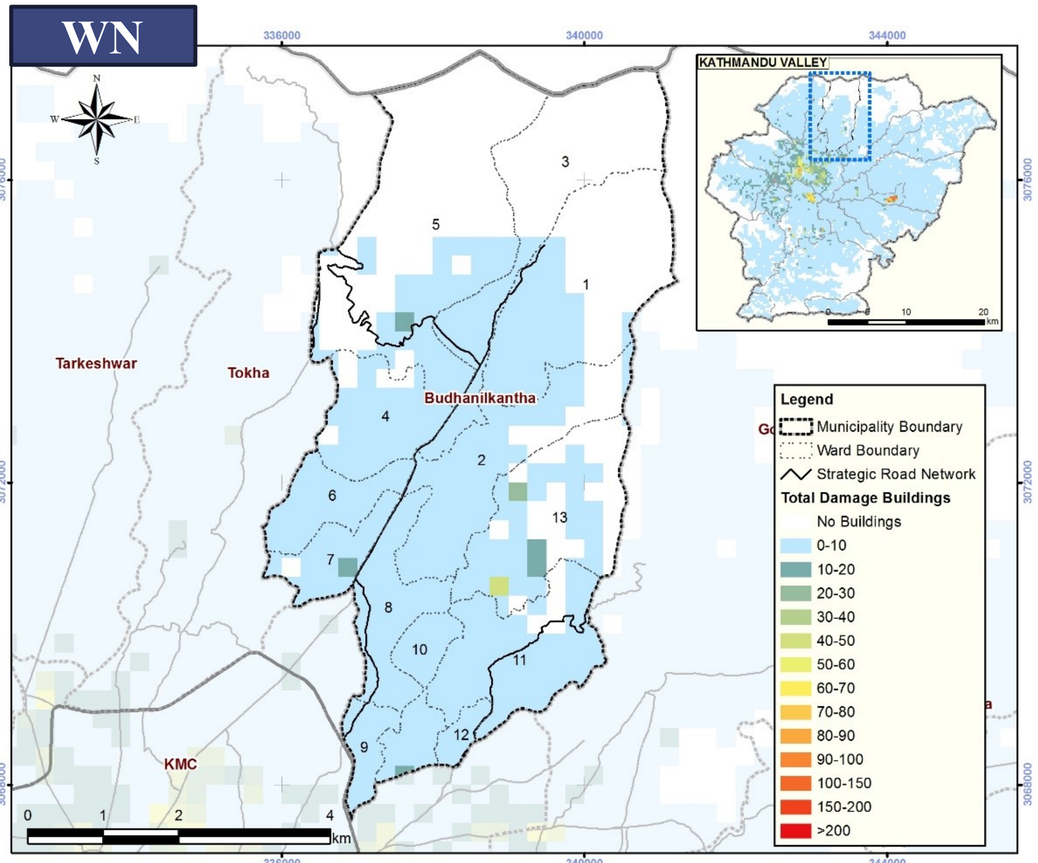
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

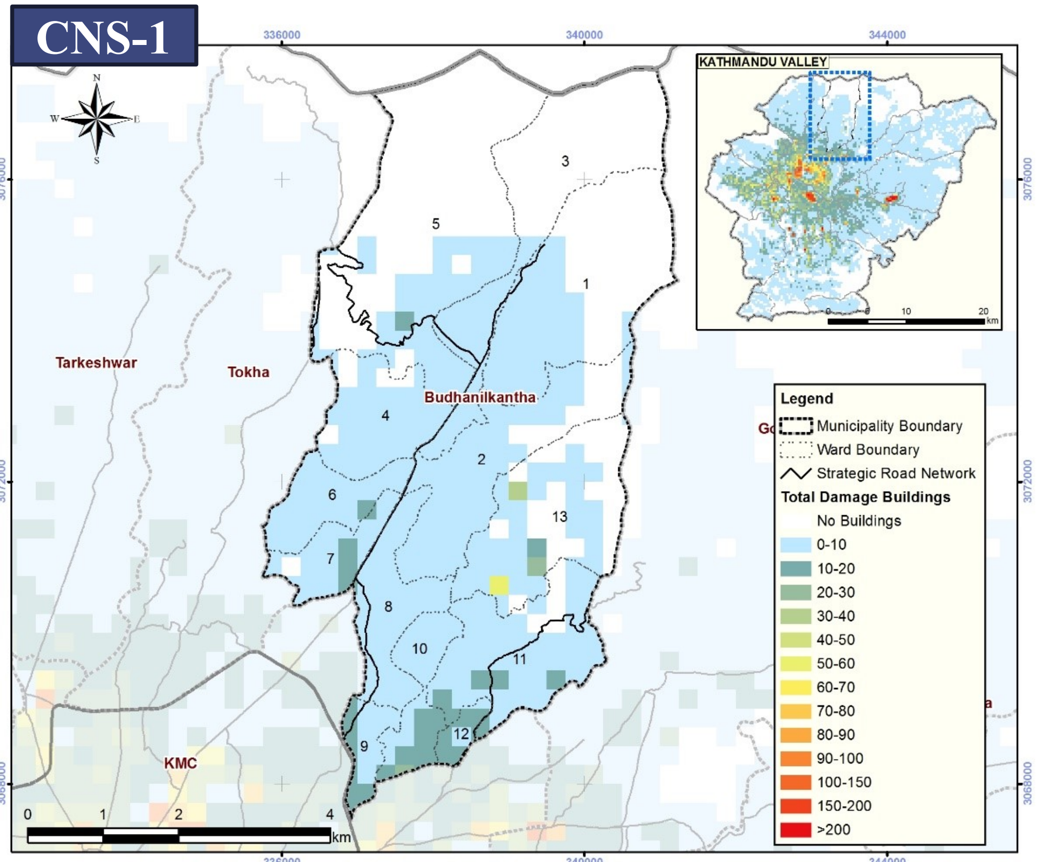
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

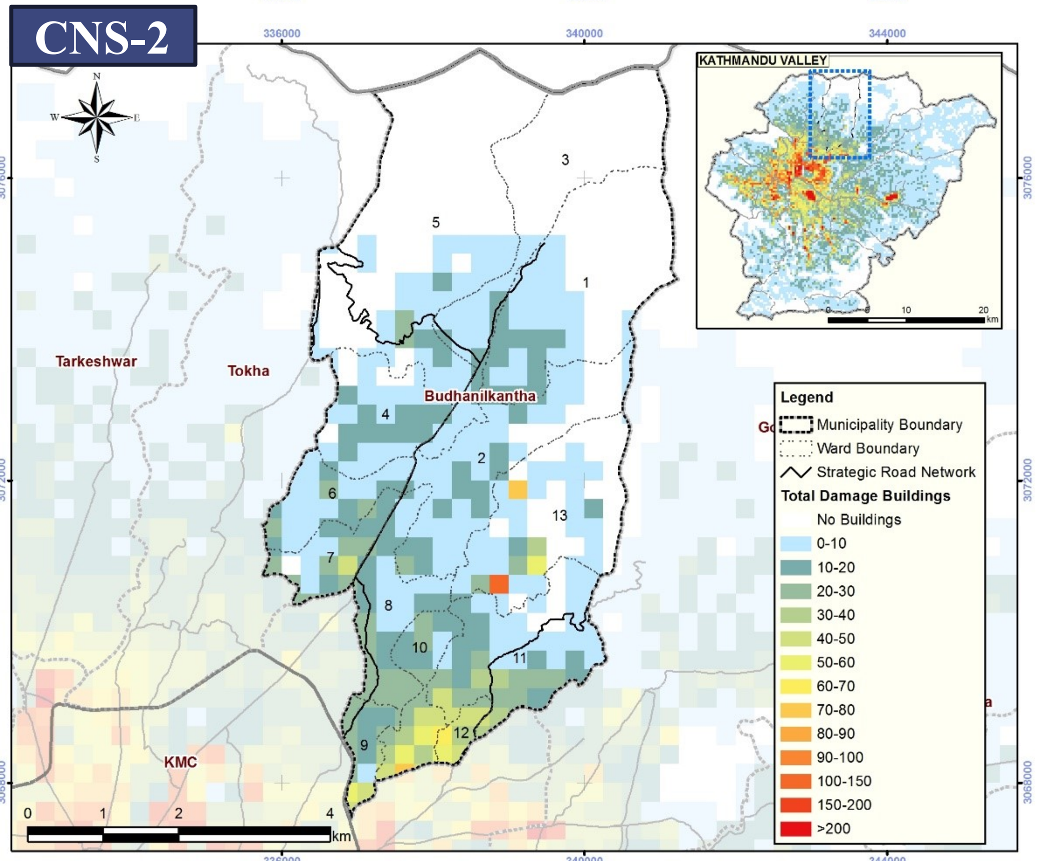
**WN**



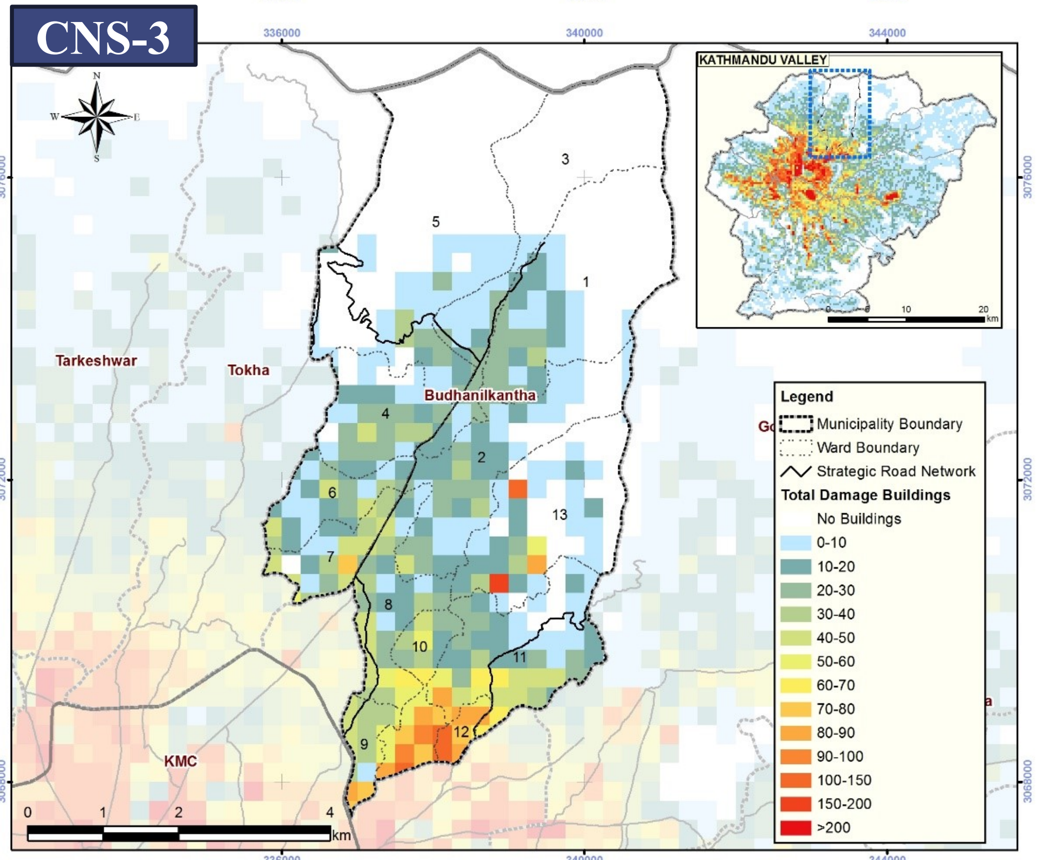

**CNS-1**




**CNS-2**




**CNS-3**




# C-9

# Distribution of Heavily Damaged Building for 2030 without BSPS

**BSPS: Promotion on Building Seismic Performance Strengthening**

**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total numbers of heavily damaged buildings in 2030 without BSPS and proportions of damaged buildings to total buildings (26,894) in 2030 based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 872 | 3.2% |
| CNS-1 | 1,380 | 5.1% |
| CNS-2 | 4,135 | 15.4% |
| CNS-3 | 7,657 | 28.5% |

**Source:**

- Grid wise damaged building distribution in 2030 without BSPS based on scenario ground motions: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

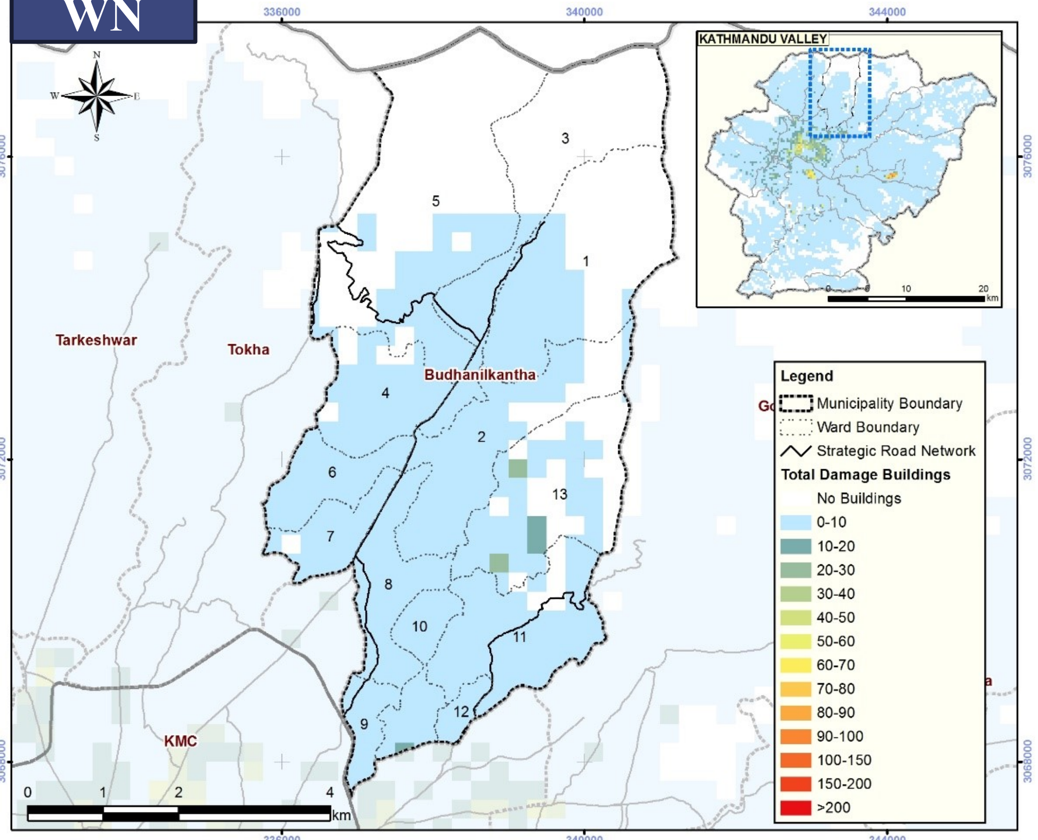
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

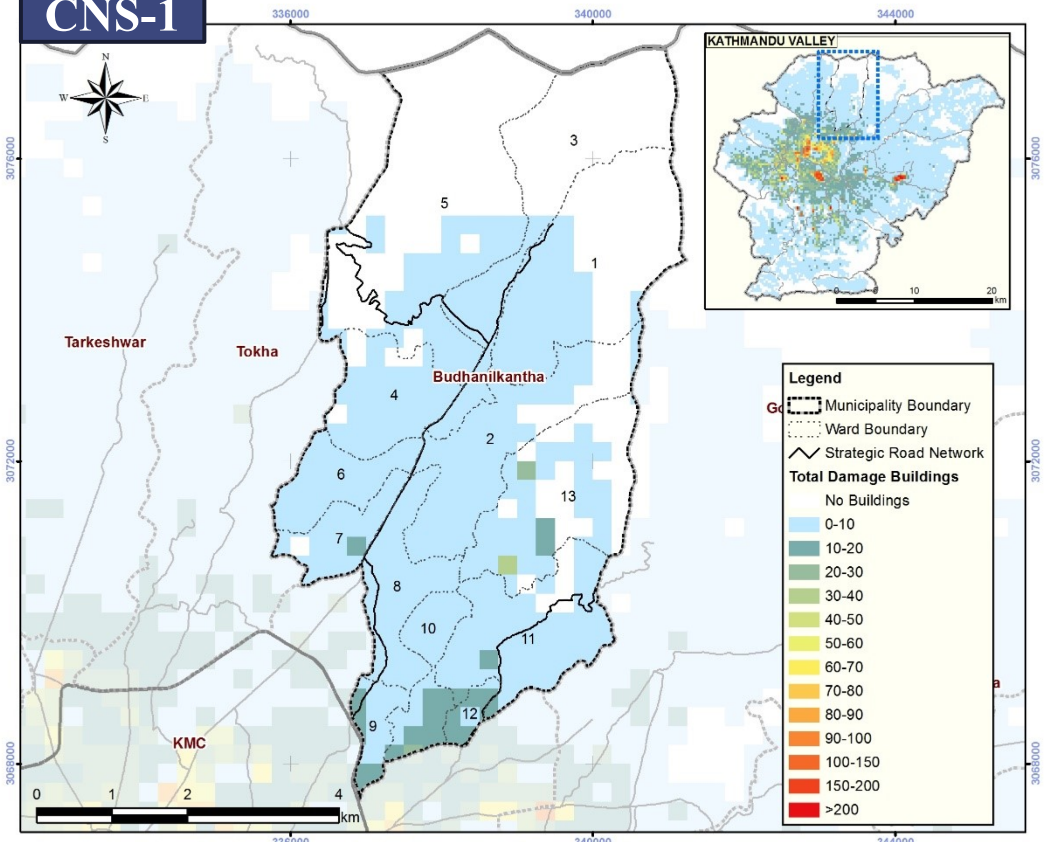
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

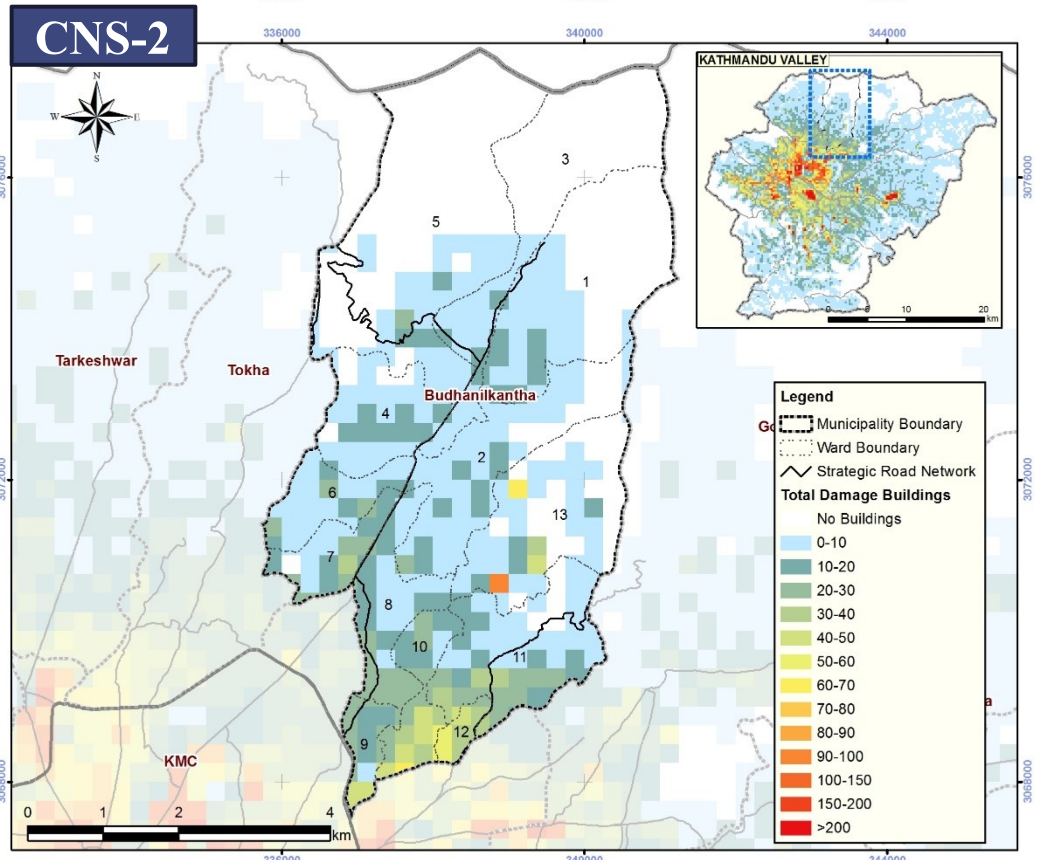
WN



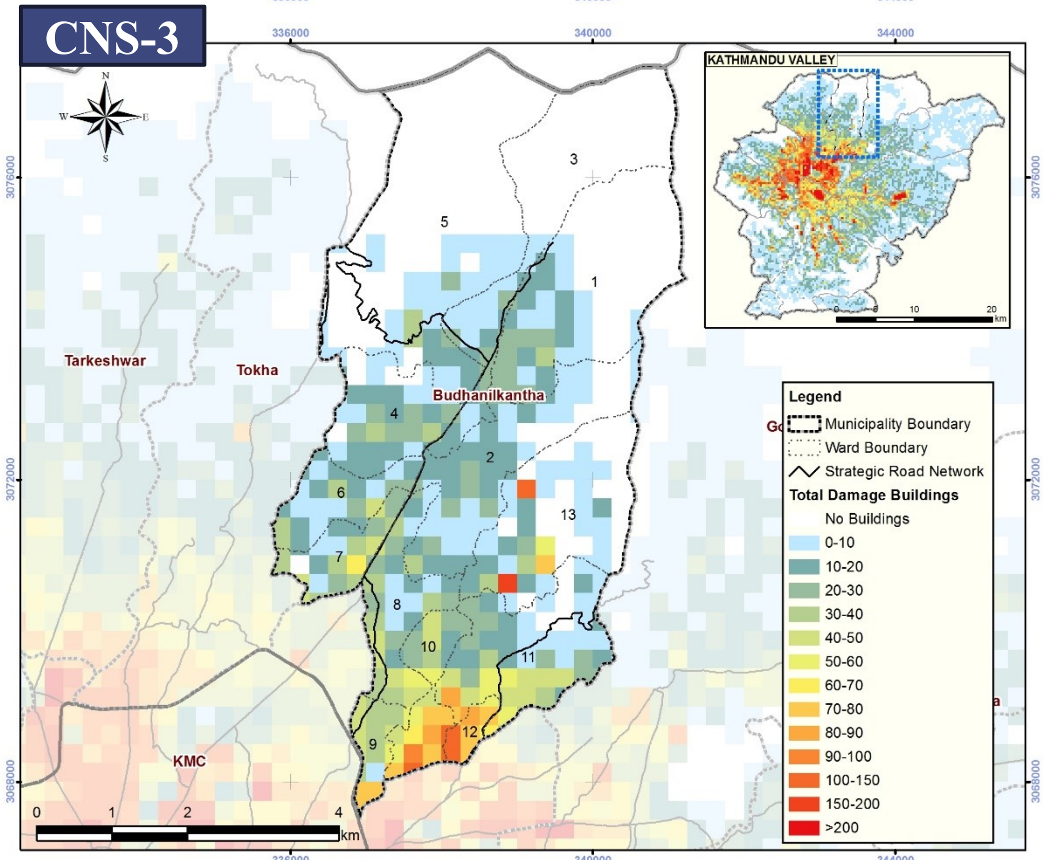

CNS-1




CNS-2




CNS-3




# C-10

## Distribution of Heavily Damaged Building for 2030 with BSPS Case-1

### BSPS: Promotion on Building Seismic Performance Strengthening

**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged building by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total numbers of heavily damaged buildings in 2030 with BSPS Case01 and proportions of damaged buildings to total buildings (26,894), in 2030, based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 691 | 2.6% |
| CNS-1 | 1,137 | 4.2% |
| CNS-2 | 3,634 | 13.5% |
| CNS-3 | 6,941 | 24.1% |

**Source:**

- Grid wise damaged building distribution in 2030 with BSPS Case01 based on scenario ground motions: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

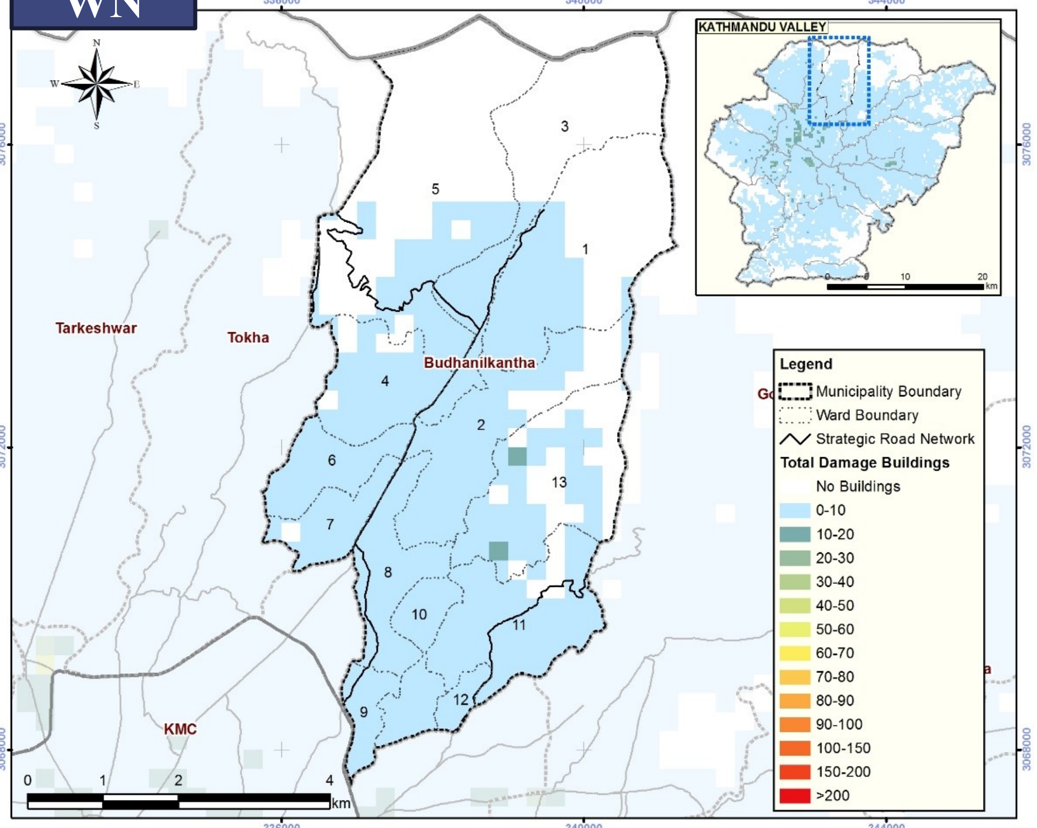
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

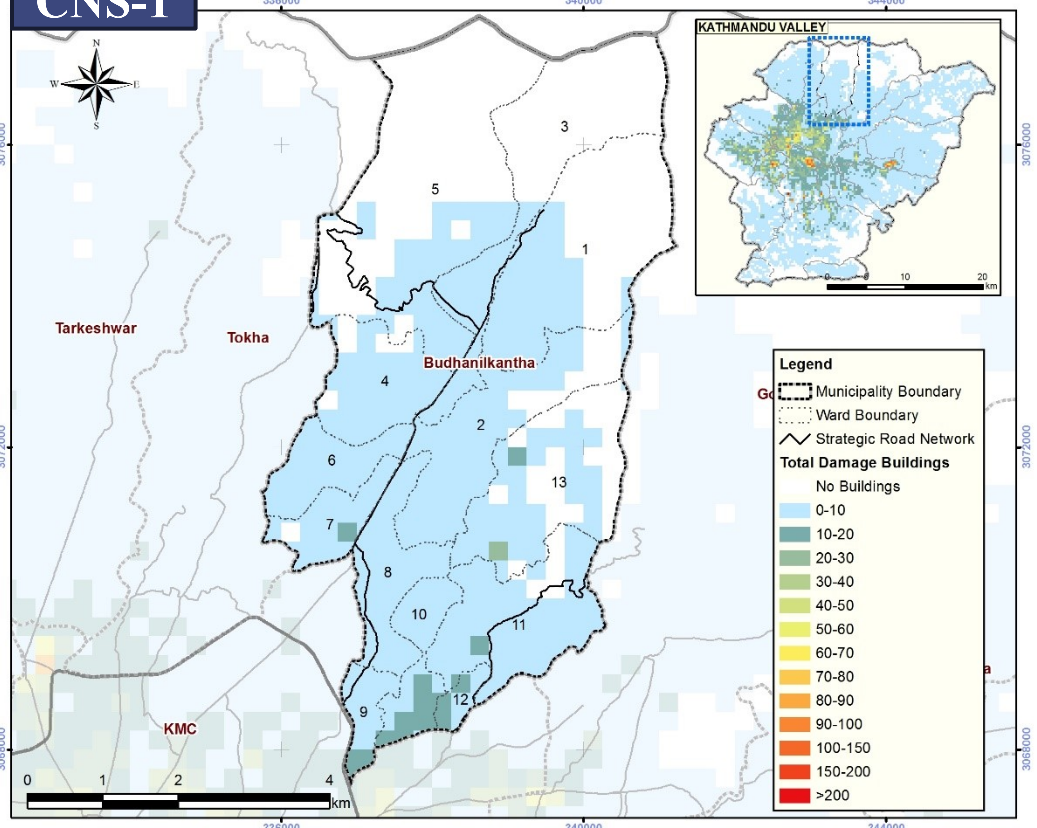
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal

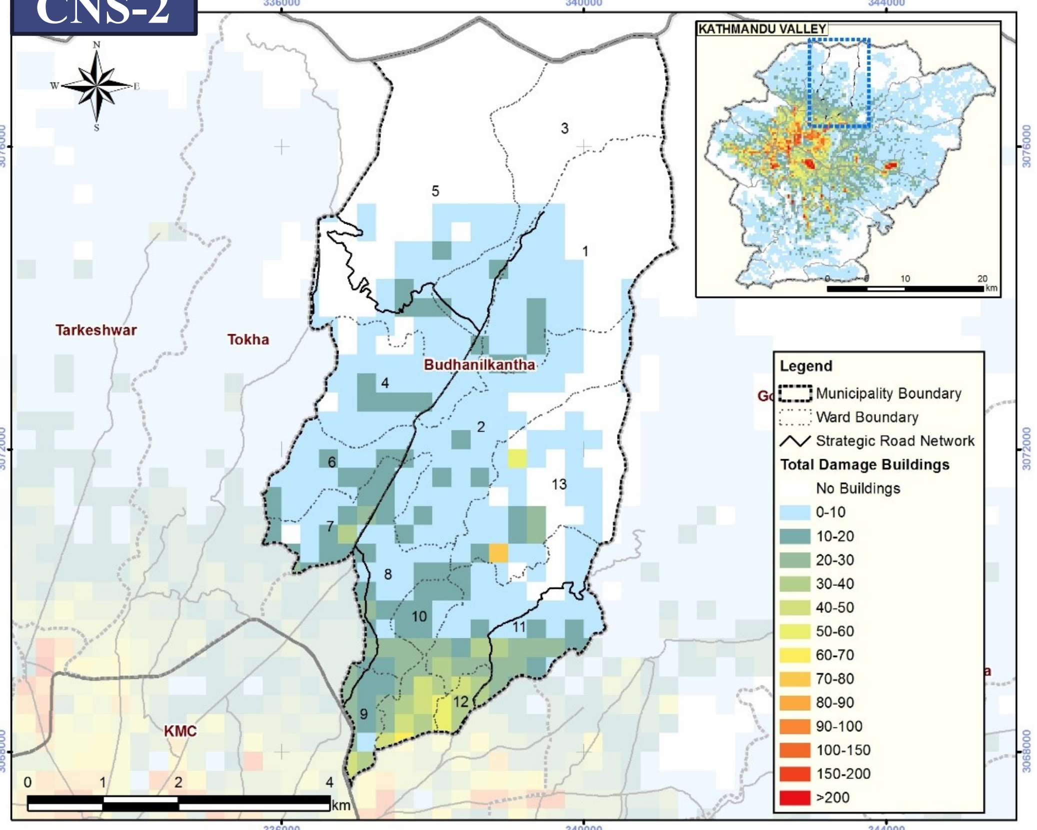
WN



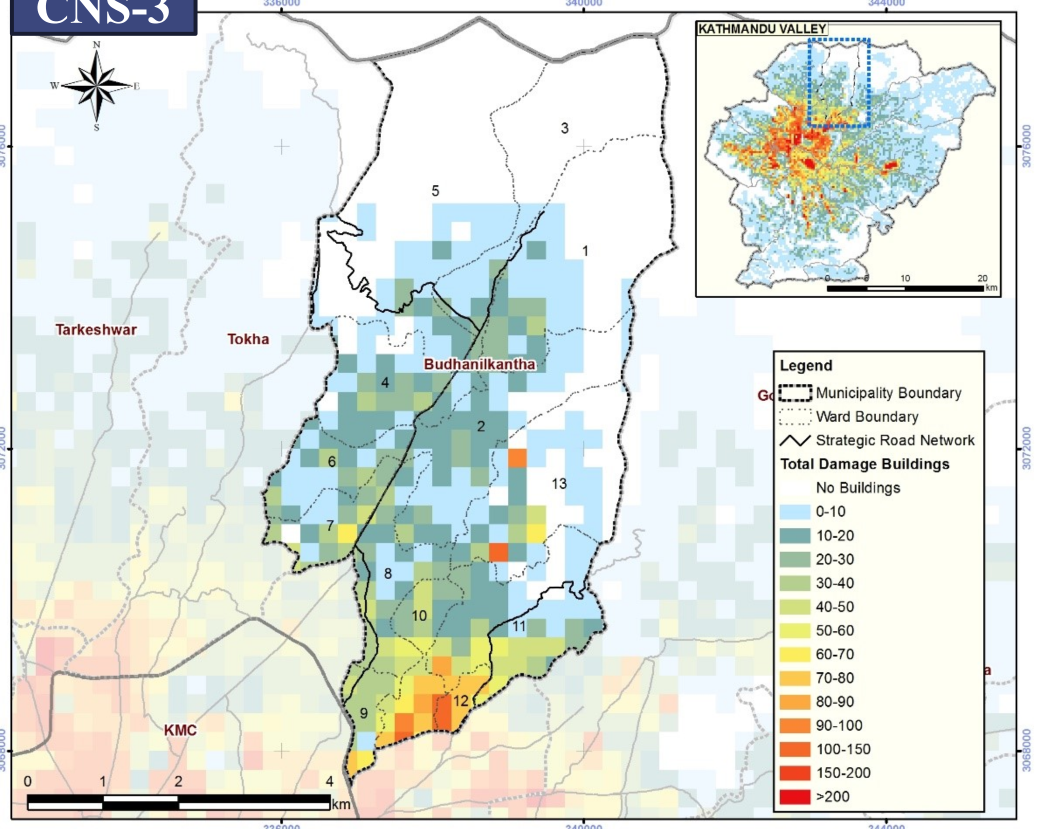

CNS-1




CNS-2




CNS-3




# C-11

## Distribution of Heavily Damaged Building for 2030 with BSPS Case-2

### BSPS: Promotion on Building Seismic Performance Strengthening

**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total numbers of heavily damaged buildings in 2030 with BSPS Case02 and proportions of damaged buildings to total buildings (26,894), in 2030, based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 440 | 1.6% |
| CNS-1 | 841 | 3.1% |
| CNS-2 | 3,218 | 12.0% |
| CNS-3 | 6,506 | 24.2% |

