# THE USE OF GIS ANALYSIS FOR LAND ACQUISITION COMPENSATION

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**Abstract.** This paper discusses the GIS analysis techniques that can be applied for land acquisition compensation due to development. According to Section 3, Land Acquisition Act 1960, the state government has the authority to take back land for the purpose of fulfilling the needs of the people or the public. However, the parties involved must be given reasonable compensation as provided under Clause 13 of the Malaysian Federal Constitution. The GIS analysis techniques highlighted in this paper are overlay and buffer analysis. The concept of the GIS analysis is explained at first before the method were discussed based on an example of a problem on how it was conducted. As a result, the land acquisition area including the owners involved and total of compensation can be estimated and displayed in GIS output. This shows that the GIS analysis is capable to produce an accurate estimation of the land acquisition area and the compensation can be given in a fair and transparent manner.
**Keywords**: *buffer, compensation, GIS, land acquisition, overlay*

## Introduction

The introduction of Geographic Information System (GIS) has simplified the work in map production because by using GIS the map produced is in digital form and it saves a lot of map processing time compared to manual map production. In 1960 the analysis of spatial data took a few minutes but today we can analyze a lot of data in just a few seconds by using GIS (Seker et al., 1998). The increasing technology nowadays also increases the effectiveness of GIS analyzing data in a short time. This will reduce the cost and energy in producing a map. One of the basic GIS analyses are overlay and buffer. It is important to know this type of analysis especially for the GIS beginners. This paper will explain first the concept of this method, specifically the overlay analysis which consists of clip, intersect, union and cut techniques. Next, the buffer analysis concept would then be described. After that, the application for land acquisition compensation would then be conducted to show the usage of this method. Other than the two methods, the technique of area estimation and calculation of the amount of compensation were also discussed in this paper.

### *Traditional Mapping and GIS*

If compared to the usage of traditional maps, the GIS will be the better choice among the researcher in mapping as it can ease their work. In addition, GIS includes spatial data and attribute data that can be used for GIS analysis where the result is an accurate digital map. In contrast, traditional mapping produced an unchanged permanent map once generated (Eboy and Sieng, 2019). A comparison between mapping using GIS and traditional mapping shows that through GIS applications, the work of mapping becomes easier. The advantage of mapping using GIS is that although in the early stages of preparation is a bit tedious but fast and efficient to monitor, while for traditional mapping the preparation must start from the beginning all the time. In terms of storage,

GIS provides a standard digital database and integrated compact memory capacity while storage for mapping traditionally, the scale is different at different and large standards. Furthermore, by using GIS mapping, data can be retrieved quickly and updated with automatic search and replace it only by using a computer. Instead, mapping has traditionally retrieved data through paper maps and tables as well as updating the data by reviewing manually and needing to be reviewed. In addition, for overlays in mapping using GIS is done systematically and faster integration of complex, multiple spatial and non-spatial data sets. Overlapping in traditional mapping is expensive and time consuming. Finally, spatial analysis and display in mapping using GIS will be faster and easier to provide better quality. On the other hand, traditional mapping is slow, tedious and time consuming (*Table 1*).

***Table 1***. *Comparison of traditional mapping and digital mapping*.

| Activities | Digital Mapping | Traditional Mapping |
|---|---|---|
| Preparation | Preparation is a bit complex but any error can be undone anytime | Need to do from the start every time encounter error |
| Storage | Stored in digital database which is small in physical size and can bring anywhere | Have many physical sizes and heavy if in bulk |
| Retrieval | Fast data retrieval | In hardcopy maps |
| Updating | Can change map every time when new elements appear | Need to do manually check and redraw map |
| Overlay | Process can be done faster even when many data involved | High cost and time consuming |
| Spatial Analysis | Very quick | Very slow and a lot of manpower needed |
| Presentation | Easy, fast and accurate | Very hard, slow and inaccurate |

