Strengthening innovation-driven inclusive and sustainable development

Asia-Pacific Tech Monitor

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Technologies for adaptation to climate change in Asia-Pacific

Plus

- Technology News and Events
- Tech Ventures & Opportunities
- Business Coach

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific
Asian and Pacific Centre for Transfer of Technology (APCTT)

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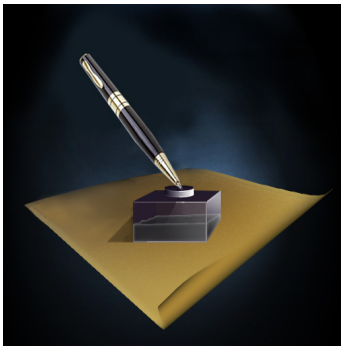

We are happy to share the third issue of *Asia-Pacific Tech Monitor* focusing on 'Technologies for adaptation to climate change in Asia-Pacific'.

The Asia-Pacific region is highly vulnerable to climate change. It is likely to face increased impacts including intense and frequent extreme events and sea level rise in the next few decades.

Transformative adaptation enabled through better technologies has become vital to enhance resilience towards these impacts. As countries are raising their ambitions to respond to the challenges of climate change as part of their Nationally Determined Contributions (NDCs), adaptation technologies will play an important role in meeting these commitments and overall objectives of the Paris Agreement. Commitments for increased finance and technology transfer support to developing countries for enhancing collective ambitions and actions at the 26th session of the Conference of the Parties (COP26) will be definitive to chart a pathway to achieve the adaptation and mitigation goals of Paris Agreement.

Many emerging technologies are now increasingly being used in different sectors for adaptation to climate risks and impacts. These technologies are helping to improve the effectiveness and efficiency of adaptation interventions. For example, big data analysis is being used to provide better services for improving crop management practices and reducing the risks in agricultural production due to uncertain weather changes. Better planning to address the impacts of climate change can be done through real-time monitoring and forecasting hazards at multiple spatial scales using digital technologies. For example, a drought monitoring system using space technology and open data is being used in the Lower Mekong Basin to enhance the preparedness of farmers to address the impacts of drought. It gives policymakers access to better data and tools to implement strategies for drought risk reduction.

Effective adoption and implementation of technologies for adaptation depends on enabling policies, cooperation at all levels, customization to the local context and integrated responses in coherence with societal objectives. Integration of technologies with local practices and indigenous knowledge can make their application more robust and effective. Bottom-up approaches considering local practices and indigenous knowledge are useful in designing adaptation technology-related interventions. Enhanced and coordinated adaptation action, alongside technical and financial support for planning and implementation are increasingly needed to reduce the risks and impacts of climate change.

This issue of *Tech Monitor* discusses how innovative technologies could support policymakers and practitioners to make the interventions for climate change adaptation more robust. The articles provide insights into the application of space and digital technologies for addressing impacts in different sectors such as agriculture, disaster risk reduction and natural resource management.

Preeti Soni
Head, APCTT-ESCAP

ASIA-PACIFIC

ASEAN countries strengthen pandemic research cooperation

Countries of the Association of Southeast Asian Nations (ASEAN) are stepping up research collaboration with a specific focus on genomic surveillance of virus strains and research into immunity against COVID-19 in regional populations, in order to boost the region's ability to combat COVID-19 and future pandemics by sharing scientific data and research.

These include a regional project analyzing genomic surveillance data, co-led by Singapore and Malaysia through Singapore's Bioinformatics Institute (BII) and A*STAR Infectious Diseases Labs, which are research institutes under Singapore's Agency for Science, Technology and Research known as A*STAR, and the National Institutes of Biotechnology alaysia.

The project will provide up-to-date genomic information on virus strains detected in the region, A*STAR said in a statement, adding that the partnership leverages existing biotechnology and bioinformatics capabilities within ASEAN and builds on existing national genome sequencing efforts. Genomic sequencing can help identify variants by detecting tiny differences in genetic code.

"The emergence of COVID-19 variants has added another layer of complexity for public health officials. To better understand the impact of these variants, such as its transmissibility and clinical severity, it is critical to identify and differentiate the strains," the A*STAR statement said. Looking beyond the current pandemic, regional research cooperation will advance the region's preparedness for future outbreaks by strengthening linkages and cultivating new networks between ASEAN member states for the sharing of information on viruses, the Singaporean research agency said.

Systematic bio-surveillance of viral genomes in the ASEAN region can assist in detecting potential transmission between countries as well as discovering new strains with mutations that could affect diagnostics or vaccination. "This information serves to inform national contact tracing processes as well as evaluate the effectiveness of mitigation measures," according to A*STAR. Sharing real-time genomic information on COVID-19 strains within the region will help public health authorities to maintain a broader, constantly updated picture of virus strains detected both nationally and regionally.

The Philippines and Singapore are co-leading a regional study to assess the levels of immunity within ASEAN communities at different stages, including before vaccination and how long immunity lasts after vaccination. The study will look into the effectiveness of seroconversion of vaccines, which refers to the development of specific antibodies in the blood serum as a result of a COVID-19 infection or vaccination. It will assess levels of immunity at different stages including before and after vaccination.

https://www.universityworldnews.com

INDIA

Updated drone rules

The Civil Aviation Ministry released the updated Drone Rules, 2021 for public consultation. The Drone Rules, 2021 will replace the UAS Rules 2021 which was released on 12 March 2021. "The updated rules are built on a premise of trust, self-certification, and non-intrusive monitoring," the ministry said. It said new drone corridors will be developed for cargo deliveries and a drone promotion council will be set up to facilitate a business-friendly regulatory regime.

Under the new rules, the approvals for unique authorization number, unique prototype identification number, certificate of conformance, certificate of maintenance, import clearance, acceptance of existing drones, operator permit, authorization of R&D organization, student remote pilot license, remote pilot instructor authorization, drone port authorization etc. are abolished. Number of forms has been reduced from 25 to 6. The ministry said the fee has been reduced to nominal levels and there is no linkage with the size of the drone.

Safety features like "No permission – no take-off" (NPNT), real-time tracking beacon, geo-fencing etc. will be notified later. As per the new rules, a 6-month lead time will be provided for compliance. Digital sky platform shall be developed as a business-friendly single-window online system. There will be minimal human interface on the digital sky platform and most permissions will be self-generated.

Interactive airspace map with green, yellow, and red zones will now be displayed on the digital sky platform. Yellow zone reduced from 45 km to 12 km from the airport perimeter. No flight permission required upto 400 feet in green zones and upto 200 feet in the area between 8 and 12 km from the airport perimeter.

In the R&D space, no pilot license is required for micro drones (for noncommercial use), nano drone and for R&D organizations. Restriction on drone operations by foreign-owned companies registered in India has also been removed. Import of drones and drone components will be regulated and no security clearance is required before any registration or license issuance. Requirement of certificate of airworthiness, unique identification number, prior permission, and remote pilot license for R&D entities is also not there.

Under new rules, coverage of drones under Drone Rules, 2021 is increased from 300 kg to 500 kg. This will cover drone taxis also. All drone training and testing will be carried out by an authorized drone school. The maximum penalty under Drone Rules, 2021 reduced to Rs 1 lakh. This shall, however, not apply to penalties in respect of violation of other laws.

https://www.business-standard.com

Indian startups in Forbes list

Twenty-two Indian startups have made it to Forbes Asia's inaugural "100 to watch" list, the most for any country on the list, which was released on 9 August 2021. The list sheds light on the top 100 startups and small companies, identified by Forbes,

which have garnered attention and are on the rise across the Asia-Pacific region. The Forbes Asia 100 to watch list covers 10 sectors. They include biotechnology & healthcare, e-commerce & retail, food & hospitality, education & recruitment, construction & engineering, agriculture, logistics & transportation, finance, technology, and entertainment & media.

The 100 companies on the list represent 17 different countries and regions in Asia-Pacific. The most number of companies are from India (22), followed by Singapore (19), Hong Kong (10), and Indonesia (8). Japan is ranked fifth with seven companies on the list. Startups from countries like China, South Korea, Malaysia, Philippines, Australia, Vietnam, New Zealand, Thailand, Pakistan, Mongolia, Laos, and Cambodia are also on the list.

From India, most of the startups—four each—were from the agriculture, biotechnology and healthcare sectors. Technology, and education & recruitment come next, with three companies each. Startups from logistics & transportation; construction & engineering; and food & hospitality sectors have two companies each on the list; while entertainment & media, and e-commerce & retail sectors are at the rear end with only one company each that has made it to the list.

https://www.forbesindia.com

Startups raise over $20 billion

Indian technology startups have shown massive growth this year as the funding rises over $20 billion. Global venture capitalists and private equity firms are allocating more funds to Indian startups than China as it amped up regulatory clampdown on its tech companies.

Record market listings and crackdown in China has come to India's aid for funding. According to the data by Venture Intelligence, Indian companies raised $20.2 billion across 576 deals, as compared to $13 billion from 878 deals in 2019. According to the statistics, manufacturing startup Zetwerk raised $120 million from a group of investors for a valuation of $1.4 billion, surpassing the $20 billion mark. This mark was breached in just 8 months, which is a record high level for India.

https://www.freepressjournal.in

FIJI

New Trade Marks Act

Fiji now has a new Trade Marks Act, to replace its almost 90 year old Trade Marks Act 1933. The new *Fijian Trademarks Act 2021* was gazetted on 20 August 2021 and should come into force in the very near future, once the commencement date is announced. There is no certainty regarding its commencement date, but Trade mark lawyers will be hoping that it is sooner rather than later.

The new Trademarks Act introduces a raft of welcome updates, not least of which is its adoption of the Nice Classification of Goods and Services. Until recently, Fijian trademark law relied upon an antiquated British system of 50 different good classes and 10 subclasses.

Conveniently, the *Fijian Trademarks Act 2021* is very similar to the New Zealand Trade Marks Act 2002 (and thus also similar to the Singapore Trade Marks Act 1998 and the United Kingdom Trade Marks Act 1994).

https://www.lexology.com

MALAYSIA

Global technology grant launched

The Malaysia Digital Economy Malaysia (MDEC) has announced the Global Technology Grant (GTG), an initiative aimed at nurturing global champions, driving investments, and catalyzing a digital innovation ecosystem. In a statement, it said the objective of GTG is to support the scaling-up of Malaysian technology companies into the global arena by way of empowering innovation, development, and commercialization of disruptive or innovative products and services.

The grant works by supporting research and development (R&D), scaling-up of provision of R&D services, development of new technologies, establishment of centers of excellence, and the creation of new market-driven products or services for the global market, it said. The GTG also serves to support high-impact ecosystem development initiatives, including the development of ecosystem players that ultimately contribute to the growth of the digital economy, it added. This includes new job creations, expansion of export and investments, and talent development.

https://www.digitalnewsasia.com

Public–private tie-up to strengthen startup ecosystem

ScaleUp Malaysia and Technology Park Malaysia (TPM) signed a Memorandum of Cooperation that establishes a public–private partnership in providing mentorship, training, market access, and capital to technology startups, allowing them to strengthen their capacity for regional expansion and foreign direct investment.

"ScaleUp Malaysia is a known accelerator programme that is operated by entrepreneurs and industry veterans. The partnership between TPM and ScaleUp Malaysia will provide startups better access to government resources that include labs, infrastructure and other facilities, as well as regulatory facilitation to advance innovation. This collaboration opens up the door for the scaleups to receive support from the private sector's networks, expertise and capital," said Dzuleira Abu Bakar, the Group CEO of TPM who delivered the keynote address at the ScaleUp Malaysia's launch of Cohort 3 Programme.

