

# Meta Design Lab

[metadesignlab.com](https://metadesignlab.com)

MDL



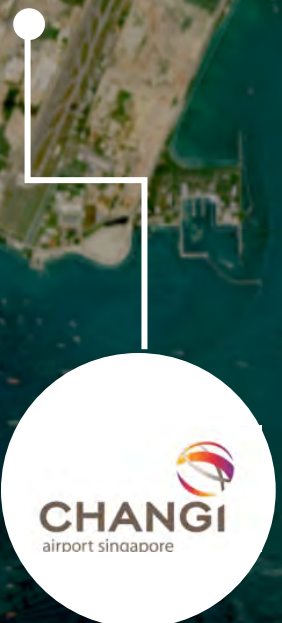
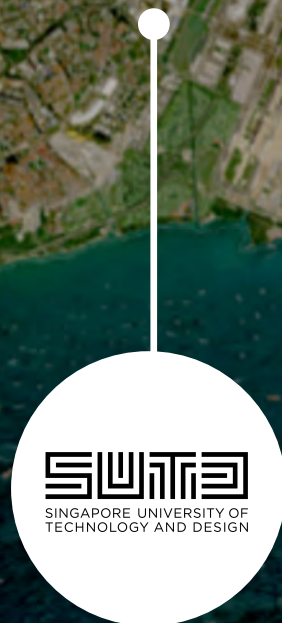
**Sam Conrad Joyce**

**Ahmed Meeran**

**Aanal Agrawal**



Who we are







**A five year fully funded project to future of airports looking  
at scales from global, city, aerotropolis, terminal, and  
experience.**

# <<Horizon 2050>>

**In collaboration with SUTD's wider aviation research cluster.**

# A global population driven perspective on South-East Asia's air transport growth prospects in the 21<sup>st</sup> century

