Ponder the Improbable since 1996

EMPOWERING DIGITALISATION IN ASEAN AGRICULTURE

LESSONS FROM EU REGIONAL PLATFORMS FOR GEOSPATIAL TECHNOLOGIES

Policy Report

July 2023

Jose Ma. Luis Montesclaros

RSiS S. RAJARATNAM SCHOOL OF INTERNATIONAL STUDIES
Nanyang Technological University, Singapore

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Policy Report

EMPOWERING DIGITALISATION IN ASEAN AGRICULTURE

LESSONS FROM EU REGIONAL PLATFORMS FOR GEOSPATIAL TECHNOLOGIES

Jose Ma. Luis Montesclaros

July 2023

TABLE OF CONTENTS

Executive Summary

Food security remains a pressing challenge among countries in ASEAN, with more than half the region's total population being unable to afford healthy diets. The Internet of Things in agriculture and various other digital technologies could potentially help farmers in ASEAN to adapt to changing climatic environments, but challenges in terms of financing, education/engagement, and infrastructure connectivity prevent the scaling-up of farmers' technology adoption. To address these challenges, this policy report recommends that ASEAN should benchmark its approach to food security with the European Union's approaches, which leverage geospatial technologies for informed and tailored government support to farmers across diverse agroclimatic environments. Specifically, it proposes (1) developing a regional platform for sharing of geospatial data at the farm level across companies and governments to allow for rationalising and creating synergies in approaches amid resource constraints; and (2) developing standards for interoperability of geospatial data, potentially referencing ISO 19131 on data product specifications for geographic information.

Introduction

Food security remains a pressing challenge among countries in ASEAN, with more than half the region's total population being unable to afford healthy diets. Rising costs of healthy diets result partly from climate change, with farmers seeing slower agricultural productivity growth in recent decades relative to previous decades, and relative to population growth as well.

The Internet of Things (IoT) in agriculture and various other digital technologies offer the potential means of helping farmers adapt to changing climatic environments. Such technologies include digitalised data-gathering, farmer advisories and farming automation. However, the scale-up of these solutions is hampered by (i) low levels of capitalisation among smallholder farmers; (ii) "trust-gaps", with farmers perceiving that private companies offer digital services with a view to marketing their related products rather than transferring and building farmers' knowledge; and (iii) disparities in infrastructure connectivity (electricity, Internet) across and within the ASEAN countries.

Based on the experience of the European Union, the adoption of geospatial technologies at the country and regional levels would serve as a useful approach for ASEAN to address these challenges to scaling up digitalisation initiatives. Geospatial technologies allow for informed and tailored government support to farmers across diverse agroclimatic environments. Despite various differences in approach to promoting the use of IoT and digital technologies in agriculture, there is scope for ASEAN's approach to be informed by that adopted by the European Union:

1. ASEAN can explore **developing a regional platform for sharing of geospatial data at the farm level** across companies and governments at multiple levels. A regional platform would allow for rationalising and creating synergies in approaches amid resource constraints.
2. ASEAN can also **develop standards for interoperability of geospatial data**, potentially referencing **ISO 19131 on data product specifications for geographic information**. These could lead to harmonised data models that can be adopted by ASEAN governments and private sector entities alike. Such standards may also complement the ASEAN Guidelines on Promoting the Utilization of Digital Technologies for ASEAN Food and Agricultural Sector, adopted in 2021.

Climate Change and Rising Costs of Healthy Diets in ASEAN

Food security remains a pressing challenge in Southeast Asia, with statistics by the United Nations Food and Agriculture Organisation (FAO) showing that more than half (53.9%) of ASEAN's populations are unable to afford healthy diets.[1] The cost of a healthy diet in 2020 was 4 International Dollars per day and has risen by 3% per year since 2017.

