Online Learners' Exposure to Natural Hazards Risks in the Philippines: Implications for Student Support and Policy

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Abstract

Climate-related disasters have been projected to intensify in the coming years. Academic institutions have looked at online learning as the disaster-resilient response for education. However, online learners remain exposed to the risks of natural disasters. Schools and universities should develop a student support system that is responsive to the needs of learners in areas with high disaster risk. There is a need to analyze the distribution of online learners in these areas and determine the student support implications of the pattern as initial steps towards developing such a system. With this, the current study analyzed the exposure of online learners of an open and distance e-learning (ODeL) university to risks of natural hazards in the Philippines. The profile of learners (n = 3,225) enrolled during the first trimester and the first semester of the Academic Year 2020–2021 and the disaster risk maps developed by the Center for Environmental Geomatics, Manila Observatory were entered into a GIS environment and analyzed. Results indicated that more than 80% of the learners are in regions with high to very high risks to climate-related hazards. Less than 10% is within areas with high risks to earthquakes. This is critical since climate disturbances in the country are recurrent and destructive, causing the loss of life and property, power outages, and internet service interruptions for weeks or months. Online learning institutions should develop a student support system that could assist their learners in overcoming the impacts of a disaster on their academic life.

Keywords: *online learning, disaster resilience, disaster risks, geographic information system, natural hazards*

Introduction

Projections of the climate change scenarios are dim in the coming years for developing countries such as the Philippines. Cinco et al. (2018) projected that the country would experience continuous warming in the future and the frequency of strong typhoons and extreme rainfall events will increase. This is critical since the country must still overcome the current pandemic's paralyzing effects on its economy and other public services including education. The education sector has integrated remote teaching and learning (RTL) as part of its operation continuity plan during the pandemic. Although it has faced several technological, pedagogical, and social challenges, many if not all academic institutions in the country and throughout the globe have adopted RTL to continue delivering education to their students (Ferri et al., 2020). In most instances, the adoption of online learning has been at the forefront of the fight against the impacts of the pandemic on education. Although Hodges et al. (2020) indicated that its adoption had prompted experts, policymakers, citizens, teachers, and learners to search for new solutions, online learning has attracted more and more institutions worldwide. In fact, Li and Lalani (2020) had reported that the overall market for online education can reach up to US$350 billion by the end of 2025 from US$18.66 billion in 2019 with the sudden shift of education away from the conventional face-to-face modality.

But while it becomes a highly utilized modality during the pandemic, online learning could be at risk with various disasters. Its dependence on the internet and power supply makes it highly vulnerable to the intensifying impacts of climate change. In countries like the Philippines, where power supply and telecommunication facilities are severely affected by disasters (Rudnick, 2011), online learning institutions should develop a disaster preparedness program that could support their teaching and learning continuity plan while enhancing their teacher's and learners' academic restoration, recovery, and rehabilitation capabilities. While the program is highly imperative (Tkachuck et al., 2018), it has received little attention from online learning-providing institutions. Collecting online learners' geographic data, analyzing their distribution in areas with high vulnerability to natural disasters, and determining the student support implications of the pattern are initial steps towards developing such a program, hence, the study.

The study aimed to: (a) analyze the learners' exposure of online learners to risks of natural hazards in the Philippines; and (b) determine its student support and policy implications. The analysis has been facilitated using a geographic information system (GIS). GIS is a valuable tool for spatial pattern analysis studies with categorical data for decision-making (Franch-Pardo et al., 2020).

Review of Related Literature

The Philippines is ranked as the fourth most at-risk country globally to climate-related natural disasters such as typhoons, flooding, and extreme temperature (Alcayna et al., 2016). These hydrometeorological events accounted for 80% of the natural disasters in the country (Jha et al., 2018). The Philippines is also among the world's top three countries with the largest population exposed to natural disasters (United Nations Office for Disaster Risk Reduction [UNDRR], 2015a). Furthermore, Anttila-Hughes and Hsiang (2013) reported that average losses in the country remain high even in highly adaptive regions due to increases in average population exposure to wind speed during a typhoon. In fact, in 16 years, about 23,000 people died, and roughly 125 million were affected by natural disasters between 2000 and 2016 (Jha et al., 2018).

