Preliminary analysis of COVID-19 response and recovery policies in Asia and the Pacific: Integrating space applications and socioeconomic data

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Additional comments on this paper are welcome and may be sent to ESCAP Space Applications Section at escap-sas@un.org.

Acronyms

AI Artificial Intelligence
API Application Programming Interface
AWS Amazon Web Service
BIG The Ministry of National Development Planning and Geospatial Information Agency of Indonesia
China CDC Chinese Center for Disease Control and Prevention
COVID-19 Coronavirus disease of 2019
CPI Consumer Price Index
DRR Disaster Risk Reduction
ESCAP Economic and Social Commission for Asia and the Pacific
GDP Gross Domestic Product
GIS Geographic Information Systems
GISTDA Geo-Informatics and Space Technology Development Agency
KCDC Korea Centers for Disease Control and Prevention
KSIC Korean Society for Geospatial Information Science
LAPAN The National Institute of Aeronautics and Space of Indonesia
NGO Non-Governmental Organization
ODM OpenDroneMap
PHEIC Public Health Emergency of International Concern
QR CODE Quick Response code
SAR Synthetic Aperture Radar
SDG Sustainable Development Goals
UN United Nations
WHO World Health Organization
Table of Contents
Acknowledgements....................................................................................................................................... 1
Acronyms ...................................................................................................................................................... 1
Introduction .................................................................................................................................................. 3
  The important role of space applications in a pandemic ................................................................. 3
Analysis methods and approach............................................................................................................... 4
Country cases and preliminary analysis demonstration: spread and development patterns.............. 6
  China: Case study analysis and country-based practices................................................................. 7
    Brief overview of COVID timeline and policy measures/actions taken ........................................... 7
    Country practices integrating geospatial information................................................................ 7
    Time series trends of COVID-19 analysis and results.................................................................. 10
  Indonesia: Case study analysis and country-based practices.......................................................... 12
    Country practices integrating geospatial information................................................................. 12
    Time series trends of COVID-19 analysis and results.................................................................. 14
  Republic of Korea: Case study analysis and country-based practices............................................. 15
    Country practices integrating geospatial information................................................................. 15
    Time series trends of COVID-19 analysis and results.................................................................. 18
  Thailand: Case study analysis and country-based practices............................................................ 19
    Country practices integrating geospatial information................................................................. 19
    Time series trends of COVID-19 analysis and results.................................................................. 21
Conclusions and future steps..................................................................................................................... 21
References .................................................................................................................................................. 25
Annex .......................................................................................................................................................... 27
Introduction

The coronavirus disease 2019 (COVID-19) has developed into a global pandemic that continues to take its toll across the world. This global crisis has and will continue to trigger tremendous social and economic impacts, reversing hard-won development gains. In addition to the tragic loss of life, travel restrictions, lockdowns, market and supply chain disruptions and economic downturns resulting in increased unemployment and social instability. To save lives, protect people, and build back better, countries, cities, and communities have incorporated geospatial information into their responses to the COVID-19 pandemic and its wake of socioeconomic impacts.

There is a natural link between geospatial information and epidemiology, not only for contact tracing, but also for many potential, though not immediately obvious, trends and risks that can help plan for and mitigate the socioeconomic impacts of epidemics like COVID-19. Geospatial information also enables cross-cutting analysis and rapid impact assessment, which is essential for analysis of policy priorities, and can be clearly illustrated through geospatial dashboards like the COVID-19 dashboards developed in Indonesia and Thailand. These help policymakers prioritize actions and target areas necessary to contain a potential crisis.

To take this kind of data analysis one step further, this working paper proposes a preliminary methodology to help determine and visualize the dynamic between socioeconomic aspects and COVID-19 as well as the impacts of Government response measures. This is complemented by country-based practices from China, the Republic of Korea, Indonesia and Thailand to serve as a guideline and example for decision makers in the Asia-Pacific region. Integrating space applications and existing data generated from health and socioeconomic sectors can help to visualize the correlations between the pandemic and (potential) impacts of policies on response and recovery. These applications can also help in the recovery phase to build back better, by providing an evidence base for decisions on the easing of lockdown and the resumption of economic and social activities.

The important role of space applications in a pandemic

The Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018–2030; Plan of Action) is a country needs-driven blueprint that harnesses space and geospatial applications, as well as digital innovations to support countries, particularly those with special needs, to achieve the 2030 Agenda. The Plan of Action, drafted by Economic and Social Commission for Asia and the Pacific (ESCAP) member States in 2018, with much foresight, included epidemics. It specifically requested ESCAP and its member States to strengthen regional cooperation to 1) leverage data sharing, and promote big data analytics for the containment of present and future spreads of diseases and epidemics, 2) to develop capacity on mapping health risk hotspots using geospatial information and big data, and 3) to pay special attention to the countries that are most vulnerable to emergency health situations.

As the COVID-19 pandemic progresses, Governments around the region rely on measures, such as contact tracing, quarantining, and social distancing. All of these are spatial in nature and rely on geospatial information, and digital solutions to enhance community resilience. Many countries have put in place geospatial information systems and have shown that hotspot mapping, contact tracing, and early warning systems open to the public are all capable of strengthening the preparedness for COVID-19, as well as other disasters\(^1\).