**Source:**

- Grid wise damaged building distribution in 2030 with BSPS Case02 based on scenario ground motions: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

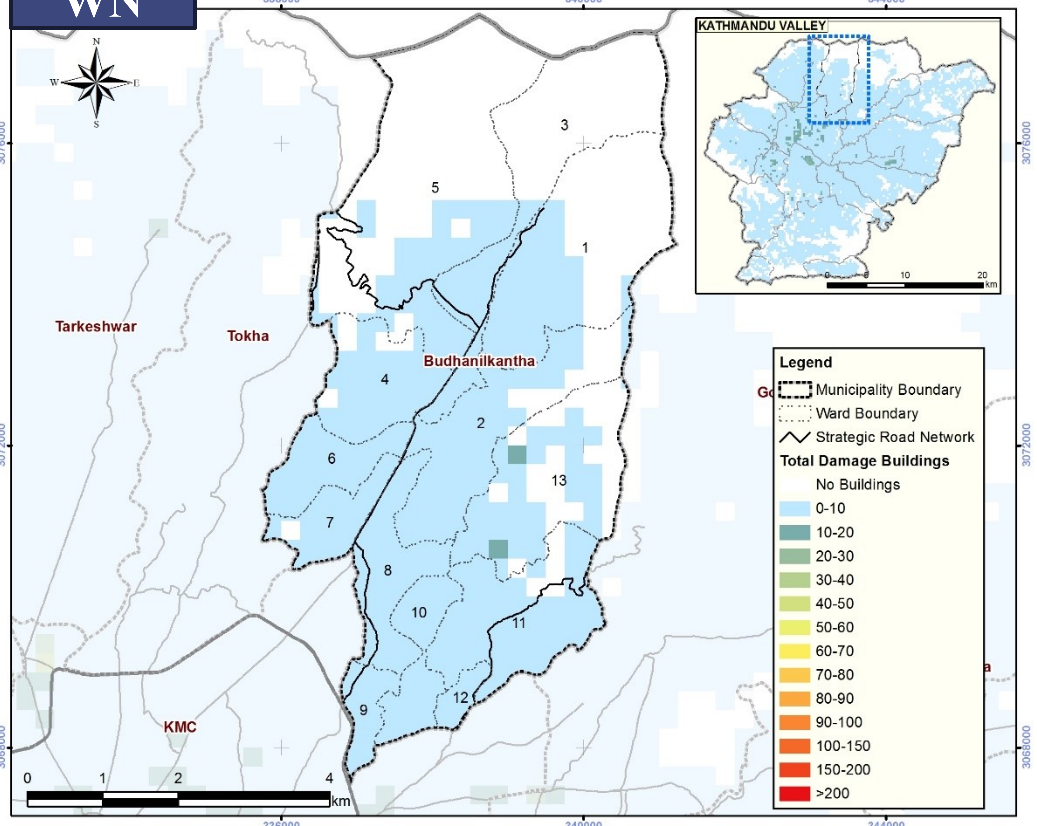
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

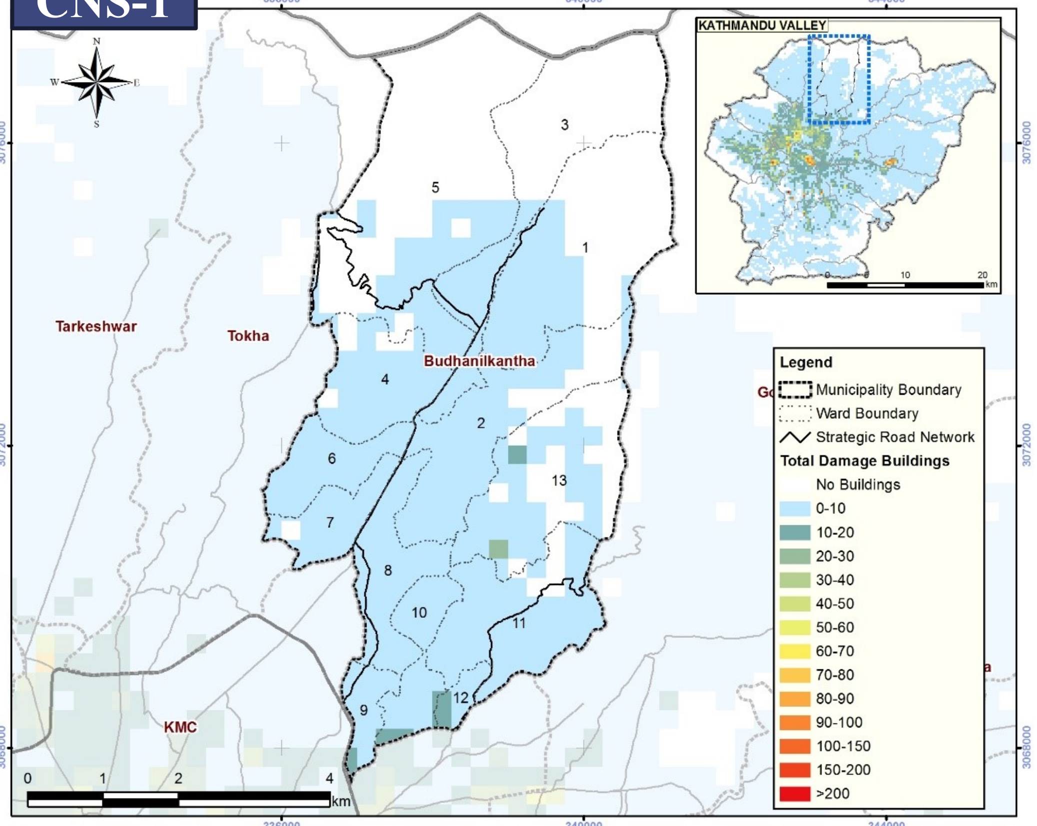
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

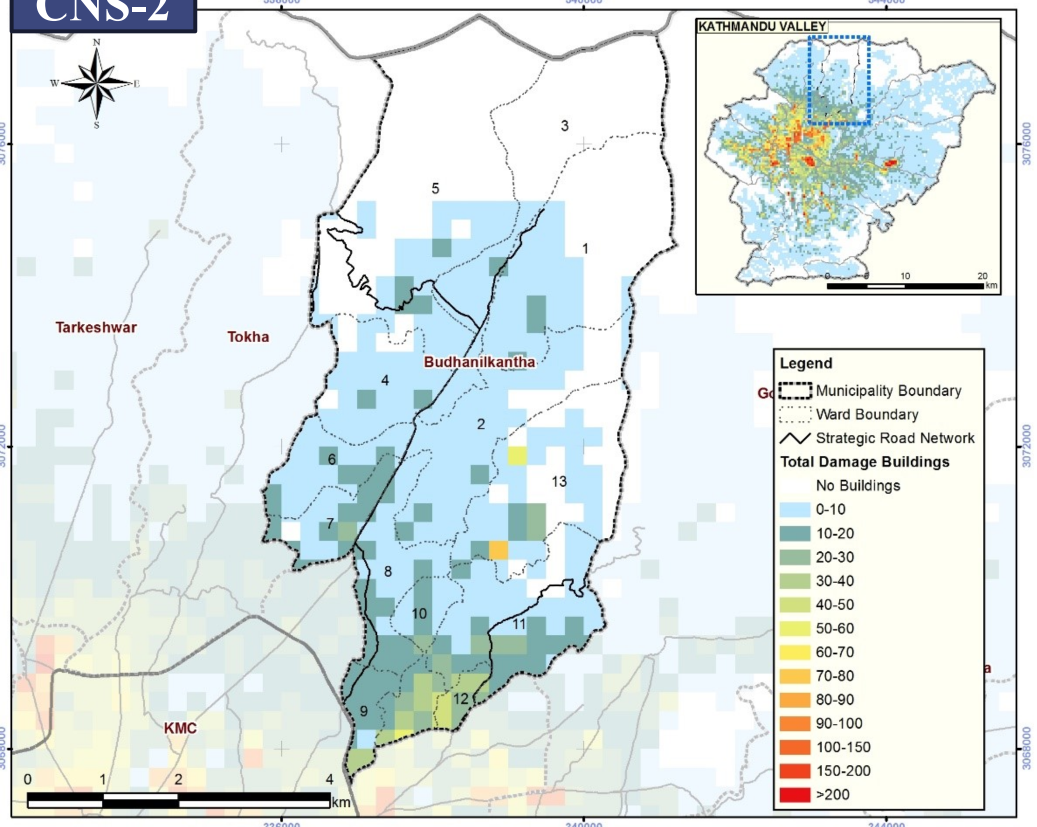
WN



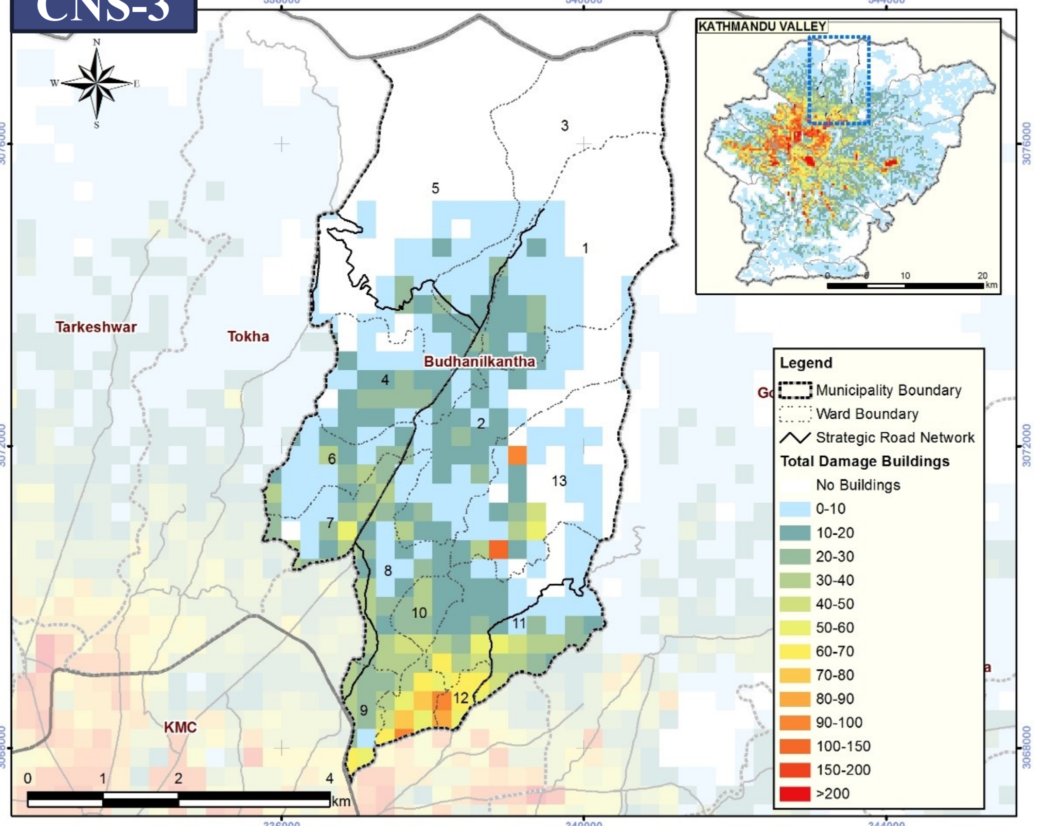

CNS-1




CNS-2




CNS-3




# C-12

## Distribution of Heavily Damaged Building for 2030 with BSPS Case-3

### BSPS: Promotion on Building Seismic Performance Strengthening

**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total numbers of heavily damaged buildings in 2030 with BSPS Case03 and proportions of damaged buildings to total buildings (26,894), in 2030, based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 381 | 1.4% |
| CNS-1 | 712 | 2.6% |
| CNS-2 | 2,744 | 10.2% |
| CNS-3 | 5,668 | 21.1% |

**Source:**

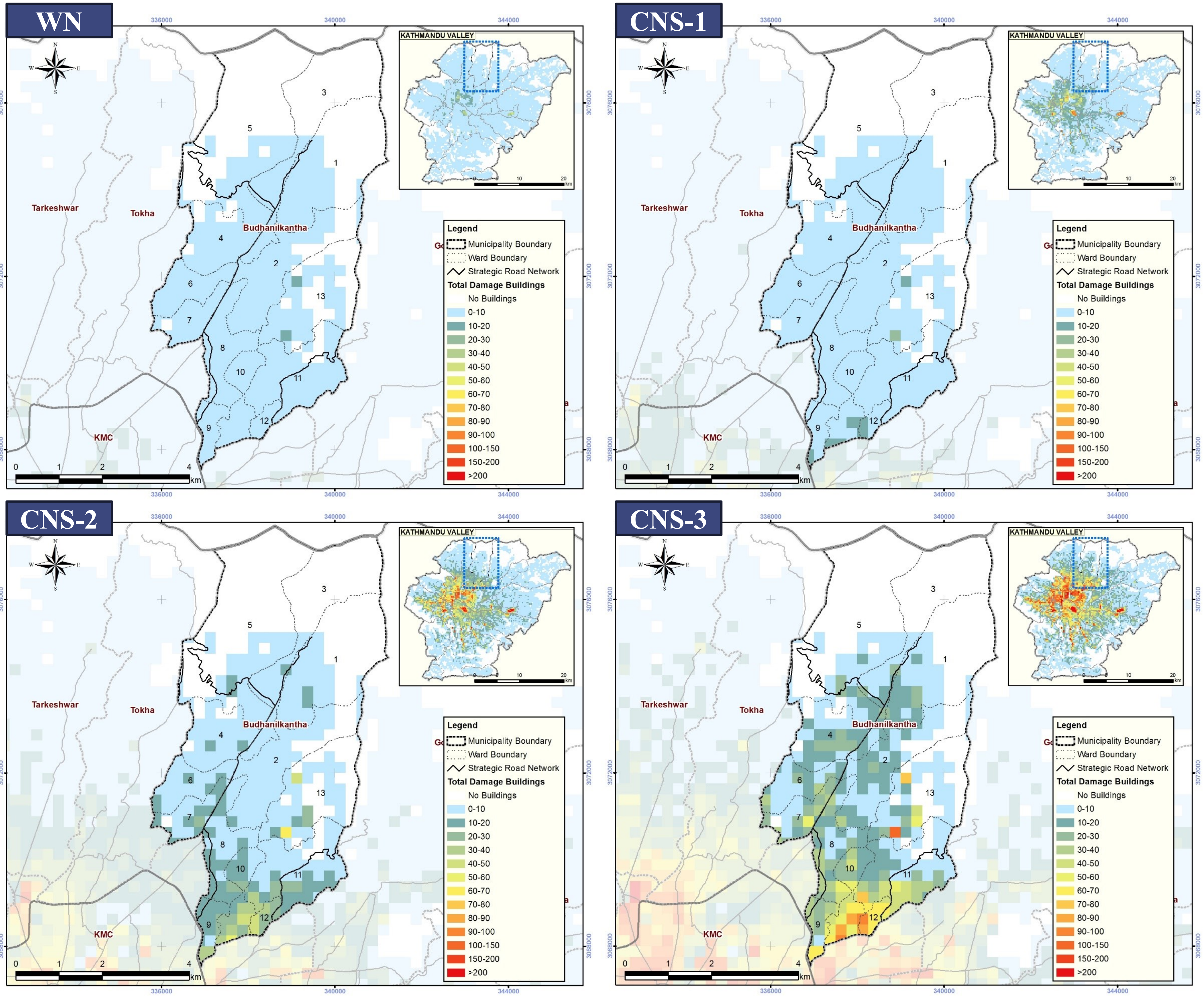
- Grid wise damaged building distribution in 2030 with BSPS Case03 based on scenario ground motions: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# C-13

## Distribution of Heavily Damaged Building for 2030 with BSPS Case-4

**BSPS: Promotion on Building Seismic Performance Strengthening**

**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total numbers of heavily damaged buildings in 2030 with BSPS Case04 and proportions of damaged buildings to total buildings (26,894), in 2030, based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 416 | 1.5% |
| CNS-1 | 736 | 2.7% |
| CNS-2 | 2,714 | 10.1% |
| CNS-3 | 5,629 | 20.9% |

**Source:**

- Grid wise damaged building distribution in 2030 with BSPS Case04 based on scenario ground motions: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ...........................Greenwich (0.0)
Datum: .........................................D_WGS_1984
Spheroid: .........................................WGS_1984

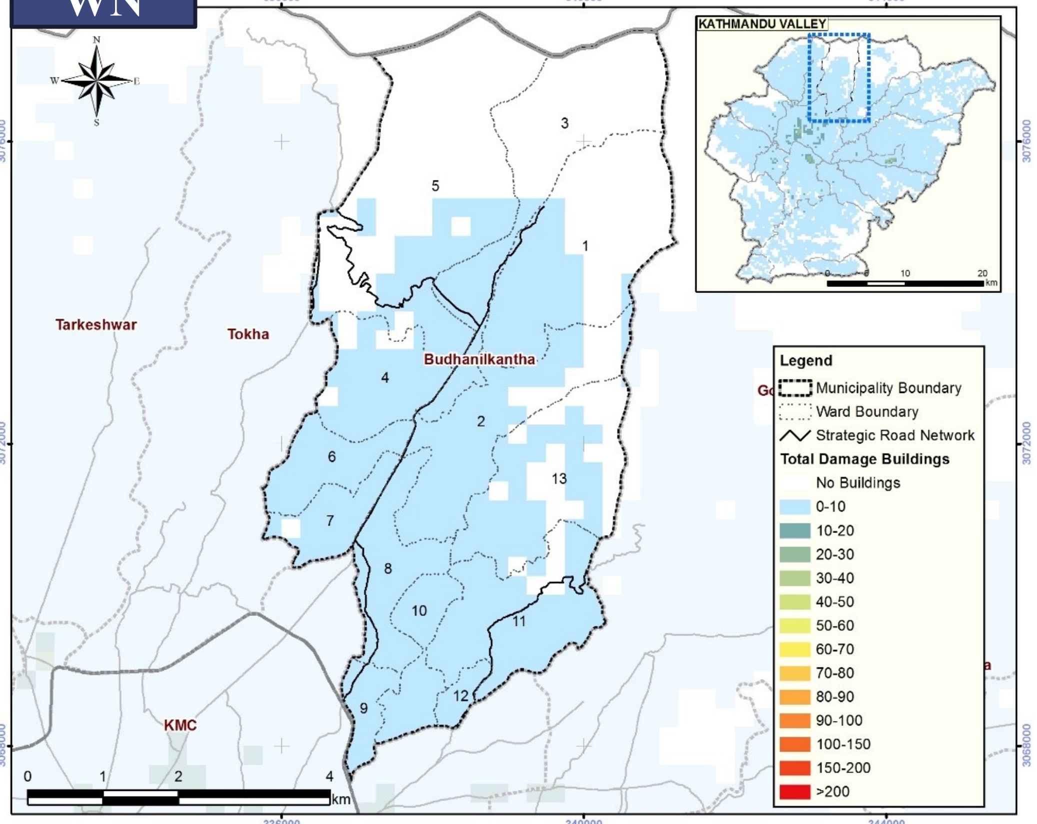
The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

# C-14

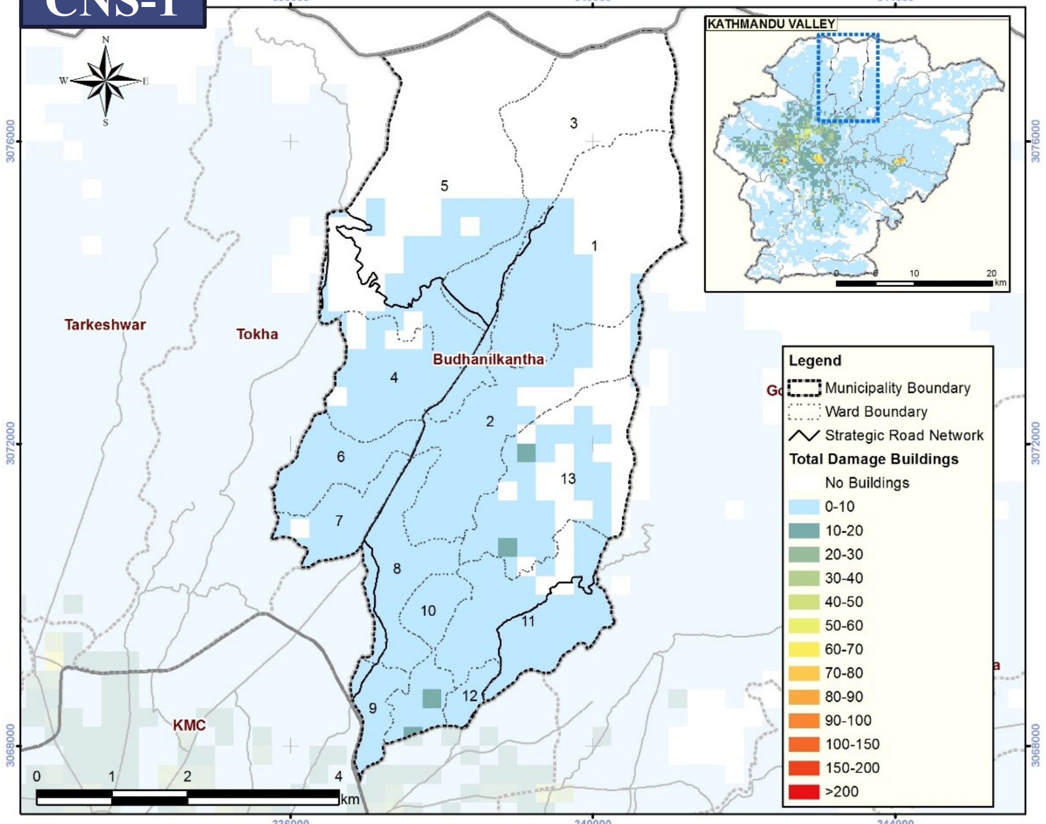
# Distribution of Heavily Damaged Building for 2030 with BSPS Case-5

## BSPS: Promotion on Building Seismic Performance Strengthening

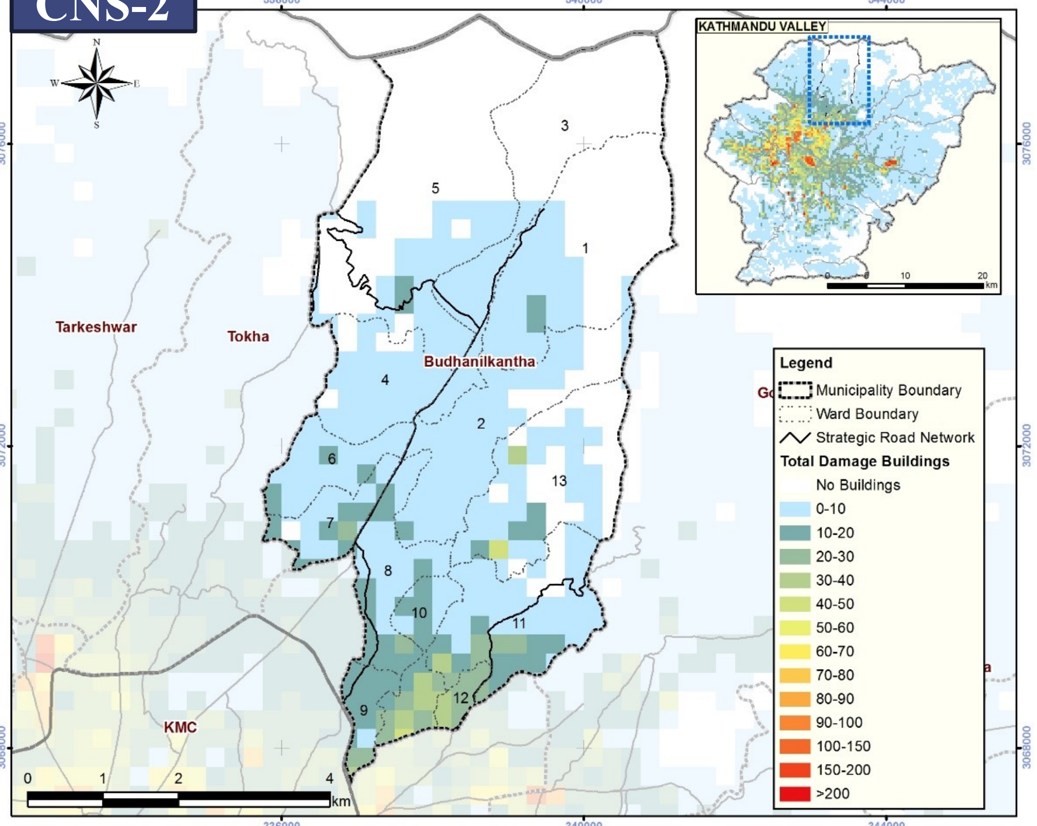
**WN**



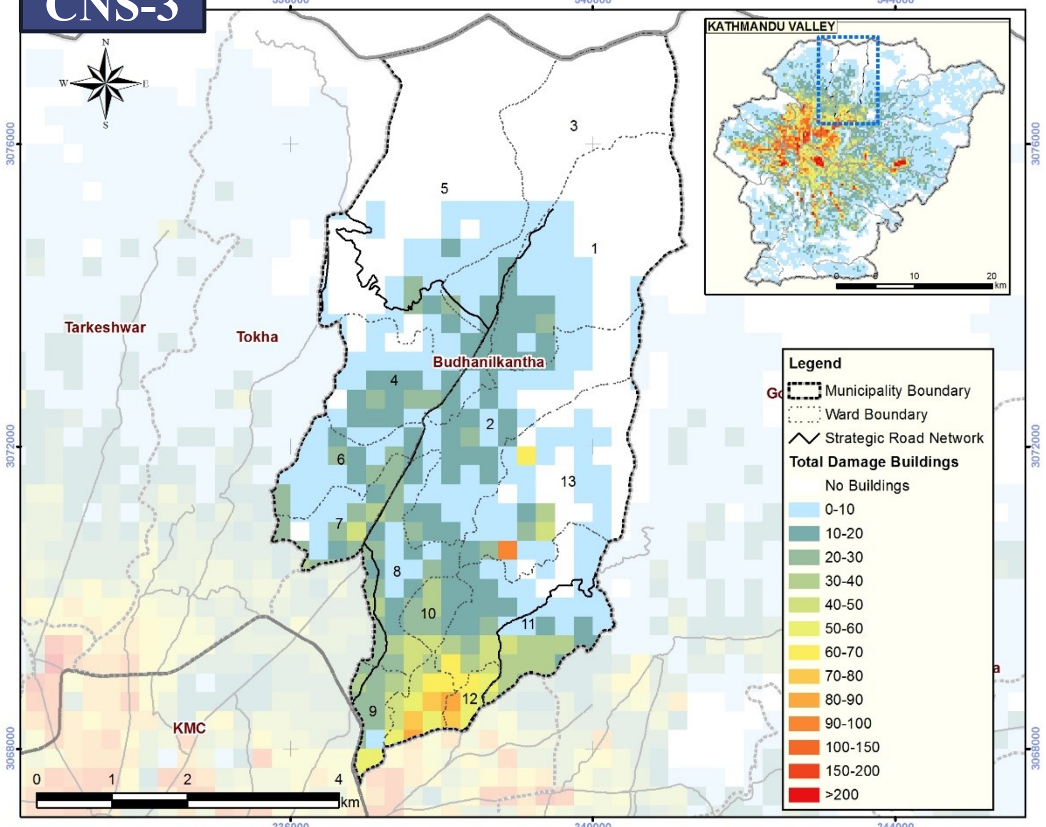

**CNS-1**




**CNS-2**




**CNS-3**




**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. The number of damaged buildings by 250m-mesh grid was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment, estimated building number and component ratio of building structure by grid using damage functions of buildings defined in the project.
- Total numbers of heavily damaged buildings in 2030 with BSPS Case05 and proportions of damaged buildings to total buildings (26,894), in 2030, based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 301 | 1.1% |
| CNS-1 | 566 | 2.1% |
| CNS-2 | 2,308 | 8.6% |
| CNS-3 | 5,037 | 18.7% |

**Source:**

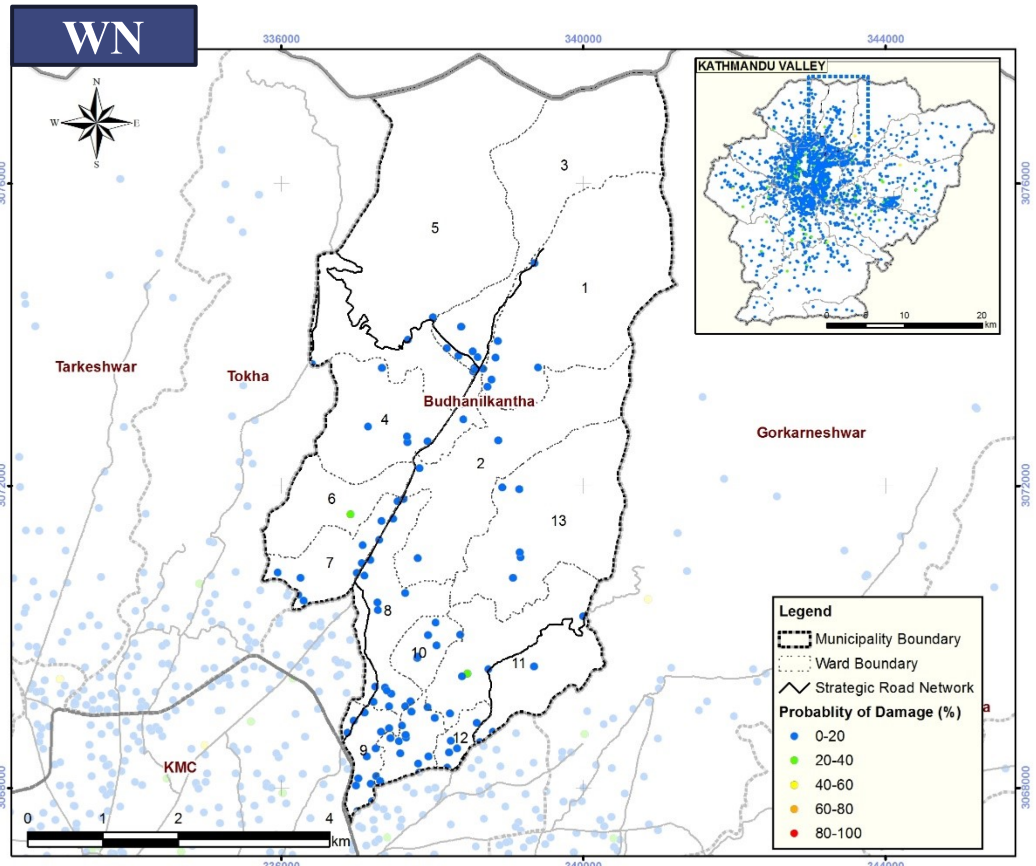
- Grid wise damaged building distribution in 2030 with BSPS Case05 based on scenario ground motions: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