*Source: Ulep (2007)*

### *Overview of Land Acquisition*

Under the Land Acquisition Act 1960 in Malaysia, land can be acquired by the authority legally (Government of Malaysia, 1960). Although this is legal, but it is a serious violation on the right to property. Eventhough, the law has been changed in certain aspects (Brown, 1991), there are still some parts of the law which need to be amended (Jain and Xavier, 1996). Normally in the past, the courts instructed that a fair amount of compensation in terms of money must be given to the respective owner. However, the complication that usually occurs is to find out what is the right amount of compensation required to be paid? The concept of market value often used by the practitioners which is also stated under the laws of required acquisition. In any acquisition of land, the laws instructed that authority need to pay a fair amount of compensation. Unfortunately, the "fair compensation" is very abstract and can be manipulate in many ways unless solid evidence can be given (Fricke, 1984). Market value and fair compensation are not stated in acquisition laws, thus it sometime can be said not the same thing. However, it is practically can be used (Khublal, 1994). Therefore, it is possible for the authority to give a fair compensation provided that each representative involved in land acquisition will do their part accordingly in just and fair manner (Khublal, 1994). Although using market values as a basis for compensation is good enough but additional payment or a percentage of the value should be paid to all or some of the property owners or occupiers. This is acknowledged by Epstein (1985) in which any constraints on the rights of others must be serve as a form of implicit, in-kind

compensation. For example, an average reciprocity can be justified as mean of compensation for the residential landowners due to zoning restrictions in a residential area. Such as the study in Aberdeen (RICS, 1995; Rowan-Robinson, 1990) in which a supplement was paid and if the compensation is too high, compulsory purchase need to be made by the owners or occupiers.

The meaning of fair compensation is very hard to define as it has different types of interpretations in different states or countries. Some countries such as United States use market value as the only mean of compensation for the owners whose land was possesed. However, some countries feels that market value is not enough as other losses affected by the previous owners must also be compensated such as in UK (Denver-Green, 1994) and most Commonwealth countries such as in Hong Kong (Cruden, 1986). In a contrary, the compensation given by country in China are lower than the adequate value based on the current compensation laws. This is due to the principle of fair compensation not being in place (Chan, 2003). In Malaysia, there is a concern regarding the payment of a fair or adequate or just compensation to the respective owners (Usilappan, 2000). Although the constitution required the payment of any land acquisition with a fair amount of compensation using market value and other type of losses that stipulated in the act, but owners still suffer. The act has gone through various changes which lead to the owners with less compensation such as relocation of place, losses in business and planned use. On the other hand, even though most jurisdictions have omitted the betterment, the clause is still included in the act (Usilappan, 2000; Xavier, 1995; Buang, 1993). Based on the above discussions and the present trend of compensation under the land acquisition laws in Malaysia, there is a need to produce a fair and adequate compensation to the respective landowners. Therefore, the usage of GIS is one of the methods that can provide this. The capability in identifying the area involves and accuracy in the estimation of the compensation makes GIS a better solution in solving the problem.

## Materials and Methods

This study aims to assists the local authority and the people regarding the land acquisition method and to obtain the compensation accurately using GIS. The GIS techniques involved in this study consists of overlay analysis and buffer analysis using ArcGIS version 10 software. This is a quantitative study using data sample based on digital parcel land in Malaysia.

### *Overlay Analysis*

Overlay analysis uses two or more layers of data and is processed using one operation to run the combination of data. The result of this overlap will produce a new form for each position in the output data layer (Mitchell and Minami, 2020). The ability to integrate data from 2 sources using overlay maps is a key to GIS analysis function. With GIS, it is not impossible to take 2 layers of thematic maps in the same area and overlay them with one on top of the other to produce a new layer. There are many overlay operations that can be obtained in GIS. Among them are clip, intersect, union and cut/erase which are described below. The clip operation is used to clip a polygon as shown in *Figure 1*. It takes the polygon layer (Input) and limits its space based on the boundary derived from the clip polygons in the overlay process. Only the elements within the clip polygon were included in the output. The intersect operation is

performed to create an intersect polygon as shown in *Figure 2*. This operation allows any intersect of two or three polygons in which the intersect polygon will be retained while only input polygons within the intersect polygon boundary are allowed to combine with the intersect polygon. This operation also allows the two polygon attribute tables involved to be combined accordingly within the intersect polygon. The union operation is performed to merge the polygons as shown in *Figure 3*. The two merged polygons will retain their space and retain all their attributes. The cut or erase operation is performed to erase parts of the polygon as shown in *Figure 4*. The overlay polygon serves as the shape or spatial boundary that needs to be erased on the input polygon.

