Modeling urban growth prediction in Yangon, Myanmar considering flood and earthquake vulnerabilities

その他のタイトル	洪水と地震脆弱性を考慮したミャンマーヤンゴンの都市成長予測モデル
学位授与年月日	2017-09-15
URL	http://doi.org/10.15083/00077555

論 文 の 内 容 の 要 旨

論文題目　Modeling urban growth prediction in Yangon, Myanmar considering flood and earthquake vulnerabilities

（和文）（洪水と地震脆弱性を考慮したミャンマーヤンゴンの都市成長予測モデル）

氏　名　スリータラーピパット タナコーン

A natural disaster is the main problem around the world. It has made huge damages to human and their properties. Due to the climate change, the damage and frequency of the disasters have become higher. There are many kinds of the natural disaster such as flood, earthquake, drought, typhoon, volcanic eruption etc. Flood, cyclone, and drought related to extreme weather events have frequently occurred. Whereas, earthquake and volcanic eruption related to extreme earth geology have rarely happened. Possibly, some disasters effects to cause the other disasters. For the instance, after a cyclone occurred, a flood can occur, or after an earthquake happened, a landslide can happen. The implications of the disasters are different because of many factors such as the damaged level of the disaster (low or high damages) and the occurred areas of the disaster (high or low values) etc. Especially, when the disaster occurs in the urban areas that have characteristics of the high population density with very important human activities, it makes huge damages with direct and indirect losses and the effect might spread the impact throughout the city or the country. In order to reduce or mitigate the damage of the disaster in the future, the disaster risk management is required such as disaster prevention, disaster preparedness, disaster relief, disaster recover.

To support the disaster management, disaster risk assessment and the disaster risk reduction are needed. Disasters risk can be expressed in term of the functions of (1) hazard, (2) vulnerability, (3) value. Disaster risk reduction is the process of a method to reduce the terms of (1) hazard, (2) vulnerability, (3) value. Hazard refers to the low or high damage of the disaster. Vulnerability refers to the safe or vulnerable areas of the disaster. Value can refer to high economic or low economic areas.

Additionally, according to Sustainable Development Goals (SDG) by United Nations, the 11.5 goal is to significantly reduce the number of deaths and the number of affected people and to substantially decrease the direct economic losses related to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. As a result, the disaster risk reduction that can reduce the economic losses in term of the gross domestic product (GDP) caused by disasters can be the significant solution in order to support the sustainable development goals.

Yangon, formerly known as Rangoon, is the largest city in Myanmar, formerly known as Burma. Yangon is the major of country's economic areas with more than five million population, and the urban areas have significantly increased. However, Yangon has suffered from the series of floods with almost every 1-2 years such as 2008, 2010, 2013, 2014 and 2015. In flooding case of 2014, Yangon had losses of more than 8.5 million US dollars with affected 63,082 people, 18 schools, 17 miles of road, 8 bridges and 56,486 acres of farmland. Yangon city also had faced the effect of the earthquake in 1930. In that time, an earthquake with the magnitude of 7.0 occurred in Bago region and caused the extensive damage including 500 killed people. In Yangon city, there were 50 died people with the population of 400,000. As a result, Yangon is at risks of flood and earthquake. In order to reduce the impacts of flood and earthquake in the future, the disaster risk assessment and disaster risk reduction in the term of economic loss relating to the gross domestic product in Yangon, Myanmar are necessary.

The objectives of this research are (1) to reduce flood and earthquake risks in Yangon from 2020 to 2040, and (2) to assess the flood and earthquake risks in term of economic loss relating to the regional gross domestic product (GRDP) with multiple-scenarios in Yangon from 2020 to 2040. To achieve the objectives, we have done mainly seven steps as follows.

