

# RESEARCH ON COOPERATION STRATEGY BASED ON SATELLITE REMOTE SENSING DATA SERVICE AND TECHNOLOGY APPLICATION BETWEEN CHINA AND ASEAN

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## ABSTRACT:

Remote sensing (RS) and earth observing technology are flourished with the development of a series of high-resolution earth-observation satellites. As the improvement of China's earth observation data acquisition capability, one critical issue is put on the agenda that is what kind of models and techniques can promote the future data processing into a new level in terms of service model, massive data processing, development methods, business models, resource sharing, and system sustainability (1). In order to embed domestic satellite advantages into global world and provide increasingly more Chinese wisdom and solution to support the ASEAN regional development, China highlights the propositions on ASEAN-China remote sensing cooperation. On November 1, 2022, the ASEAN-China Satellite Remote Sensing Application Centre (hereinafter referred to as the ACSAC) was officially inaugurated in Beijing. The ACSAC will mainly focus on the establishment of a system and mechanism for a series of substantive operation, promoting the comprehensive sharing of China's land and ocean satellite data, comprehensively rich the international application scenarios of Chinese satellites, promoting applications in multiple fields and carrying out satellite remote sensing application promotion and typical demonstration, continuing to carry out technical exchanges and training with mutual demands and development. At present, ACSAC has stepped into the substantive construction stage. It will give full play to the advantages of China's natural resources land and ocean satellite remote sensing resources, to form a multi-scale, full coverage data resource support, jointly carry out the construction of the ASEAN-China satellite remote sensing data network platform based on the cloud environment, and to jointly build an integrated service open portal for land and ocean satellite data products to ASEAN region. Focusing on the core construction content of ACSAC, this paper systematically collects, summarizes and analyse the data and application needs of satellite remote sensing in ASEAN countries, finds out the current needs to meet the gap, and puts forward some thoughts and ideas on cooperation mechanism, data sharing, customized products and application demonstration of advanced products, aiming to lay a solid foundation for the substantial construction of ACSAC.

## 1. INTRODUCTION

The ASEAN-China Satellite Remote Sensing Application Centre (ACSAC) is jointly constructed by the Ministry of Natural Resources of China, the People's Government of Guangxi Zhuang Autonomous Region and some of collaborative ASEAN countries. It aims to establish a cooperation mechanism for satellite remote sensing between China and ASEAN countries and build a satellite remote sensing data sharing network system between China and ASEAN countries to promote the further data sharing and technical training and exchange as well as application cooperation. According to the layout of 1 headquarters, 2 remote sensing centers and 10 data application centers, ACSAC is composed of Steering Committee, Expert Committee, Secretariat, Land remote sensing center, Ocean Remote Sensing Center and ASEAN-Country Data Application Centers (data nodes). ACSAC is led by the Land Satellite Remote Sensing Application Center of the Ministry of Natural Resources (LASAC), and jointly established with National Satellite Ocean Application Service of China, Guangxi Institute of Natural Resources Remote Sensing of China(ACSAC Land Remote Sensing Center), Fourth Institute of Oceanography, Ministry of

Natural Resources of China (ACSAC Ocean Remote Sensing Center) and China Aero Geophysical Survey and Remote Sensing Center for Natural Resources, and the institutions related to satellite remote sensing of the cooperative ASEAN countries. Therefore, ACSAC was based on a relative strong and extensive technical capacity and cooperation consensus.

The construction of ACSAC is supposed to be a significant incubator for ASEAN-China satellite remote sensing application and cooperation mechanism, gradually realizing the supply and service of standardized production and satellite remote sensing data, jointly applying for and carrying out satellite remote sensing projects, and exploring the ways of transformation of regional scientific and technological products to jointly built satellite remote sensing commercial cooperation and mechanism. It is known to all, big data with its vast volume and complexity is increasingly concerned, developed, and used for all professions and trades. Remote sensing, as one of the sources for big data, is generating earth-observation data and analysis results daily from the platforms of satellites, manned/unmanned aircrafts, and ground-based structures (2). Aiming at making full use of remote sensing data as one of important big data, the first three years of ACSAC construction

is crucial. How to optimize, integrate and fully release the multilateral technical advantages to meet cooperation needs, solidate joint ACSAC organizations, implement sound policies, and put forward ideas and thoughts are all of great significance to the subsequent construction and development of ACSAC.

