GIS Analysis for Vocational School Site Selection for Disabled Community in Vietnam

BSAN 6100

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Executive Summary

This GIS project addresses the urgent need for well-situated vocational schools for the disabled in Vietnam, particularly in the southern regions. Our study, utilizing ArcGIS Pro's Weighted Overlay and Location-Allocation tools, assessed potential school locations across key districts. Five potential sites were identified, alongside existing schools considered as competitors. Kernel Density Analysis revealed high concentrations of vocational schools in Ho Chi Minh City and Hanoi, underscoring the southern districts' lack of such facilities. The Weighted Overlay tool was instrumental in integrating factors like land use and public transport accessibility. The Location-Allocation analysis then determined the most accessible site for students, enhancing the potential for equitable educational infrastructure distribution. The findings provide valuable insights for decision-makers, aiding in the establishment of vocational schools in strategic locations to serve disabled students effectively and facilitate their social integration.

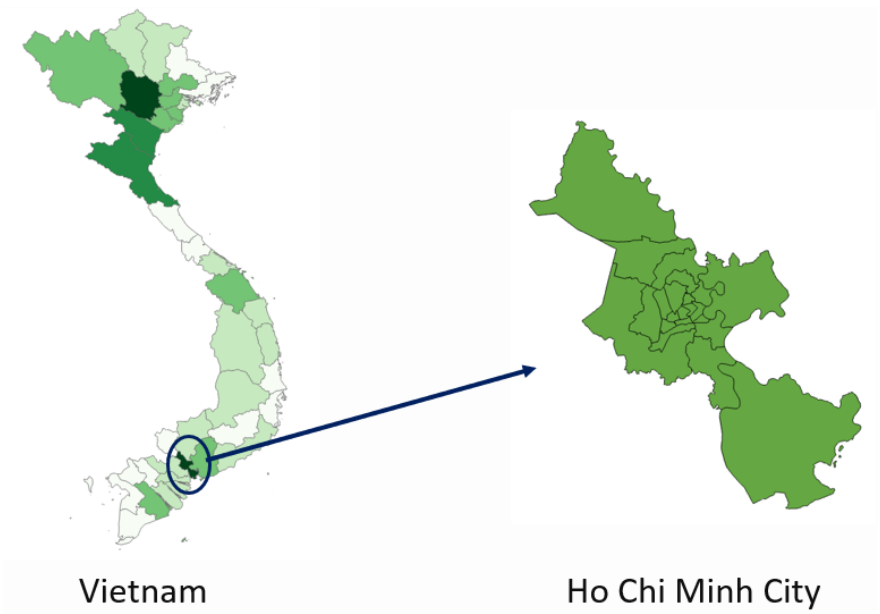
Introduction and Problem Definition

In Vietnam, the challenges faced by people with disabilities (PWDs) in accessing vocational education are significant, particularly for those from low-income backgrounds. With only 31.7% of PWDs participating in the labor force, compared to 82.4% of non-disabled individuals, the disparity is stark. Given that 93.4% of disabled individuals over the age of 16 lack technical qualifications and many have faced job losses during the pandemic, enhancing vocational training is crucial.

Our GIS study aims to identify accessible locations for new vocational schools, considering public transportation and essential services, and factors in population density

and proximity to existing educational facilities. This approach is designed to strategically improve educational and employment opportunities for PWDs, aligning with Vietnam's efforts towards a more inclusive society.

Our study area began as the entire Vietnam and then drilled down to city level, specifically Ho Chi Minh city, as it will be more feasible due to its high population density, significant economic and social development, and comprehensive data availability for in-depth analysis. The detailed reasons we chose Ho Chi Minh city will be detailed in the subsequent section (IV. Analysis and Result).



Data Processing

1. Feature Class Details

	Name	Description	Data Source	Type
1	Vietnam Boundary	The geographical boundary of Vietnam, defines the study area.	https://data.humdata.org/dataset/cod-ab-vnm	Polygon (Shapefile)