The recurrence of disasters in the Philippines can compromise the effectiveness of online learning as a mode of teaching and learning. The increasing frequency of strong typhoons and extreme floods in the country can negatively affect several critical infrastructures such as electricity and internet towers that support online learning. Aside from being destroyed, these facilities may not be able to withstand the increased stress during post-disaster usage, and consequently, may fail to accommodate the increasing demands of the affected communities (Choi et al., 2016). For instance, the power supply in affected communities may be rationed by electric cooperatives to avoid operation disruption of the remaining plants after a disaster. Internet service providers may even discontinue their services to allow rehabilitation of their affected infrastructures.

These and other post-disaster rehabilitation activities for the facilities will significantly impact learners' access to learning activities and participation in peer interactions and discussion forums in online education. Power and internet service interruptions can negatively affect the performance of learners in their studies. According to Bisharyan (2021), online learners in the United States have fallen behind on schoolwork because of power outages and unstable internet connections. The condition was acute for underprivileged learners who did not have access to a stable internet connection (Bisharyan, 2021). Walravens (2020) reported that power outages due to disasters during online education had marginalized the underprivileged learners. Delos Reyes (2021) reported a similar situation in the Philippines, where rotational power outages after a typhoon or other natural disasters have complicated the challenges that poor internet connection creates

among rural learners. These learners are unable to fully participate in their online classes that are either synchronously or asynchronously conducted. Alam (2020) and Bao (2020) had indicated the impact of inadequate participation in the teaching-learning process on the mental health of online learners. They reported that learners had developed a negative perception of online learning, which might increase their psychological distress. Such psychological distress has been complicated by the fear of losing an academic year. Hasan and Bao (2020) also stated that fear of academic year loss enhanced learners' psychological anxiety.

These impacts highlight the importance of making online education resilient to disasters. Though the need for resilient online learning is glaring, its development has received little attention from education managers and academic institutions worldwide. However, academic continuity is necessary since education is considered a key driver for sustainability. The UN Sustainable Development Goal (SDGs) emphasized that quality education promotes core societal values, including sustainable lifestyles, respect for human rights and diversity, and culture of peace and non-violence (Bartusevičienė et al., 2021). According to Bartusevičienė et al. (2021), online learning providers must continue to deliver uninterrupted quality education through adaptations and adjustments to their learners even during a disaster.

Methodology

The study was conducted following a descriptive design approach where data were processed and analyzed using a geographic information system. Means and percentages were computed, and there has been no attempt to do any inferential statistics with the data.

The total enrollment data (n = 3,225) during the First Semester and First Trimester of the Academic Year 2020–2021 was used in the study. Students' data on geographic location were retrieved from the Office of the University Registrar's (OUR) database in an online learning university in the Philippines. Geographic location refers to the students' municipality or city of residence. The total number of students per geographic location was requested from the OUR and used as the value for each geographic ID, which was named following the official political name of the municipality or city in the GIS-enabled map. The resulting map was then labeled the "Student Distribution" map.

Likewise, the level of risk was determined using the qualitative description used by the Center for Environmental Geomatics, Manila Observatory, as reflected in their natural disasters' vulnerability maps for the entire country. The maps were downloaded from their website, http://vm.observatory.ph, as open access. Since these were jpeg maps showing the level of vulnerability of each municipality to natural disasters, they were converted into vector maps in the GIS. The attributes tables for these maps were populated with the levels of risks to the three commonly occurring hazards in the country, namely, typhoons, extreme rainfall, and earthquakes. However, a combination of the climate-related risks was also considered in the analysis. There were five (5) levels of vulnerability used in the study, namely, very high, high, medium, low, and very low, which corresponds to the levels of risk to natural disasters computed for each of the municipalities. The resulting maps were labeled "Vulnerability Maps."