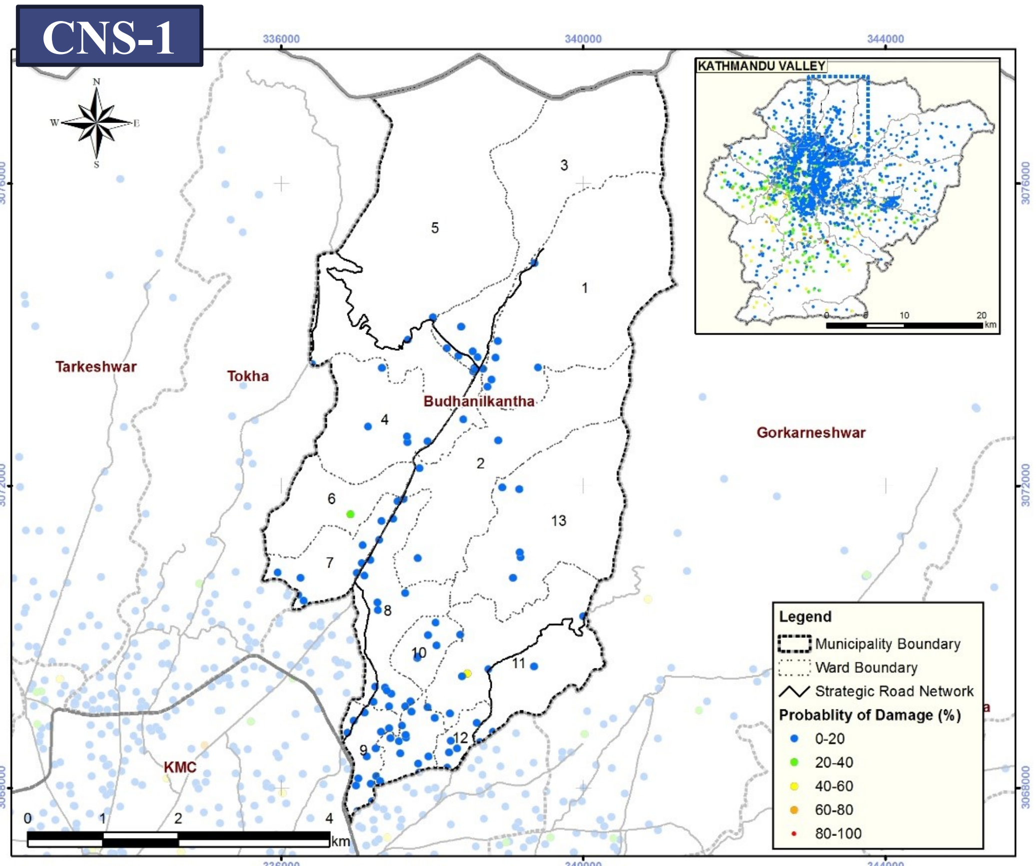
WGS_1984_UTM_Zone_45N

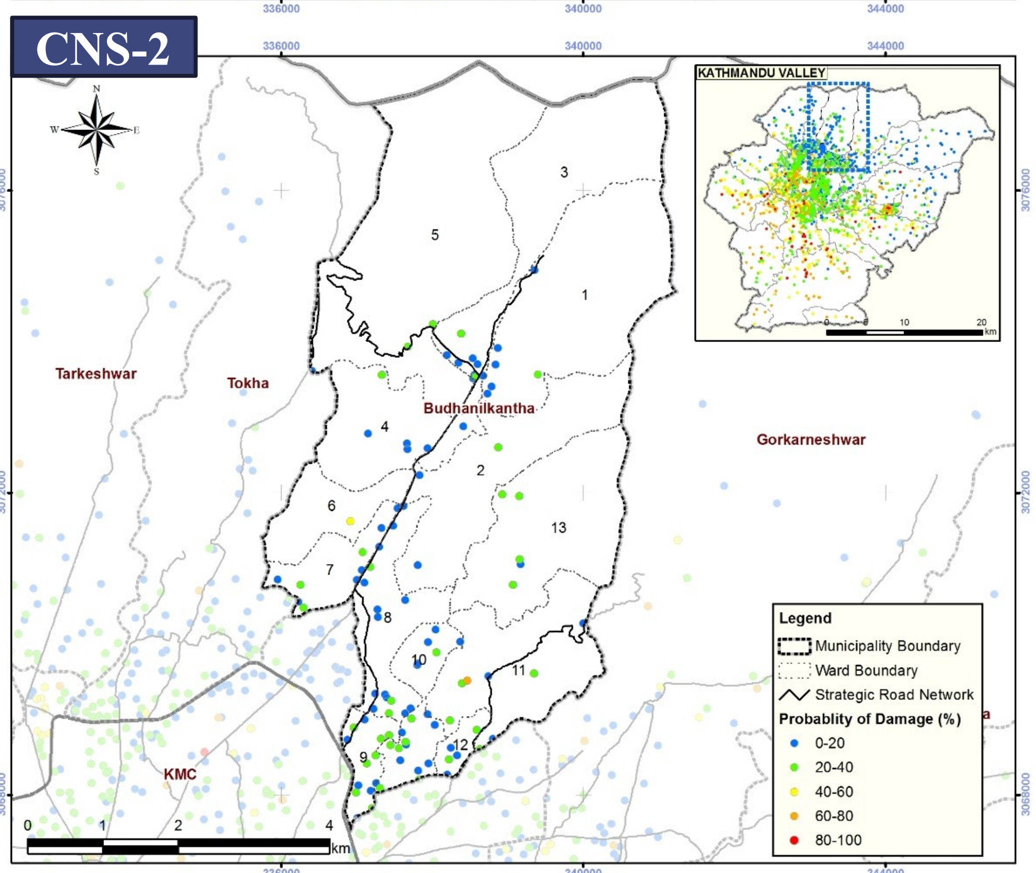
Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

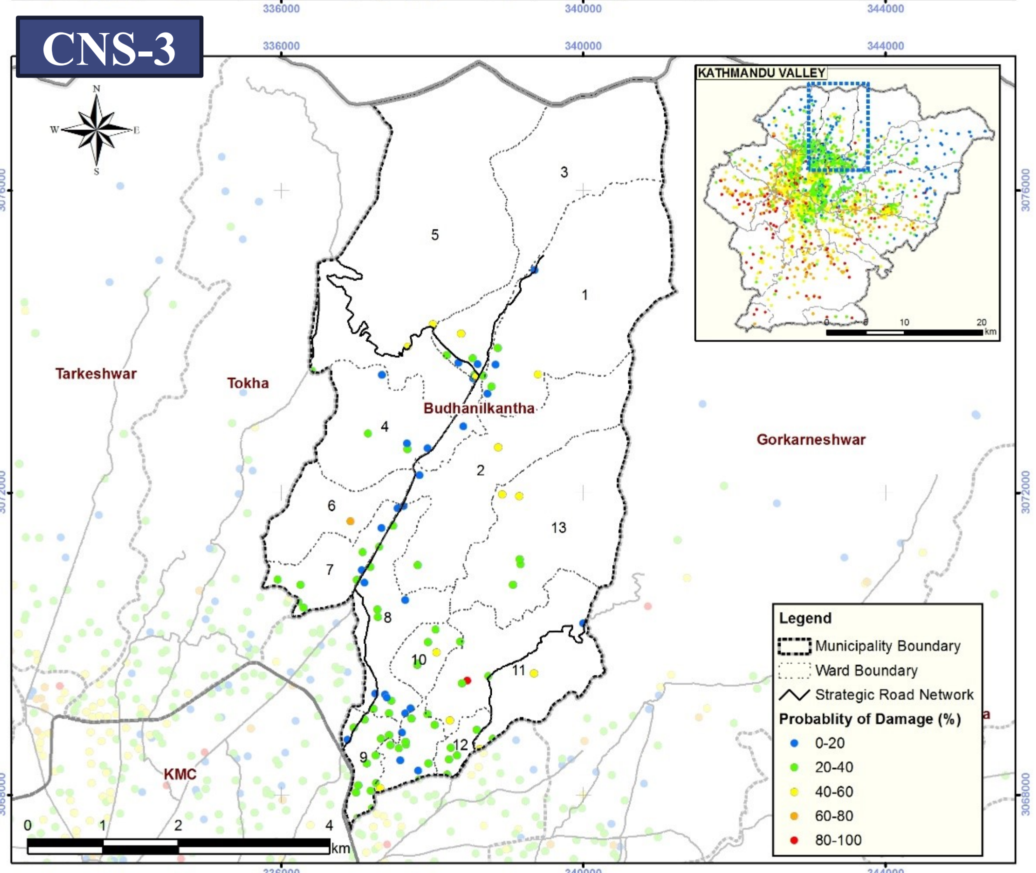
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ............................................D_WGS_1984
Spheroid: ............................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# C-15

## School Building Damage

### Probability of Heavy Damage [Damage Level 4+5 by EMS-98]

**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. A school building damage ratio was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment on which the school building is located and the structure type of the school building using damage functions of buildings defined in the project.
- The total number of damaged school buildings was calculated to add up all values of building damage ratios (Probability of damage) in the study area.
- Total numbers of heavily damaged school buildings and proportions of damaged buildings to total school buildings (267) based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 10 | 3.7% |
| CNS-1 | 15 | 5.6% |
| CNS-2 | 48 | 18.0% |
| CNS-3 | 88 | 33.0% |

**Source:**

- Result of school building damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD

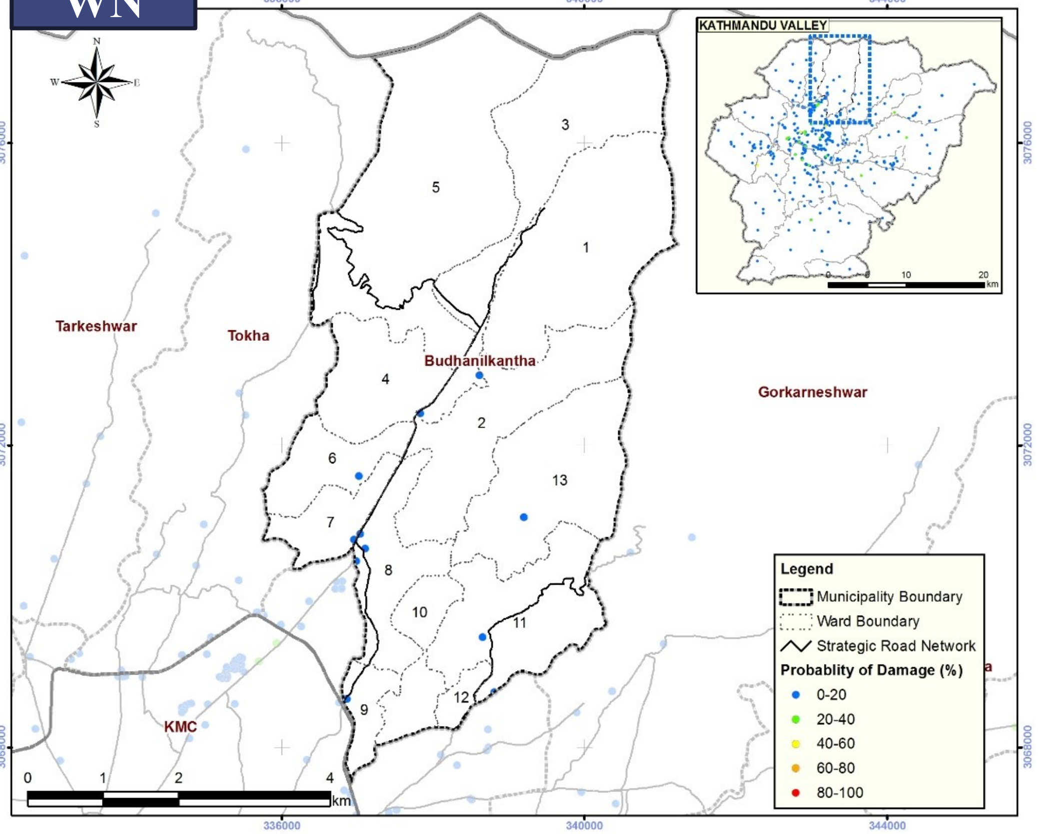
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

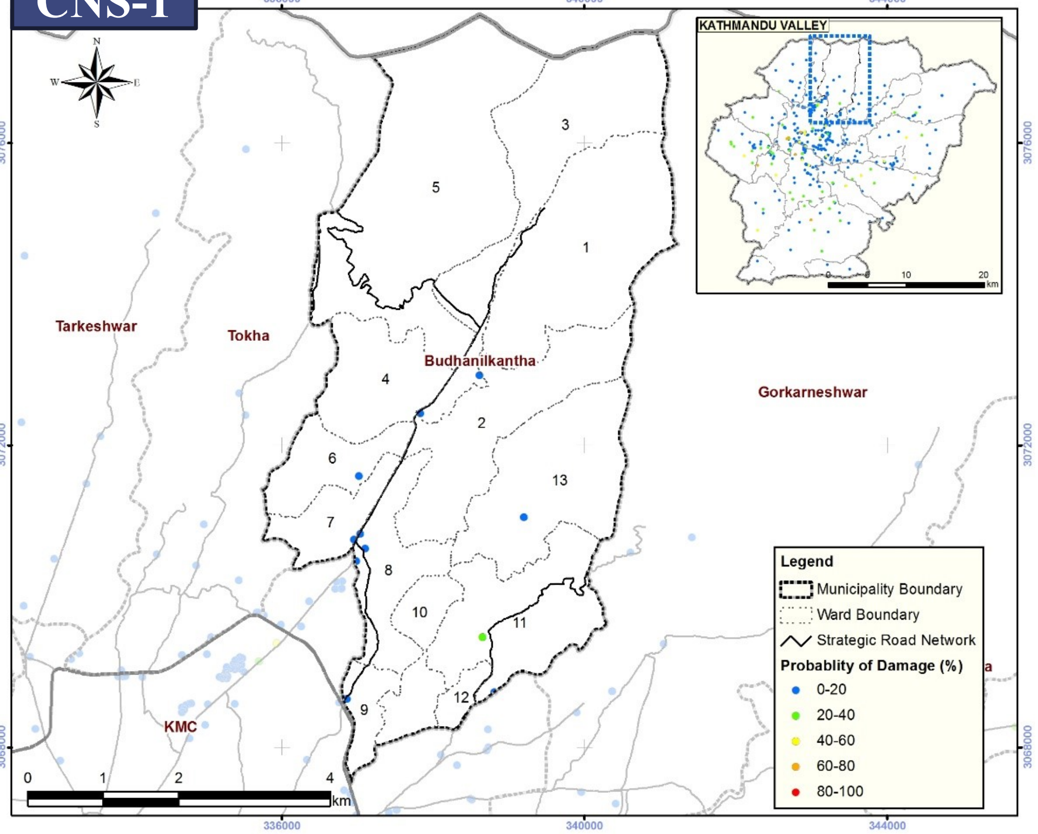
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

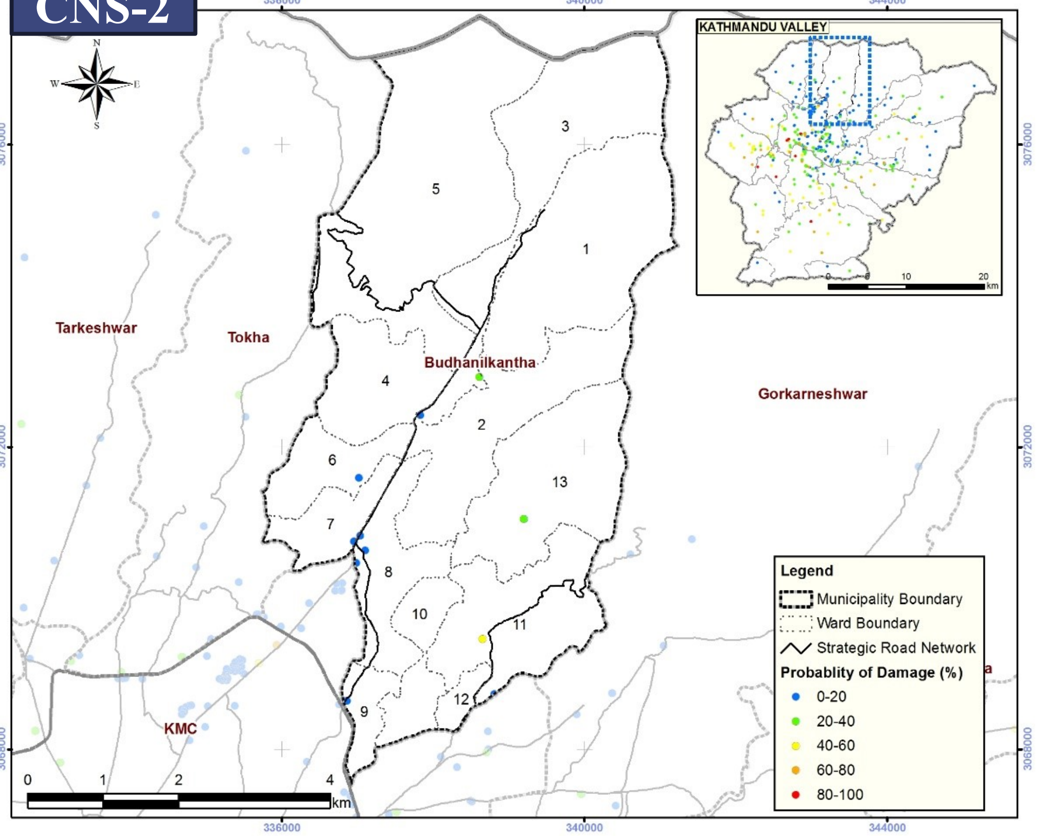
WN



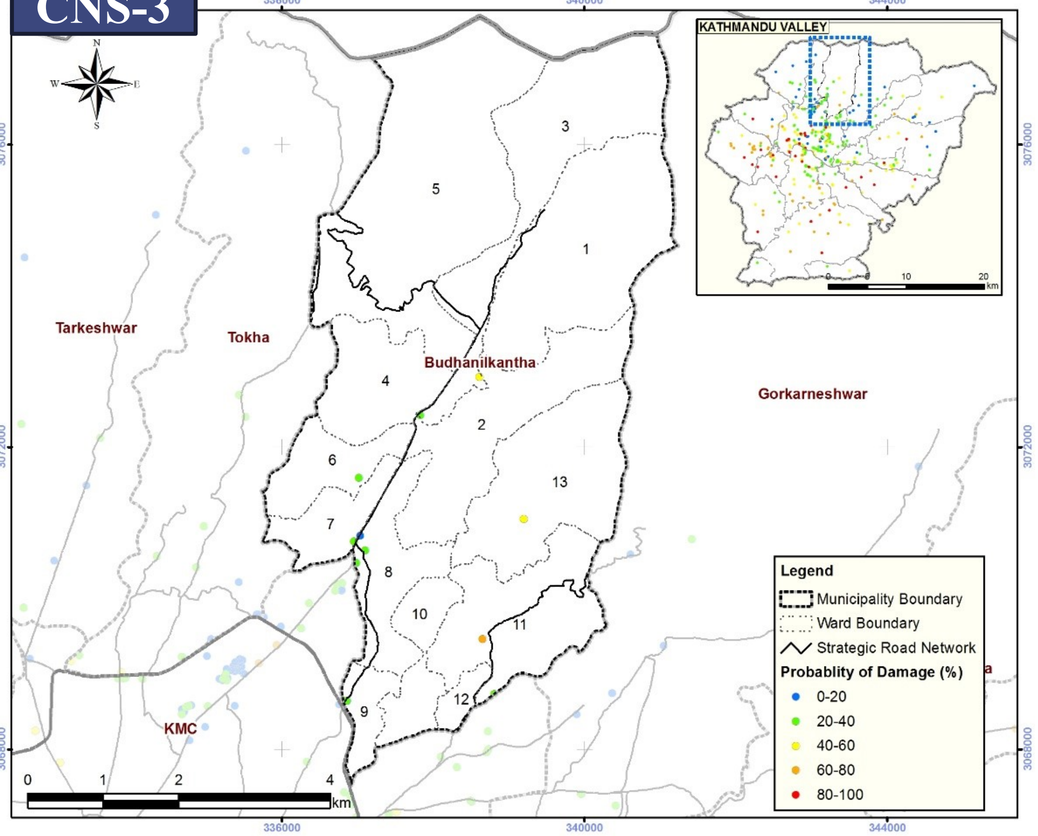

CNS-1




CNS-2




CNS-3




# C-16

# Health Facility Building Damage

## Probability of Heavy Damage [Damage Level 4+5 by EMS-98]

Note:

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. A health facility building damage ratio was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment on which a health facility building is located and a structure type of health facility building using damage functions of buildings defined in the project.
- The total number of damaged health facility buildings was calculated to add up all values of building damage ratios (Probability of damage) in the study area.
- Total numbers of heavily damaged health facility buildings and proportions of damaged buildings to total health facility buildings defined as 13 based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 0 | 0.0% |
| CNS-1 | 1 | 7.7% |
| CNS-2 | 2 | 15.4% |
| CNS-3 | 4 | 30.8% |

Source:

- Result of health facility building damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

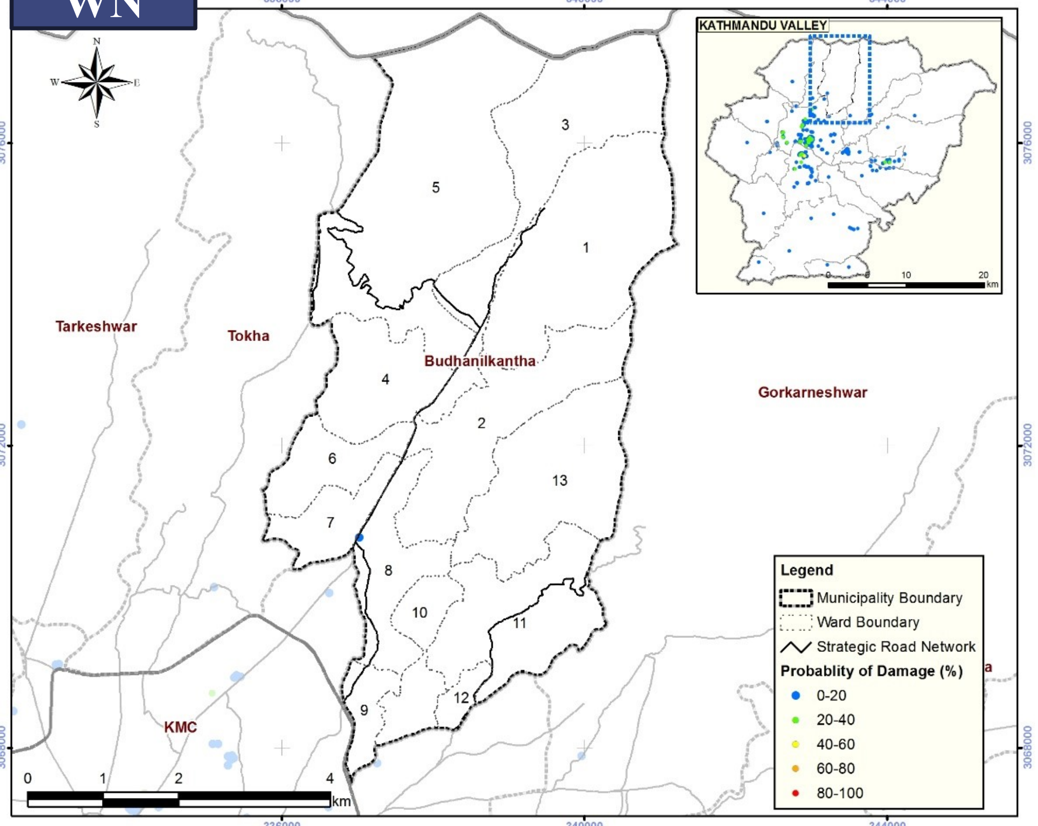
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

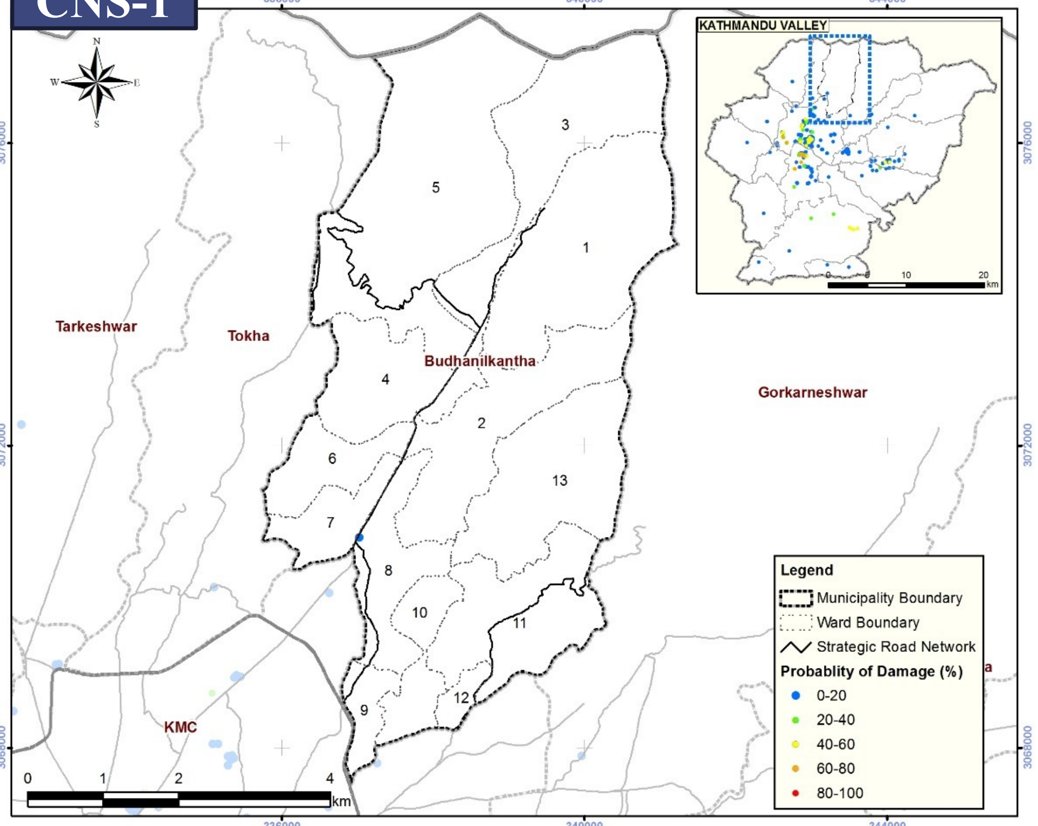
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal

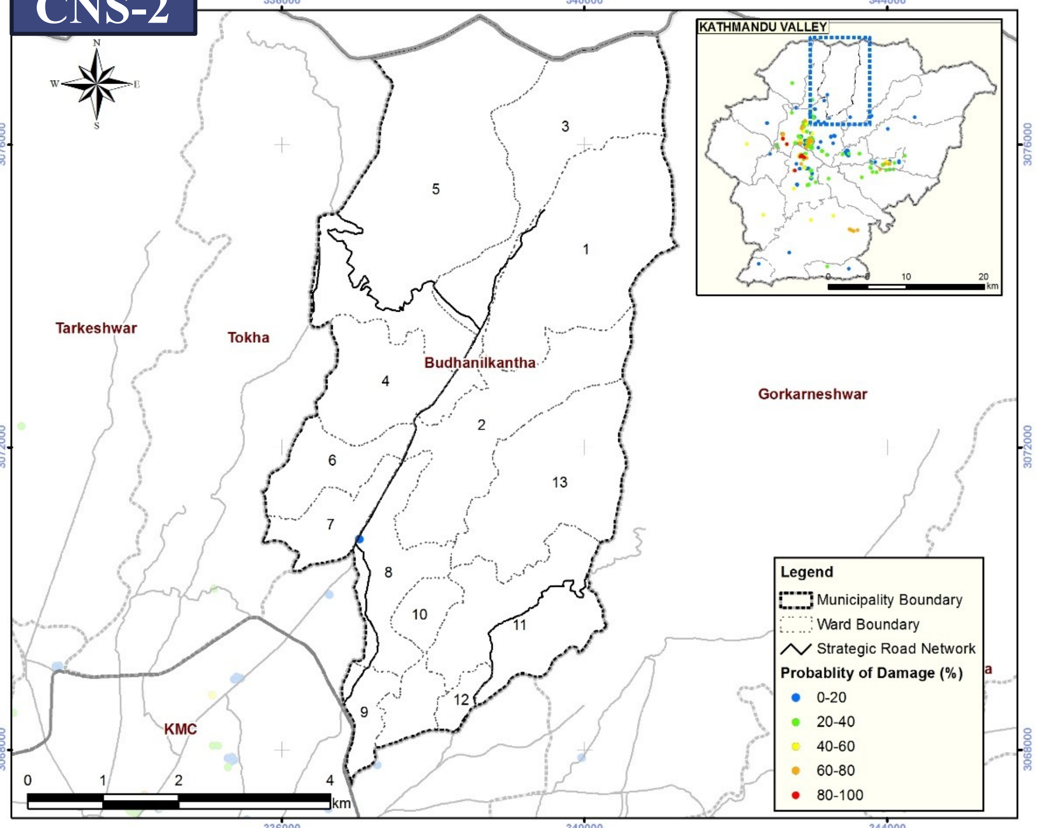
**WN**



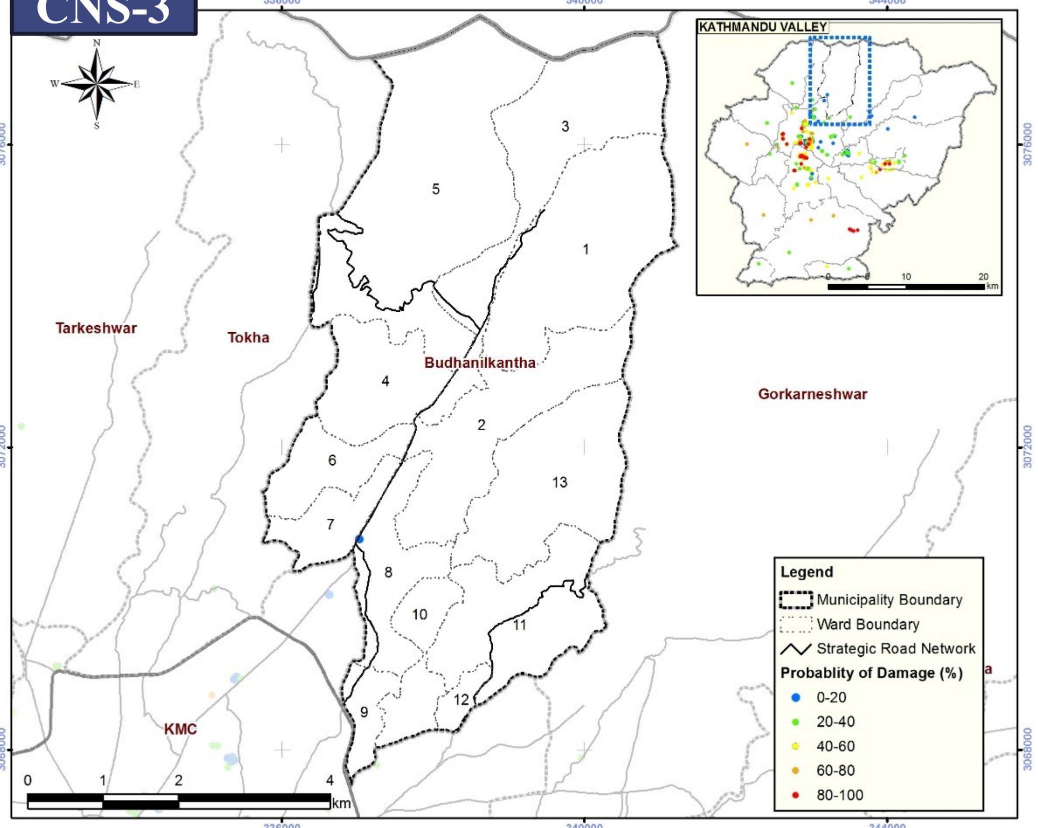

**CNS-1**




**CNS-2**




**CNS-3**




# C-17

## Government Building Damage

### Probability of Heavy Damage [Damage Level 4+5 by EMS-98]

**Note:**

- "Heavily Damaged Building" means a building classified as Damage Level 4 & 5 by EMS-98. A government building damage ratio was estimated from a value of peak ground acceleration (PGA) at ground surface from seismic hazard assessment on which a government building is located and a structure type of government building using damage functions of buildings defined in the project.
- The total number of damaged government buildings was calculated to add up all values of building damage ratios (Probability of damage) in the study area.
- Total numbers of heavily damaged government buildings and proportions of damaged buildings to total government buildings defined as 1 based on four types of scenario ground motions were estimated as below.

| Scenario ground motion | Number of heavily damaged building | Ratio of damage |
|---|---|---|
| WN | 0 | 0.0% |
| CNS-1 | 0 | 0.0% |
| CNS-2 | 0 | 0.0% |
| CNS-3 | 0 | 0.0% |

