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Development of a landslide risk area display system by using the geospatial technology with daily rainfall data via the internet network in the Northern region of Thailand

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Abstract The results showed that the areas with the lowest landslide risk were 50,813.832 square kilometers (sq. km) (54.236 %). The moderate landslide risk areas of 20,924.511 sq. km (22.334 %) are located in Chiang Mai, Chiang Rai, and Mae Hong Son provinces. The most high-risk area was 21,952 sq. km (23.431 %) in the districts of Chiang Dao, Chai Prakan and Wiang Haeng in Chiang Mai. The risk areas of Nan province are shown in the districts of Chaloem Phra Kiat and Chiang Klang. The risk areas of Chiang Rai province are in the district of Mae Fah Luang, Mae Chan and Mae Suai. The risk area of Uttaradit Province is located in the district of Nam Pat. The risk areas of Phrae province are located in the Muang District. The risk area of Lampang province is located in the Wang Nuea District. The risk areas of Mae Hong Son province are located in the district of Pai and Mae Sariang. The high to the highest landslide risk areas are located in Nan province with the areas of 3,415.30 sq. km (29.77 %). Phayao province has 1,475.32 sq. km (23.29 %). Lampang province has 1,821.13 sq. km (14.53 %). Lamphun Province has covered 937.98 sq. km (20.82 %). Uttaradit province has covered 2,522.97 sq. km (32.19 %). Chiang Rai province has covered 3,917.91 sq. km or (33.55 %). Chiang Mai province has covered 4,958.91 Sq.Km. (24.66 %). Phrae province has covered 1,912.30 sq. km (29.25 %). Mae Hong Son province has covered 990.84 sq. km (7.81 %). The visualization of landslide risk areas has multiple accessed the channels via mobile phone and computer via with internet network https://landslide.gis-cdn.net/. The website can be retrieved the analysis of the highest daily average rainfall in the past 30 years (1981 – 2010) from the Thai Meteorological Department. It showed the distribution of water with the cumulative rain for 6 different tones with less than or equal to 5, 5-20, 20-35, 35-60, 60-90, and more than 90 millimeters per day in the province, district, and sub-district levels.

Keywords: Geoinformatics, Landslides, Disasters, Python, GeoServer

Introduction

The world situation has changed from the past quite until fluctuating the environment with severely changing the weather conditions that steadily rised

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the temperatures and caused the disaster all over the world. The natural disasters are caused by the geological processes such as earthquakes, tsunamis, sinkholes, landslides, volcanic eruptions, etc. (the office of Natural Resources and Environmental Policy and Planning, 2019). Thailand becomes particularly intense the thunderstorms in summer and the rainy season which is characterized by severing the weather that produces the strong winds, hail and lightning. Thailand is also affected by tropical cyclones that often form in the South China Sea, especially the storms, that often occur in the North and the Northeast due to the high pressure from China spreading over and bring the hot air and humidity until causing the rain along the coast and mountains (Department of Social Development and Welfare, 2019). The most destructive landslides occur after heavy rains in mountainous areas in the North and the Northeast of Thailand. The Department of Mineral Resources (2018) found that the major natural disaster in Thailand were 53 earthquakes which's down from 148 times in 2017. For 27 earthquakes, they caused the landslides followed by the earthquakes, bank collapses, landslides, rock falls, sinkholes and fissures. The Office of Policy and Resource Planning Nature and Environment (2019) found that the past 10 years (2009-2018) natural disasters tended to increase.

The Northern region has an area of approximately 93,691 square kilometers. The topography is a mountain range stretching from North to South. Thanon Thongchai mountain range is a large mountain range and the longest in the North with the highest peak in the country. Doi Inthanon Peak in Chiang Mai is 2,565 meters above sea level, which is a mountain range on the border of Laos, Thailand and Myanmar. There is the country's second-highest peak. Yod Doi Pha Hom Pok is in Mae Ai District with a height of 2,297.84 meters and the top of Doi Luang Chiang Dao is 2,222 meters that the height is the third in Chiang Mai (Chananyu and Chalat, 2015). The most of the topographies are the high mountains, valleys and basin-and-range in the mountains, forests, and watersheds. It is steep from the Northwest then slopes to the Southeast and the central region and gradually rises again in the East and Northeast. The lower part is high mountains and the West and the Middle East are the plain areas with the river of Ping, Wang, Yom, Nan, Sakae Krang and Pa Sak that flowed through the lower part (Regional Development Policy Integration Committee, 2022). The Earthquake Operation Center, Department of Mineral Resources, Ministry of Natural Resources and Environment (2023) have warned to the landslides and flash floods that are risky in the province of Chiang Mai, Chiang Rai, Mae Hong Son, Nan, Phrae, Phayao, Tak, and Kanchanaburi. These areas have continuous heavy rain with more than 100 mm of precipitation. The Department of Mineral Resources (2021a) has a specific disaster notification for the prone areas to landslides in 54 provinces and 331 districts, mostly occurring during heavy rains. Respectively, the highest landslide risk areas of the Northern 9 provinces are Chiang Mai, Chiang Rai, Nan, Phayao, Phrae, Mae Hong Son, Lampang, Lamphun, and Uttaradit. There is a high chance of landslides from May to September due to the influence of the southwest monsoon winds.

