# End of AY 2016 Report for SIP – Group8

**Project Title**

Disaster Management for the Future: Part B - Technological packages for Natural Disasters

**Team**

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**Objective:** Explain what social/global issues that this project tried to address and why the issue is important.

[Overall objectives of the program - Disaster Management for the Future]
The overall objective of the program "Disaster Risk Management for the Future" is to improve natural disaster mitigation in Asia - with a special focus on Southeast Asia - using space-based assets. This proposed program aspires to achieve this via a two-pronged holistic approach.
[Positioning of each project]
Project A is a policy proposal for encouraging innovations in the space sector which will lead to improved technology and procurement for Earth Observation space systems applied to disaster management. This is the "upstream" project, which aims to explore and exploit opportunities in the 'technology-push' currently happening in the space sector. Project B, the complementary "downstream" project concentrating on the 'market-pull', is aimed at understanding customer requirements for a space-based disaster management system, and outputs a basic conceptual but feasible design including costing and financing, and an international cooperation framework to enable it from the viewpoints of industry.
[Objective of this project - Technological packages for Natural Disasters]
We will propose a "technological package" by utilizing aerospace technologies, which including useful and effective information for not only specific natural disasters but also for many fields such as policy, economics, or other aspects depending on customers' demands. We pursue its effectiveness and cost-performance to verify its feasibility as a private company model.

**Method:** Explain through what kind of approaches you tried to achieve the objective.
*About the list and details of the interview, add the appendix.

[How to approach the project]
We chose the bottom up approaches for achieving our project. Firstly, we tried to make sure what is the problems caused by natural disasters in southeast Asia by categorizing the types of natural disasters and

investigating some disaster cases and summarized the statistics of damages of natural disasters. Besides, we had been investigating through several discussions and bibliographic survey about what kinds of technology are effective to mitigate damages from natural disasters or to minimize the disaster risk, and found that a synthetic aperture radar (SAR) satellite technology could be a breakthrough of the problems in terms of its versatility for any situations caused by disasters. We made sure the effectiveness of the technologies and determined how to utilize this technology with considering of the limitation of the technology export, difficulties of analyzing the raw data, and cost-effectiveness. Finally, we made a business model that provides the SAR data to Southeast Asia, which includes not only business concepts, but also including feasible satellite system, data services, its developing cost and benefits, and its potential marketing.

[The way of investigation/design]

- Natural disaster investigation

We focused on two disasters, typhoon and wildfire, in which SAR has some advantages over conventional optical observation. We investigated some disaster cases and sorting out its damages and estimate the effectiveness of the SAR system. Besides, we tried to make sure the SAR performance quantitatively by considering the standard of damages caused by typhoon/wildfire.

- SAR satellite system design

The satellite system we proposed is based on SAR technology "MicroXSAR" under development that is highly likely to be launched. We estimated the possibility of profit generation with this SAR technology. We used the extrapolation to estimate the development, launch, analysis, and operation cost of the past SAR satellites and image price.

**Outcome**: Explain what kind of results you obtained from this project and discuss how it addressed your focal social/global issues.

From the case of typhoon, Some disruptions (ex. building, signs, trees), landslide, floods with secondary disasters were found to be the main damages that SAR system can deal with. Through applying real time investigation of SAR system, evacuation and road congestion should be more smooth in accordance with immediate broadcast. Furthermore, combining with the data of current residents, we can roughly estimate the casualties with collapsed buildings. Moreover, SAR system is effective for main damages caused by wildfire such as haze, disruptions, and loss of human life. One of the difficult obstacles of wildfire fighting activity is haze, which makes it impossible to use general monitoring methods, like optical sensors. SAR can overcome it by using sub-millimeter wavelength region applies and enables radar to go through haze. It must be the strength of SAR and provide the enough data for prevention, evacuation and fire fighting.

And, the value of the resulting SAR images that is effective for such disasters could be estimated at 0.3-1 dollars/$km^2$. It is equivalent to 150M dollars to 500M dollars per one single MircoXSAR and it is sufficiently large compared to the anticipated MicroXSAR development and launch cost of 30M dollars.

**Budget**: List the budget this project implemented. *About the details, add the appendix.

| **Purposes** | **Expense** |
|---|---|
| Books | 0 |
| Travel fee | 0 |
| Honorarium | 0 |
| Others | 0 |
| Total | 0 |

**Appendix**

1. Background: Natural disasters

1.1. Trends of natural disasters

The number of natural disasters in the world has been gradually increasing since 1950 as shown in Figure 1. Especially flood and storm have been increased very rapidly. Asia and pacific area occupies almost 43 % of the total occurrence of natural disasters, which causes 2 million fatalities and 1.15 trillion USD economic losses. Besides, focusing on subarea of Asia, Southeast Asia has the most occurrence rate per area in Asia as shown in Figure 2.