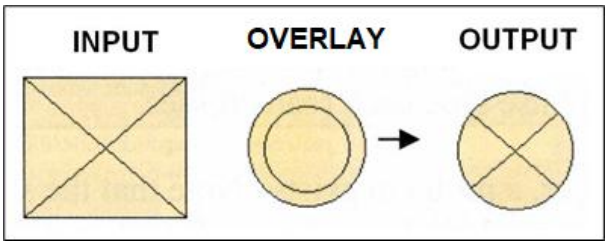


***Figure 1.*** *Overlay process using CLIP operation.*

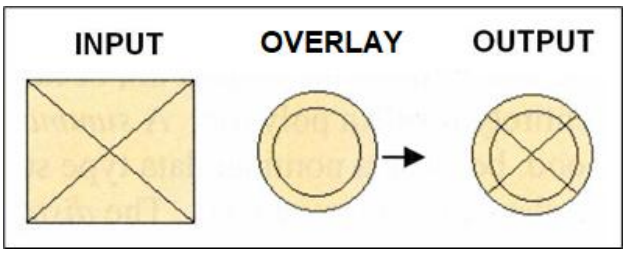


***Figure 2.*** *Overlay process using INTERSECT operation.*

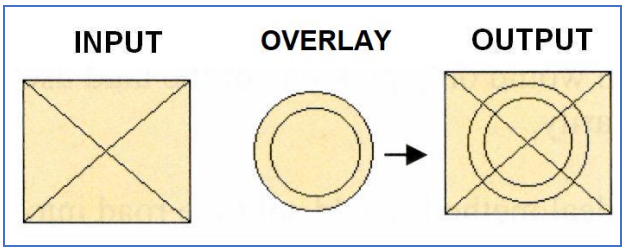


***Figure 3.*** *Overlay process using UNION operation.*

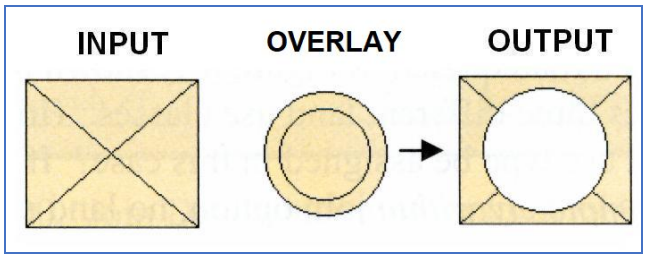


***Figure 4.*** *Overlay process using CUT operation.*

### *Buffer Analysis*

There are many functions in GIS that allow a spatial entity to influence or be influenced by its nearest neighboring objects. Among the popular GIS functions used

for this is buffering analysis. The buffer process is one of the GIS analyses used to measure the distance and produce a buffer zone. The principle of producing a buffer zone is simple in which one or more target positions will be selected, then determine the area around it within a certain distance. *Figure 5* shows a buffer distance can be generated of various shapes either around a point, line or area as its target position. The use of buffering analysis is numerous. In the example of radioactive waste management, buffer zones are used as part of the process to identify land use, total population and conservation status to determine suitable areas for radioactive waste disposal (Openshaw et al., 1989). Andersson (1987) used bus stop center data buffering with population data to identify the best location to locate a bus stop center. Eboy and Sieng (2019) made a local study by using buffering to determine the extent of the walking distance of each location factors which involves the accommodation, food eatery, public transport, and recreation centre to the subject area. This is useful for the researcher to measure the distance without going to the field.