Domestic food production plays an important role in ensuring that affordable food is available and accessible in sufficient quantities. Yet, agricultural productivity growth in ASEAN has been slowing down relative to the previous decades, and relative to population growth as well. Climate change contributes to this slowing down through heightened variability in rainfall as well as warming temperatures, which are unfavourable for food production in affected areas.[2]

Falling productivity growth applies especially to rice, which is the largest component in diets in the region. FAO statistics show that rice yields or productivity (measured in tonnes produced per hectare) grew by an average of 1.1% per annum in the recent three decades (1991–2021),[3] which was much slower than population growth of 1.6% per annum over the same period.[4] In fact, rice productivity growth in recent decades was only half the 2.2% growth in the preceding three decades (1961–1991). The falling productivity growth highlights the imperative of adapting ASEAN agricultural practices to changing climates.

[1] UN FAO, "Cost and Affordability of a Healthy Diet (CoAHD)", FAOStat Database, 2023, https://www.fao.org/faostat/en/#data/CAHD.
[2] Mbow, C., et al., "Food Security" in *Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*, ed. P.R. Shukla et al. (IPCC, 2019).
[3] UN FAO, "Crops and Livestock Products", FAOStat Database, https://www.fao.org/faostat/en/#data/QCL.
[4] UN FAO, "Annual Population", FAOStat Database, https://www.fao.org/faostat/en/#data/OA.

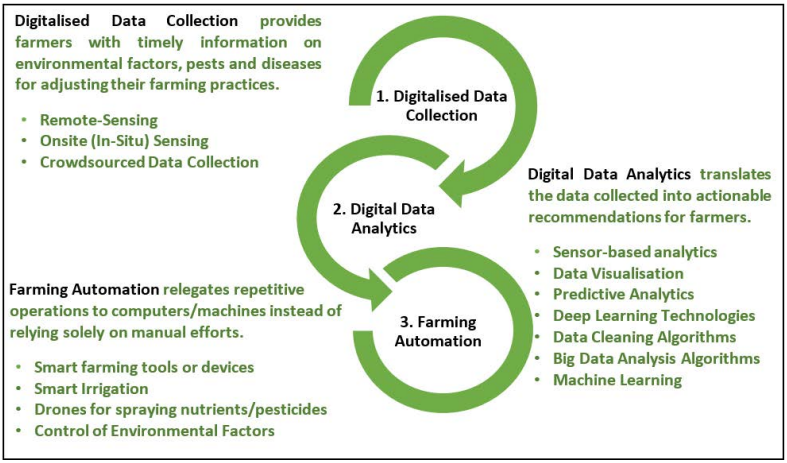
Internet of Things for Climate-Smart Food Production

Digital technologies can potentially allow the rice sector, and the broader agricultural sector, to be "climate smart" or more adaptable to climate change. Amid the Fourth Industrial Revolution, the application of digital technologies to farming allows for the Internet of Things (IoT) in agriculture, which is a combination of three technology groups: data collection technologies, data analysis, and automation (**Figure 1**).

1. Digitalised Data Collection

Amid climate change, farmers need ready and timely access to information for adjusting their farming practices. The first group of technologies tracks changes in the crop growing environments, with data tagged to **global positioning systems (GPS)** coordinates. According to a 2019 compilation by the OECD,[5] these include **remote-sensing technologies** (e.g., satellites, autonomous/unmanned aerial vehicles or drones, and manned aircraft); **onsite-sensing ("in-situ") technologies** (e.g., technologies for measuring water quantity, water and air quality, soil quality and nutrients, and technologies for tracking pests/invasive species) and **crowdsourced data collection** (farmers reporting pests/diseases through their mobile phones).

Figure 1: Internet of Things in Food Production



[5] OECD, "Digital Innovations and the Growing Importance of Agricultural Data", Chapter 2 in *Digital Opportunities for Better Agricultural Policies* (OECD Publishing, 2019).

2. Digital Data Analytics

Farmers do not typically have the training for interpreting biological and environmental data, which need to be readable to allow for actionable recommendations. The OECD's 2019 compilation[6] included **predictive analytics** to provide accurate weather projections, and **data cleaning algorithms** to filter out measurement errors from the data. **Big data analysis algorithms** further help combine data from multiple types of sensors, and **machine learning technologies** improve how computers prioritise and store important environmental changes and convert them into farming advice.