Since the beginning of the COVID-19 pandemic a large amount of research has been conducted into the many dimensions that surround a global event of this magnitude. These cover issues such as the spread of the virus, socioeconomic factors, policy impacts and effects on global and local economies. Whist the results and analysis conducted in this paper draws parallels with those conducted before in both analysis technique and data used, a number of unique factors are presented by this style of analysis. Significant work was previously completed in time series analysis\(^2\), GIS analysis\(^3\) and Structural Break Analysis with other studies also using the chow test\(^4\) to achieve this. However, most studies previously conducted are either not geographically located in the Asia-Pacific region or have differing overall aims. Most other research and analysis conducted focuses on either projecting future metrics or providing an overview of the current state of economic situations rather than the effects of various policy measures implemented. Therefore, this analysis and presentation of country cases provides a unique viewpoint and customizable approach for analysis in Asia and the Pacific whilst also providing an overview of how policy planning and implementation in individual countries has shaped local trends.

**Analysis methods and approach**

The main purpose of this analytical approach is to identify the mutual impact of COVID-19, response measures, policies and socioeconomic aspects and impacts of these. At the same time, we hope to develop the analysis into a methodology and guideline that can be applied to disentangle the socioeconomic related impacts of other kinds of disasters and significant events in order to provide guidance for evidence-based decision making.

The research is important for several reasons. First, COVID-19 is a worldwide problem that showed clear and different patterns of development in multiple regions and countries. Even within the Asia-Pacific region, countries face very distinct COVID-19 patterns, impacts and challenges. Analysis of these patterns and trends may provide guidance and methodological approaches to address problems of a similar nature and support decision making. Second, the correlation or causation between the pandemic and other socioeconomic aspects is worth identifying, as the two are deeply intertwined and therefore worth investigation. Usage of geospatial information, Geographic Information Systems (GIS) and time-series analysis provides us with new opportunities to perform such type of research.

Four country case studies (China, Republic of Korea, Indonesia and Thailand) serve as a demonstration of the methodology and involve the following aspects:

- Covid-19 pandemic spread patterns within countries.
- Correlations and impact of government response measures and policies on COVID-19 patterns and socioeconomic aspects within the country. For example, the correlation between COVID-19 development patterns and trends in socio-economic indicators like employment rate, consumer price index (CPI), gross domestic product (GDP) or crime rates etc.
- Correlations and impact of COVID-19 to select socioeconomic aspects within the country.

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Procedure of data collection

It is necessary to have data at national and (preferably) city or regional level. For analysis of the pilot countries, we used official, open-source statistics from the governments or other officially authorized sources like the Kaggle COVID-19 data visualization competition for Republic of Korea and national media sources. A brief summary of the data sources used is as follows:

<table>
<thead>
<tr>
<th>DATA SOURCE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>COVID-19 TIME SERIES DATA</td>
<td>In the pilot analysis, at the most basic level, it included daily data of new and total confirmed, recovered, and deceased cases. For more refined analysis, data of the COVID-19 tests done, number of suspected cases, severe and light cases can also be added. For this pilot analysis, we used daily case breakdown by countries and (sometimes) provinces, as provided by open-source official statistics, such as that of the Chinese Center for Disease Control and Prevention (China CDC)'s data(^5) and the time-series data from Johns-Hopkins University. However, analysis done at more refined geographical scale can be done, given the availability of detailed data.</td>
</tr>
<tr>
<td>DEMOGRAPHIC AND GEOSPATIAL STATISTICS OF COVID-19 CASES</td>
<td>Preferably at the individual level. For example, for the Republic of Korea we used the Kaggle COVID-19 data(^6) released by KCDC (Korea Centers for Disease Control &amp; Prevention), which had anonymized demographic statistics of the initial cases, including gender and age group, as well as their tracing in the Republic of Korea right before they were diagnosed to have COVID-19.</td>
</tr>
<tr>
<td>SOCIOECONOMIC DEVELOPMENT DATA</td>
<td>Mostly those available from national level statistics agencies. Only monthly data was available for the pilot analysis, but data at shorter time scales are highly preferred.</td>
</tr>
<tr>
<td>SUMMARY AND DATA OF PUBLIC POLICIES OF THE ABOVE METRICS</td>
<td>Including but not limited to lock-down measures, economic boosting policies or social welfare policies.</td>
</tr>
</tbody>
</table>

The file template in the Annex is designed as guidance for others to follow this methodology. There are three sheets in the file for collection of all data – socio-economic metrics, COVID-19 related and major policies. Please note that for socio-economic metrics, we addressed several metrics based on data availability and our interest – the table is meant to be revised based on specific needs of each countries. An excel spreadsheet version can be shared upon request\(^7\).