According to Dzuleira, the recent announcement by the Ministry of Science, Technology and Innovation (MOSTI) on the formation of a technology commercialization accelerator (TCA) through the consolidation of TPM and the Malaysian Global Innovation and Creativity Centre (MaGIC) will create incredible opportunities for entrepreneurs, scientists, researchers as well as startups to accelerate commercialization of technology and innovation.

"In our bid to propel and create more startups, scaleups and future unicorns,

this partnership as well as the formation of TCA is a boost to the startup scene in Malaysia and is poised to see more technology companies that will succeed within the Malaysian ecosystem," Dzuleira said.

"This is a strategic move where ScaleUp Malaysia aims to help create the right alliance with the Government's resources and support with private sector networks, expertise and capital. ScaleUp Malaysia will continue on to support the Government by providing training, market access and capital to these companies to contribute towards the national agenda in creating a vibrant entrepreneurship ecosystem," said Dr Sivapalan Vivekarajah, Managing Partner of ScaleUp Malaysia.

https://www.digitalnewsasia.com

PHILIPPINES

Intellectual property filings record 20% growth

Filings for intellectual property (IP) protection in the first half of 2021 posted a 20% year-on-year growth as the economy recovered further from eased lockdown restrictions while the Intellectual Property Office of the Philippines (IPOPHL) succeeded in highlighting the importance of IP in business recovery. In total, IP applications stood at 22,919. Utility model (UM) filings saw the biggest increase at 26%, from the 592 recorded from January to June last year to 744.

Driving the increase were residents whose filings climbed 29% from 555 to 715. On the other hand, nonresident UM filings contracted by 22% from 37 to 29. The top fields for UM filings during the period were in food chemistry (239); basic materials chemistry (39); special machines (32); handling (20); and IT methods for management (19). Trademark filings increased as well by 23% from 15,969 filings to 19,649. Resident filings made up the bulk of the applications and registered a 39% surge from 8,859 to 12,288.

International filings, which are made through the Madrid Protocol, took a 5% drop from 3,859 to 3,677. Most trademark filings were in pharmaceuticals, health, cosmetics (5,786); agricultural products and services (5,473); scientific research, information and communication technology (4,204); management communications, real estate and financial services (3,614); and textiles, clothing and accessories (2,865).

Patent filings rose by 2% from 1,899 to 1,945. Majority of the growth came from nonresidents with 165 filings, an increase of 23%. Filings through the international Patent Cooperation Treaty edged down by a mere 1% from 1,599 to 1,586.

The top fields for patent filings were in pharmaceuticals (1,020); organic fine chemistry (523); biotechnology (312); basic materials chemistry (198); and food chemistry (176). Meanwhile, copyright deposits soared by 163% from 285 to 761. The lone laggard during the period was industrial design with filings sliding 10% to 581. While resident filings increased by 8% to 339, nonresident applications for ID decreased by 27% to 242.

https://www.ipophil.gov.ph

Accelerating innovation through partnerships

A business process outsourcing (BPO) firm in the Philippines has recently partnered with 10 universities and academic institutions to help accelerate technology innovation in the country. The tech company handed over PHP80 million in grants to its academic partners to fund programs focusing on emerging technologies, sustainability, and inclusion and diversity.

As per the company's technology lead in the Philippines, Africa, and the Asia-Pacific, the funding aims to help boost the local innovation system, particularly Filipino technology talents. "By supporting on-campus labs and incubators that are embarking on initiatives to accelerate the use of new technologies, develop more sustainable business practises, and foster a more inclusive culture in the technology field, we are helping to nurture the next generation of Filipino technologists that will solve complex business and social challenges in the future," he said.

- The partnership between the tech firm and Adamson University's Technology Business Incubator for Neo-Environmental Science and Technology will include curriculum updates and startup support for Industry X applications. The BPO firm will help finance the Innovate with Data program at the Asian Institute of Management-Dado Banatao Incubator, which will develop a collaborative learning journey to transform local startups into data-driven companies.
- Its collaboration with Ateneo de Manila University (ADMU) entails curriculum intervention in order to establish data and analytics programs at the tertiary education level. In addition, the company will work with Ateneo Blockchain Labs to launch programs to scale healthcare startups using multi-party systems, as well as blockchain curriculum development and the development of government applications for multi-party systems with ADMU Loyola Schools.

https://opengovasia.com

REPUBLIC OF KOREA

R&D investment by drugmakers

Large pharmaceutical companies increased their investment into research and development in the first half of 2021 despite an uncertain profitability outlook due to the prolonging COVID-19 pandemic. According to semi-annual reports submitted to the Financial Supervisory Service, seven out of the top 10 pharmaceutical companies expanded R&D investment in the first 6 months from the same period of 2020 to find a new growth engine.

Celltrion spent 202 billion won ($172 million), 21.12% of its sales in the year's first half, on R&D. It marked the 42.3% increase from 141.9 billion won a year ago. The company is rapidly expanding its R&D activities to drugs other than its mainstay of biosimilars. Celltrion's COVID-19 antibody therapy Regkirona, which received conditional approval from the Ministry of Food and Drug Safety in February based on

phase 2 clinical trial results, is experiencing a sharp market demand increase amid the ongoing fourth viral wave.

Health authorities estimated that 8,610 COVID-19 patients had received Regkirona at 85 domestic medical institutions as of 31 July. Celltrion's biosimilar drug Remsima SC, a hypodermic injection, also won authorization from the European Commission in July 2020 for all indications except for treating pediatric patients. The drug began generating sales with the approval, and phase 3 clinical trials are underway in the U.S.

Daewoong Pharmaceutical spent 90.63 billion won as R&D expenses in the first half-year, up 25.5% year on year. It is the second-largest increase after Celltrion. The ratio of R&D investment to sales rose to 17.61%. The company conducted studies on its pancreatitis drug Foistar (ingredient: Camostat) and investigational drug DWRX2003 (ingredient: niclosamide) for tapeworm infestation to re-purpose them into COVID-19 therapies. In addition, a clinical trial of mesenchymal stem cell therapy targeting severe COVID-19 patients in need of a ventilator is going on.

Samsung Biologics' R&D spending amounted to 43.42 billion won, up 38.24%, over the cited period. The company is maintaining its growth trend thanks to contracted manufacturing orders' increase due to the COVID-19 pandemic. Other large Korean drugmakers are also actively seeking R&D investment opportunities for growth.

Expansion of R&D investment was noticeable in Ildong Pharmaceutical, DongA-ST, Chong Kun Dang, and inno.N, focusing on their bestsellers. Ildong Pharmaceutical poured 48.4 billion won, or 17.6% of cumulative sales, into R&D, marking a 41.19% growth. Chong Kun Dang lifted R&D investment by 25.52 to meet its goal of developing new drugs. Its R&D spending increased to 78.05 billion won in the January–June period compared with 62.18 billion won a year ago.

In contrast, some companies reduced their R&D spending, reflecting their worsening profitability due to the prolonged pandemic. Hanmi Pharmaceutical, Yuhan Corp, and GC Pharma reduced investment in R&D compared to last year. However, they used more than 10% of their sales for this purpose. Hanmi Pharmaceutical, which had actively engaged in R&D activities, saw an unusually significant reduction in investments. Hanmi Pharm's R&D investment in the first half was 72.76 billion, down 28.88% from the previous year. However, the company still spent 13.2% of its sales on R&D.

https://www.koreabiomed.com

New drug development projects

The Korea Pharmaceutical and Bio-Pharma Manufacturers Association announced on 5 September that 193 out of the 299 South Korean companies in the industry are working on 1,477 new drug pipelines. For reference, 100 companies were working on 573 new drugs according to the association's 2018 survey.

The 1,477 are divided into 599 synthetic drugs, 540 biopharmaceuticals, and 338 others. 27.3% of the projects are in their lead compound and candidate phases, 26.9% in nonclinical, and 18%, 11.4%, and 7.9% in their first to third clinical phases, respectively. The number of projects more than doubled in 3 years in every phase. Especially, the number of those in the third phase soared 274.2%. The 1,477 include 317 anticancer drugs, 173 metabolic disease drugs, 146 nervous system drugs, 112 drugs against infectious diseases, and 79 digestive system drugs.

In the industry, the number of cases of technology transfer including license in and out increased from 36 to 105 last year. The number was 85 in the first quarter of this year. The cases include 45.7% related to biopharmaceuticals and 26.8% related to synthetic drugs.

More than 25% of the cases are related to anticancer drugs, followed by infectious disease (9.7%), metabolic disease (5.8%), eye disease (4.9%), and digestive disease (4%). The smaller and larger companies transferred 250 and 81 licenses, respectively. The larger companies transferred 17 to foreign capital companies and the smaller companies transferred 64 to their domestic peers, 50 to foreign capital companies, and 35 to larger companies.

http://www.businesskorea.co.kr

THAILAND

Smart city plans en route to Industry 4.0

Thailand is forging ahead with its plans to become a developed digital hub in the Southeast Asian region, as part of its Thailand 4.0 policy that was outlined way back before the pandemic, in 2019.

The COVID-19 situation did, however, highlight to what extent that digital tools and enhancements could play in a city, as Thailand relied on both 5G networking technology and 5G-enabled tech enhancements to support overwhelmed public health services even early on in its pandemic response.

As one of the regional economies on the path towards Industrial Revolution 4.0 (or Industry 4.0) maturity, Thailand is restructuring itself into a value-based, innovation-driven economy by looking towards future economic trends—and as part of the Thailand 4.0 roadmap, one of those trends is to modernize urban centers in the country into smart, sustainable cities.

The Smart City concept, according to the *Bangkok Post* daily, is "a core pillar of the Thailand 4.0 policy that the country is pursuing, as part of its 20-year national development plan. The country aims to boost the digital capacity of its city management ecosystem, while preserving Thailand's unique social fabric, as well as enhancing the quality of life for urban residents. Moreover, the plan looks to further encourage locals in the participation of the future development of their city."

As part of the smart city drive, an organization called the National Charter of Thailand (NCT) has been tasked with planning the sustainable development of the nation's cities. The NCT has developed a blueprint for creating "smart blocks," experimental zones comprising of 0.25 square kilometers, in communities where

physical "smart" infrastructure such as sensor connectivity and the Internet of Things (IoT) will be deployed to gather data and to gauge public acceptance for increased tech adoption.

The development of smart blocks is already underway in 6 out of 13 municipalities: Chiang Mai, Nakhon Sawan, Udon City, Khon Kaen, Rayong City, and Patong City. These experimental zones will utilize all-in-one "smart poles" embedded with IoT sensors to gather traffic data, to make designated areas more pedestrian-friendly placing priority on pedestrians, followed by cyclists, public transport users, and finally private car users.

https://techwireasia.com

Medical technology innovations

Under its development target of becoming an international healthcare and medical hub by 2036, Thailand is currently aiming to reach the next level of medical and wellness services by promoting precision medicine for the treatment of more complex illnesses, such as cancer and genetic-related diseases.

The action plan focuses on improving R&D and skill training technology, with the local medical device industry also expected to benefit from the cutting-edge innovations and R&D facilities in the Eastern Economic Corridor (EEC) which covers the three provinces of Chachoengsao, Chonburi and Rayong in the country's Eastern Region. As Thailand's pilot industry 4.0 special economic zone, the EEC provides support for all of the country's target high-tech industries with facilities that promote the whole R&D and innovation development process, including the Startup and Innovation Center, National Quality Infrastructure and Translational Research Infrastructure.

One project that is fundamental to this plan calls for the Public Health Ministry to establish the Thailand Genome Sequencing Center in the EEC as a facility to provide clinical services for patients from across Southeast Asia and beyond.