The spatial analysis in planning and surveillance has a pattern for applying the Remote Sensing (RS) Technology to study the various elements on the earth and in the atmosphere. It is able to track changes in the natural environment in conjunction with the Geographic Information System (GIS) that can manage data analysis and plan to manage the various natural resources efficiently by using the plan decisions on the various matters accurately and quickly (Phetsawang, 2016). The Python programming language is used to write many types of programs without being limited to any specific work. The Python language can develop programs to work on such as network work on mobile applications, Internet of Things and web application development. In addition, the Python is a glue language that is able to run with the other languages to coordinate data processing together and the following outstanding abilities as follows: To be able to connect to the various databases such as MySQL, Oracle, SQL Server and PostgreSQL/PostGIS, or connect to a NoSQL database such as MongoDB, To work for all operating systems including Windows, Linux, Unix and macOS, to support the development of graphical programs called Graphic User Interface (GUI) by using the Tkinter library which is a library to install with the Python language, so the users do not need to install additional libraries, to support the development of applications via mobile phones that supports both Android and iOS operating systems by using the Kivy Library, a library that can be used for free, to support the development of web applications with popular libraries such as Diango, TuboGears, web2py. There libraries are used for game development such as PyGrame, PyKyra, Pyglet, etc. There are also many other libraries used to develop 2D, 3D and animation such as Pymunk, PyOpenGI, PySoy, etc. The Python language supports the development of various devices that can be connected to the system. The Internet can be called the Internet of Things (IoT), which can be applied to develop various areas such as Smart Cities, Smart Homes, Smart farms, etc. (Khampakdee, 2018).

The software is used to analyze data and display the warning results of landslide risk areas through the website. In the processing part, it uses the Pycharm program to write the Python program to retrieve data. An application Programming Interface (API) is a connection from one system to another system for external software to access and update the data of the daily rainfall which obtained from the Meteorological Department's measuring stations and to accompany with the other factors to analyze the results and display. The notification results are displayed on the website with the program Geoserver. The objectives were to analyze the factors of landslides and map out landslide risk areas, and developed a display system for landslide risk areas by applying the geoinformatics technology together with the daily rainfall data via the internet in the Northern region of Thailand.

Materials and methods

Selection of the factors used to analyze the landslides risk areas

The 10 factors/parameters along with their weight (WI) and score (RI) were analyzed and displayed the landslide risk areas by using a geographic information system (GIS) in overlay technique. The highest daily rainfall in the past 30 years (1981 - 2010) has latest recorded of the Thai Meteorological Department data which used in the analysis of landslides that determined from the sum of the weight multiplied by the key factor score and adjusted the weight (Weighting Score) of all tables to be in the same digits 1 - 10. The rating score is adjusted the score range in each factor to value between 1 - 6 equal in every table as shown in Table 1.

The lowest score is the range of factors that least influences on the occurrence of landslides. The highest score is the range of factors that mostly influences on the occurrence of landslides. The sum of the importance scores of 10 factors are divided by the level of landslide-susceptible areas from the highest to lowest score to reclassify the data to landslide risk areas of five levels as highest, high, medium, low and lowest sensitive areas using the equation (1):-

Expressed as equation $S = (W1R1) + (W2R2) + (W3R3) +....+ (WnRn)$ (1)

where S = Sum of all scores, W = Weight of key factors, R = Rating according to the priority of each item detail of sub-factors and N = Number of factors used in the analysis.

Table 1. Weights divided the range together with the scores of each factor in the analysis

Parameter	Class	Rating(r)	Weighting(10)
1. Maximum daily rainfall (mm)	More than 200	3	10.00
	150 – 200	2	
	100 – 150	1	
2. Slope, S (Degrees)	more than 45	4	7.31
	30-45	3	
	15-30	2	
	Less than 15	0	
3. (Landuse, L)	not a forest area	3	5.00
	degraded forest	2	
	perfect forest	1	
4. Elevation of the area (m)	altitude more than 1000	5	4.98
	800-1000	4	
	600-800	3	
	400-600	2	
	Less than 400	1	
5. Distance from fault (DF) (m)	Less than 1000	3	3.33
	1,000-2,000	2	
	more than 2,000	1	
6. Distance from water source (m)	0 – 100	5	2.42
	101 – 200	4	
	201 – 300	3	
	301 – 500	2	
	more than 500	1	
7. Soil drainage	bad drainage	5	2.41
	The drainage is quite bad.	4	
	medium drainage	3	
	good drainage	2	
	very good drainage	1	
8. Distance from the road (m)	0 – 100	6	2.28
	101 – 200	5	
	201 – 300	4	
	301 – 400	3	
	401 – 500	2	
	more than 500	1	
9. Type of rock	Sedimentary ,metamorphic rock	2	2.02
	granite	1	
10. Direction of rainwater collection (Aspect - A)	north east	4	1.67
	southwest	3	
	other direction	1	
	plain	0	

The analysis of landslide risk areas in northern Thailand displayed using the Web Map Service