3. Farming Automation

As labour shifts towards modern industrial sectors, the agricultural sector is left largely in the hands of ageing farmers. To alleviate labour shortages in agriculture, repetitive operations can be relegated to computers/machines. For instance, traditional tools such as tractors, seeders and harvesters can be retrofitted into **automated smart farming tools or devices**. Drones can **spray chemical fertilisers, pesticides and herbicides** in an even and consistent manner according to **GPS** coordinates.[7] Within greenhouses or indoor growing environments, **automated control of environmental factors** can provide crops with ideal temperatures, air pressure and humidity. These can be complemented by **smart irrigation**, whether indoors or outdoors, for timely release of water and fertilisers. In combination, these allow for shorter growing periods and more efficient use of water and crop nutrients as well.

[6] OECD, "Digital Innovations and the Growing Importance of Agricultural Data".

[7] Sylvester, G., ed., "E-Agriculture in Action: Drones for Agriculture", UN FAO and International Telecommunication Union, 2018, https://www.fao.org/3/I8494EN/i8494en.pdf

Key Challenges in Scaling up IoT in Food Production

Several factors prevent ASEAN's farmers from adopting IoT in agriculture, even if this is clearly a much-needed solution in mitigating the impacts of climate change on agriculture.

1. Financing

Automation and the adoption of IoT technologies in farming is generally **highly capital-dependent** and requires significant capital outlays.[8] But smallholder farmers, i.e., those who possess up to two hectares of farmland, may not have sufficient collateral in terms of land to obtain financing. It has been estimated that 87% of the world's smallholder farmers are in the Asia-Pacific.[9] Furthermore, poverty is significantly higher in rural areas where farmers reside, unlike in urban areas, where there are modern industrial/service-sector jobs.[10]

2. Farmer Engagement and Education

A further challenge lies in engaging and educating farmers on the use of IoT technologies. There is often a "**trust gap**" wherein farmers perceive that private companies offer such services to market their related products rather than to transfer and build farmers' knowledge.[11] Grow Asia, a multistakeholder platform which engages smallholder farmers, has highlighted the importance of trust-building in enticing farmers to utilise digital technologies, including in-person communication or communication through social media, and peer group dialogues.[12]

---

[8] Montesclaros, J.M.L. and Babu, S.C. and Teng, P.S. 2019. "IoT-Enabled Farms and Climate-Adaptive Agriculture Technologies: Investment Lessons from Singapore." *IFPRI Discussion Paper* 1805. Washington, D.C.: International Food Policy Research Institute.

[9] Hazell, P.B. and Rahman, A. (Eds.), 2014. *New directions for smallholder agriculture.* Oxford: Oxford University Press.

[10] Rigg, J., Salamanca, A. and Thompson, E.C. 2016. "The puzzle of East and Southeast Asia's persistent smallholder." *Journal of Rural Studies*, *43*, pp.118-133.

[11] UNESCAP, "Assessment of Stakeholder Interventions for Sustainable Agriculture in Myanmar's Dry Zone", CAPSA-ESCAP, 2016, https://repository.unescap.org/bitstream/handle/20.500.12870/4269/ESCAP-2016-WP-Assessment-stakeholder-interventions.pdf?sequence=1&isAllowed=y

[12] Voultier, P., "Driving Smallholder AgriTech Adoption: What will it take?", Grow Asia Partnership, 2019, http://exchange.growasia.org/system/files/Driving%20AgriTech%20Adoption%20-%20Insights%20from%20Southeast%20Asia%27s%20Farmers.pdf

3. Infrastructure Connectivity

IoT technologies require stable Internet/electricity connections. While most people in ASEAN have **access to electricity**, those who do not are mostly in rural or less-developed areas. For example, ASEAN statistics show that 43% of Myanmar's population and close to 15% of Cambodia's population still do not have access to electricity.[13] **Access to the Internet** is an even bigger challenge since even many areas that already have electricity still lack Internet access. In Laos, where 93% of the total population have access to electricity, only 52% are Internet users. Furthermore, it is important to consider that most of ASEAN's land area – 96.6%, according to World Bank statistics – comprises rural areas rather than urban centres.[14] Since rural areas are less densely populated, larger shares of the ASEAN countries' land areas are therefore likely to be beyond the reach of national electrical grids. This applies potentially to a significant share of the 333 million individuals residing in ASEAN's rural areas.[15]

[13] ASEAN, "ASEAN Key Figures 2021", pp. 62–66, ASEAN Secretariat, 2021.
[14] World Bank, World Development Indicators Database, 2023.
[15] World Bank, World Development Indicators Database, 2023.

