A Geospatial Approach for Visualizing Infrastructure in Myanmar

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Abstract – According to a report by the Economist Corporate Network, Myanmar's positive economic growth will be challenged by a massive infrastructure need in which the government does not have the resources to meet alone. To better analyse Myanmar's current state of infrastructure and development, a geospatial web application was developed using R. A choropleth map accompanied by a histogram chart is used to help build an understanding of the current infrastructural needs of the regions. Furthermore, to assess the existence of clusters and their relationship with the surrounding neighbours, a Local Indicators of Spatial Association (LISA) map and Spatial Neighbours Model Map are processed. The maps can be viewed in two states, either on a nationwide or by region basis.

I. Introduction

Myanmar has enjoyed a steady, consistent economic growth rate of about 7.5% from 2012 – 2017. One of the biggest challenges Myanmar faces in up-keeping this positive trajectory in economic growth is infrastructure.

Infrastructure remains scarce amongst many regions in Myanmar and will impede future economic growth and massive investment from the government, development finance institutions (DFIs) and the private sector is necessary in order to prevent the infrastructure gap from growing, and to meet growing demands as the nation heads towards economic growth. [1]

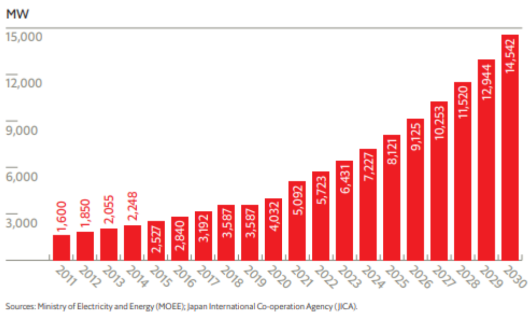


Fig 1 – Electricity demand forecast for Myanmar. The next ten years are likely to see major shortfalls as demand for power outnumbers peak generation capacity

Huge opportunities exist for investors with the patience and understanding to back infrastructure development in Myanmar, and what Myanmar offers in return is promising - rich natural resources and a large, youthful labour force, emerging after decades of relative isolation.

In addition, Myanmar has caught the attention of two of the world's most important emerging markets, China and India, with Myanmar playing a central role in China's One Belt ambitions. Thus partnering on Myanmar infrastructure development offers a gateway, especially for non-Chinese firms, into the Belt and Road Initiative.

For these good reasons, the Myanmar government is pushing to fasten the pace in which their country's infrastructure needs are addressed, particularly around power, water and transport, and are also seeking foreign investors to support this push.

In order to facilitate infrastructure development, an understanding of the current state of regions in Myanmar at hand is necessary. While data on Myanmar's infrastructure is available at hand, they merely exist in static data tables. Our application assists the stakeholders in assessing the current situation in Myanmar by processing this data and visualizing the data in a form of a choropleth map along with a histogram, based on a sector and a corresponding area of interest (e.g. Information and Communication, Number of households with a landline). Local Indicators of Spatial Association (LISA) and Spatial Neighbours Model Map are also plotted to identify cluster and assist analysts in identifying root causes for high or low indicator rates in these clusters. The maps can be viewed in two states, either on a nationwide (comparing between regions in Myanmar) or by region basis (comparing between townships in a region).

II. Related Work

With the development of spatial analytics techniques, it is helpful to spatially analyse the infrastructure needs in order to visualise the places that are underdeveloped clearly. Previously, there are projects led by UNOSAT GIS team from America[2], to identify the affected areas through change area analysis and remediate the situation by sending out the help and volunteers for effective rehabilitation and restructuring when the Cyclone Nargis hit Myanmar in 2008. However, there is no remarkable project initiative been carried out to identify the areas in need of overall infrastructure improvement and identify clusters using Local Indicators of Spatial Association (LISA). Thus, to the best of our knowledge, we are the first to explore on this topic.

With regards to the usage of LISA, we have found valuable resources on exploratory spatial data analysis on Turkey.[3] LISA was used to shed light on the distribution of growth across Turkish regions and its relation with indicators of development such as public investments and human capital. We were able to derive much insight and apply them to the situation in Myanmar.

III. Methods

Data Preparation and Procurement

Data related to infrastructure in Myanmar was retrieved from Myanmar Information Unit(MIMU) where baseline datasets are available both regarding regions in Myanmar and townships in each region.[4] Myanmar state region boundary shapefile was used for displaying the maps at the countrywide level, with segmentation via regions. Township boundary shapefile was used for displaying the maps at the township level, with segmentation to the township level. Both shapefiles were also retrieved from MIMU.