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\(^7\) Please contact ESCAP Space Applications Section at escap-sas@un.org for this template, more information and resources.
Data analysis methodology

The data was primarily collected via open-source data and API provided by official statistic offices, and the analysis and visualization scripts were mainly written in R 3.8.1 (R shiny, leaflet, plotly, and multiple statistical and data wrangling packages). This pilot analysis includes the following three categories of methods and output:

1. Development of interactive visualizations and dashboards to show the trends and development of COVID-19 inside countries. The figures and dashboards, combined with further analysis (see below), can be used to identify trends and correlations. For all pilot countries, we drew line charts with date as the X axis and Y as different metrics (for example, COVID-19 daily cases) to show the trends and developments, and put annotations on the chart for turning points and notable policy release dates. Most of the visualization was developed with R plotly and allows a certain level of interactive activities to further examine the patterns. Similar analysis can be done by easily adjusting the scripts and inputting different data sources.

2. Time series-based analysis, mostly Chow structural break test. Such analysis was performed to identify a) turning points of the pandemic at the national level and b) how public policies correlated with socio-economic trends and the pandemic. The Chow test examines whether the slope of two linear regressions differ. It is commonly done by splitting the data into two groups and modelling them separately. For time series data, x is commonly the date and y the dependent variable, and the data is split by before and after the suspected structural break date point. By running those tests, we hope to identify whether the time-series development pattern of certain metrics (e.g., the daily new confirmed cases) differs before and after a certain time date, or before and after a certain policy. Therefore, the turning points, correlations, and potential impact of public policies can be briefly illustrated.

3. Geospatial visualization and analysis to show spread patterns of the disease primarily interactive dashboards.

Country cases and preliminary analysis demonstration: spread and development patterns

The analysis illustrates the trends of how COVID-19 spread and developed in four pilot ESCAP member countries: China, Republic of Korea, Indonesia, and Thailand. The analysis includes trends of break and decline, geographical spread of COVID-19 inside countries or regions, and whether certain policies appear to have an impact on or correlate with the pattern of the trend. Data sources included daily confirmed/deceased/cured cases of COVID-19, source of infection of the cases (if any), demographic and geographic location of the cases, and date and summaries of the policies released. Please note that for this preliminary analysis, we did not incorporate up-to-date data for all four countries because of gradual loosening of restrictions. For example, in China, the COVID-19 measures have entered a ‘new normal’ period. They are incorporated to illustrate the methodology.

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8 Please contact ESCAP Space Applications Section at escap-sas@un.org for scripts, more information, and resources.
9 H0: there are no statistical differences between the two slopes. If Hypothesis 0 is rejected (usually tested with F-test), then the results suggest a difference between the coefficients, or a ‘structural break’ exists.
China: Case study analysis and country-based practices

Brief overview of COVID timeline and policy measures/actions taken

COVID-19 cases were first identified in China and the Government began implementing response measures including lockdowns and transport restrictions in January. On 30 of January, the WHO Director General declared that the outbreak constitutes a Public Health Emergency of International Concern (PHEIC)\(^{10}\), and on March 11, 2020 a global pandemic. By May, mass testing in China was beginning. An estimated RMB 4.6 trillion (4.5% GDP) of fiscal stimulus\(^1\) was announced with key measures focus household, investment and local governments\(^1\), to support the economic recovery after the COVID-19 pandemic.

Country practices integrating geospatial information

Geospatial information played an important role in mitigating the COVID-19 Pandemic. In China's case, two examples of country-implemented practices include the Geographical Information Professional Knowledge Service System and the health QR code system illustrate how geospatial information helps to detect, monitor and predict the spread of COVID-19.

**Geographic Information Professional Knowledge Service System for COVID-19**

The National Geomatics Centre of China and China Knowledge Centre for Engineering Sciences and Technology jointly developed the Geographical Information Professional Knowledge Service System for COVID-19,\(^1\) which provides users with authoritative and real-time updated information of the pandemic distribution map service. System users can find a pandemic thematic map, designated hospitals and fever clinic locations, and trace the development history of the pandemic, which provides scientific geospatial information support for pandemic prevention and control. The dynamic epidemic map service uses Tianditu (Map World)\(^1\) as the base map. Information sources include public information from government departments at country, province, and city levels. After all the information is spatially

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\(^{12}\) Quick view: State Council executive meeting on March 3. Available at http://english.www.gov.cn/policies/infographics/202003/04/content_WS55e5f45b7cdd0c201c2cd84b.html

\(^{13}\) Geographic Information Professional Knowledge Service System for COVID-19 Available at http://kmap.ckcest.cn/epidemic/index

\(^{14}\) Tianditu (Map World). Available at https://map.tianditu.gov.cn/
processed, it can be visually searched, displayed and tracked on the map. The system can reveal the spatial and temporal pattern of the pandemic situation and spread, predict the risk analysis of the spread, carry out early warning and forecast, and support regional epidemic situation differentiation, prevention and control.

*Figure 1 Geographical Information Professional Knowledge Service System for the COVID-19 epidemic.*

The left-hand side shows the number of confirmed cases, suspected cases, cured cases, and mortality cases at the national and provincial level. The center shows the epidemic hot spot map. The right-hand side shows the designated hospitals and fever clinic locations.

