OverView of Space Applications for Environment (SAFE) initiative

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Overview of Space Applications for Environment (SAFE) initiative

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Abstract. Climate change and human activities have a direc or indirect influence on the acceleration of environmental problems and natural hazards such as forest fires, draughts and floods in the Asia-Pacific countries. Satellite technology has become one of the key information sources in assessment, monitoring and mitigation of these disasters and related phenomenon. However, there are still gaps between science and application of satellite technology in real-world usage. Asia-Pacific Regional Space Agency Forum (APRSAF) recommended to initiate the Space Applications for Environment (SAFE) proposal providing opportunity to potential user agencies in the Asia Pacific region to develop prototype applications of satellite technology for number of key issues including forest resources management, coastal monitoring and management, agriculture and food security, water resource management and development user-friendly tools for application of satellite technology. This paper describes the overview of SAFE initiative and outcomes of two selected prototypes; agricultural drought monitoring in Indonesia and coastal management in Sri Lanka, as well as the current status of on-going prototypes.

1. Introduction

Space Application for Environment (SAFE) is a voluntary initiative aims to encourage environmental monitoring using space based technologies, specifically satellite remote sensing to identify and characterize changes in the environment through long-term observations that may be useful to reduce possible risks. SAFE also attempts to contribute to implementing adaptation programs related to disasters risk activities and further to other climate change associated problems using satellite remote sensing technology. Satellite remote sensing is identified as one of important source of information to identify some of the critical environment parameters such as perennial water resources, land cover, forests, estuaries and wetlands, mangroves areas with respect to spatial distribution and temporal changes.

SAFE considers continuous data provision with sensor capable of acquiring data in different wavelengths and varying spatial resolution could provide environment sensitive information in order

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to better understand the status of the environment and its changes. Initiated in the Asian-Pacific Regional Space Agency Forum (APRSAF), SAFE is a robust approach for long-term monitoring of the natural environment by using satellite remote sensing to evaluate current status, understand ongoing changes, monitor the nature of changes and, where possible, use as baseline information for hazard assessment, risk management and helping in developing mitigation and adaptation strategies. Furthermore, end users of SAFE activities are the agencies and experts working in various agencies that are responsible for the natural environment of their own country as well as responsibilities over regional and international directions. These agencies have their own mandate, functionalities and responsibilities to sustainable management of the environment.

2. SAFE overview

2.1. Background

Satellite data are widely used to augment the need of past data for continuous study of climate change and related phenomenon of the planet. The usage are varies and monitoring long-term phenomenon is said to be one of valuable contribution by space borne satellite data. Intergovernmental Panel on Climate Change (IPCC) use of earth surface temperature estimation is one of the key applications of space borne satellite data and it is reported that the use of satellite data will be the one of major information sources that could come handy in validating certain climate change indicators. On the other hand, observations of Earth from space have been done for well over 40 years and have contributed to many application areas including climate science. However, attempts to exploit this wealth of data are often hampered by a lack of homogeneity and continuity of satellite data and also by the insufficient understanding of the products and their uncertainties. This in fact has hampered the effective use of satellite data in Asia and the Pacific, specifically in developing countries.

The APRSAF was established in 1993, to increase the awareness on space based programs including earth observation and application of regional countries and to exchange views toward future cooperation (For details: http://www.aprsaf.org/). The forum provides a stage for space agencies in the Asia Pacific region as well as potential user agencies to exchange their ideas, share information and grow together as a region contributing to the advancement of space science. Among many positive directions under APRSAF, Japan Aerospace Exploration Agency (JAXA) proposed initiated SAFE as a scheme to collaborate with APRSAF member countries to promote the use of satellite data in understanding natural environment. At the APRSAF-15 held in Hanoi, Vietnam, members recommended and approved the official establishment of SAFE as a new initiative.