The Excellence Center for Genomics and Precision Medicine at King Chulalongkorn Memorial Hospital has provided assurances that it could support and strengthen the whole genome sequencing project. On top of that, the BOI and the EEC office have provided tax and non-tax incentives to foreign businesses and experts to work in the EEC.

In a related development, Thammasat University5 has confirmed its plan to develop a Total Digital Healthcare Solution at its Pattaya campus in Chonburi province. With a focus on healthtech, state-owned Mahidol University has introduced Salaya Startup Town which houses a comprehensive ecosystem of lab and R&D space for engineering, biotechnology, and healthcare technology.

In the capital city of Bangkok, around 20 medical academic institutions and research houses have signed an agreement to strengthen their collaboration on research and human clinical trials under the "Multicenter Medical Innovation Clinical Trial" project. The institutions which have formed a network called "the Yothi Medical Innovation District" have worked together on the development of medical devices such as a portable chest x-ray and its application for patients with noncommunicable diseases.

https://www.bangkokpost.com

Enhanced incentives to promote R&D

The Thailand Board of Investment (BOI) at a meeting on 30 June 2021 approved a series of measures to encourage more investment in research and development (R&D) and engage the industry more actively in human resource development (HRD). Enhanced incentives are also offered to attract investment in the growing semiconductor, digital and packaging industries.

As Thailand aspires to become more innovation-driven, private sector R&D plays a very significant role. To encourage companies to step up their R&D, the BOI has proposed to the Board that projects that invest or spend at least 200 million baht or 1% of their total sales of the first 3 years be entitled to a longer tax breaks (maximum 13 years) with no corporate income tax exemption ceiling. The number of additional years of tax holidays depends on the amount of R&D spending/investment. Moreover, companies that participate in apprenticeship programs or spend on advanced technology training can also enjoy greater tax incentives.

The BOI also approved a revamp of its promotion policy for businesses operating on the supply side of the digital economy by focusing on hiring and developing IT workforce as well as upgrading companies to relevant international standards. Companies applying for BOI privileges under the single reorganized category called "Development of Software, Digital Services Platform or Digital Content" will be eligible for an 8-year tax holiday, with the yearly ceiling reflecting additional hiring of Thai IT personnel, training expenses and costs of international standard certifications, such as ISO 29110 and CMMI Level 2 and above.

https://www.bangkokpost.com

UZBEKISTAN

UNESCO support to further enhance STI

Over the last couple of years Uzbekistan has taken some bold steps to promote STI areas that are perceived as the foundation for the country's future development. Under the leadership of H.E. President Shavkat Mirziyoyev, the Ministry of Innovation Development, the National Council on Science and Technology, as well as brand new innovation centers, scientific clusters, and technology parks were established in the country. With the state support, the number of research institutions of the national Academy of Sciences has grown from 20 to 35 and the funding for science has quadrupled.

Promoting Science, Technology and Innovation (STI) has become a key policy objective in developed and developing economies, as governments around the world have recognized STI to be a driving force for achieving the Sustainable Development Goals (SDGs).

As a pillar of UNESCO's mandate, the development of STI is an important focus

of bilateral cooperation with Uzbekistan. This collaboration expanded significantly in several fields of UNESCO's competence following the official visit of Ms Audrey Azoulay, Director General of UNESCO, to Uzbekistan in August 2019, when she held some productive high-level meetings with the leadership of the Republic of Uzbekistan.

One of the key elements of cooperation has been UNESCO's technical assistance through a project on strengthening inclusive STI systems in Uzbekistan that was launched in 2019 with the financial support of the Islamic Development Bank (IsDB). This project, implemented with the Ministry of Innovative Development of the Republic of Uzbekistan and UNESCO, aims at strengthening the capacity of Uzbekistan on STI policymaking through reviewing the national system to identify strategic investments in STI that tackle major development, social-economic and environmental challenges, as well as formulating policy options and governance recommendations.

The review further serves as an evidence base for the next stages of cooperation—namely, developing a national STI policy and key policy instruments (Action Plan) for its implementation.

The publication of "Mapping Research and Innovation in the Republic of Uzbekistan" (available in English, Russian, and Uzbek) in October 2020 was an important milestone in this project. It is the 10th volume of a series of country profiles produced by UNESCO's Global Observatory of Science, Technology and Innovation Policy (GO-SPIN), and it is the first of its kind for Central Asia. The Publication presents an analysis of key characteristics of Uzbekistan's STI system and includes an overview of STI development needs and opportunities, analysis of strengths and weaknesses, and recommendations formulated for the Government of Uzbekistan. By analyzing the national STI system, the report serves as a reference in providing evidence base for the development of the national STI policy as the next step of the project.

In the framework of this project, several capacity building activities and national workshops on STI policy were held with the participation of the Ministry of Innovative Development and other national stakeholders engaged in these areas. Moreover, a national survey of the STI potential of eight regions—Andijan, Bukhara, Ferghana, Jizzak, Kashkadarya, Khorezm, Namangan, and Navoi—has been conducted. The survey collected more in-depth information on the state of the STI system in the country.

Based on the information collected through these studies, bilateral activities and exchanges, UNESCO has developed the first draft of Uzbekistan's STI Policy. The document should serve as the foundation for achieving the STI objectives in Uzbekistan over the next 10 years and an important tool to facilitate a successful recovery from the COVID-19 crisis.

https://indiaeducationdiary.in

VIET NAM

National strategy for artificial intelligence

The Vietnamese government has issued a national strategy on the research, development, and application of artificial intelligence (AI) till 2030. It aims to gradually turn Vietnam into an innovation and AI hub in ASEAN and the world. The Minister of Science and Technology, Bui The Duy, noted that the strategy intends for Vietnam to be among four leading countries in ASEAN and 50 nations globally in terms of AI research, development, and application over the next few years. Also, it targets to build 10 prestigious AI trademarks in the region and develop three national big data and high-performance computing centers.

By 2030, Vietnam will set up 50 interconnected open databases in economic sectors in service of the effort. To achieve this, the country is fine-tuning legal documents, creating a legal framework regarding AI, and promoting international cooperation in the field. According to a news report, further attention should be paid to human resources training and building a database that is synchronous with computing infrastructure. Since the COVID-19 pandemic broke out nearly 2 years ago, the application of AI in health care in Vietnam has become a bright spot in the world. AI has helped ease burdens on medical workers and anti-pandemic forces through tracing apps and epidemiological maps.

The Hanoi University of Science and Technology officially debuted an international center on AI under the model of a mixed international research center. It is expected to conduct basic studies and create Make-in-Vietnam core technologies. Professor Ho Tu Bao, Director of the Centre, said that the digital environment is creating invaluable opportunities to develop and master technologies like AI. Minister Duy added that construction on the National Innovation Centre began at Hoa Lac Hi-Tech Park to support the startup ecological system in Vietnam, contributing to renewing the growth model based on advanced technologies.

In June, Vietnam introduced an AI application that issues warnings when facemasks are not being worn on public transport. The computer vision app alerts authorities of passengers who are not wearing or improperly wearing masks. As OpenGov Asia reported, the app is connected to surveillance cameras on public transport vehicles and can access image data and automatically analyze it. It sends appropriate notifications to the server of the transport company if it detects someone not wearing a mask or wearing one incorrectly.

Meanwhile, a group of scientists from the Medicine Faculty at the Vietnam National University Ho Chi Minh (HCM) City unveiled a technological solution that combined the internet of things (IoT) with AI to concurrently manage people in quarantine sites and crowded places. Further, medical and delivery robots have been put into use at quarantine sites to replace health workers in transporting food, medicine, and essential goods and collecting waste, thus minimizing direct contact. Many other organizations have also created a number of high-quality scientific and technological products such as testing kits and vaccines.

https://opengovasia.com

ASIA-PACIFIC

AUSTRALIA

Coral reef restoration

Ocean scientists from The University of Western Australia (UWA) have partnered with global company Mars to optimize the design of a coral reef restoration system which could help accelerate the recovery of damaged reefs while also helping to protect coastlines from storm damage. Originally developed by Mars in 2011, the Mars Assisted Reef Restoration System (MARRS) involves growing coral fragments on large hexagonal-shaped structures coated in coral sand, which develop into larger reef structures over time.

Professor Ryan Lowe, from UWA's Oceans Institute and Oceans Graduate School, said the impacts of global warming and resulting marine heatwaves, tropical cyclones, and poor water quality had all contributed to a substantial decline in coral reefs worldwide. The research team—which includes Master of Professional Engineering student Sonia Westera and PhD student Justin Geldard—evaluated the performance of the MARRS reef stars using a 54-m long wave flume at UWA's Coastal and Offshore Engineering Laboratory, which allows realistic wave conditions to be simulated in a controlled environment.

Mars Marine Program Manager Alicia McArdle said the wave flume was an important part of the partnership, as it enabled the team to further understand the interaction between reef stars, ocean waves, and the coral rubble underneath. "Since 2007, we've been working with leading experts, researchers and communities across Indonesia, Mexico and Australia's Great Barrier Reef to develop a process that is capable of rapidly rebuilding a damaged coral reef," Ms McArdle said. "Our restoration process has been successful in rebuilding coral reefs in Indonesia where coral cover has increased from 10 per cent to more than 60 per cent within just two years."

"Our restoration process has been successful in rebuilding coral reefs in Indonesia where coral cover has increased from 10 per cent to more than 60 per cent within just two years, driving significant increases in fish diversity and biomass." According to Professor Lowe, the future global demand for coral reef restoration is set to increase. "As the focus becomes more on large-scale implementations of coral restorations, there are many more practical and technological challenges that will require engineering solutions," he said.

https://indiaeducationdiary.in

CHINA

High-tech anti-flood efforts

China's inland Henan Province has been severely hit by torrential rains and floods since mid-July. Shortly after the flood occurred, Fengyun-series satellites developed by China Aerospace Science and Technology Corporation (CASC) have been put into use to acquire space-based observation data for real-time situation analysis and subsequent disaster assessment.

FY-4B satellite, inter alia, was activated with the fast-imaging mode in high frequency to incessantly monitor the rainfall patterns and tendencies. In addition, Gaofen-series satellites including GF-3 and GF-6 have also delivered necessary services to the Ministry of Emergency Management and on-site rescue teams in checking the local conditions and adjusting the relief work.

Apart from supply carriage and epidemic disinfestation, unmanned aerial vehicles (UAVs) could also perform in illumination and communication. Damaged by the floods, domestic water and electricity were cut off in many residential zones and the water supply plant of Zhengzhou City was in a burning need to be repaired. The Dolphin-1 surface rescue robot, a smart lifeboat that can bear two or three adults and reach three meters per second with no load, was transported to the deluge-afflicted areas and operated over water by a remote controller, allowing the rescuers to swiftly and accurately stretch out to the victims.

Another type of intelligent equipment – an emergency floating bridge – was installed overnight with miscellaneous shapes to transfer 1,400 people trapped in Xinxiang City. It is one of the most pioneering water-rescue apparatus designed by China State Shipbuilding Corporation Limited (CSSC), and can be utilised to tackle the ever-changing conditions and ensure the resettlement of the affected people, thus it's also known as "the lifesaving bridge."

https://opengovasia.com

Anti-mosquito technique using nuclear technology

Chinese researchers had studied and developed a modern biological technology that can potentially eradicate deadly mosquito-borne diseases using nuclear technology. Their eradication project intends to wiping out specific mosquitoes in different regions and prevent its transmission. The study founded by researchers from the Nuclear Technology Research and Development Center of the China Atomic Energy Authority (CAEA) was commended by International Atomic Energy Agency for its innovation. CAEA was founded in partnership with the Sun Yat-sen University in 2020.