2	Disability Population Density	Indicates areas with higher concentrations of the disabled population, important for targeting the school's location effectively.	Enrich Data from ArcGIS	Polygon
3	Land Use	Shows different types of land use in Vietnam. Categories: #1: Water #2: Urban/Built-up #3: Rice #4: Other Crops #5: Grass/Shrub #6: Woody Crops/Orchards #7: Barren #8-11: Forests and Aquaculture	https://www.eorc.jaxa.jp/ALOS/en/dataset/lulc/lulc_vnm_v2309_e.htm	Raster (TIFF)
4	Spending Level	Regions by average spending, identifying areas with lower living costs to support student affordability.	Enrich Data from ArcGIS	Raster
5	Hospitals	Locations of hospitals, indicating access to medical facilities.	https://data.nextgis.com/en/region/VN-SG/base	Point
6	Public Transportation	Locations of public transportations, ensuring convenient travel.		Point
7	Current vocational schools	Locations of existing schools, useful for understanding educational infrastructure and avoiding overlap.	http://gdnn.gov.vn/AIAdmin/AIGIS/GISDetail.aspx	Point

2. Process

A) Data Collection

The majority of the datasets needed for our analysis were readily available and easily obtained. We sourced disability data from a publicly accessible database. For comprehensive information specific to Ho Chi Minh City, we procured data from a GIS Data Company at a nominal cost of $5, ensuring access to up-to-date and relevant geographic information. This data acquisition process laid the foundation for our detailed GIS analysis.

However, a challenge was encountered in sourcing the current vocational school's data. This particular dataset lacked a direct download option, necessitating the implementation of a web scraping technique. Utilizing custom coding, we were able to efficiently extract the necessary data from the website.

B) Data Cleaning

Most of the data were ready to use, but some required specific cleaning and processing to align with our analysis needs:

- **Disability Population**: The existing data included separate figures for overall population density and the percentage of disabled individuals. To create a more relevant dataset, we calculated the disability population density in ArcGIS and saved this as a new, distinct feature.
- **Land Use**: Initially represented as a color map indicating continuous data, the land use raster was modified to a categorical format with **'Unique Value'** symbology. This change facilitates identification of distinct land use types and is crucial for the subsequent weighted overlay analysis, where each land use category is assigned a different suitability score. The revised data was saved as a new feature.

- **Spending Level**: Initially captured as a polygon, this data is converted to raster format using **'Polygon to Raster'** for reclassification purposes. This enables its use in weighted overlay analysis.
- **Current Vocational Schools**: The original dataset contained only the addresses of the schools, lacking geographical coordinates. We utilized Google API with Python programming to extract latitude and longitude for each location. Further data cleaning was undertaken to remove duplicates and address missing values. The enriched dataset was then added to ArcGIS using **'X, Y to Points'** features, subsequently saved as a new feature. Alongside with current vocational schools, we filtered out the schools that served specifically for the disabled community using **'Select by Attribute'** features.

C) Spatial Analysis

Our spatial analysis is segmented into three distinct parts: Hot Spot Analysis, Weighted Overlay, and Location Allocation. Initially, we conducted Hot Spot Analysis, determining the study area based on population density to identify regions with high demand. Next, in the Weighted Overlay phase, we assign weights and suitability scores to various data layers, and then amalgamate them to formulate a suitability map. Lastly, utilizing this map, we select five provisional locations for potential schools and proceed with Location Allocation to ascertain the most optimal site among these choices.

D) Result Interpretation

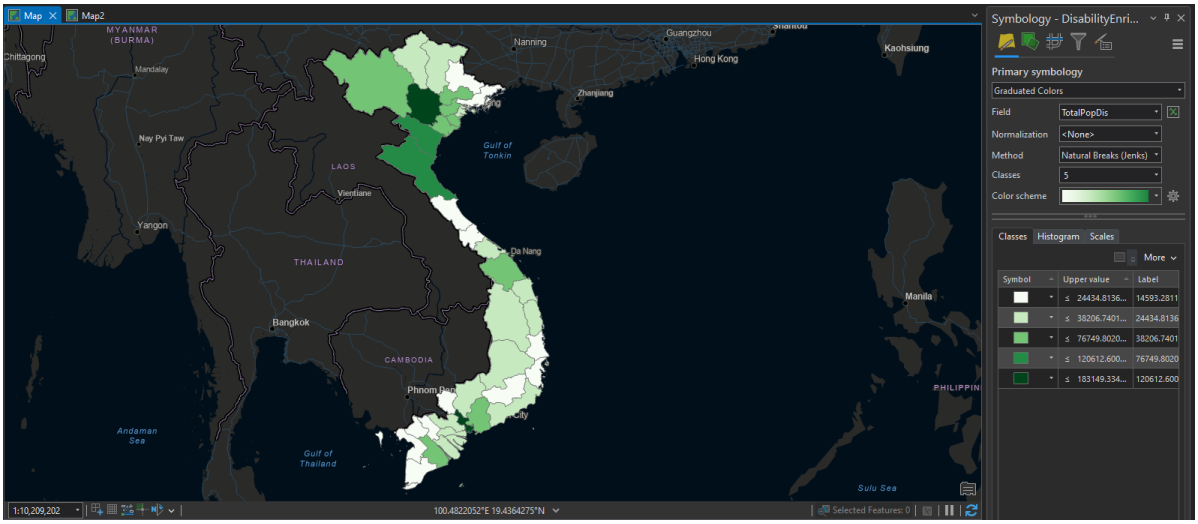
Following the completion of our spatial analysis, we proceed to the Result Interpretation phase. This involves a thorough examination of the suitability map, with the