## 2. SOME OF REMOTE SENSING APPLICATION DEMAND IN ASEAN COUNTRIES

There are complex geographical environment, frequent disasters, basic conditions of satellite remote sensing technology, and strong demand for satellite remote sensing image applications in ASEAN countries. Some of these countries have been short of effective satellite image data sources for a long time with various technical exchange and training demand in satellite remote sensing technology and application, as well as infrastructure and talent reserves. The application of satellite remote sensing has not been widely popularized that much, and there is a very strong application demand in traditional fields such as agriculture, disaster prevention and mitigation, marine management, natural resource monitoring and urban construction, etc.

For example, Thailand has needs in farmland and water resources monitoring, cash crop yield forecasting, flood, harmful algal blooms monitoring, urban core area management, etc; Laos is in urgent need of satellite remote sensing and GIS capacity building to cope with the difficulties in obtaining data when major natural disasters occur; Indonesia has a wide demand for ocean remote sensing application in terms of oil spill, marine fishery, coastal zone management, etc; Cambodia has demands in value-added products of satellite remote sensing data, and urgent needs in technical training of remote sensing and GIS talents; The development of remote sensing applications in Myanmar depends on foreign countries, and the international community is expected to provide relevant technology transfer, training and financial support; Malaysia has demand for remote sensing applications in agriculture, forestry and marine areas, and there are data product standard system to be established and further improved, remote sensing industrial system and talents are also relatively in need; Vietnam needs to use remote sensing data to monitor natural disasters such as floods and typhoons.

The overall economic situation of ASEAN countries is well and improving, and the development prospects are promising. ASEAN countries have the economic foundation to carry out large-scale and high-frequency satellite remote sensing applications. At present, nodes of Natural Resource Satellite Remote Sensing Cloud Service Platform have been established in four of ASEAN countries of Thailand, Laos, Indonesia and Cambodia, making data push service been realized in an efficient and effective way regularly. Next, in view of the continuous demand for image resources, applications and technical support of ASEAN countries, ACSAC will make efforts to comprehensively establish more and more cloud service platform nodes to achieve the goal of updating the data sharing from a point-to-point now to nodes fully cover the whole ASEAN countries to conduct the data share as needed. What's more, according to the specific

technical exchange plan coming up with needs from cooperation countries in ASEAN, a joint-host seminar and training program that focus on multi-level and multi type technical application service for visual, radar, hyperspectral remote sensing technologies are going to be planed and arranged every year, aiming at help to deepen communication and understanding of remote sensing dynamic monitoring served natural resources management and urban construction by Chinese satellite remote sensing technology in ASEAN countries, and to further practice and consolidate the principle of "extensive consultation, joint contribution and shared future" with ASEAN countries.

## 3. STATUS QUO OF SATELLITE REMOTE SENSING APPLICATION IN SOME OF COLLABORATIVE ASEAN COUNTRIES

### 3.1 The Data Nodes Opened in ASEAN Countries and the Satellite Data Coverage

At present, four countries in the ASEAN region have established the cooperation relationship and opened data nodes of Natural Resource Satellite Remote Sensing Cloud Service Platform ( <http://sasclouds.com/english/statistics/push> ), including Thailand in 2017, Laos in 2017, Cambodia in 2018, and Indonesia in 2019.

As it is shown in Table.1 through four international nodes, the four countries have achieved the automatic push of 2m-resolution satellite image data by LASAC, and three of them have achieved almost full coverage. The annual coverage of Thailand, Laos and Cambodia are also getting a relatively high coverage rate.