2.2. Objectives

SAFE was launched to facilitate the gap between science and application of satellite technology in real-world usage and providing opportunity to potential user agencies in the region to collaborate to develop prototype applications. The SAFE program and its objectives are dynamic in nature in order to address and find solutions to ever changing climate and environment related problems. The overall concept of SAFE is given in figure 1. The current emphasize of SAFE is to develop solution oriented applications using space based technologies in following areas but members are always encourage to communicate for other potential applications;

1. Forest resources management including mangrove forest; mapping, monitoring, non-forested vegetation and integration in carbon estimations,
2. Coastal monitoring and management; erosion and accretion of coasts, modelling sediment transportation, and relate to climate change,
3. Agriculture and food security; drought assessment, monitoring and effect on paddy areas, paddy area mapping and yield estimation,
4. Water resource management; rainfall estimation, anomaly assessment, identify water scarcities and extreme events such as drought and floods,

5. Development user-friendly tools and share modules and information on the use of satellite data primarily for above fields of applications.

Figure 1. Concept of SAFE activity.

2.3. SAFE Implementation scheme

Principally, SAFE adopts a prototyping approach to demonstrate the value of space-based technologies to tackle issues related to environment and climate change. Typically, SAFE prototype is implemented by three groups; a prototyping executor, a technical supporter, and data & application creator. The team can collaborate other SAFE members to support their activities, and it is expected SAFE members response to the team's request. To ease the barriers of the start-up process, a given prototype activity is limited to two years.

SAFE secretariat announces the APRSAF community to submit requests for SAFE prototypes through various communication modes. These call for a proposal (CFP) is announced a couple of months in advance before a SAFE workshop, with necessary documentation including format template to submit new proposals to SAFE Secretariat. Since the activities are voluntary based, each proposed members have to provide necessary resources to analyze earth observation data provided by APRSAF member agencies and applied analyzed results to implement the problem addressed in the proposal in cooperation with operational governmental bodies, specifically with the end users. The project team member work together under the rules and guidance set forth by APRSAF.

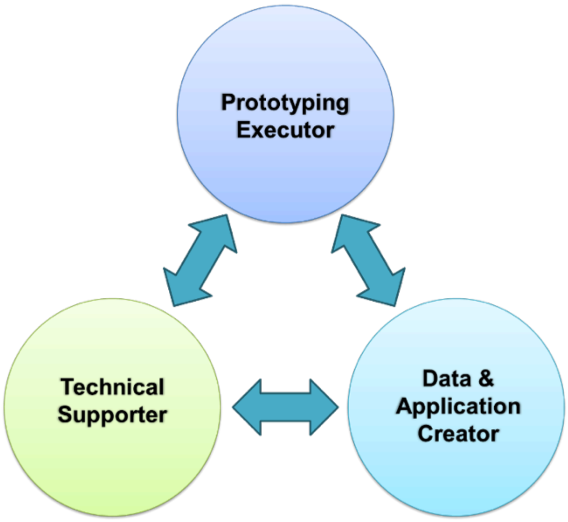

Figure 2. SAFE implementation structure.

It is expected that the Prototyping Executor applies the outcome of the prototype into their routine work related to environmental monitoring. The Technical Supporters / Data & Applications Creator validate their products/services within a practical framework, given that authority has been granted by the prototyping executor.

SAFE prototyping can provide some of the changing environmental parameters in land, forest, sea, coastal, agricultural products, and ecosystems. It can also provide a bridge to implementing operational and/or practical systems to contribute to solving national/regional climate change adaptation and mitigation issues by using space-based technologies in the Asia-Pacific region.

2.4. **SAFE Project Design Matrix**

Project Design Matrix (PDM) is a tool for management of project. PDM is adapted in some international cooperation project. Recently, SAFE secretariat is trying to connect the completed prototype to international donor project for practical sustainable use. Therefore, SAFE adapted PDM for management and evaluation of prototype. However, the SAFE PDM is not strictly same with commonly-used PDM. SAFE PDM is modified considering SAFE concepts; nature of prototype, voluntary manner and regarding practical or sustainable use of prototype results. In SAFE prototyping activities, each SAFE PDM is revised by SAFE secretariat after every SAFE workshop, and the evaluation of prototype is carried out based on the PDM.

2.5. **SAFE prototyping activities**

Through on-going SAFE prototyping, effects of climate change and related information by using space based technologies are provided to national/regional end users.