![Geographical Information Professional Knowledge Service System for the COVID-19 epidemic](http://kmap.ckcest.cn/epidemic/index)

*Source: China Geographical Information Professional Knowledge Service System. Available at http://kmap.ckcest.cn/epidemic/index*

*Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.*

**Big Data health QR code platform**

In February 2020, Hangzhou introduced the Big Data health QR code platform for tracing, managing and monitoring the population flux during the COVID-19 pandemic outbreak. People could use Alipay, WeChat and other popular mobile applications to declare their health status, including whether they have any symptoms and whether they have been in contact with an infected or suspected person within 14 days. Based on the self-reported information, each person is assigned a QR code with a colour indicator (Green: healthy; Yellow: need 14-day quarantine; Red: need treatment and quarantine). Later, different cities launched their own QR codes. The national government officially published the national service platform for health QR code in April, which has become available for cross-province recognition. The platform is connected to real-time information databases, such as a dynamic name list of confirmed or suspected patients and a local community risk database that evaluates users’ real health status automatically and intelligently. The health QR code platform has achieved efficient crowd control,
improved the efficiency of inspection in crowded places, such as office buildings, shopping malls, and railway stations, and minimized direct contact\textsuperscript{15}.

**Increasing hospital capacity**

To improve the hospital capacity, the new and mobile hospitals of Leishenshan and Huoshenshan were built. Multisource satellite images can monitor the short-term land cover changes, environmental and socioeconomic impacts of this rapid construction. For example, the construction process was monitored by the high-resolution optical satellites such as Gaofen-2, Jilin-1 and Pleiades, the water environment near the hospitals were assessed by the hyperspectral satellite of Zhuhai-1, and the socioeconomic activities can be assessed by the nightlight data of Jilin-1. Additionally, synthetic Aperture Radar (SAR) of Sentinel-1 can be used to monitor the situation on the ground before the hospital construction.

*Figure 2 Partial image map of Huoshenshan Hospital.*

The figure shows the construction process of Huoshenshan hospital using Gaofen-2, Jilin-1 and Pleiades high resolution satellite images at the snapshot of 2019-10-29, 2020-01-28, 2020-01-29, 2020-01-30, 2020-01-31 and 2020-02-04.


\[\text{Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.}\]
The above figure shows the trend of COVID-19 in China, and periods when major policies were released. For the demonstration analysis in China, we are incorporating and reporting key findings on data dated to late March as the pandemic was relatively contained afterwards. The key findings from the figure are as follows:

- **Key turning point**: February 12th appears to be the approximate turning point for the number of daily increased cases. This is when $p<0.001$ for chow structural break test, which means the trend of data before and after the break point are different statistically, suggesting ‘breaking point’ exists and the trend changes direction.

- Most of the social welfare and economic boosting policies were released in early March\(^\text{17}\), which correlated with the loss and decline that can be seen in economic categories in Table 1 below.

- In April, the Chinese Government released policies that require ‘normalized protection measures’ against COVID-19 in daily life such as wear masks appropriately, reduce gatherings, strengthen ventilation and disinfection\(^\text{18}\).

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\(^{16}\) Johns Hopkins University Coronavirus Research Center. Available at https://coronavirus.jhu.edu/


\(^{18}\) Guiding Opinions of the State Council on the Joint Prevention and Control Mechanism for the Prevention and Control of the Novel Coronavirus Pneumonia Outbreak. Available at http://www.gov.cn/zhengce/content/2020-05/08/content_5509896.htm
Table 1. A selection of socioeconomic data trends in China from January to March 2019/20 (DURING COVID-19) with comparison to 2018/19 (PRIOR TO COVID-19)

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Metric</th>
<th>2019/20 (DURING COVID-19)</th>
<th>2018/19 (PRIOR TO COVID-19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LABOUR &amp; EMPLOYMENT</td>
<td>Unemployment Rate</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Internet retail volume increase(%)</td>
<td>16.50</td>
<td>not reported</td>
</tr>
<tr>
<td></td>
<td>Food online retail volume increase(%)</td>
<td>29.60</td>
<td>not reported</td>
</tr>
<tr>
<td></td>
<td>Apparel online retail volume increase(%)</td>
<td>16.50</td>
<td>not reported</td>
</tr>
<tr>
<td></td>
<td>Other goods and services online retail volume increase(%)</td>
<td>19.80</td>
<td>not reported</td>
</tr>
<tr>
<td>RETAIL &amp; PRICE</td>
<td>Consumer Price Index (CPI) - 100, total</td>
<td>4.50</td>
<td>5.40</td>
</tr>
<tr>
<td></td>
<td>Food, total</td>
<td>17.40</td>
<td>20.60</td>
</tr>
<tr>
<td></td>
<td>Staple food, total</td>
<td>0.60</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Meat</td>
<td>66.40</td>
<td>76.70</td>
</tr>
<tr>
<td></td>
<td>Egg</td>
<td>6.20</td>
<td>2.40</td>
</tr>
<tr>
<td></td>
<td>Fish</td>
<td>1.30</td>
<td>3.80</td>
</tr>
<tr>
<td></td>
<td>Vegetable</td>
<td>10.80</td>
<td>17.10</td>
</tr>
<tr>
<td></td>
<td>Fruit</td>
<td>-8.00</td>
<td>-5.00</td>
</tr>
<tr>
<td></td>
<td>Apparel, total</td>
<td>0.80</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>Other daily necessities and services</td>
<td>0.40</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Communication and transportation</td>
<td>-0.70</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>1.80</td>
<td>2.20</td>
</tr>
<tr>
<td></td>
<td>Medical expenditure</td>
<td>2.10</td>
<td>2.30</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>4.40</td>
<td>4.80</td>
</tr>
<tr>
<td>COVID-19 RELATED</td>
<td>COVID-19 Monthly Increase</td>
<td>0.00</td>
<td>9687.00</td>
</tr>
<tr>
<td></td>
<td>COVID-19 Monthly Death</td>
<td>0.00</td>
<td>213.00</td>
</tr>
</tbody>
</table>