MDL



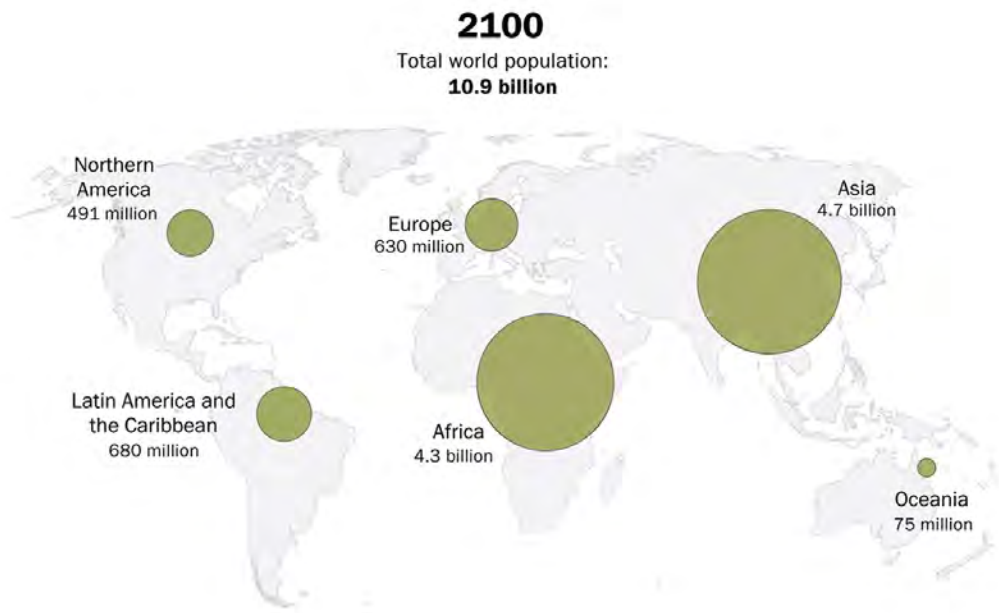
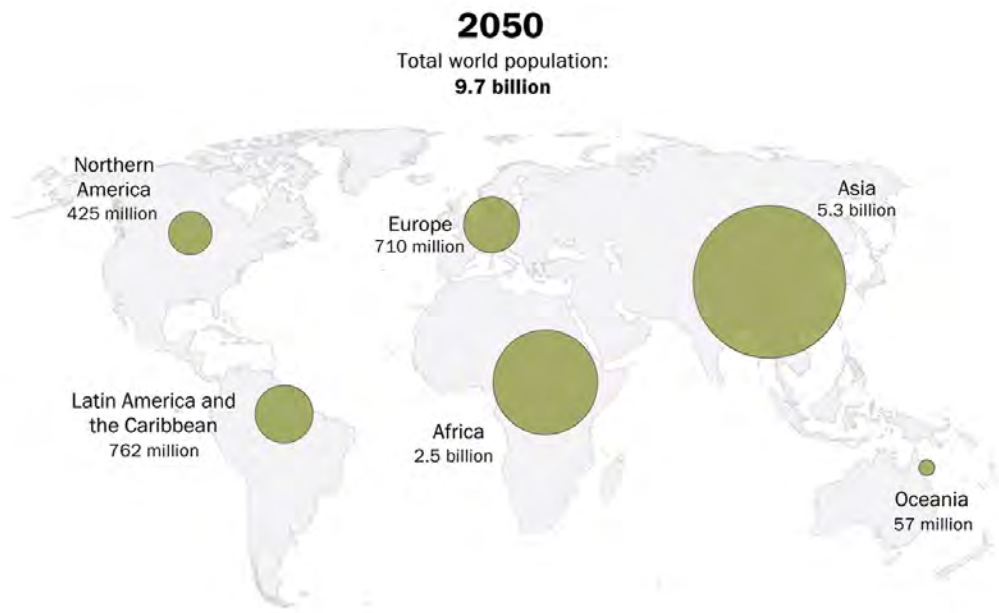
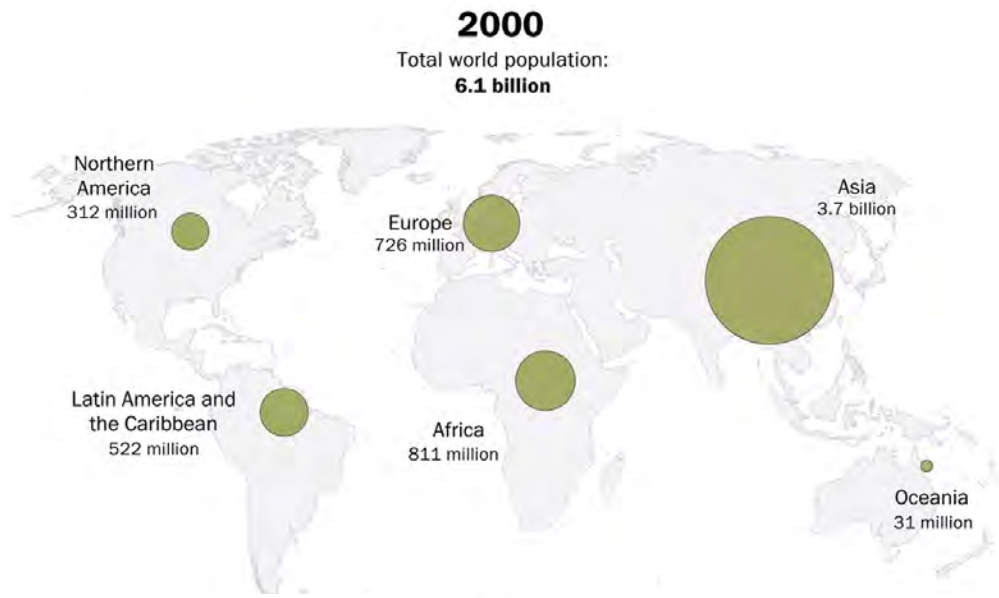
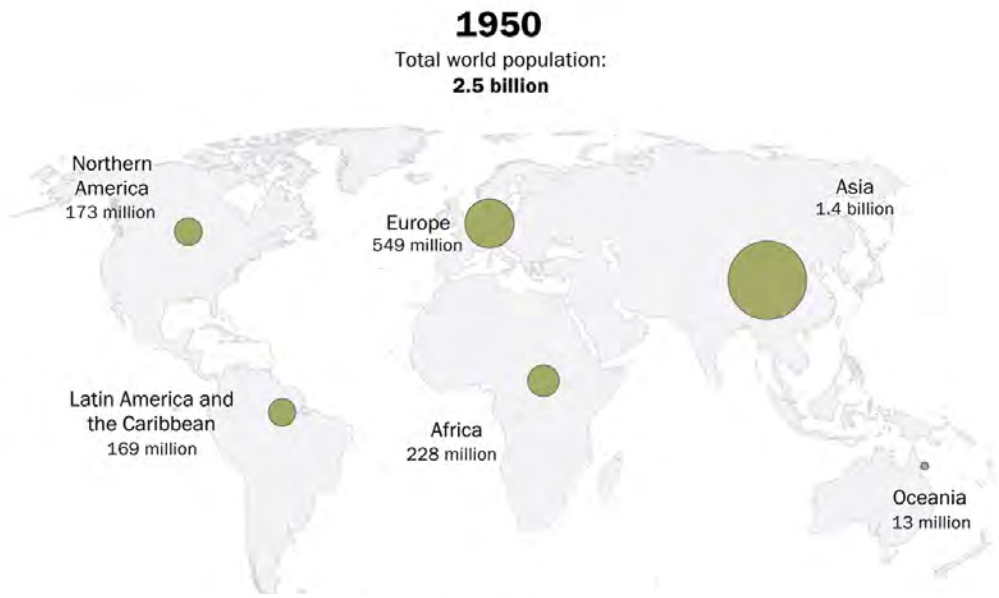
SINGAPORE UNIVERSITY OF  
TECHNOLOGY AND DESIGN

**Sam Conrad Joyce**

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# Introduction Demography



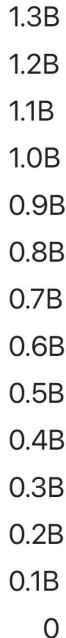


# Introduction



This circle contains 22 of the world's 37 megacities, which each hold at least 10 million people.

There are more people in this circle than outside of it



**Of which India, China and Indonesia are the fastest growing emerging economies**

# Introduction Road & Rail vs Air

India and China have huge rail network and are ready to invest massively in expanding the network

## China plans to expand railway network to 200,000 km before 2035

By Reuters Staff

4 MIN READ

BEIJING (Reuters) - China plans to expand its railway network, the second largest in the world, by one-third in the next decade and a half, as part of a long-term plan to rev up urbanisation and stimulate local economies.

China aims to have about 200,000 kilometres (124,274 miles) of railway tracks by the end of 2035, including about

ECONOMIC NEWS FEBRUARY 26, 2015 / 3:23 PM / UPDATED 6 YEARS AGO

## India aims to invest \$137 billion in railways in next 5 years

By Manoj Kumar

4 MIN READ

NEW DELHI (Reuters) - The government unveiled plans on Thursday to invest \$137 billion in its decrepit rail network over the next five years, heralding Prime Minister Narendra Modi's aggressive approach to building infrastructure needed to unlock faster economic growth.