Basically, male mosquitoes are prevented to produce an offspring by removing their reproductive capacity using radiation from nuclear technologies. This way, the event of them repopulating would not be possible even when they mate with wild female mosquitoes. The sterile mosquito technique was proven to have "strong and long-lasting effectiveness, without chemical pollution harm to other animals or drug-resistance in mosquitoes," according to the director of the center, Wu Zhongdao. Wu believes the technique can reduce mosquito-borne disease and its transmission to people, which is considered a global problem. World Health Organization (WHO) estimates 700,000 deaths every year linked to mosquitoes.

The sterile mosquito technique is also built to reduce morbidity, according to Zhang Dongjing, a research fellow of the center. Zhang also went to Johannesburg in 2020 to facilitate and assist the technique to the China's national infectious diseases center. The Sun Yat-sen University in Guangzhou, China also studied sterile mosquitoes in hopes to fight Zika, a virus transmitted primarily by *Aedes* mosquitoes. Their lab

was considered the world's largest mosquito factory which prevents fertilization of eggs. The mosquitoes infected with a strain of *Wolbachia pipientis*, a bacterium that inhibits Zika and other viruses, were then released by the center on Shazai Island to mate with wild females and stop the next generation.

Using the nuclear technology, the university also plans to set up three to four anti-mosquito demonstration sites in the Guangdong-Hong Kong-Macao Greater Bay Area and set up overseas training bases to completely suppress mosquito population.

https://www.natureworldnews.com

INDIA

Agronomy services to empower farmers

Amazon Retail has launched its agronomy services to empower farmers through an initiative that gives them timely advice and enables them to make accurate decisions on actions required for their crops. This includes introducing machine learning technology for better produce and build a robust supply chain infrastructure.

As part of the agronomy service launch, Amazon Retail has built an ecosystem through a combination of Agronomist driven field interventions, and farm management tool to track the impact of interventions. Each enrolled farmer partner is onboarded on the farm management tool to provide timely intervention that farmers need and value. The team of qualified Agronomists offer Agritech expertise to registered farmer partners for better farm yield and improved product quality. Along with it, the Agronomists provide a comprehensive scientific and precise advisory to the farmers.

The program includes proactive and reactive crop plans: Proactive crop plan is based on scientific crop and soil management practices and is aimed to get better yield and quality; Reactive crop plan is an intervention-based initiative where farmers can raise alerts on pests and diseases and get remedial solutions for their farm problems. Currently, 80% of farmers onboarded with us have access to a personalized Crop Plan on their mobile app with an ability to raise reactive crop-related queries and get resolution as and when needed.

The second offering of the Amazon Retail agronomy services is an application interface through machine learning and computer-vision-based algorithms. It simplifies supply chain processes, helps farmers to identify defects (rotting, spots, cuts, mold) in fruits and vegetables, reduces wastage of produce, which in turn will help in ensuring that customers get the best quality of fruits and vegetables.

Amazon Retail is investing to leverage state-of-art technology to build a robust temperature-controlled supply chain infrastructure that reduces shrinkage and provides the freshest quality to customers. Amazon Retail associates use technology to inspect and monitor quality at multiple stages once the produce is sourced from farmers and dispatched to the processing centers. The fresh produce (fruits and vegetables) are then sorted, graded, and packed in different sizes at the processing centers and dispatched to Amazon Fresh fulfillment centers located closer to customers. The fulfillment centers operate with 4 separate temperature zones (ambient, tropical, chilled, and frozen) to maintain the quality and freshness of produce.

https://www.business-standard.com

Polyhouse technology to help cultivate off-season crops

A polyhouse is a specially constructed structure like a building where specialized polythene sheet is used as a covering material under which the crops can be grown in partially or fully controlled climatic conditions. It is covered with a transparent material as to permit the entry of natural light. Polyhouses are also helpful in reducing threats such as extreme heat and pest attacks in crops.

Professor (Dr.) Harish Hirani, Director, CSIR-CMERI, Durgapur recently inaugurated a "naturally ventilated polyhouse facility" and laid the foundation stone of "retractable roof polyhouse" at CSIR-Central Mechanical Engineering Research Institute (CMERI)'s regional center based in Ludhiana. Briefing about the technology, Prof. Hirani said that with rapidly rising temperatures due to mounting greenhouse gases in the atmosphere from human activities, crops are increasingly facing both threats—extreme heat and pest attacks—simultaneously.

This is especially important for crops growing in the open field with no protection from the weather, and therefore its yield, quality, and crop maturity timings are changed. A combination of open field conditions and conventional greenhouse conditions is a more robust way to deal with climate change and associates problems in the future. Crop losses in India due to insect pests is about 15% at present and this loss may increase as climate change lowers the plant defense system against insects and pests.

"Retractable Roof Polyhouse Technology will have an automatic retractable roof which will be operated based on weather conditions and crop requirements from the conditional database using PLC software. This ongoing development will be useful in our country with its 15 different agro-climatic zones and will help farmers to cultivate off-season crops that can fetch higher value and income," says Dr. Hirani.

Jagdish Manikrao, Senior Scientist, who is leading the research team on the development of this technology, explained that the retractable roof will be used to manipulate sunlight quantity, quality and duration, water stress, humidity, carbon dioxide levels, and crop and soil temperatures. Dr. Pradeep Rajan, Sr. Principal Scientist, Head, Farm Machinery and Precision Agriculture, further elaborated that this structure is being developed in collaboration with CSIR-IHBT, Palampur and is in the process of integrating artificial intelligence (AI) in automating the Polyhouse based on the crop and weather requirements and providing an IoT-enabled farmer friendly user interface.

The director also briefed that as the scientific experimental data on the advantages

of the new polyhouse system are lacking, therefore, horticultural crops will be cultivated in both naturally ventilated polyhouse and retractable roof polyhouse for comparing the crop production and produce quality. "With installation of naturally ventilated polyhouse and retractable roof polyhouse side by side, we can get the required scientific data and by analyzing the results we can enhance productivity," said Dr. Hirani.

https://www.eetindia.co.in

Ocean-energy-powered desalination plant

Chennai-based National Institute of Ocean Technology (NIOT) will soon start working to build the world's first self-powered desalination plant using Ocean Thermal Energy Conversion (OTEC) at Kavaratti Island in Lakshadweep. OTEC is an eco-friendly method to generate power using the difference in temperatures of the surface and the deep sea. As we go deeper and deeper in the sea, the temperature gets lower. In tropical countries like India, the temperature gradient is more or less constant throughout the year, thus ensuring constant power generation potential. The process involves vaporizing a low-boiling-point fluid like ammonia or water under vacuum using the surface warm sea water and condensing the vapor thus generated using deep-sea cold water. The vapor generated would drive a turbine connected to a generator, thus generating power. This cycle can be continued without breaks, and is fully renewable.

NIOT head (energy and fresh water group) Purnima Jalihal said that the Kavaratti plant, which has a capacity to produce one lakh liters of fresh portable water, will be the world's first prototype of a OTEC-powered desalination plant and would pave the way for future large-scale plants.

"The main advantage of OTEC is that it's completely environment friendly. NIOT had installed Low Temperature Thermal Desalination (LTTD) plants in Kavaratti in 2005 and subsequently at Agatti and Minicoy Islands. The pumps used in these plants are run using the diesel generator grid on the islands. Transportation of diesel is difficult especially during monsoon. It is also better if we adopt clean and green energy sources for the islands' delicate ecosystem," she said. NIOT officials also noted that there are many challenges in this project since it is being carried out for the first time ever.

https://www.newindianexpress.com

INDONESIA

Pokemon-style app to save Indonesia's forests

An Indonesian crowdsourcing app is tapping into the competitive spirit of its users by creating Pokemon Go-type games to help map land across the sprawling archipelago and protect forests and indigenous people, organizers said. The Urundata application uses publicly available satellite images to create games where users visit an area and then answer simple questions on the type of land they see and what it is being used for—plantations, natural forests, or shrub, for instance. Initially started as a pilot project in April last year in South Sumatra and East Kalimantan provinces—with the help of more than 600 students - the mobile application went nationwide in November and is due to end in March.

"You can choose what kind location you're interested in - it's pretty much a game because you collect scores as you are providing answers," said Ping Yowargana, a coordinator at land project RESTORE+, which launched the app. "People can compete with each other - they can change their statuses from 'volunteer' to 'warrior' of data - and then share on social media," said Vienna-based Yowargana, whose organization is backed by the German government and aims to restore degraded land in Indonesia and Brazil.

The Urundata app is supported by the World Resources Institute (WRI), a U.S.-based environmental think-tank, as well as Nairobi-based research group the World Agroforestry Centre and the World Wildlife Fund for Nature (WWF). In some ways it is "pretty similar to Pokemon Go," said Yowargana. "We try to make it fun."

Pinning down on-the-ground details about land seen in satellite images is usually done by researchers or experts and can be labor-intensive and costly, a spokeswoman at WRI Indonesia said. "The hope is that by crowdsourcing this, instead of having one expert looking... we can do it in a different way that allows many people to look at a similar amount of data," Yowargana said.

To avoid misuse of the app that could skew results, answers from multiple users on the same area of land will be compared to form a consensus, Yowargana added. Data collected by the Urundata app will be made publicly available on its website. Backers hope the website will improve land restoration efforts by governments and researchers, enable authorities to better protect forests and indigenous lands, and help companies identify and develop land in a sustainable way. It will also make more data available for "people who are needing it", including indigenous groups, Yowargana said. After the Urundata app completes its current mapping project, it may then be used in other efforts, such as looking at the impact of infrastructure or other land use changes.

https://news.trust.org

UAE

Waste heat from solar cells for seawater desalination

Researchers from King Abdullah University of Science and Technology (KAUST) previously developed a photovoltaic-membrane distillation device (PV-MD) capable of producing clean water from seawater while simultaneously generating electricity.

Silicon photovoltaic cells typically convert a quarter of absorbed solar energy that reaches them; the rest heats the solar cell. Cooling with water does little to reduce the temperature, but the researchers realized this excess heat could be repurposed to drive water distillation and desalinate seawater. At the same time, the cell would be cooled. Their PV-MD uses a multi-stage membrane distillation (MSMD) device consisting of four layers: a top thermal

conduction layer, a hydrophilic porous layer for water evaporation, a hydrophobic porous layer for vapor permeation, and a water vapor condensation layer.

The MSMD device, fixed to the back of a photovoltaic cell, draws seawater into the layered channels. The water vaporized in the uppermost channel by the heat of the solar cell passes through a porous membrane to a lower layer, where it is redistilled using the latent heat released during vapor condensation. In their latest study, Wenbin Wang and Sara Aleid helped create a theoretical model to examine the relationship between specific membrane parameters, like thickness, porosity, and solar cell hotness.

The device now features a five-stage photovoltaic-membrane distillation evaporative crystallizer (PME). The result is a reduced solar cell temperature, accompanied by a high and stable freshwater production. In addition, electricity production increased by 8%, and evaporation of concentrated brine – an unwanted byproduct – by the evaporative crystallizer.

This elimination of the concentrated brine byproduct was just one of the issues the team had to overcome before their laboratory results could be applied to real-world applications. Others include minimizing the energy required for desalination. The researchers developed a gravity-driven system inspired by infusion technology. The seawater is fed into the solar-cell device without external pumps while a special fabric wicks away solid salts and minerals, preventing the release of toxic liquid brine.