After launching the SAFE initiatives at APRSAF-15 in Hanoi in 2008, the workshops were held twice a year so far. The last workshop was held in early December, 2013, at Hanoi, Vietnam. in conjunction with APRSAF-20. The SAFE executers participated the Earth Observation Working Group (EOWG) in the APRSAF-20 and also gave a presentation about own prototype.

At the SAFE workshop in Hanoi last year, two prototyping proposals from Vietnam was endorsed by all of participants and adopted. This was reported at the EOWG in APRSAF-20. With the approval of two new proposals there are nine prototypes listed in Table 1 are on-going as of January 2014.

Table 1. SAFE prototype activities.

Status	Country / Executor	Theme
Completed	VIETNAM / NHMS,MONRE	Integrated water resource management
	VIETNAM / FIPI,MARD	Forest monitoring
	CAMBODIA / MOWRAM	Water Cycle and Agricultural Activities
	LAO PDR / WREA,WERI	Forest monitoring and management
	INDONESIA / LAPAN	Potential Drought Monitoring
	SRI LANKA / CCD	Risk of Sea Level Rise on Coastal Zone
	PAKISTAN / PMD	Monitoring Water Cycle Variations & Assessing Climate Change Impacts
	SRI LANKA / NARA	NARA Modeling ocean frontal zones using high resolution satellite and float data to locate tune fish aggregations
	THAILAND / DOF	Economic Fish Larvae Mapping and Monitoring
	VIETNAM / FIPI,MARD	Mangrove Forest Mapping and Carbon Stock Estimation
	SRI LANKA / GI,CEA	Mapping and Detecting Wetlands in River Basin
On-going	INDONESIA / ICALRD, IAARD, MOA	Assessment of drought impact on rice production in Indonesia by satellite remote sensing and dissemination with web-GIS
	CAMBODIA / MOWRAM	Water and Flood Security under the Climate Change
	BANGLADESH / LGED	Investigation of sedimentation process and stability of the area around the cross-dams in Meghna estuary
	INDONESIA / LAPAN	The assessment of Mangrove Forest Carbon Stock Monitoring of Indonesia using Remote Sensing Approach
	INDONESIA / ICALRD,IAARD,MoA	SAR Technology Application for Paddy Crop Monitoring in Center of Paddy Area, in Indonesia
	MALAYSIA / UPM	Monitoring of agricultural land abandonment using remote sensing
	VIETNAM / HCMIRG,VAST	Rice crop monitoring in the Mekong delta, Vietnam
	VIETNAM / VAWR	Assessment and Evaluation of Erosion and Sedimentation on the Coast from Hai Phong to Thanh Hoa Province, in Vietnam
	VIETNAM / NCHMF	Utilizing Satellite Data, Numerical Rainfall Forecasts, Combining with Ground Observations in Flood Forecasting for the Thai Binh River System

3. Accomplishments

Since the inception in 2008, SAFE has completed ten completed prototypes. The list of successfully completed prototypes is given in table 1. This paper describes two of the successfully completed prototypes in detail.

3.1. Use of spaced based technology characterize coastal changes and application in coastal zone management

3.1.1. Overview

As an Island Nation in the Indian ocean, Sri Lanka coastal zone is vulnerable for the severe impacts due to climatic change but mainly due to sea level rise; inundation, increased erosion, salinity intrusion, surges & wave over topping etc. Assessment of the hazards, vulnerabilities and risk are required for the identification of preparedness, adaptation and mitigation alternatives. One of the critical sources for these studies is access to reliable, continuous, and affordable data. The proposal by the Coast Conservation Department (CCD), Sri Lanka to use space based technologies to assess and monitor coastal changes of Sri Lanka, identify erosion and accretion and use of these information in formulating future coastal zone management program was favorably reviewed and adopted as a prototype of SAEF. The basic approach of the proposal was to use remote sensing and space based technology for assessing coastal dynamics and related changes objectively and cost effectively. The objective of this prototype is the followings;

