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BUILDING MAINTENANCE: DETERMINE OF FUNGAL GROWTH ON OFFICE BUILDING USING GEOGRAPHIC INFORMATION SYSTEM (GIS)

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Abstract:

This paper presents the preliminary concept using a Geographic Information System (GIS) to determine fungal growth in an office building, especially in the UiTM Perak branch. As we all know, various viruses and bacteria exist in our environment. The quality of the air affects our health throughout the day. If the quality of the air is polluted, then it is very likely that we will get sick and vice versa. In this research the methodology applied is using geocoding in GIS applications. Analysis using a GIS is used to find the contributing factors to the reproduction of fungi on the walls of the buildings being studied. Based on the obtained results it can be concluded that the proposed methodology creates a convenient, efficient, and inexpensive tool for massive inspection of building resources in large areas. There are several processes to investigate the effects of buildings factors contributing to fungal growth cases such as the creation of rooms database, temperature derivation process and lastly data analysis using the attributes spatial table. Finally, the location of the rooms where the fungal growth is determined is shown by the map results.

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Keywords:

GIS, Fungal Growth, Mould Growth, Office Building, Health, Spatial Table

Introduction

Employees often spend more than a third of their daily lives at work 5 days a week regardless of where they work, be it in offices, factories, construction sites, hospitals, business centers and so on. The workplace environment has a very effective influence on the life of every employee not only in terms of social and safety but also in terms of their physical and mental health. A safe workplace will ensure good health for employees, thereby increasing employee productivity (Arifin et. al 2019).

Various health issues and risks often exist in relation to the workplace environment which is caused by several factors such as indoor air quality, lighting, noise, cleanliness and so on. Among the diseases caused by the workplace environment are outbreaks of infectious diseases such as severe acute respiratory syndrome (SARS), influenza virus A (H1N1), bird flu, dengue, chikungunya, malaria, building-related illness or building syndrome. sick (sick building syndrome) and so on. (Park & Chang, 2020)

As we all know, there are various viruses and bacteria that exist in our environment. The quality of the air affects our health throughout the day. If the quality of the air is polluted, then it is very likely that we will get sick and vice versa. The indoor air quality of a building will be polluted due to factors such as mouldy ceilings or walls, cigarette smoke, biological air pollutants such as animal hair, and so on.

Research shows that the ventilation system for a good office space depends a lot on the air conditioner used. If the air conditioner is not working properly, it affects the humidity level of the room. This atmosphere creates discomfort for employees. If the internal temperature of the organization is too hot, it increases fatigue and disturbs the emotions of the employees. Otherwise, it can cause skeletal muscle disorders and affect long-term health. (mediapermata, 2022)

The ventilation system in the office space or building needs to function properly. Also, make sure the building room has good air flow if it is used for a long period. This ventilation will help the air to go out and in and help to get rid of contaminated materials from accumulating in the room or space. We also need to make sure the air conditioner works well throughout the day. An air conditioner that operates well in a room or building is able to control the humidity level of the room. Air conditioners equipped with filters trap dust and other air pollutants. Therefore, it is important for users to keep this filter clean, changed or washed regularly according to the recommended schedule. For the organization, periodic maintenance is essential to ensure the quality of the air in the building is good and healthy to be inhaled. The humidity level of the room also needs to be controlled. High humidity can encourage mould growth on ceilings and walls. (mediapermata, 2022).

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Literature Review

Geographic Information System (GIS)

GIS is a spatial-visualization, computer-based tool that visualizes, analyses, stores, and manipulates geographic information. According to Mandala (2019), In the healthcare industry, GIS is useful in merging the geographic and health care data to identify the relationships among various environmental factors, enduring diseases, hospitals accessibility and utilization, variables that are specific to health or illness. GIS has huge applications in health access and planning, health promotion, community profiling, disease surveillance in many countries. GIS includes different tools that enables working with multiple data layers concurrently and accomplish different spatial analysis to identify. According to Zhou, Su, Pei, et. al., (2020) with a complete technological path for data preparation, platform creation, model construction and map output, GIS has developed and matured very swiftly.