The scarcity of clean water and the energy shortage crisis are just two of the critical challenges for global sustainable development. This research is focused on providing low barrier-of-entry electricity and fresh water supplies to off-grid communities for points of consumption. Their PV-MD is well suited and will be commercially competitive to supply water and electricity for regions suffering from economic and physical water scarcity, believes Wang.

These investigations have important implications for further understanding and advancing solar distillation. Technology such as this could enable drinkable water production in locations where it is not currently available and provide clean, renewable energy to local communities in areas like the Middle East, which accounts for 45% of the global seawater desalination.

https://www.azocleantech.com

EUROPE

SWITZERLAND

Global restoration now has an online meeting point

With all of the environmental problems in the world, it can be easy to forget that there are also many solutions. Across the globe, people are working to restore nature, and good ideas abound. Organizing and visualizing this work, however, is a mammoth task, but it is one that the online platform Restor is attempting to achieve. Restor is a map-based, open-source platform that combines on-the-ground knowledge, ecosystem research, and satellite imagery, so people can better plan, manage, and monitor restoration projects.

The locations of more than 50,000 restoration and conservation initiatives are now registered in Restor, as well as data from more than 60,000 scientists on environmental parameters such as climate, temperature, precipitation, local plant and tree species, soil characteristics and more.

"Restor will make the whole world of environmental conservation and restoration accessible on any smartphone," Thomas Crowther, a professor at the Swiss Federal Institute of Technology in Zürich (ETH Zürich) whose lab group developed Restor, said in a press release. "We did this by developing a kind of Google Earth to guide the restoration of all types of Earth's ecosystems."

The idea for the platform originated in the Crowther Lab at ETH Zürich in 2017, where researchers create maps of global ecosystems using machine-learning models, field data, satellite imagery, and environmental information. In 2020, in collaboration with Google, the Crowther Lab began working with scientists, communities, and environmental groups to expand Restor into a functioning online ecosystem. Headquartered in Switzerland, Restor is now its own organization and is owned by a charitable foundation.

"Restor combines networking, monitoring, and information exchange in one dynamic and comprehensive visual platform, filling a huge gap in the practice and policy of restoring ecosystems around the world," Robin Chazdon, a global restoration expert from the University of the Sunshine Coast in Australia, who was not involved in the creation of Restor, told Mongabay in an email.

Using the platform, Restor users can view regions of the Earth at a resolution of up to 50 centimeters (20 inches) and learn about their potential for restoration or conservation. The Crowther lab has even developed a model that allows researchers to determine what tree species are native to a particular location to serve as a useful guide for reforestation efforts.

Currently, Restor is collecting data from restoration projects around the world. Anyone with a project can apply for access to the site where they will be able to enter data about their project and ecosystem. The project managers have the option of whether their projects are saved publicly or privately. All of the public data will be made available to the public on the platform.

https://news.mongabay.com

UK

Fighting drug-resistant malaria with genetic surveillance

A large collaborative project of in-depth genomic surveillance of malaria has identified and tracked drug-resistant malaria parasites in the Greater Mekong Subregion*, helping inform public health decisions in Southeast Asia. The project, known as GenRe-Mekong, involves researchers from the Wellcome Sanger Institute, the University of Oxford, MalariaGEN, and several partners in the Greater Mekong Subregion, including multiple National Malaria Control Programmes. It

has gathered data from some of the most remote areas of the Greater Mekong Subregion to give a clearer genetic picture of drug resistance in malaria.

In the latest paper, published on 10 August 2021 in *eLife,* the GenRe-Mekong group describes how they developed and implemented the platform for genetic surveillance of malaria in Southeast Asia, where drug resistance in malaria parasites is an urgent issue. They also describe how the data are used by local public health agencies to plan interventions in malaria endemic areas.

Malaria continues to be a major cause of mortality in many tropical countries, particularly in sub-Saharan Africa, and efforts are ongoing to eliminate the parasite, *Plasmodium falciparum*, which causes the most severe form of disease. Even though the Greater Mekong Subregion is an area of relatively low *P. falciparum* malaria prevalence and mortality, drug-resistant strains of the parasite have repeatedly arisen from this region and migrated into Asian and African countries, undoing years of progress against the disease, and costing many lives**. Hence, malaria elimination has become an urgent priority in the Greater Mekong Subregion.

In collaboration with the Wellcome Sanger Institute, the University of Oxford, and MalariaGEN, the GenRe-Mekong project developed the SpotMalaria genetic surveillance platform that analyses the collected blood samples and provides a broad range of detailed genetic information about each sample. The project has processed 9,623 blood samples from symptomatic patients across eight countries, the majority of which originated from Vietnam, Laos, Cambodia, Thailand, and Myanmar.

GenRe-Mekong also processed samples from Bangladesh, India, and the Democratic Republic of Congo. SpotMalaria processing only requires small dried blood spot samples, which are easy to collect at public health facilities as part of routine treatment, making it possible to obtain data from the most remote and resource-poor parts of these countries. The DNA analysis, which was primarily conducted at the Wellcome Sanger Institute, uses high-throughput technologies to extract large amounts of parasite genetic information from each sample. The results are used to create Genetic Report Cards, which are regularly delivered to National Malaria Control Programmes to keep them updated about changes in the parasite population in their country. National Malaria Control Programmes are involved throughout the entire process, from sampling strategy planning, and sample collection, through to joint analyses of results.

GenRe-Mekong uses the key genetic mutation data extracted to identify areas of parasite resistance to specific drugs, and then collates the results, creating a map showing the prevalence of resistant parasites. These results have helped inform public health agencies, notably influencing decisions in Laos and Vietnam, such as the choice of frontline therapy, or highlighting which areas require special interventions.

https://www.cambridgenetwork.co.uk

NORTH AMERICA

USA

Predicting weather hazards using data and AI

CoreLogic, a leading global property data and analytics-driven solutions provider, announced a nationwide, three-year collaboration with One Concern, a Menlo Park-based, resilience-as-a-service solutions provider. By using CoreLogic's flood, storm surge, wind and climate change data, and flood and wind vulnerability models, One Concern can accelerate its AI-enabled resilience solutions and disaster-risk reduction technologies to address and predict weather hazards and escalating climate threats amidst an increasing global focus to develop environmental, social, governance and resilience (ESG+R) goals.

CoreLogic collects and maintains property data on 99% of all U.S. residential properties. Leveraging this information, One Concern can pinpoint the hyperlocal vulnerabilities ahead of climate threats and continue to train its AI systems to assist organizations in shifting from recovery to resilience.

"Amidst worsening natural hazards, enterprises must build resilience strategies for an environment where black swan events are considered normal. As the world looks to face increasing climate risk, we believe ESG should have an 'R' for Resilience in order to address these evolving new hazards," said Ahmad Wani, CEO and co-founder, One Concern. "Through this partnership with CoreLogic, we will be able to make disasters less disastrous by uncovering climate-risk blind spots, enabling communities to address the ripple effects of adverse climate events. CoreLogic's data will give us a major advancement for data modeling to build the resilience-as-a-service category, while setting the stage for enterprises to operate at the nexus of resilience and sustainability. With unparalleled precision and granularity, we can now identify and plan for resilient enterprises to be sustainable, while also reducing their vulnerabilities from extreme weather caused by climate change."

"Many of CoreLogic's solutions play an integral role in climate change management, as well as in natural hazard risk and post-event recovery. We continue to provide these dynamic solutions to insurance companies, and this collaboration with One Concern presents a new market for CoreLogic as we help inform resilience strategies," said Mick Noland, Managing Director – Protect, CoreLogic. "We look forward to establishing more relationships with cutting-edge solution providers like One Concern as we carry out our mission of helping millions of people find, buy and protect the homes they love."

https://www.businesswire.com

AI to better predict blazes

Last summer, as Will Harling captained a fire engine trying to control a wildfire that had burst out of northern California's Klamath National Forest, overrun a firebreak and raced towards his hometown, he got a frustrating email. It was a statistical analysis from Oregon State University forestry researcher Chris Dunn, predicting that the spot where firefighters had built the firebreak, on top of a ridge a few miles out of town, had only a 10% chance of stopping the blaze.

"They had spent so many resources building that useless break," said Harling, who directs the Mid Klamath Watershed Council, and works as a wildland firefighter for the local Karuk Tribe. "The index showed it had no chance," he told the Thomson Reuters Foundation in a phone interview.

The Suppression Difficulty Index (SDI) is one of a number of analytical tools Dunn and other firefighting technology experts are building to bring the latest in machine learning, big data and forecasting to the world of firefighting. As climate change and gaps in forest management create more intense and deadly wildfire seasons, firefighting resources are increasingly stretched to the limit.

Researchers like Dunn hope their tools can help ease that pressure by making sure scarce fire resources are deployed as efficiently as possible. Dunn said so far firefighters at half of national forests are using one popular analytical tool he helped develop called Potential Operational Delineations (PODs). It combines local firefighter know-how with advanced spatial analytics to help teams plan where to take on a fire even before it breaks out.

The tool superimposes a number of statistical models—such as the SDI—over a map of a region, so fire managers and communities can plan out their control lines and plans of attack in advance. "You will never take the personal element out of fighting fires," said Brad Pietruszka, a fire manager at the 1.8-million-acre (728,000-hectare) San Juan National Forest who has been using advanced analytical tools like PODs since 2017. "But people make bad decisions under stress - they can't crunch all this data on their own. This is about reducing the uncertainty, and helping firefighters make better decisions"

Combining machine learning with years of research, fire analysts like Calkin and Dunn build models that add layers of data on top of the institutional knowledge of local firefighting crews, explained Rick Stratton, a fire analyst at the USFS. "Firefighters only see so much, their careers are short - but now we can model thousands of artificial seasons and pull all sorts of insights," said Stratton, who runs an online dashboard that lets fire managers see analytics of their terrain in real-time. "We wouldn't have been able to do that 15 years ago. We didn't have the computer power."

One of the most complex tools developed by researchers in recent years is the Potential Control Locations (PCL) algorithm, which uses machine learning to suggest where firefighters should place their control lines during a blaze. "It's very data hungry," Dunn explained. "It takes into account distances from roads, where there are ridges and flat ground, what kind of fuel is present on the ground, and it samples historical fire perimeters too." Armed with an alphabet soup of analytic tools—PCLs, SDI, PODs, and others—firefighters are getting crucial help deciding where to direct their efforts during increasingly out-of-control fire seasons, Pietruszka said.

https://news.trust.org

Nanobubble-infused fertilizer

Nanobubble tech company Moleaer and liquid fertilizer group RainAg have announced a partnership to market new nanobubble-infused fertilizers. The partnership will combine Moleaer's patented nanobubble technology with RainAg's patent-pending Rain Technology. RainAg's nanobubble-infused fertilizers have been trialed and utilized across a range of commodity crops including fruit and vegetable crops, corn, cotton, wheat, and sugarcane. According to the companies, the nanobubble enhanced RainAg fertilizers have significant benefits, including increased crop marketability by more than 110% in strawberries, a reduction in fertilizer utilization, and a reduction in off-target nutrient run-off and groundwater leaching.

In agriculture, Moleaer's nanobubbles have independently been proven to improve irrigation water quality, resulting in 50% reduction of crop loss by disease, increased crop resilience in high heat temperatures up to 110°F, and reduction of Pythium levels of up to 94%. The groups said that, when combining Moleaer's nanobubble technology with RainAg fertilisers, farmers would be able to reduce operational costs, reduce risks from crop loss, and reduce the environmental impacts to local water sources from increased phosphorus and nitrogen levels.