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1) Determine the availability, accessibility & reliability of data & tools for assessment of climate change impacts on coastal zone
2) Execution & streamlining observations, measurements, data collection & monitoring programs at national & regional level for enhancing the assessment of impacts on climate change
3) Assessment of risk on sea level rise spatially & temporally with available data

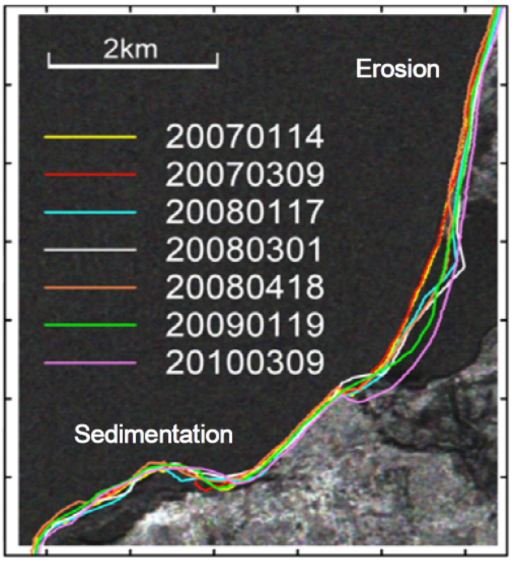

Figure 4. Trend of west coast shoreline changes in Kalpitiya area.

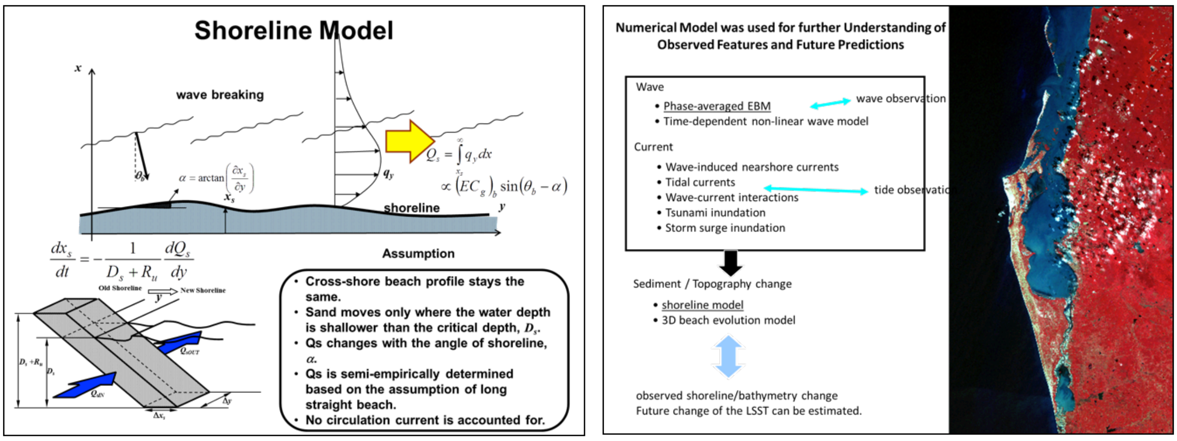

Figure 5. Elucidated show line model and future prediction.

3.1.2. Outcome
The outcome of activities of this very successful prototype can be summarized as below;

1) Contribution to Kalpitiya tourism project
Two meetings were conducted by the prototype executer with inviting coastal experts in the country & government high level officials involved in Kalpitiya tourism development project.
As the result, for the urgent decision making, interim report of the project was released on the request of the Sri Lanka government. Investors in the project area are officially instructed to follow the report for investment planning & EIA studies.

2) Contribute to national planning through stakeholder meeting
The meeting was held with 80 participants including state & local government, CBO, NGO & INGO and private developers from 45 agencies/institutions on August 25, 2011 as the stakeholder meeting, and following conclusions were confirmed;
- Thematic (coastal) standard for land use category mapping
- Provision of results as evidence for land ownership court cases
- Review of tourism & fisheries master development master plans in the area
- Continue monitoring of the coastal area