aim of pinpointing the ideal locations for the new school, guided by the insights gleaned from our comprehensive analysis.

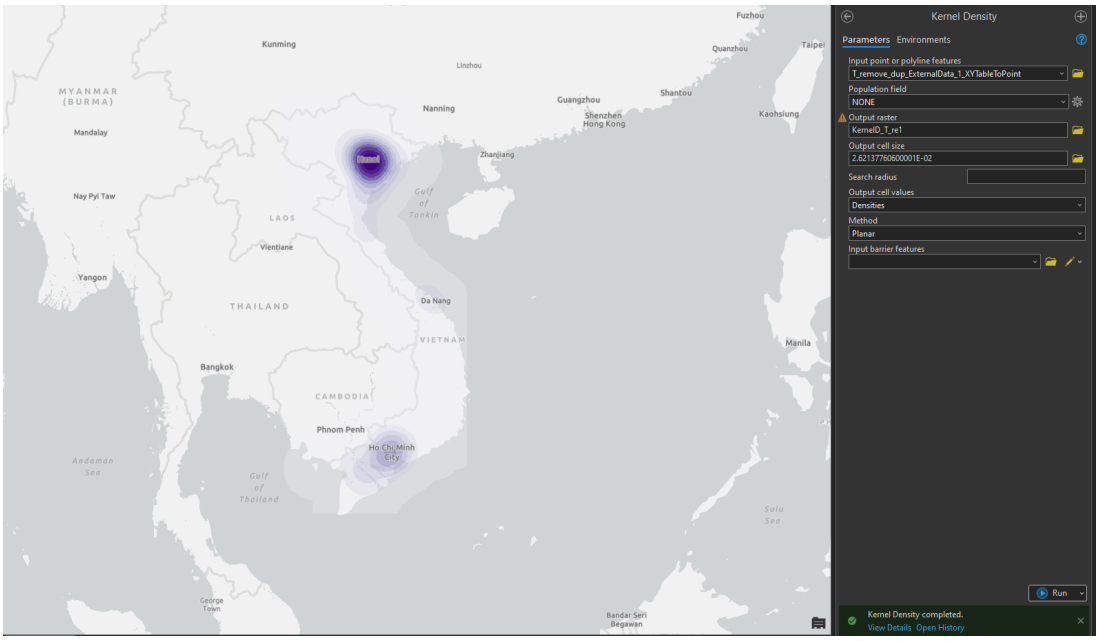
Analysis and Result

1. Kernel Density Analysis

Using a combination of disability data segmented by city level, as well as population data by city. We performed a variety of hot spot analysis methods to determine the concentration of disabled populations. The result concluded for 2 biggest metropolitan areas, which also reflects accurately in the real world, as disabled vocational students and workers tend to work and reside in the city and visit their family in the countryside during breaks. When comparing the two metropolitans, we decided to focus on Ho Chi Minh City as it seems to be the more underserved market for vocational schools compared to Hanoi.