The GeoServer is used as a server containing standards defined by the Open Geospatial Consortium (OGC). It is a very flexible program for creating maps and sharing data. It can display user geospatial information all over the world using the Web Map Service (WMS) standard. GeoServer can create maps in a variety of output formats on GeoTools, a Java GIS toolkit. Direct JavaScript that supports graphical interactive tools. System installation is ordered for using the GeoServer program as Install Java:- find the jdk-6u24-windows-i586.exe file, configure the Java environment:- the system properties window is opened from the control panel and click on Tab:- Advanced. The environment variables are clicked new to add a variable named JAVA_HOME and set a path to where Java is installed. Verify the JAVA_HOME variable that appears at the system variables. Tomcat (Servlet Engine) is installed as locate the apache-tomcat-7.0.21.exe file and double click to begin the installation, click the Next, and click I Agree, Apache (HTTP Server) is installed to select the installation type, click the Next, configure the Username = admin Password = tomcat, click the Next, select the JRE used for Tomcat, and click the Next, The connection is configured between Apache and Tomcat. GeoServer is installed to show details to install Java, Tomcat (Servlet Engine), Apache (HTTP Server) and GeoServer. GeoServer is applied with display data on mapping applications such as Google Maps, Google Earth, Microsoft Bing Maps, and MapBox. GeoServer can also connect to GIS such as ESRI ArcGIS which is comprised of the users and developers from all over the world. There is a fixed release cycle that provides transparency and reliable updates (OSGeo, 2022). Python is a language to write commands for retrieving the daily rainfall data and physical factors of the area displayed through the website. The reported daily rainfall data recorded rain fall, for example; If running data on Thursday, the used data is the cumulative rainfall from 7:00 a.m. on Wednesday until rainfall at 7 a.m. on Thursday, which is in Application Programming Interface (API) format. Python scripting retrieves the daily rainfall factor data from the Thai Meteorological Department to analyze the risk of landslides in the Northern region of Thailand as import the library in use, retrieved the rainfall data from meteorological stations, convert the data in CSV format to the database format (.dbf), delete the rainfall data (Filed) in the description table of the meteorological station, link the rainfall data with meteorological station data, precipitate the range estimation from the meteorological stations, group the new rainfall data by determining the score according to the factor table, and overlay the analysis of the landslide risk areas at the daily level.

The results of landslide risk areas displayed on the internet network for warning the landslide areas with multiple channels via mobile phone, PC, Notebook, etc. The risk areas and rainfall volume can show the resolution at sub-district, district, and provincial boundaries. It is displayed in the form of a map with different color tones.

Results

The analysis of landslide risk areas in 9 provinces in the North of Thailand by taking 10 factors that weighted and scored the data with a geographic information system, performed the overlay analysis, and divided the landslide-prone areas into 5 levels with actual records of landslide. The rainfall factor is the highest daily average rainfall in the past 30 years climate standards from 1981 – 2010 by the Thai Meteorological Department.

The results of the landslide risk area are divided into five levels, namely, the lowest landslide risk areas are 22,571.677 square kilometers or 14,107,298.004 rai, representing 24.092 percent. The most areas were located in Mae Hong Son, Chiang Mai, and Lampang Provinc. The low landslide risk areas were 28,242.155 sq. km, representing 30.144 percent, the most of the areas werev located in Chiang Mai, Lampang, and Mae Hong Son provinces, respectively. The landslide risk area was moderated with an area of 20,924.511 square kilometers or 13,077,819.140 rai, representing 22.334 percent. The most areas were located in Chiang Mai, Chiang Rai, and Mae Hong Son provinces. The high landslide risk areas were 15,952.100 square kilometers or 9,970,062.418 rai, representing 17.026 percent. The most areas were located in Chiang Mai, Chiang Rai, Nan, Lampang, and Phrae provinces. The Landslide risk area was the highest with an area of 6,000.558 square kilometers or 3,750,348.750 rai, representing 6.405 percent. The most of them were located in Chiang Mai, Nan, and Chiang Rai provinces. The total high and the highest are 21,952 square kilometers or 23.431 percent in the area of Chiang Mai in the districts of Chiang Dao, Chai Prakan, Wiang Haeng, Doi Saket, Phrao, and Mae Taeng. Nan Province is considered as the risk areas in the districts of Chaloem Phra Kiat, Chiang Klang, Pua, Thung Chang, and Bo Kluea. Chiang Rai province is reported to be the risk areas in the districts of Mae Fah Luang, Mae Chan, Mae Suai, and Muang Chiang Rai. Uttaradit province is faced to be the risk area in Nam Pat District. Phrae Province is recorded to be the risk area in Muang Rong Kwang District. Lampang province is considered to be the risk area in Wang Nuea District. Mae Hong Son province is reported to be the risk areas in the districts of Pai, Khun Yuam, Mae Sariang, and Mae La Noi. Lamphun Province is shown to be less risk area as shown in Tables 2, 3, and Figures 1 and 2.