The key difficulty is coming up with ways to modify established technical procedures and increase the efficiency and precision of information delivery for social management. In identifying the places where mould growth is more likely to occur, temperature, humidity, and moisture data can be analysed using GIS. GIS can assist in identifying locations that are at risk for mould growth due to factors like poor ventilation or moisture intrusion by superimposing this data with maps of building materials. GIS can be used to monitor the progress of mould inside a building or across a broader area. GIS can help detect developments and possible sources of mould contamination by mapping the location and extent of mould growth over time. Overall, GIS can be a beneficial tool for recognising and managing mould growth by providing a better understanding of the environmental elements that contribute to its growth as well as the location of places at risk for contamination.

According to Ma, Q. (2021) the temporal and spatial evolution can be impacted by spatial and temporal distribution analysis, which can also identify significant clusters of the illness, investigate potential variation rules, and ascertain whether the observed space-time patterns of the epidemic are random or the result of chance.

According to Boyacı (2022) GIS is a computer-based tool utilised in a variety of fields, including public health, emergency management, environmental sciences, and land management. GIS is a strong tool because it can be used to ask intricate questions about the environment, combine feature analysis, and then display numerous parts of the findings on a map. GIS enables the analysis of numerous elements based on spatial data, including monitoring, risk factor evaluation, control strategy formulation, and process management. In distinct layers, the spatial and non-spatial data are merged and can be queried and analysed jointly in GIS Xia (2022).

Geocoding with ArcGIS

According to Duncan, Castro, Blossom, et. al. (2011), the process of matching addresses to geographic coordinates, is a necessary first step when using geographical information systems (GIS) technology. However, different geocoding methodologies can result in different geographic coordinates. Geocoding is the process of converting a physical address to a location on earth's surface such as latitude and longitude coordinates. The process of batch geocoding is to geocode multiple addresses as a batch through submitting the list of addresses to be

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geocoded in the form of a comma separated values (CSV) file or an excel file. (Paramasivam & Venkatramanan, 2019).

With the help of statistics and geographic information systems, spatial analysis can be carried out using a variety of approaches GIS. A GIS enables it for attributes to interact with geographic data in order to enhance interpretive accuracy and spatial analysis prediction. The spatial analysis used in GIS can create geographic data, and the information that results will be more relevant than simply collected data. A suitable geospatial method is selected and integrated with GIS depending on the needs of the end user. The classification and analysis approach will be influenced by the selection of geospatial technique. (Paramasivam & Venkatramanan, 2019).

According to Al-Kindi (2020) different spatial statistics of any epidemic risk, such as distribution, hotspots, orientation, and spread trajectories, can be determined using a wide range of GIS tools. The used GIS techniques in this context to look into regional variations in disease incidence, visualise the information about the epidemic and geographic tracking of pandemic hotspots over the research period. This is a first, but crucial step in understanding how spatial variation in incidence relates to various environmental, socioeconomic, topographic, and demographic factors. It is also important for a spatiotemporal prediction of the speed and magnitude of regional transmission in the near future.

Additionally, spatial data can be validated, its quality assessed, or it can be simulated in real-time. Urban planning frequently makes use of data from geographic information systems. As spatial objects, buildings and installations can also have information recorded and analysed in GIS. Buildings Information System can be used to manage and distribute data on buildings (spatial and characteristics). (BIS). Advanced Computer Aided Building Management (CAFM) systems already exist and include GIS system functionalities. They are particularly utilised for renting, leasing, and managing space. They often use 2D data, such as 2D CAD drawings and dimetric views of buildings. These systems' user interfaces are often accessible from your computer's desktop or through a web browser (Mitka,2015).