## China targets big expansion of high-speed rail network

Published date: 21 August 2020

Share:



China is planning a major expansion of its high-speed railway network as part of its post-Covid-19 infrastructure investments, potentially eroding demand growth for road and aviation fuel.

State-owned railway operator China State Railway (CR) announced a blueprint this month that would double capacity of the country's high-speed rail lines in the next 15 years. CRC is aiming to almost double the high-speed rail network –

Southeast Asia is less contiguous than the West and East Asia and South Asia.

It has many islands – so cannot be so reliant on railways, aviation will be critical.



### Countries with highest number of Inhabited Islands

1. **Indonesia = 6000**
2. Chile = 2300
3. **Philippines = 2000**
4. Norway = 2000
5. Sweden = 984
6. Finland = 780
7. China = 433
8. Japan = 430
9. Greece = 227

# Introduction Why South-East Asia?

1<sup>st</sup>



Largest  
Consumer base:  
**125 million hh**  
by 2025

2<sup>nd</sup>



Value of **foreign direct investment**  
inflows – 136.2  
Billion USD  
(More than  
China)



Second fastest  
growing **Internet**  
users

3<sup>rd</sup>



**Population** : With 650  
million, 3<sup>rd</sup> largest  
population in the world



Third **Largest and**  
**Youngest** labour force



Seat capacity doubled in  
last decade – from 200  
mn seats in 2008, to 530  
mn in 2018

4<sup>th</sup>



Value of  
**Exports**, after  
EU, China and  
HK



Local  
**Companies** in  
Forbes Global  
2000

5<sup>th</sup>



Global **GDP**  
Ranking forecast  
for 2050

6<sup>th</sup>

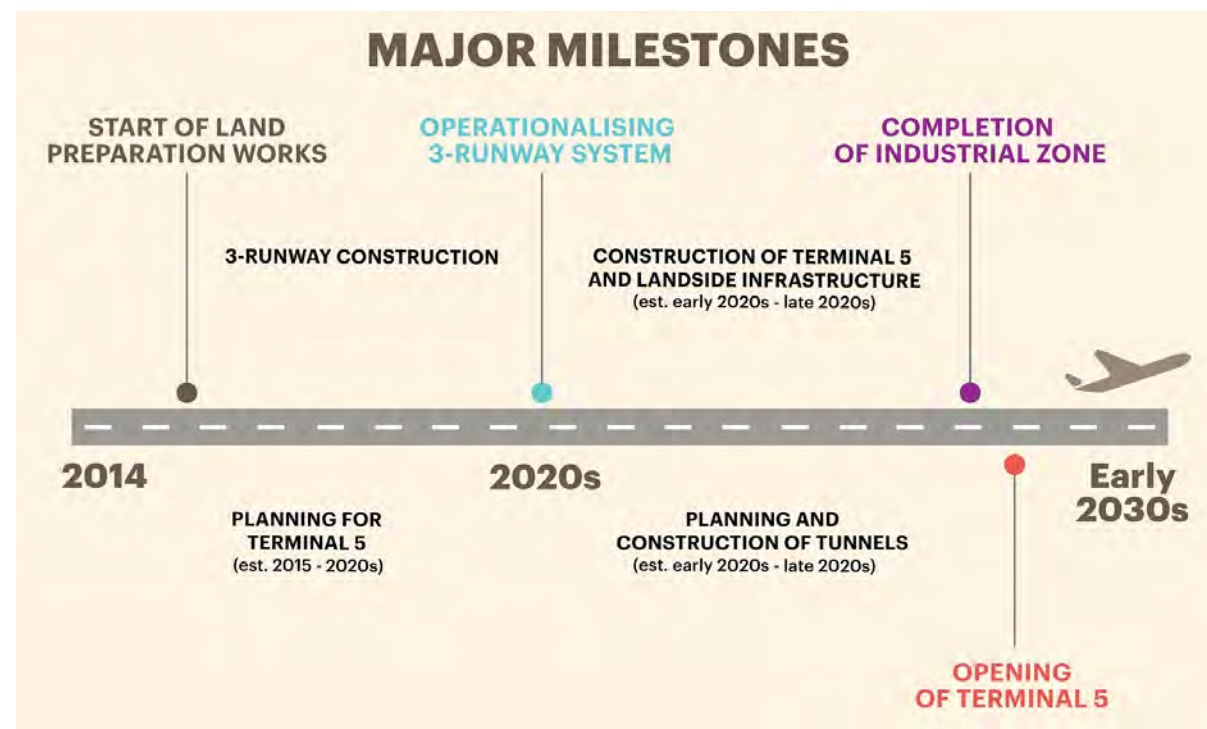
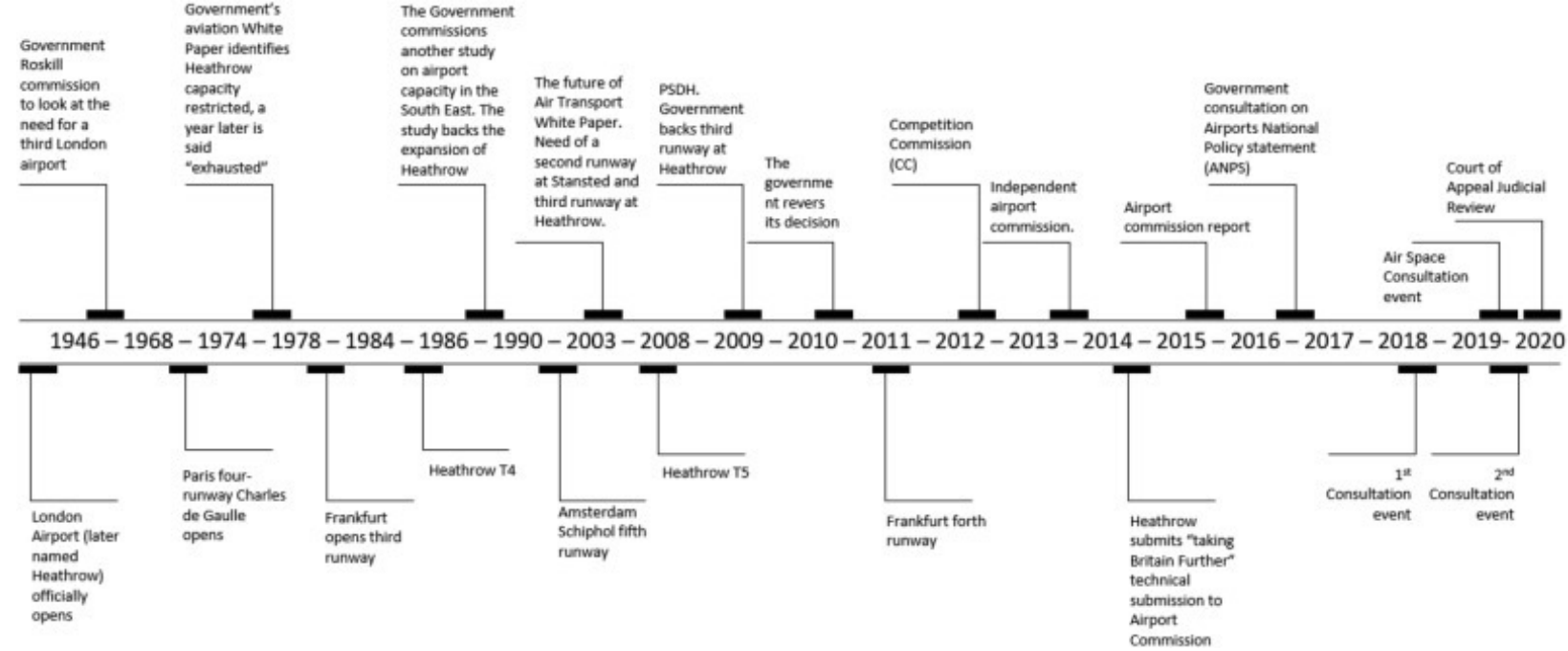