Regional Solutions: Benchmarking against EU Geospatial Initiatives?

The challenges raised above are not unique to ASEAN. In fact, the European Union too has been looking into ways of expanding the range of digital services that can be provided to its farmers. The EU approaches can potentially help inform ASEAN approaches (**Figure 2**).

1. Funding for Agriculture within EU's Common Agricultural Policy

The European Union treats food security as a **public good** since a stable food sector also contributes to income security for its farmers across all member states. In 1962, the European Union established its **Common Agricultural Policy (CAP),** which sought to support farmers in improving agricultural productivity as a means of ensuring a stable supply of affordable food.[16]

On one hand, the European Union's CAP has been critiqued in various respects, including its contributions to food "oversupplies"; the diminished competitiveness of less-developed countries' agricultural products owing to EU export subsidies; artificially higher prices owing to EU import restrictions; a bias towards larger farmers who produce more food and therefore receive more subsidies; and inequity among EU members, with some states being net beneficiaries of financing at the expense of other states, which are net contributors.[17]

On the other hand, the European Union's CAP has allowed for several key measures for supporting food security among member states, including (i) farmer income support measures and reward for compliance with the Good Agricultural and Environmental Conditions (GAEC) guidelines; (ii) market measures to stabilise agricultural markets that are prone to price fluctuations; and (iii) rural development measures to foster knowledge transfer and promote farmers' use of innovative technologies.

[16] EU website, "The Common Agricultural Policy at a Glance", n.d., https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en.

[17] Pe'er, G., et al. (2017). Is the CAP Fit for Purpose: An Evidence-based Fitness-Check Assessment, German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, pp. 1–20.

2. The EU's INSPIRE System for Interoperability of Geospatial Databases and IACS System for Aid to Farmers

In 2007, the European Commission issued a directive for developing infrastructure for spatial information, known as Infrastructure for Spatial Information in Europe (INSPIRE).[18] The INSPIRE directive requires interoperability of geographically identifiable data across multiple themes (e.g., transport, human health, agriculture), under multiple levels of authority.[19]

The INSPIRE directive complements what is known as the Integrated Administration and Control System (IACS), serving as a key mechanism utilised in the CAP for providing farmer payments that are tagged to spatial information or the locations of farms.[20] Farmers apply for aid using their land parcels, which are tracked through an EU-wide system, the Land Parcel Identification System (LPIS). Farmers likewise submit proof of compliance with GAEC guidelines to their national governments to receive EU aid, through the LPIS and IACS.

3. Integrated Crop Data Management within a "Single Farm File"

An earlier foresight study commissioned by the European Parliament envisioned developing an "integrated and synchronous management of crop data"[21] that builds on the European Union's information infrastructure framework. This was envisaged to evolve into a "single farm file" that includes information at the land parcel level, e.g., "land cover type, farming limitation, farmer aid application, agricultural parcel … and crop code." [22]

[18] European Commission, "INSPIRE Directive", n.d., https://inspire.ec.europa.eu/inspire-directive/2,

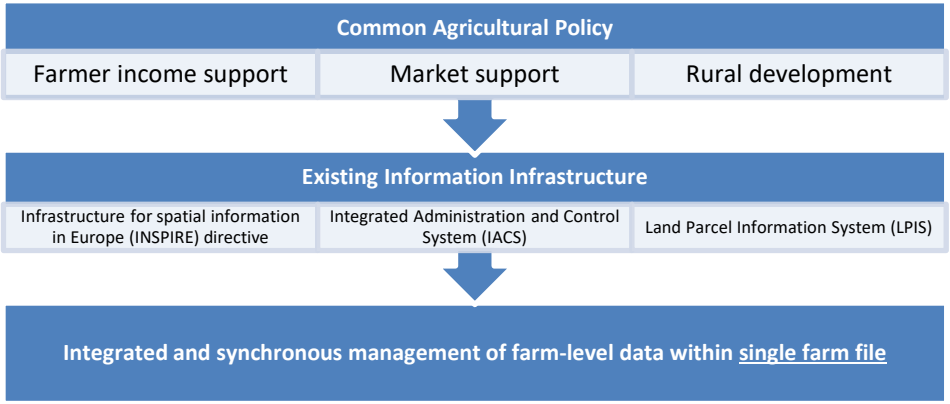
[19] European Commission, "Commission Regulation. EU No 1089/2010 of 23 November 2010: Implementing Directive 2007/2/EC ... interoperability of Spatial Data Sets and Services", https://eur-lex.europa.eu/eli/reg/2010/1089/oj