**Source:**

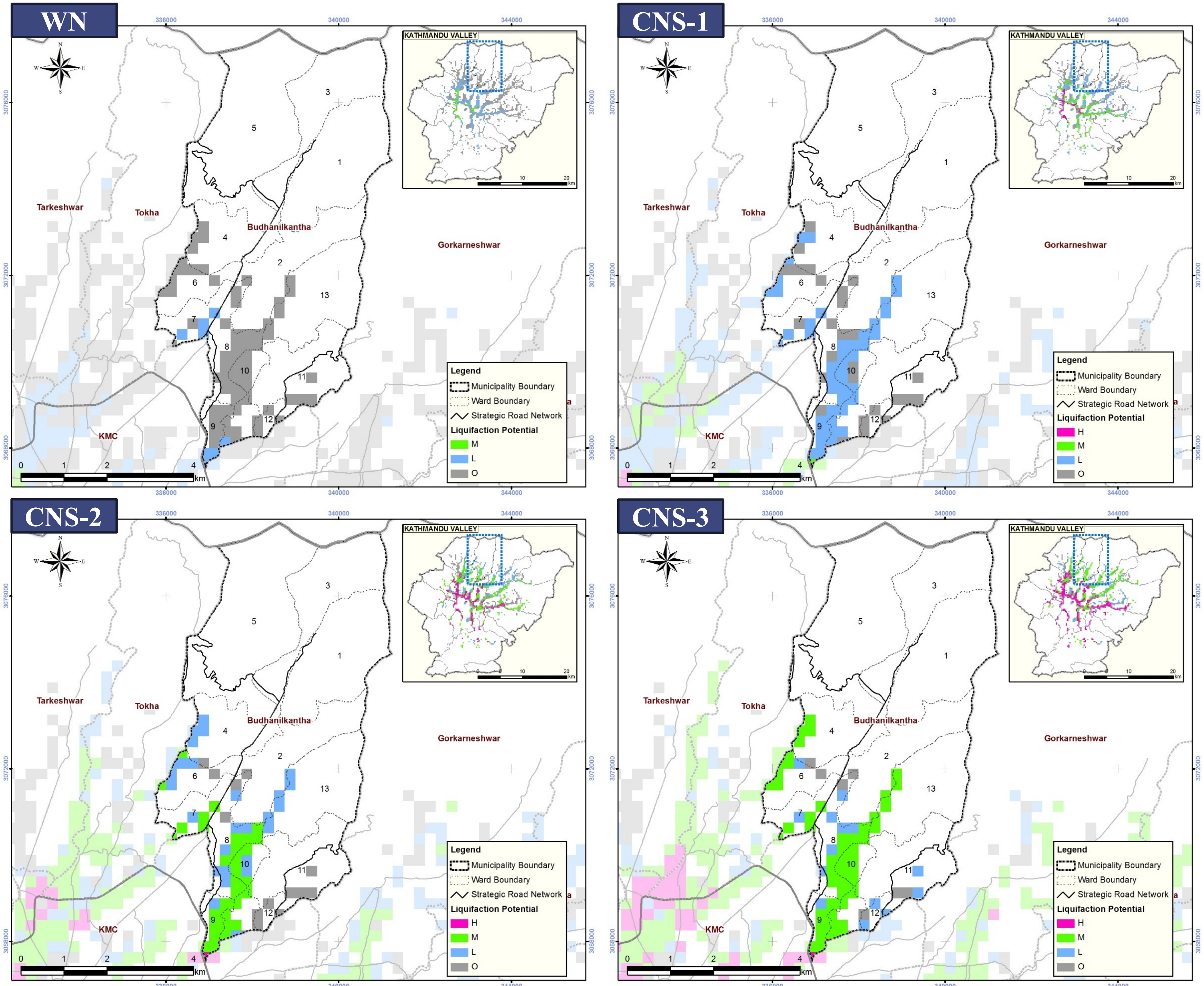
- Result of government building damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# C-18

## Possible Damage of Road by Liquefaction

**Note:**

- Roads located in the area with high potential of liquefaction tend to be affected by a risk of traffic disturbance, due to the subsidence of the ground and damage of road facilities. The road at high risk of traffic disturbance was identified by spatially superimposed comparison and analysis on liquefaction potential of each grid and road network. Since liquefaction was estimated based on the assumption due to insufficient soil data and it might lead to an overestimation, the medium and low potential were not considered.
- Total road length in Budhanilkantha Municipality is 308.6 km 14.1 km Feeder Road (Major and Minor), 4.4 km Strategic Urban Road and 290.1 km Municipal Roads.
- The road length in the area with high potential of liquefaction is calculated as below.

| Scenario ground motion | Road length in liquefaction area (km) | Ratio to total road length |
|---|---|---|
| WN | 0 | 0% |
| CNS-1 | 0 | 0% |
| CNS-2 | 0.4 | 0.1% |
| CNS-3 | 0.4 | 0.1% |

**Source:**

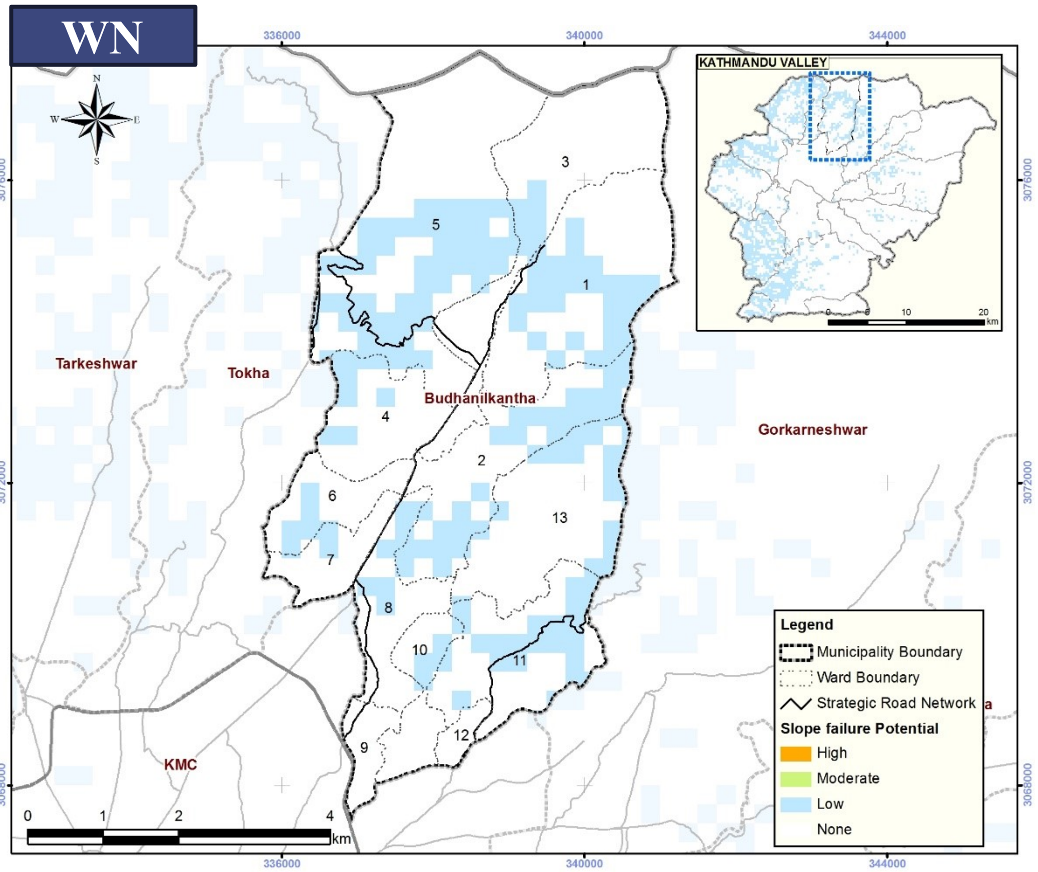
- Result of liquefaction: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

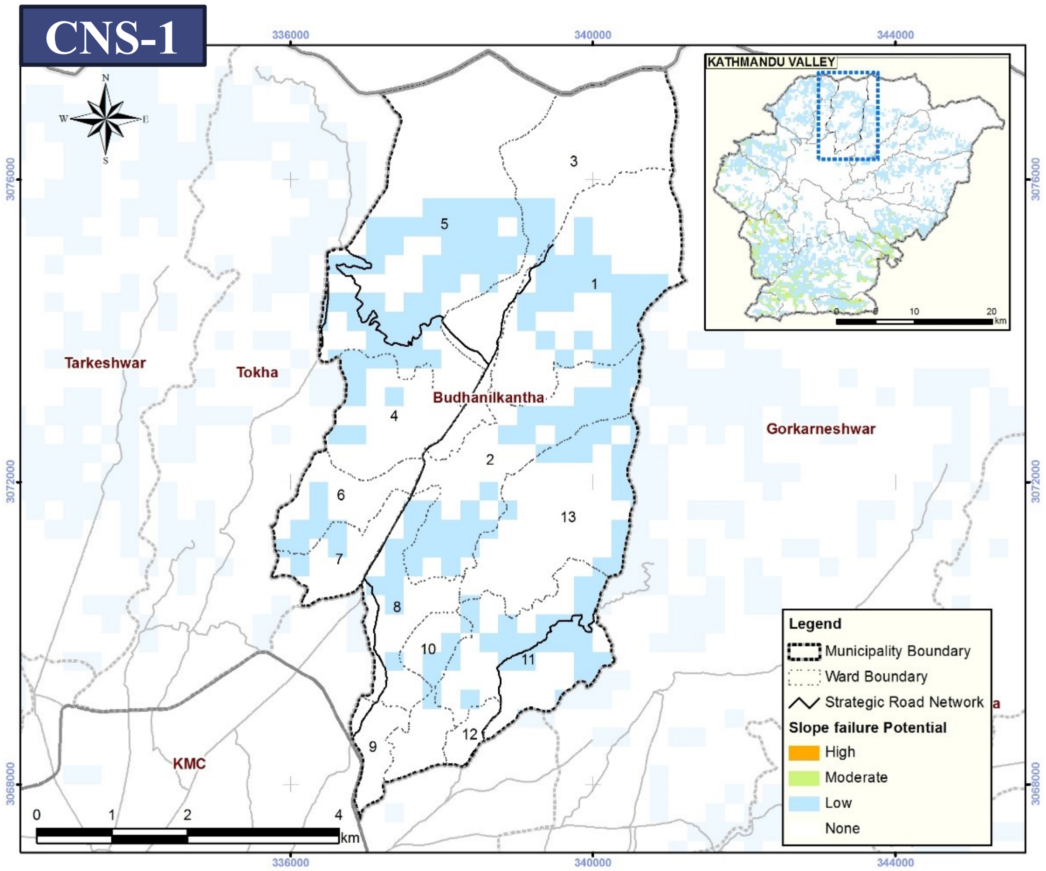
WGS_1984_UTM_Zone_45N

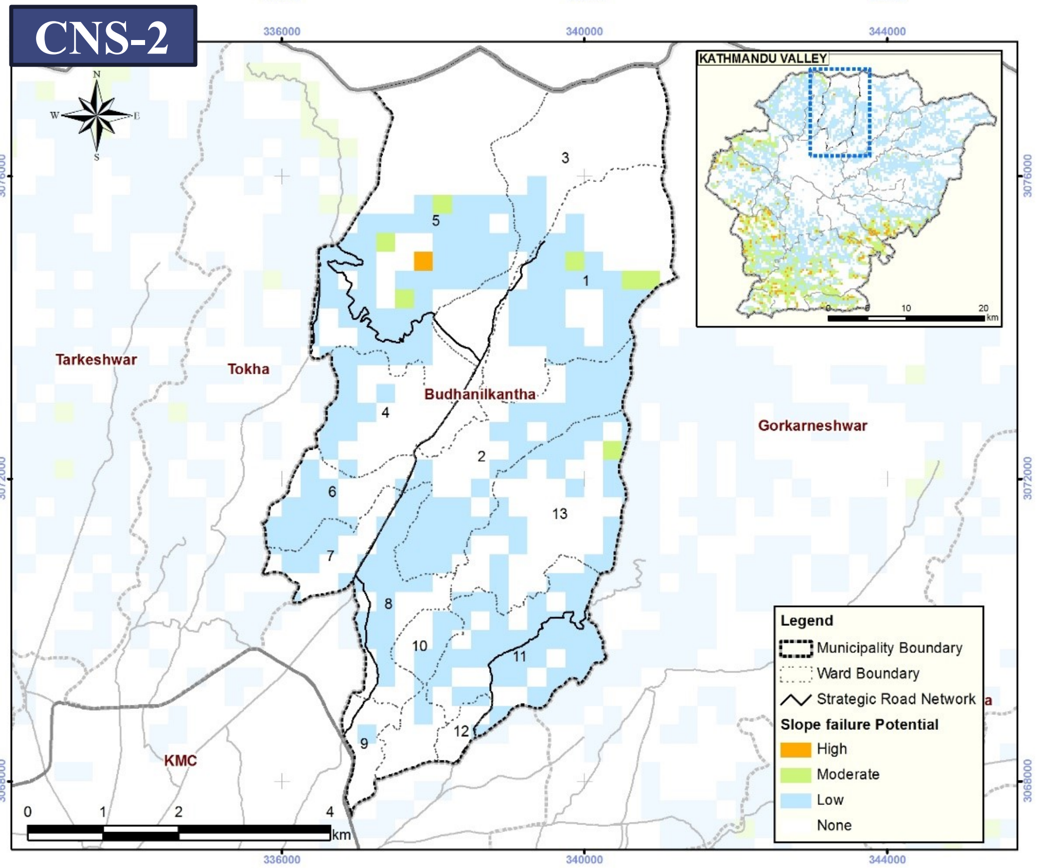
Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

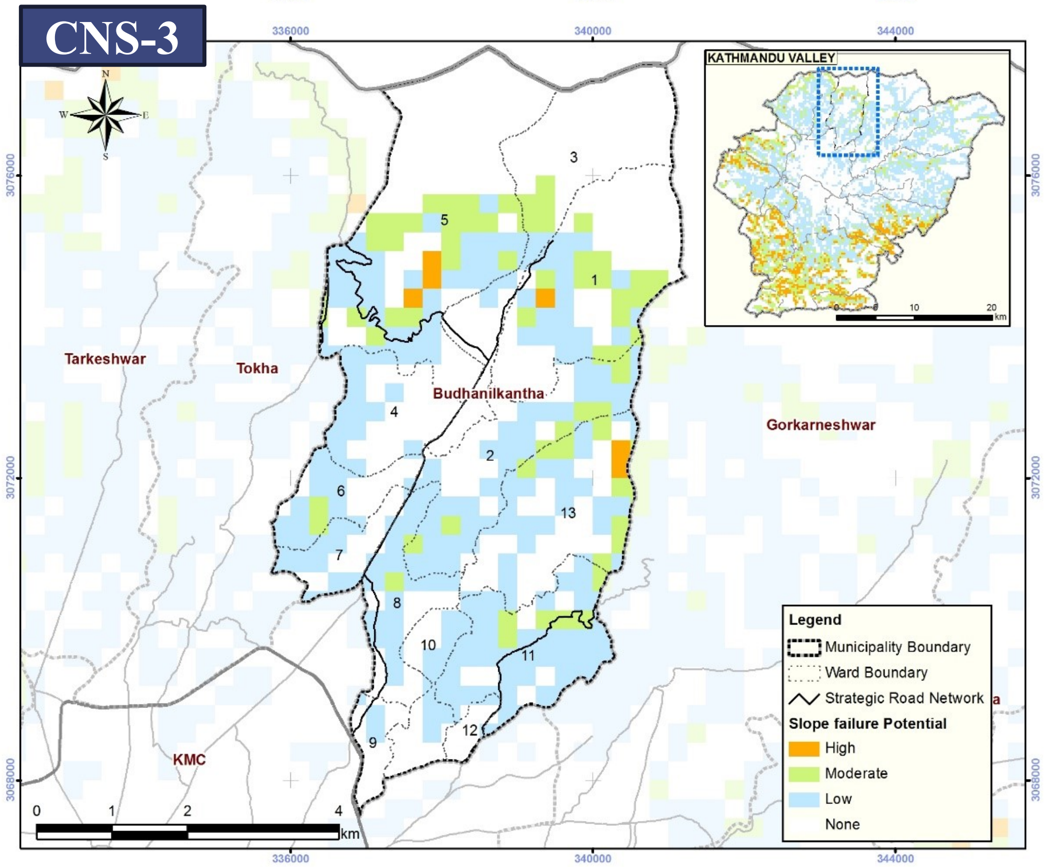
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# C-19

## Possible Damage of Road by Slope Failure

**Note:**

- Roads along the mountainside tend to be blocked or damaged by landslides caused by earthquakes. The road at high risk of traffic disturbance was extracted by spatially superimposed comparison and analysis on the results of slope failure potential of each grid and the road network. Since slope failure was estimated based on some assumptions due to insufficient soil data and it might lead to an overestimation, the medium and low potential were not considered.
- Total road length in Budhanilkantha Municipality is 308.6 km with 14.1 km Feeder Road (Major and Minor), 4.4 km Strategic Urban Road and 290.1 km Municipal Roads.
- The road length in the area with high potential of slope failure is calculated as below.

| Scenario ground motion | Road length in slope failure area (km) | Ratio to total road length |
|---|---|---|
| WN | 0 | 0% |
| CNS-1 | 0 | 0% |
| CNS-2 | 0.2 | 0.1% |
| CNS-3 | 1.8 | 0.6% |

**Source:**

- Result of slope failure: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

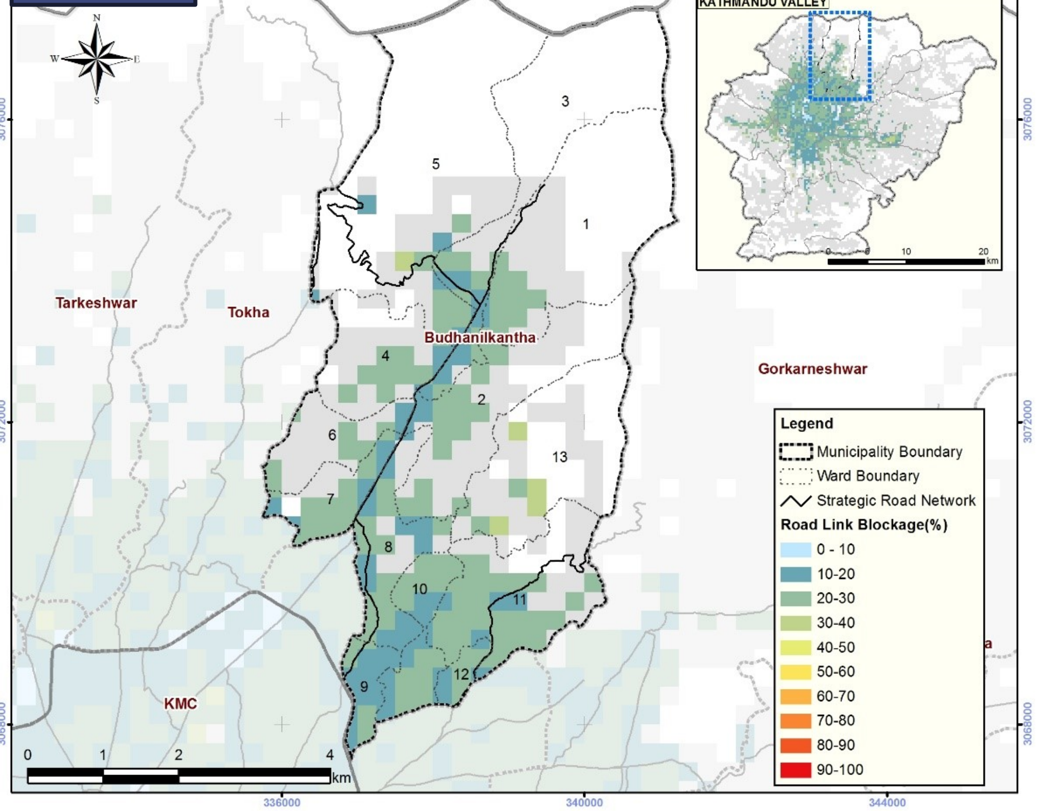
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

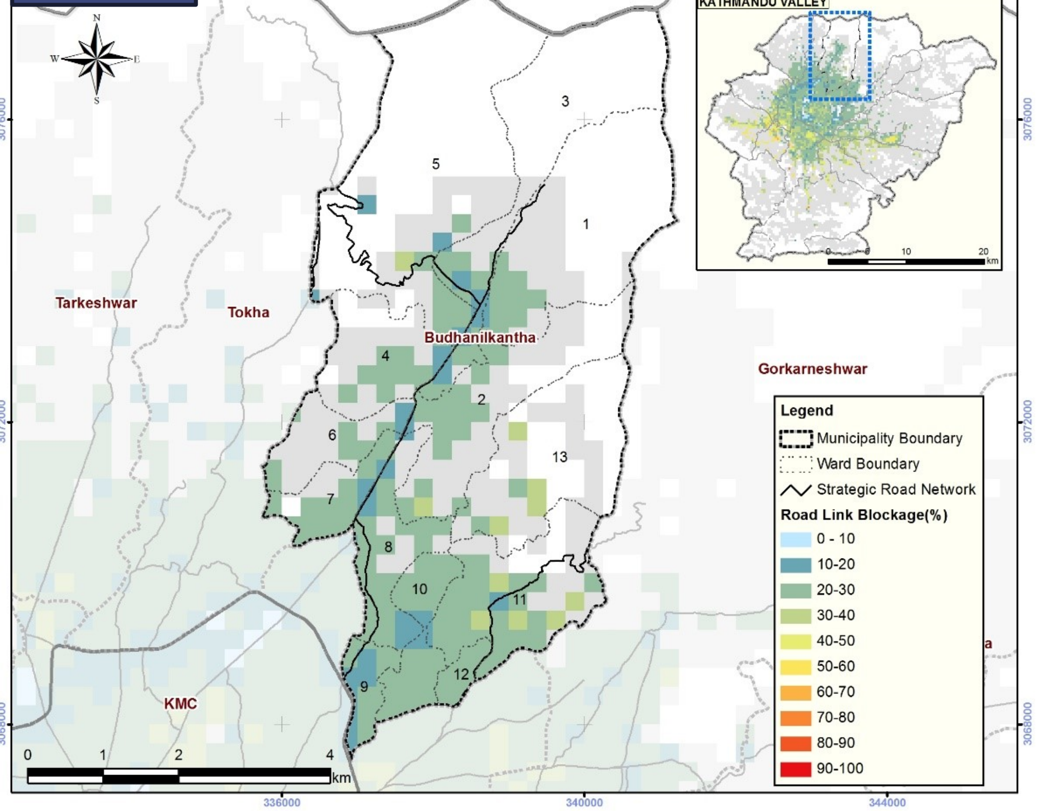
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

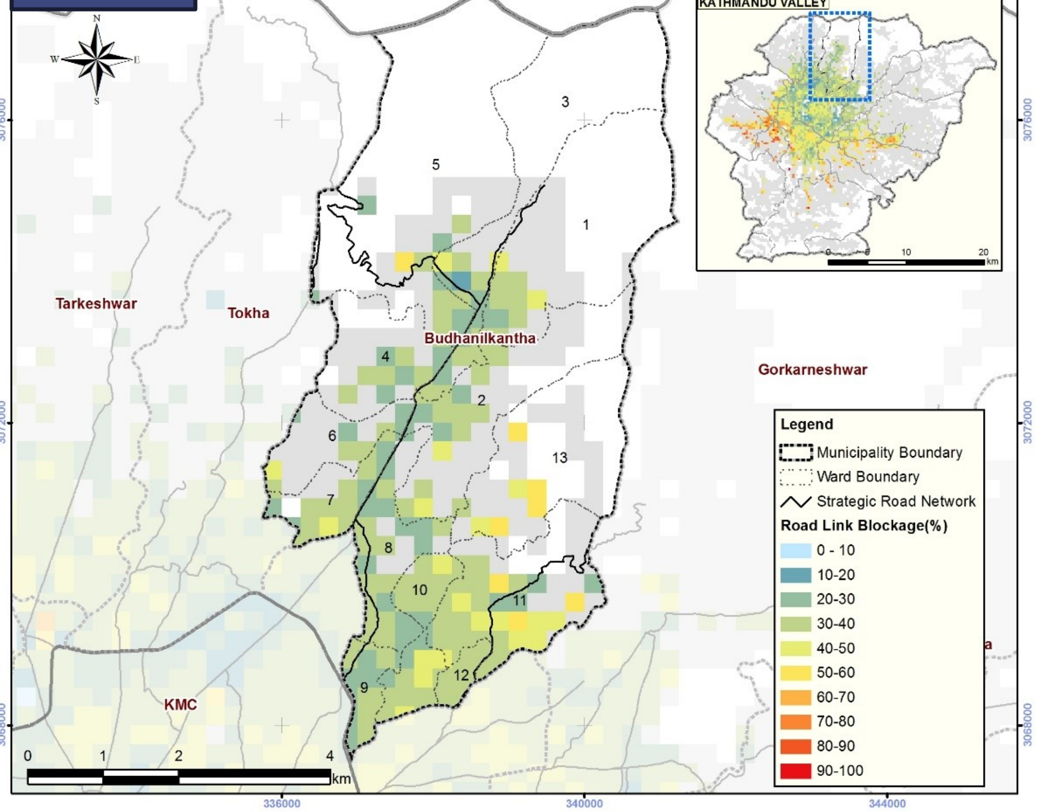
**WN**



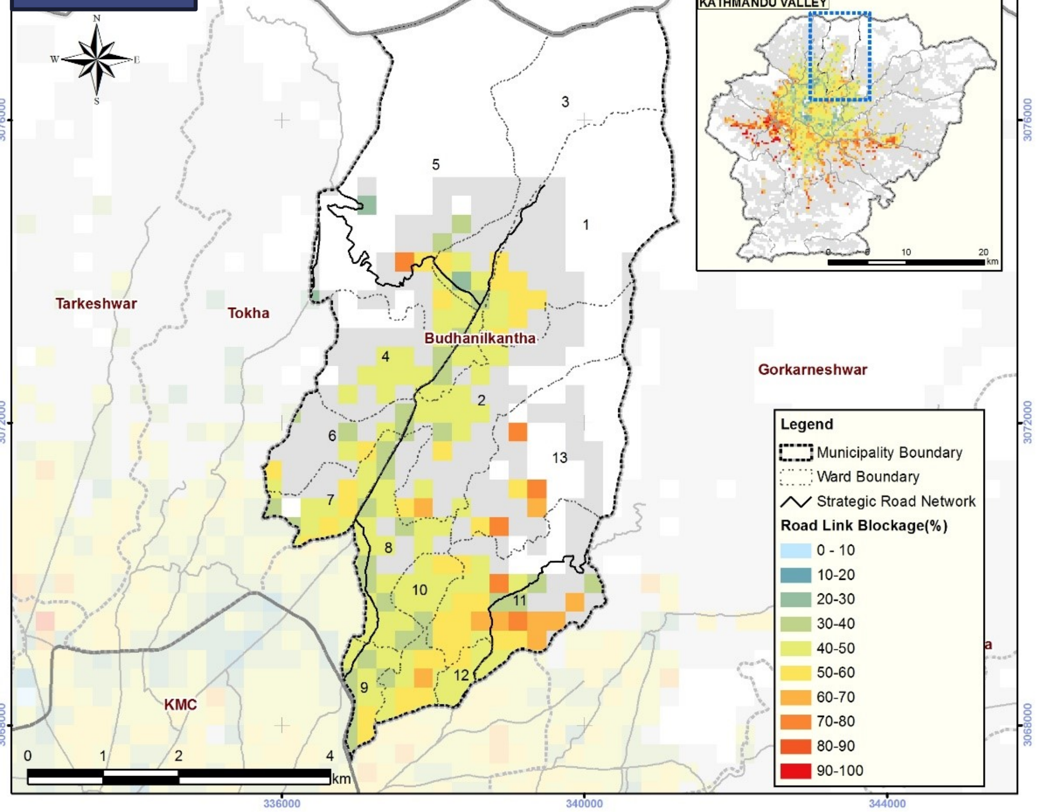

**CNS-1**




**CNS-2**




**CNS-3**




# C-20

## Possible Link Blockage of Road by Building Damage

**Note:**

- There is a risk of road blockage due to the debris of collapsed buildings in the relatively narrow streets and it is expressed by road link blockage rate. In order to estimate the risk of traffic disturbance after the earthquake due to the collapse of adjacent buildings, the rate was calculated for each grid by considering the different road width and the building damage rate of the grid as below.

(1) Road width less than 3.5 m

Road link blockage rate ＝0.9009 * building damage rate + 19.845

(2) Road width from 3.5 m to 5.5 m

Road link blockage rate ＝0.3514 * building damage rate + 13.189

(3) Road width from 5.5 m to 13 m

Road link blockage rate ＝0.2229 * building damage rate + 1.5026

- Total road length in Budhanilkantha Municipality is 308.6 km with 14.1 km Feeder Road (Major and Minor), 4.4 km Strategic Urban Road and 290.1 km Municipal Roads.

**Source:**

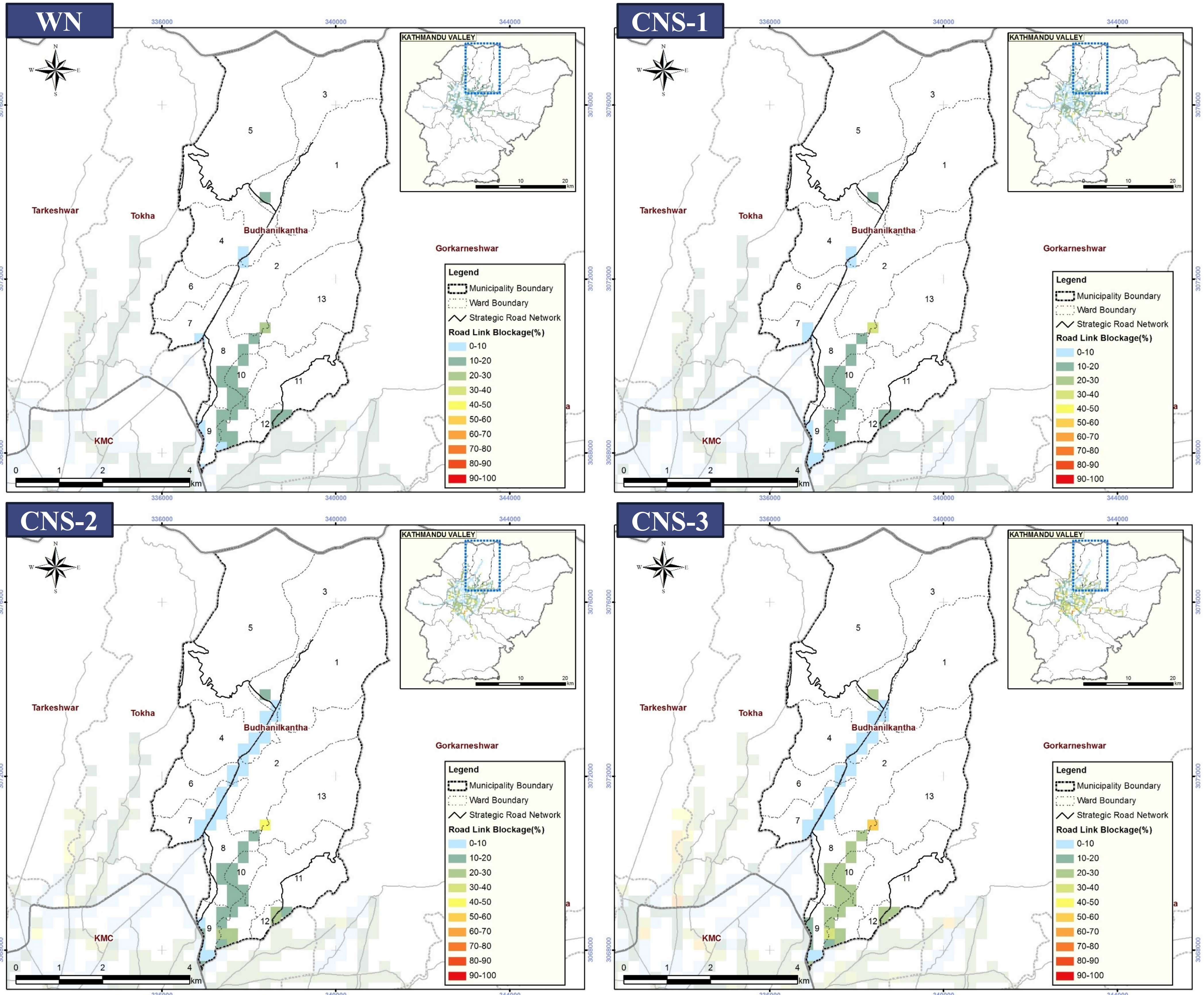
- Result of building damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# C-21

## Possible Link Blockage of ETRN by Building Damage

**Note:**

- There is a risk of road blockage due to the debris of collapsed buildings in the relatively narrow streets and it is expressed by road link blockage rate. In order to estimate the risk of traffic disturbance after the earthquake due to the collapse of adjacent buildings, the rate was calculated for each grid by considering the different road width and the building damage rate of the grid as below.

(1) Road width less than 3.5 m

Road link blockage rate ＝0.9009 * building damage rate + 19.845

(2) Road width from 3.5 m to 5.5 m

Road link blockage rate ＝0.3514 * building damage rate + 13.189

(3) Road width from 5.5 m to 13 m

Road link blockage rate ＝0.2229 * building damage rate + 1.5026

- Besides the whole road network (C-20), road blockage was also estimated for the emergency transportation road network proposed by JICA RRNE project.