From January to March, we observed the following key trends in various socioeconomic indicators during COVID-19’s development in China, from official statistics of China\(^\text{19}\), as shown in Table 1. There is a correlation between social metrics and COVID-19 development, which was limited to data availability. The following trends arise:

- Strong impact to the retail industry: great decline in total retail volume from January to March.
- Significant increase of the price of daily necessities (vegetables and meat)
- Decline of profit of most traditional industries and investment
- Unemployment rate increases

\(^{19}\) National Bureau of Statistics. Available at https://data.stats.gov.cn/
Positive trends for the e-commerce industry, such as internet retail and virtual goods: although the total volume of e-commerce suffered from a decrease from January to February, Internet retail of food and miscellaneous goods increased significantly.

In March and April: Unemployment rate, price, sale, production was improving in general

Indonesia: Case study analysis and country-based practices

Brief overview of COVID-19 timeline and policy measures and actions taken

The first confirmed cases of Covid-19 were announced on the 2nd of March 2020 in Indonesia. At this stage, limited school closures occurred, and people were encouraged to work from home. On the 13th of March a national task force was established under presidential decree followed by the declaration of a health emergency and imposition of social restrictions on the 31st March. The 2nd of April saw the closure of international borders. On the 10th of April large scale social restrictions were imposed in Jakarta followed closely by the declaration of a state of emergency on the 13th April20. Other major events included the resumption of intercity travel in May and the extension of restrictions in July. The Indonesian government announced plans to implement the new normal scenario to accelerate the handling of COVID-19 in the health and socio-economic aspects considering epidemiological studies and regional preparedness in June 2020.

Country practices integrating geospatial information

The Ministry of National Development Planning and Geospatial Information Agency of Indonesia (BIG) dashboard

In order to tackle the challenges of the COVID-19 Pandemic on the ground, The Ministry of National Development Planning and Geospatial Information Agency of Indonesia (BIG) deployed a national dashboard. This dashboard integrates geospatial information using shared services with each authorized data custodian that related to the dashboard contents and updated daily national case numbers (infection, death, recovery cases), spatial analyses map (Jakarta, Bogor, Jakarta Greater Area case) all layered on the official base map.

BIG used key datasets in order to conduct spatial analyses, such as positive cluster suspects, location points of public spaces (which is the centre of a public crowd), distribution of transportation hubs, location points of economic sectors that are still permitted to operate, distribution of vulnerable ages, and population density.

The data sets were combined with a variety of spatial analysis tools such as, spatial distribution and clustering analysis, prevalence analysis, hotspot analysis, origin destination cost analysis, service area analysis, and overlay and scoring tools to conduct hazard vulnerability analysis as well.

The resulting dashboard has a number of capabilities including providing information in updated daily national statistics such as infection, death and recovery, distribution of temporal cases, distribution of referral hospital and community health centres. Combined with this, a Story Map was included along with a variety of maps showing the results of spatial analysis in the areas of Jakarta and Greater Area and Bogor. The analysis included Spatial distribution and prevalence analysis, clustering and hotspot analysis, origin destination cost and service area capacity, hazard vulnerability and integration of hazard vulnerability with capacity into risk mapping.

Figure 4 BIG Coronavirus Dashboard

Source: Coronavirus COVID-19 Indonesia Cases by BIG. Available at https://covid19.big.go.id/

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

LAPAN vulnerability analysis

The National Institute of Aeronautics and Space of Indonesia (LAPAN) developed a data hub in April 2020 to perform regional-level risk assessment and visualization on COVID-19. Indonesia is among the countries that are applying geospatial techniques to generate ‘heatmaps’ for those communities that are vulnerable to the impacts of COVID-19, and to locate the poorest people who are left out of social protection systems. By combining geo-referenced aggregated data and artificial intelligence, this deepens the understanding of the impact of COVID-19 for better pandemic preparedness in the future.21

Time series trends of COVID-19 analysis and results

Figure 5 COVID-19 Time series analysis for Indonesia

The above figure shows the trend of COVID-19 in Indonesia, and periods when major COVID-19 response measures and policies are released.

**Highlights of what this analysis reveals within country context**

**Spread patterns:** The COVID-19 pandemic figures in Indonesia are currently still on the rise (as of writing in December 2020), with confirmed and death cases significantly on the rise since June 29th (structural break test after controlling for the number of testing kits, p<0.001).

Government control measures seemed effective in the early stages, but the situation seemed to worsen in July. It is hoped that with measures such as that of a vaccine, it will be on the decline like the patterns of other three pilot countries analysed.