[20] Kritikos, M., "Precision Agriculture in Europe: Legal and Ethical Reflections for Law-Makers", European Parliament Science and Technology Options Assessment, 2017.

[21] Kritikos, "Precision Agriculture in Europe".

[22] Kritikos, "Precision Agriculture in Europe". p. 9.

Figure 2: Advantages of EU's Food Security Framework in Relation to IoT



Relevance to ASEAN Food Security: A Comparison with the European Union

This section provides a comparison of ASEAN's approach to food security to that of the European Union's. It is intended to allow for the mainstreaming of IoT-related data-gathering practices at the farm/parcel level (**Figure 3**).

1. Comparison of Mandates: EU's CAP vs. the ASEAN Integrated Food Security Framework

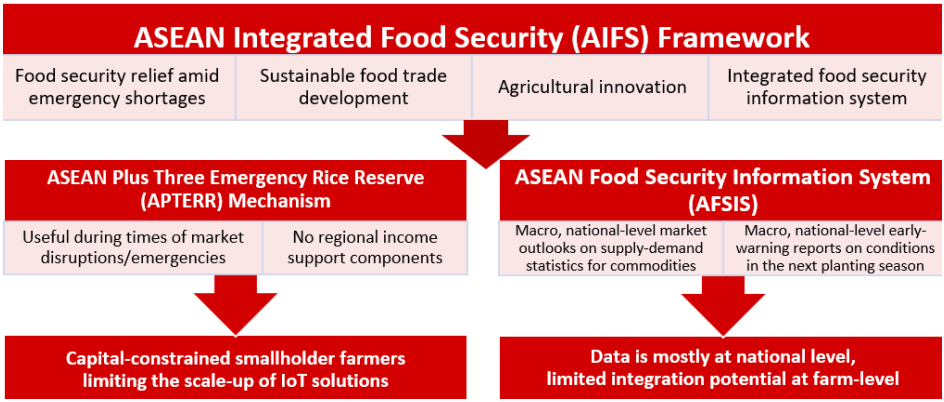
The closest framework in ASEAN that parallels the European Union's CAP is the ASEAN Integrated Food Security (AIFS) Framework, which "provide(s) scope and joint pragmatic approaches for cooperation among ASEAN Member States."[23] The AIFS framework is supported by successive Strategic Plans of Action on Food Security (SPA-FS) for 2009–13, 2015–20, and 2021–25.

Analogous to CAP's market support mechanisms, the AIFS seeks to achieve (i) food security relief amid emergency shortages and (ii) sustainable food trade development. These objectives of the AIFS are translated into the ASEAN Plus Three Emergency Rice Reserve (APTERR) mechanism of earmarked reserves that are released to stabilise rice markets. Similar to CAP's rural development measures, the AIFS also prioritises (iii) agricultural innovation in implementing long-term R&D plans for promoting efficient and sustainable food production, including the ASEAN standard of Good Agriculture Practices (GAP).

While the European Union's CAP cannot be adopted wholesale by ASEAN, a comparison of the extent of agricultural support provided within both regions reveals stark differences. Unlike the CAP, which is backed by a common fund to support farmers across the European Union's 27 member states, i.e., the European Agricultural Guarantee Fund,[24] the AIFS has no funding mandate; funding is left to the discretion of ASEAN's 10 member states.

