CHAPTER 2

Innovative SGT for the ASEAN Economy

Following general considerations on the potential of space and geospatial technology (SGT) in Chapter 1, this chapter will present concrete areas of application of SGT in ASEAN and is divided into the following sections:

1. General role and potential of SGT;
2. Presentation of key areas of application of SGT to the ASEAN economy; and
3. Concrete recommendations based on the key areas introduced in Section 2.

The Role of SGT

As described in the previous section, SGT consists of four aspects:

1. Real-time localisation and tracking of people, cargoes, and vehicles (air, sea, and land).
2. Real-time monitoring of environmental and contextual information covering all land and sea such as: dynamic maps (traffic, congestion, people flow, and city changes) or environmental changes (weather, water and air quality, and greenery) from which events, accidents, and disasters can be extracted. Silent but meaningful changes such as climate change and crustal deformation can be included.
3. 'Ubiquitous' data communications at any time/anywhere with small Internet of Things (IoT) devices to collect data from and send instructions/guidance to people and machines in the field.

4. High-precision mapping of three-dimensional (3D) space and landscape framing activities of people and autonomous vehicles/machines, which could include very slowly moving phenomena like crust movement monitoring.

For aspect 1, it is technically possible to track most of the locational information of cars and people with the use of the widely distributed smartphones. However, the collected data are often scattered, and neither shared nor well exploited. Regarding aspect 4, the Quasi–Zenith Satellite System (QZSS) will start full operation in 2018, and seven satellites will be operated in 2023. Along with these developments, reinforcement service for high-precision positioning such as MADOCA will be provided; and more accurate location information can be obtained. As a result, location information can be rapidly applied in various fields such as automatic driving and tracking of ground movement. Regarding aspect 3, an integration of various information covering people and cars in mega cities and interior areas, including oceans and rural communities, can be achieved with the help of IoT sensor networks and machine-to-machine (M2M) communication network developments. Indeed, 'OneWeb', the data communication service with global coverage and with 648 low-altitude satellites, will provide a satellite Internet network to the entire world by 2020. Regarding aspect 2, based on the PLANET and AXELGLOBE plans, typical emerging satellite observation companies deploying constellations of small satellites, real-time monitoring of the entire globe can be achieved within a few years.

These four principal functions are supposed to be implemented by 2025. Therefore, as described in the previous section, it is necessary to discuss the 2025 infrastructure strategy in the Master Plan on ASEAN Connectivity 2025 (MPAC-2025), and the sustainability, toughness, and innovation of the ASEAN Socio-Cultural Community Blueprint 2025 (ASCCB-2025) associated with the current technological innovations.

ASEAN countries face many challenges. For example, economic development and population growth in the region are remarkable. Furthermore, there is enormous potential for socio-economic developments resulting in excellent human resource developments. On the other hand, the shortage of infrastructure investments, traffic congestion, environmental destruction, urban problems, and income disparity have been severely deepened.

Risks of natural disasters such as storms, floods, earthquakes, tsunamis, and landslides are also very high. Therefore, a huge investment is required for proper disaster management. Transportation network developments connecting countries and socio-economic developments are still insufficient. Investments of US$16.6 trillion for road development will be needed by 2030 (Dobb et al., 2013).

SGT provides essential information on disaster response, expansion and strength of international transportation networks, reduction of traffic congestion, optimisation of logistics, and comprehensive urban management; and strengthens the Plan-Do-Check-Act (PDCA) cycle.

The Expected Contributions of SGT

The significant contributions of SGT in addressing social issues are summarised as follows:

1. Better urban development/control, including sound financial basis;
2. Better infrastructure planning and management, including financing;
3. Better, safer, and smoother transportation systems;
4. Better quality of life by reducing costs and risks from disaster, accidents, and diseases; and increasing job and financing opportunities;
5. Better disaster responses, evacuation, and recovery;
6. More efficient and secure logistics;
7. More stable, profitable, safer, and sustainable agriculture and fishery while conserving resources and the environment;
8. More efficient manufacturing and service industries supported by better logistics and transportation systems; and
9. Better quantification and management of environmental services and national resources.

Better urban development control, including more sound financial basis

Information, such as stagnation and movement of people and vehicles, urban facilities developments, and construction of houses and infrastructures such as roads, can be continuously provided by SGT. Therefore, governments and local communities can conduct proper policymaking and monitoring, aimed at urban

planning, urban growth management, and environmental improvement in an efficient way. For example, individual information on stagnation and movement condition of people and vehicles can be used for introducing new taxes such as congestion pricing and space use charge. Furthermore, extraction of buildings and land uses, and their changes from satellite imagery can be used for strengthening building taxation and land tax levies. To apply location information for taxation, it is necessary to implement a location authentication system to prevent spoofing.

Better infrastructure planning and management, including financing (road pricing, etc.)

Infrastructural conditions can be detected in timely fashion through image analysis and sensor information. This will contribute to the prevention of accidents caused by infrastructure damage, and to the optimisation of maintenance methods and timing of infrastructure constructions. Real-time digital data on vehicles and people using transport infrastructure will help improve the optimisation of infrastructure investment and the overall optimisation of infrastructure management, including operations. For instance, an infrastructure usage-based charging system can be applicable. As a result, new resources and budgets for infrastructure management can be secured in addition to the better use of limited infrastructure resources. To apply location information for taxation, it is necessary to implement a location authentication system to prevent spoofing. Authentication can also be made possible using encrypted signal broadcasting from satellites.

Similarly, real-time supply and consumption of energy can be monitored as digital data. It will also contribute to the optimisation of energy infrastructure operation and then investment, and finally lead to overall optimisation. In the field of renewable energy, where fluctuations of energy production are quite dominant, more detailed and reliable data on natural environments causing fluctuations can be obtained by SGT, leading to the significant reduction in risks.