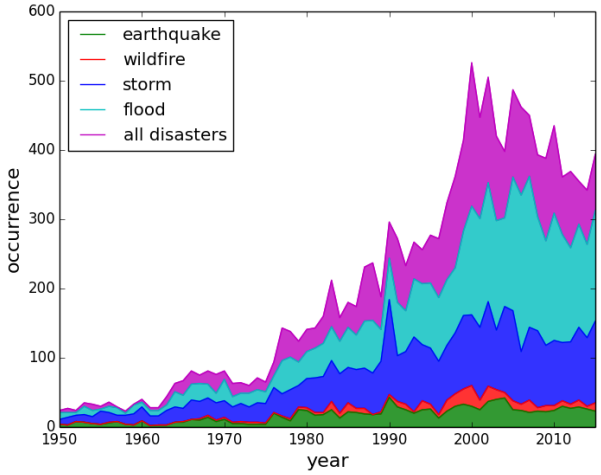


Figure 1: Trends of natural disasters in the world [1].

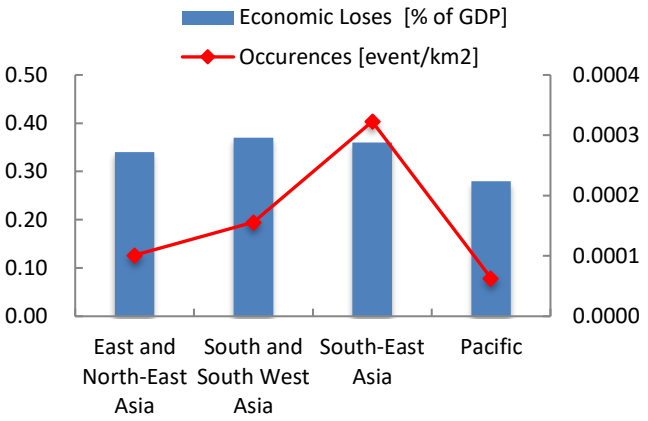


Figure 2: Asia's natural disaster in 1970-2014.

1.2. Disasters types

There are many types of natural disasters such as floods, earthquake, wildfire, typhoon and they are related to each other to some extent. Especially typhoon and wildfire have unique characters as shown in Figure 3 and 4. The typhoon, which is one of the major disasters, occurs constantly and causes lots of damages. On the other hands, the wildfire happened not often but once it happens, it gave relatively big damage.

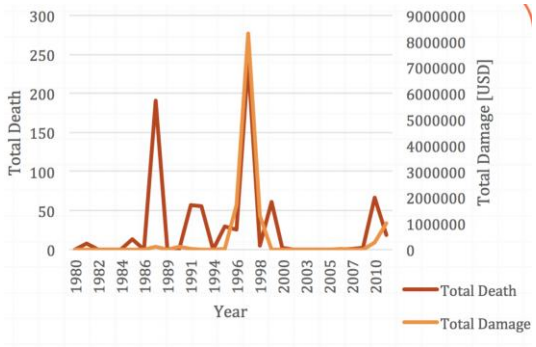


Figure 3: Wildfire in Southeast Asia.

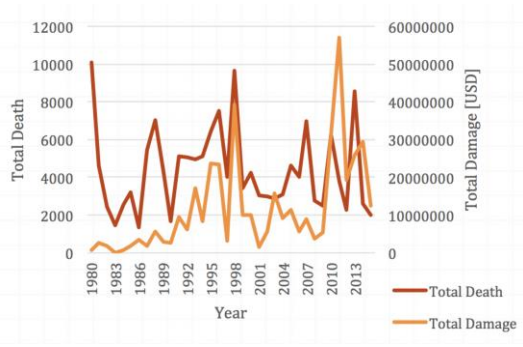


Figure 4: Floods in Southeast Asia

2. Our project concept

2.1. The importance of Observation of natural disasters

There is a necessity of new observation technology to mitigate natural disasters damages especially for typhoon and wildfire because conventional observation using optical sensor doesn't work when the sunlight is inserted into the ground, which means it cannot observe it when it is night, cloudy, foggy, or smoky.

In the context, the synthetic aperture radar (SAR) is a latest and innovative technology that uses relatively long electromagnetic waves to get images, which enables it to observe the disasters anytime without the limitation by weather and daylight. In our project, providing innovative observation service of natural disasters to Southeast Asia has been focused and investigated in order to mitigate disaster risks.

2.2. The concept of technological packages

The most challenging parts in our project is to determine how to serve this technology to Southeast Asia. In our first concept is to serve technology directly to the demander, but it is not feasible because the SAR system export is limited legally. Second, we think the raw data export, but the image data obtained by SAR system is hard to understand. Therefore, we determined to sell the SAR data as a package that includes the all information demander wants as shown in Figure 5.