Source: ESCAP analysis based on data from Johns Hopkins Coronavirus Resource Center
Republic of Korea: Case study analysis and country-based practices

Brief overview of COVID timeline and policy measures and actions taken

The Republic of Korea had its first COVID-19 case confirmed on January 20, 2020\(^22\). On January 3, 2020, the Korean government issued the national infectious disease risk alert level to “Attention” and began to operate the 24/7 monitoring system in emergency operation centre under the Korea Centers for Disease Control and Prevention (KCDC). The public’s participation in the government’s recommendation of social distancing starting from March 22, stringent social distancing campaign up until 20 April 2020 and basic distancing extended till 5 May. The daily average number of confirmed new patients dropped sharply from 95.9 to 8.9. Many people also accepted 14 days self-quarantine measures with installation of monitor applications and its report for protection of public health. The Korean government has introduced a total of KRW 277 trillion (14.4% of GDP) for economic stimulus with four rounds of financial stimulus package from February. In addition, four rounds of 2020 supplementary budget were provided to different sectors including small business and SME, employment, low income households, daycare and others\(^23\).

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>First COVID-19 confirmed case</td>
<td>20 January</td>
</tr>
<tr>
<td>Big cluster occurred (Shincheonji, Daenam Hospital)</td>
<td>19 February</td>
</tr>
<tr>
<td>Stringent social distancing campaign ended</td>
<td>20 April</td>
</tr>
<tr>
<td>Authorities raised Level Two of distancing guidelines</td>
<td>22 August</td>
</tr>
</tbody>
</table>

Country practices integrating geospatial information

The existence of national governance systems responding to this unexpected national crisis, public-private partnership, and compliance with government guidance are the key success factors of managing the COVID-19 pandemic in the Republic of Korea. To respond to COVID-19, the following steps were taken for disease control and management: 1) screening and diagnosis, 2) epidemiological investigation, 3) patient and contact management, and 4) prevention. Geospatial information can promptly trace and monitor confirmed patients and quickly provide information by open public data while ensuring transparency.


The COVID-19 Epidemiological Investigation System

The COVID-19 Epidemiological Investigation System is a system that automates the process of contact tracing for COVID-19 confirmed cases, which is based on the smart city platform. The system shows travel routes of confirmed COVID-19 patients on a map that is embedded on the platform, and also provides related statistical information with big data. In this regard, the National Geospatial Information Institute (NGII) provided the map to the government’s epidemiological investigation system for being used as background map to show the routes of confirmed cases, and contributed to COVID-19 response by open and free data to the public. This ease of access helped the private sector develop diverse applications promptly and broadly. The COVID-19 Epidemiological Investigation Support System operates in a strict manner to protect privacy, with due procedure followed in acquiring data.

Figure 6 The COVID-19 Epidemiological Investigation System showing the tracking analysis on confirmed cases.


Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The Korean government provides various datasets such as public mask sales data and national and international confirmed cases to local government websites and the open data portal. IT engineers and

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24 The COVID-19 Epidemiological Investigation System is developed by the Ministry of Land, Infrastructure and Transport (hereinafter ‘MOLIT’) and is being co-operated by MOLIT and Korea Centers for Disease Control & Prevention.
the public utilize the data and combine it with geospatial information to create information of public interest which has been shared globally. The Ministry of Health and Welfare, the Ministry of the Interior and Safety, the Ministry of Science and ICT, the National Information Society Agency, and the Health Insurance Review & Assessment Service have worked together to provide public mask sales data in open API format by collecting real-time mask sales data at state-designated sellers. Real-time data of publicly distributed face masks is provided to people through mobile map-based applications and web services, reducing confusion and inconvenience while raising distribution efficiency.

**COVID-19 Comprehensive Situation Map**

In January 2020, the Korean Society for Geospatial Information Science (KSIC) started work on location-based maps for public notification and began their first service on February 5, 2020. The COVID-19 Comprehensive Situation Map\(^\text{25}\) provides detailed information and fast updates. Specifically, this map can quickly and comprehensively provide spatial data relating to coronavirus such as location information, selective clinic, medical centre, religious facilities (New World Church), elementary, middle and high schools, libraries and real time mask service. Additionally, it analyses the routes, activity radius and actions of the COVID-19 confirmed patients. The platform uses cloud-sourced statistic data about confirmed cases by regions and is immediately updated using the information released by Korea Centers for Disease Control and Prevention.

*Figure 7 COVID-19 Comprehensive Situation Map. It shows the overall pandemic information of confirmed patients, quarantine, dead, and inspection progress numbers, map of confirmed patients, map of occurrence trends by city and province*

![Image of COVID-19 Comprehensive Situation Map](https://dev.ksic.net:8099/)


*Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.*

**Self-quarantine Safety Application**

The Korean government has also developed the Self-quarantine Safety Application to effectively support the monitoring of those under self-quarantine. The application has become available for download since March 7\(^\text{th}\). The application supports 3 languages (Korean, English and Chinese) and requires users to

\(^{25}\) COVID-19 Comprehensive Map. Available at https://dev.ksic.net:8099/
provide location and other personal information. The application allows the users to monitor their conditions and conduct self-diagnosis and ensures that the self-quarantine orders are kept by setting off an alarm when a user ventures out from the designated quarantine area. Installation of the application is voluntary for those living in Korea, which means that the user voluntarily downloads the application and gives consent to providing location data and personal information. However, with an increasing number of inbound cases, as of April 1, all inbound travellers including Korean nationals must download the app to enter Korea.