Better, safer, and smoother transportaion system

In the transportation system, SGT can track locations of vehicles, passengers, and cargoes. This will help in real-time performance monitoring of transportation

systems (smoothness, efficiency, and safety). SGT can easily detect problems and help continuously improve the system in combination with performance monitoring. Furthermore, automatic operation and sharing of vehicles can be performed by using real-time positioning service, which dramatically improves the efficiency and smoothness of the transportation system. It also provides the possibility to simultaneously improve uneconomical external factors such as traffic congestion, air pollution/noise, and greenhouse gas (GHG) emissions. Improvements in traffic congestion greatly contribute to the improvement of productivities (e.g. service industry) by shortening traveling time in cities. Moreover, freedom of location (houses and shops) in towns can be significantly improved, enabling city expansion and improving competitiveness. To secure the safety of automatic operation, the improvement of the security of positioning service is necessary.

Better quality of life by reducing costs and risks from disasters, accidents, and diseases, and increasing job and financing opportunities

Collection and provision of real-time disaster information by SGT efficiently help reduce disaster risks. SGT significantly contributes to improving the quality of life in Asia where disasters generate huge numbers of victims. Also, risk information such as regarding traffic accidents and diseases can be provided as a temporal/spatial distribution so that these risks can be effectively reduced. The outbreak of epidemic diseases could be better controlled with SGT, through monitoring people and patient movement, together with environmental data to estimate the distribution of vectors like mosquitoes.

Furthermore, collecting credit information for micro credit could be made easier and more reliable, providing evidence of an individual's mobility pattern, social networks, and mobile payment data. This system contributes to increasing employment opportunities, such as matching for temporary work. Also, the quality of life of people in terms of safety and income can be continuously traced and evaluated so that continuous improvement can be carried out through the PDCA cycle.

Better disaster response, evacuation, and recovery

The use of SGT helps to quickly and exhaustively detect hazardous areas during disasters such as floods, landslides, earthquakes, and tsunamis. Therefore, evacuation can be promptly carried out in zones with high risks, leading to a substantial reduction of possible damage. Moreover, knowledge of the distribution and condition of evacuees facilitates the efficient provision of medical services and distribution of necessary items to the victims.

Furthermore, SGT allows the monitoring of post-disaster activities such as rebuilding or economic recovery in affected areas. The continuous and detailed assessments of disaster response and recovery activities help provide timely and appropriate support at suitable stages. Moreover, problems can be continuously discovered and solved through the PDCA cycle.

More efficient and secure logistics

The use of SGT enables the tracking of movements of cargoes, vehicles, and ships in real time so that a reliable and continuous evaluation of transport and logistics performances can be made, leading to a significant reduction of the cost and duration of transportation.

In case of disasters and failures, logistical delays can be forecast. Therefore, damage can be reduced by adapting the production amount and the distribution process. Moreover, damage to roads can be detected in advance, so delays and losses of logistics can be minimised by rearranging routes and transport methods. By combining trajectory analysis and location verification, deliveries of products to recipients can be confirmed, leading to secure logistics without theft or illegal sales during the process. Acquiring detailed information such as routes also enables companies to better manage the quality of their products (e.g. refrigerated items and fragile objects). Furthermore, the automation of cargo handling machines during transfers from ships to trucks using secured high-precision positioning services has been developed. This contributes greatly to improving efficiency and reducing cost and time during operations, especially considering the very large geographic range of ASEAN.

More stable, profitable, safer and sustainable agriculture and fishery while conserving resources and the environment

In the agriculture industry, the use of SGT helps in the understanding of the details of agricultural production systems, including growing processes and crop management practices. It contributes to improving agricultural operations, reducing the risks of production, and improving/stabilising productivity and profits. More importantly, the accumulation of these data and integrating them into weather and market predictions can significantly contribute to risk reduction and production optimisation at a higher level. In addition, purchasing insurance can further reduce possible risk. Governments and agricultural market personnel can reduce agricultural impacts by controlling market fluctuations through arranging the stockpile and adjusting imports and exports based on production forecasts. Furthermore, from the viewpoint of management of land and water uses, SGT can contribute to the examination of proper resource use in agriculture (cultivation, products, water use, etc.) and forestry. Thus, necessary improvements can be carried out accordingly.

In the fishery industry, the use of SGT enables the checking of detailed conditions of sea and fishing boat operations, the estimation of the catch amount, and the understanding of the status of fish resources and fish farm operations. This improves fishery operations and reduces risks of production and maritime accidents, leading to an improvement and stabilisation of productivity and profits. Furthermore, entrance fees and charges/regulations based on resource use can be applied in the operation, leading to sustainable use of resources as well as ensuring funds for resource management. Accumulating these data and integrating them with the predictions of sea, weather, and market can contribute to risk reductions and production optimisation. In addition, purchasing insurance can further reduce possible risks. Governments and marine products market personnel can reduce risks by controlling market fluctuations through arranging the stockpile and adjusting imports and exports based on the production forecasts. And from the viewpoint of fishery resources and coastal environmental management, SGT can contribute to the examination of proper resource uses in terms of operation and coastal area utilisation (water quality management, topography modification, and protection of mangroves), and its improvement, if necessary. To apply location information for developing charging

systems and regulations, a location authentication system must be implemented to prevent spoofing.

More efficient manufacturing and service industries supported by better logistics and transportation systems

The use of SGT can improve efficiency and safety in logistics, and reduce distribution cost and transportation time, leading to the reduction of production costs in the manufacture, service, and construction industries. Furthermore, allocations of production bases and branches will be flexible. As a result, unbundling of production, distribution, and consumption will be further promoted. Especially in the construction industry, uncertainties in procuring materials, equipment, and labour will be reduced, leading to efficient process management and lower construction costs. As a result, arrangements in production and logistics bases will be further optimised in ASEAN countries. Consequently, management styles, such as company size expansion, will be more flexible. An improved traffic system will also facilitate the flow of people, expand living areas such as shopping and commuting areas, and easily attract tourists. This will lead to the expansion of industries and revitalisation of the regional economy. The competitiveness amongst ASEAN countries will be further improved.

Better quantification and management of environmental services and natural resources

The development of SGT will enable the understanding of details in a quantitative way, including the amount and distribution of environmental services and natural resources. This helps governments and companies to more rationally conduct decision-making by considering a balance between development, use, and conservation. In addition, as the use of environmental services and natural resources can be understood, countermeasures can be immediately taken against inappropriate use. Furthermore, introducing a charging system further promotes its appropriate usage. This process strongly secures financial resources for environmental resources management. Thus, sustainable and adequate environmental services and use of natural resources can be achieved through system development.

