# National Earth Observation Program for Digital Earth - the Malaysian Case: Issues in Consideration

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Abstract

Digital Earth, a virtual geospatial data infrastructure, has become a strategic asset to Malaysia in embracing the new economy. Earth Observation Satellite (EOS) is currently a major tool employed to build and maintain DE. Acknowledging the strategic need of having her own capability, Malaysia has embarked into EOS development programs since the early 1990s, starting with TiungSAT-1, a micro-satellite carrying a small camera, followed by RazakSAT, a small satellite carrying a 2.5 m PAN medium-aperture-camera. The current satellite development program, the RazakSAT-2, plans to carry a 1.0m high resolution PAN camera and a 4.0m MS camera, would become a strategic initiative by the Government in developing and accelerating the nation's capability in the area of satellite technology, and its applications. This paper aims to review the implementation of a national DE, and to discuss the country's space sector development in support of the DE implementations via the proposed National Space Policy. Emphasis is placed on the EOS program, as described in the policy paper, as well as on supporting local space industry. The paper concludes with identifying several related issues of importance, their impact, and finally, proposes techniques to address these issues.

*Keywords:* digital earth Malaysia, National Earth Observation Program

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## Introduction

Digital Earth (DE) was first visualised by former US vice president Al-Gore in 1998. It was described as a virtual representation of the geo-physical features of the Earth that is geo-referenced and connected to the world's digital knowledge systems. As three-dimensional (3D) representation of the planet, DE enables users to perform functionality actions in its system, as described in the Gore speech (Grossner, et al., 2008) as such;

- embed geo-referenced data in any quantity (i.e. contribute, publish, etc.);
- view the Earth (i.e., multi-resolution imagery, photographs, and other data, to 1 m per pixel) at multiple scales, from multiple viewpoints, simulate motion (e.g., animated, still; zoom, pan; orthogonal, oblique);
- locate information at various levels of granularity by means of browsing (maps and lists), direct queries and hyperlinks to associated data stores;
- create visualizations of uploaded data;
- travel through time; display conditions at any place for system-aware time periods, from Mesozoic, to the future, in the case of predictive models;
- "predict the outcomes of complex natural phenomena"; and
- "simulate phenomena that are impossible to observe".

Since then, various implementations of the concept have been taken up by the authoritative bodies, either at the municipal and district level, state, or at the country level (Kadir Taib, 2013; Abu Hanifah and Majeed, 2007; Kufoniyi, 2013). The concept has also been implemented for specific applications such as hydrological research (Wise, 2000), supporting global change research (Shupeng and van Genderen, 2008) and crisis management (Corbane, et al., 2011).

## The Malaysian Digital Earth Initiative

Geospatial data has always been, and will continue to be, critical and fundamental information for governments and businesses (Kadir Taib, 2013). It was estimated that nearly 80% of government data has a spatial (geospatial) component, of which most public and private decision making is based upon, with some geospatial aspects addressing diverse issues. Since the early 1980s, various initiatives of geospatial-related systems were developed; amongst them are the Computer Assisted Land Survey System, the National Forestry Information System, the Computer Assisted Mapping System and the Property Assessment System. More systems were developed during the 1990s, some of which are: the Land Use Information System, the Computerized Land Registration System, the National Infrastructure for Land Information System (NaLIS) and the Cadastral Data Management System (CDMS).

These developments have been put into place to steer the country towards a knowledge-based society and economy by 2020, where key initiatives of the transformation include e-government and the Digital Malaysia program. As for the spatial data infrastructure, the main program is the Malaysian National Spatial Data Infrastructure (NSDI).

## The Malaysian National Spatial Data Infrastructure (NSDI)

The Malaysian NSDI is a national initiative to develop a seamless single geospatial system for the country, as depicted in figure 1. The implementation of this initiative is the Malaysia Geospatial Data Infrastructure (MyGDI) (Abu Hanifah and Majeed, 2007). As the NSDI for Malaysia, MyGDI provides a national geospatial infrastructure comprising policies, data, and standards. MyGDI was established by Circular Letter No. 1 of 2006 - Guidelines for the Implementation of Malaysia Geospatial Data Infrastructure (MyGDI). The Malaysian Center for Geospatial Data Infrastructure (MaCGDI), a department under the Ministry of Natural Resources, is the entity responsible to spearhead the development and implementation of MyGDI, providing governance and services to end users; engaging in the development of human resources; and carrying out necessary R&D.