227 of world's  
**companies** in  
ASEAN



# Need of the Study

Airport Planning and design is a decade or more long project – it is important to preempt the expected airport location on a long-term horizon. In last 30 years US has only built 5 new airports.



Airport Planning timeline for LHR (top) and SIN (left)

# Aim

To Understand the expected growth demand in ASEAN region, based on existing models.

# Objectives

To understand the historic trends of global demography and its growth into 2050.

To explore the correlation between air travel and population growth now and going forward.

Develop a forecasting approach to understand the aviation growth driven by projected population growth.

Using the model to derive growth metrics for ASEAN aviation and translate this into specific need for airports and terminals in 2050.

# Methodology

- Building a forecasting model for mapping aviation demand for country/city pairs globally envisioning 2050
- Mapping global population growth with air traffic demand for 2020 and comparing with that of 2050
- Predicted air traffic demand per country for 2050 to be translated to the number of passenger gates required in addition to 2020's numbers to be built

## The Gravity Model

$$D_{AB} = f(C, P_A, P_B, S_{AB})$$

where

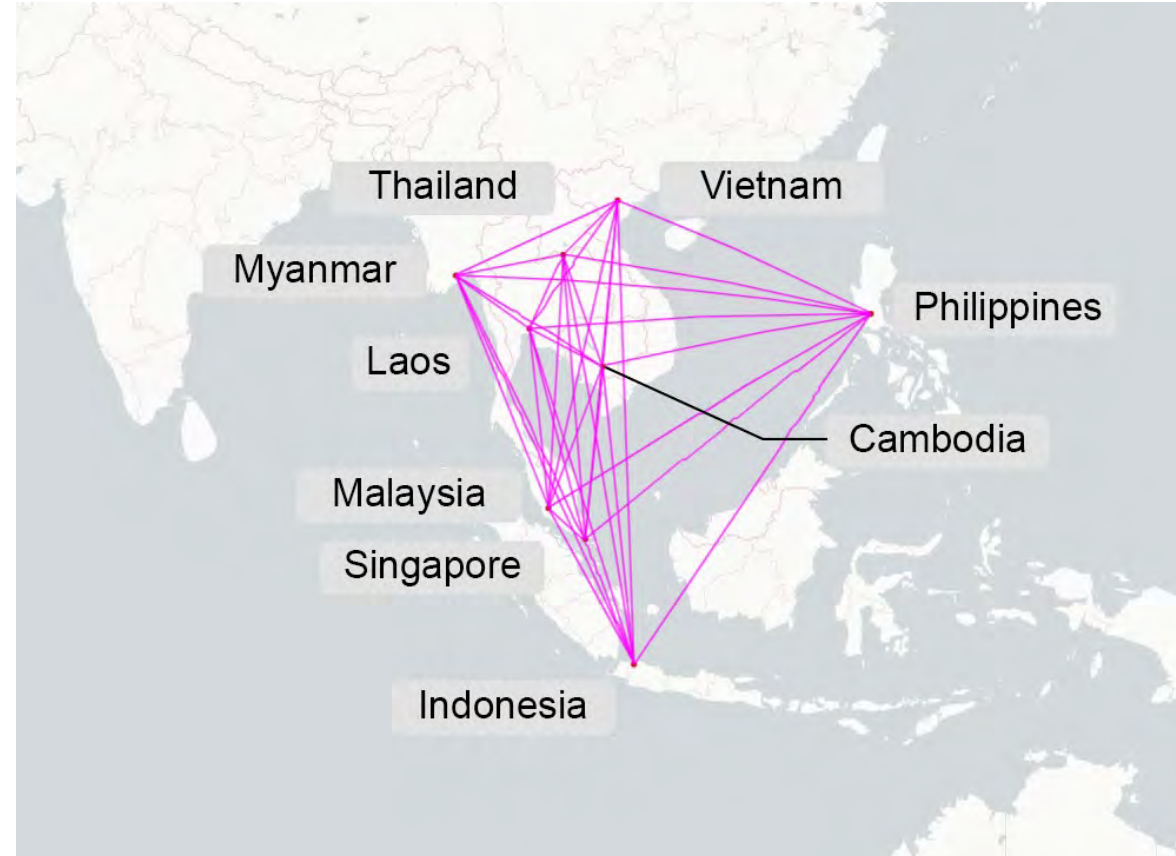
$D_{AB}$  = traffic demand between the city pair A-B