Concrete Recommendations and Example of Efficient use of SGT

This section presents concrete recommendations for the application of SGT for the enhancement of the ASEAN economy.

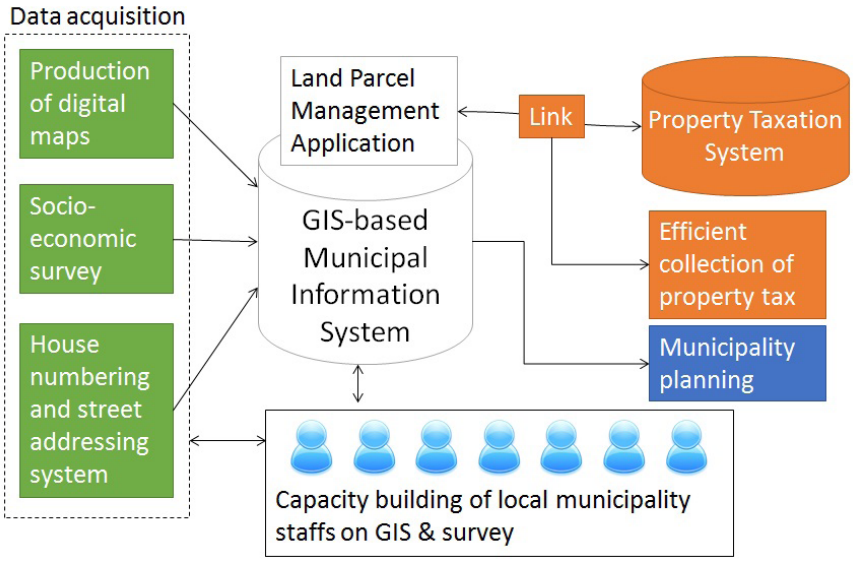
Make cities smarter

The key points in applying SGT to city management are: 1) to reinforce the financial basis of city administration by monitoring land/space values and city infrastructure uses; and 2) to share information on use of city resources like roads and building spaces to facilitate sharing and improve efficiency of usage. It could be accompanied by taxation and rewards

- Greater efficiency and effectiveness in taxation of land and fixed properties by monitoring constructions, vacant land, and land use from space.
- Better and more efficient cadastral surveys by providing basic information for taxation, such as land property.
- Availability of 24/7 monitoring of urban transport (including passengers and cars) to enable choosing less congested routes and efficient transportation, minimising confusion/congestion when events/accidents occur.
- Charging car drivers and pedestrians for congestion time and at congestion places. In addition, charging road parking, street stalls, and disposals to control use of urban space and infrastructure. Then, increasing the financial resource for urban management, while achieving more efficient use of urban facilities/spaces.
- Promotion of sharing economy by frequent (daily/hourly) monitoring of parking, offices, and accommodation. Greater efficiency in the use of urban spaces.

An example is the use of the geographic information system (GIS) application in municipality management in Nepal, which also focuses on the reinforcement of the financial basis through land property taxation. Data on land parcels, including ownership, use, and value are monitored by combining field surveys and aerial/satellite imagery interpretations.

Figure 7: Example of Urban Application of SGT in Nepal



GIS = geographic information system, SGT = space and geospatial technology.

Source: Authors.

Improve the transportation sector

SGT enables the collection and sharing of dynamic information on passengers, cargoes, and vehicles (demand side), and on transportation infrastructure such as roads, railways, harbours, etc. (supply side). Better and safer uses of transportation infrastructure could be facilitated and encouraged by fees and regulations with this information.

- Significant improvement of management and operations by monitoring both the movements of people/cargo and the health of transportation infrastructures/vehicles.
- Better safety through fewer incidents in transportation systems.
- Reduction of disaster damage to transportation systems. Speedy evacuations of passengers and recovery of services.
- Data-driven, evidence-based planning of transportation infrastructure and healthy implementation of plans and operations.
- Flexible adjustment of toll fees (roads, etc.) by location and time. This will contribute to infrastructure development finance and better traffic control.

Improve people's quality of life

To improve the quality of people's lives, top priority should be given to the provision of information on potentially life-threatening risks so that people can avoid them. This should not be limited to disaster and accident risks. Health information can also be regarded as long-term risk information.

The second priority should be provision of information on risks related to convenience, such as the reduction of costs, including time consumed by traffic jams, etc. SGT will contribute to visualising congestions and the like so that people can avoid them. In the longer term, by helping more efficient/effective investment on infrastructure based on reliable information, congestion itself can be mitigated.

The third priority should be enhancing career development and capacity building of individuals. The contribution of SGT here would be limited, though behaviour log data collected through SGT could be used to generate personal credibility information for financing, when traditional credit information is limited.

- Ensure people's security by delivering precise information about disasters and incidents.
- Ensure epidemiological security by delivering precise risk information to people.
- Provide health advice and information personalised according to daily activities and exercise. These will improve the efficiency of public health insurance.
- Reduce commuting time and traffic incidents through better traffic management, to improve the safety and quality of family life.
- Better and more efficient medical and health services by sharing location information of medical service resources such as doctors, nurses, pharmacies, and instruments in situations where there are limited resources.
- More job opportunities and lower unemployment rate by better job matching around home.
- Also, greater safety by avoiding hazardous jobs and better job opportunities.

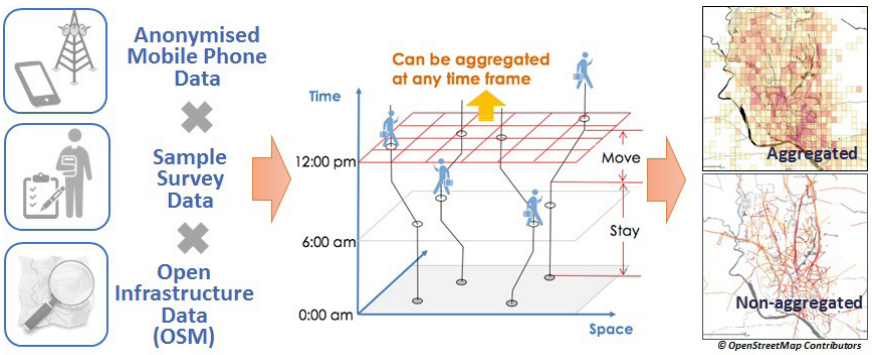
- Diverse education chances through various e-learning systems in ubiquitous network environments.
- Promote community-based assistance through connections by location information and social media. This is very helpful in emergency responses.
- Personal logs of activities and authenticated locations are utilised as proof for individual authentication, anti-identity spoofing, and credit information of finances. It facilitates jobs of start-ups and small businesses via appropriate micro financing systems.