Time series trends of COVID-19 analysis and results

*Figure 8 COVID-19 Time series analysis for the Republic of Korea*

Source: ESCAP analysis based on data from Johns Hopkins Coronavirus Resource Center

**Highlights of what analysis reveals within country context**

For Korea, the analysis shows the development of COVID-19 before mid-April in terms of its development, source of infection and geospatial spread. The structural break test (chow test, p<0.001) shows that the number of confirmed cases began to increase significantly starting on February 20: the slope of the changing patterns of confirmed cases were statistically different before and after the date.

- The turning point of the spread of pandemic appeared to be around March 10th (chow test, p<0.001, with number of tests controlled). It is worth mentioning that this is approximately 3-4 days after compulsory self-quarantine monitoring was applied.
- Source of infection: Church community infection seemed to be a major source before people were advised to stayed at home (Feb 25) and decreased afterwards. There was also an increasing overseas inflow since Mid-March.
- Socio-economic impact: economy appeared steady, and the pattern may result from economic boosting policies in early 2020.
Thailand: Case study analysis and country-based practices

Brief overview of COVID timeline and policy measures/actions taken

Thailand confirmed its first case of Covid-19 on January 13, 2020 and its first death of a Thai national was confirmed on 1st March. On the 22nd of March a number of measures were put in place including airport screening, isolation, contact tracing and self-quarantine along with the promotion of personal and community hygiene. On the 26th of March the Thai government declared a state of emergency. On 3rd April a nationwide curfew was implemented from 10pm to 4am and a travel ban on all flights entering Thailand was introduced.26 On the 3rd May the first phase of reopening was introduced27 with the state of emergency being extended.

Country practices integrating geospatial information

iMaP portal

The Geo-Informatics and Space Technology Development Agency (GISTDA) is the core national space agency under the supervision of the Minister of Higher Education, Science, Research and Innovation of Thailand and a member of the Working Group on Data Integration and Analysis for Covid-19 Situation. The working group was initiated under the Centre for COVID-19 Situation Administration. GISTDA played a prominent role in the integration of COVID-19 related information.

To support the working group, GISTDA identified the need for a platform to help at the operational level, especially the inspection teams in each province in Thailand. The platform integrates data so that it can be summarized, linked to maps and visualized on a dashboard customized for specific users. The target users of this platform are mainly the government agencies to enable them to monitor the pandemic situation, medical capacity and supplies, consumer goods, and design necessary preventive and precautionary measures.

The COVID-19 iMap is an operational platform that not only allows users to visualize and monitor the pandemic situation in Thailand, but also enables them to examine and monitor the impact of the policies employed in the country. The datasets used are both geospatial and non-geospatial in nature and collected from relevant agencies in the country. These datasets were contributed by a variety of

different agencies with different mandates. The data is integrated, summarized, analysed and displayed on the newly developed dashboard.

Over the course of the pandemic the iMap Dashboard has evolved to incorporate numerous additional features and data displays. Some of these included the availability of consumer goods, medical capacity and supplies, the overall pandemic situation and preventative or precautionary measures. The use of these measure has allowed for better monitoring and management of the situation and operational planning.

The COVID-19 iMap is considered an efficient tool to support policy makers, the Working Group on Data Integration and Analysis for Covid-19 Situation for operation planning, as well as inspection teams, Centre for Correction of Security Emergency, and Provincial Disease Control Centres. It also showcased the huge benefits of geospatial information and space technology applications for emergency response at both the policy and operational level.

GISTDA promotes the use of geospatial information and space technology for emergency response. In order to integrate the available data into the platform, cooperation, authority and communication among different agencies is key.

*Figure 9 Thailand COVID-19 IMAP dashboard showing availability of medical supplies*


Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
Highlights of what analysis reveals within the country context

In general, the COVID-19 situation in Thailand was controlled effectively as of writing (December 15, 2020). From the figure we can see that the effect of the response measures put in place after the initial wave of COVID-19 cases. The turning point (April 12) occurred soon after the state of emergency, travel ban, and curfew came into effect. The daily infection cases dropped significantly afterwards.

Conclusions and future steps

In this report, a simplified method was developed to briefly analyse and visualize the development of COVID-19 and interactions between the pandemic, socio-economic development and public policy. Using official statistics, we applied the methodology to four pilot countries to show its potential. With available local data, we anticipate that this method can be applied by stakeholders at the domestic level to analyse COVID-19 and similar problems. Although this pilot analysis was centred around COVID-19, it is possible to expand the methodology to identify patterns in other socio-economic areas and in similar situations.

First, the analysis we developed showed the influence of response measures and policies or other trend-breaking events on the patterns of COVID-19 development and vice versa. If using other statistical
metrics and more data such as poverty rate, damage caused by flood, traffic congestion and others, it would be possible to evaluate policy and the impact of influencing factors. Second, from the case of the Republic of Korea and China, we saw the possibility of integrating geo-spatial information and statistical analysis by combining both types of data.