The key objectives of MyGDI are as follows:

- To enhance the awareness about data availability
- To improve access to geospatial information
- To facilitate the sharing and dissemination of geospatial information amongst government agencies, the private sector and the general public
- To provide customer-focused, cost effective and timely delivery of geospatial data

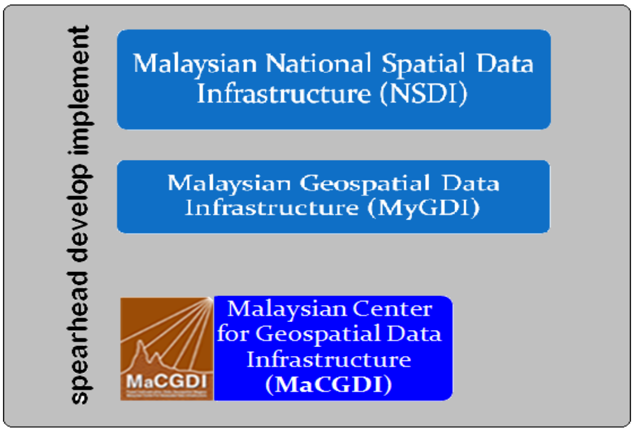


*Figure 1*. The Malaysian National Spatial Data Infrastructure

The primary goal of MyGDI is to enable members of geospatial communities in Malaysia to seamlessly share and access geospatial data, which is a noble feature with huge challenges. After almost a decade of deliberate NDSI development through MyGDI (figure 2) and other state Web-based applications, progress has been made in reaching this goal. Based on the assessment presented by (Majeed, et al., 2009), the initial steps in SDI developments have successfully set the general direction and goals, but remain far from fully achieving the nation's vision to have a single unified NSDI.

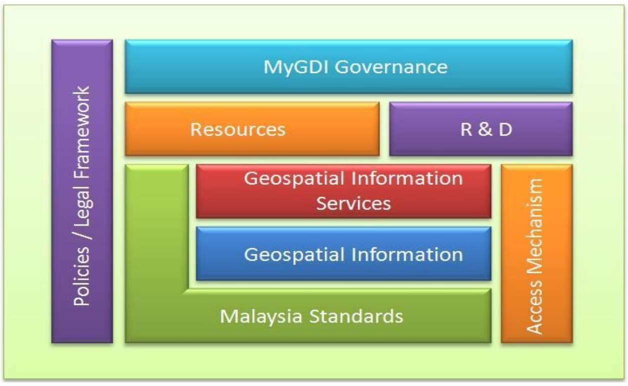


*Figure 2*. MYGDI – The Components

## The Space Components in the NSDI

### The National Space Policy

The National Space Policy is a strategic document used to chart the way-forward, and provides the framework of development of the country's space sector (National Space Agency of Malaysia, 2012). The document envisions on building the nation's capability to embrace space as a strategic sector for the national wellbeing towards achieving the Vision 2020, and beyond. This could be achieved by developing the country's potential in the space sector to support the development of the new economy, and to strengthen national security. The listed objectives of the policy are as follows:

1. To build up space infrastructure and industry for economic benefit and safeguarding the nation's sovereignty
2. To empower the civil society in enriching their quality of life through information from the innovative application of space technology

3. To capitalize/harness on space as the frontier for a new knowledge generation towards contributing to scientific and technological advancement

4. To ensure critical talent in the space related sector to support the realization of the space policy

This policy has also come up with a related policy framework in support of SDI development in Malaysia (Subari, 2013), in terms of the physical development of satellite systems, as well as of the downstream local space industry sector. The National Satellite Program development, which includes EOS satellites, as described in the paper, will become the backbone of the DE development (Subari and Hassan, 2015). The proposed National Space Policy also consists of a program that aims to nurture and develop the local space industry in order to sustain the economic growth of the country. Within this proposed program, the geospatial-related industry would be included in the local space industry category, and would be given special focus to ensure growth.

**The National EOS Program**

The space components provide several key data for the SDI, namely, satellite images from EOS satellites, geo-spatial positions through the Global Navigation Satellite System (GNSS), as well as (to a certain extent) communication linkages between the NSDI and end users, through communication satellites. Although Malaysia has plans for the development of all three satellite systems (the EOS, communication and GNSS satellites system), this paper only discusses the national EOS satellite program, and how it would contribute towards the development of the NSDI.

