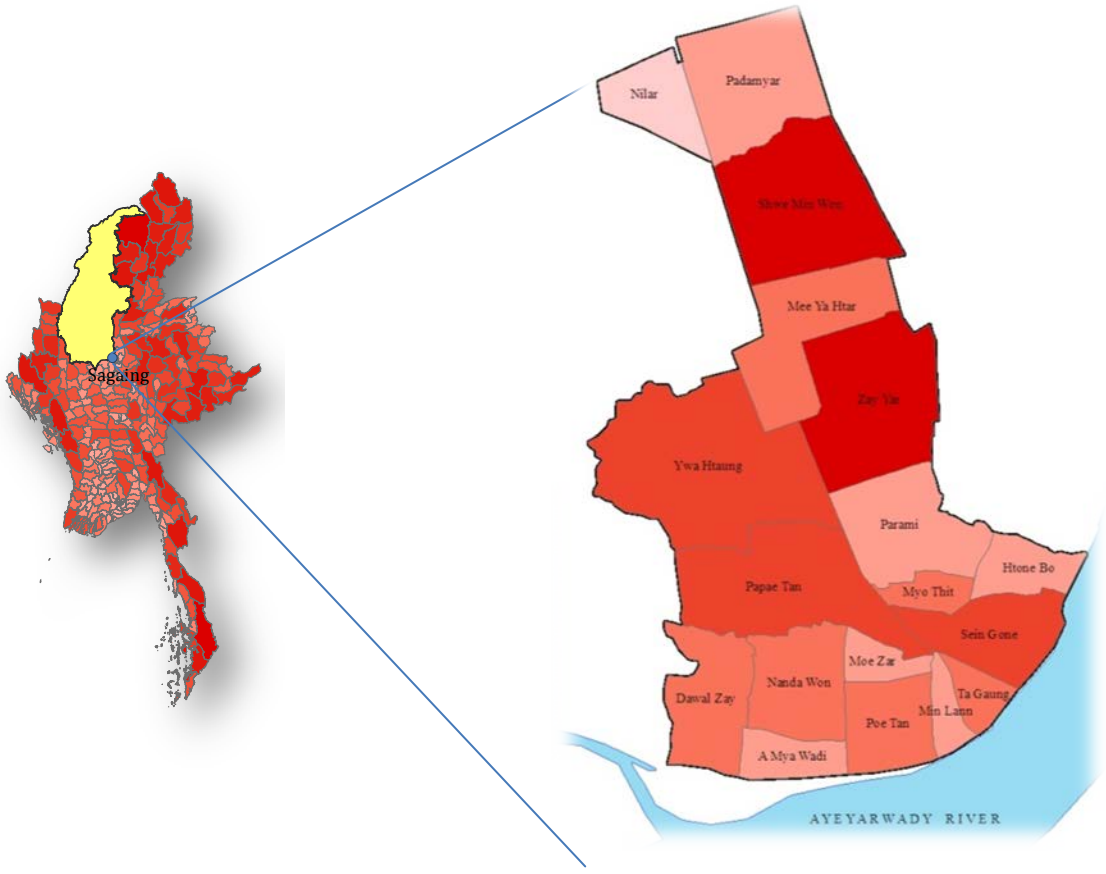
ENHANCING AND DEVELOPING SEISMIC RISK ASSESSMENT FOR SAGAING CITY OF MYANMAR



Safer Costal and Urban Communities through Inclusive Disaster Risk Reduction in Myanmar

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Background

Myanmar is exposed to range of natural hazards such as floods, cyclone, earthquakes, drought, tsunami etc due to its geophysical location. In particular, Myanmar lies in one of the two main earthquake belts of the world with a complex seismotectonic processes (Le Dain et al., 1984). At least nineteen earthquakes of $M_s > 7$ have occurred in the region. The great Arakan earthquake of 1762 caused extensive geo-morphological changes in Myanmar (Burma) coast. The 1878 earthquake caused uplift of 6 m on the west coast of Ramree Island, while another island has disappeared. Another event in 1843 was associated with the eruption of mud volcanoes (GSHAP).