$P_A$  = population of city A

$P_B$  = population of city B

$S_{AB}$  = distance between the two points of A and B

$C$  = constant of proportionality





# Data Collection

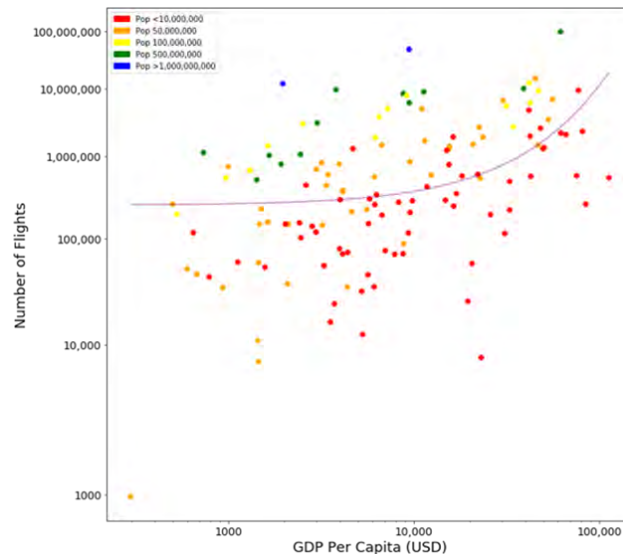
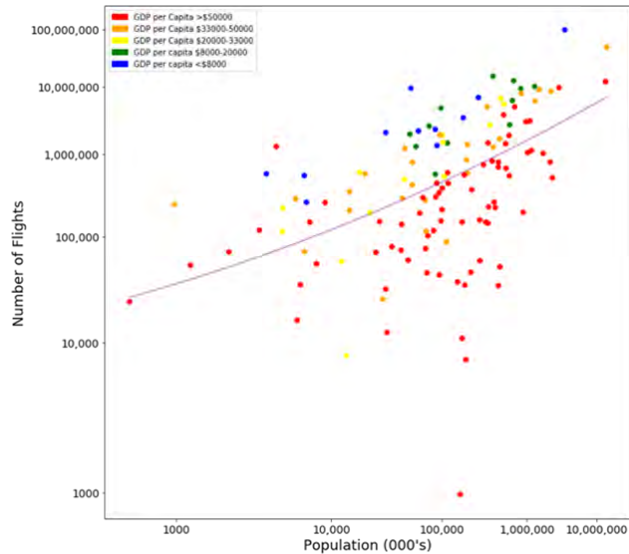


- **United Nations world population prospects** – Global time series population data from 1950 - 2050
- **World Bank Group** – Air Transport Annual report (flights data by country)
- **Open Street Maps** – City and Airport Location

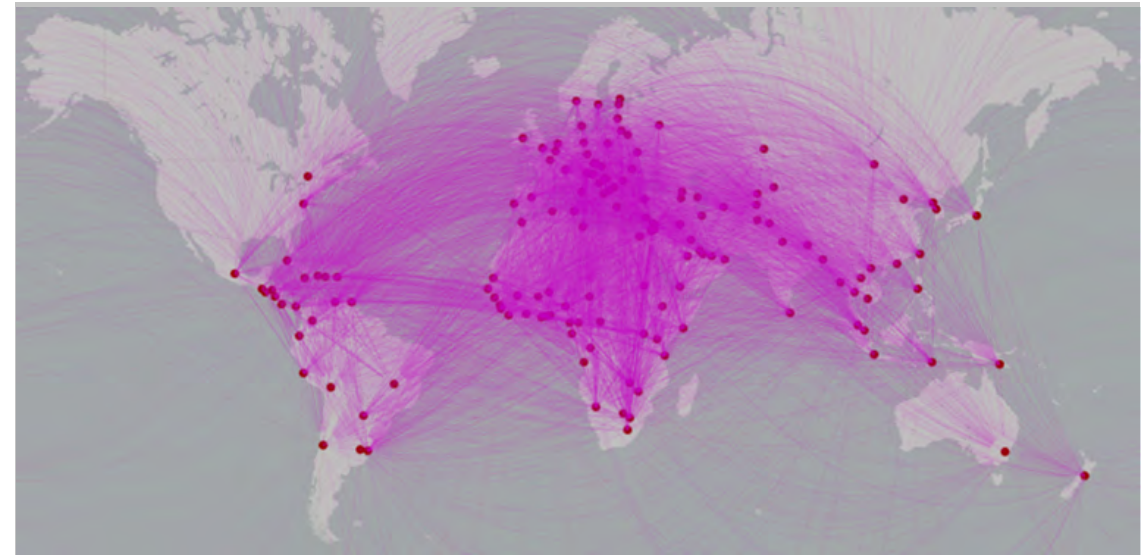
- Data from multiple sources collected computationally and pre-processed to remove errors and bias.
- More accurate analytics can be performed with economic variables such as GDP and consumer travel patterns but those data can be often cumbersome to retrieve and different countries use different ways to calculate GDP which may lead to bias