"Moleaer has demonstrated its patented nanobubble technology is superior for increasing root zone oxygenation and plant health compared with other methods," said Tim Ford, general manager of RainAg.

http://www.fruitnet.com

SOUTH AMERICA

BRAZIL

AI tool helps forecast Amazon deforestation

Named PrevisIA (from the Portuguese *previsão* for "forecast" and IA for "artificial intelligence"), the tool analyzes images provided by European Space Agency satellites, and through an algorithm created by the Brazilian conservation nonprofit Imazon, finds areas prone to deforestation. Imazon studies published in scientific journals show that 95% of accumulated deforestation in the Amazon is located within a 5.5-kilometer (3.4-mile) radius of roads; 90% of annual fires occur 4 km (2.5 mi) from illegal roads built in the middle of the forest for logging, mining, and land grabbing.

The first report using the new tool launched last week shows that 192 municipalities have a high or very high risk of deforestation in Brazil's portion of the Amazon. Additionally, 48 Indigenous reserves have the same level of risk, as well as 18 conservation units. Also at high and very high risk of deforestation are two quilombos, communities of the Afro-Brazilian descendants of runaway slaves, and 789 rural settlements. In total, this comprises 9,635 km^2 (3,720 mi^2) of threatened forest.

The next step of the project, developed jointly by Imazon, U.S. technology giant Microsoft, and Brazilian mining company Vale, is to build partnerships with local governments and institutions to act on preventing deforestation, which is the most challenging phase of the project, according to Imazon researcher Carlos Souza Jr.

https://news.mongabay.com

Digital and Space-Based Technologies for Climate Change Adaptation and Resilience

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Abstract

Digital technologies when integrated with spatial technologies have started play an important part in tackling the climate change adaptation and disaster resilience. This paper provides the status of digital technologies and applications, and their potential benefits based on past practices in Asia and the Pacific. It includes information about what combination of technologies were applied and how they contribute to the climate change and resilience by key issues. But there is necessity of transborder mechanisms to deliver digital and space-based technology providers and data users in disaster-affected areas, with the support of international activities. Public–private partnerships enable the collaborative integration of the technologies and to harness the full benefits of available applications for climate resilience. Policy makers need to explore innovative ways of building cooperative framework at regional level for upscaling digital technologies and secured data flows.

Introduction

In the past few years, industries from all corners of the globe have experienced a challenge that's unique in scale and scope. The pandemic also presented an immediate threat to business continuity, but it also served as a catalyst for rapid digital change that includes information and communication technologies and geospatial technology. Not only has this change helped businesses conquer near-term disaster risks such as the health pandemic, but it has also opened the doors to an intelligence revolution that will enable to tackle global issues such as climate change adaptation. Digital, space and geospatial technologies are no longer just fields of advanced technological development, but they have become key components to help achieve sustainable development and strengthen climate resilience. They can improve the efficiency and resilience of industrial operations.

But there is necessity of (i) transborder mechanisms to deliver geospatial and space-based information from data providers to end users in disaster-affected areas, with the support of international activities; and (ii) financial schemes involving the private sector or public–private partnerships (PPP) to enable the collaborative integration of the technologies in sustainable and practical ways. To implement such a mechanism, it is important to assess the benefits from digital and geospatial technologies and available applications, and conceptualize necessary policies.

This paper provides the status of digital technologies and applications, and their potential benefits based on past practices in Asia and the Pacific. It includes information about what combination of technologies were applied and how they contribute to the climate change adaptation and resilience by key issues, including industrial development, infrastructure planning and management, transportation management, improving quality of life, post-disaster management, improving logistics efficiency, sustainable operations of agriculture and fishery, improving efficiency manufacturing and service industry, and management of environmental services and natural resources. This paper also covers policy perspectives with strategy options about how to implement the regional connectivity supported by the technologies, especially focusing on the transborder mechanism of data and information.

Integrated digital technologies for climate resilience

Digital and geospatial technology is an intelligence technology that enables the global monitoring of a wide range of parameters such as the distribution of facilities and buildings; the movements of cars, ships, aircraft, and people; environmental change; or post-disaster economic development processes. While geospatial technology was originally developed for military and security use, it has been, in —recent years, quickly advanced as a general civil technology. It is now widely applied in the field of public services (e.g., disaster —response, social infrastructure management, traffic management), business support (e.g., marketing), and personal mobility services (e.g., navigation). The extensive use of low-cost and high-performance -mobile devices such as smartphones has further accelerated its popularization all over the world. Subsequently, the development of the Internet of Things (IoT) and Artificial Intelligence technologies have enabled researchers to conduct deeper analyses and quicker and broader information collection. In this regard, geospatial technology is expected to expand its utilization and development much further.

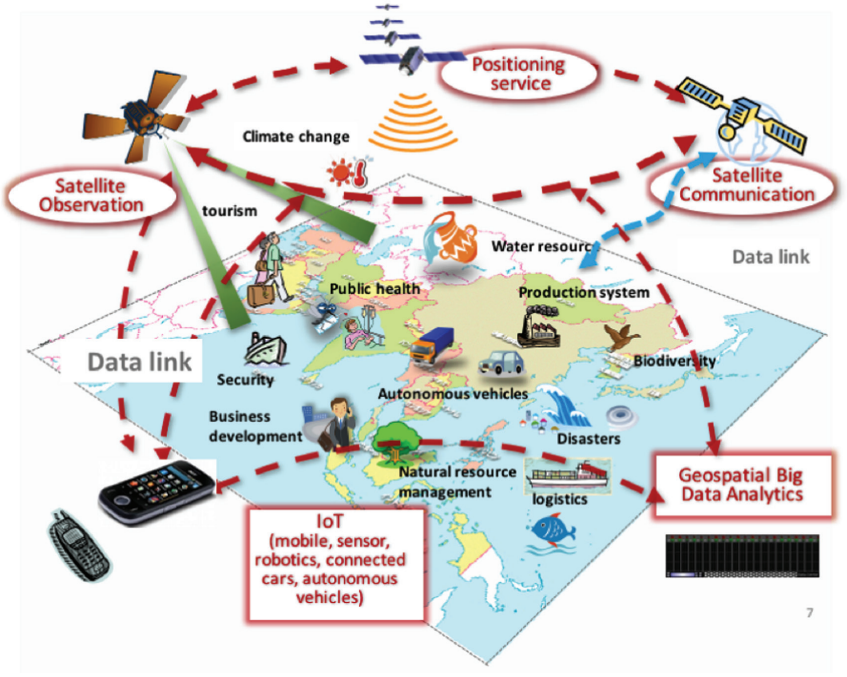
The rise of intelligence technologies resulted in the development of the following three technological areas (ERIA, 2018):

- Satellite-based earth observation technology—monitoring occurrences all over the world;
- Positioning technology—measuring and tracking precise positions in real time; and
- Communication technology—connecting almost instantly every single part of the world.

Digital and information technology provides services anywhere using dynamic information on physical, socioeconomic demographics, and environmental aspects. The technology is very naturally enhanced by space infrastructure, as illustrated in Figure 1, in a seamless manner. Therefore, the improvement in the performances of digital and space infrastructure directly leads to the climate resilience.

Integrated digital technologies could provide diverse information services using "real-world data." More concretely, the major services and contributions of the integrated digital technologies could be summarized in the following four aspects (Dobbs et al., 2013):

1. Real-time monitoring of climate information covering all land and sea such as: dynamic maps (traffic, congestion, people flow, and city changes) or environmental changes (weather, water and air quality, and greenery) from which events, accidents, and disasters can be extracted. Silent but meaningful changes such as climate change and crustal deformation can be included.
2. "Ubiquitous" data communication at any time/anywhere with small IoT devices to collect data from and send instructions/guidance to people and machines in the field.
3. Real-time localization and tracking of people, cargoes, and vehicles (air, sea, and land).
4. High-precision mapping of three-dimensional (3D) space and landscape framing activities of people and autonomous vehicles/machines, which could include very slowly moving phenomena like crust movement monitoring.



IoT = Internet of Things, SGT = Space and Geospatial Technology.

(Source: ERIA (2018))

Figure 1: Integrated digital, information and communication and space supporting climate resilience

Digital data, communication and space technologies for climate change adaptation and disaster risk management

The strong impacts of climate change disasters in the Asia-Pacific region do not simply refer to the intensity of these unfortunate events but also to the set of systemic weaknesses of Asian countries and the companies along the supply chains. One of the main reasons for the vulnerability of the Asia-Pacific region to disasters is its demography (ADB, 2013). According to the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), the Asia-Pacific is the most populated area in the world, with more than 4.5 billion inhabitants in 2016 (UNESCAP, 2016). The region has most of the world's largest metropolises. In 2016, the United Nations estimated that 18 of the world's 31 megacities (cities with more than 10 million inhabitants) were in Asia-Pacific and that this number is expected to reach 24 out of 41 in 2030 (UNESCAP Population Division, 2016). These high densities of population, often located around riverside flood areas, along coastlines at risk of tsunami, or at the base of landslide-prone mountains, put large numbers of human life in jeopardy due to climate change (ADB, 2016).

In its 2015 Asia-Pacific Disaster Report, the UNESCAP drew a sad portrait of the region. Between 2005 and 2014, 1,625 incidents had been reported. Most of these disasters were floods, followed, in order, by storms, earthquakes, tsunamis, and landslides. These climate disasters had a dramatic impact on the region's human security by killing almost half a million inhabitants and directly affecting the lives of approximately 1.4 billion people (see Table 1). Moreover, beyond long-term economic impact due to the loss of workforce as well as the increase in spending for health-related issues, the 1,625 disasters generated direct economic damages worth US$523 billion (UN (2016).

It is therefore primordial for the region to develop and implement ambitious climate change adaptation and disaster

risk management policies and strategies based on digital technologies. The following steps describe how an integrated digital and spatial technology will contribute to climate resilience via real-time tracking, monitoring, mapping, and ubiquitous data communication capabilities:

- Monitoring and forecasting hazards at the local to regional scale, typically heavy rainfall, flooding, typhoon, drought, and tsunami, allowing governments and people to know what could happen.
- Anticipating risks or damages on human lives and economic activities by overlaying the hazard prediction on the data of people distribution/activity information, vehicle movement, and economic activity distribution/intensity.
- Mitigating damages by guiding the evacuation of people based on people distribution data and helping in the reconstruction of people's lives and economic activities.
- Improving preparedness by providing realistic simulations and trainings on DRM based on the historical records of disasters and reconstruction processes.

The capabilities described above are made possible by sharing data among governmental agencies, private industries, nonprofit organizations, and people. In this regard, digital technologies and more generally data sharing can play a prominent role. It should therefore be smartly and strongly designed, not only for climate change adaptation and disaster management but for multipurpose uses, aiming at the strengthening of the regional socioeconomic environment.

As explained earlier, the potential of digital technologies incites users to go further than immediate issues like disaster by using it as an ambitious tool at all levels of the economy. It largely contributes to decision-making processes among governments, companies, communities, cities, and individuals in various contexts by providing necessary information. As digital technologies enhances the economy and facilitates "smartification" or "optimization" across various kinds of "borders," such as the border between the inside and outside of a factory, and borders among companies and regions/countries, it is extremely effective to connect all actors more tightly.

Digital technologies for enhanced climate change adaptation and resilience

Potential contributions of digital technologies for climate change mitigation

Information, such as stagnation and movement of people and vehicles, urban facilities developments, and construction of houses and infrastructures such as roads, can be continuously provided by digital. Therefore, governments and local communities can conduct proper policy making and monitoring, aiming for urban planning, urban growth management, and environmental improvement in an efficient way. For example, individual information on stagnation and movement condition of people and vehicles can be used for introducing new taxes such as congestion pricing and space use charge (OECD, 2016). Furthermore, extraction of buildings and land uses, and their changes from satellite imagery can be used for strengthening building taxation and land tax levies. To apply location information for taxation, it is necessary to implement a location authentication system to prevent spoofing.