From the baseline datasets retrieved from MIMU, we identified the sectors that were relevant to infrastructure in Myanmar (e.g. education, transportation) and within each sector, areas of interest/indicators.

As the dataset contains data collected from several different resources, there are several different values associated with almost each indicator. To ensure consistency, we chose only data coming from the 2014 Myanmar Population and Housing Census since it offers the most relevant indicators for infrastructure.

Thus, we end up with arrive at the following sector – area of interest pairs:

Sector	Area of Interest
Education	• High schools • Middle schools • Primary schools • Adult Literacy Rate (percent)
Demographic	• Average Household size • Population size • Total Fertility rate
Environment	• Proportion of households with access to electricity • Percentage of households with safe sanitation
Info comm	• Number of household which have Computer • Number of household which have Internet • Number of household which have Landline • Number of household which have Mobile • Number of household which have Radio • Number of household which have television

Fig [2]– sector and corresponding area of interest pairs for the nationwide level

Sector	Area of Interest
Education	• High schools • Middle schools • Primary schools • Pupil-teacher ratio (High schools) • Pupil-teacher ratio (Middle schools) • Pupil-teacher ratio (Primary schools) • Students (High schools) • Students (Middle schools) • Students (Primary schools) • Teachers (High schools) • Teachers (Middle schools) • Teachers (Primary schools)
Demographic	• Number of households • Population density • Population size
Environment	• Proportion of households with access to electricity • Percentage of households with safe sanitation
Info comm	• Number of household which have Computer • Number of household which have Internet • Number of household which have Landline • Number of household which have Mobile • Number of household which have Radio • Number of household which have television

Fig [3] – sector and corresponding area of interest pairs for the region level

The data is filtered by the sector and corresponding area of interest chosen by the user, and the data is left joined to the shapefile according to the region code, or township code depending on the type of view the user chooses (nationwide or region).

Choropleth Map

The choropleth map shows the distribution of the selected area of interest and its intensity by colour across the nation/region. It provides a good birds-eye view and enable the user to see at a glance, which regions/townships are doing better or worse. The map is also accompanied by a histogram that allows the user to view the data in bins.

Settings for the display of the choropleth map are available and users are able to specify the number of classes they want and also select between different classification methods like equal interval, quantile and jenks to perform their analysis. Users may also choose different colour schemes like 'blues', 'reds', or 'purples' to their preference. Users may also specify the number of bins for the histogram.

Local Indicators of Social Association (LISA)

We use LISA to evaluate the existence of clusters existing in the spatial area of concern with regards to the sector and area of interest chosen by the user. Using LISA, one would be able to determine the areas of local clusters that have higher or lower indicator values than is expected by chance alone.

There are four types of outcome for the LISA map:

Low – low : The area and its neighbours have significantly low indicator values

Low – high: The area has significantly low indicator values and it surrounded by neighbours with significantly high indicator values

High – low: The area has significantly high indicator values and it surrounded by neighbours with significantly low indicator values

High-High: The area and its neighbours have significantly high indicator values

Insignificant: The area and its surroundings do not have higher or lower values than expected by chance

Spatial Neighbours' Model

Spatial Neighbours Model analysis is used to an indicate of whether one region is a spatial neighbor of another or equivalently, which regions are neighbors of a given region.The two types of spatial neighbour's model is being used to analyse the neighbourhood classification and patterns in terms of contiguity based with k=2 as well as distance based using queen's method.

IV. Results

The following is an example analysis for the indicator, 'number of households with landline phone', under the Information and Communication sector. The analysis is done on a nationwide level and on a regional level, witch Kachin being the region of interest.

4.1 Nationwide

Choropleth

We can observe from the choropleth map that Yangon has the largest number of landlines(130,083) in Myanmar. The regions in the middle of Myanmar such as Shan (57,055) and Mandalay(59,648) tend to be hold mid-range values. The region in the corners such as Kachin(17,147), Kayah(2,719) and Rakhine(12,886) tend to have lower number of households with landline phone.