While the main active tectonics characteristics are the subduction zone of Indian plate and Burma (Myanmar) plate in the West of Myanmar and the collision zone of Indian plate and Eurasia plate in the North West there are several fault lines traversing across the country. The major seismotectonically important faults in Myanmar are some unnamed major thrust faults in north-western Myanmar, Kabaw Fault along the Kabaw Valley in western Myanmar, the well-known Sagaing Fault, and the Kyaukkyan Fault situated west of Naungcho. The Sagaing fault is the most prominent active fault in Myanmar which extends from north of Lake Indawgyi southward along the Ayeyarwaddy River north of Mandalay and along the eastern margin of the Bago Yoma to the Andaman Sea (Hazard Profile of Myanmar, Sato, 2009). According to a recent study, on relocation of historical earthquakes since 1918 along the Sagiang Fault, there exist two seismic gaps: one between 19.2°N and 21.5°N in central Myanmar, and another south of 16.6°N in the Andaman Sea. Considering the length of the first seismic gap (~260 km), a future earthquake of up to M ~7.9 is expected to occur in central Myanmar (Nobuo Hurukawa and Phyo Maung Maung, 2011).

The Deterministic Seismic Hazard Zonation Map of Myanmar developed in 2005, classifies Myanmar into five seismic zones, Zone I (Low Zone), Zone II (Moderate Zone), Zone III (Strong Zone), Zone IV (Severe Zone), and Zone V (Destructive Zone). Among the other regions Taungoo – Bago, and Sagaing – Tagaung (Zone V) did not experience any major seismic activity over the past half a century and 2011 Tarlay earthquake in Shan State highlighted the vulnerability of building stock in Myanmar. Considering the majority of the building stock in both urban and rural areas comprising of non-engineered structures such as timber, brick, reinforced concrete there is an increasing concern on the potential damage to major urban areas such as Yangon, Bago, Taungoo and Sagaing, Meikhtila, Taunggyi along the Sagaing fault.

While Disaster Risk Reduction is a nascent stage, efforts are underway to reduce the vulnerabilities through specific interventions such as multi-hazard risk assessment, the earthquake risk assessment for Mandalay city, development of Myanmar National Building Code; community based DRR etc in the country.

Sagaing city is lying on the Sagaing Fault, however no studies have been carried out to assess their earthquake related risk. In addition, Sagaing has undergone recent urban developments with the construction of higher storey buildings. In this regard, earthquake

related risk assessment in Sagaing is carried out to estimate the damages. The findings from this report can lead to develop comprehensive risk reduction programs addressing the specific vulnerabilities as well as guiding the future development in the cities along with UN-Habitat's Myanmar Comprehensive Disaster Risk Reduction Programme and also with broader DRR-WG activities and those of initiatives by the local and national Government.

Research Methodology

The current research adopted methodology from the HAZUS-MH Earthquake Loss Estimation Model developed by Federal Emergency Management Agency (FEMA), USA.The framework of the methodology includes Potential Earth Science Hazard (PESH), Direct Physical Damage, Induced Physical Damage, Direct Economic/Social Loss and Indirect Economic Loss. Inventory for general building stock and essential facilities are used as input data. Direct damage data of building and essential facilities, casualties, and economic losses are developed as output result of HAZUS analysis because of limited resources. The earthquake loss estimation methodology can produce the preliminary estimation of damages to prepare before disaster situation and to plan and stimulate efforts how to reduce probable risk from earthquake. The flow chart of the methodology is shown in Figure1.