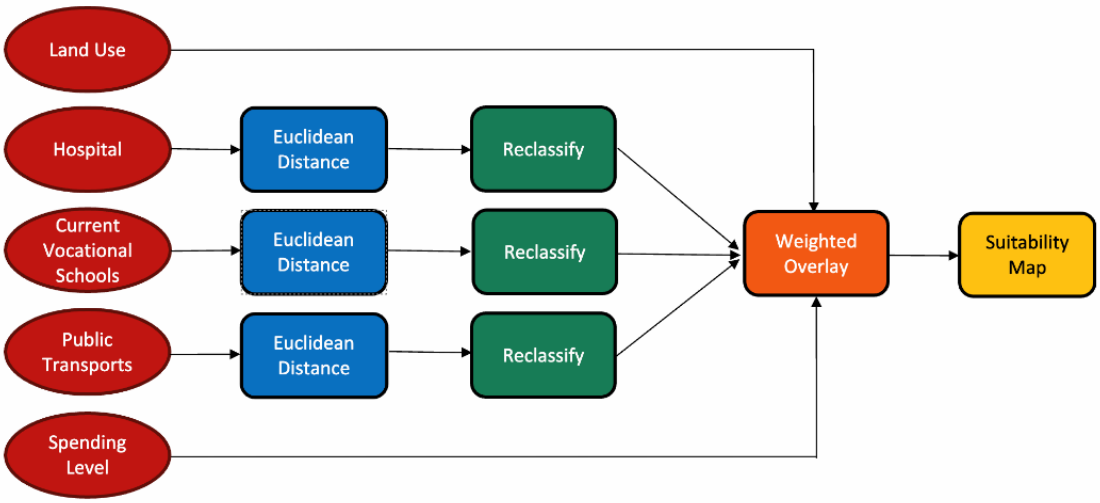


To validate our decision, we performed a kernel density analysis to determine where most of the vocational schools in the country are located. Further concludes that Ho Chi Minh City presents itself as the underserved area for the vocational school markets.



2. Weighted Overlay

The Weighted Overlay process involves calculating the Euclidean distance from point features, reclassifying these distances into a common suitability scale, and then combining them with other reclassified factors using assigned weights to produce a final suitability map. We decided to use **Land Use**, **Hospitals**, **Current Vocational Schools**, **Public Transportation** and **Spending level** as criteria for finding the most suitable areas to build a new school for the disabled population.

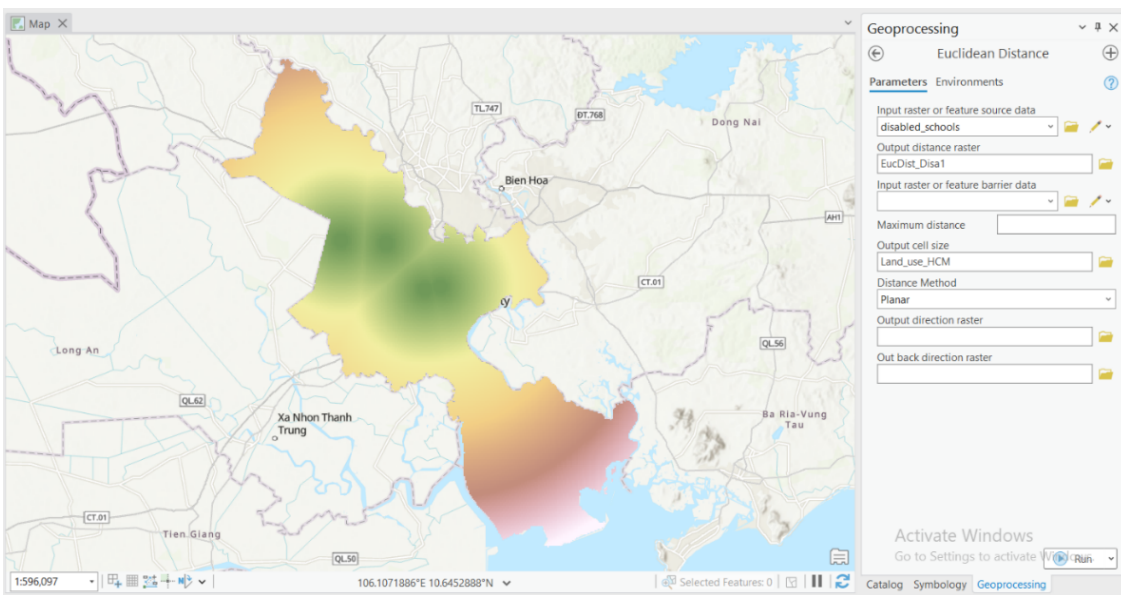


The weighted overlay process involves these following steps:

<u>Step 1</u>: Calculate Euclidean Distance for point features

For **Hospitals**, **Current Vocational Schools,** and **Public Transportation** point features, we calculated the Euclidean distance for each feature, which is the straight-line distance from each cell in the raster to the nearest hospitals, schools, and public transportation.