Table 2. Landslides risk areas at 5 levels in northern Thailand

level of risk of landslides	Total (sq.km.)	Total (rai)	Percentage
Lowest risk	22,571.677	14,107,298.004	24.092
Low risk	28,242.155	17,651,346.688	30.144
Medium risk	20,924.511	13,077,819.140	22.334
High risk	15,952.100	9,970,062.418	17.026
Highest risk	6,000.558	3,750,348.750	6.405
Total	93,691.000	58,556,875.000	100.000

Table 3. Landslides risk areas at 5 levels digest provinces in northern Thailand

Province	Lowest	Low	Medium	High	Highest	Total(sq.km.)
Chiang Mai	5,037.270	5,575.014	4,535.802	3,464.805	1,494.109	20,107.000
Chiang Rai	833.774	3,498.088	3,428.629	2,727.649	1,190.261	11,678.400
Phrae	1,163.438	1,811.227	1,651.639	1,394.434	517.862	6,538.600
Mae Hong Son	5,333.344	3,876.692	2,480.421	898.803	92.040	12,681.300
Nan	3,330.514	2,859.560	1,866.724	2,081.045	1,334.257	11,472.100
Phayao	908.325	2,438.869	1,512.585	1,144.500	330.821	6,335.100
Lampang	4,241.922	4,212.733	2,258.214	1,502.764	318.367	12,534.000
Lamphun	804.548	1,682.051	1,081.324	798.475	139.502	4,505.900
Uttaradit	918.541	2,287.921	2,109.173	1,939.626	583.339	7,838.600
Total (sq.km.)	22,571.677	28,242.155	20,924.511	15,952.100	6,000.558	93,691.000
Percentage	24.092	30.144	22.334	17.026	6.405	100.000