The GIS integrates geographic and attribute data using spatial analytic tools and modelling techniques to get computational findings. It then analyses and visualises geospatial, environmental, and natural resources. (Wu et al., 2018). Better use of spatial and attribute data on urban areas is made possible by the GIS's solid database base and computational ability to manage multi-source data.

Mould Analysis

Mould identification in buildings can be a challenging task, as there are many different types of mould that can grow in various parts of a building. It is important to identify and address mould growth in a building as quickly as possible, as mould can pose health risks and cause structural damage over time.

According to Wahab et. al. (2014), mould or microscopic organisms can be found anywhere around, both indoors and outside. Oxygen, a proper temperature, nutrients, and water are all necessary for fungus growth. As they expand, spores that are common in the environment and will float indoors are produced as a means of reproduction. These spores will develop into fungal colonies that eat the organic materials to stay alive if they settle on damp or moist

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organic material. This scenario may result in some property damage and health issues (Ghosh et al., 2015) as shown in Figure 1.

Source: Wahab (2019)

Figure 1. Visible Mould Growth

According to Jamaludin et. al. (2015), one of the standards for sustainable buildings is the indoor thermal environment. The occupants' indoor environment must fulfil this requirement in order to be safe. The sustainability of the building design may be effectively integrated if environmental concerns were taken into account early in the design process. Numerous things must be taken under consideration when designing comfortable room environments (Chong & Low, 2006). These factors include human physiological characteristics like body metabolic rate and level of activity, as well as microclimate conditions like moisture, temperature difference, air temperatures, and air movement.

Material and Methods

This research was conducted in Perak. This study is focused on buildings at UiTM Perak branch campus, Seri Iskandar, the selection of government offices in this study is based on various complaints that are often heard about government buildings having a low level of maintenance, safety and cleanliness. Analysis using a GIS is used to find out the contributing factors to the reproduction of fungal on the walls of the buildings being studied. There are several processes to investigate the effects of buildings factors contribution fungal growth cases such as the creation of rooms database, temperature derivation process and lastly data analysis using the attributes spatial table. The overall research framework was described in Figure 2.

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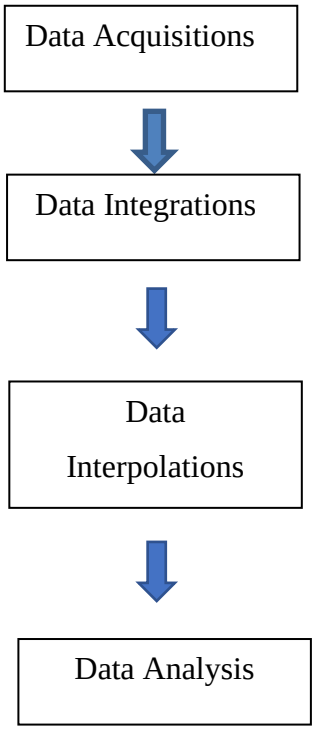

Figure 2. Research Design

The data involved in this study started from 2020 to 2021 when the MCO was carried out in Malaysia due to the Covid-19. These data include diverse data related to the factors that contribute to the growth of fungal. The respondents were given a questionnaire as part of the study. Which is the question regarding visible mould that appears in such areas as rooms, walls, ceilings, floors, HVAC systems, and any other potential locations where mould growth is likely. Take note of any visible mould signs, such as discolouration, musty odours, or physical growth. The data collected in Google Forms and Excel is then used to rearrange the data obtained from Google Forms. The csv data obtained will be processed using GIS methods to show the location of the office where there is fungal growth, if before, the data could only be displayed through a report without further analysis. The data obtained in this study will be integrated in a GIS application with analysis and shown in the form of mapping for the locations of the rooms where fungal are present in this study. The software used in this study is ArcGIS and AutoCAD, the development of a GIS Database is carried out by performing a data entry process that involves the entry of spatial data that requires data conversion activities into a format that can be supported by the system. The process of entering attribute data is to convert the form of the shared space usage table into the database table format. The combination of spatial data and attribute data in GIS in a standardized format allows users to quickly update, share, retrieve, manipulate, and analyze data. Spatial data must be projected according to the actual projection, which is to obtain the actual coordinate position on the surface of the earth for the spatial data. The image in Figure 3 shows a table of addresses in a CSV file format.