Data Privacy and Confidentiality

To address data privacy, only aggregated data per geographic location were collected and reflected in the analysis and discussion of the results. Permission from the OUR was also secured to use such a data set.

Data Analysis and Visualization

The students' vulnerability level to natural disasters was determined and analyzed using the GIS software's georeferencing extension. The maps for the student distribution and vulnerability were intersected. The resulting map was re-coded to reflect the number of students across vulnerability levels on each polygon. The percentage of the students in each vulnerability level was then computed. Data were visualized as tables and maps.

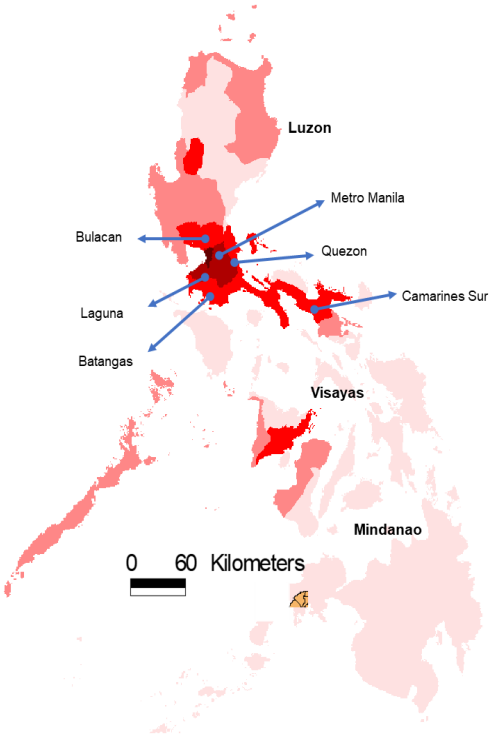
Results and Discussion

Spatial Distribution of Students

Students enrolled during the first semester and first trimester AY 2020-2021 were highly concentrated (n = 3,062, 85%) in the Metropolitan Manila areas and the municipalities and cities of Laguna, Bulacan, Batangas, and Quezon though some were in Camarines Sur and Iloilo (Figure 1). This is critical since most of these places are highly vulnerable to climate-related natural disasters such as flash floods, typhoons, extreme rainfall, and landslides or mudslides.

Figure 1

Spatial distribution of students



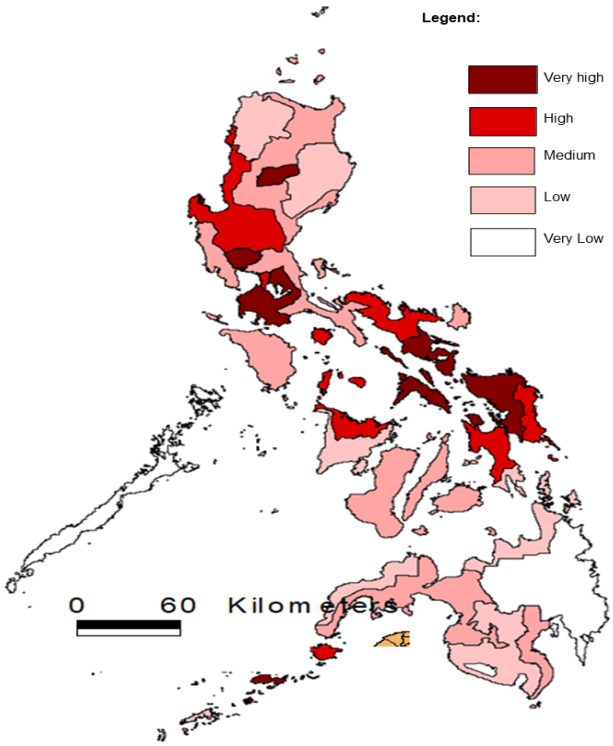
Note. Base map adapted from Manila Observatory-Center for Environmental Geomatics, 2005; Student data were retrieved from the OUR database with permission.