Country	Open Time	Total Batch	Total Scenes	Coverage Rate (2m data)
Thailand	2017	277	6949	93%
Laos	2017	276	5004	100%
Cambodia	2018	156	1972	100%
Indonesia	2020	217	4303	77%

**Table 1.** 2m data coverage for collaborative ASEAN member countries

Taking the 2m coverage of ASEAN countries in first half year of 2023 for example, the general land coverage in ASEAN is 77.39%, and the coverage in various countries are as follows: 98.61% in Vietnam, 98.58% in Laos, 97.59% in Thailand, 57.99% in Malaysia, 14.46% in Indonesia, 96.13% in Cambodia, 99.98% in Myanmar, 64.53% in the Philippines, 52.41% in Singapore and 52.22% in Brunei. (<http://sasclouds.com/english/statistics/push>)

For the first half year of 2023, by the data nodes, 697 scenes of data were pushed to Laos, with a coverage rate of 98.57%; 1832

scenes of data were pushed to Thailand, with a coverage rate of 97.59%; 355 scenes of data were pushed to Indonesian, with a coverage rate of 14.46%; 294 scenes of data were pushed to Cambodia, with a coverage rate of 95.47%. By sharing data to ASEAN countries, it will benefit both China and ASEAN to jointly discover and collect the new remote sensing demands by conducting assessment application results and effects in solving problems of natural resources management and sustainable development.

(<http://sasclouds.com/english/statistics/push>)

### 3.2 Satellite Remote Sensing Applications in Some of the Collaborative ASEAN Countries

In the past two decades, China's land and ocean satellite remote sensing technology has developed rapidly. In recent years, the Ministry of Natural Resources and ASEAN countries have gradually established a sound international application service mechanism, laying a solid foundation for ASEAN-China in-depth cooperation in satellite remote sensing. The ASEAN cooperative countries represented by Thailand, Laos and Cambodia and so on have also made a series of achievements in developing their own satellite remote sensing application capabilities, and the satellite remote sensing application cooperation are still continues to be with a potential.

Geo-Informatics and Space Technology Development Agency (GISTDA) of Thailand is carrying out the Thailand's Earth Observation System (THEOS) project. It plans to launch the THEOS-2 satellite and the THEOS-2A satellite. GISTDA is responsible for coordinating medium and high resolution optical and radar satellite data resources and providing satellite remote sensing application services for mapping, natural resource management, agriculture, urban and rural planning, water resource management and disaster management in Thailand. Over the years, Thailand has accumulated many application cases and experiences in disaster monitoring, agricultural monitoring (rice growth assessment), air pollution monitoring platform, carbon emission monitoring, urban green belt monitoring, offshore oil leakage monitoring, global satellite navigation and positioning services, etc. In addition, GISTDA has carried out in-depth cooperation with many Chinese institutions. In particular, ZY-3, GF-1 satellite images shared by the Land Satellite Remote Sensing Application Center (LASAC) of the Ministry of Natural Resources of China provide support for the production of Thailand's national base map work. Related products are also widely used in the Ministry of Interior, the Ministry of Natural Resources and Environment, the Ministry of Public Health and other ministries and commissions of Thailand. Among them, the project of providing farmers with digital images effectively promotes the economic development of Thailand, helping farmers develop family industries, and also facilitates the government's agricultural monitoring. Next, GISTDA hopes to jointly carry out application cooperation in carbon credit monitoring, drought and flood disaster management, digital twins, smart agriculture, blue economy, etc. Under the framework of ACSAC, strengthen and continue cooperation in human resource capacity building, extend the network on the basis of existing regional project cooperation, and build a stable multi-party coordination mechanism to achieve sustainable development goals.

Laos and China have carried out joint mapping projects since 1974. In 1994, a joint mapping office was set up, and in 2017, the Laos node of the natural resources and land satellite remote sensing cloud service platform was jointly established, enabling data sharing and joint project research. The ZY series and GF series of Chinese satellites have been well applied in many aspects such as hydrology and mining in the public and private sectors of Laos. Laos has implemented a series of geographic information standards, established a national geodetic network, a national leveling network and a national gravity network, and produced ortho-photo maps, topographic maps and thematic maps using both satellite and aerial remote sensing images. In the next step, National Geographic Department, Ministry of Home Affairs of Laos (NGD) will continue to promote the CORS construction project, update 1:50000 maps, produce 1:25000 digital maps and further promote the development of human resources and the construction of the National Spatial Data Infrastructure (NSDI).