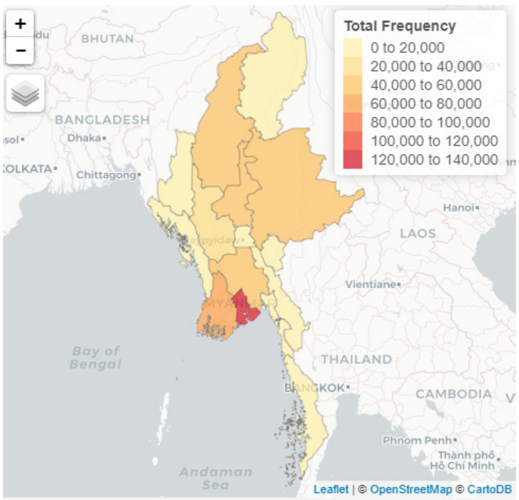


Fig [4]–nationwide choropleth map for Information Communications > number of households with landline, pretty classification

The above choropleth mapping is done using Pretty classification method but the information could be manipulated to mislead depending on the choice of classification method and number of classes picked. For example if we changed the classification method to quantile, the following map appears:

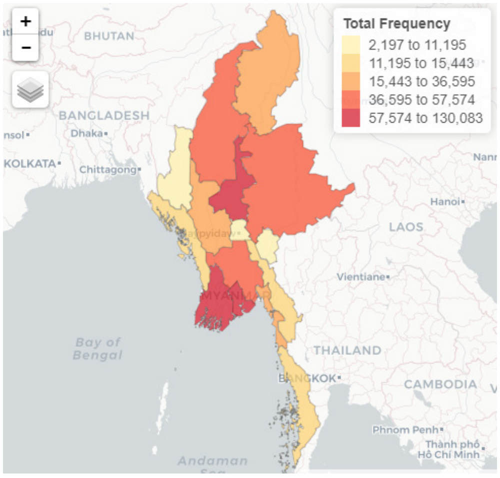


Fig [5]– nationwide choropleth map for Information Communications > number of households with landline, quantile classification

Comparing the two maps, we can easily see that the colours have intensified for many regions, such as Kachin in the upper corner and its surrounding neighbour regions Chin, Shan and Mandalay.

In this way, the choropleth map could be misleading despite being an intuitive method of representing distribution. The Local Indicator of Spatial Autocorrelation thus provides a more reliable tool in the analysis of spatial clustering.

Local Indicator Spatial Association (LISA)

The LISA analysis shows that a high-high cluster exists in Yangon and Ayeyarwady, meaning that high values are associated with these two regions and their surrounding area and these observations are proven to be more than a random occurrence.

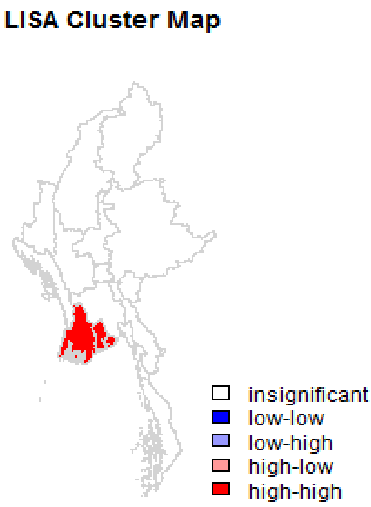


Fig [6] - nationwide LISA map for Information Communications > number of households with landline

Stakeholders can thus look into how these regions manage to maintain high landline ownership, and see if the factors that promoted landline ownership can be applied to other regions as well.

Spatial Neighbours Model

Spatial Neighbours model has identified Magway,Mandalay and Naypyidaw as the centroid of the country as those areas have the most connected dots compared to others whereas Tanintharyi region as least connected region.

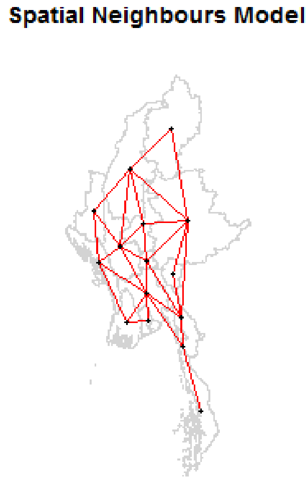


Fig [7]– nationwide Spatial Neighbours Model map for Information Communications > number of households with landline

4.2 Regional (Kachin)

Choropleth

From the choropleth map of Kachin, under pretty classification, we observe that the regions in the north of Kachin has lesser number of households with landlines such as Nawngmun(5) and Puta-O(123). Myitkyina has the highest value(4,499)