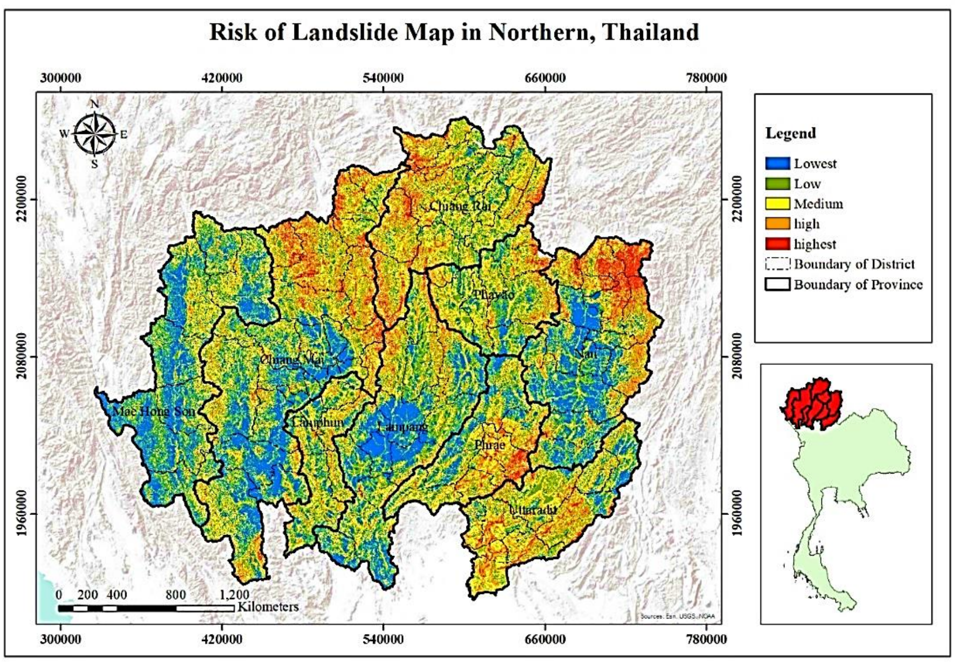

Figure 1. Landslide risk areas 5 levels in 9 provinces in the Northern, Thailand

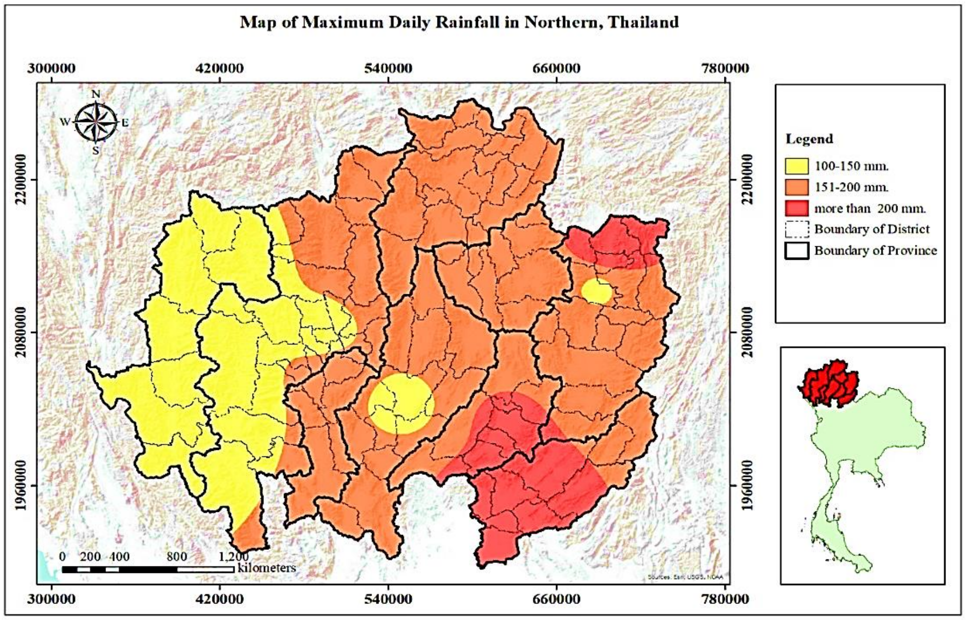

Figure 2. Maximum daily rainfall in Northern, Thailand

Finally, the results of the analysis of landslide risk areas from the high to the highest levels were shown by the total area of the provinces as follows:- Chiang Mai had the area of 4,958.91 square kilometers (sq. km), accounting for 24.66 percent. The most of them were in the districts of Chiang Dao, Mae Chaem, and Omkoi. Chiang Rai province has the area of 3,917.91 sq. km, accounting for 33.55 percent. The most of them are in the district of Mae Suai, Mueang Chiang Rai, and Wiang Pa Pao. Phrae province has the area of 1,912.30 sq. km, accounting for 29.25 percent, mostly in the districts of Muang Phrae, Song, and Wang Chin. Mae Hong Son Province has the area of 990.84 sq. km, accounting for 7.81 percent. The most of them are in the districts of Pai, Mae Hong Son and Mae Sariang. Nan Province has the area of 3,415.30 sq. km, accounting for 29.77 percent. The most of them are in the districts of Bo Kluea, Thung Chang Pua. Phayao Province has the area of 1,475.32 sq. km, accounting for 23.29 percent. The most of them are in the districts of Pong, Chiang Kham, and Mueang. Lampang Province has the area of 1,821.13 sq. km, accounting for 14.53 percent. The most of them are in the districts of Mueang, Pan, Thoen, Ngao. Lamphun Province has the area of 937.98 sq. km, accounting for 20.82 percent. The most of them are in the districts of Li, Mae Tha, Thung Hua Chang. Uttaradit province has the area of 2,522.97 sq. km, accounting for 32.19 percent. The most of them are in the district of Tha Pla, Nam Pat, and Muang.

Developing the landslide risk areas display system by using the geoinformatics technology along with the daily rainfall data via the internet in Northern Thailand

Python language and the Pycharm program were used to develop the automatic landslide display system in the processing section by writing programs, retrieving data, and displaying landslide risk areas on the website**.** The website https://landslide.gis-cdn.net/ details the landslide areas in various formats. It can display on mobile phones, computers, notebooks, iPads, and laptops. The website starts the writing scripts by using the index.html files and displays them in the web browser by using the table formatting images and the other content on the website. The map is available via the web on GeoServer by using the main.js file to display the map through a web browser. The results of landslide risk areas and the daily rainfall are analyzed and displayed the boundaries of sub-districts, districts, provinces, and daily rainfall in 9 provinces in the Northern of Thailand in the form of a map with the different color tones in five risk levels of the lowest risk, low-risk, medium risk, high-risk, and highest risk areas were shown in the Figure 3 – 8.

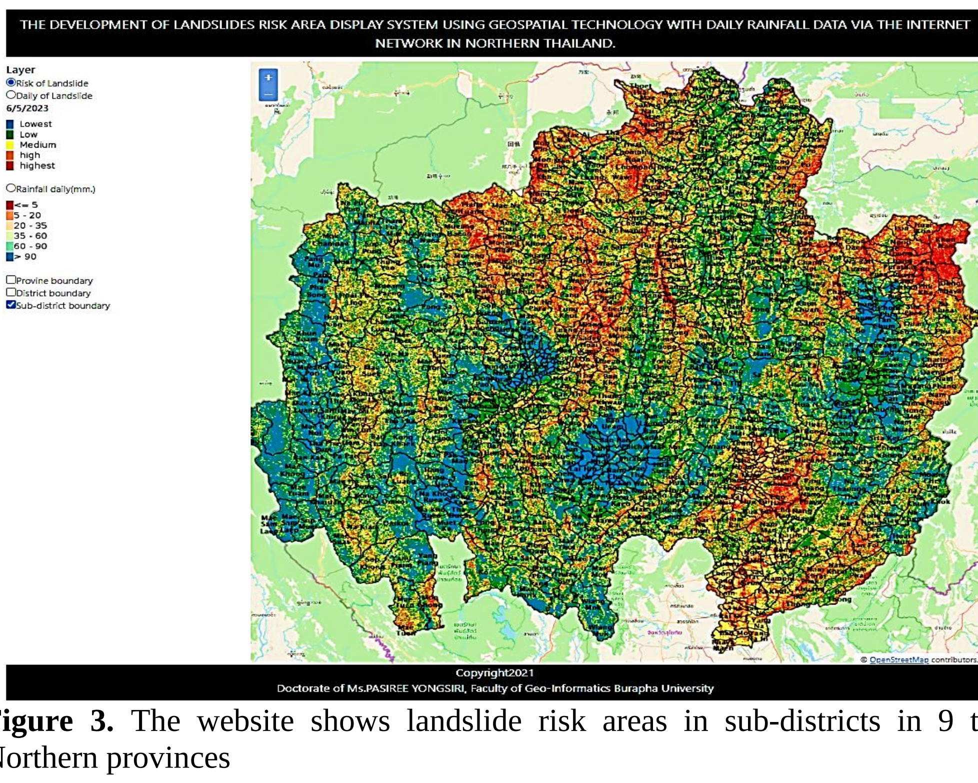

Figure 3. The website shows landslide risk areas in sub-districts in 9 the Northern provinces