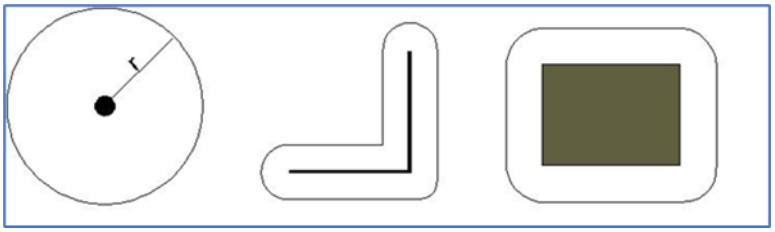

***Figure 5.*** *Buffer analysis output around point, line and area.*

## Results and Discussion

This section will show the methods or steps of using some basic spatial GIS operations performed when faced with a problem. The GIS software used in this application is ArcGIS software. The state government wants to build a road to reduce traffic congestion that has occurred recently. However, the land parcel area affected by the road construction is owned by some public individuals. According to Section 3, Land Acquisition Act 1960, the state government has the authority to take back the land to provide the needs of the people or the public. In spite of that, the parties involved must be given reasonable compensation as provided under Clause 13 of the Federal Constitution (AGCM, 1987). According to the consultant's suggestion, the width of the road must be 10 meters. Therefore, GIS analysis need to be used to identify the land area of the parcel that affected by the construction of the road. According to the consultant's suggestion, the width of the road must be 10 meters. Therefore, GIS analysis need to be used to identify the land area of the parcel that affected by the construction of the road. Subsequently, the compensation of the affected land can be estimated and be given to respective owners. For that reason, to conduct the GIS analysis, three objectives need to be passed to solve this problem, namely, (i) identify areas within 10 meters of road width, (ii) identify the parcel land within the road construction area, and (iii) Calculate the area involved for each parcel and then estimate the compensation.

### *Identify Areas Within 10 Meters of the Road Width*

In the initial step, both the road file and the land lot area involved need to be opened or activated first in the GIS software as shown in *Figure 6*. In *Figure 6*, the ROAD layer

represents the proposed road to be built while the GEOLOT data represents the area of the parcel land affected by the construction. Since the width of the road to be built is within 10 meters, then the widening from the center line of the road must be done. This widening is made by using a buffering process that will enlarge the line by 5 meters on the left and right of the center line of the road. The buffering results are shown in *Figure 7*. With the result of the widening of the road of 10 meters obtained, then we can see a clearer picture of the parcels involved in the construction of the new road.

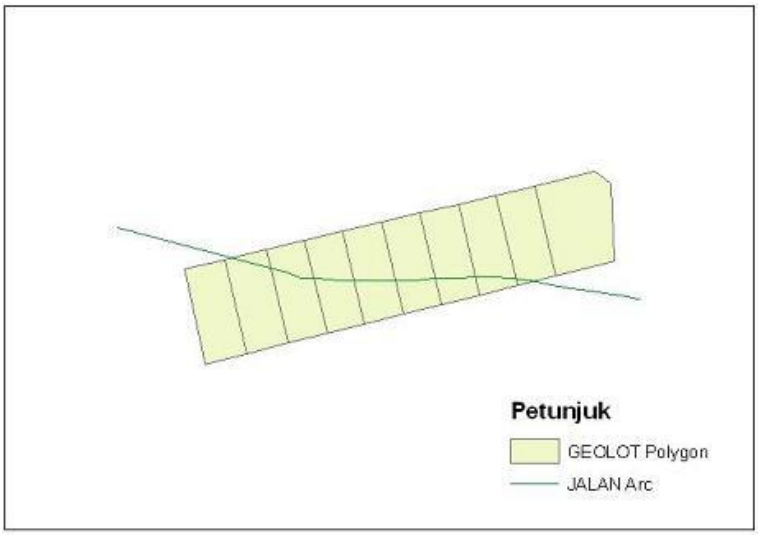


***Figure 6.*** *Display of land parcel (GEOLOT) and road (JALAN).*

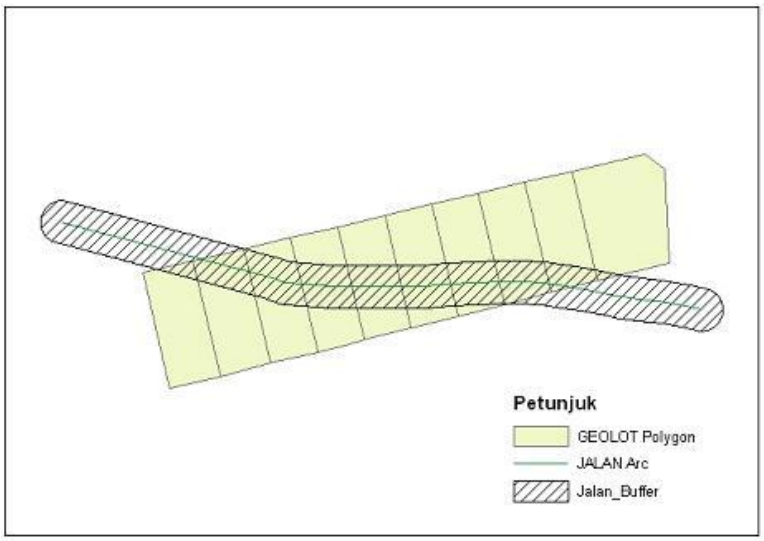


***Figure 7.*** *Buffer road (Jalan_Buffer) overlay with parcel land (GEOLOT).*

### *Identify the land parcel within the road construction area*

The parcel land affected by the road construction area can also be identified using the GIS overlay analysis using clip operation. This process will clip the GEOLOT area affected by the buffer road allowing us to obtain only the required GEOLOT (*Figure 8*).