For instance, Marikina City, which is located along the eastern border of Metro Manila, suffered from a severe flood event on November 12, 2020, due to Typhoon Ulysses (Marquez, 2020). In 2009, the Metro Manila area had been affected by a flood due to Typhoon Ondoy. The flood had caused more than 200 fatalities and affected almost a million people throughout the metropolitan areas (Sato & Nakasu, 2011). Moreover, the provinces of Laguna, Quezon, and Batangas had suffered significantly from the impacts of Typhoon Glenda in 2014. According to Francisco (2014), the typhoon had toppled down trees and

powerlines, resulting in widespread blackouts in these areas. The recurrence of these disasters highlights the need to develop strategies that can make online learning more adaptive and resilient to the impacts of these disasters. This is necessary because the computed risks to climate-related disasters for these areas are high to very high (Manila Observatory-Center for Environmental Geomatics, 2005), as indicated in Figure 2. Areas with high or very high risks to disasters have a higher likelihood that lives would be lost, and properties and infrastructures would be damaged (UNDRR, 2015b).

Figure 2

Combined Risks to Climate Disasters



Note. Base map adapted from Manila Observatory-Center for Environmental Geomatics (2005). Student data were retrieved from the OUR database with permission.

Meanwhile, students from the Visayas region (n = 132) constituted only 4% of the total enrollment while students from the Mindanao region have recorded no enrollment during this term. However, it must be emphasized that the data utilized in this study came from the enrollment report for the first trimester and first semester AY 2020-2021 only. The university may have students based in the Visayas and Mindanao regions but was unable to register during this term. Hence, it is recommended that a study involving enrollment data in various terms and academic years be conducted to widen the temporal scope of the analysis. Moreover, it is possible that similar student support and policy implications can be derived from the analysis.

Exposure of Students to Rainfall Change Risks

The intersection of the student distribution and vulnerability maps revealed that about 80% of the total number of students enrolled during the period of the analysis is residing in areas with high to very high risks to changes in rainfall patterns (Table 1).

Table 1

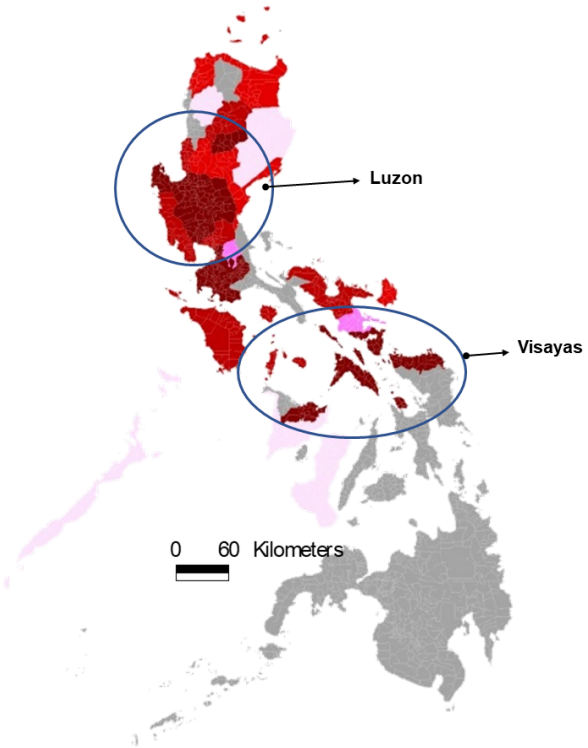
Percent distribution of students by level of risk to rainfall change

Level of Risk	Total Number	Percent
Very High	2,290	71
High	290	9
Medium	194	6
Low	193	6
Very Low	258	8
Total	3,225	100