Infrastructural conditions can be timely detected through image analysis and sensor information (Sadoff et al., 2016). Similarly, real-time supply and consumption of energy can be monitored as digital data. It will also contribute to the optimization of energy infrastructure operation and then investment, and finally lead to overall optimization. In the field of renewable energy, where fluctuations of energy production are quite dominant, more detailed and reliable data on natural environments causing fluctuations can be obtained by digital technologies, leading to the significant reduction in risks.

In the transportation system, digital technologies can track locations of vehicles, passengers, and cargoes. This will help in real-time performance monitoring of transportation systems (smoothness, efficiency, and safety). Digital technologies can easily detect problems and help continuously improve the system in combination with performance monitoring. Furthermore, automatic operation and sharing of vehicles can be performed by using real-time positioning service, which dramatically improves the efficiency and smoothness of the transportation system. It also provides the possibility to simultaneously improve uneconomical external factors such as traffic congestion, air pollution/noise, and greenhouse gas (GHG) emissions. Improvements in traffic congestion greatly contribute to the improvement of productivities (e.g., service industry) by shortening traveling time in cities. Moreover, freedom of location (houses and shops) in towns can be significantly improved, enabling city expansion and improving competitiveness. To secure the safety of automatic operation, the improvement of the security of positioning service is necessary.

Table 1: Human impact of disasters in Asia and the Pacific, 2005–2014

Disaster type	Lives lost	People affected (millions)
Earthquakes and tsunamis	199,418	74
Storms	166,762	321
Floods	43,800	771
Others	73,772	199
Total	483,752	1,366

(Source: The Asia-Pacific Disaster Report 2015, Disasters without Borders, United Nations Economic and Social Commission for Asia and the Pacific)

Better disaster response and recovery

The use of digital technologies helps quickly and exhaustively detect hazardous areas during disasters such as floods, landslides, earthquakes, and tsunamis. Therefore, evacuation can be promptly carried out in zones with high risks, leading to a substantial reduction of possible damages. Moreover, knowledge of the distribution and condition of evacuees facilitates the efficient provision of medical services and distribution of necessary items to the victims. Furthermore, a combination of information and space technologies allow the monitoring of post-disaster activities such as rebuilding or economic recovery in affected areas. The continuous and detailed assessments of disaster response and recovery activities help provide timely and appropriate support at suitable stages. Furthermore, problems can be continuously discovered and solved through the Plan-Do-Check-Act (PDCA) cycle.

More efficient and secure logistics

The use of digital technologies enables the tracking of movements of cargoes, vehicles, and ships in real time so that a reliable and continuous evaluation of transport and logistics performances can be made, leading to a significant reduction of the cost and duration of transportation. In case of climate disasters and failures, logistical delays can be forecast. Therefore, damages can be reduced by adapting the production amount and the distribution process. Moreover, damages on roads can be detected in advance, so delays and losses of logistics can be minimized by rearranging routes and transport methods. By combining trajectory analysis and location verification, deliveries of products to recipients can be confirmed, leading secure logistics without theft or illegal sales during the process. Acquiring detailed information such as routes also enables companies to better manage the quality of their products (e.g., refrigerated items and fragile objects). Furthermore, the automation of cargo handling machines during transfers from ships to trucks using secured high-precision positioning service has been developed. This contributes greatly to improving efficiency and reducing cost and time during operation, especially considering the very large geographic range of the region.

More stable, profitable, safer, and sustainable agriculture and fishery

In the agriculture industry, the use of digital technology helps in the understanding of the details of agricultural production systems, including growing processes and crop management practices. It contributes to improving agricultural operations, reducing risks of productions, and improving/stabilizing productivities and profits. More importantly, the accumulation of these data and integrating them into weather and market predictions can significantly contribute to risk reductions and production optimizations at a higher level. In addition, purchasing insurance can further reduce possible risks. Governments and agricultural market personnel can reduce agricultural impacts by controlling market fluctuations through arranging the stockpile and adjusting imports and exports based on production forecasts. Furthermore, from the viewpoint of management of land and water uses, digital technologies when combined with space technologies can contribute to the examination of proper resource uses in agriculture (cultivation, products, water use, etc.) and forestry. Thus, necessary improvements can be carried out accordingly.

In the fishery industry, the use of digital technologies enables the checking of detailed conditions of sea and fishing boat operations, the estimation of the catch amount, and the understanding of the status of fish resources and fish farm operations. This improves fishery operations and reduces risks of production and maritime accidents, leading to an improvement and stabilization of productivity and profits. Furthermore, entrance fees and charges/regulations based on resource use can be applied in the operation, leading to sustainable resource uses as well as ensuring funds for resource management. Accumulating these data and integrating them with the predictions of sea, weather, and market can largely contribute to risk reductions and production optimization. In addition, purchasing insurance can further reduce possible risks. Governments and marine products market personnel can reduce risks by controlling market fluctuations through arranging the stockpile and adjusting imports and exports based on the production forecasts. Furthermore, from the viewpoint of fishery resources and coastal environmental management, digital technologies can contribute to the examination of proper resource uses in terms of operation and coastal area utilization (water quality management, topography modification, and protection of mangroves), and its improvement, if necessary. To apply location information for developing charging systems and regulations, a location authentication system must be implemented to prevent spoofing.

More efficient manufacturing and service industries

The use of digital technologies can improve efficiency and safety in logistics, and reduce distribution cost and transportation time, leading to the reduction of production costs in the manufacture, service, and construction industries. Furthermore, allocations of production bases and branches will be flexible. As a result, unbundling of production, distribution, and consumption will be further promoted. Especially in the construction industry, uncertainties in procuring materials, equipment, and labor force will be decreased, leading to efficient process management and reduction of construction costs. As a result, arrangements in production and logistics bases will be further optimized on regional basis. Consequently, management styles, such as company size expansion, will be more flexible. Improved traffic system will also facilitate the flow of people, expand one's living area such as shopping and commuting areas, and easily attract tourists. This will lead to the expansion of the industries and the revitalization of the regional economy. The competitiveness among regional economies will be further improved.

Better quantification and management of climate services and natural resources

The development of digital technologies will enable the understanding of details in a quantitative way, including the amount and distribution of environmental services and natural resources. This helps governments and companies to more rationally conduct decision-making by considering a balance between development, use, and conservation. In addition, as the use of environmental services and natural resources can be understood, countermeasures can be immediately taken against inappropriate uses. Furthermore, introducing an appropriate payment system for environmental services further promotes its appropriate usage. This process strongly secures financial resources for environmental resources management. Thus, sustainable and adequate environmental services and use of natural resources can be achieved through system development.

Eficient use of integrated digital and space technologies

Enhanced disaster resilience

Digital technologies enable the monitoring of ongoing disasters, including how people evacuate, and the forecasting of possible situations and impacts on society. Based on information, people, communities, industries, and societies could mitigate possible damages, more easily recover from the damages, learn lessons from the past experiences recorded as digital data, and get better prepared against possible disasters. It can

- Reduce human damages by ensuring rapid information collection and delivery about disaster hazards and damages.
- Ensure goods delivery and debris removal by goods tracking and real-time recovery monitoring after disasters.
- Ensure higher accuracy of forecasts on ground/ocean weather information. Significant improvements are made using satellite earth observation. This provides industry and people with lots of social benefits.
- Secure the safety of people by improving the accuracy of monitoring and forecasting of floods, slope failure, earthquakes, and volcanic eruptions, as shown in Figure 2.
- Even after disasters, the care and consideration of vulnerable people such as babies, mothers, the aged, and injured must be provided. SGT will provide continuous monitoring capability on how the vulnerable people suffer and survive so that society can provide the necessary support in a more effective manner, as shown in Figures 2 and 3.

Enhanced multi-sector resilience

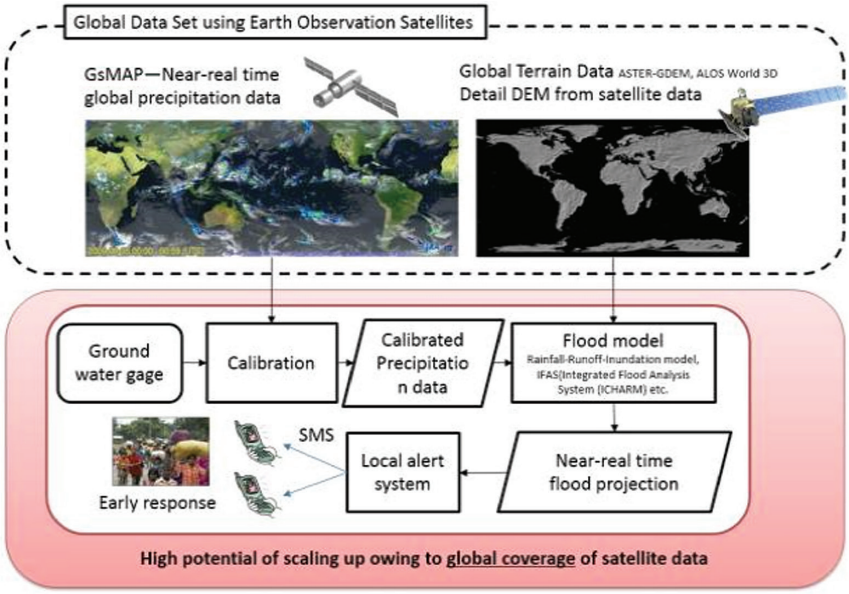
Agriculture

Agricultural production often suffers from unexpected changes in weather etc. Such environmental changes could be monitored and forecasted using digital technologies, and farmers could mitigate damages and adopt practices as illustrated in Figure 4.

- Less damages by preparing for expected typhoons and hazardous weather, as well as adjusting the timing of cropping, harvesting, shipping, and so forth.
- Optimized insurance cost by reducing agricultural risks and less compensation for agricultural damages from public sectors.

Fishery

Fishery is also very seriously affected by sea conditions. In monitoring and



ALOS = Advanced Land Observing Satellite, ASTER-GDEM = Advanced Spaceborne Thermal Emission and Reflection Radiometer-Global Digital Elevation Model, DEM = digital elevation model, GsMAP = global satellite mapping of precipitation, ICHARM = International Centre for Water Hazard and Risk Management, SGT = space and geospatial technology, SMS = short message service.