Establish dynamic census

SGT provides new means to complement demographic and economic statistics/indicators that form the basis for better decision-making by stakeholders.

Mobile phones would be the most important devices to collect information on people and their economic/social activities considering the very high penetration in the market. Log data collected through the operation of mobile phone systems could be used not only to complement demographic and socio-economic statistics but also to enhance them because the log data reflects daily activities and movements of people. Figure 9 illustrates how the log data from mobile phones could be used to complement and enhance population census by combining sample field surveys and digital map data created from the satellite imagery. Newly created census could be called 'dynamic census' because it could cover movement and migration of people.

Figure 8: Schematic Description of Dynamic Census



OSM = OpenStreetMap.

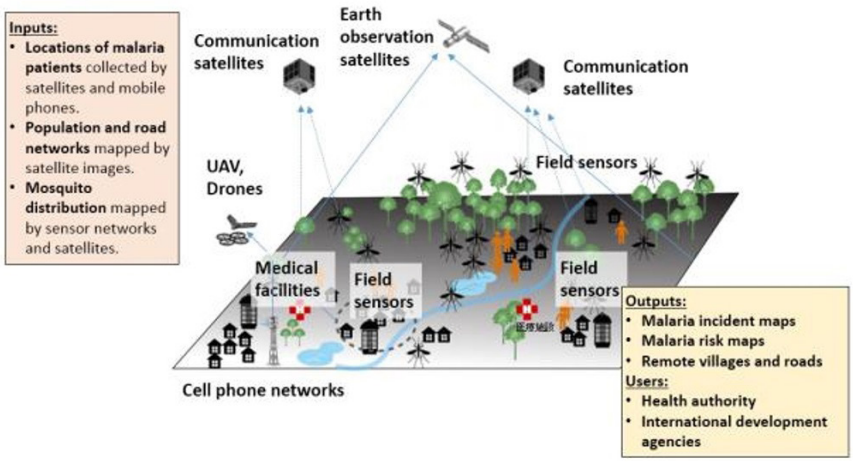
Source: Authors.

The following examples are ongoing efforts to explore new frontiers of applying 'dynamic census' to social problem solving.

Example 1: Space-based Malaria Monitoring and Control

By combining space technologies and ground communications technologies, near real-time mapping of malaria incidents and risks is made, enabling decision-making for malaria control. Overall, malaria risk to people entering high malaria risk areas like forests could be estimated. Dynamic census is used as the basis in the estimation process.

Figure 9: Near Real-time Mapping of Malaria Incidents



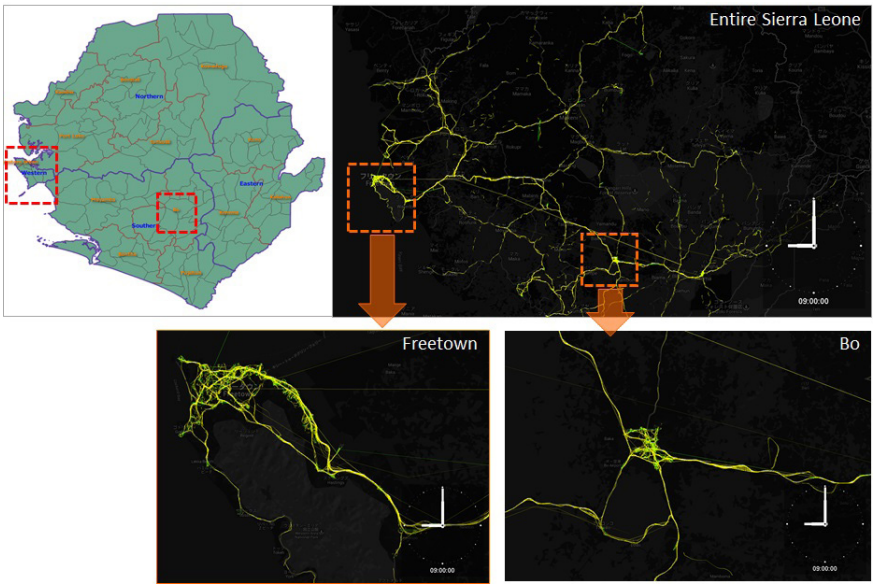
UAV = unmanned aerial vehicle.

Source: Authors.

Example 2: People Monitoring for Ebola Control

In Example 2, the propagation risk of the Ebola virus using the movement of patients and carriers could be readily estimated by using dynamic census or the dynamic monitoring capability of people movement with mobile phone data. Background data for the analysis of people movement can be generated with satellite imageries.

Figure 10: People Movement Monitoring for Ebola Control



Source: Authors.