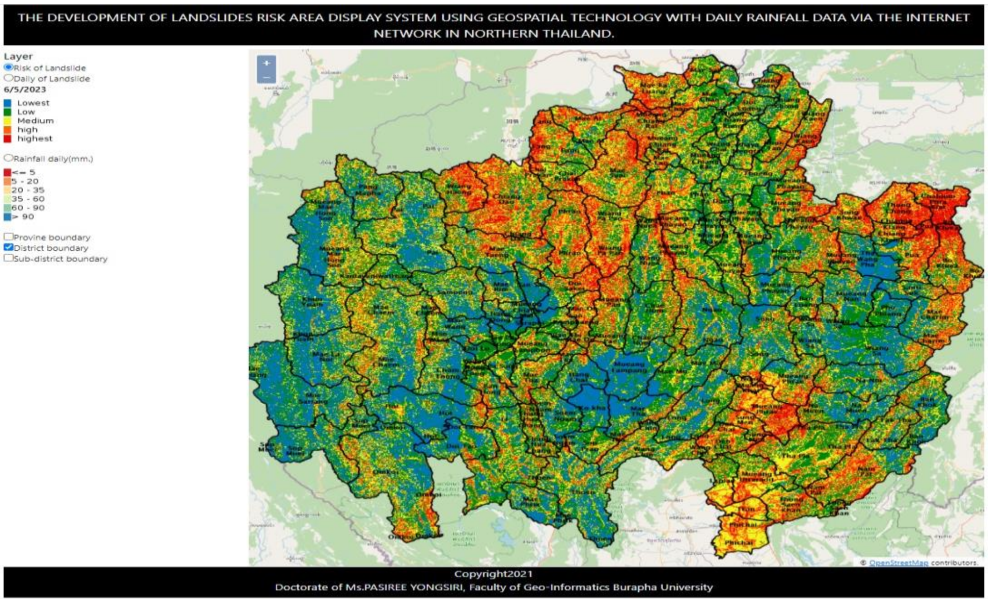

Figure 4. The website shows landslide risk areas in districts in 9 the Northern provinces

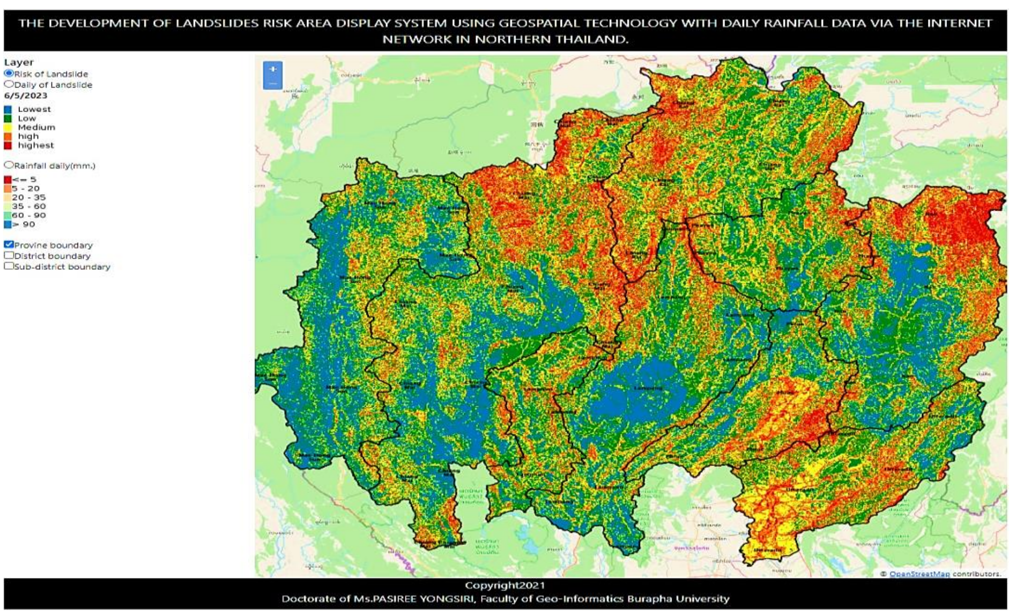

Figure 5. The website shows the provincial landslide risk areas in 9 the Northern provinces