As indicated in Figure 3, these students are distributed in the Luzon and Visayas regions specifically in the municipalities of Ifugao, Tarlac, Pampanga, Metro Manila, Cavite, Laguna, Batangas, Rizal, Quezon, Northern Samar, Masbate, and Capiz. These students are highly vulnerable to the impacts of flash floods and landslides as consequences of the changing rainfall patterns (Marengo et al., 2021). These consequences can be catastrophic and detrimental to the students' academic performances, especially when the infrastructures that support online learning are damaged during the occurrences. Guzzetti et al. (2012) indicated that landslides could result in massive loss of life and destruction of infrastructure and housing. Kocaman et al. (2020) cited similar impacts and reported that flash floods and landslides could cause loss of many lives, displacement of people, and collapse of critical infrastructures such as power lines, hospitals, water supply, and large construction. Power outages and internet disconnections due to these disasters can create significant academic impacts on online learning, given that such a modality is greatly dependent on these facilities.

Figure 3

Risks to Rainfall Change



Note. Base map adapted from Manila Observatory-Center for Environmental Geomatics (2005). Student data were retrieved from the OUR database with permission.

In a study by Rotas and Cahapay (2020) on the difficulties in remote learning due to the pandemic, power interruptions and unstable internet connections were among the factors identified that affected students' learning motivation and performance in an online learning modality. Ragobeer (2020) also pointed out that internet disconnection can create fear among online learners, leading to stress and anxiety. On the other hand, Campbell (n.d., as cited in Ragobeer, 2020) argued that power outages could be more stressful to students because of the uncertainty of when the power will be restored. The presence of stress and anxiety among online learners is critical because these can affect their cognition, physiology, and behavior (Huberty, 2009), which can significantly affect their academic performance (Ajmal & Ahmad, 2019).

Exposure of Students to Risks of Typhoons

Although only 4% of the total enrollees during the period of analysis were in areas with very high risk to typhoons, about 83% were within places with high risk to such a hazard (Table 2).

Table 2

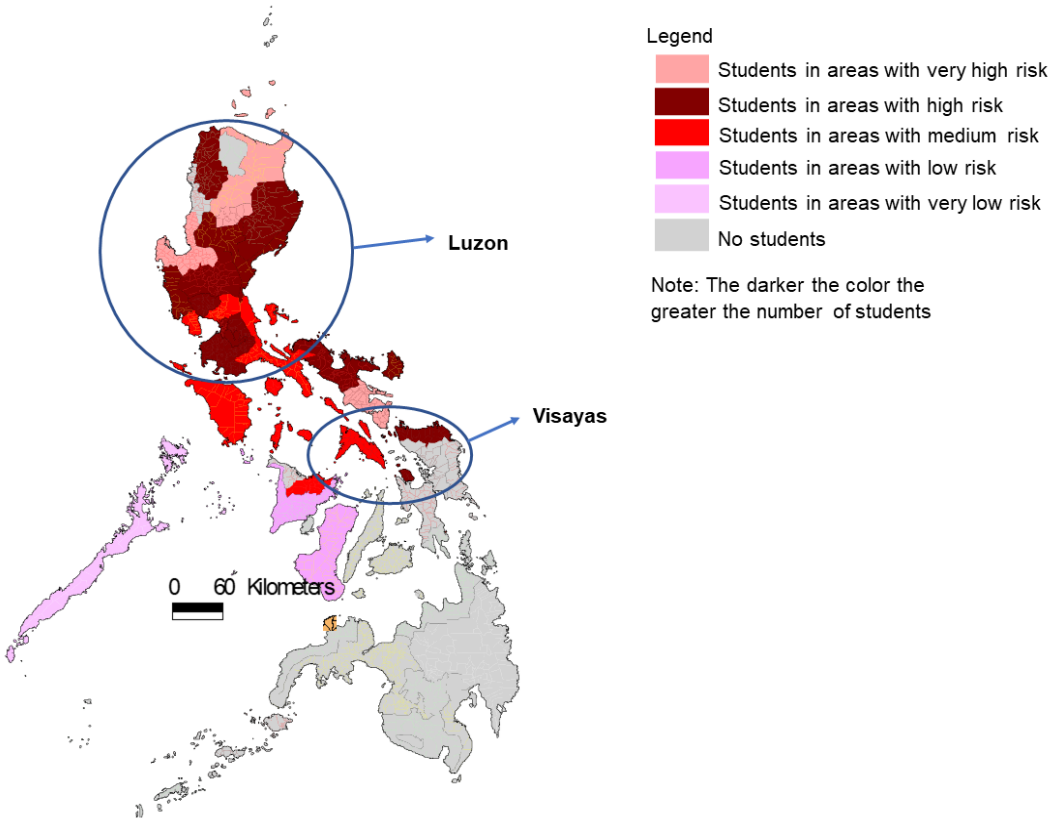
Percent distribution of students by level of risk to typhoons (n = 3,225)