Cambodia has formulated a satellite development plan, which will provide necessary databases for different types of monitoring applications, such as land and forest monitoring system, urban and rural broadband system, e-government system, disaster management system, digital broadcasting, etc.

Vietnam has launched the optical satellite VNREDSAT-1, and the S-BAND Industrial Park is under construction. In recent years, it has mainly carried out remote sensing applications in such fields as topographic map updating, surface coverage monitoring, forestry investigation, thermal investigation, disaster monitoring, etc., especially in topographic map updating, Mekong River database, forest reserve monitoring, landslide and debris flow monitoring and flood inundation analysis, offshore oil spill identification and monitoring, natural disaster radar image mapping, etc.

Myanmar mainly uses aerial photography and satellite imagery to conduct national mapping, and uses Pleiades, Worldview-3, Kompsat and other stereo satellite imagery to produce topographic maps for world historical and cultural heritage conservation buildings. The next step will update topographic maps and establish GIS databases using high-resolution satellite images, with the goal of establishing an online mapping system.

### 3.3 A Case Study with Partner Group of Chiang Mai University in Thailand Based on Chinese Natural Resources Land Satellite Data

Cooperated with a remote sensing application team of Chiang Mai University, the project of Demonstration of Application of Remote Sensing Dynamic Monitoring of Water Resources Distribution and Land Use in Lancang-Mekong River Basin, is successfully launched in 2020, with a three-year project cycle (2020-2022). The project carried out change monitoring of water resources, mangroves and land changes in study areas along upper part of Ping river and upper Nan river basin by remote sensing technology to detect the change morphology during 2013, 2015 and 2019 respectively. In this project, remote sensing technology has been utilized to monitor and analyze the characteristics of river runoff and the spatial-temporal distribution of water resources in the study basin area. While the changes in water resources in the basin and their consequences

on the ecological environment tell tectonic and climatic events of the region and even the world, the accurate and rapid monitoring of water resources dynamics reveals the impacts of natural factors and human activities on the watershed and is particularly in need and significant for the appropriate development, utilization, and protection of the watershed.

In the study of Assessing the Effect of Land Use/Land Cover Change on Surface Runoff in Upper Nan basin, which one of the working tasks of the cooperative project above, the data resources are mainly by Ziyuan-3 (ZY-3)01 and 02 satellites. The Ziyuan-3 (ZY-3) satellites are China's first high-resolution civilian stereo mapping satellites, with the ZY-3 01 and ZY-3 02 satellites launched successfully in 2012 and 2020, respectively. The ZY-3 satellites can cover a broad regional area with a huge swath width (50 km) and a spatial resolution of 2.1 m due to their large swath width. The study has been conducted on Upper Nan River Basin, Thailand. Rainfall-runoff pattern and land use change has been analyzed using Ziyuan-3 (ZY-3) satellite products during 2015-2020. The data resources used in this study are in Table2.

Year	Satellite	Date	Path / Row	Resolution (meter)
2015	ZY-301a	16-11-2013	027/176	2.1 × 2.1
		24-12-2014	029/176	
		03-01-2015	028/176	
		03-01-2015	028/177	
		03-01-2015	028/178	
		03-01-2015	028/179	
	ZY-302a	06-02-2017	027/177	
		06-02-2017	027/178	
		06-02-2017	027/179	
		11-11-2019	027/177	
2020	ZY-302a	09-01-2020	027/178	
		09-01-2020	027/179	
		02-01-2020	027/176	
		25-10-2020	027/177	
		18-12-2020	028/176	
		20-02-2021	028/176	
		20-02-2021	028/177	
		20-02-2021	028/178	

**Table 2.** data resources used in the Nan river basin study area

The SCS Curve Number Runoff model was applied in the study. The relationship between rainfall and SCS runoff demonstrated that the SCS Curve Number model's performance is adequate for runoff estimates. Through spatial analysis, the GIS-based technique seemed to be an effective tool for analyzing land use change and surface runoff. The following conclusions are drawn: The greatest changes in land use occurred as a result of the conversion of agricultural land to built-up areas. Water, agriculture, built-up, forest, and bareland all saw the greatest shift between 2015 and 2020. Regions with greater runoff, particularly those dominated by urban built-up regions, should be given more attention during land use planning.