Firstly, the assessment of flood vulnerability in Yangon, Myanmar has been conducted base on the multi-criteria analysis modeling. We used the seven factors with (1) land cover types, (2) elevation, (3) slope, (4) soil types, (5) flow accumulation, (6) the distance from the drainage network, (7) rainfall. We combined the empirical model linking with the historical water surface to estimate the coefficients in the flood vulnerability assessment. Then, the flood vulnerability map in Yangon was computed based on the empirical model.

Secondly, the assessment of earthquake vulnerability in Yangon, Myanmar has been performed base on the multi-criteria analysis modeling. We used the factors of (1) shaking of ground due to seismic wave, (2) soil type (3) slope (4) the height of a building, and (5) the age of the building. Then, the earthquake vulnerability map was calculate based on the defined factors.

Thirdly, the estimation of land price based on the empirical model in Yangon, Myanmar has been done. The defined factors are (1) building types, (2) land cover change, (3) elevation, (4) the distance from railways. The empirical model was used to relate to land price information at the township scale to estimate the parameters in the land price estimation. Then, Land price map base on the empirical model was provided.

Fourthly, urban expansion model has been proposed in order to predict the urban areas in the future in Yangon, Myanmar by using the dynamic statistical model. The defined factors are (1) the distance from the multi-center of the urban areas, (2) the distance from the urban areas in the past, (3) the distance from roads, (4) the distance from railways, (5) the class translation, (6) elevation, (7) separated lands by rivers. The maximum likelihood estimator was employed with the defined factors to estimate the urban expansion.

Fifthly, by relating the prediction of urban expansion, enhanced with the masterplan as future dataset, to the assessments of flood and earthquake vulnerabilities, the predicted urban growths by considering flood and earthquake vulnerabilities in order to reduce the damage of the flood and earthquake from 2020 to 2040 with multi-scenarios were proposed.

Finally, by relating the predicted urban expansion, merged with land price estimation and the predicted economic growth relating to the regional gross domestic product (GRDP), to the assessments of flood and earthquake vulnerabilities, the assessments of flood and earthquake risks in term of economic loss relating to the GRDP from 2020 to 2040 with multiple-scenarios were proposed.

The experimental results showed that by using flood risk reduction, the total flood loss in term of economic from 2020 to 2040 can be reduced by 4-28 million US dollars, and by using earthquake risk reduction, the total earthquake loss in term of economic from 2020 to 2040 can be reduced by 8-47 million US dollars. According to the spatial information of the total flood economic loss at the township scale, THANLYIN, TWANTE, Haingtharyar, Mingalardon, Dagonmyothit (South) are the five highest flood loss in term of economic townships. For the spatial information of the total earthquake economic loss at the township scale, THANLYIN, Mingalardon, Dagonmyothit (South), KYAUKTAN, Dagonmyothit (East) are the five earthquake loss in term of economic townships.

In this research, the various remotely sensed data have been employed since remote sensing technology can observe wide areas with long-time monitoring. As a result, it can support as the input data for the disaster risk assessment and the disaster risk reduction; especially under the situation of limitation of data. MODIS surface reflectance 8 days composition can observe the water surface from 2001 to 20015 as the historical water surface areas in order to support for flood vulnerability assessment. Landsat time-series can observe the land cover change with wide areas from 1978 to 2015. Stereo GeoEye images can be used to extract building heights. For earthquake vulnerability assessment, the stereo GeoEye images and Landsat time series were employed to provide the ages of buildings. By using stereo GeoEye images, Landsat image, and Nighttime light data, the building types with commercial, industrial, residential buildings can be estimated to support in land price estimation. For modeling urban expansion, the stereo GeoEye images were used to detect the multi-centers of the urban areas. Also, urban expansions from 1978 to 2015 were detected by using Landsat time series.

To confirm the reliable data that were analyzed from remotely sensed data, the validations are necessary. For the land cover image, we compared the resultant land cover image in 2009 with the land cover map in 2012. For elevation, we compared the estimated elevations from SRTM and GeoEye with the surveying data. For the building height, we compared the building heights with the surveying building height data. The validated results confirm that our products by using remotely sensed data are reliable to be used in this research.