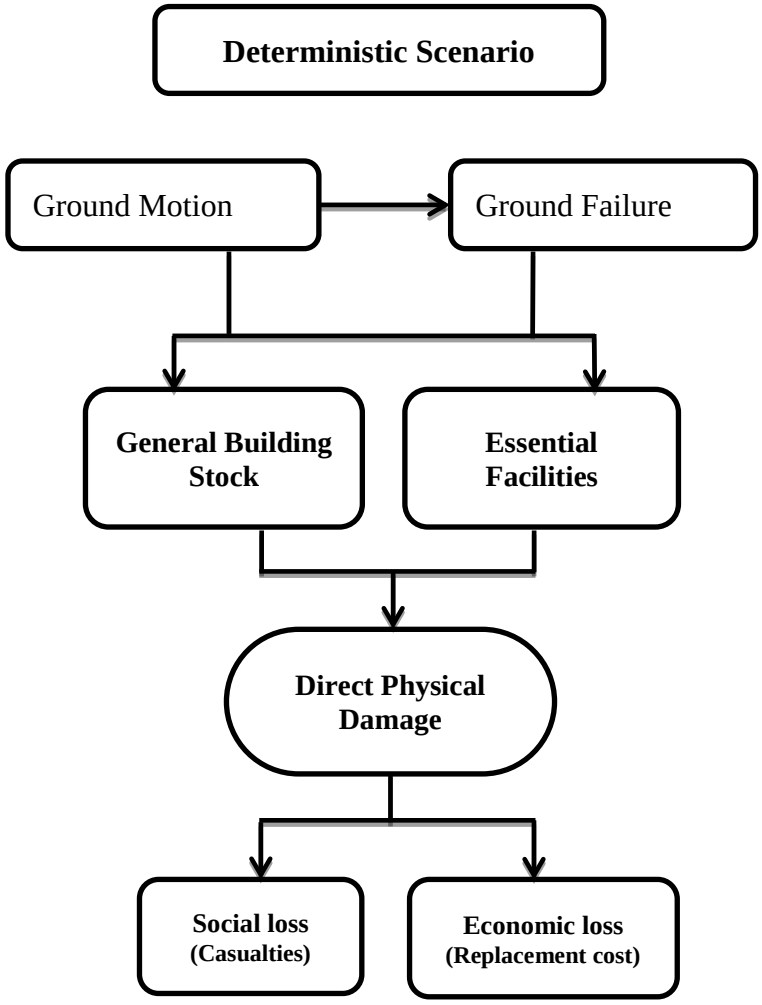

Figure (1) Flowchart of the Earthquake Loss Estimation Methodology adopted by HAZUS

Sagaing City

Sagaing city is situated in the middle part of Myanmar and it lies on the west bank of Ayeyarwady River. The geographical size of Sagaing is 10.84 square miles and contains 18 wards. There are over 15 thousand households in the region with a total estimated population of 77619 people whereas demographic data from government administration office is slightly lower than that number. As per city development plan in Sagaing, five more wards are proposed to be added in existing wards to make the city wider. Some parts of the wards are connected to sloping ground which tends to landslide susceptibility whereas some are in lower land which can be affected by flooding. The location map of Sagaing city is shown in Figure 2.