# Analysis

- Demand computed for all possible pairs of countries of the world by using the **Gravity model** for both 2019 and 2050
- **DRatio** per country obtained by taking the ratio of current versus 2050 Demand factor.
- **DRatio** is then multiplied with the current number of flights per country to get future aviation demand
- It could also be possible to look at actual airport demand



**Population Growth vs GDP Per Capita for ASEAN Economies**



$$\frac{\text{Demand}_{n2050}}{\text{Demand}_{n2019}} = D_n$$

$$F_{n2050} = F_{n2020} \times D_n$$

Where,

$F_{n2020}$  = Number of flights at country n at 2020

$F_{n2050}$  = Number of flights at country n at 2050

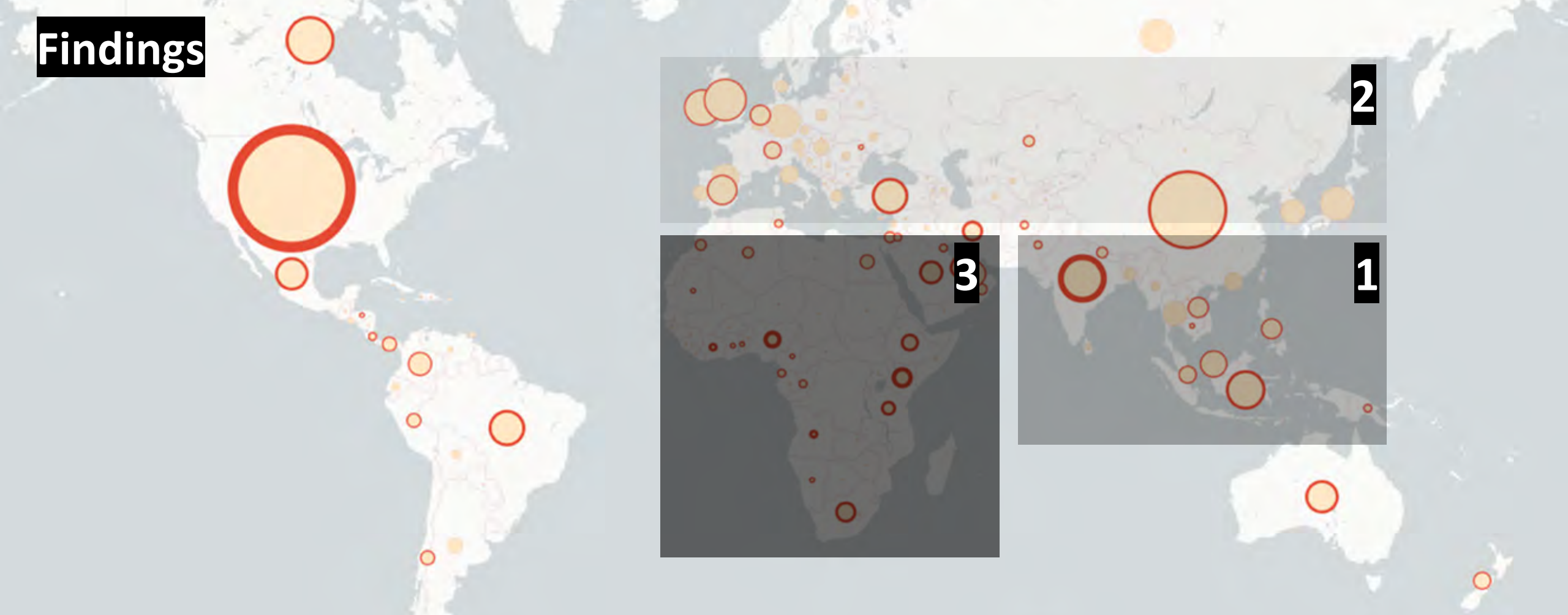
$$N_{n2050} = \frac{(F_{n2050} - F_{n2020})}{T_{\text{ratio}}};$$