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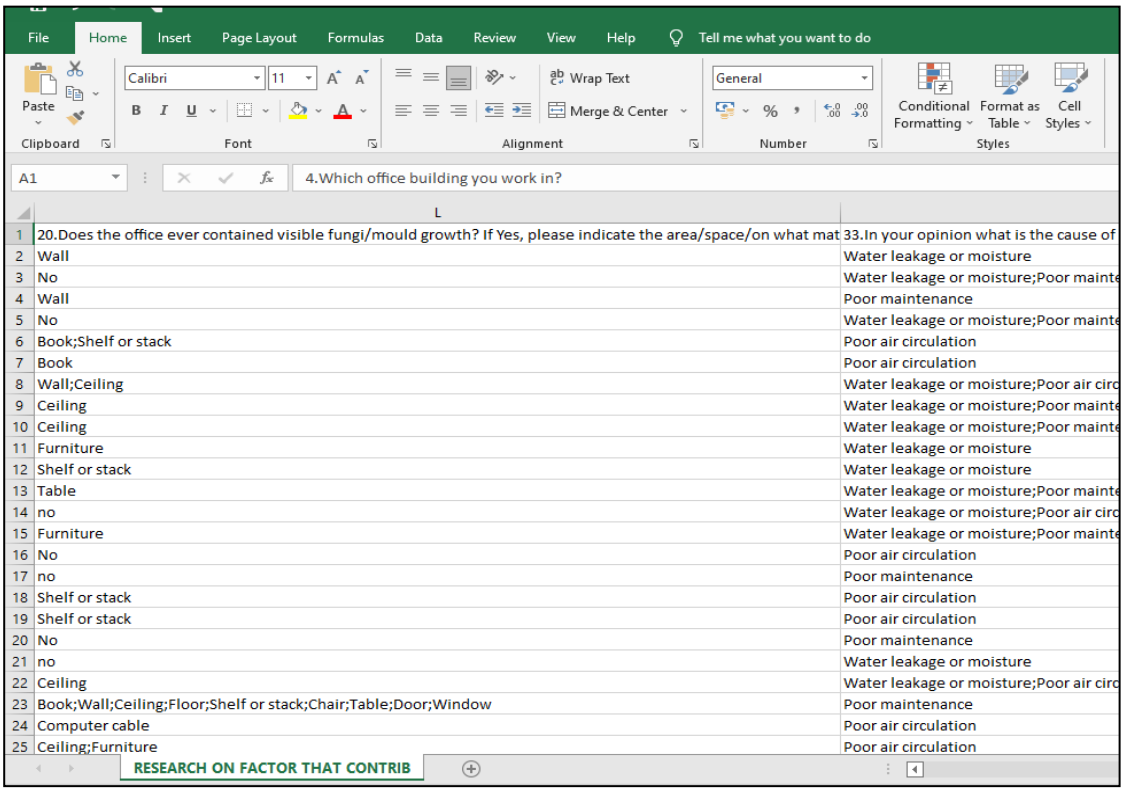