However, this is only a pilot analysis with certain limitations, which may be addressed in further analysis and research. First, the analysis was done with national level statistics primarily at daily and monthly levels. If similar procedures were taken with data in a shorter time scale, more detailed analysis could be done, and more insights could be generated. Second, as mentioned above, we are looking forward to incorporating geo-spatial based analysis into the methodology following a guideline informed by the analysis and dashboards created in countries in the region. For example, with information on the infrastructure in pilot cities, further analysis concerning the impact of lockdown to particular regions (in aspects such as public security and the environment) during COVID-19 can be done. In summary, we hope research in this area can progress further with the increased availability of data. This work is at initial stage and has promise to become more comprehensive and operational. This is a preliminary pilot application and is currently under development in collaboration with Thailand and Indonesia.

**The UN Open GIS Initiative**

The UN Open GIS Initiative, established in March 2016, will **identify** and **develop** an **Open-Source GIS bundle that meets the requirements of UN operations**, taking full advantage of the expertise of UN partners such as Member States, International Organizations, Academia, NGOs and the Private Sector.

The UN Open GIS Initiative aims to provide a full scale of **Hybrid GIS Solutions** for the UN Secretariat, UN field missions and regional commissions with the option to extend this capacity to UN agencies, UN operating partners, and assist developing countries. This hybrid approach will effectively support UN operations as well as ESCAP and its member States through integrating Geo-databases and complementing GIS systems to support various operational requirements.
More than 200 **geospatial analytical functions** have been developed as open-source GIS applications. These functions are available in specialized analytical software and some of the functions are included in QGIS.

Various **mobile GIS solutions** such as QField, KoBoToolbox/KoBoCollect, Geopaparazzi and Smash have been assessed in the field and the effectiveness of each mobile GIS solution was evaluated. Evaluation criteria included specific operational demand and analytical compatibility in QGIS, GeoServer and PostgreSQL/PostGIS.

In order to provide cost-effective map dissemination, **UN Vector Tile Toolkit** has been developed with the latest and efficient web-mapping technology ([https://github.com/un-vector-tile-toolkit](https://github.com/un-vector-tile-toolkit)).

**The Cloud-Free Satellite Imagery** pilot aims to explore removal of clouds and shadows in optical satellite image with cloud free pixels from the same sensor. The primary platform use is OpenDataCube in Amazon Web Service (AWS) where workflows are designed to execute in sequence from processing fresh images to final cloud free image generation. The outcome could be extremely useful during rainy season to effectively support disaster risk reduction (DRR) and/or emergency operations.

Partnership with **OpenDroneMap (ODM)** has provided an opportunity to apply ODM technology to the UN operational environment. ODM technology include open-source toolkit for aerial drone imagery, modern photogrammetry and developing digital surface modelling and mosaicking.

The **UN Open GIS Initiative** is now focusing on the provision of support to UN field operations. Initially starting with peacekeeping operations and following by extension of support to wider UN operations including humanitarian and sustainable development goals (SDGs) for UN agencies and UN operational partners (NGOs and international organizations) as well as for developing countries.

Many of UN Open GIS efforts could be effectively appliable to support ESCAP and its member States in development of a thematic GIS platform for integrating geospatial data. For example, the hybrid GIS infrastructure, together with geospatial analytical functions, UN Vector Tile Toolkit and various open-source based mobile GIS solutions, could be considered as baseline to technically equip the envisioned regional geospatial service centre and support GIS capacity building initiatives. Cloud-Free Satellite Imagery and OpenDroneMap could be immediately used to support disaster relief operations and drought monitoring as well as other SDG related demands. On-line tutor-led train-the-trainer courses on QGIS, PostGIS/PostgreSQL and mobile GIS solutions could be arranged for ESCAP and its Member States.

Furthermore, ESCAP is now working in pilot areas with national partners to integrate geospatial and socio-economic information and identify correlations between COVID-19 and “place, space and community” characteristics.

Countries with strong legal and regulatory geospatial frameworks and infrastructure, that already had systems and processes in place for collecting, managing and disseminating information for COVID-19...
response and prevention were ahead of the curve. For example, the Korean National Spatial Data Infrastructure Portal allowed collaboration among various ministries, the police, telecommunication and other private companies.

Regional cooperation will help the Governments to operate a comprehensive platform in order to better integrate various data and information, including satellite-derived data and ground geo-referenced data, in response to the COVID-19 pandemic, although the structure of the platform used by Governments vary from country to country. Despite good progress in several countries in Asia and the Pacific, there are many challenges that remain on data integration, such as rapid data collection and integration, links with policy implementation and action, data privacy, and cooperation with the public on data collection and access.

There is much hope for the future as vaccines are beginning to be distributed and administered. Geospatial information will continue to be important to help identify the communities still at risk and map and plot where potential risk areas remain for targeting vaccination, prevention and response measures.

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Annex

This template for data analysis is meant to be revised based on specific needs of each countries. An excel spreadsheet version can be shared upon request. Please contact ESCAP Space Applications Section at escap-sas@un.org for this template, more information and resources.

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