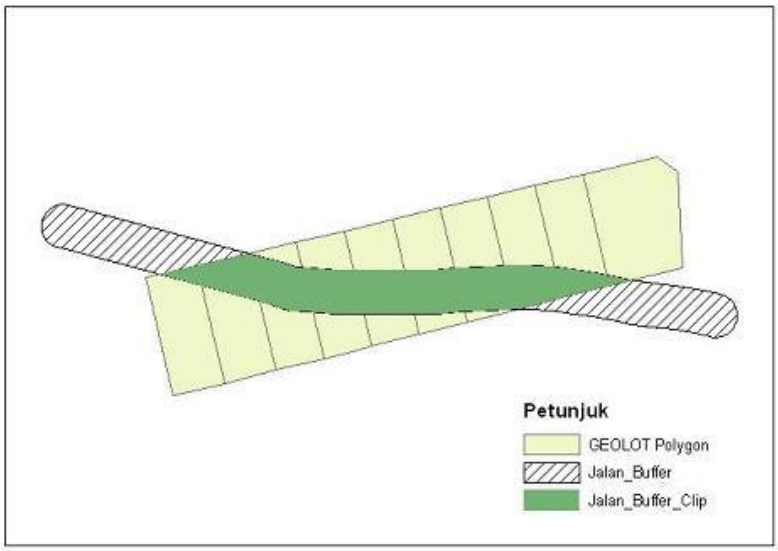


***Figure 8.*** *Clipping of buffer road that intersect with parcel land.*

### *Estimating the Compensation*

Among the advantages of current GIS software is its ability to calculate the area involved. In ArcGIS 10.1, 'Calculate Geometry' can be used to calculate the new estimated area (Luas Baru) as shown in *Figure 9*. By using the new area generated from the calculation, the amount of the compensation can then be estimated to be given to the landowners involved assuming the total payment for 1 square meter is RM15.00. This calculation can be done by using the 'Field Calculator'. The results of the calculation and the amount of compensation to be given to everyone involved can be shown in the attribute table (*Figure 10*) below.


***Figure 9.*** *Calculate the new area involved with the land acquisition using Calculate Geometry.*

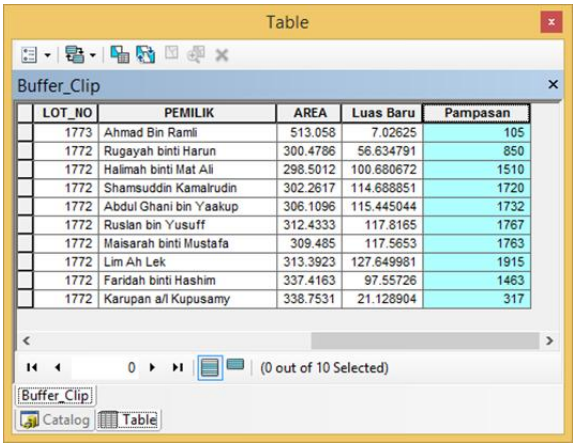


***Figure 10.*** *Display of the estimated compensation (Pampasan) to be paid to the owners for land acquisition.*

## Conclusion

This paper has covered some of the basic GIS analysis techniques that can be obtained on any GIS software today. It is suitable for those who want to start research or are just starting out with GIS related applications. Although the GIS techniques discussed here do not comprehensively cover all the existing GIS techniques but at least it can become a starting point in GIS applications before further techniques are learned. The application of GIS to estimate the compensation in land acquisition shows its capabilities in solving the problem. Indeed, new GIS analyzes will always emerge to meet user demand. However, the current GIS functions as described in this paper are sufficient to meet the demands of most GIS users.

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## Conflict of interest

The authors confirm that there is no conflict of interest involved with any parties in this research study.

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