While topographic maps become the fundamental dataset, satellite images undoubtedly remain a key source of input information for a Spatial Data Infrastructure (Kufoniyi, 2013;

Michalak, 2004). Since the early 1970s, satellite images have been employed in several applications in Malaysia, mainly for meteorological applications using TIROS/NOAA data (Ibrahim et al, 2004), Landsats images for earth resources, images from the SPOTs satellites, the Indian IRS, the Canadian RADARSATs, and others. Malaysia has also greatly benefitted from the Global Earth Observation System of Systems (GEOSS), which provides links to existing systems and networks to achieve comprehensive, coordinated and sustained observations of the Earth (Craglia, et al., 2008). The GEOSS are overseen by the Group on Earth Observations (GEO), of which Malaysia is a member of. Current satellite images in use include the highest resolution data available from IKONOS and QuickBird.

The fact that all of these images are currently obtained from international satellite image providers, the country has taken a stand that, for long term sustainability, a more active involvement strategy is required. The strategy adopted in the proposed Malaysia Space Policy is to have the capability to replace some of these dependents with our very own EOS satellites.

Hence, the Malaysian EOS Satellite Programs are very much focused on building the nation's capability in satellite technology. It started with the TiungSAT-1, a microsatellite development program carried out through a technology transfer and training program with the United Kingdom's Surrey Satellite Technology Ltd (SSTL), in 1997. Successfully launched in the year 2000, and has been in operation for about 4 years, although not a 'real' operational remote sensing satellite, the TiungSAT-1 has given a complete cycle of experience to the country in satellite development and operation. It was then followed by the development of the Razaksat satellite, a small EOS carrying a 2.5 PAN and 5.0 MS camera. RazakSAT was a joint-development program with SatRecI, a South Korean company. This first indigenous satellite development project was carried out by a local company, Astronautic Technology Sdn. Bnd.

(ATSB), which was set-up by the Government to acquire the nation's capability in satellite technology. RazakSAT was successfully developed, launched and operated for about a year, and took several hundred images, when the on-board computer (OBC) died in mid-2010. This is believed to have been caused by the frequent passing of the South Pacific Anomaly area. Again, RazakSAT has provided another enriching cycle of experience to the country.

The current EOS project is the RazakSAT-2. RazakSAT-2 is a continuation of the country's effort in building the nation through acquiring satellite technology. Although ANGKASA is the project owner, ATSB is the project contractor for the Government. The RazakSAT-2 satellite development project is to be carried out under the 10th Malaysian Plan (2010-2015), and is expected to be launched at the end of 2015. As an operational EOS satellite, RazakSAT-2's mission primarily aims for infrastructure planning and development (National Space Agency of Malaysia, 2013).

**The Local Space Industry**

The other important plan of implementation in the NSP is the development of the local space industry – the downstream sector (Subari and Hassan, 2015). Under EOS downstream categories, several industry players that already exist in the country include those supplying satellite images, image processing software development, image processing for various applications, and specific applications developers. Closely related to these are the GIS-related industry players, which involved in supplying GIS-related data such as digital maps of various details. These are crucial players in the development of DE in the country, both on the supply, as well as on the user's side, of the DE system.

The other downstream space industry that has made significant contributions to DE development and applications is the GNSS sector. Providing precise referenced locations to spatial data, these GNSS players provide the much needed geo-referenced details of such data, hence, making those data unique and ubiquitous. Players in this category include surveyors, map makers, as well as location-based application-related developers. The NSP proposed that players in this industry are identified as downstream space industry players, and should be given special status, with various incentives planned to assist in their growth and contributions.

## Issues of Importance

For the long-term success and sustainability of a DE implementation in the country, the author notes that several key issues of pertinent importance need to be clearly worked out. These are presented and discussed hereafter.

### Sustainability of the EOS Program

Acknowledging the crucial need of the EOS input for the development of a DE, and ensuring a continuous supply of satellite images, are of importance. China, for example, has placed great importance on the development of Earth observing satellites (Huadong Guo, 2012). The four satellite series in China, which include resource satellites, environment satellites, meteorological satellites and ocean satellites, have been developed within the past few decades. They also plan to have more high-resolution remote sensing satellites for building their next generation Digital Earth. Currently, the EOS program in Malaysia is carried out on a piece-meal basis, depending on the project-by-project approval basis. The preferred approach is to have a long-term plan. This has been proposed in the draft Space Policy document. Failing to achieve that plan, we would have to rely on foreign EOS, where issues of data availability and accessibility would then be pertinent. The government needs to build its own capability to obtain key EOS data, on a real-time basis, such as high resolution images and specific-purpose data (e.g., radars or high spectral). Others could be obtained from the commercial data supplier.