	L	
1	20.Does the office ever contained visible fungi/mould growth? If Yes, please indicate the area/space/on what mat	33.In your opinion what is the cause of
2	Wall	Water leakage or moisture
3	No	Water leakage or moisture;Poor mainte
4	Wall	Poor maintenance
5	No	Water leakage or moisture;Poor mainte
6	Book;Shelf or stack	Poor air circulation
7	Book	Poor air circulation
8	Wall;Ceiling	Water leakage or moisture;Poor air circ
9	Ceiling	Water leakage or moisture;Poor mainte
10	Ceiling	Water leakage or moisture;Poor mainte
11	Furniture	Water leakage or moisture
12	Shelf or stack	Water leakage or moisture
13	Table	Water leakage or moisture;Poor mainte
14	no	Water leakage or moisture;Poor air circ
15	Furniture	Water leakage or moisture;Poor mainte
16	No	Poor air circulation
17	no	Poor maintenance
18	Shelf or stack	Poor air circulation
19	Shelf or stack	Poor air circulation
20	No	Poor maintenance
21	no	Water leakage or moisture
22	Ceiling	Water leakage or moisture;Poor air circ
23	Book;Wall;Ceiling;Floor;Shelf or stack;Chair;Table;Door;Window	Poor maintenance
24	Computer cable	Poor air circulation
25	Ceiling;Furniture	Poor air circulation

Figure 3. Data Of Research In. Csv File

Results and Data Analysis

Fungal growth is an important ecological process that plays a crucial role in nutrient cycling and decomposition. GIS technology has been used to document and analyse fungal growth patterns in various ecological communities. These systems have been utilized to map and predict fungal growth potential in different regions to better understand the ecological impact of fungi. Using GIS for mould growth analysis allows for a spatial perspective that can provide insights into the spatial patterns, trends, and potential factors influencing mould occurrences in buildings. It helps in identifying high-risk areas, prioritizing remediation efforts, and developing strategies for mould prevention and control. Additionally, GIS technology has allowed researchers to overlay fungal growth data with other environmental factors such as temperature, humidity, and soil moisture content in order to identify correlations and better understand the factors that contribute to fungal growth. GIS technology has also enabled researchers to create 3D models of fungal growth and their habitat, which provide a realistic view of the physical environment in which the fungi thrive. Furthermore, GIS technology has proven to be a valuable tool in identifying and monitoring the spread of fungal diseases. This aids in the development of effective management strategies to prevent or reduce the spread of fungal diseases that pose a threat to human and animal health, as well as to the health of various ecological systems. In Figure 4. and Figure 5 shows display of mould data with table building location in ArcMap.

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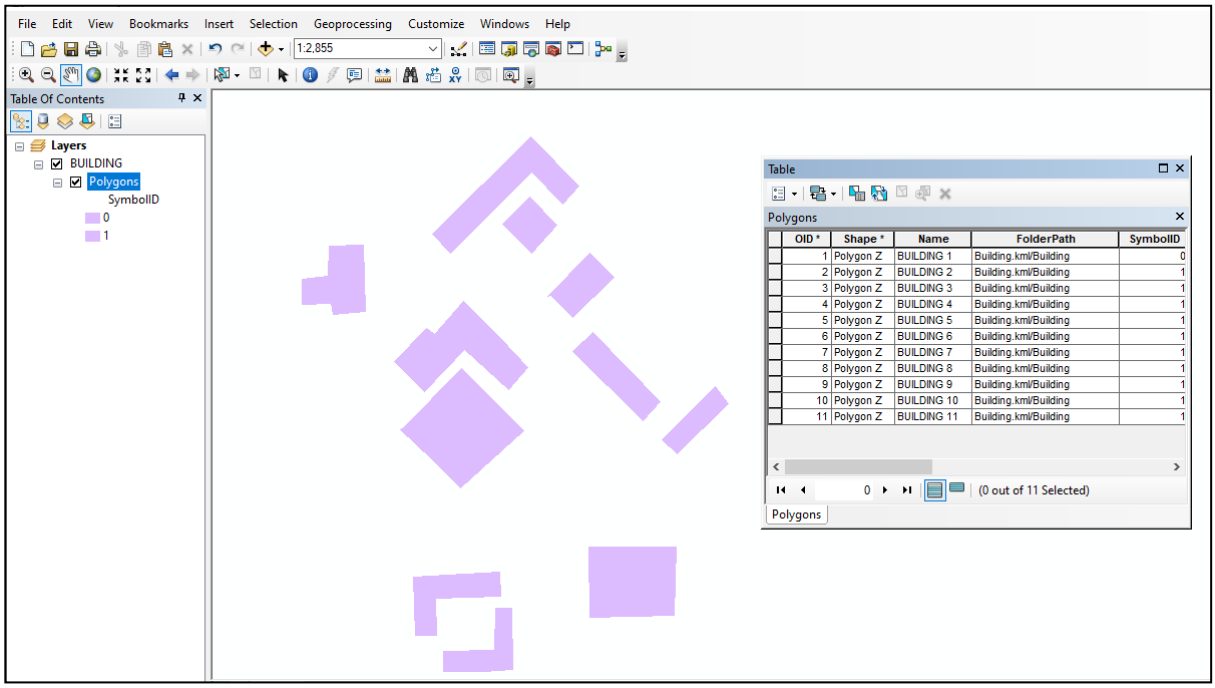