Level of Risk	Total Number	Percent
Very High	129	4
High	2,677	83
Medium	258	8
Low	129	4
Very Low	32	1
Total	3,225	100

As with the change in rainfall patterns, students in Luzon especially those living in Ilocos Norte, Abra, Ifugao, Pampanga, Metro Manila, Quezon, Laguna, Batangas, Bataan, Zambales, Pangasinan, Benguet, Bulacan, Camarines Norte, Camarines Sur, and the Bicol region as well as students in the Visayas provinces (e.g., Northern Samar and Biliran) are highly vulnerable to typhoons (Figure 4). Specifically, as indicated in Figure 4, most of the students who are vulnerable to typhoons during the period of analysis are in Luzon. But this pattern may change, especially when more and more students from the Visayas and Mindanao islands will be re-enrolling in the succeeding academic years.

Figure 4

Student distribution by level of risk to typhoons



Note. Base map adapted from Manila Observatory-Center for Environmental Geomatics (2005). Student data were retrieved from the OUR database with permission.

Nonetheless, this situation can be considered a "double disaster" (Cueto & Agaton, 2021) for these students considering that Luzon has also been the center of the recent pandemic. There have been studies (e.g., Ku, 2020; Cueto & Agaton, 2021) indicating the increasing impacts of this state of "double disaster" on the mental wellness of online learners. For instance, Ku (2020) reported that the impacts of Super Typhoon Rolly that hit the country in November 2020 had negatively affected the mental health of online students in the Bicol region. Online students were stressed and depressed because they failed to participate in their online interactions, access their learning materials, and submit their assignments and outputs of the learning activities. After the typhoon, the power supply outage and the intermittent internet and mobile signal in the region disrupted students' access to their virtual classrooms (Ku, 2020).

In addition, Cueton and Agaton (2021) reported that the occurrence of natural disasters during the lockdown from pandemic in the country had brought stress to students, especially those who need to be relocated to evacuation centers. Students expressed their anxieties about failing to complete their requirements and access their online learning, aside from their worries of being infected by the COVID-19 virus within the evacuation facilities (Cueton & Agaton, 2021). Thus, the concentration of students in areas with high to very high risks to typhoons highlighted the need to provide mental wellness support to students to minimize both disaster-related and academic-related stresses and depression.