**Building the EOS Program - the Government's job?**

Most individuals agree that the EOS project is a not-for-profit making venture, and that the Government is responsible for it, more on the justification of needs, rather than on the economy. It is only recently that industries have ventured into EOS projects that offer high resolution imaging. Possible involvement of the private sector is through a PPP implementation. Examples of such an implementation are the Galileo and the SkyNet program (Betrand and Vidal, 2005). Note that these two projects are communication and GNSS satellites respectively. A possible implementation of a PPP on EOS is based on offering high resolution imaging, with services extended to global customers rather than guaranteed long-term commitment purchases from the government and local users.

**Digital Earth Development - a Governmental Program**

To ensure the seamless implementation of a SDI system through the formulation of policies and standards, such as the sharing and dissemination of geospatial data among users and data providers (Abu Hanifah and Majeed, 2007), it is logical that the government should be the one developing and maintaining the national DE. Key activities of a DE implementation include facilitating and providing professional services related to geospatial data services. It is also, in the long run, an expensive venture; hence, the government's financial mechanism would be the best one to support such an implementation. It is satisfactory for the government to be the care taker of the national DE system, but the private sector should also be encouraged to contribute to the sustainability of the system.

**The need for a Suitable Geospatial Policy**

In order to ensure the rapid growth of the DE development in the country, we certainly need a reliable geospatial-related policy. A good example would be the Indian policy (Federation of India Chambers of Commerce and Industry, 2013). India has made several major reforms to mainstream the use of geospatial technologies in various sectors and applications. These reforms are: the National Map Policy 2005, which provides an innovative approach to deal with the country's security concerns; the RS Data Policy 2011, which provides modalities for managing RS data, for example, allowing data up to 1 m in resolution to be distributed on a non-discriminatory basis; and the National Data Sharing and Accessibility Policy 2012, which allows the sharing of non-sensitive data. These reformed policies have enabled the enhanced participation of the private sector, resulting in the GIS based technologies market to expand at such a substantial pace that it is estimated to touch the figure of USD 10 billion by 2019. The current Malaysian geospatial policy and related regulations have to change; for example, the restriction on the open distribution of up to 5m resolution images, as well as limiting the source of the RS data supply by the government.

## Conclusion

Malaysia is currently embracing a digital economic strategy. Digital Malaysia is a unique program that is predicted to create an ecosystem that promotes the pervasive use of ICT in all aspects of the economy, in order to connect communities globally, and interact in real time, resulting in increased Gross National Income, enhanced productivity and an improved standard of living (National ITC Council of Malaysia, 2013). This is predicted to lead to a developed digital economy that connects and empowers the government, businesses and citizens. For this new digital economy, DE, a virtual geospatial data infrastructure is a strategic asset to the country.

To ensure the seamless implementation of a DE system, the healthy growth of DE and its related industries is pertinent, through the formulation of good policies and standards, such as in the sharing and dissemination of geospatial data among users and data providers. It is also logical that the Government should be the one developing and maintaining the national DE, with inputs from various industry players, and with the former playing an active role in facilitating and providing professional related services.

The policy must formulate a related policy framework to support SDI development in Malaysia in terms of the physical development of satellite systems, as well as the downstream local space industry sector. The National Satellite Program development, which includes EOS satellites, as described in the paper, will become the backbone of the DE development. The proposed National Space Policy also has a program to nurture and develop the local space industry in order to sustain the economic growth of the country. Within this proposed program, the geospatial-related industry would be included in the local space industry category, which would be given special focus for growth.

The fact that all of the satellite images used to develop the DE were currently obtained from international satellite image providers, it is crucial that, to guarantee the long term strategic implementation of a DE system, the country has to build up its own sustainability in the EOS. The proposed Malaysia Space Policy has identified the need for our very own EOS satellites, in fulfilling those strategic needs. Hence, the Malaysian EOS Satellite Programs are very much focused on building the nation’s capability in strategic satellite technology.

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