Enhance resilience

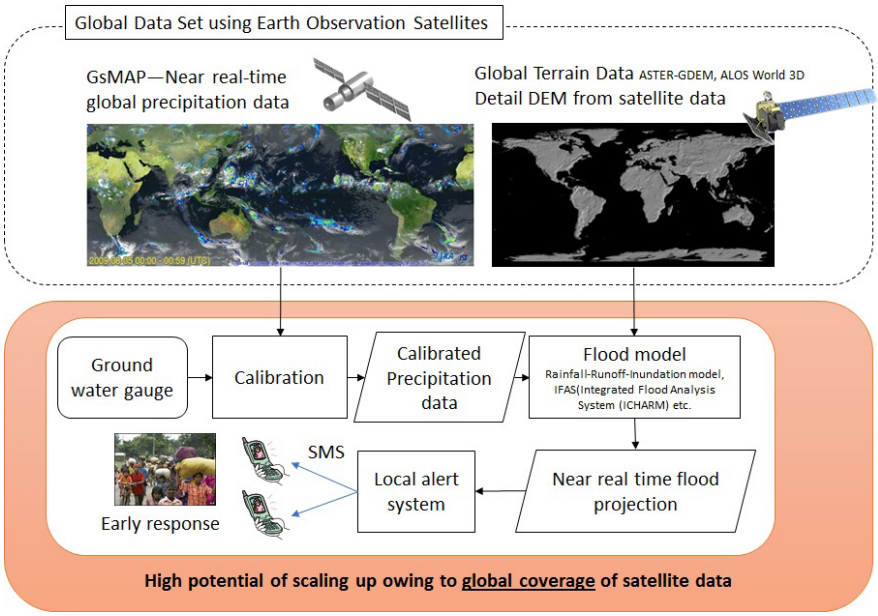
SGT enables the monitoring of ongoing disasters, including how people evacuate, and the forecasting of possible situations and impacts on society. Based on information, people, communities, industries, and societies could mitigate possible damage, more easily recover from damage, learn lessons from past experiences recorded as digital data, and get better prepared for possible disasters.

SGT can:

- Reduce human damage by ensuring rapid information collection and delivery about disaster hazards and damage.
- Ensure goods delivery and debris removal by goods tracking and real-time recovery monitoring after disasters.
- Ensure higher accuracy of forecasts on ground/ocean weather information. Significant improvements are made using satellite earth observation. This provides industry and people with lots of social benefits.

- Secure the safety of people by improving the accuracy of monitoring and forecasting of floods, slope failure, earthquakes, and volcanic eruptions, as shown in Figure 11.

Figure 11: Flood Alert System with SGT

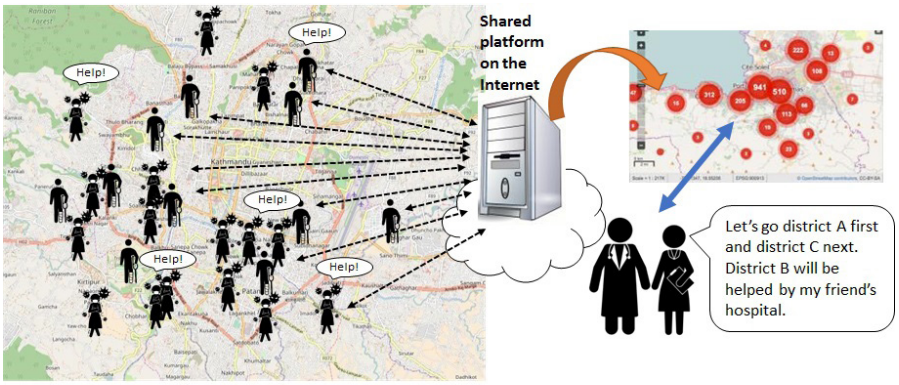


ALOS = Advanced Land Observing Satellite, ASTER–GDEM = Advanced Spaceborne Thermal Emission and Reflection Radiometer–Global Digital Elevation Model, DEM = digital elevation model, GsMAP = global satellite mapping of precipitation, ICHARM = International Centre for Water Hazard and Risk Management, SGT = space and geospatial technology, SMS = short message service.

Source: Authors.

- Disaster nursing supported by SGT. Even after disasters, care for vulnerable people such as babies, mothers, the aged, and injured must be provided. SGT will provide continuous monitoring capability on how vulnerable people suffer and survive so that society can provide the necessary support in a more effective manner.

Figure 12: Supporting Disaster Nursing with SGT



SGT = space and geospatial technology.

Source: Authors.

Improve Logistics

Tracking the movement of things (cargoes, freights) with authenticated position/time information enables the following improvements in the existing logistics systems. However, it should be highlighted that autonomous trucks and convoys could drastically improve the efficiency and safety of road transport of cargoes.

- Certification of production place. More added value by branding and safety, strengthening competitiveness, and leading to more competitive industries and attractive markets.
- Less delivery loss and damage. Smoother and cheaper logistic services. Strengthened logistic networks in remote areas, mountainous villages, and coastal areas.
- Uber-like delivery service by sharing available vehicles and labour that could lead to more efficient and flexible logistic services to fill gaps amongst professional, dedicated logistics services.
- More security and speed in custom clearance through certificates verified by authenticated mobility or location logs.
- Securing the collection, transport, and disposal of hazardous materials (e.g. industrial waste) through movements monitoring. Contribute to environment conservation.

- Reduction of long-distance logistics cost through the convoy transport of autonomous trucks on highways. ASEAN countries should have notable benefits owing to its dependency on road transports.
- Much lower operating cost and transport time through the automation of container handling in harbours.

Strenghten Industrial Activities

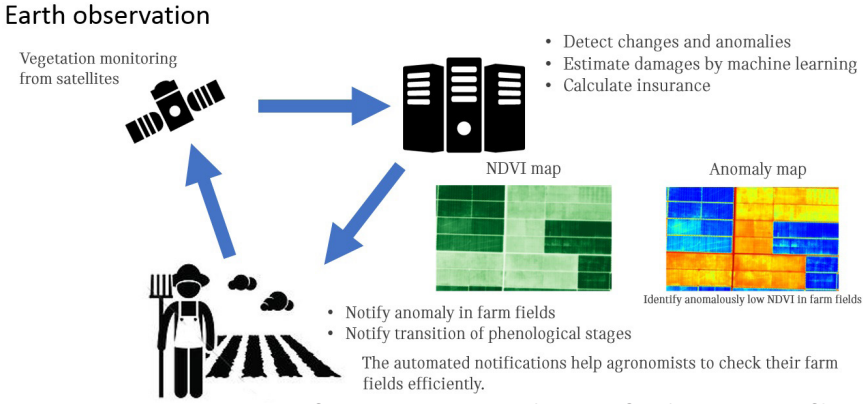
• Agriculture

Agricultural production often suffers from unexpected changes in weather etc. Such environmental changes could be monitored and forecasted using SGT, and farmers could mitigate damage and increase resilience.