Where,

$N_{n2050}$  = Number of new airports in country n by 2050

$T_{\text{ratio}}$  = Number of flights per airport

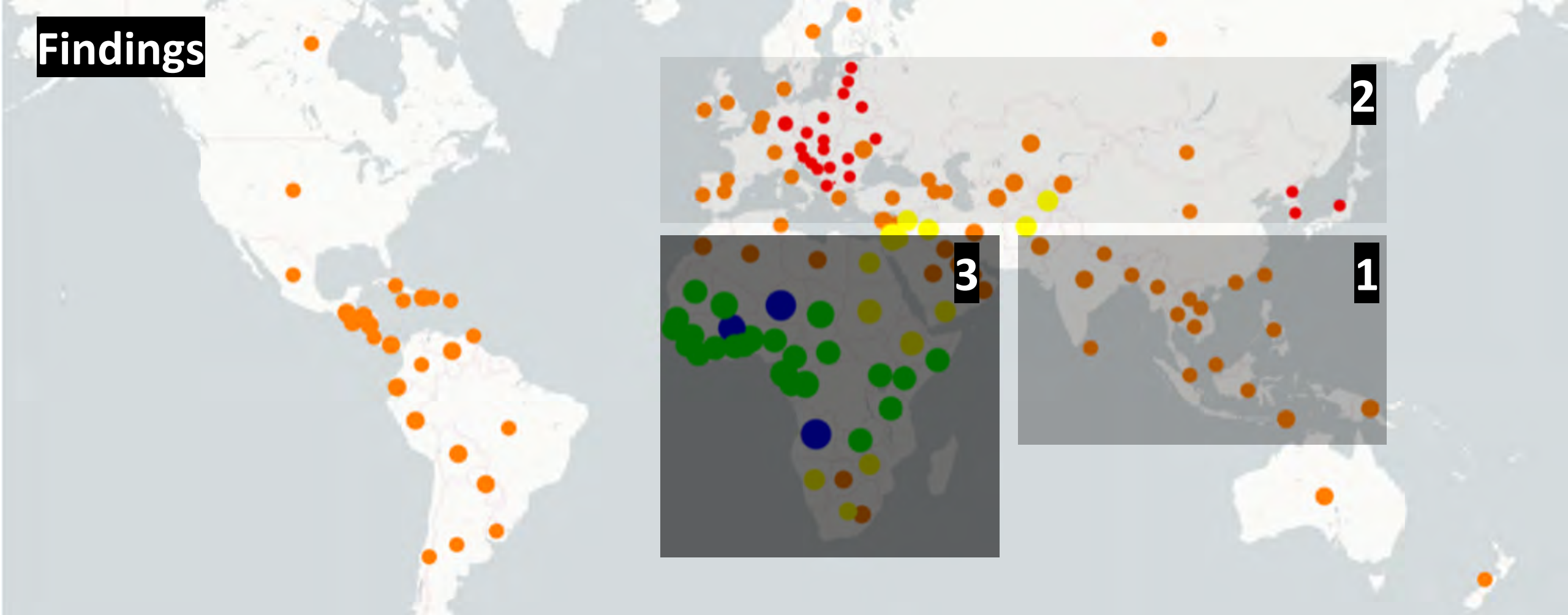
# Findings



1. **Positive aviation demand growth** in Asian countries is a sign of the growing population and increasing share of the middle class in developing Asian countries such as **China, India, Indonesia**
2. **Slow but plateauing growth** in mature economies such as the **Europe** and **East Asian** countries (Korea & Japan)
3. **Steep and rapid growth** in **Sub-Saharan nations** due to population growth and current less number of flights due to poor aviation infrastructure and demand.



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# Findings ASEAN

- General trend of population rise in ASEAN economies contribute to the **positive DRatio** numbers for 2050 for these countries.
- Further investigation for ASEAN countries by considering the “ease of airport infrastructure expansion” by analysing **land availability around the airport site**
- Further reinforced by analysing computationally retrieved **satellite images of ASEAN airports** and using **ML to identify** urban built-up land versus unbuilt.

Table 1.	
Country	% demand growth 2020 to 2050
Malaysia	46%
Lao PDR	45%
Philippines	44%
Cambodia	44%
Indonesia	42%
Singapore	32%
Myanmar	29%
Vietnam	26%
Thailand	11%

# Insights

- Net average **positive** aviation demand growth for South-East Asia by 2050 due to increasing **population**
- **Two** of SEA’s largest airports **SGN-Vietnam & MNL-Philippines** are highly built-up (urbanized) and **difficult** to expand.
- **Low** urbanization around **REP-Siam** might be **helpful** for the airport to expand if it were to.



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# Limitations

This work is **not** a complete view of what is possible for aviation in **ASEAN** in 2050, but a **preliminary thought-provoking suggestion** as to what it **might** look like. The study must be developed and analysed **further** for a fuller picture.

- Simplistic population and distance driven model, it does not factor in economic growth
- Country pair distance was calculated from capital cities not considering spatial population distribution and accounting for urban population primacy rule.
- Existing airline connectivity and terminal expansion capacity wasn't taken into account for simplicity
- Factors such as GDP, airfares, tourism trends, consumerism, and geopolitics weren't considered.
- Predicts the number of flights for 2050 by applying growth to current flights which might not be representative of demand (especially in currently poorer economies but large countries like India and Africa)



# Further Work

- Current work us involves Analytics and **Machine Learning** applied to high-resolution airport images to understand ground truth using **Computer Vision**
- **Computationally** retrieved large and on-demand aerial imagery of airports combined with **pixel level analytics** to map changing land use patterns can help us answer the Billion Dollar question