3.2. **Use of spaced based technology for drought monitoring**

3.2.1. Overview
This is a proposal submitted by National Institute of Aeronautics and Space (Lembaga Penerbangan dan Antariksa Nasional: LAPAN), Indonesia and successfully adopted as a prototype in 2010. Drought monitoring and providing early warning are major components of drought risk management. One of the goals of drought risk management is to increase society's coping capacity, leading to greater resilience and to reduce the need of government or donor interventions in the form of disaster assistance. Drought is the second major disaster in Indonesia. In the agricultural area, drought is the major disaster besides flood and landslide. The following are the objectives of this prototype;
1) To enhance the understanding on climate change-related drought in Indonesia
2) To develop the methods/techniques of drought monitoring over the agriculture areas in Java island accessible for users and public

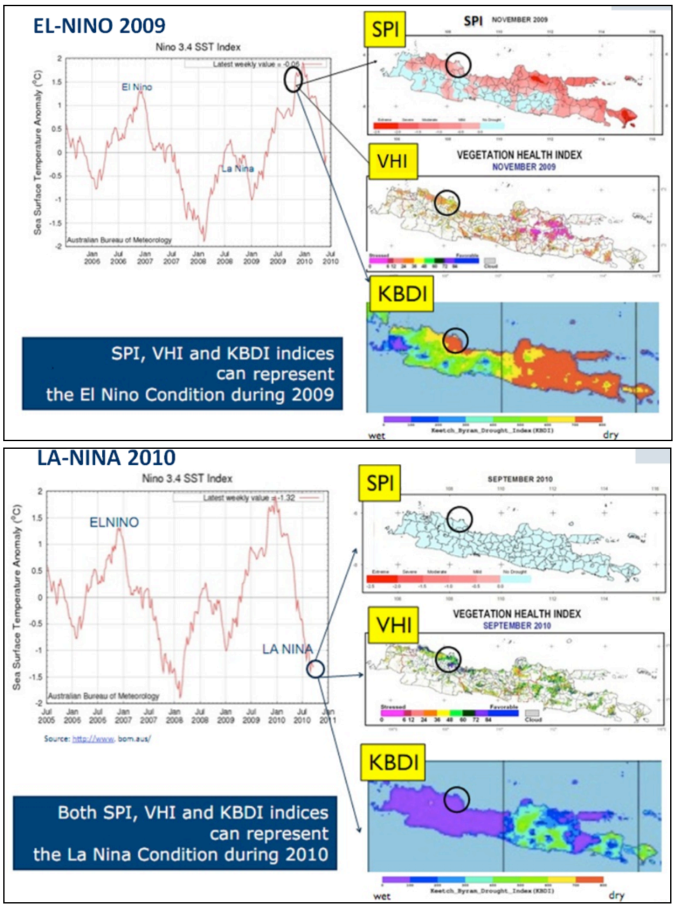

Figure 6. Drought comparison of the El-Nino and the La-Nina.

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3.2.2. Outcome
1) The drought information and prediction is delivered every month to the end user through routine meeting activities, monthly bulletin, website and monthly report.
2) A system is developed and installed showing drought situation by the WEB-GIS
3) The outcome will be integrated in a couple countries under the international cooperative project funded by Asia Development Bank (ADB).
4) The derived information such as drought status and paddy cultivated area are provided to Asian Rice Crop Estimation & Monitoring (Asia-RiCE) initiative led by JAXA as one component of GEO Global Agricultural Monitoring (GEOGLAM).

4. Conclusion
SAFE prototyping is a regional activity under APRSAF assisting to bridge the gap between satellite based technology and application the technology in real-world operational work though the combination of experts from various agencies helping the end user. Since the inception of SAFE in 2008, prototypes have completed in several application areas providing opportunities to collaborating partners of number of countries to enhance the knowledge in the use of space based technologies in their own environment. Further, SAFE has developed a resource bank with successful application to share with the potential users in the region thanks to the collaborators under APRSAF. It expects that the outcome, such as utilization of developed system, gathered knowledge, potential use of remote sensing and approaches of applications can become a corner stone in contributing to find mitigation strategies against climate related hazards and risks to make the society a safer place.

Reference
[1] http://www.eorc.jaxa.jp/SAFE/index.html
[2] http://www.aprsaf.org/jp/about/