Exposure of Students to Earthquake Risks

Unlike the trends in the first two hazards, the spatial analysis of the data indicates that only a few students who were enrolled within the period of analysis are exposed to medium to high risks in terms of earthquakes. To cite, about 9% (n = 290) of the total enrolled students included in the study are in areas with high risks to the earthquake, while more than 60% of the students (i.e., 65%, n = 2,097) are in areas with medium risks to an earthquake. Specifically, these students are distributed in areas like Metro Manila and its nearby provinces of Cavite, Batangas, Bulacan, Aurora, and Rizal and the provinces of Bicol and Eastern Visayas regions (Figure 5). These areas have existing active fault lines, which may move anytime and cause significant damage including toppling down of critical infrastructures such as power lines and internet towers. Both facilities are important in the delivery and access of online learning courses. For instance, Pacific Consultants International (2004) conducted an earthquake damage analysis for Metro Manila and nearby areas that indicated a gloomy scenario for these areas. According to their analysis, the Metropolitan Manila areas will possibly be separated into four regions because of the impacts of the earthquake. These impacts include a collapse of buildings, immobility due to the collapse of major bridges and flyovers, cutting of communication and power lines, and interruption of water supplies. Likewise, the earthquake that jolted the Eastern Visayas region in 2017 had triggered power interruptions in the affected areas such as Tacloban and Ormoc City (Bartolome, 2017).

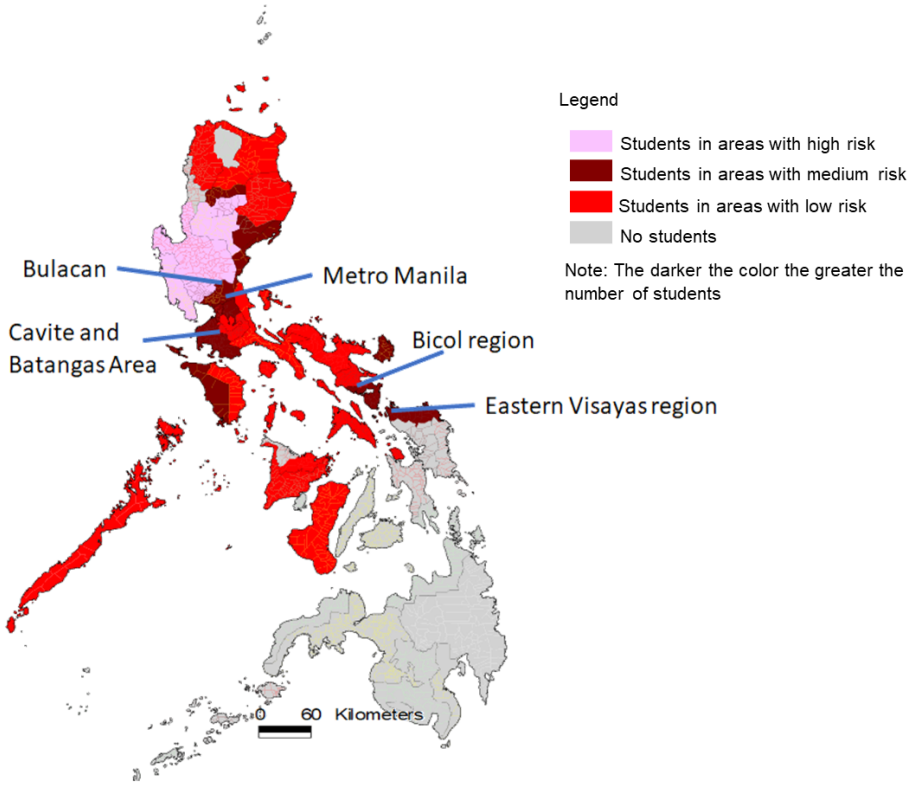
Thus, it is important to consider how to manage the impacts of this hazard in the teaching-learning continuity plan of the University.

Implications for Student Support and Policy

The occurrence of climate-related hazards such as typhoons and floods, as well as geologic-related hazards such as earthquakes and landslides, should be an important consideration in an online learning environment. Though all teaching and learning transactions in this modality may take place in a virtual environment, online learning is highly vulnerable to power outages and internet service disruption during a disaster. Thus, it is imperative for online learning institutions to create and establish a student support system that allows continuity of the teaching-learning process. The creation of this system should be supported with policies.

Figure 5

Spatial distribution of students by level of risks to earthquake



Note. Base map adapted from Manila Observatory-Center for Environmental Geomatics (2005). Student data were retrieved from the OUR database with permission.