#### 4. IDEAS AND THOUGHTS ON THE ACSAC CONSTRUCTION

By using e-commerce, the prototype system tries to change the traditional mode of remote sensing applications, provides network users data services, products services, on-line analysis services and other needed services. Practice has proved that above-mentioned techniques and methods are feasible and practical (3). ACSAC is at the early stage of its establishment process and the organizational structure, cooperation mechanism and mode are still being explored, so it is very important to consider cooperation system in both e-commerce and traditional way to fully release efficiency of data share and product exchange. Regarding to the satellite remote sensing application and cooperation with ASEAN countries, there is still a large gap between various needs and current situations. It is necessary to make an overall planning and design based on analysis and research and take the first three years of the establishment of ACSAC as an important opportunity to strike while the iron is hot and form a series of ideas and thoughts based on joint constatation. In addition to the mechanism and policies, by comprehensive analysis of the application requirements of satellite remote sensing in ASEAN countries and the existing satellite image resources used, taking current working progress in ASEAN countries, demands for satellite image acquisition, satellite data processing, standardized image products and technical training and services into consideration, it can be summarized into the following five major aspects that need to be valued and solved in the current situation and near futher.

1) The first is to well implemented ASEAN-China satellite remote sensing application cooperation mechanism. It is necessary to step up the building of a complete ASEAN-China remote sensing application and cooperation mechanism by starting from who are willing to participate and support at the beginning, to jointly initiate and lead the concrete cooperation at data, products, project and training levels to further promote the follow-up actions of other member countries in ASEAN. The establishment of the Steering Committee and Expert Committee of the ACSAC and jointly formulate working regulations for ACSAC is now accomplished, and the deployment of office space and working personnel are step by step to established, which positively strengthening the construction of ACSAC both at mechanism and entity level.

2) The second is to constantly increase data access and sharing for ASEAN region. In order to meet the needs of ASEAN countries for satellite image, it is planned to provide annual coverage of 2-meter satellite images for each of ASEAN member country. At the same time, when civilian remote sensing satellite image data has entered the submeter era, the demand of ASEAN countries for higher resolution remote sensing data has increasing a lot. Therefore, using Chinese submeter remote sensing satellite data to jointly carry on the remote sensing applications is an effective way to speed up and deepen the data application service for ASEAN countries with requirements. While it will also promote ASEAN countries' users better understanding for Chinese satellite remote sensing technology and be good at using Chinese high resolution remote sensing products to conduct survey and monitoring.

Moreover, most of ASEAN countries are in special geographical circumstances, with population and economic

activity concentrated in coastal areas, which are highly affected by climate change such as floods, droughts and rising sea levels. It is difficult to only use optical satellite image to response requirements of climate change and disaster emergency management. As a result, long-term satellite images of typical areas and new sensor such as SAR and hyperspectral data might be integrally used as needed. Currently, Thailand, Laos, Indonesia and Cambodia in ASEAN countries have opened international nodes by Sasclouds Platform, to receive Chinese 2-meter resolution optical satellite image data, while Myanmar, Malaysia and other countries have not established the data access yet. The Land Satellite Remote Sensing Application Center (LASAC) and National Satellite Ocean Application Service will further coordinate to open more international nodes to push data for other ASEAN countries and establish land-sea satellite data transmission channels and data sharing mechanisms as needed. At the same time, a fully functional system and platform of data sharing and exchange between China and ASEAN member countries is planned to be further established and improved, to explore the way of coordinating and exchange satellite data resources and products with ASEAN partners on line. Hierarchical services and a notion of identity, both user identity and data authentication will be introduced, and stakeholders' security requirements have to be satisfied (4) .