**Source:**

- Result of building damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

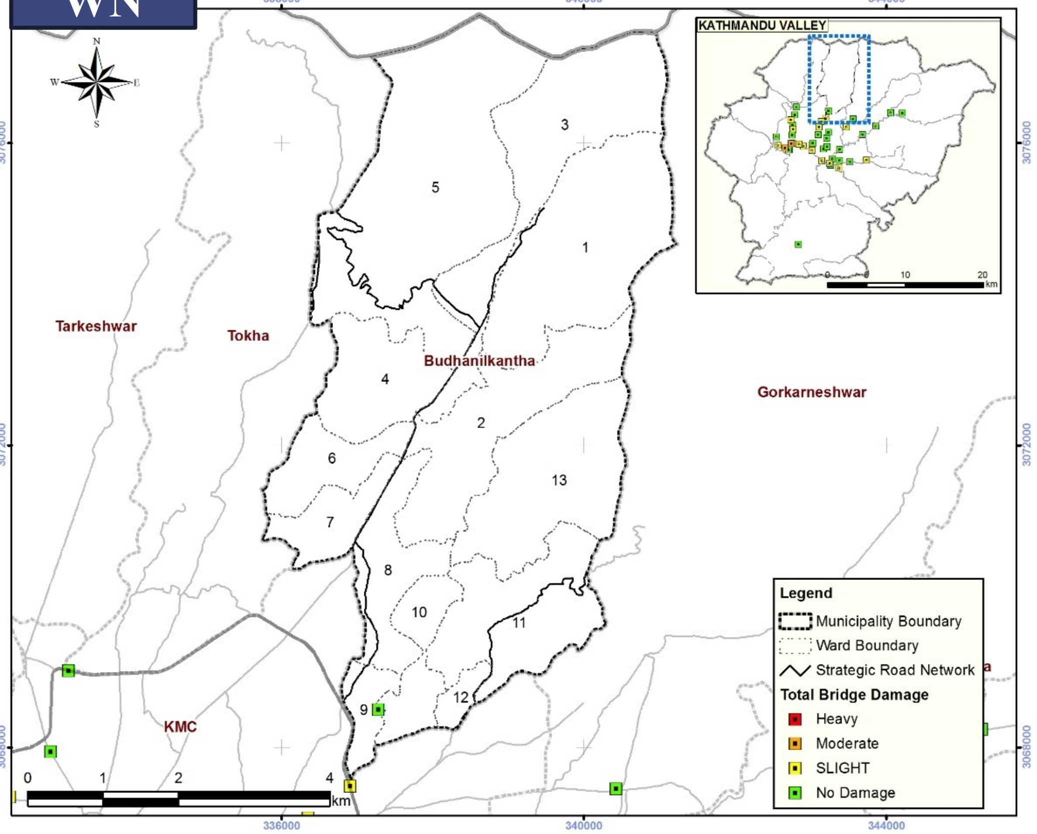
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

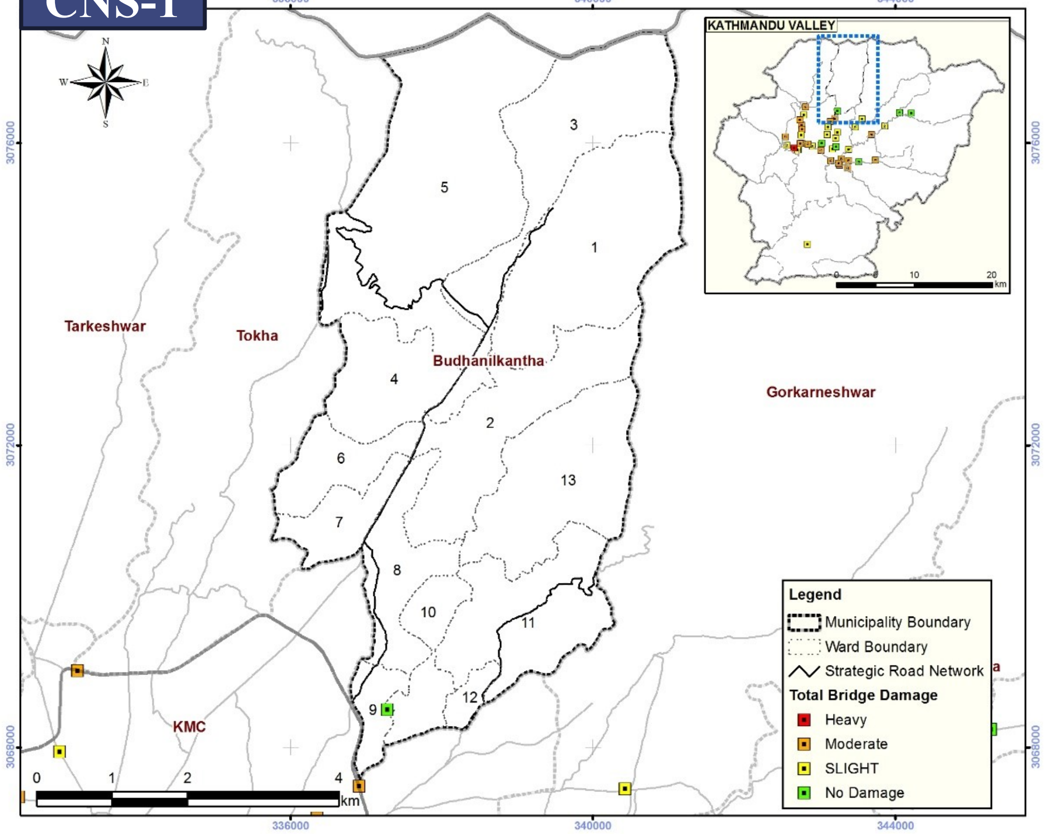
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

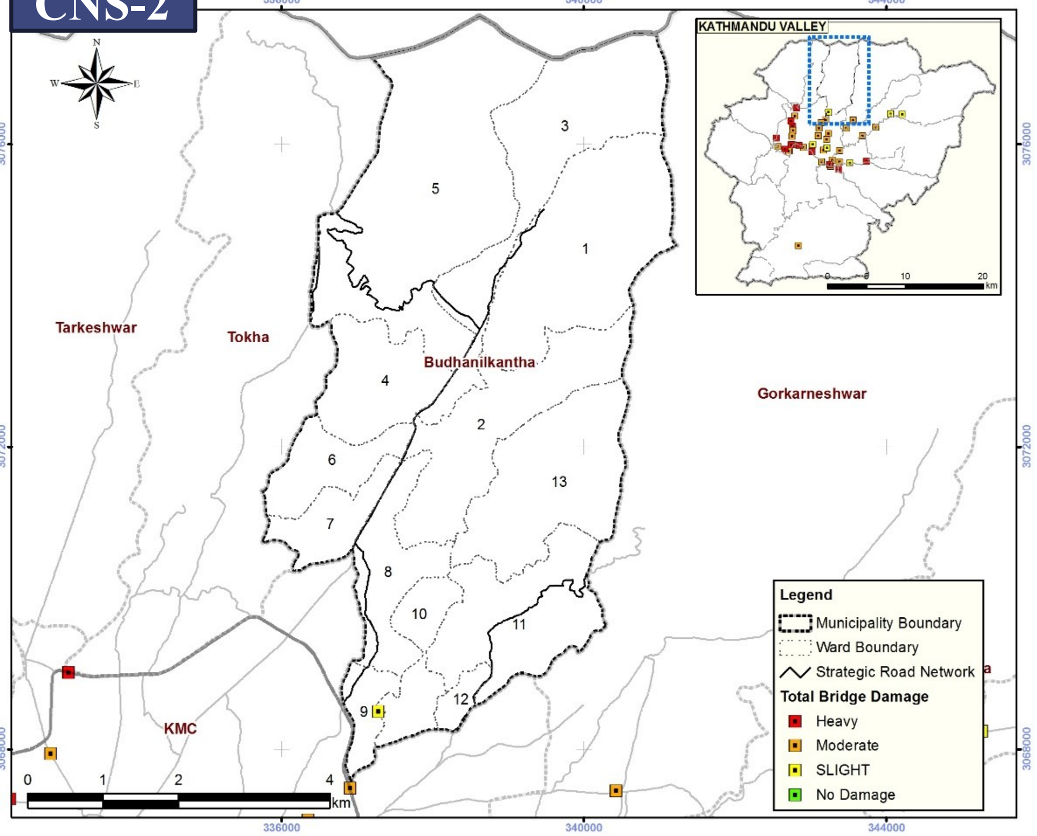
**WN**



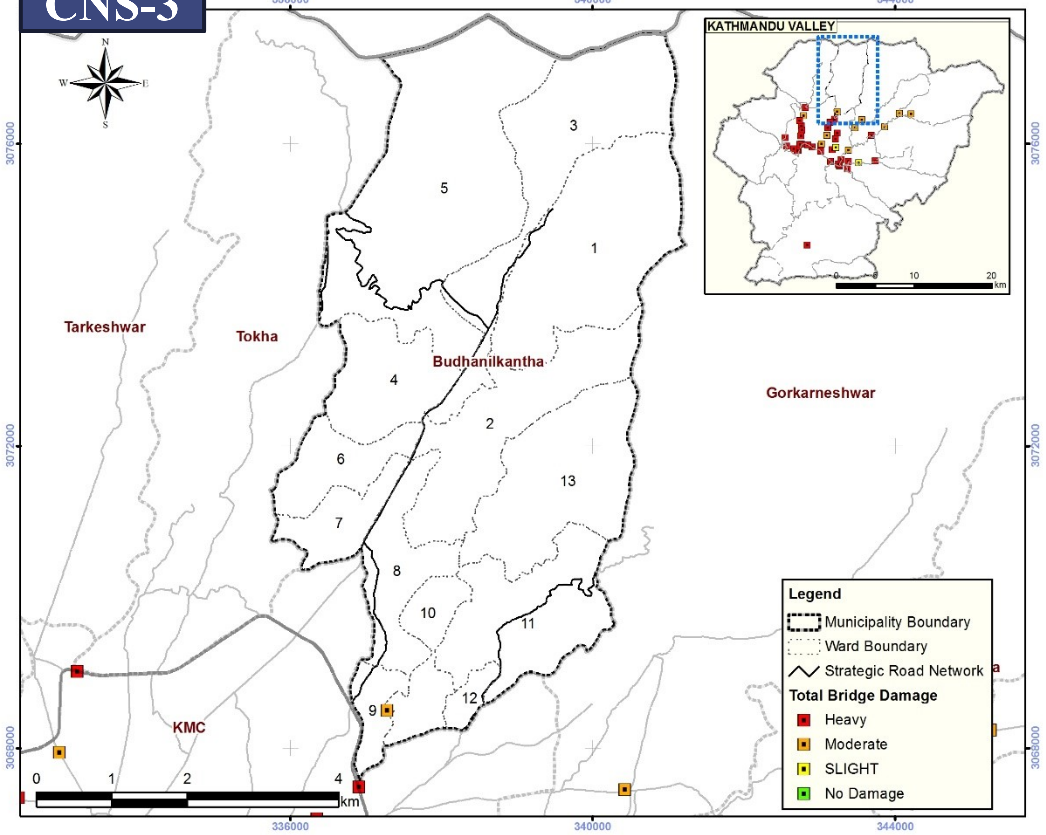

**CNS-1**




**CNS-2**




**CNS-3**




# C-22

# Damage of Bridge

**Note:**

- Damage of bridge, from the point of view of functional failure, can be mainly represented by the collapse of the substructure and the falling down of superstructure. In this project, the collapse of substructure was estimated by the response ductility factor of pier and the seating length was used for the judgment of the possibility of falling down of superstructure. An example of criteria for damage degree classification is (refer report for more detail)

Heavy damage: ductility factor <= 1.5
Moderate damage: 1.5 < ductility factor <= 3.0
Slight damage: 3.0 < ductility factor

- The total number of bridge is 12 with 2 multi span and 10 single span bridges. Within 2 multi span bridges, 1 of them having RC pier were assessed by their ductility factor. The results are as below.

-

| Scenario ground motion | Heavy damage | Moderate damage | Slight damage |
|---|---|---|---|
| WN | 0 | 0 | 0 |
| CNS-1 | 0 | 0 | 0 |
| CNS-2 | 0 | 0 | 1 |
| CNS-3 | 0 | 1 | 0 |

**Source:**

- Results of bridge damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

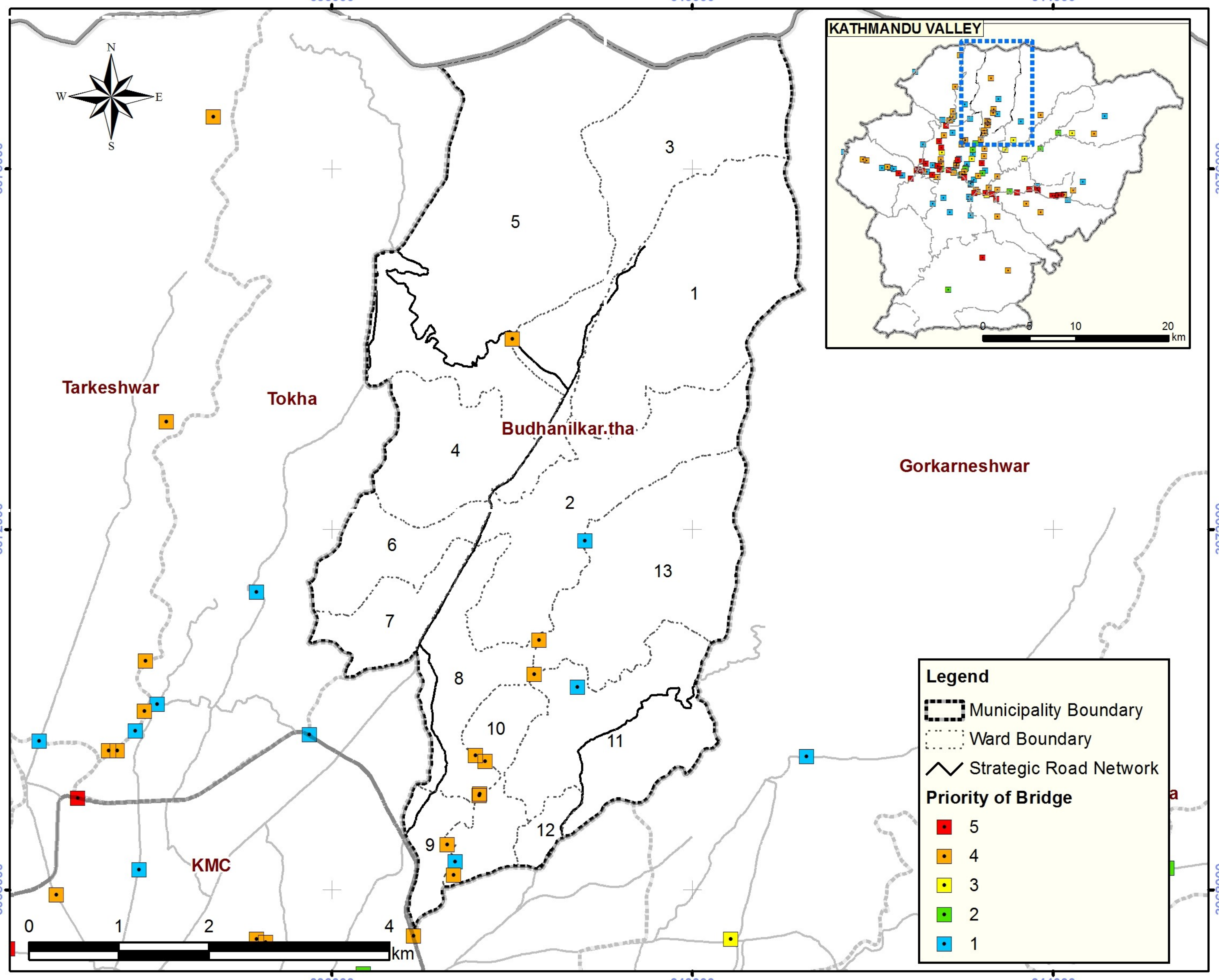
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

CNS-2




# C-23

## Priority Rank of Bridge for Seismic Strengthening

**Note:**

- Damage of bridge, from the point of view of functional failure, can be mainly represented by the collapse of the substructure and the falling down of superstructure. In this project, the collapse of substructure was estimated by the response ductility factor of pier and the seating length was used for the judgment of the possibility of falling down of superstructure. An example of criteria for damage degree classification is

Heavy damage: ductility factor <= 1.5
Moderate damage: 1.5 < ductility factor <= 3.0
Slight damage: 3.0 < ductility factor

- The total number of bridge is 12 with 2 multi span and 10 single span bridges. Within 2 multi span bridges, 1 of them having RC pier were assessed by their ductility factor (C-22). Besides, a priority rank from 1 (low priority) to 5 (high priority) was worked out by collectively considering the pier damage, seat length and scour for the 1 bridge and bridge material, seat length and scour for the other bridges. The number of bridge for each rank is shown as below.

| Rank 5 | Rank 4 | Rank 3 | Rank 2 | Rank 1 |
|---|---|---|---|---|
| 0 | 9 | 0 | 0 | 3 |

**Source:**

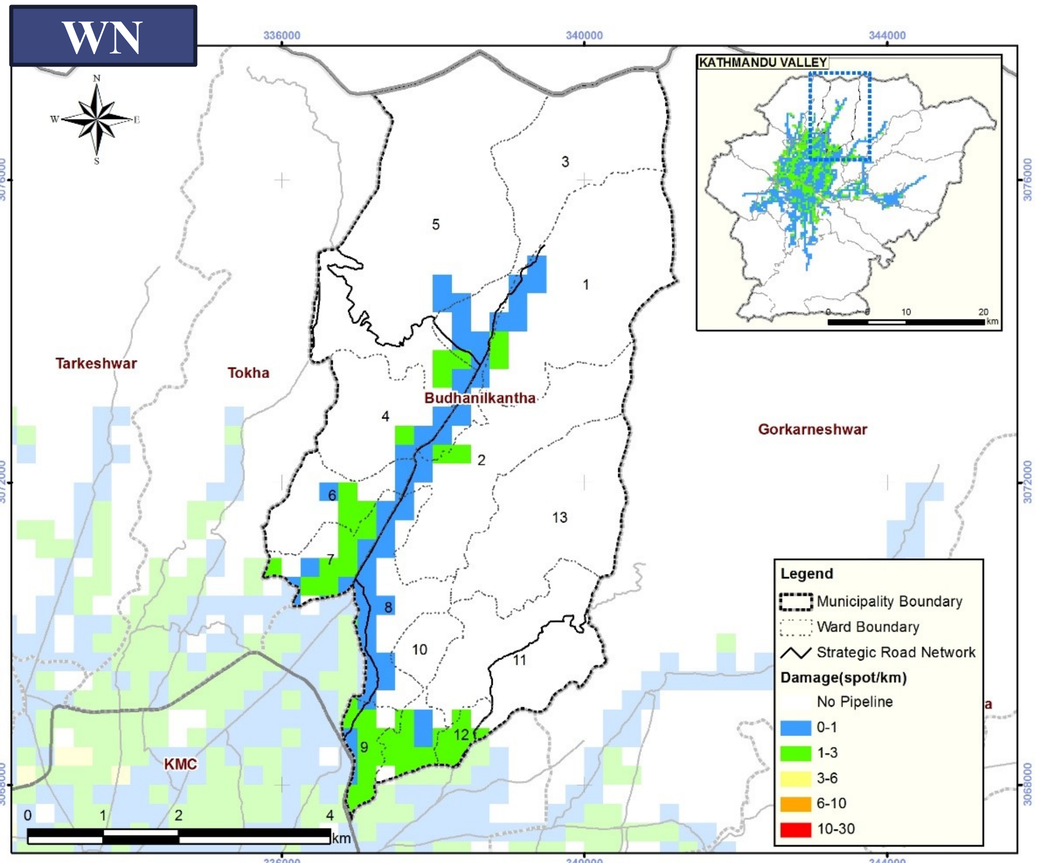
- Results of bridge assessment: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

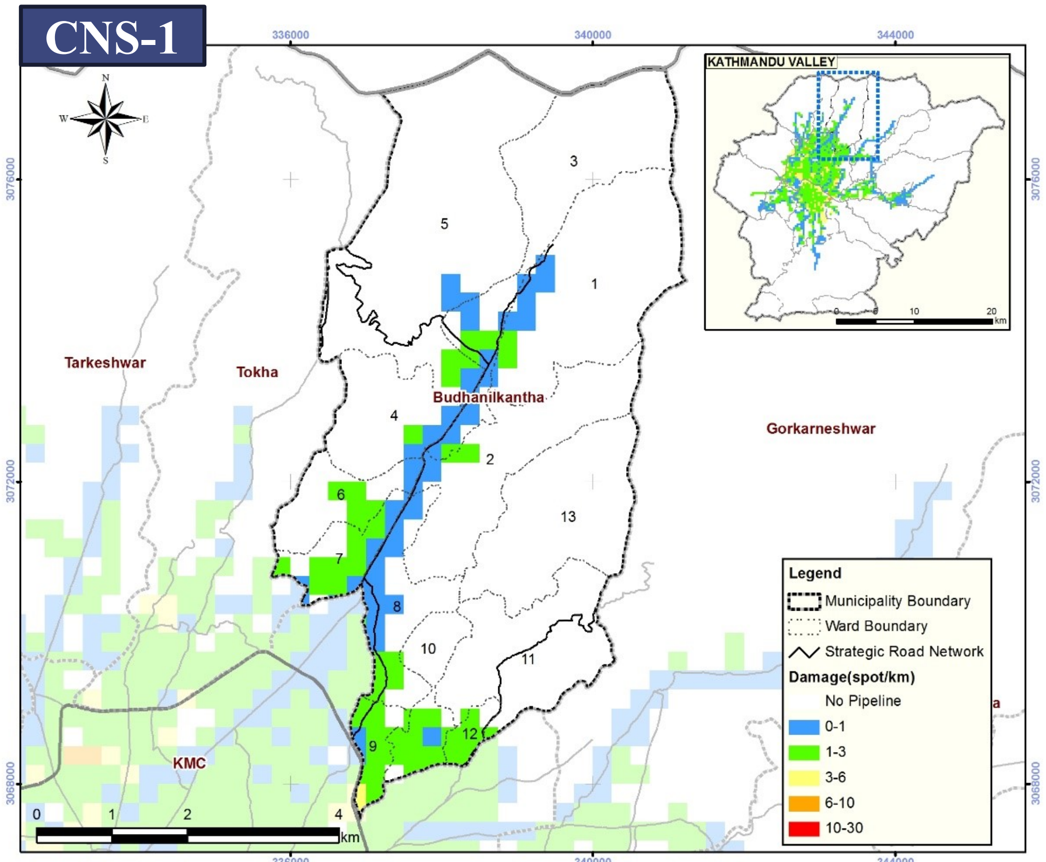
WGS_1984_UTM_Zone_45N

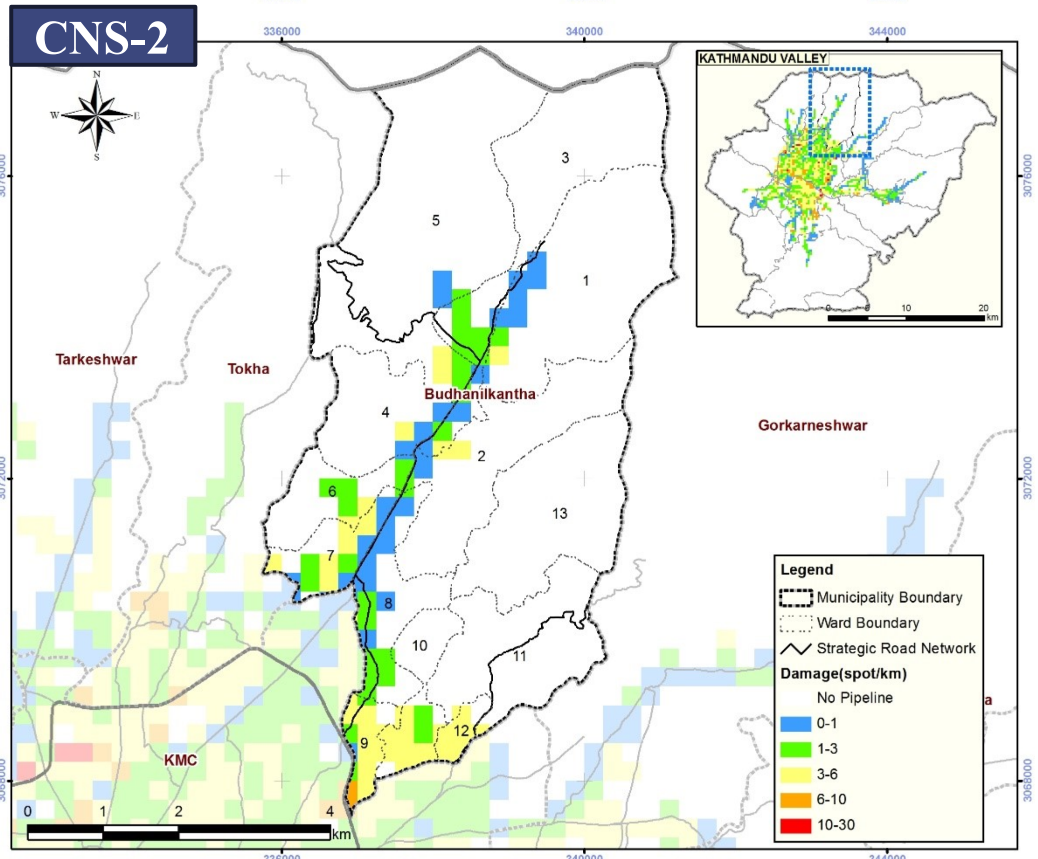
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ....................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

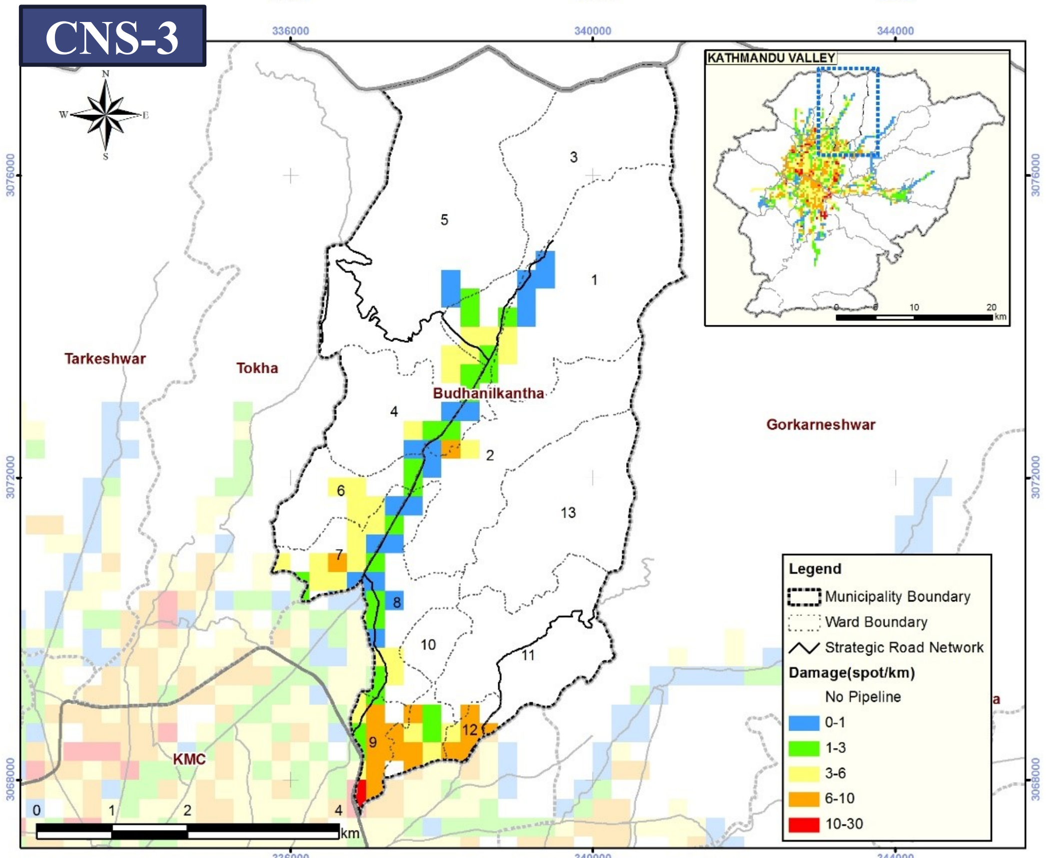
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ...........................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: .........................................WGS_1984

The Project for Assessment of EARTHQUAKE DISASTER RISK for the Kathmandu Valley in Nepal




# C-24

# Distribution of Water Supply Network Damage (Existing)

**Note:**

- For damage estimation of water supply pipeline, standard damage rate R(v) is usually used and it is given as the function of PGV based on the recent findings of earthquake damage of pipelines. In addition to PGV, liquefaction potential, micro-terrain, pipe type, joint type and pipe diameter were also involved in the damage estimation. The pipeline damage was estimated in grid wise and was represented by damage points.
- Total length of existing water supply pipeline is 37.4 km. There are six types of pipe materials: cast-iron (CI), ductile cast-iron (DI), galvanized iron (GI), high density polyethylene (HDPE), polyvinyl chloride (PVC) and spun iron.
- The estimation was carried out for each pipe material and diameter in grid wise. The damage is summarized as below.

| Scenario ground motion | Damage points | Damage ratio (points/km) |
|---|---|---|
| WN | 33 | 0.9 |
| CNS-1 | 46 | 1.2 |
| CNS-2 | 87 | 2.3 |
| CNS-3 | 130 | 3.5 |

**Source:**

- Result of pipeline damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

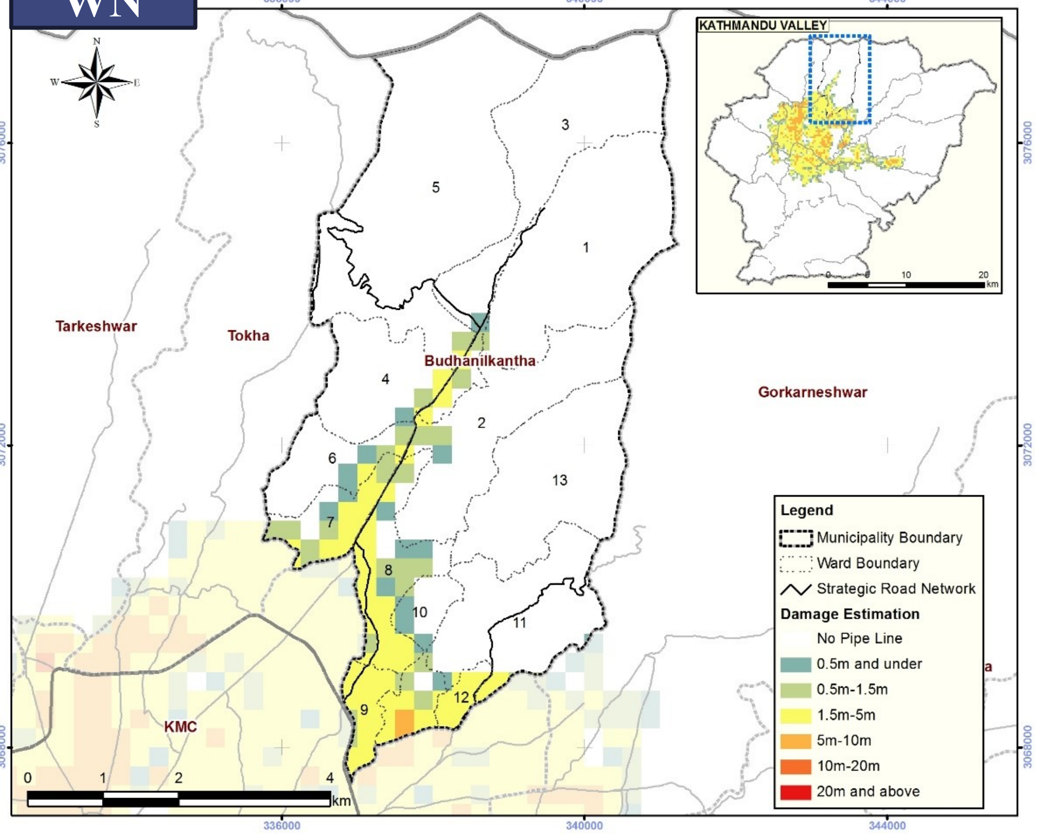
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