[23] ASEAN, "AIFS Framework and Strategic Plan of Action on Food Security in the ASEAN Region (SPA-FS) 2009-2013, adopted in Cha-am, Thailand, 1 March 2009.
[24] European Union, "The Common Agricultural Policy at a Glance".

Figure 3: ASEAN's Food Security Framework in Relation to IoT and Key Challenges



In short, providing regional capital support to farmers is not yet organic within ASEAN, unlike in the European Union. Within ASEAN, "the key roles of the governments are to encourage success models, support R&D, technology transfer and capacity building, and develop [the] GAP certification scheme and its accreditation system." Except for initiatives such as the APTERR, where ASEAN member states and their Plus Three partners (China, Japan and Korea) have some pooled financial contributions to their upkeep, ASEAN leaves farmer income support provision to the discretion of member states.

2. Comparison of Data-Gathering Approaches: CAP's INSPIRE/IACS vs. ASEAN Food Security Information System

Similar to the European Union's INSPIRE and IACS, ASEAN has the ASEAN Food Security Information System (AFSIS), approved by the meeting of the ASEAN Ministers on Agriculture and Forestry (AMAF) Plus Three in 2002. AFSIS includes "systematic collection, analysis and dissemination of food security related information."[25] Its key outputs have included semi-annual market outlooks (supply–demand statistics for commodities) and early-warning reports on forecasted conditions in the next planting season (mostly weather conditions).

A key difference is in the use of geospatial data at the farm level. Within the European Union's European Agricultural Guarantee Fund (EAGF), income support to agriculture is tagged to individual farming areas, with budget allocations

[25] ASEAN Food Security Information System (AFSIS) website, "About Us", n.d., https://aptfsis.org/aboutUs.

tagged to the number of hectares owned by farmers. Geospatial identification in turn allows for further tailored support across farms of diverse agroclimatic environments.[26] In contrast, existing AFSIS reports are currently at the macro, national level. In fact, ASEAN launched the ASEAN Geospatial (AG) initiative in 2021, but it was still seeking to "raise interest" in this approach, referencing geospatial agencies in only five countries (Brunei, Indonesia, Philippines, Singapore and Vietnam).[27]

[26] European Commission, "Common Agricultural Policy Funds", n.d., https://agriculture.ec.europa.eu/common-agricultural-policy/financing-cap/cap-funds_en#eagf

[27] ASEAN Geospatial website, "Government Agencies", n.d., https://aseangeospatial.org/business-listings.

Conclusion and Policy Recommendations

The European Union's approach of seeing the regional agricultural sector/food security as a public good that requires regional income and market support differs starkly from ASEAN's approach of leaving financing aspects largely to member states and the private sector. While the European Union's CAP is not without challenges, the relatively weaker regional capital support in ASEAN's approach to food security hinders the adoption of IoT in agriculture, given capitalisation challenges faced by smallholder farmers. In this regard, two key policy recommendations are provided, borrowing a page from a foresight study commissioned by the European Union.[28]

1. Develop a Regional Platform for Data-Sharing at the Farm Level

Farmers in ASEAN can benefit from better collection of field-specific information using multiple sensors, as well as analytics that allow for targeted recommendations for improving agricultural productivity amid climate change.

There are a handful of private sector companies offering related services in the region. The GSM Association's database notes that there were 700 active digital agriculture services globally in 2020.[29] Within ASEAN, the Grow Asia database shows 200–230 use-cases of digital technologies in agriculture in Southeast Asia, which are drawn from approximately 60–70 companies across eight crops in the ASEAN member states.[30] The total scope or reach of these companies is unknown, but it can be gleaned that most of them are still in the incipient stages, with some even at trial stages.

However, capitalisation gaps are preventing farmers from adopting these technologies. To rationalise and synergise approaches amid resource constraints, ASEAN can explore developing a **regional platform for data-sharing of farm-level data across companies and governments** at multiple levels. This requires coordination at the national level for climate and satellite data and farm-level crop performance data from companies providing farmer advisory services. Pooling data-gathering efforts reduces redundancy in data-gathering and could possibly expand such pooled efforts to related areas of digitalisation as well.