– Less damage by preparing for expected typhoons and hazardous weather, as well as adjusting the timing of cropping, harvesting, shipping, and so forth.

– Optimised insurance cost by reducing agricultural risks and less compensation for agricultural damage from public sectors.

Figure 13: SGT for Agriculture



Source: Authors.

• Fishery

Fishery is also very seriously affected by sea conditions. In monitoring and forecasting such conditions, risks could be mitigated. Analysing fish catch and sea condition data enables the estimation of potential fishing ground, which leads to further risk reduction and improvement of fish catch.

– More efficient activities and operations of vessels and port facilities by forecasting harvestable areas and seasons. Better controlled market prices.

– Less impact of oceanic hazards to fishery productions by meteorological forecasting. Better security through the reduction of shipwrecks.

– Better productivity and reduced risk of aquaculture production disasters through information about ocean condition and water quality (e.g. red tide).

Management of fishery resources, securing safe operations, and detection of suspicious vessels by tracking locations and operations of vessels with verified position authentication.

• Forestry

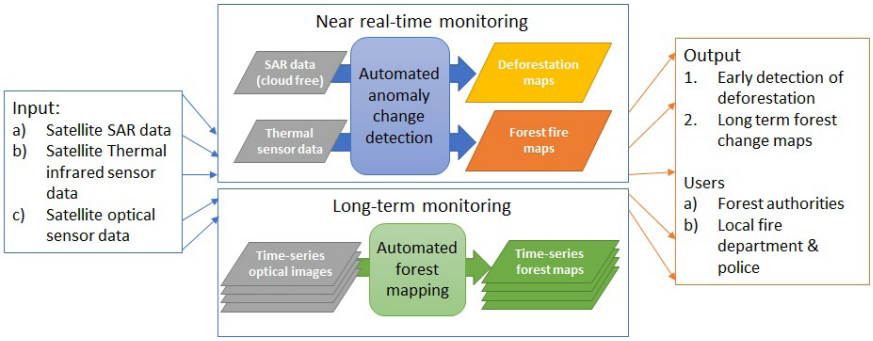
By measuring forest resources such as biomass and its distribution through SGT, the optimisation of timber production could be achieved, including logging, transport, and processing.

– Ensure sustainable use of forest resources (planting, conservation, logging) by continuous monitoring of forest resources (biomass and tree types).

– Better efficiency and effectiveness in logging, lumber, and transport by quantified planning of forestry operations. Less labour hazard.

– Suppress damage of forest fires and illegal loggings.

Figure 14: Forest Monitoring with SGT



SAR = synthetic aperture radar, SGT = space and geospatial technology.

Source: Authors.

• Construction

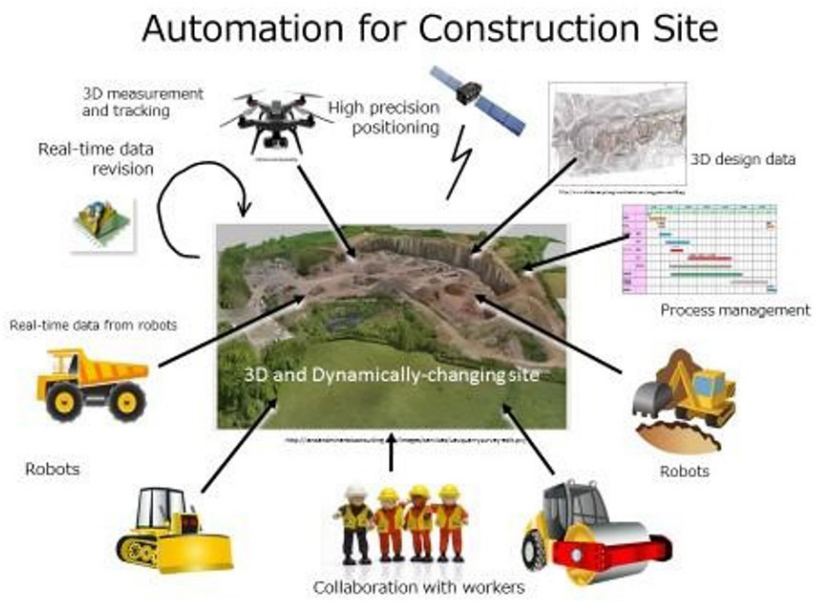
SGT will accelerate the automation of construction works through very precise real-time positioning, 3D mapping, and monitoring of environmental impacts of the works. In parallel, the process of construction will be fully digitised, which will accelerate the improvement of the construction management and technology.

– Risk reduction through effective designs and construction plans with accurately measured and shared data on terrain and geology.

– Effective management of labour and staff safety with better efficiency in transport and stock usage through continuous and accurate monitoring of things and people's position.

– Quality assurance and improvement through detection and prevention of faults by accurate 3D measurement of construction progress.

Figure 15: Automation in Construction Industries with SGT



3D = three dimensional, SGT = space and geospatial technology.

Source: Authors.

• Manufacturing

– Lower logistics cost and uncertainty to deliver and procure products, leading to cost reduction of manufacturing.

• Service

– Less cost of service delivery through significant reduction of cost and uncertainty in logistics.

– Realise possibilities of micro-consumer services, such as e-commerce and food delivery, through low-cost and effective delivery services.

– Better reliability of mobile payment using personal credit information based on locations and activities verified by positioning authentication.

– Scaling up of mobile micro consumer services through more reliable personal micropayment systems.

Figure 16: SGT to Support Distribution and Service Sectors

ID = identification, SGT = space and geospatial technology.