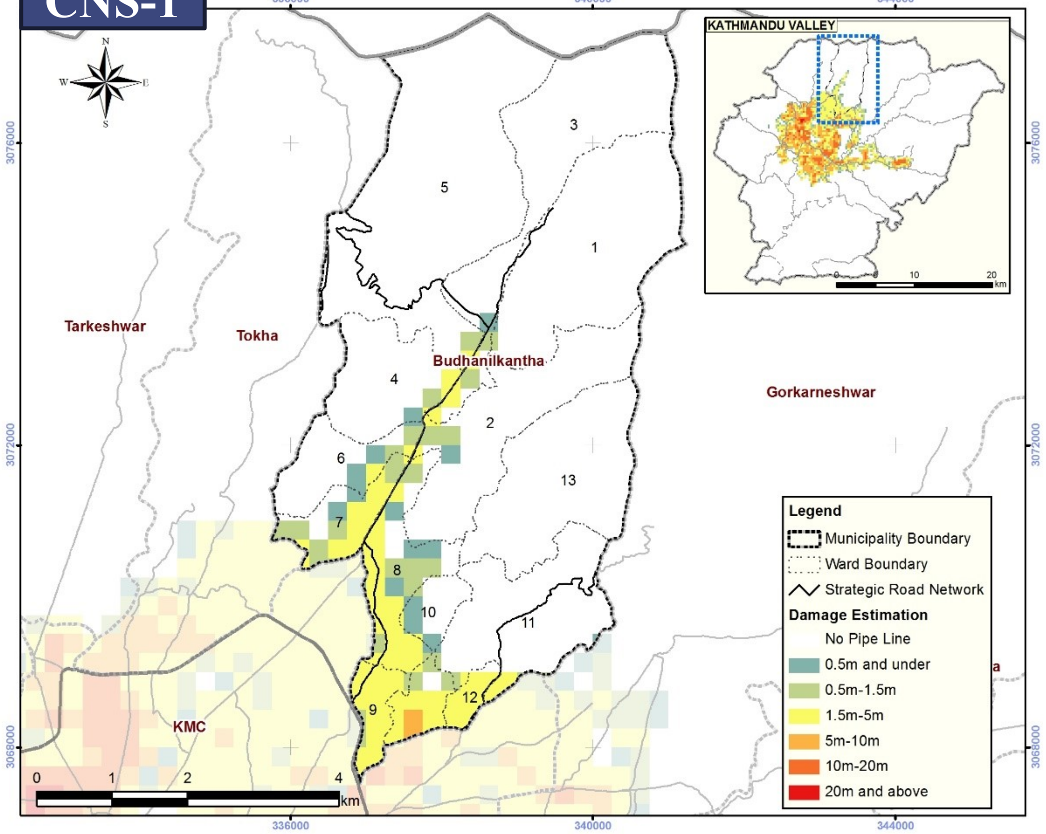
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ............................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

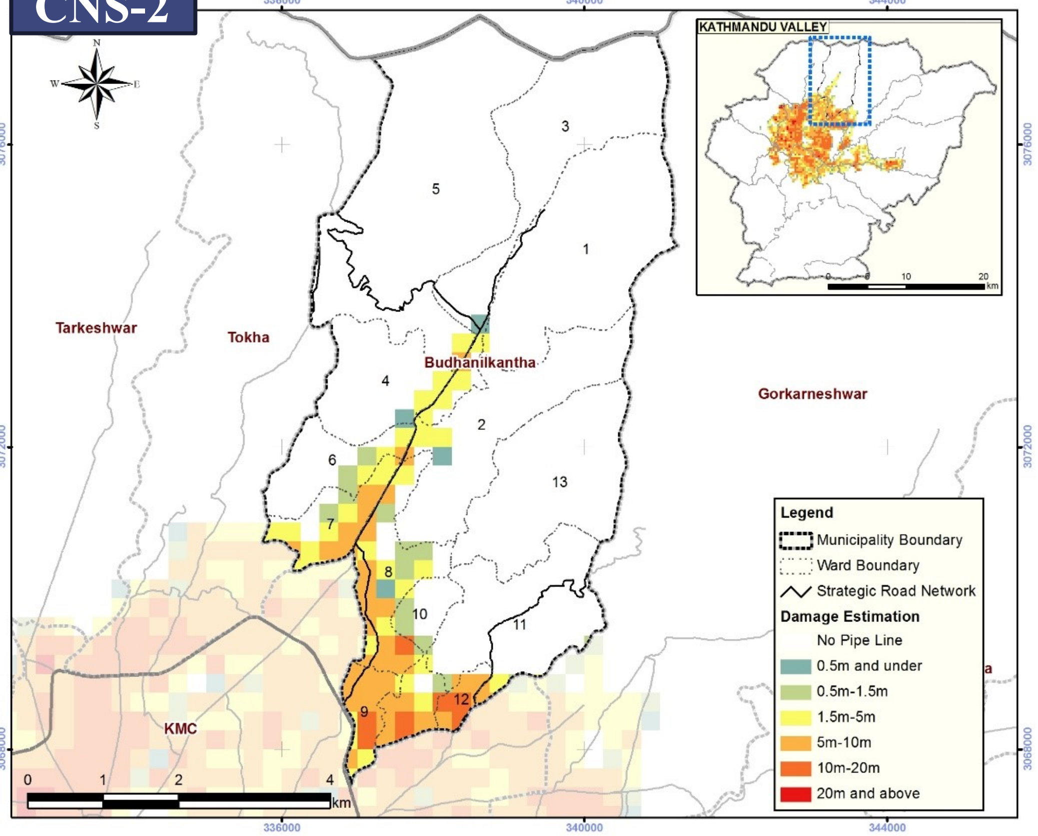
WN



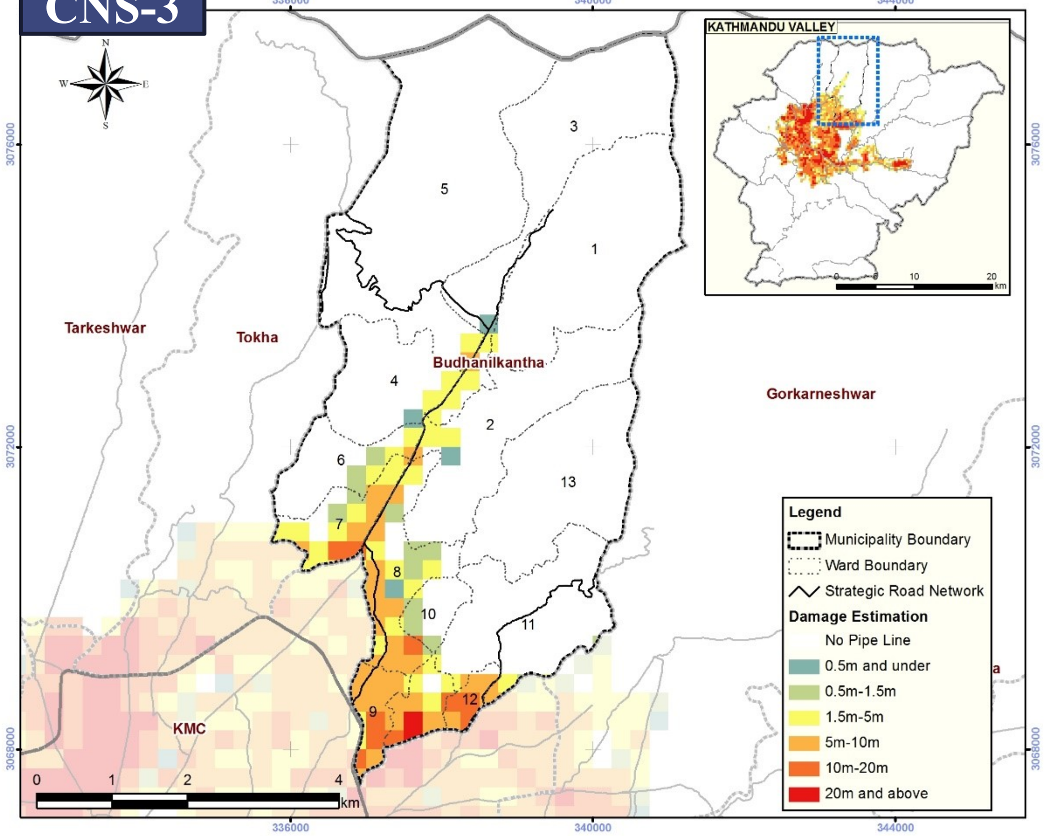

CNS-1




CNS-2




CNS-3




# C-25

## Distribution of Sewage Network Damage

**Note:**

- It is known that sewage pipelines and manholes tend to lift up when the surrounding ground liquefies, as the pipeline is almost empty if not in the case of full flow. On the other hand, since there is no inside pressure, the damage tendency of the sewage pipeline and water supply pipeline are completely different. The damage of sewage pipeline was estimated for damage length, rather than damage points like water supply pipeline.
- Sewage pipeline data was obtained from KUKL. It has a total length of 43.6 km and distributed mainly in urban area.
- The estimation was carried out in grid wise and the results are as below.

| Scenario ground motion | Damage Length (km) | Damage ratio |
|---|---|---|
| WN | 0.2 | 0.4% |
| CNS-1 | 0.2 | 0.4% |
| CNS-2 | 0.4 | 0.9% |
| CNS-3 | 0.5 | 1.0% |

**Source:**

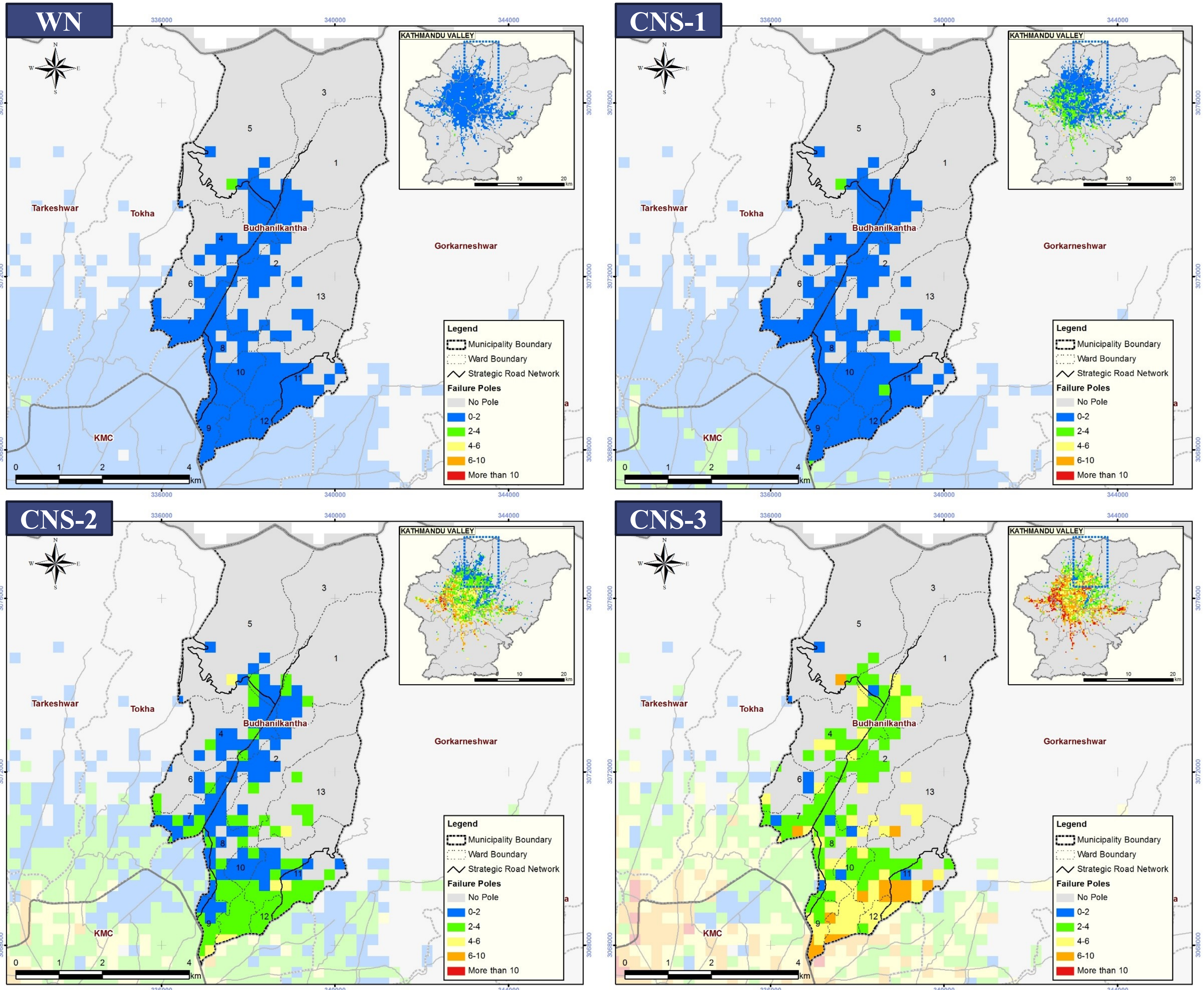
- Result of pipeline damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# C-26

# Distribution of Power Pole Damage

**Note:**

- Seismic risk assessment of power system in Japan is generally carried out for power distribution network through the damage estimating of power pole and the number of blackouts is evaluated from the breakage rate of utility poles in the power distribution area. The damage of power pole was estimated considering two reasons, i.e. (1) damage directly caused by ground motion and (2) damage caused indirectly by the damage of buildings.
- There is no data available for power pole distribution in KV. So it was estimated based on some assumptions and making use of the road network information and the relation between the road and the density of the power pole.
- The estimation was carried out in grid wise and the results are as below.

| Scenario ground motion | Number of pole damage | Ratio of pole damage |
|---|---|---|
| WN | 66 | 0.5% |
| CNS-1 | 108 | 0.8% |
| CNS-2 | 344 | 2.5% |
| CNS-3 | 655 | 4.7% |

**Source:**

- Result of power pole damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: .......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

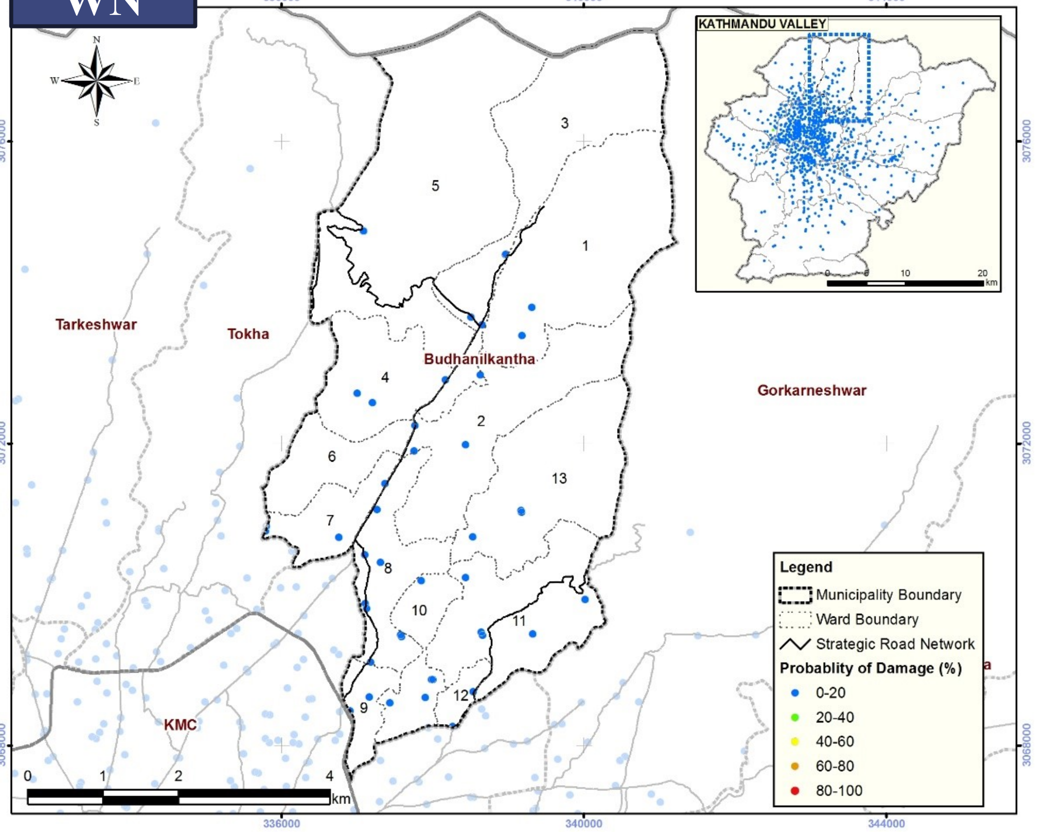
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

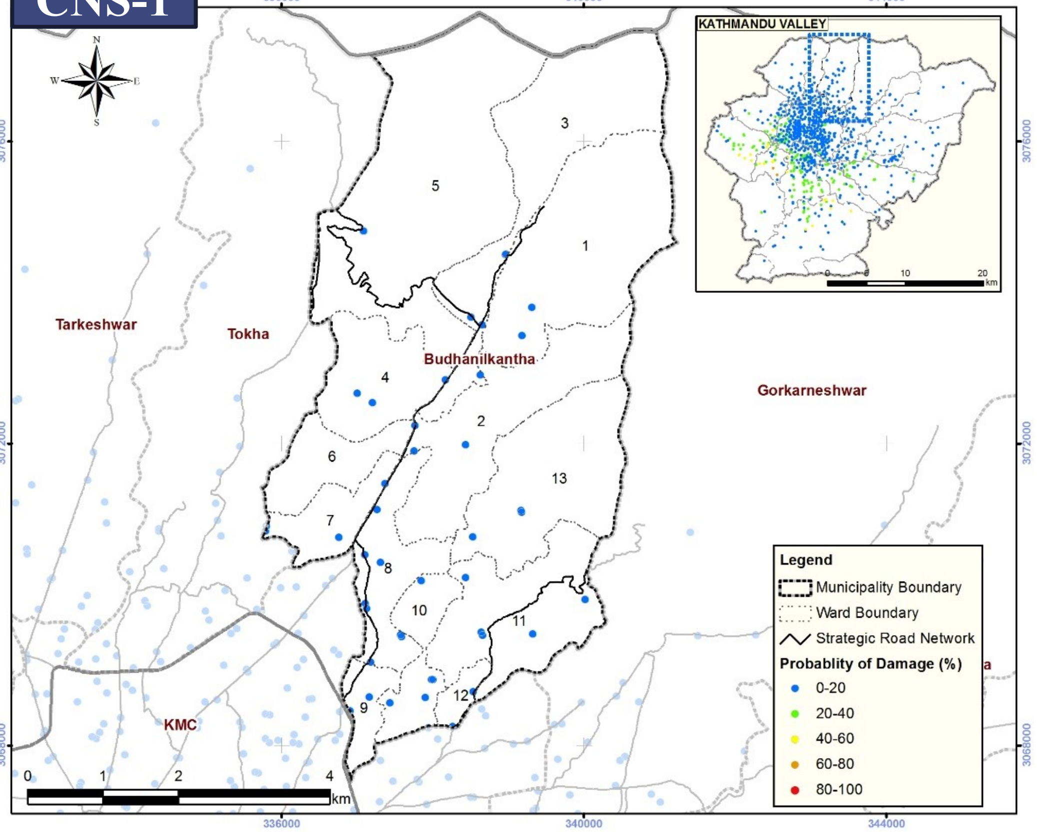
# C-27

## Distribution of Mobile BTS Tower Damage

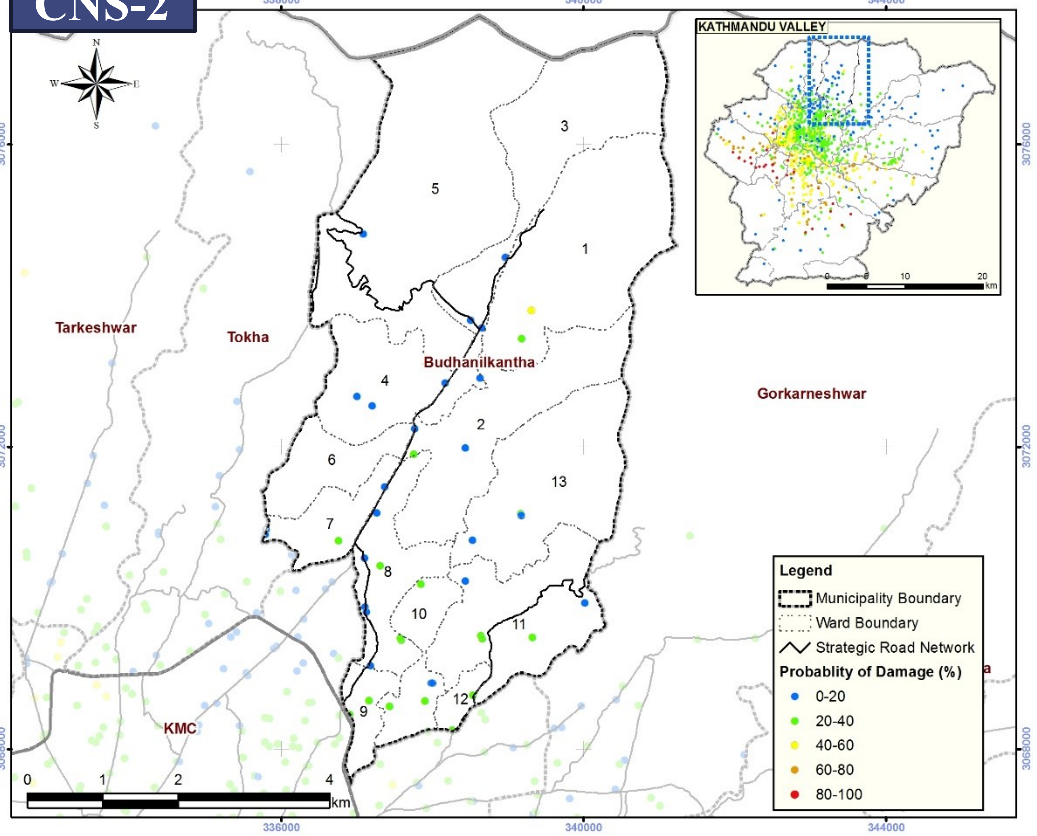
**WN**



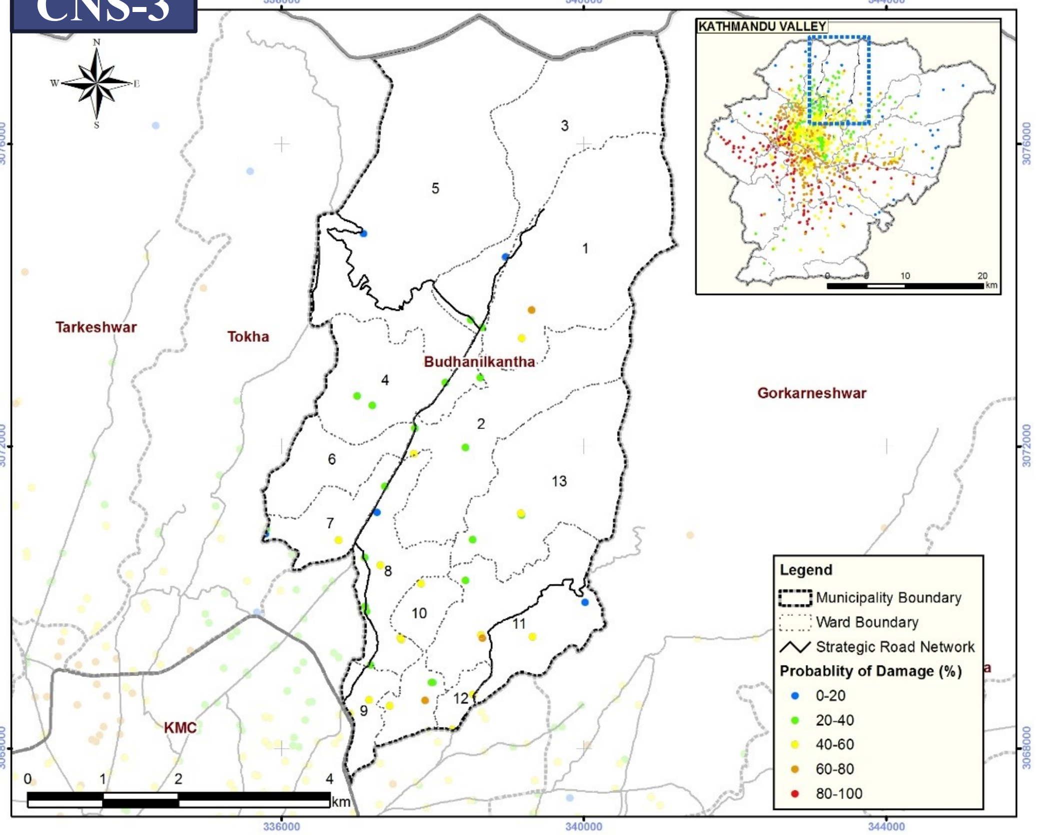

**CNS-1**




**CNS-2**




**CNS-3**




**Note:**

- Mobile BTS tower is the target of risk assessment for telecommunication system in this project. If BTS tower is constructed on ground, the damage of tower will be estimated by damage function of itself. As a matter of factor, the majority of BTS tower are installed on the roof of building. In this case, the damage of BTS was estimated by combining the damage function of building and tower. In this way, the damage probability of BTS was estimated for each BTS tower.
- There are a total of 48 BTS towers in Budhanilkantha Municipality. For the purpose of damage assessment, all of the buildings for roof top BTS has been surveyed and the building structure type was confirmed.
- The damage of BTS, including damage of building, is as below.

| Scenario ground motion | Number of BTS damage | Ratio of BTS damage |
|---|---|---|
| WN | 2 | 4.2% |
| CNS-1 | 2 | 4.2% |
| CNS-2 | 8 | 16.7% |
| CNS-3 | 18 | 37.5% |

**Source:**

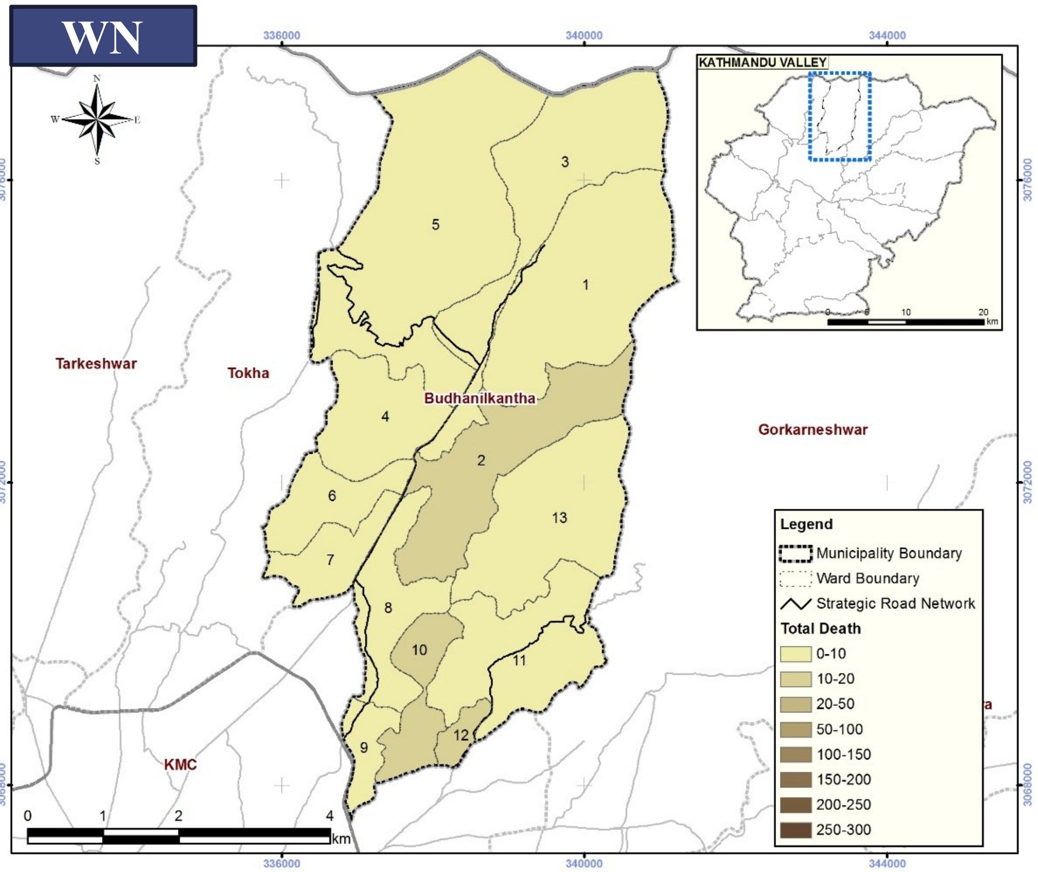
- Result of BTS tower damage: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD
- Road Network: DoR, DoLIDAR

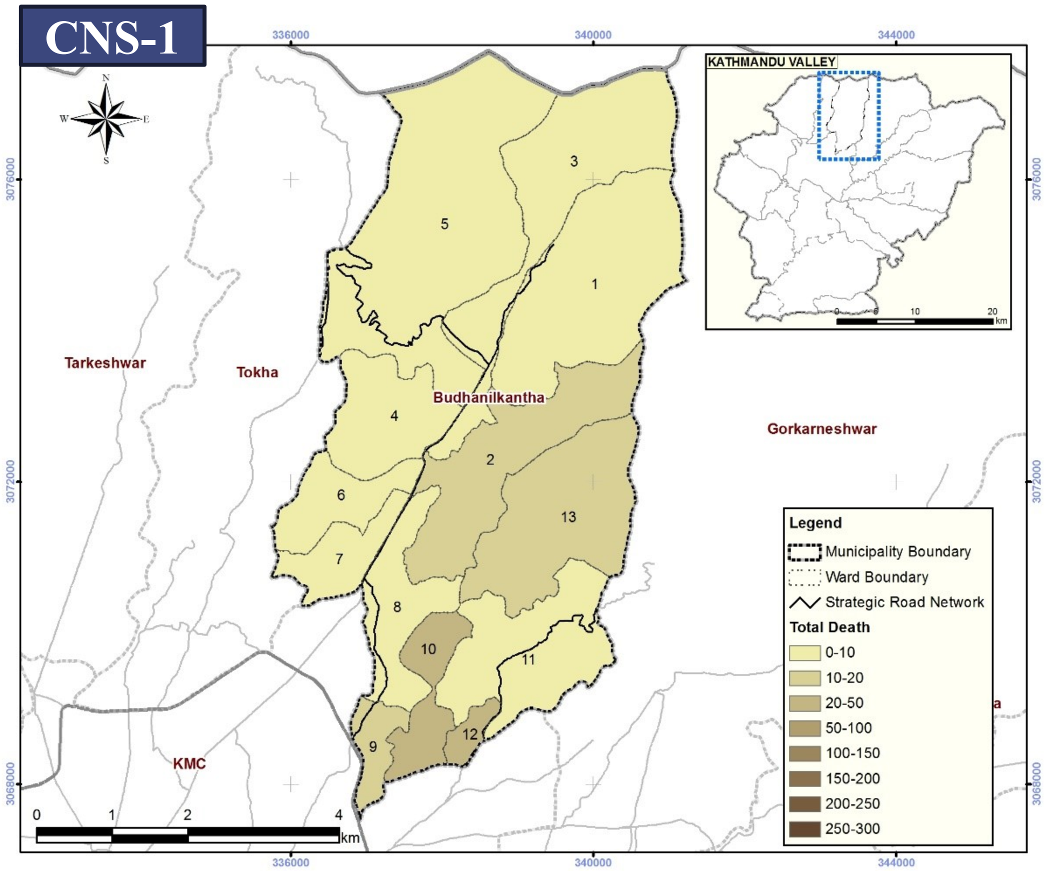
WGS_1984_UTM_Zone_45N

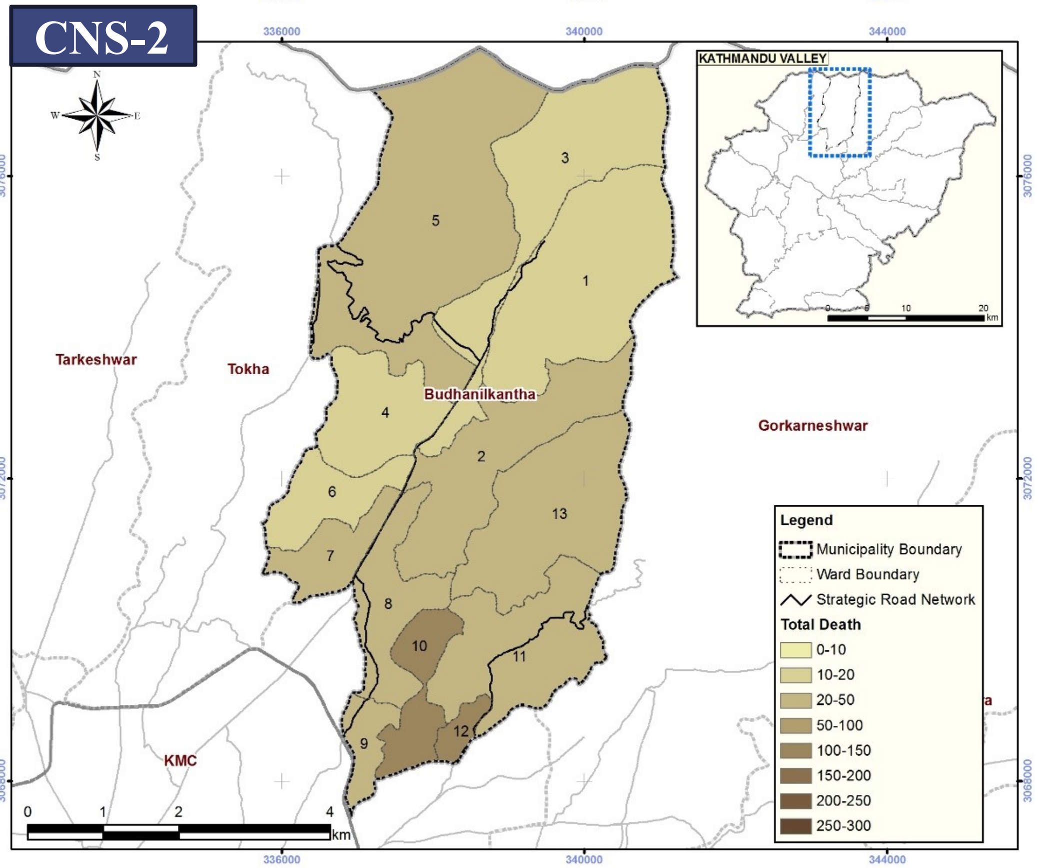
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