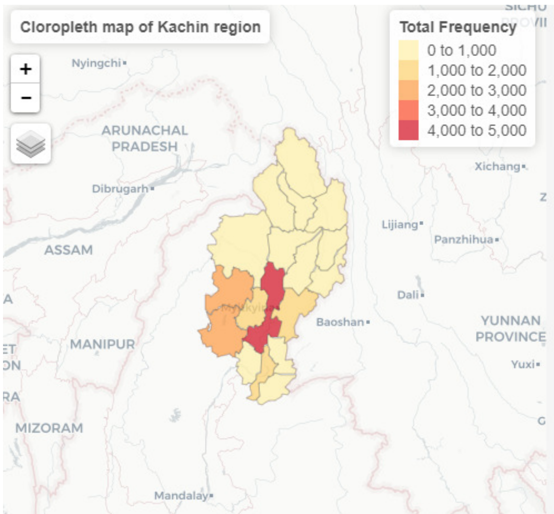
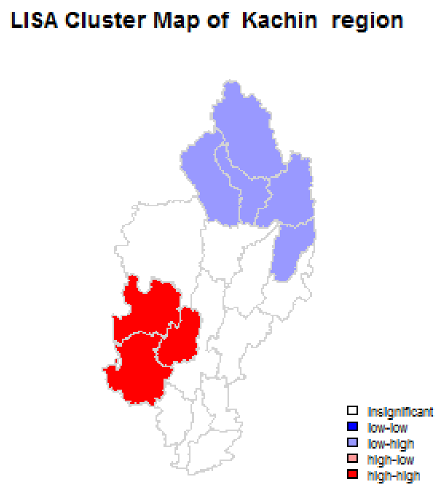


Fig [8] – Kachin choropleth map for Information Communications > number of households with landline, pretty classification

Local Indicator Spatial Association (LISA)

The LISA map shows the existence of two clusters. A high-high cluster is present in the southwest region of Kachin consisting of the townships of Mogaung, Mohnyin and Hpakant and a low-high cluster in the north of Kachin including the townships of Tsawlaw, Khaunglanhpu, Machanbaw, Nawngmun and Puta-O.



Fig[9] Kachin LISA map for Information Communications > number of households with landline

Spatial Neighbours Model

For the Kachin region, township such as "Sumprabum" and "Myitkyina" are considered centroid for the region having the most connected dots while township like "Mansi" is identified to be the least connected.

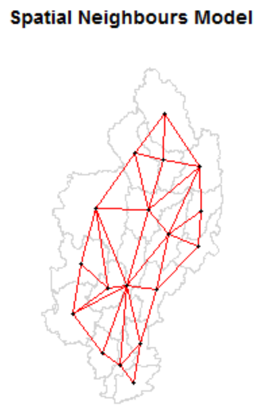


Fig [10]- Kachin Spatial Neighbours Model map for Information Communications > number of households with landline

V. Discussion

The study of visualizing infrastructure in Myanmar was thought to be a relevant and interesting topic to many. The users that came held different interests regarding the matter, some were curious about the social trends existing in certain regions, especially given the region's' historical background and context such as Rakhine. Others were more interested in the business implications, which areas were better to invest in, and so on. Most were curious as to where we managed to get our datasets from.

Many found the UI to be intuitive and easy-to-use. However, a few suggested that more could be done to determine the relationship between at least two indicators. Overall, the application was well-received and given positive comments but more can be done to give a clearer picture of the current state of infrastructure in Myanmar.

VI. Future Work

Our application can be further improved to meet the user's needs.

Firstly, we could extend the application to be able to select a wider range of data. We could add a field to select data source, so that we can include data values not only from the 2014 consensus as used in our project so that the user can access historical data for his own use. Adding a functionality where users can immediately upload datasets would also be useful for the user, since the current datasets are limited and is not inclusive of many other indicators.

We could also display the relationship between the indicators better by selecting multiple indicators and lining the maps up side by side to easily see if any possible relationships exists, e.g. low adult literacy rates and number of schools.

Lastly, the website performance could be improved on to accommodate to users' needs and ensure website can handle multiple users without crashing. Enabling API would also be helpful to generate multiple reports easily.

References

[1] Jo Daniels, Baker Mackenzie,"Building Myanmar: Bridging an Infrastructure Gap" https://www.bakermckenzie.com/en/insight/publications/2017/11/building-myanmar-bridging-infrastructure-gap

[2] GIS Corps, "UNOSAT Myanmar(Burma) Project" https://www.giscorps.org/nargis_034/

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[4] Myanmar Information Unit (MIMU),

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