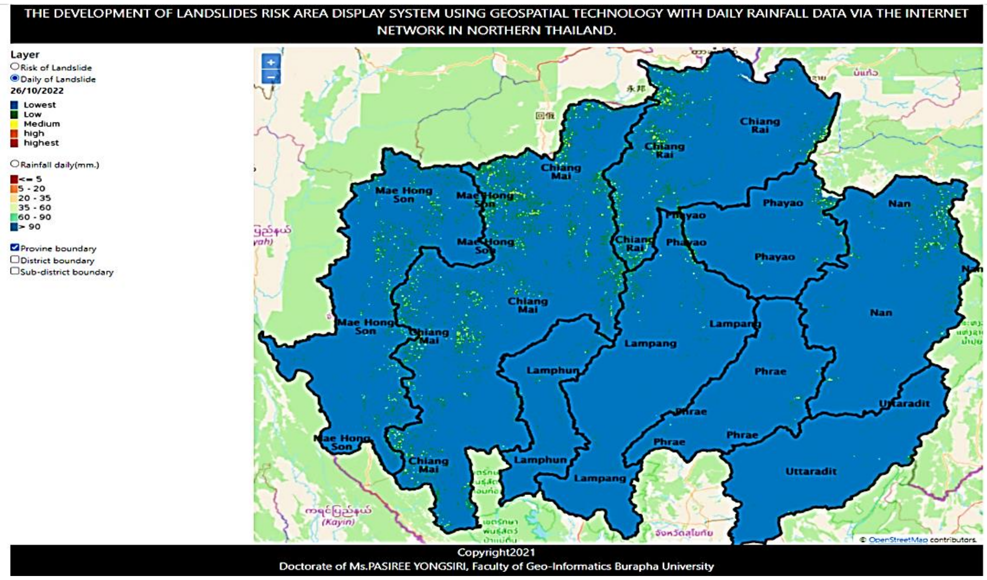

Figure 6. The website page shows daily rainfall areas in 9 the Northern provinces

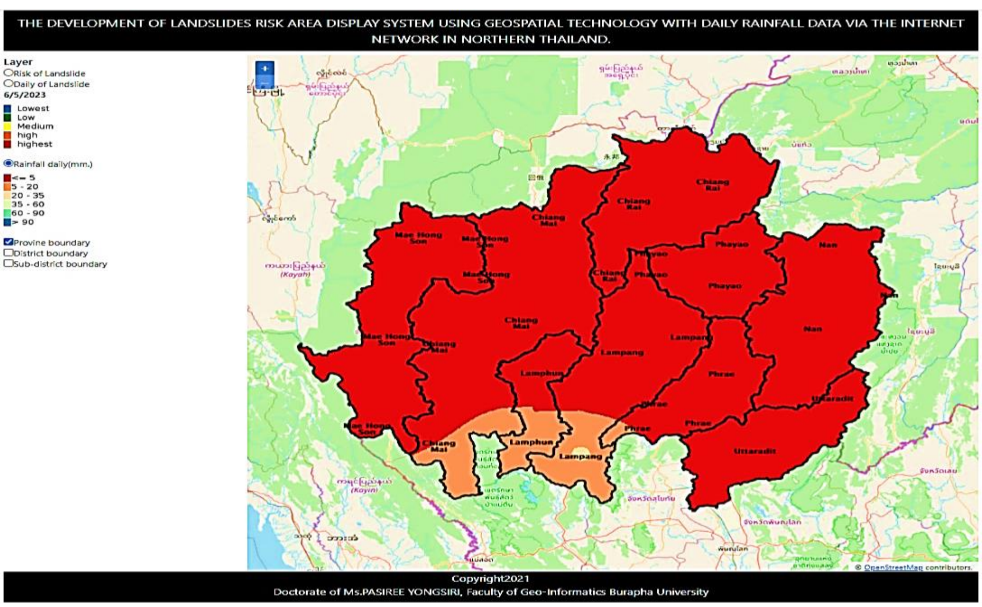

Figure 7. The website shows daily rainfall for provincial boundaries on the computer

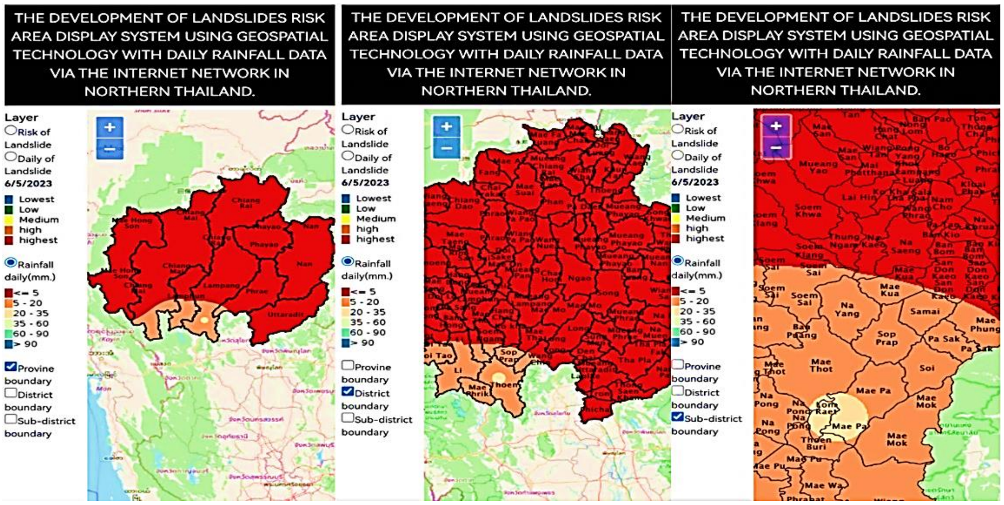

Figure 8. Daily rainfall shows the province, district, and sub-district in smartphone

The reported data on the website is shown the cumulative precipitation of rainfall that recorded between 7:00 a.m. on the previous day and 7:00 a.m. on the day of data access. In the map format, there are divised to be six levels of different color tones as the rainfall is less than or equal to 5 mm per day, 5-20 mm per day, 20-35 mm per day, 35-60 mm per day, 60-90 mm/day and more than 90 mm/day.