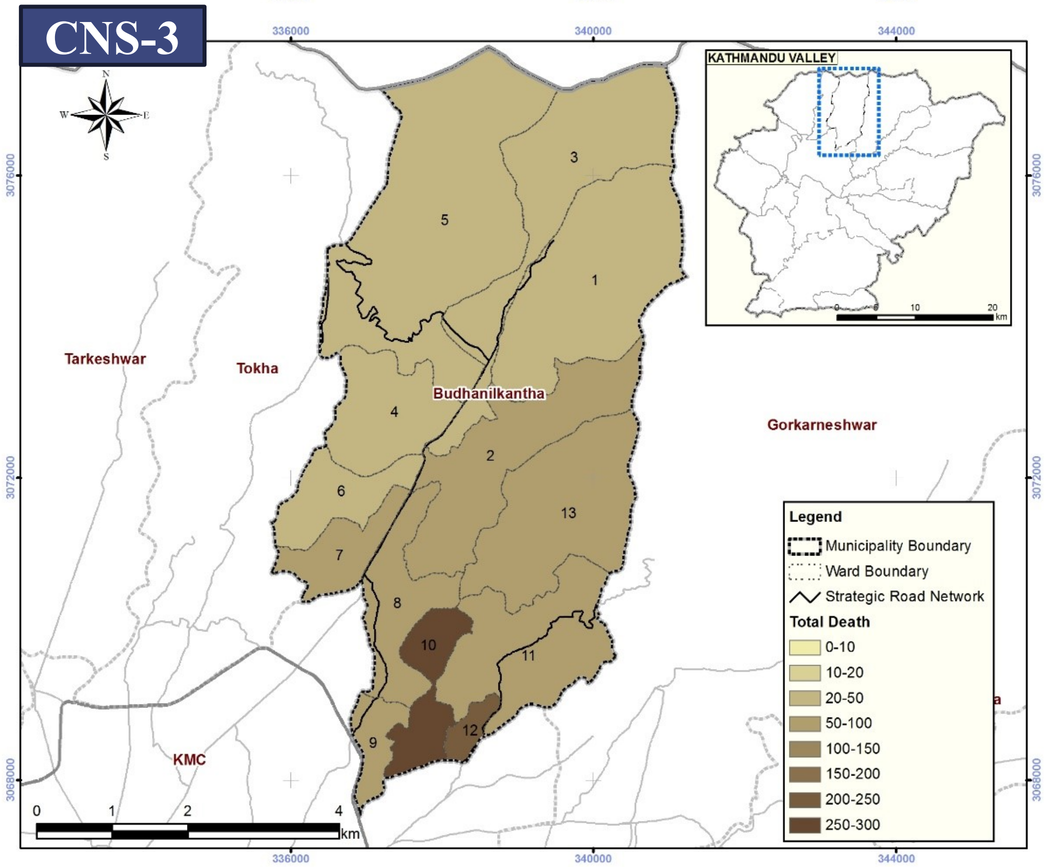
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# C-28

## Distribution of Death in 2016 at Night

**Note:**

- Possible death due to the Scenario ground motions was evaluated based on the relationship derived from the human casualty and building damage data of Gorkha earthquake. The factors of different building damage level (EMS damage level 4 and 5), different building structure type (masonry and RC building) as well as the people inside building when earthquake happens (inside building ratio), which were confirmed could affect death estimation from Gorkha earthquake data, were considered in the formula of death estimation.
- In order to consider different inside building ratio for different time and different day, the death estimation was carried out for three scenes, i.e. night (100% inside), weekday noon (90% inside) and weekend afternoon (70% inside). The total population of Budhanilkantha Municipality is 129,708.
- The death for scene of night is estimated as below.

| Scenario ground motion | Number of death | Ratio of death |
|---|---|---|
| WN | 92 | 0.07% |
| CNS-1 | 158 | 0.12% |
| CNS-2 | 545 | 0.42% |
| CNS-3 | 1,109 | 0.85% |

**Source:**

- Result of death estimation: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD

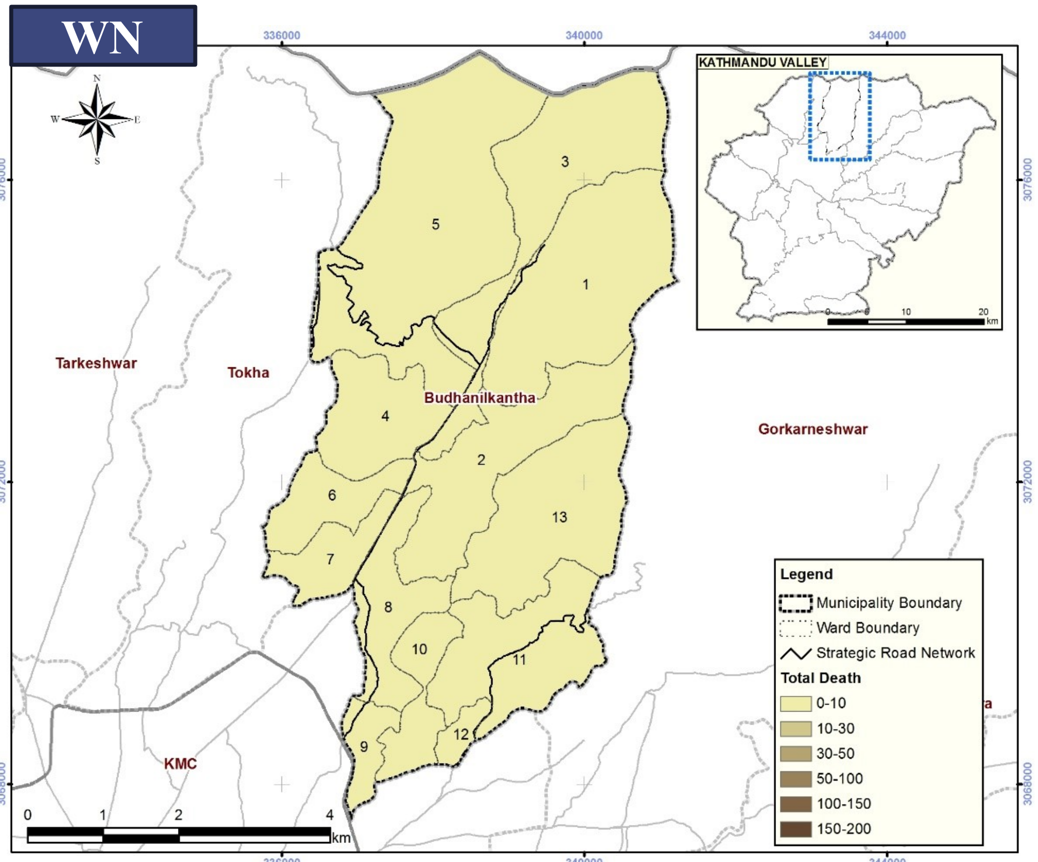
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ..................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

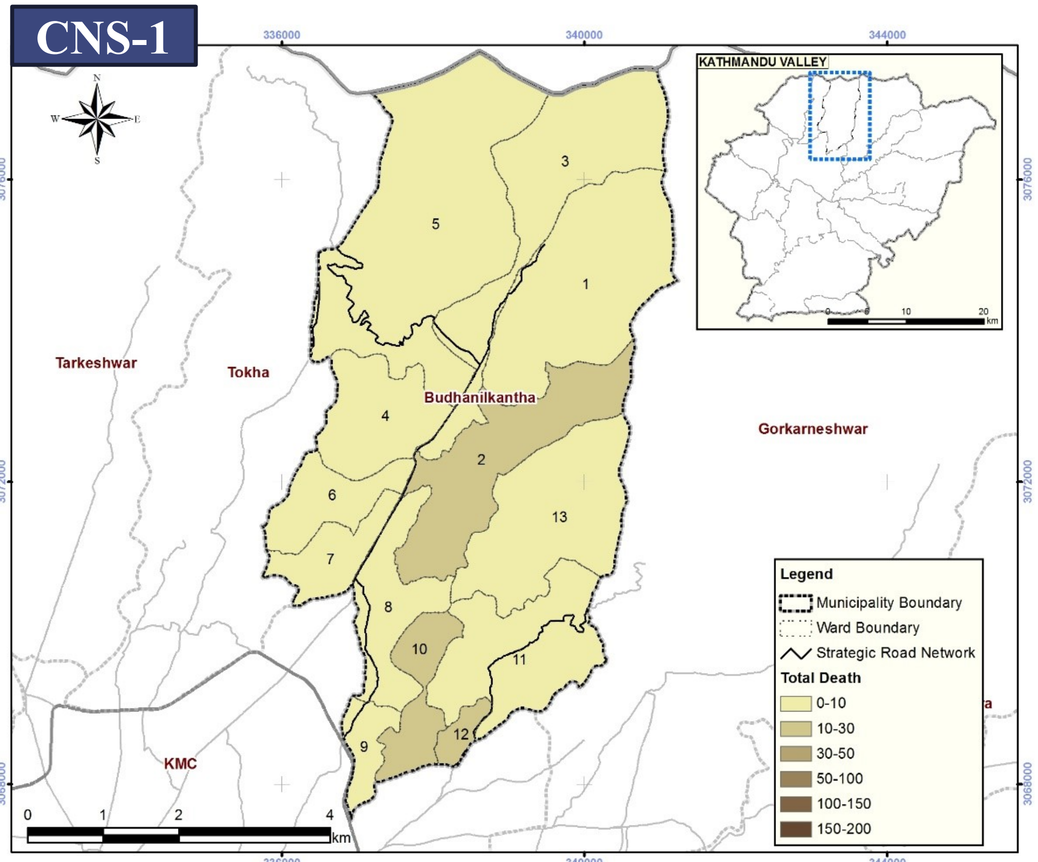
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ...........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

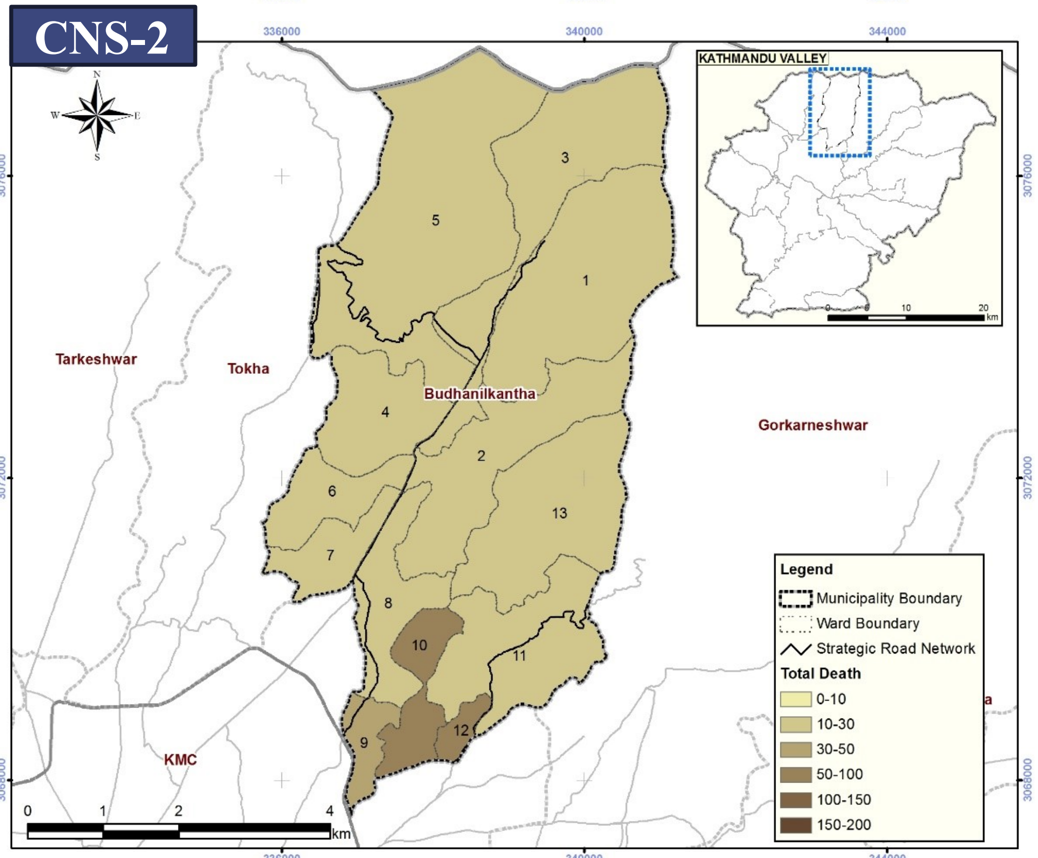
WN



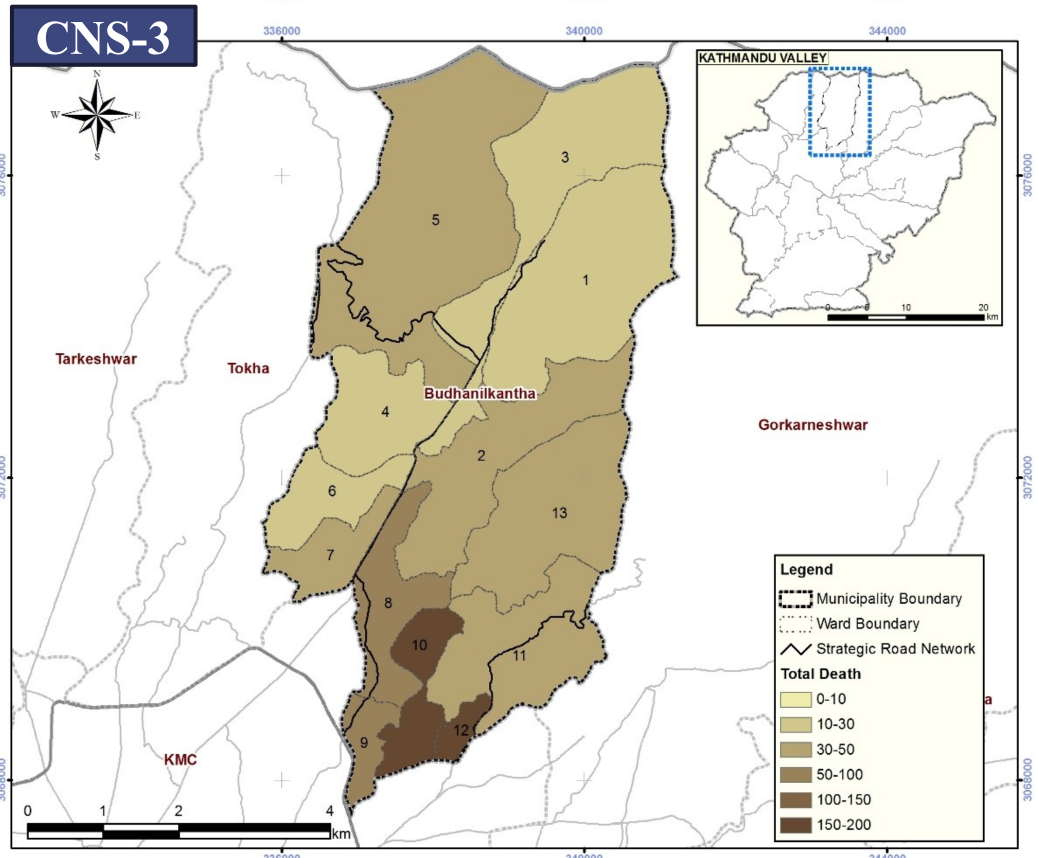

CNS-1




CNS-2




CNS-3




# C-29

# Distribution of Death in 2016 at Weekday Noon

**Note:**

- Possible death for Scenario ground motions was evaluated based on the relationship derived from the human casualty and building damage data of Gorkha earthquake. The factors of different building damage level (EMS damage level 4 and 5), different building structure type (masonry and RC building) as well as the people inside building when earthquake happens (inside building ratio), which were confirmed could affect death estimation from Gorkha earthquake data, were considered in the formula of death estimation.
- In order to consider different inside building ratio for different time and different day, the death estimation was carried out for three scenes, i.e. night (100% inside), weekday noon (90% inside) and weekend afternoon (70% inside). The total population of Budhanilkantha Municipality is 101,436.
- The death for scene of weekday noon is estimated as below.

| Scenario ground motion | Number of death | Ratio of death |
|---|---|---|
| WN | 65 | 0.06% |
| CNS-1 | 111 | 0.11% |
| CNS-2 | 384 | 0.38% |
| CNS-3 | 782 | 0.77% |

**Source:**

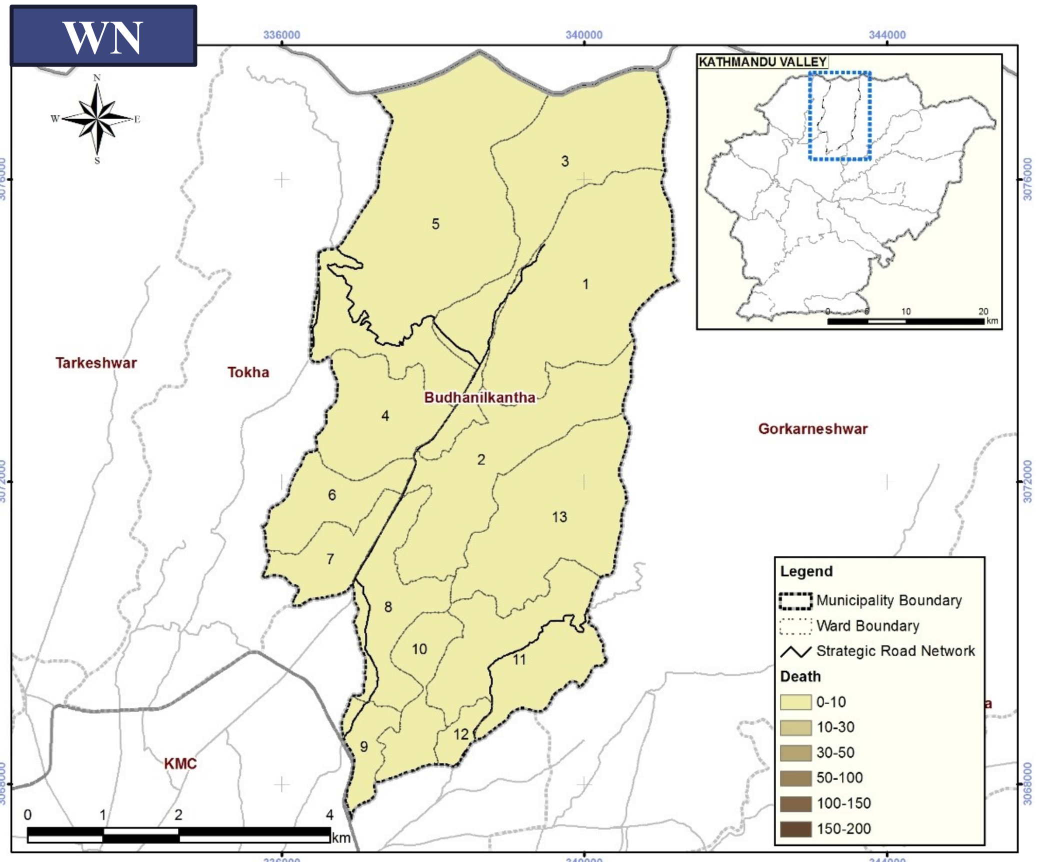
- Result of death estimation: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD

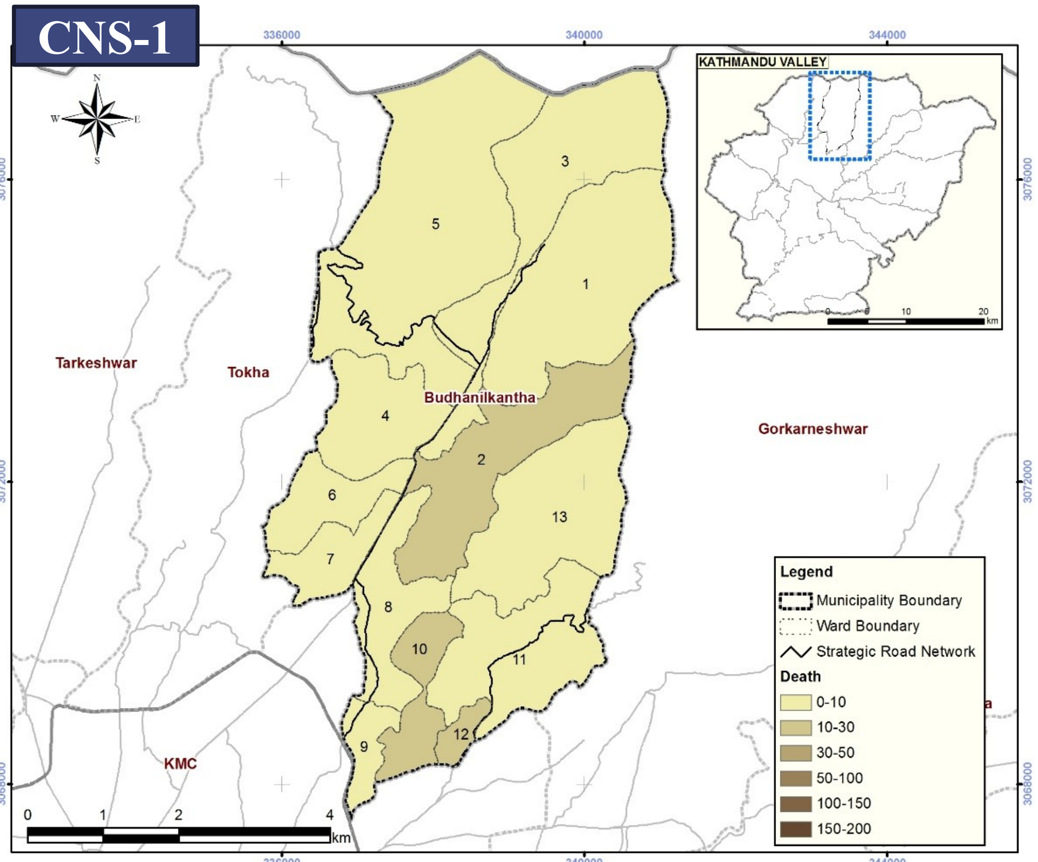
WGS_1984_UTM_Zone_45N

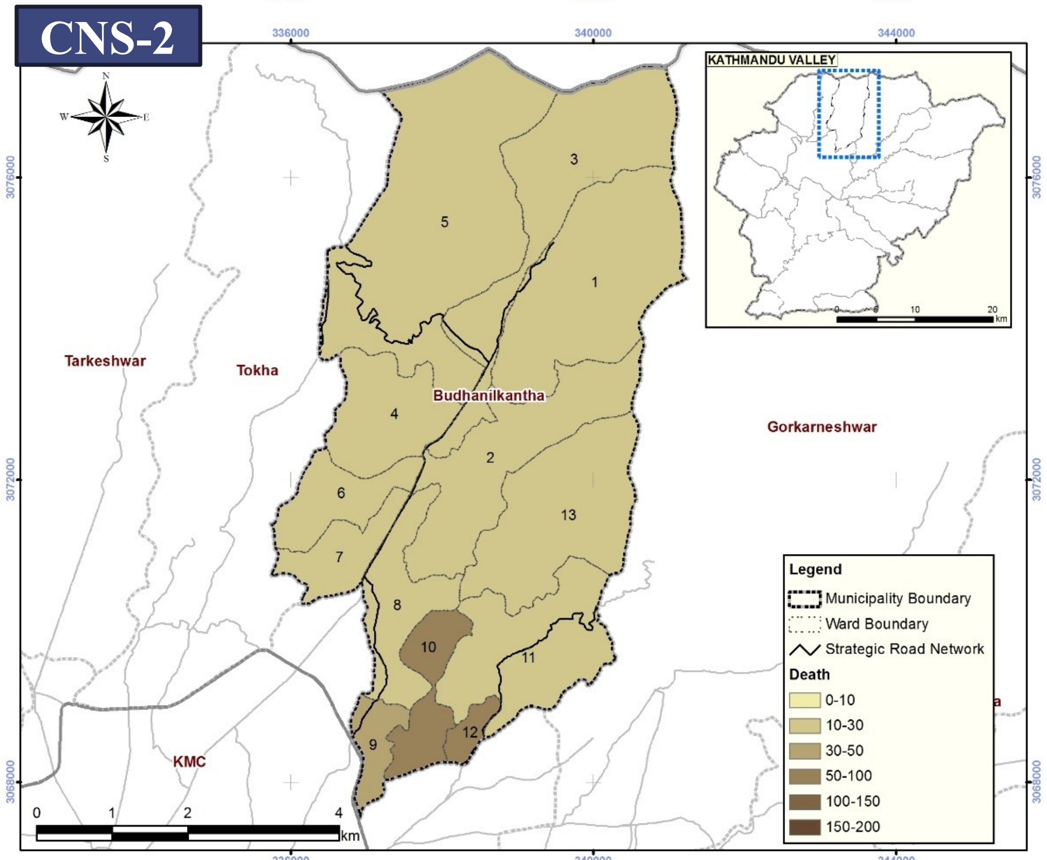
Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

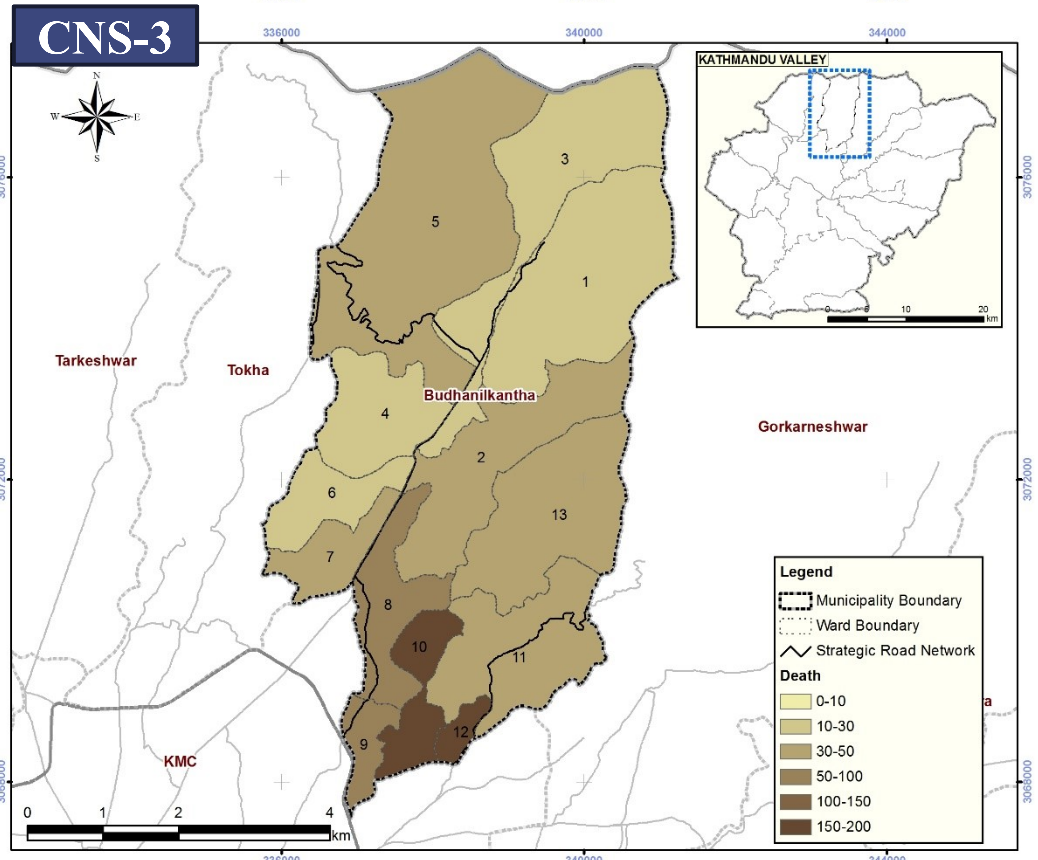
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal




# C-30

# Distribution of Death in 2016 at Weekend Afternoon

**Note:**

- Possible death for Scenario ground motions was evaluated based on the relationship derived from the human casualty and building damage data of Gorkha earthquake. The factors of different building damage level (EMS damage level 4 and 5), different building structure type (masonry and RC building) as well as the people inside building when earthquake happens (inside building ratio), which were confirmed could affect death estimation from Gorkha earthquake data, were considered in the formula of death estimation.
- In order to consider different inside building ratio for different time and different day, the death estimation was carried out for three scenes, i.e. night (100% inside), weekday noon (90% inside) and weekend afternoon (70% inside). The total population of Budhanilkantha Municipality is 129,708.
- The death for scene of weekend afternoon is estimated as below.

| Scenario ground motion | Number of death | Ratio of death |
|---|---|---|
| WN | 65 | 0.05% |
| CNS-1 | 111 | 0.09% |
| CNS-2 | 381 | 0.29% |
| CNS-3 | 776 | 0.60% |

**Source:**

- Result of death estimation: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD

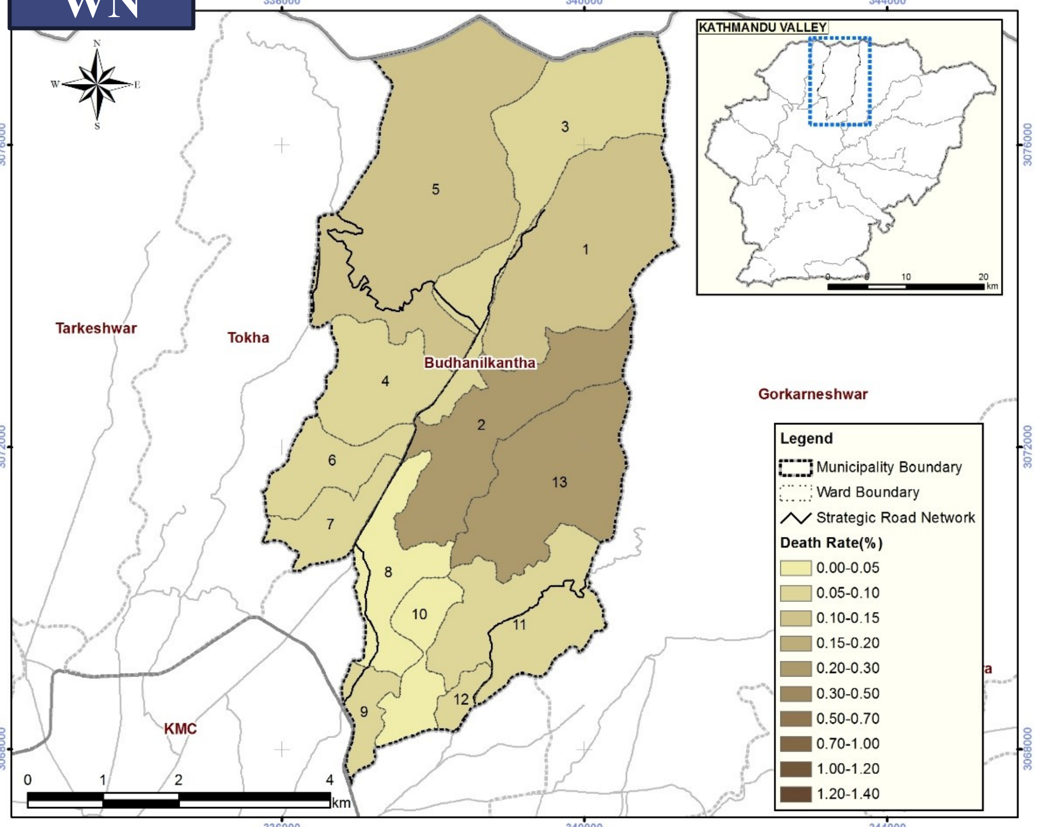
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ................87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

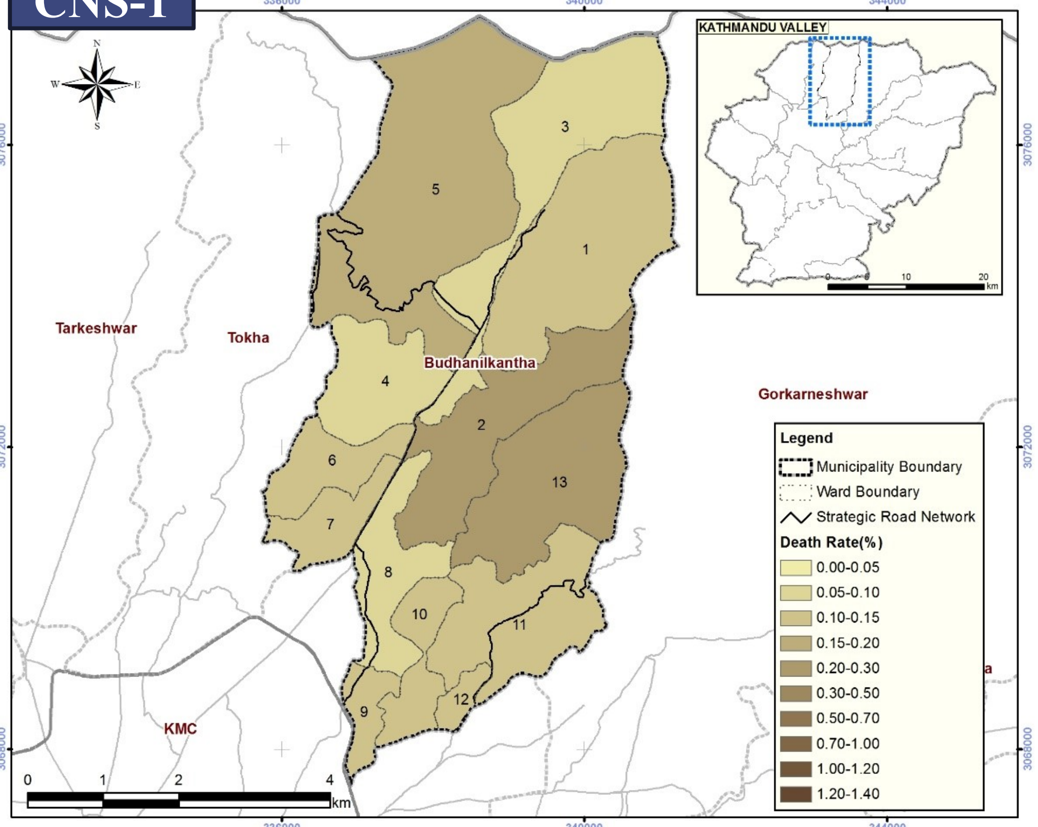
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