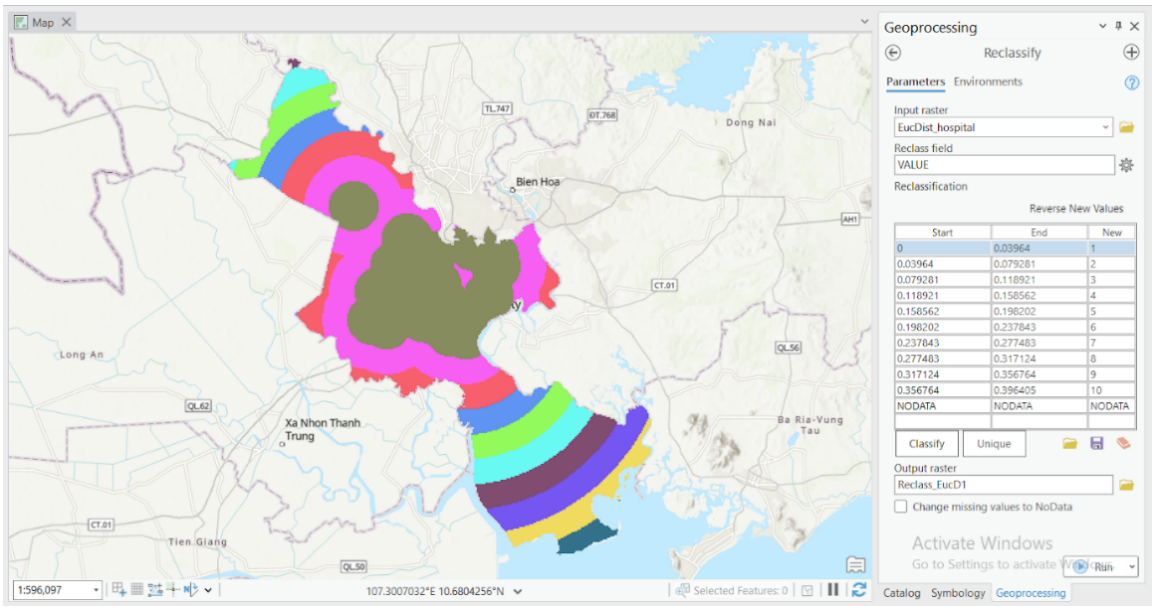
This is done using the **Euclidean Distance** tool. We also set the same Cell Size: Land Use to all features to make sure that they have the same spatial resolution, can be directly comparable and accurately combined to generate a suitability map.



(Example of Calculating the Euclidean Distance for Current Vocational Schools feature)

<u>Step 2</u>: Reclassify Distance Raster

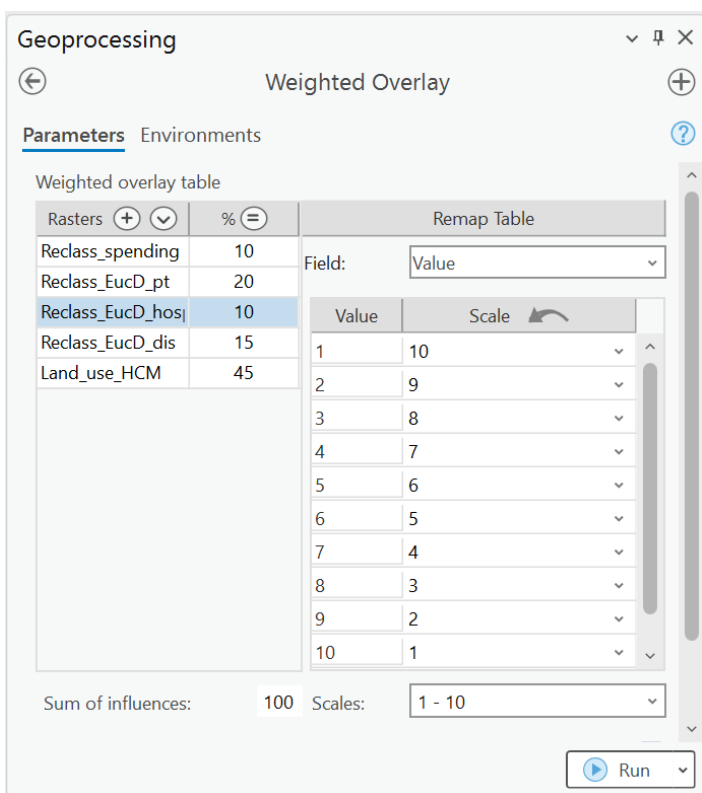
The distance raster (**Hospital**, **Current Schools,** and **Public Transportation**) now needs to be reclassified into a common scale that represents their suitability. This is done by using the **Reclassify** tool in ArcGIS. We reclassified these distances into 10 distinct classes using the Equal Interval method, each representing a specific range of distances.