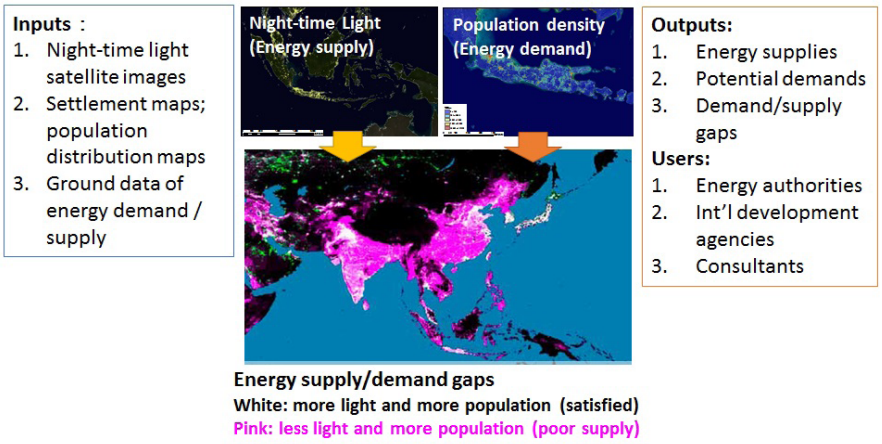
Source: Authors.

• Energy sector

–Energy (electricity power) supply with renewable resources, typically wind, water, and solar radiation, could be estimated with SGT, leading to smoother matching of energy supply and demand; while energy demand could be estimated by combining multi data sources like people activity and movement monitoring, heat radiation measurement from buildings/houses and city lights mainly from airborne and satellite observation.

Figure 17 is a visualisation of energy demand and supply gaps through satellite observations of city lights.

Figure 17: Estimating Energy Needs through Night Satellite Observation



Source: Authors.

Support Environmental Resources Management

Natural or environmental resource management is an area where SGT could make significant contributions because the lack of information on the status of and changes in resources has created difficulties in decision-making and evaluation of actions taken. In addition, through the improvement of efficiency in social systems like transportation/logistics, achieved with the help of SGT, GHG emissions and impacts on the environment can be reduced.

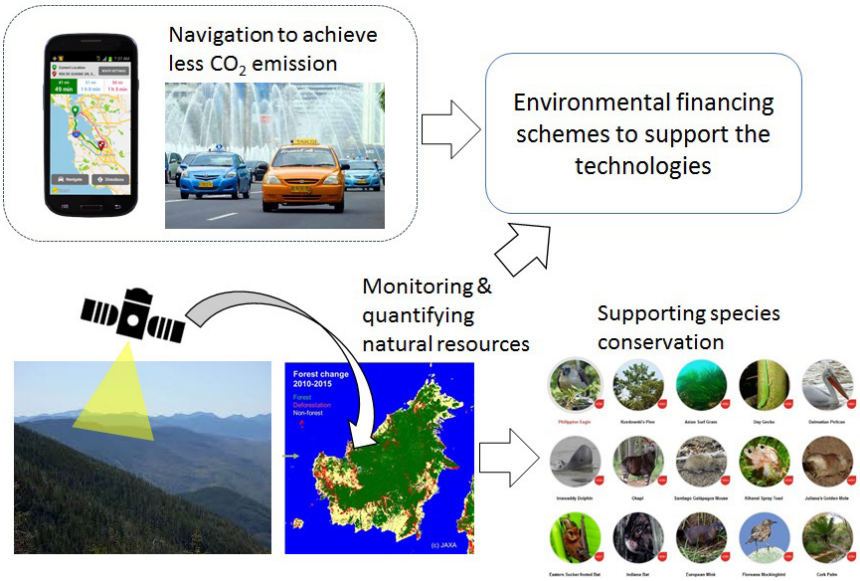
• Carbon dioxide (CO2) emission reduction by optimising transport operations (taxi, commercial vehicles, and shipping vehicles) based on vehicle mobility data. This supports fundraising by environmental finance schemes such as bilateral carbon offsets.

• Effective conservation of ecosystem services by continuous monitoring of the ecological status of forests, oceans, and marines.

• Social bonds can be applied to improve and sustain the services based on the value evaluation of ecosystem services.

• Effective conservation and management of specific areas for species conservation and gene banks.

Figure 18: SGT for Environmental Resouces Management



CO2 = carbon dioxide, SGT = space and geospatial technology.

Source: Authors.

Strengthen National Land and Sea Management

Enhancing observation capabilities for better informed decision-making enabled through SGT can contribute to the strengthening of the management of land and sea territories.

• Higher accuracy of forecasts in ground/ocean weather information using advanced satellite earth observation. This provides basic background information to a broad range of industries and people in making decisions from daily actions to long-term investments.

• Achieve marine safety and fishery resources conservation by strengthening detection and monitoring of unidentified ships.

• Better safety/security of people by improving accuracy of monitoring and forecasting floods, slope failure, earthquakes, and volcanic eruptions.

Policy and Economic Impact

The policy directions of the ASEAN, incorporated in 'ASEAN Connectivity 2025', are illustrated in Figure 22. The contributions and impacts of SGT on the policy directions above are summarised in Table 2.

Figure 19: ASEAN Connectivity 2025

ASEAN = Association of Southeast Asian Nations.

Source: ASEAN Secretariat.

The impacts and contributions of SGT were summarised in the previous section. However, the economic impacts of SGT cannot be evaluated quantitatively because SGT is an emerging technological system and no enough historical data is available to delineate the impacts.

Table 2: Contributions and Impacts of SGT on Policy Directions

Contribution to ASEAN Strategic Connectivity	Sustainable Infrastructure	Data Innovation	Seamless Logistics	Regulatory Excellence	People Mobility
Real-time localisation and tracking of people, cargoes, and vehicles (air, sea, and land)	Efficient planning/ designing and smarter operation	Creation of new services for SMEs	Supply chain efficiency through addressing key checkpoints	Consolidated data policy balancing openness and security	Better risk management (accidents, epidemics, disasters etc.)
Real-time monitoring of environmental and contextual information covering all land and sea	Real-time monitoring of infrastructure and uses	Creation of new services for SMEs	Enhanced trade routes and logistics	Open data policy and standards for distribution	Better risk management
'Ubiquitous' data communication at any time/ anywhere	Real-time monitoring and remote management for all territory	Enhance borderless data network	Real-time monitoring of cargo	Regulations for safer, reliable communication	Mobility support, risk alert service
High-precision mapping of 3D space and landscape framing activities of people and autonomous vehicles/ machines	Real-time monitoring and proactive maintenance	Facilitating automation in indoor to outdoor environment	Automated logistics with autonomous truck and logistics robots	Quality assurance and secure positioning	Seamless navigation from indoor to outdoor

3D = three dimensional, ASEAN = Association of Southeast Asian Nations, SGT = space and geospatial technology, SMEs = small and medium enterprises.