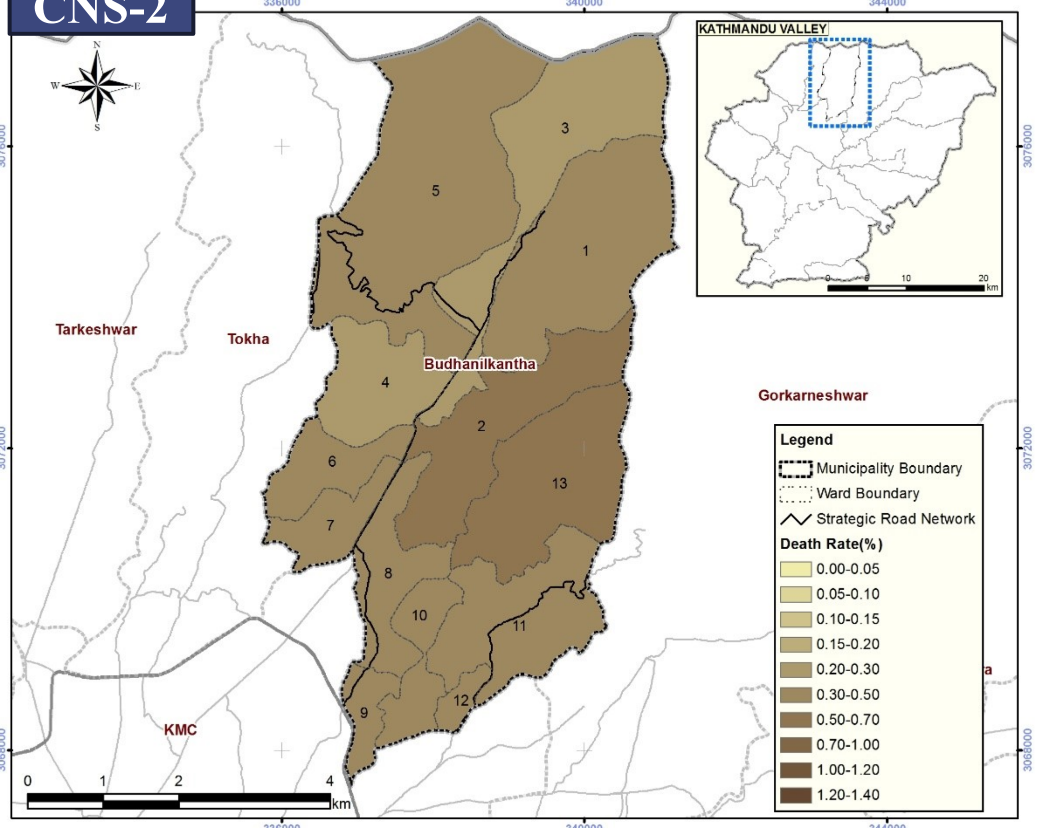
**WN**



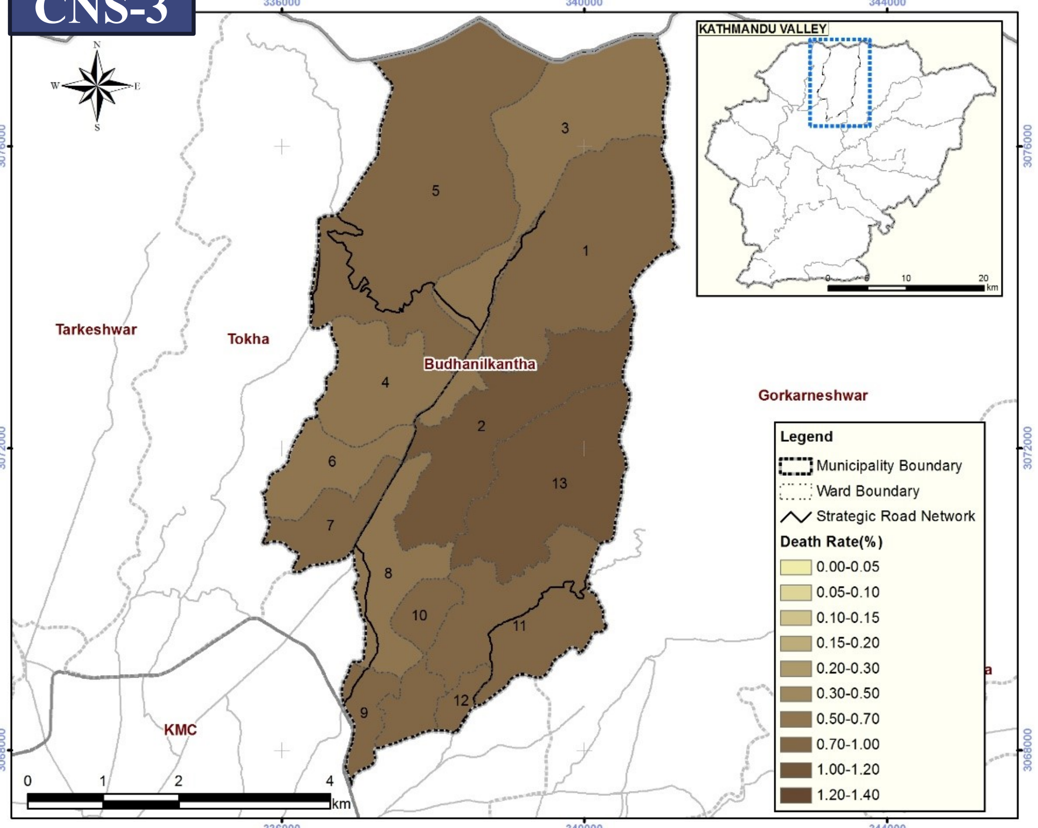

**CNS-1**




**CNS-2**




**CNS-3**




# C-31

# Distribution of Death Ratio in 2016 at Night

**Note:**

- Possible death for Scenario ground motions was evaluated based on the relationship derived from the human casualty and building damage data of Gorkha earthquake. The factors of different building damage level (EMS damage level 4 and 5), different building structure type (masonry and RC building) as well as the people inside building when earthquake happens (inside building ratio), which were confirmed could affect death estimation from Gorkha earthquake data, were considered in the formula of death estimation.
- In order to consider different inside building ratio for different time and different day, the death estimation was carried out for three scenes, i.e. night (100% inside), weekday noon (90% inside) and weekend afternoon (70% inside). The total population of Budhanilkantha Municipality is 129,708.
- The death for scene of night is estimated as below.

| Scenario ground motion | Number of death | Ratio of death |
|---|---|---|
| WN | 92 | 0.07% |
| CNS-1 | 158 | 0.12% |
| CNS-2 | 545 | 0.42% |
| CNS-3 | 1,109 | 0.85% |

**Source:**

- Result of death estimation: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD

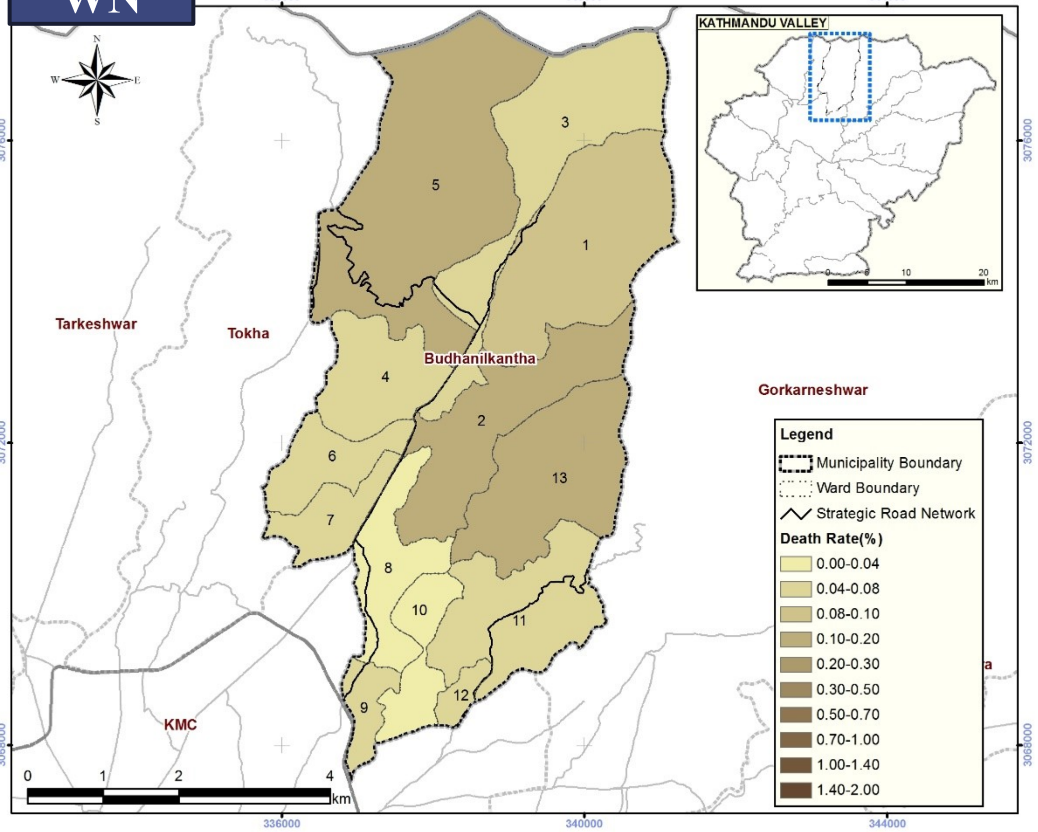
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: ............500000.0
false_northing: ......................0.0
central_meridian: ...............87.0
scale_factor: ..................0.9996
latitude_of_origin:................ 0.0
Linear Unit: Meter (1.0)

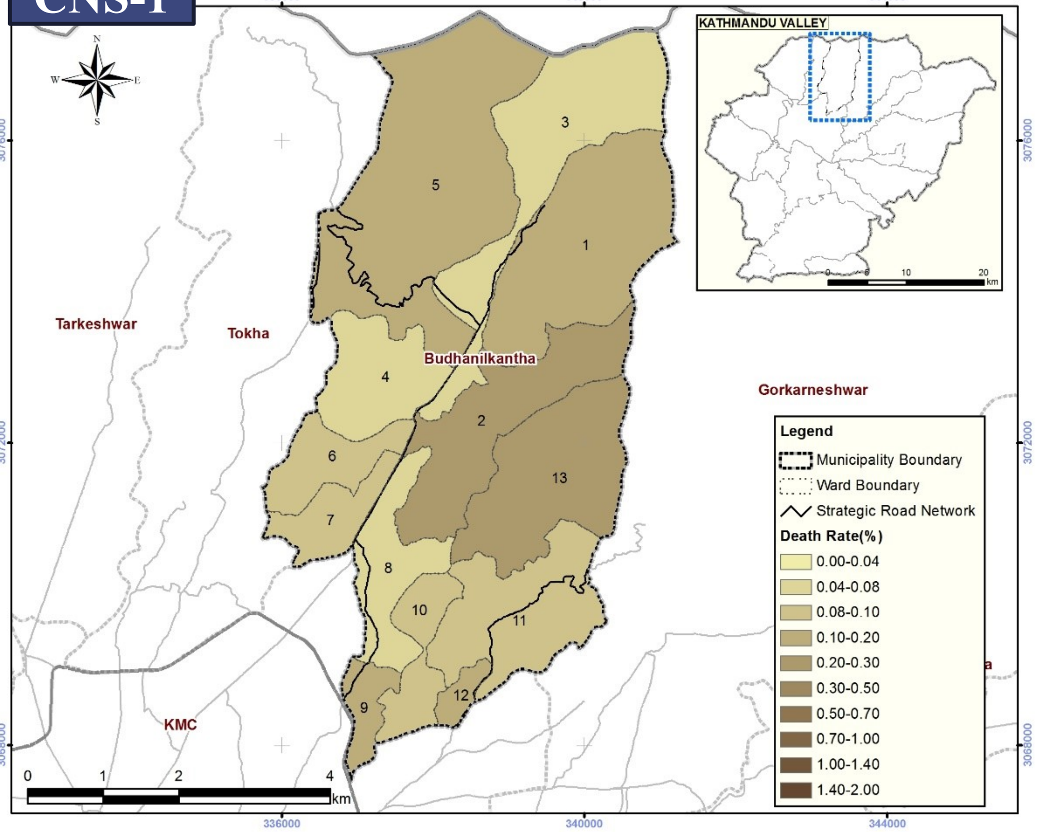
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: ............................Greenwich (0.0)
Datum: ..........................................D_WGS_1984
Spheroid: ..........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

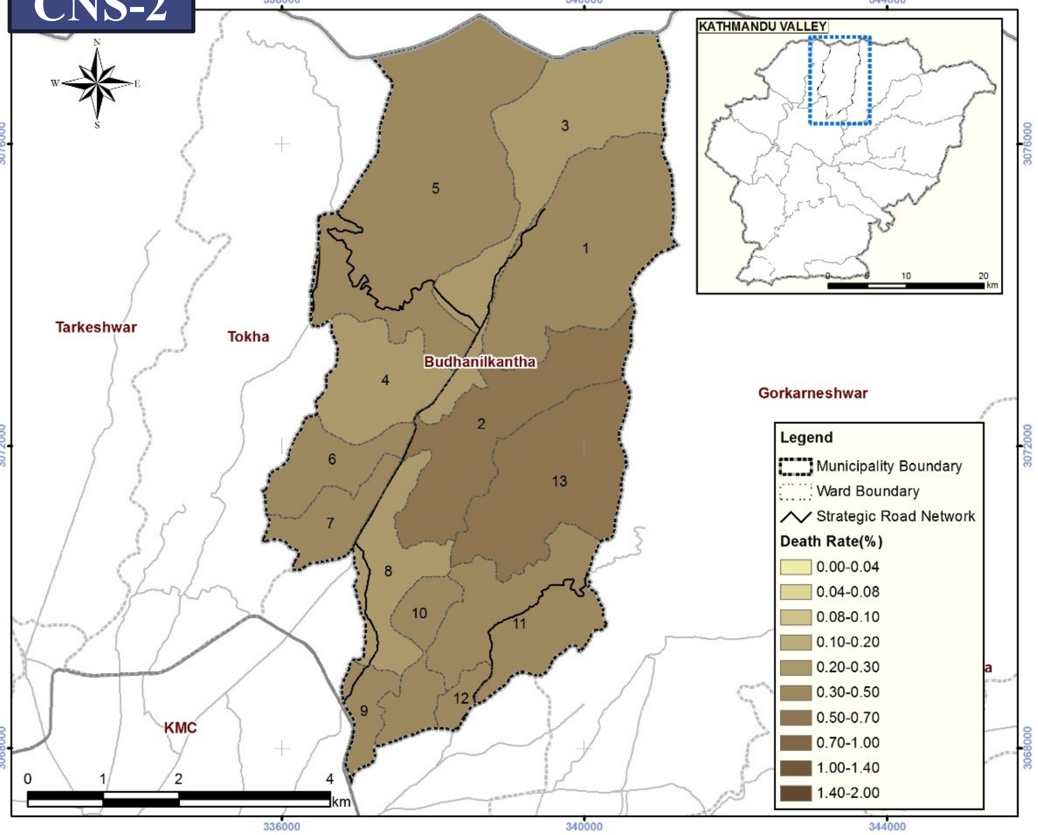
WN



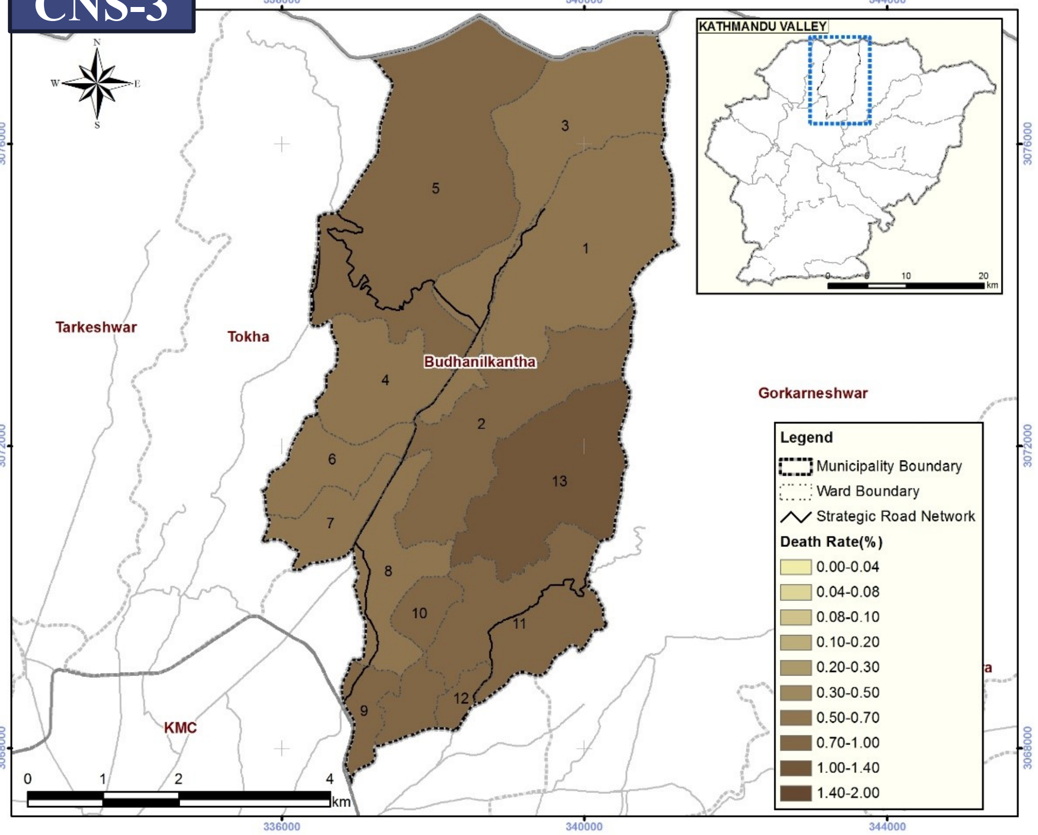

CNS-1




CNS-2




CNS-3




# C-32

## Distribution of Death Ratio in 2016 at Weekday Noon

**Note:**

- Possible death for Scenario ground motions was evaluated based on the relationship derived from the human casualty and building damage data of Gorkha earthquake. The factors of different building damage level (EMS damage level 4 and 5), different building structure type (masonry and RC building) as well as the people inside building when earthquake happens (inside building ratio), which were confirmed could affect death estimation from Gorkha earthquake data, were considered in the formula of death estimation.
- In order to consider different inside building ratio for different time and different day, the death estimation was carried out for three scenes, i.e. night (100% inside), weekday noon (90% inside) and weekend afternoon (70% inside). The total population of Budhanilkantha Municipality is 101,436.
- The death for scene of weekday noon is estimated as below.

| Scenario ground motion | Number of death | Ratio of death |
|---|---|---|
| WN | 65 | 0.06% |
| CNS-1 | 111 | 0.11% |
| CNS-2 | 384 | 0.38% |
| CNS-3 | 782 | 0.77% |

**Source:**

- Result of death estimation: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD

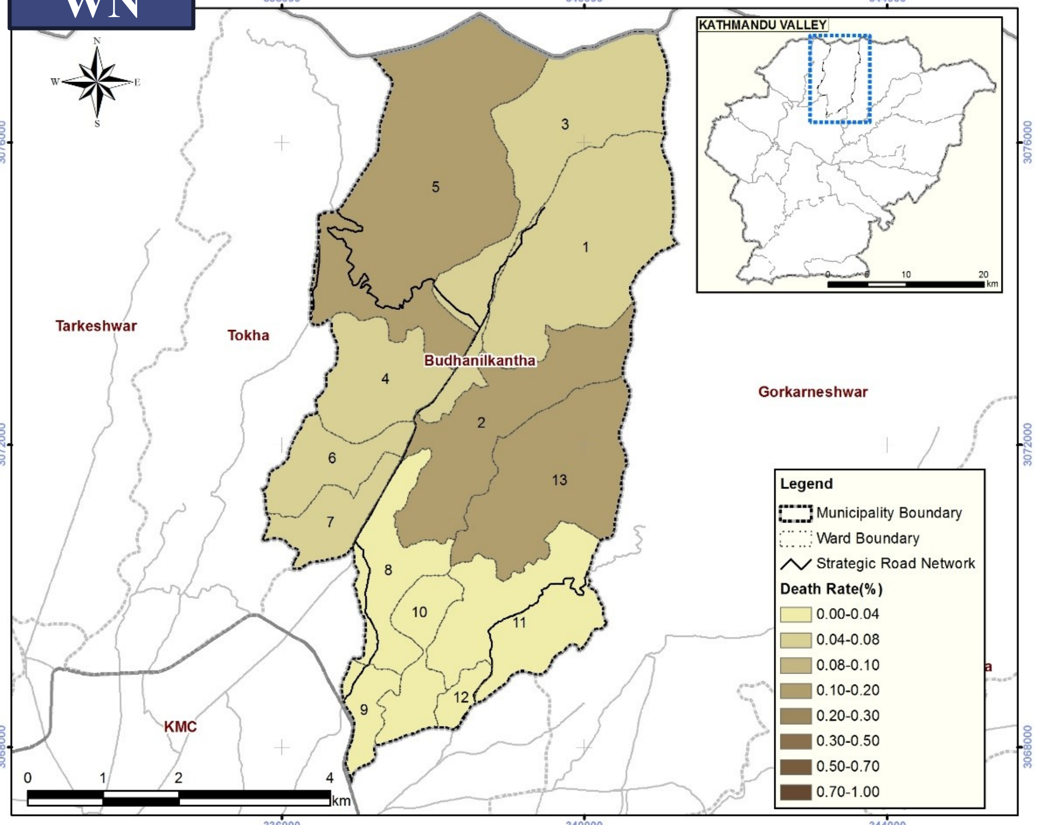
WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ...............87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

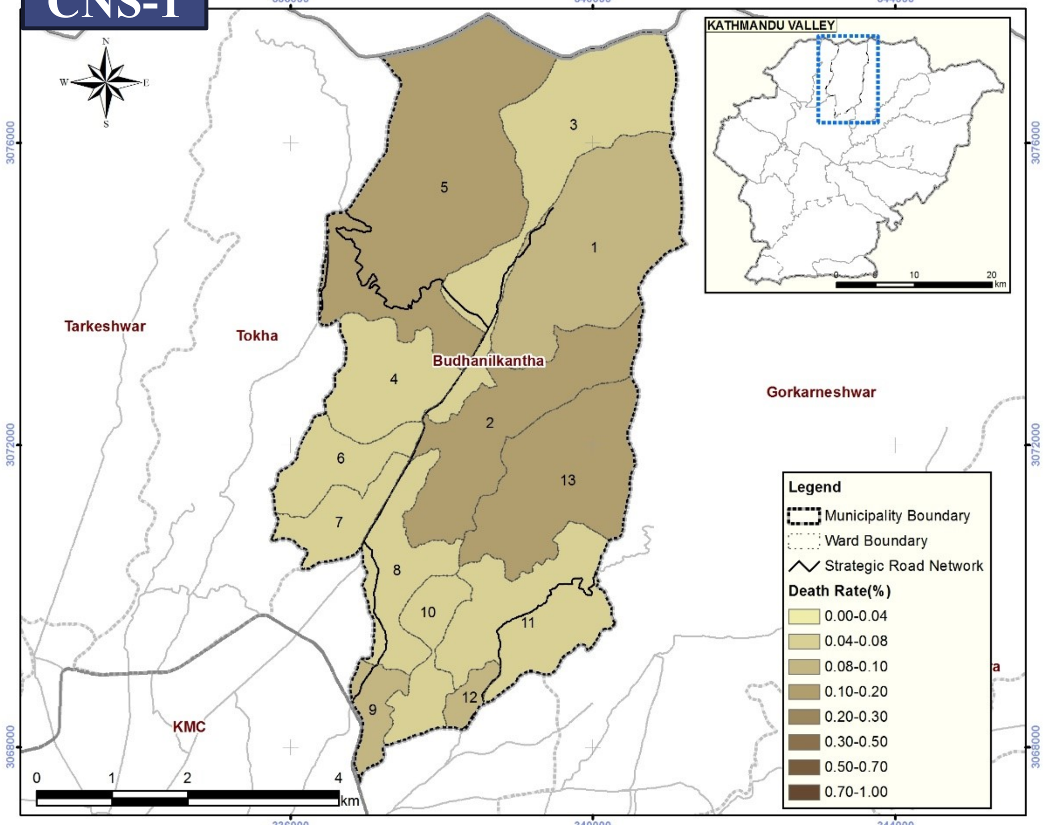
Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ............................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

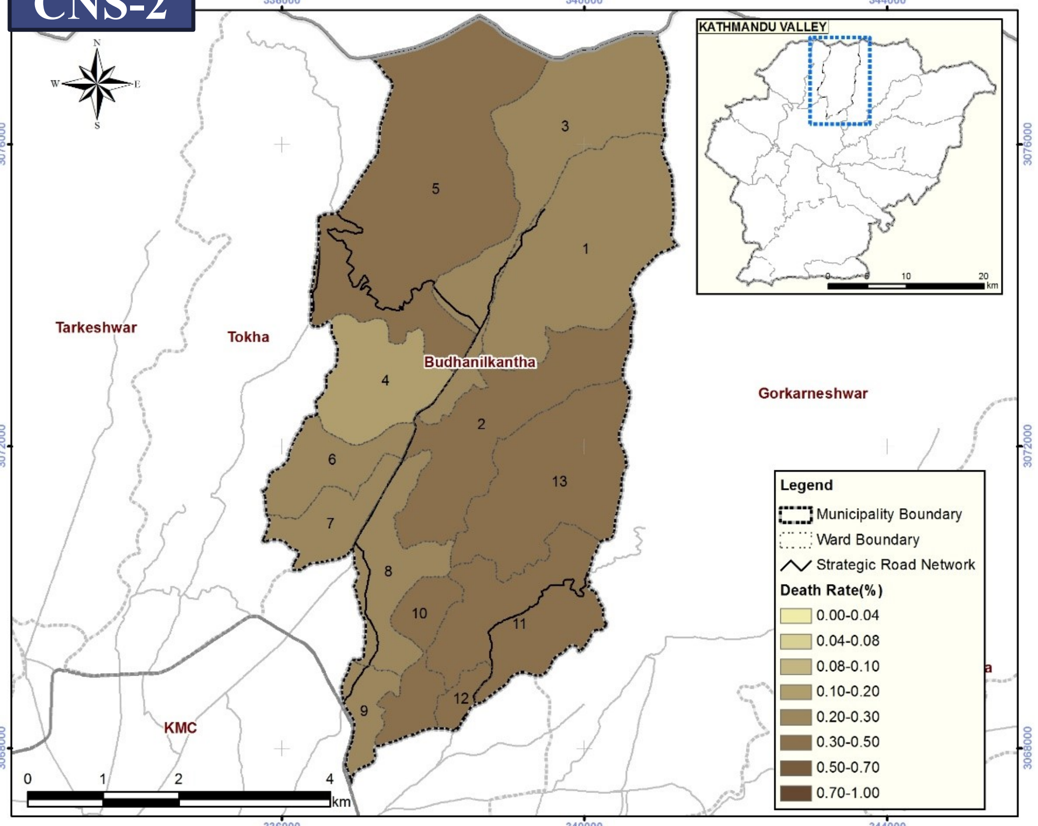
WN



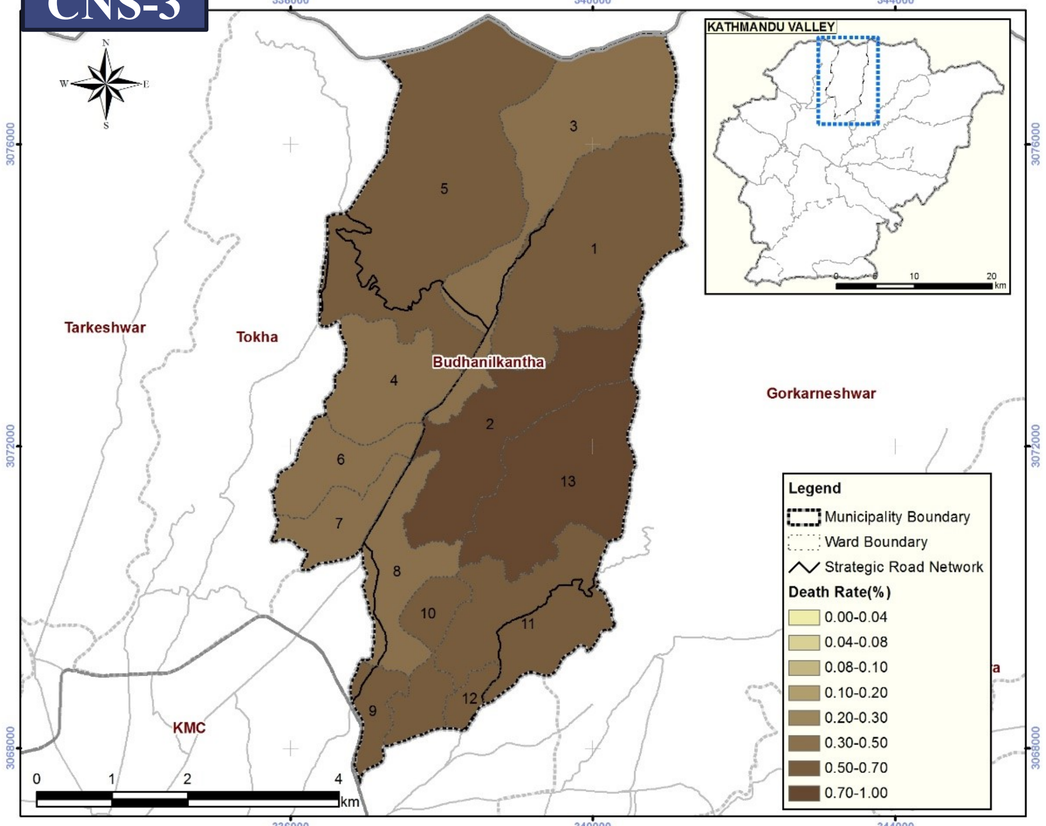

CNS-1




CNS-2




CNS-3




# C-33

# Distribution of Death Ratio in 2016 at Weekend Afternoon

**Note:**

- Possible death for Scenario ground motions was evaluated based on the relationship derived from the human casualty and building damage data of Gorkha earthquake. The factors of different building damage level (EMS damage level 4 and 5), different building structure type (masonry and RC building) as well as the people inside building when earthquake happens (inside building ratio), which were confirmed could affect death estimation from Gorkha earthquake data, were considered in the formula of death estimation.
- In order to consider different inside building ratio for different time and different day, the death estimation was carried out for three scenes, i.e. night (100% inside), weekday noon (90% inside) and weekend afternoon (70% inside). The total population of Budhanilkantha Municipality is 129,708.
- The death for scene of weekend afternoon is estimated as below.

| Scenario ground motion | Number of death | Ratio of death |
|---|---|---|
| WN | 65 | 0.05% |
| CNS-1 | 111 | 0.09% |
| CNS-2 | 381 | 0.29% |
| CNS-3 | 776 | 0.60% |

**Source:**

- Result of death estimation: ERAKV 2017
- Boundary of Municipality: DoS, MoFALD

WGS_1984_UTM_Zone_45N

Projection: Transverse_Mercator
false_easting: .............500000.0
false_northing: .......................0.0
central_meridian: ................87.0
scale_factor: ...................0.9996
latitude_of_origin:................. 0.0
Linear Unit: Meter (1.0)

Geographic Coordinate System: GCS_WGS_1984
Angular Unit: Degree ........(0.0174532925199433)
Prime Meridian: .............................Greenwich (0.0)
Datum: ..............................................D_WGS_1984
Spheroid: ...........................................WGS_1984

The Project for Assessment of
EARTHQUAKE DISASTER RISK
for the Kathmandu Valley in Nepal

Prepared By:

The Project for Assessment of

**EARTHQUAKE DISASTER RISK**

for the Kathmandu Valley in Nepal