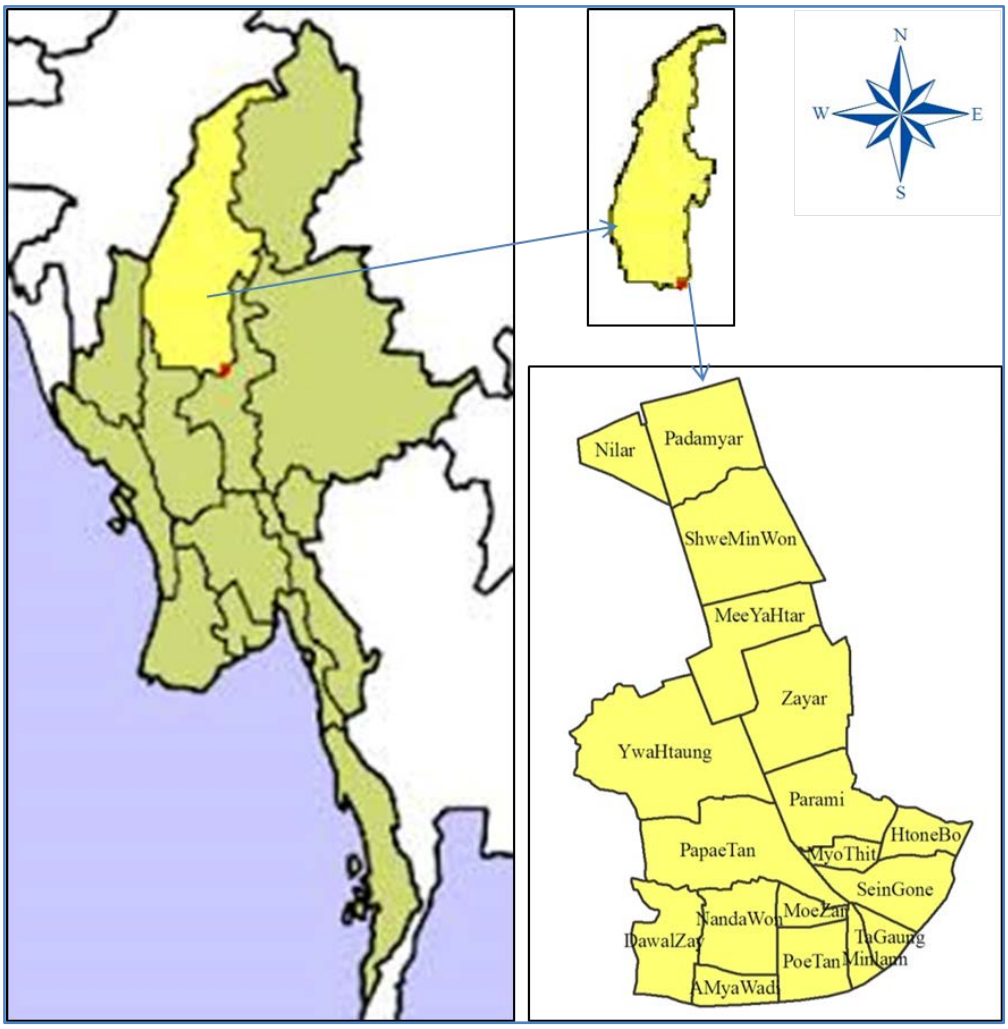

Figure (2) Location Map of Sagaing City

The eastern part of Sagaing is Mandalay city, which is located on the other bank of Ayeyarwady river. Along with the Ayeyarwaddy River, there are the Myatheintan Pagoda, the Mingun Pahtodawgyi and the Largest Ringing bell known as Mingun Bell. Sagaing and Min Won hills are close to Sagaing city and are kind of important places for Buddhist study and meditation. Many famous pagodas and monasteries are scattered on the hills. These places can keep tourist attraction. One of the largest stupas in Myanmar, the Kaunghmudaw Pagoda in Sagaing is also the tourist destination (Figure 3).

Figure (3) Famous Pagodas near Sagaing City

Livelihood in Sagaing

As per demographic data, Shwe Min Won Ward has the highest population whereas Nilar ward has the lowest one. Among all other data in the livelihood, the highest number of building, population, and households are in Shwe Min Won ward. Zayar ward is the second populated area in Sagaing in which Ywa Htaung is in the third place. Padamyar ward is the industrial area, and it includes the second lowest number of livelihood. Shwe Min Won (7917), Zay Yar (6904), and Ywa Htaung (6624) have got the highest population among any other wards in Sagaing whereas Nilar (1142) have got the lowest population. Population is just above 25% of highest population in Parami, Htone Bo, Moe Zar, and Min Lann wards (Figure A-1). The highest population density (population per area-km^2) among any other wards is in Myothit. Through Myothit ward, pagodas in Sagaing hill can be visited. The wards in a higher population density are in the developed part of the city, near market (Figure A-2).

As Shwe Min Won ward has got the highest population amongst any other wards, the total number of children/youngster under 18 is also the highest. Younger population in Min Lann (466) and Nilar (485) are the lowest (Figure A-3). In Poe Tan ward, population aged over 18 is 4.6 times higher than young population (Figure A-4). The ratio of female to male is higher than one in every ward, which is telling that the number of female is higher than the number of male for the whole city. In Shwe Min Won ward, female population is 1.56 times greater than male population (Figure A-5). The number of households in Shwe Min Won, Zayar, Ywa Htaung, and PapaeTan are the largest as population distribution. Thewider the ward is, the higher the household is (Figure A-6).Most of the wards have got the building count around 1000. Among all wards, Nilar ward has the lowest building count 254 (Figure A-7). In the above map, Myothit and Tagaung wards have got the biggest building density in any other wards in Sagaing (Figure A-8).

Inventory Data for general building stock and essential facilities

Inventory data includes general building stock, essential facilities, and its related replacement cost. The former two inventory data deal with direct damage data whereas the latter will provide additional information to calculateeconomic loss. Three groups of wards in Sagaing are classified depending on levels of economic condition; rich, medium, and poor, to take rapid visual screening survey. The main idea of dividing three groups is to get the different types of building and its use because of the interdependency between building type and income of the family. There are mainly six structure types which can be found in Sagaing. These are timber, brick nogging, reinforced concrete, brick masonry, steel, and bamboo (Figure 4 to 8). Timber building types are the most common type in Sagaing.

Figure (4) Timber Building Type

Figure (5) Brick Nogging Building Type

Figure (6) Reinforced Concrete Building Type