Source: Authors.

Conceptually, the economic benefits of SGT could be categorised as follows:

1. Cost reduction and efficiency improvements in existing industries and services.

Monetary evaluation could be made if the contribution of SGT could be delineated from the entire cost reduction.

2. Emergence of new services and industries.

It also includes the expansion of employment and contribution to new market development.

3. Improvement of people's welfare such as safety, stability of community/ society, and quality of life.

The improvement can be evaluated in terms of social indicators such as the number of casualties by traffic accidents. Monetary evaluation, however, is not easy. When benefit is localised or belongs to a specific area/location, land price, or rent could be used for evaluation using a more subjective approach.

4. Environmental impacts or benefits such as the reduction of GHG emission, ecosystem conservation, and biodiversity.

As far as carbon emission is concerned, reduction of emission could be evaluated in monetary terms. Conservation of ecosystems and biodiversity etc. could be evaluated in terms of indicator value changes, such as the number of species.

Though SGT is not yet deployed on a full scale, some elementary technologies are applied to some fields such as traffic management (traffic monitoring and navigation, guidance, etc.) in developed countries.

According to the report of the Ministry of Land, Infrastructure and Tourism (MLIT) of Japan, the introduction of the Electronic Toll Gate (ETG) to national highway systems, assuming 50% of cars use ETG, is estimated to have a cost reduction of ¥350 billion per year (US$3.2 billion)[1]. Since the total loss due to traffic congestion is estimated to be ¥12 trillion per year (US$110 billion) or 2.4% of gross domestic product (GDP)[2], 3% of the congestion cost was reduced by the introduction of ETG.

To approximately evaluate the order of possible SGT contribution in mitigating the severity of social issues, the authors summarised loss or damage due to such social issues as traffic congestion and safety. It should be noted, however, that these examples are not peer-reviewed reports on the losses but collected from

1 2006, http://www.mlit.go.jp/road/ir/ir-perform/h18/09.pdf
2 2006, http://www.mlit.go.jp/road/ir/ir-perform/h18/07.pdf

governmental reports, newspapers, and other sources to highlight the magnitude of the loss.

1. Traffic congestion

According to the Jakarta Post,[3] US$5 billion is lost each year due to traffic jams. This means US$167 loss per person per year or 5% of the per capita GDP. Thailand Herald reported in 2016 that traffic jams in Bangkok cost the economy ฿11 billion.[4]

2. Disaster loss

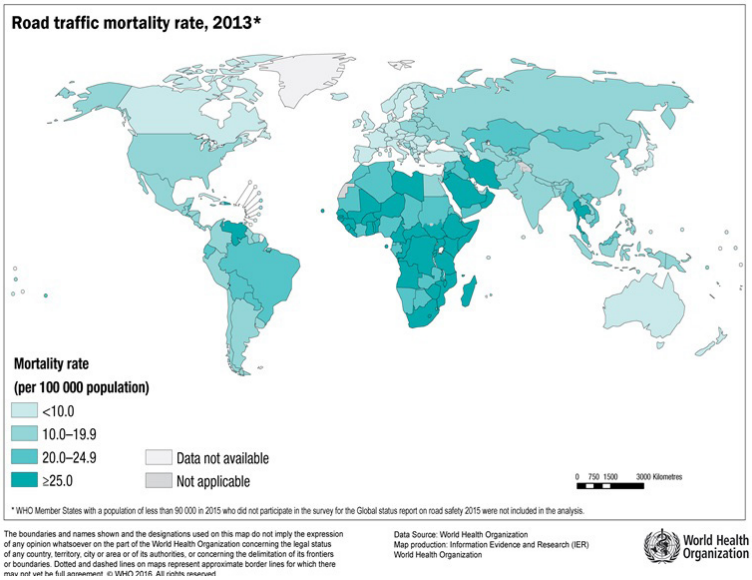
The economic damage of the tsunami caused by the 2004 Indian Ocean Earthquake to Thailand was evaluated by the Natural Resources and Environment Program, Thailand Development Research Institute.[5] According to the report, total loss was ฿40.6 billion (฿12.2 billion for human loss and ฿28.4 billion for capital loss), around 0.3% of Thailand's GDP.

3. Traffic accidents

The Bureau of Highway Safety, Department of Highways of Thailand reported that the annual economic loss of traffic accidents as of 2004[6] is estimated to be US$5,630 million (including human loss of US$3,175 million), equivalent to 2.6% of GDP.

[3] http://www.thejakartapost.com/news/2017/10/06/jakarta-foots-us5b-annual-bill-for-traffic-jams-minister.html
[4] http://www.thailandherald.com/news/247551269/cost-of-traffic-jams-in-bangkok-costs-the-economy-11-billion-baht
[5] http://tdri.or.th/wp-content/uploads/2013/01/n75.pdf
[6] http://bhs.doh.go.th/files/Project/accident/ENG/Executive%20Summary_EN

Figure 20: Road Traffic Mortality Rate 2013



Source: World Health Organization.

4. Logistics

The logistics performance of ASEAN countries is shown in Table 3, based on the Logistic Performance Indicator of the World Bank.[7] Logistics cost seems to be affected by the size of the territory and the level of transportation infrastructure. The performance improvement of the logistics industry plays a very vital role in economic growth.

[7] Logistics Performance Index of ASEAN Countries

Table 3: Logistics Performance Index of ASEAN Countries

Country	**Logistics performance index** Overall (1=low to 5=high)	**Logistics** (% of 2015 GDP)	**2015 Logistics Cost**
Brunei Darussalam	2.87	–	–
Cambodia	2.8	–	–
Indonesia	2.98	24	206.7
Lao PDR	2.06	–	–
Malaysia	3.42	13	38.5
Myanmar	2.46	–	–
Philippines	2.86	13	38
Singapore	4.14	8.5	25.2
Thailand	3.26	15	59.9
Viet Nam	2.98	20	38.3

ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic.

Source: Logistic Performance Index, World Bank, 2015.