Figure 4. Mould Data Display with Table Building location in ArcMap

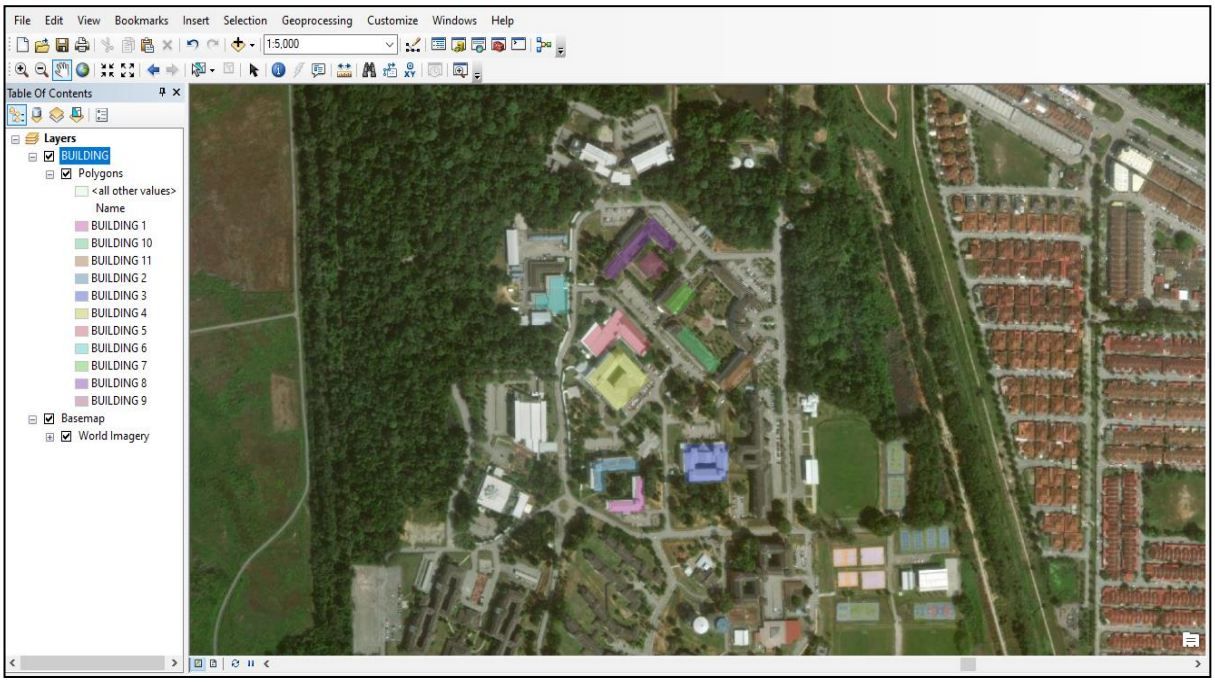

Figure 5. Location of Buildings from Base Map in ArcMap

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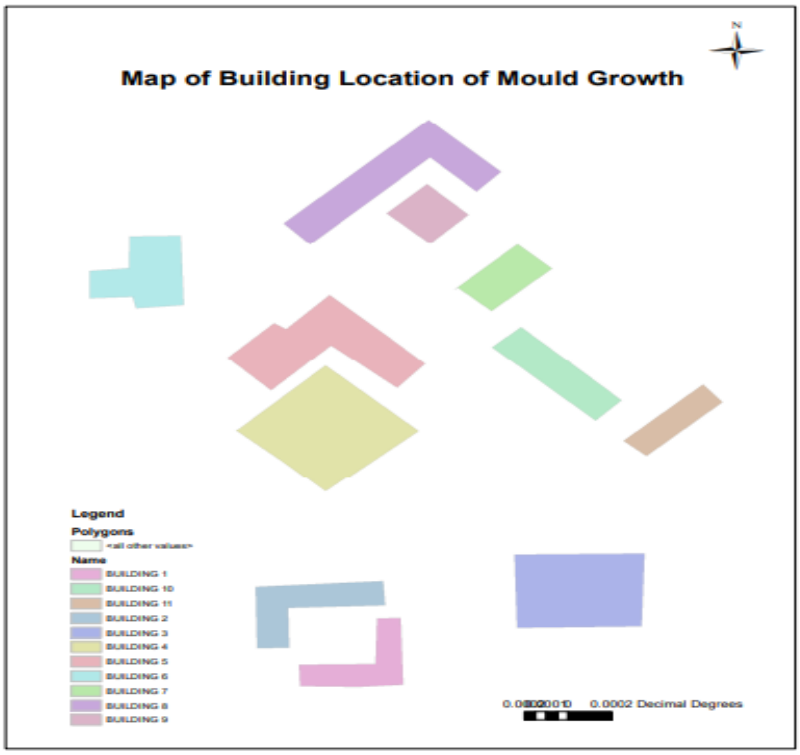

Figure 6. Map of Location Building Fungal Growth

The image in Figure 6 shows a table of addresses in a SHAPEFILE file format.

Conclusion

GIS technology has opened new avenues in the study of fungal growth in buildings. By utilizing GIS, researchers can spatially analyse data related to building characteristics, environmental conditions, and fungal growth patterns. This allows for a better understanding of how different factors such as temperature, moisture levels, and building materials can impact the prevalence and distribution of fungi. Furthermore, GIS can aid in identifying areas within buildings that are at higher risk for fungal growth, as well as tracking the spread of fungi over time. The use of GIS technology can also assist in developing effective strategies for preventing or mitigating fungal growth, by pinpointing areas where remediation efforts would be most effective.

GIS provides a powerful tool for studying and addressing fungal growth in buildings, improving our ability to manage the risks posed by these common indoor contaminants. Moreover, GIS can help in mapping the distribution of different types of fungi within buildings and identifying any potential hotspots that require attention. This can aid in developing targeted prevention and remediation strategies, reducing the negative impacts of fungal growth on indoor air quality and occupant health. In conclusion, GIS technology offers a promising approach to studying fungal growth in buildings.

Its spatial analysis capabilities enable researchers to gain insights into the factors that contribute to fungal growth, identify high-risk areas, and track its spread over time. Therefore, it has the potential to revolutionize how we manage fungal growth and improve indoor air quality in

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buildings. Furthermore, the integration of GIS with other technologies such as remote sensing and building information modelling (BIM) can offer even more detailed insights into fungal growth and aid in developing more targeted prevention and remediation strategies. Overall, the objectives achieved in this study involve utilizing GIS to create spatial maps, identify risk zones, integrate environmental data, optimize resource allocation, and provide decision support for building maintenance activities related to fungal growth in an office building. The study would be expanded in the future to include multiple office buildings in different locations to compare the prevalence and characteristics of fungal growth. This would enable a better understanding of regional differences, building-specific factors, and potential mitigation strategies.

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