In the current study, it is observed that most of the learners are distributed in areas with high to very high risks to climate-related hazards such as typhoons, changes in rainfall patterns, and floods. Such spatial distribution pattern implies that most students could be disconnected from their virtual classes whenever these hazards occur in their area. A student support system that provides an offline learning experience for these students is necessary. It means that the learning materials, activities, and/or interactions should have offline equivalents to allow these students to continue their learning process amidst disruption in power or internet services. For instance, learning materials can be in downloadable formats so that students can download and use them even if they are not connected to the internet. A policy that supports free downloading, using, and storing of materials outside of their original online repository sites should be formulated so that students can be legally protected from any copyright infringement issues. However, such a policy should provide the limitations on the distribution and reproduction of materials to protect the copyright of the authors or institution over them unless they are published as open educational resources.

Likewise, the institution should also invest in a learning management system with an offline feature or one that supports offline access to the course contents. Such a learning management system feature allows students to engage in self-paced offline learning according to their learning conditions after a disaster (Paradiso, n.d.). Allowing the learning process to continue even in an offline mode may reduce students' anxiety from being disconnected from their classes. As Ragobeer (2020) reported, students have developed anxiety when disconnected from their online classes due to internet service interruption. Thus, the offline feature of a learning management system can help address this concern (Paradiso, n.d.).

In addition, a student support system should ensure flexibility in the teaching-learning process. Such flexibility could range from extending the deadlines of submission of course requirements to having diverse assessment tools. Diversifying the assessment approaches to learning does not only address the impacts of disasters on the teaching-learning process but also ensures the appropriateness of a tool on the current learning environment of the students after a disaster. It should also provide an enabling environment to the faculties-in-charge to identify, develop, and implement such a variety of tools.

The vulnerability of students to both climate and geologic-related disasters necessitates that the online learning-providing institutions establish a student support system that addresses the impacts of disasters on students' mental health. According to Makwana (2019), disasters can result in the mental instability of the victims, which might precipitate Post Traumatic Stress Disorder, anxiety, and depression. These disorders may affect the learning process of the students (Bisson, 2017), which may lead them to disengage from their classes. To minimize, if not eliminate the desire to drop out from their courses after a disaster, the student support system should be able to assist and connect students to available resources that will sustain them in their path of success (Bisson, 2017). A policy that allows such assistance and connection should be formulated by and implemented in the institution.

Conclusion

There is an increasing demand for online learning, especially with the uncertainty of the current pandemic. However, the high dependence of online learning on the availability of power and internet services makes it highly vulnerable to the impacts of disasters. Because the Philippines is a disaster-prone country, it is important to analyze the spatial distribution of online learners in the country to the risks of such natural hazards as typhoons, floods, extreme changes in rainfall patterns, and earthquakes. The use of GIS has facilitated this analysis in the current study.

Results have indicated that most online learners enrolled during the First Semester and First Trimester of the academic year 2020–2021 in an open and distance e-learning university in the Philippines are distributed in areas with high to very high risks to climate-related hazards such as typhoons and floods. However, this spatial pattern may change if the university's total student population is included in the analysis and a more recent geospatial distribution of risks to natural hazards in the country will be used in the GIS analysis.

Nonetheless, the current pattern has significant implications for student support and policy formulation. The concentration of students in areas with high to very high risks to climate-related hazards necessitates the creation of a student support system that allows self-paced offline learning either as an important feature of the learning management system of the university or an integral part of its course delivery and management system. For instance, such a support system should allow students to download, use, and save their learning materials outside of their original repository site. The student support system should also ensure flexibility in the teaching-learning process and address the impacts of disasters on students' mental health. The provision of assistance and connection to available resources that could help students overcome their depression and anxiety due to the disaster must be an important feature of the student support system. All processes and activities of this support system should be backed up with policies.

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