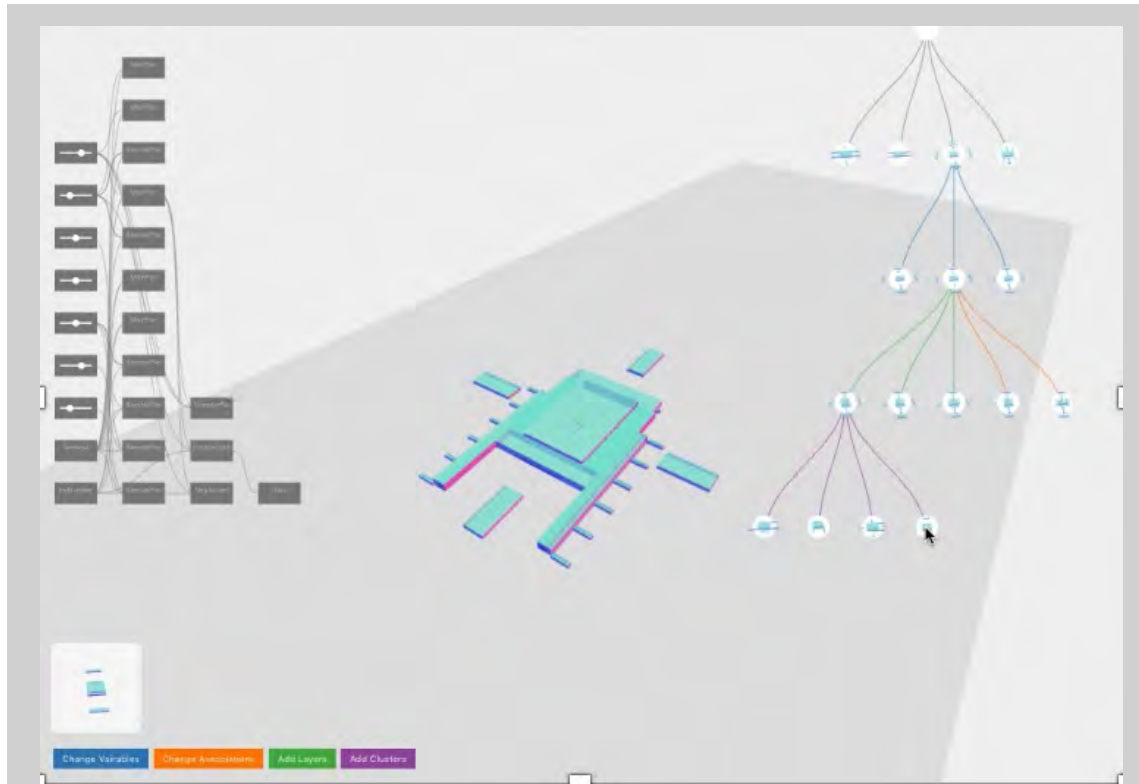
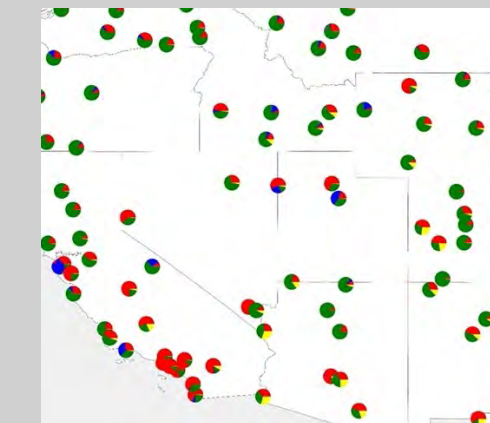
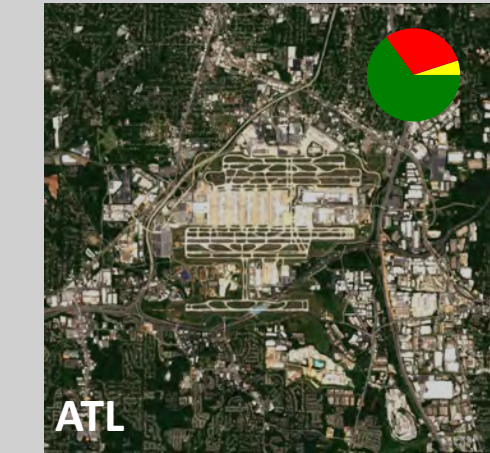
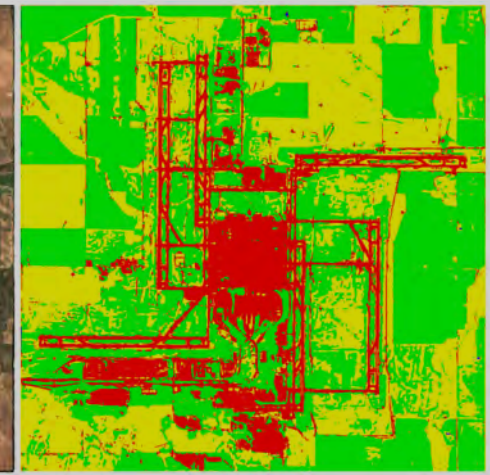
Is it operationally possible for airports to expand?

**Left:** Top 80 emerging South East Asian airports in the decreasing order of passenger traffic (2018 data)



# Further Work

- **Machine Learning** to understand spatial features in satellite images can be translated to ground truth parameters such as **vegetation**, **urban built-up**, **water** and **arid land**.
- Per-pixel **analytics** to understand the current **land use** and identifying ease of expansion by mapping the distribution of land use types per airport  
<http://metadesignlab.com/demo/aerial/>
- Exploration of Automatic possible airport configuration development on sites using Meta Parametric Models <http://metadesignlab.com/demo/airport2/#/gallery>







# Thank You

We encourage collaborations

Please contact us

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