(Example of Reclassifying the Hospital feature)

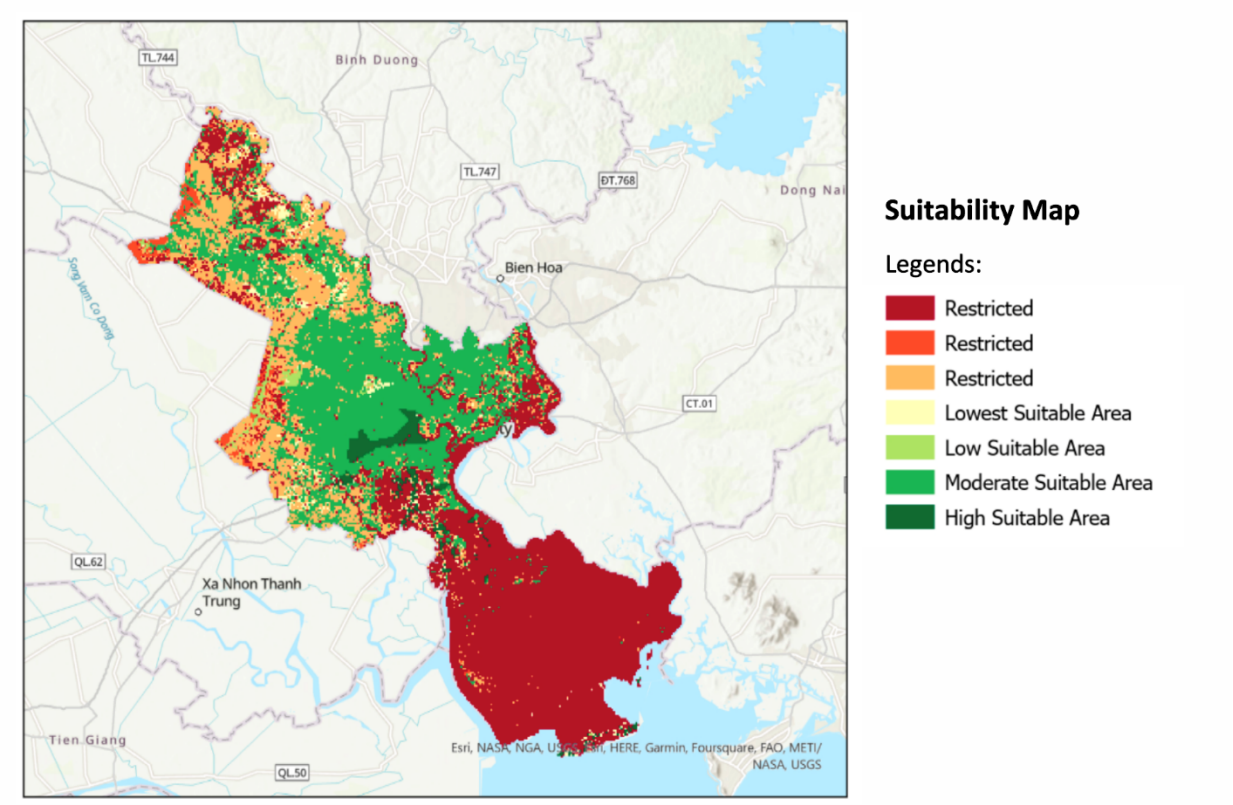
<u>Step 3</u>: Assigning Weights

In the Weighted Overlay tool, we set the scale to 10 and added all the criteria into the Weighted Overlay table then assigned weights to each feature.