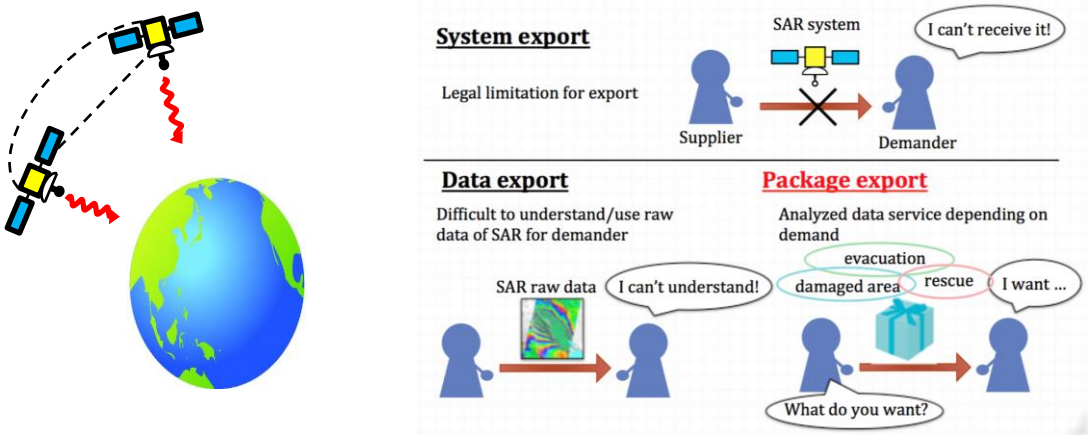


Figure 5: Concept of technological packages

2.3. Business model

The estimated business models are shown in Figure 6. There are two types. One of them is "Lease model" that manage the demand sides and developer of the SAR satellite system and serve the analyzed data for demander. Another is "Image sale model" that company does launch the satellites and sale images directly.

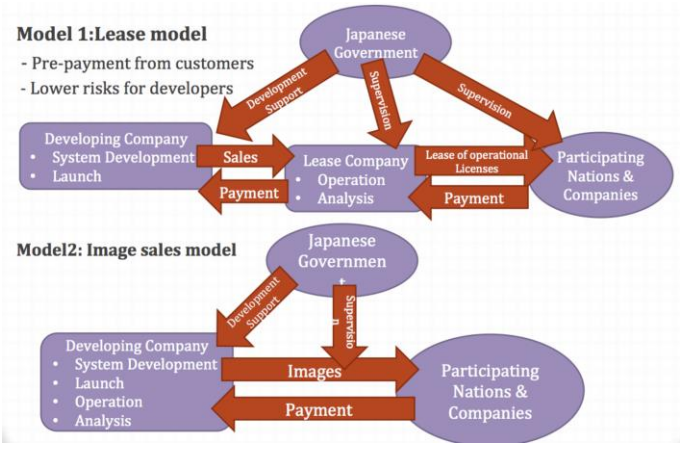


Figure 6: Business model

3. Cost performance discussion

One of the most important efforts was to verify the feasibility of our project. Figure 7 and 8 show the specifications of our SAR satellite system based on MicroXSAR and its estimated development cost.

Table 1: Specifications

| Specifications | | | | |
|---|---|---|---|---|
| MicroXSAR | | | DMC-3 (Reference) | |
| | Units | | Units | |
| Development | - | Keio Univ., JAXA, UT | - | SSTL (UK) |
| Operation | - | - | - | DMC-ii, 21AT |
| Frequencies of Observations | times/day | 4 | times/day | 1 |
| Design Life | years | ~5 | years | 7 |
| Number of Constellation | - | 6 | - | 3 |
| Resolution | m | 3 | Purple, m | 1 |
| | m | 10 | Visible-IR, m | 4 |
| Swath | km | 28.55 | km | 23 |
| Total Lease Price | $ | - | - | 170M |

Table 2: Development cost

| Subsystems | Selection | Costs | Selection | Costs |
|---|---|---|---|---|
| Projects | MicroXSAR | | X SAR Micro-Sat by SSTL | |
| Satellites | Hodoyoshi-based | $20M | SSTL-300/600-based | $35M |
| Launchers | Electron | $5M | Falcon - 1e | $11M |
| GSN & Analyses | The Prime Contractor | $2.5M | SSTL and 3rd party elements | $2.5M |
| Operations (for 5 years) | The Prime Contractor | $1.5M | SSTL | $1.5M |
| **Total** | | **$30M** | | **$50M** |

Besides, value of SAR images was estimated at 0.3 – 1.0 $ km$^2$ as shown in Figure 7. If Swath is assumed as 28.55 km, covered Area in 5-year mission is 5x10$^8$ km$^2$, and Duty cycle is 2%, the total value of the system is calculated as 150-500 M$ /MicroXSAR.

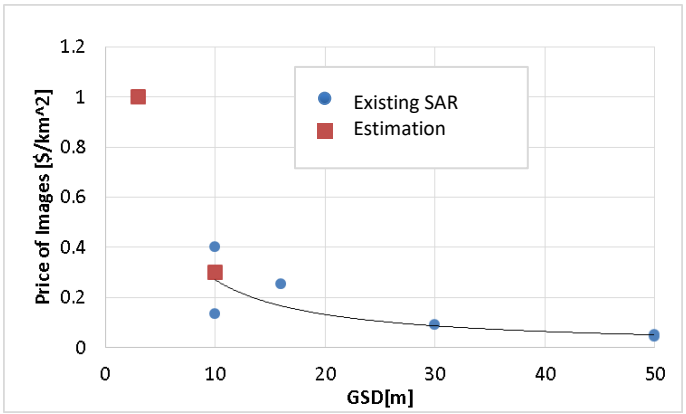


Figure 7: Cost estimation of images