[28] Kritikos, M., "Precision Agriculture in Europe".
[29] GSM Association, "Digital Agriculture Maps", GSMA, 2020.
[30] Grow Asia Partnership, "Grow Asia Digital Directory", n.d., https://directory.growasia.org/

2. Develop Regional Standards for Interoperability of Geospatial Data

Even if ASEAN aspires to achieve region-wide data-sharing of farm-level data, further challenges may arise from the differences in the purposes of data collection by multiple actors/agents. To ease the way for such an initiative, ASEAN's technical data collection standards need to be harmonised to allow for multi-sector data systems to interface with one another and potentially be integrated. Such interfacing and integration also requires harmonising semantic standards in data organisation and management and in legal standards (e.g., licensing requirements).[31]

The European Union is currently addressing this challenge by coming up with a set of implementing rules for its INSPIRE system for interoperability of spatial data sets and services.[32] Following INSPIRE's lead, ASEAN could issue guidelines aligning with ISO 19131 on data product specifications for geographic information. These can then be translated into an intuitive and replicable methodology for developing data specifications, guidelines for data measurement, and encoding, thus allowing for harmonised data models that are useful to ASEAN governments and private entities alike. Such standards may also complement the ASEAN Guidelines on Promoting the Utilization of Digital Technologies for ASEAN Food and Agricultural Sector, adopted in 2021.

[31] Kritikos, M., "Precision Agriculture in Europe".

[32] European Commission Joint Research Centre, "INSPIRE Thematic Working Group Addresses: D2.8.I.5 Data Specification on Addresses – Technical Guidelines", 17 April 2014, https://inspire.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_AD_v3.1.pdf

About the Author

Jose Ma. Luis Montesclaros is Research Fellow with the Centre of Non-Traditional Security Studies (NTS Centre) at S. Rajaratnam School of International Studies (RSIS), Nanyang Technological University, Singapore, where he is concurrently a PhD candidate (International Political Economy). He was Co-Investigator of the "Enhancing Food Supply Chain Resilience and Food Security in ASEAN with Utilisation of Digital Technologies" project, which involved conducting an assessment of digital technology adoption in ASEAN agriculture, supported by the Economic Research Institute for ASEAN and East Asia (ERIA) and the ASEAN Secretariat. He obtained his Master's in Public Policy (MPP) from the Lee Kuan Yew School of Public Policy (LKYSPP), National University of Singapore, as an ASEAN Scholar, and his BS Economics degree from the University of the Philippines, and was one of the two "Leaders of Tomorrow" representing LKYSPP at the 44th Saint Gallen Wings of Excellence Awards (Switzerland) in 2014.

About the Centre for Non-Traditional Security Studies (NTS Centre)

The **S. Rajaratnam School of International Studies (RSIS)** is a think tank and professional graduate school of international affairs at the Nanyang Technological University, Singapore. An autonomous school, RSIS' mission is to be a leading research and graduate teaching institution in strategic and international affairs in the Asia Pacific. With the core functions of research, graduate education, and networking, it produces research on Asia Pacific Security, Multilateralism and Regionalism, Conflict Studies, Non-traditional Security, Cybersecurity, Maritime Security and Terrorism Studies.

NTS Centre conducts research and produces policy-relevant analyses aimed at furthering awareness and building the capacity to address non-traditional security (NTS) issues and challenges in the Asia Pacific region and beyond. The Centre addresses knowledge gaps, facilitates discussions and analyses, engages policymakers, and contributes to building institutional capacity in Sustainable Security and Crises. The NTS Centre brings together myriad NTS stakeholders in regular workshops and roundtable discussions, as well as provides a networking platform for NTS research institutions in the Asia Pacific through the NTS-Asia Consortium.

For more details, please visit www.rsis.edu.sg and http://www.rsis.edu.sg/research/nts-centre. Join us at our social media channels at www.rsis.edu.sg/rsis-social-media-channels or scan the QR code.

RSiS | S. RAJARATNAM SCHOOL OF INTERNATIONAL STUDIES
Nanyang Technological University, Singapore

Nanyang Technological University, Singapore
Block S4, Level B3, 50 Nanyang Avenue, Singapore 639798
Tel: +65 6790 6982 | Fax: +65 6794 0617 | www.rsis.edu.sg