Features	Scale	Percent Influence
Land Use	- Water and Other Forests: Restricted - Urban/Built-up: 10 - Rice: 3 - Other Crops: 4 - Grass/Shrub: 6 - Woody Crops/Orchards: 3 - Barren: 2	45%
Hospital	For proximity to hospitals, crucial for easy access to medical facilities, we assigned the highest value of 10 to the closest range (the first value), decreasing incrementally to 1 for the farthest range (the tenth value).	10%
Current Vocational Schools	For proximity to current schools, to avoid building in already served areas, we inverted this scheme, assigning a value of 1 to the closest range and increasing to 10 for the farthest range, encouraging the placement of new schools in less-served locations.	15%
Public Transportation Points	We prioritized proximity to extensive public transportation networks by assigning higher values to areas with greater access, ensuring that students relying on this mode of transit can reach the school conveniently and affordably.	20%
Spending level	Areas with a lower cost of living received a higher rating, aiming to ease the financial burden on students, making daily expenses more manageable and supporting their educational journey.	10%

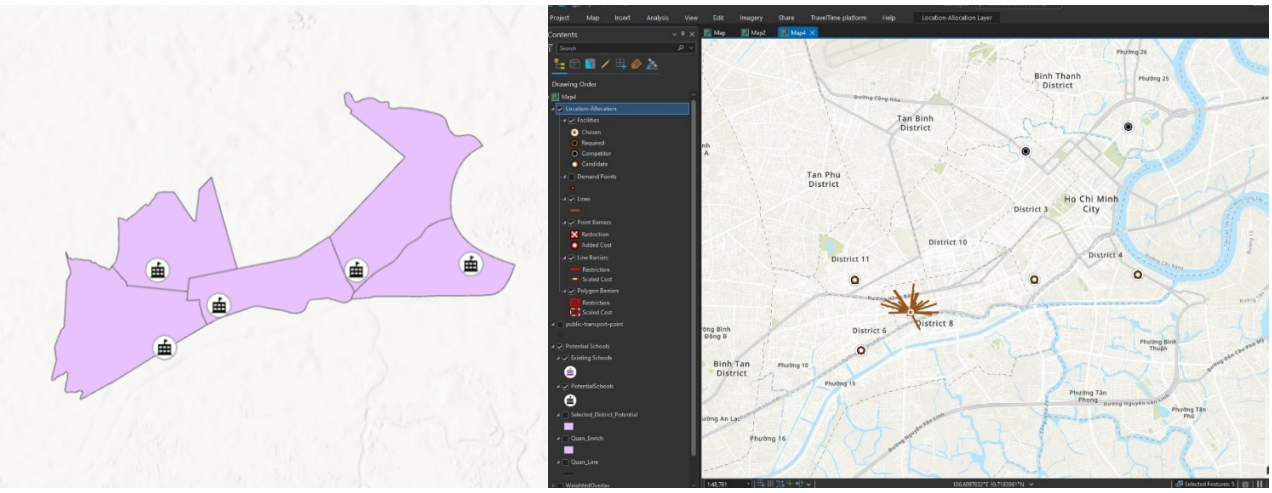
After running the analysis, we come up with the following suitability map, showing varied land use potential. Gradients of red to orange areas are 'Restricted', unsuitable for development, while green patches indicate 'High Suitable Areas' for potential use. Gradients of yellow to light green denote low to moderate suitability, reflecting a nuanced assessment of the region's viability for specific purposes.



After examining the greenest areas on the suitability map, which denote 'High Suitable Areas,' it was determined that these regions correspond to **Districts 1, 4, 5, 6 and 11**. These districts have been selected for further analysis in Location Allocation to assess their potential for development and to determine optimal sites.

3. Location Allocation

After identifying the top districts in Ho Chi Minh City as viable candidates for a new vocational school for disabled individuals. Within these districts, we generated five random locations using ArcGIS Pro's Random Points Generator, designating them as potential construction sites granted preliminary approval.



Our analysis required two types of points: facilities and demand. We classified the hypothesized locations as facility points, alongside existing disabled vocational schools, which we considered as competitors. For demand points, we selected bus stops, reflecting our focus on accessibility for economically disadvantaged students. Our objective is to pinpoint the location that encompasses the highest number of bus stops within a one-mile radius, thereby maximizing accessibility and convenience for our prospective students. The result is the chosen facility noted in star as the best location out of all candidates.

Calling for Action

Our findings highlight an urgent need for vocational schools in Vietnam's southern region, tailored to the disabled community. We urge policymakers and educational authorities to prioritize the establishment of these schools in identified areas. Collaboration with local communities and disability advocacy groups is essential for ensuring that the schools meet the specific needs of the students. Additionally, investment in accessible transportation and infrastructure is crucial. By acting on these recommendations, we can make significant strides towards educational equity and inclusion, providing disabled students with the opportunities they deserve to thrive and contribute meaningfully to society.

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