3) The third is to strengthen the supply of the standardized satellite products, thematic products and to make integrated and full-linkage services solution according to the specific application needs from ASEAN countries. Providing of simple and undifferentiated original data service, which can fill the corresponding data source vacancy in the short term, however, in the long run, it cannot meet the differentiated and refined application service demands of end users. Some of clear demand directions are as follows: DOM (Digital Orthographic Map), DSM (Digital Surface Model), thematic map of carbon sinks in natural ecosystems, data sets of natural resources elements, thematic map of spatial distribution and area of staple crops, thematic map of staple crops growth (sugar cane, rice, etc.), land change map and base map products, etc. In particularly, practical monitoring demonstration work has been carried out, e.g., overseas traffic engineering monitoring, overseas industrial parks and major projects monitoring, bulk crop monitoring and other aspects. Therefore, it is valuable and meaningful to carry out multi-type satellite image screening, data trial production and base map production in ASEAN countries and regions. However, in view of the huge differences in satellite remote sensing technology and talent conditions among ASEAN countries, some of the satellite image production and processing capabilities are insufficient. Joint efforts will be made to establish and promote a unified land satellite data product standard, deploy relevant technical software systems, and provide technical services and training as a regular work twice a year, so as to make adequate preparations for the standardized and integrated service by China's satellite image, products and training, with the goal of clearing the blockage of data application in countries with different remote sensing application capacities.

4) The fourth is to explore remote sensing application strategies according to specific and different local conditions. The way of

user demand-oriented asks for specific analysis. So it is necessary to strengthen targeted communication with partners in ASEAN countries to formulate different high-resolution satellite remote sensing application strategies for different ASEAN countries on the basis of the individual demands. At the same time, a more active and open attitude will be positive way to promote an effective consultation mechanism on satellite remote sensing application cooperation between China and ASEAN countries. By mutual consultation and contribution, the top-level design of future cooperation under the ACSAC framework is planned to be made taking various demands and requirements as well as capacities into consideration. Accommodate different needs, so as to ensure that Chinese high-resolution satellite remote sensing technology, application and cooperation thoughts are well accepted and worked with ASEAN partners.

5) The fifth is to strengthen remote sensing application publicity with ASEAN countries. On the basis of sharing and exchange of satellite images and products, we will emphasize to carry out application cooperation to conduct monitoring, investigation in a practical and effective way at project level, such as rapid investigation and monitoring of major geological disasters, marine disaster emergency monitoring, and marine fishery environmental monitoring in typical demonstration areas. Design and improve the ASEAN-China satellite data and big data remote sensing application platform is also a significant task to be done in next year to form an efficient capacity covering the display of results and achievements, data and product sharing and technical services. In addition, international and commercial cooperation in satellite remote sensing is another valuable working direction that to be further explored through various of technical training, joint implementation of projects, and transformation of scientific and technological achievements with ASEAN partners.

## 5. CONCLUSION

ASEAN-China relationship and cooperation benefits both sides. The two sides are neighbors in friendship and willing to give a hand in natural resources management and utilization with remote sensing technology. The year of 2023 is the ASEAN-China Year of Cooperation on Agricultural Development and Food Security, which satellite remote sensing will contribute a lot in this field with advantage of large scale and high frequency observation. With the ACSAC gradually entering the substantive construction, partners will solidate the cooperative mechanism and substantive entity of ACSAC, improving the output and supply of integrated satellite remote sensing solutions and taking data, thematic products, technical services, training, and exchange as a whole, to further provide joint wisdom and strength in satellite remote sensing application to ASEAN region. Besides, we will also lay joint emphasis on conducting joint research on remote sensing monitoring of land surface and natural resources elements in typical study area, breaking through the key technologies such as intelligent extraction of natural resources elements information, automatic inversion of key ecosystem parameters together, to carry out remote sensing monitoring demonstrations in surface water, arable land, green reserves, biodiversity conservation,

supporting the regional sustainable development and economic and social development etc.

“Digital Earth” offers a great tool that allows us to resolve global problems and overcome difficulties in developing mutual economic relationships between countries (5). To jointly construct “Digital Earth” of ASEAN-China is also one of the

significant mission and task for ACSAC. In General, the thoughts and ideas mentioned above in this paper will not go to realize without joint efforts with ASEAN partners in the following years. It is believing that ASEAN-China remote sensing cooperation will enjoy broader prospects with mutual efforts and share benefits.

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