Discussion

The development of the landslide areas are displayed the system by using the geoinformatics technology along with the daily rainfall data via the internet in the Northern of Thailand used on the scores and weighted overlay with 10 factors, which are recorded as the maximum daily rainfall (millimeters per day), the slope of area (Slope, S), the land use (Landuse, L), the elevation of the site (m), the distance from fault (distance to fault, DF), the distance from water source (m), the soil drainage, the distance from road (meters), the type of rock, and the direction of rainwater intake (Aspect - A), which has influenced on the landslides, respectively. These are consistent with the study conducted by Hidayah and Dzakiya (2018) about the analysis of geological and geophysical data for the landslide hazard zone prediction with the weight of evidence method in Pacitan Regency, East Java, to predict the potential landslide using the weight of evidence method. The importance factor focused in the highest daily average rainfall in the past 30 years climate standards from 1981-2010 by the Thai Meteorological Department that corresponds with Deng *et al.* (2021), which used the rainfall parameters to interface with the standard regional rainfall raster layers that provided by the government which could reduce the uncertainty and increase the reliability of the landslide-susceptibility warning results. In case of the amount of rainfall is greater than 90 millimeters in a 24-hour period, there would possible be flashed floods. If the rainfall is more than 150 millimeters, some soil layers may cause soil flow or landslide. The amount of rain has fallen continuously for several days that accumulated more than 300 millimeters in some places. It may also cause landslides. The Antecedent Precipitation Model (AP Model) is a statistical analysis of the accumulated rainfall and landslide events in the past to create a rainfall threshold. The critical accumulation for landslide surveillance and the warning precipitation forecast data of 72 hours in advance by Hydro Informatics Institute are analyzed with the AP Model to predict the area for monitoring/patrolling the earthquakes and landslides that would possible forcast more rain and some heavy rain in the Upper North of Thailand (The Department of Mineral Resources, 2021b).

The results of analysis of the landslide risk areas with the high to the very high risk or the highest are recorded to be the areas in total of 15,952.100 square kilometers, accounting for 17.026 percent and the very high-risk areas are in total of 6,000.558 square kilometers, accounting for 6.405 percent, representing a total of 23.431 percent in the districts of Muang Chiang Mai, Chiang Dao, Chai Prakan, Wiang Haeng, Doi Saket, Phrao, Mae Taeng and Mae Chaem. The risk areas of Nan province are reported in the districts of Chaloem Phra Kiat, Chiang Klang, Pua, Thung Chang and Bo Kluea. The rick areas of Chiang Rai are recorded in the districts of Mae Fah Luang, Mae Chan, Mae Suai and Muang Chiang Rai. The risk areas of Uttaradit province are shown in the districts of Nam Pat and Tha Pla. The risk areas of Phrae province are observed in the districts of Muang, Wang Chin and Rong Kwang. The risk areas of Lampang province are recorded in the districts of Wang Nuea and Sop Moei. The risk areas of Mae Hong Son province are recorded in the districts of Pai, Khun Yuam, Mae Sariang and Mae La Noi. The risk area of Phayao province is shown in the districts of Pong, Chiang Kham, Muang, Dok Khamtai and Chun. The risk areas of Lamphun province are shown in the districts of Li, Mae Tha, Thung Hua Chang, Muang Lamphun and Ban Hong. These results were similar to the Earthquake Operations Center (2019), the announcement and bewaring of landslides, the earthquake warnings had started from July 31 to August 2, 2019. There were more than 100 overlapping measurements to fill the water level in 9 provinces. Nan province would be possible faced in the districts of Bo Kluea, Chaloem Phra Kiat, Wiang Sa, Chiang Klang, Tha Wang Pha, Na Noi, Na Muen, Pua, Santisu and Mae Charim. Mae Hong Son province would be faced in the districts of Khun Yuam, Mae Sariang, Pai, Pang Mapha, Sop Moei and Muang. Phayao province would be faced in the districts of Pong, Chun Chiang Kham and Phu Kam Yao. Chiang Rai province would be faced in the districts of Thoeng, Pa Daet and Chiang Khong. Chiang Mai province would be faced in the districts of Mae Wang, Mae Chaem, Mae Ai, Fang, and Phrae province. The Department of Disaster Prevention and Mitigation (2021) reported the situation of disasters on a daily basis Cyclone source "YAAS" splashed the upper Bay of Bengal and the monsoon as well as blowing crowded the Andaman Sea. There are occued thunderstorms daily life causing the thunderstorms, strong winds, floods, and soil slides in the area in the Northern provinces, especially in the province of Mae Hong Son, Chiang Rai and Phayao. It was caused by the topography of many mountains. The slope of the mountain is quite steep when the rain has continued for a long time, the soil would slide down.

Python language is chosen to write a set of command codes or retrieve the daily rainfall data from the Meteorological Department for analyzing the results together with the other factors. The website pages were developed and customized by using HTML and Python languages in accordance with the research of Radu. Withthis, Radescu and Dragu (2019) who developed the applications through the processing software with built-in sensors. The report of the events of fire, flood, avalanche, or landslide, etc. can inspect the areas and assess the damages. The reports are generated by mapping with the Python programming language on the different platforms (CPU, GPU and TPU) from desktop to server or mobile device. The display of landslide-prone areas are multiple accessed the channels via mobile phone and the PC notebook computer via internet network.

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