Figure 2: Flood alert system with integrated ICT and space technologies

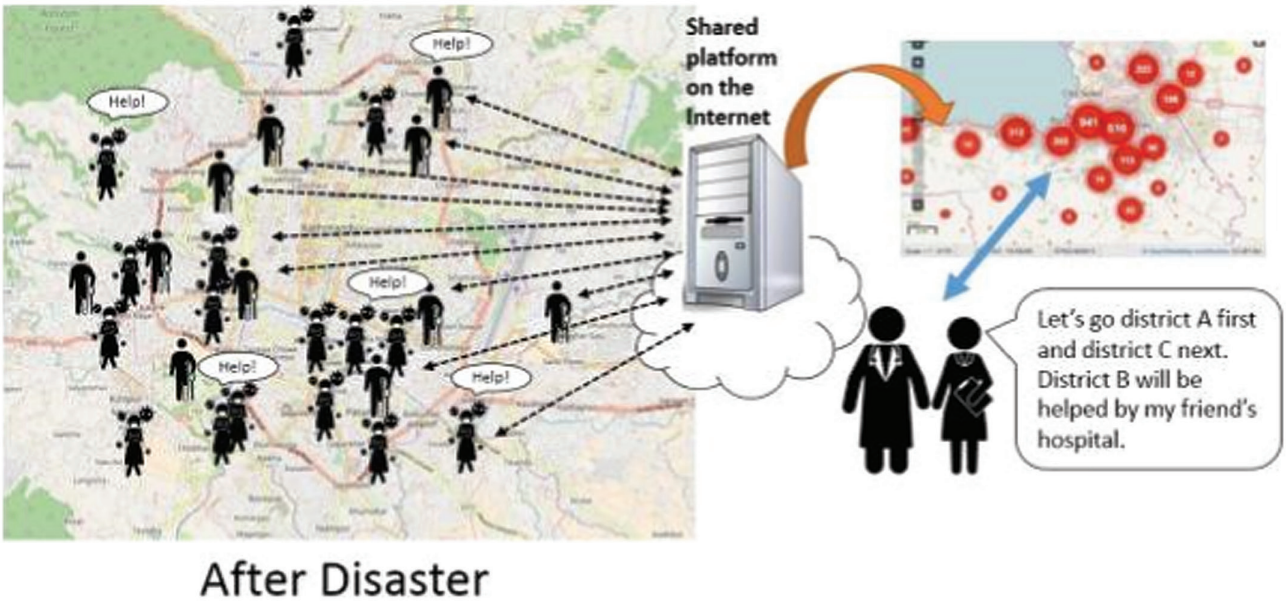
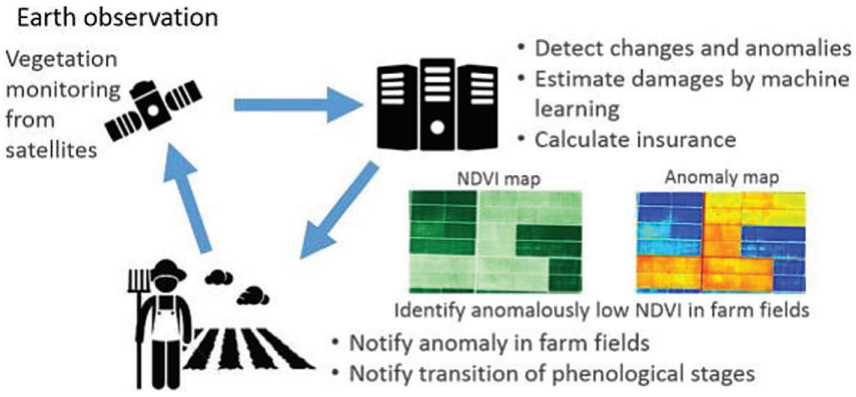


Figure 3: Supporting disaster nursing with digital technologies



NDVI = normalized difference vegetation index.

Figure 4: Application of digital technologies in agriculture sector

forecasting such conditions, risks could be mitigated. Analyzing fish catch and sea condition data enables the estimation of potential fishing ground, which leads to further risk reduction and improvement of fish catch.

- More efficient activities and operations of vessels and port facilities by forecasting harvestable areas and seasons. Better controlled market prices.
- Less impact of oceanic hazards to fishery productions by meteorological forecasting. Better security through the reduction of shipwreck.
- Better productivity and reduced risk of aquaculture production disasters through information about ocean condition and water quality (e.g., red tide).
- Management of fishery resources, securing safe operations, and detection of suspicious vessels by tracking locations and operations of vessels with verified position authentication.

Forestry

By measuring forest resources such as biomass and its distribution through the integrated digital and space technologies, the optimization of timber production could be achieved, including logging, transport, and processing.

- Ensure sustainable use of forest resources (planting, conservation, logging) by continuous monitoring of forest resources (biomass and tree types).
- Better efficiency and effectiveness in logging, lumber, and transport by quantified planning of forestry operations. Less labor hazards.
- Suppress damages of forest fire and illegal loggings.

Construction

Digital technologies will accelerate the automation of construction works through very precise real-time positioning, 3D mapping, and monitoring of environmental impacts of the works. In parallel, the process of construction will be fully digitized, which will accelerate the improvement of the construction management and technology.

- Risk reduction through effective designs and construction plans with accurately measured and shared data on terrain and geology.
- Effective management of labor and staff safety with better efficiency in transport and stock usage through continuous and accurate monitoring of things and people's position.
- Quality assurance and improvement through detection and prevention of

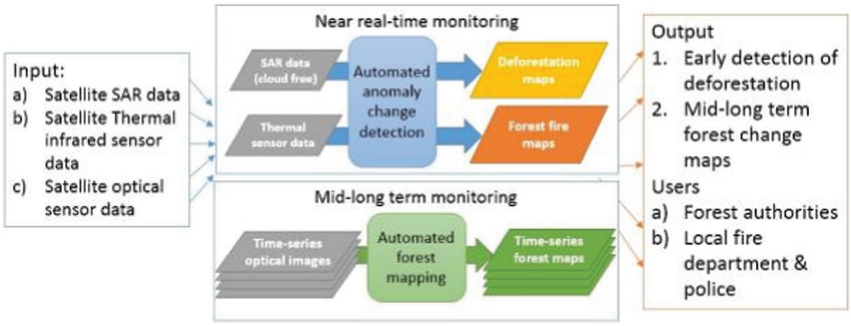
faults by accurate 3D measurement of construction progress.

Energy sector

Energy (electricity power) supply with renewable resources, typically wind, water, and solar radiation, could be estimated with digital technologies , leading to smoother matching of energy supply and demand; while energy demand could be estimated by combining multi data sources like people activity and movement monitoring, heat radiation measurement from buildings/houses, and city lights mainly from airborne and satellite observation.

Support environmental resources management

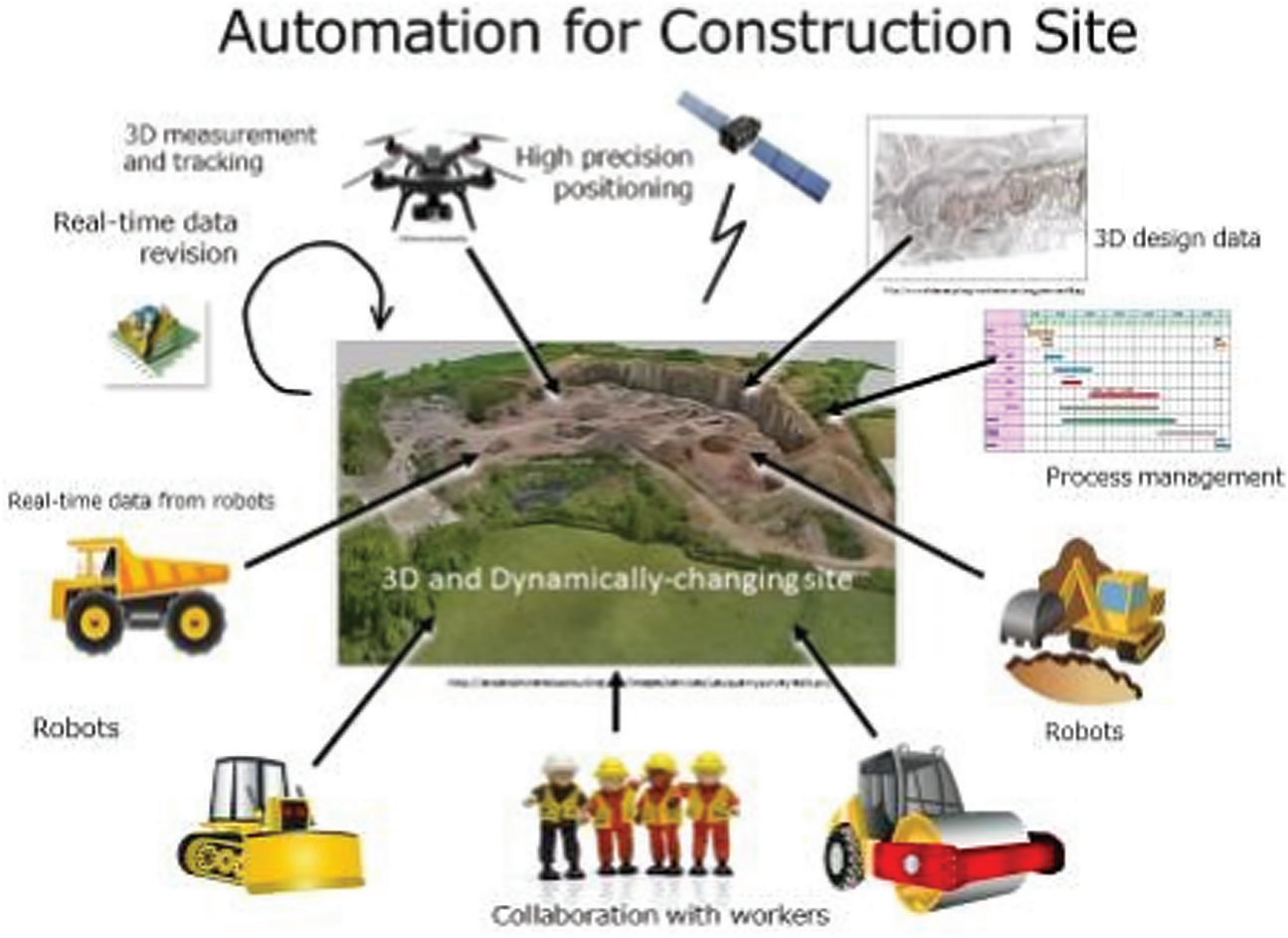
Natural or environmental resource management is an area where digital technologies could make significant contributions because the lack of information on the status of and changes in resources has created difficulties in decision-making and evaluation of actions taken. In addition, through the improvement of efficiency in social systems like transportation/logistics, achieved with the help of SGT, GHG emissions and impacts on the environment can be reduced.



SAR = synthetic aperture radar.

(Source: ERIA, 2018)

Figure 5: Forest monitoring with integrated digital technologies

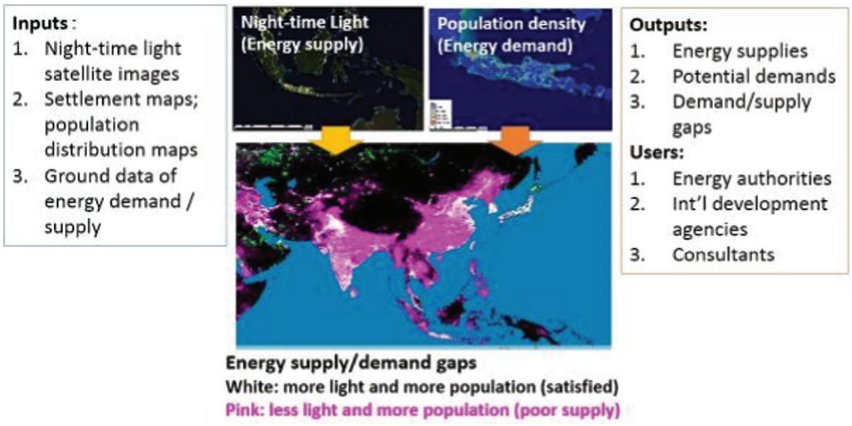


3D = three dimensional, SGT = space and geospatial technology.

(Source: ERIA, 2018)

Figure 6: Automation in construction industries with digital technologies

- Carbon dioxide (CO_2) emission reduction by optimizing transport operations (taxi, commercial vehicles, and shipping vehicles) based on vehicle mobility data. This supports fund raising by environment finance schemes such as bilateral carbon offsets.
- Effective conservation of ecosystem services by continuous monitoring of the ecological status of forests, oceans, and marines.
- Social bonds can be applied to improve and sustain the services based on the value evaluation of ecosystem services.
- Effective conservation and management of specific areas for species conservation and gene banks.



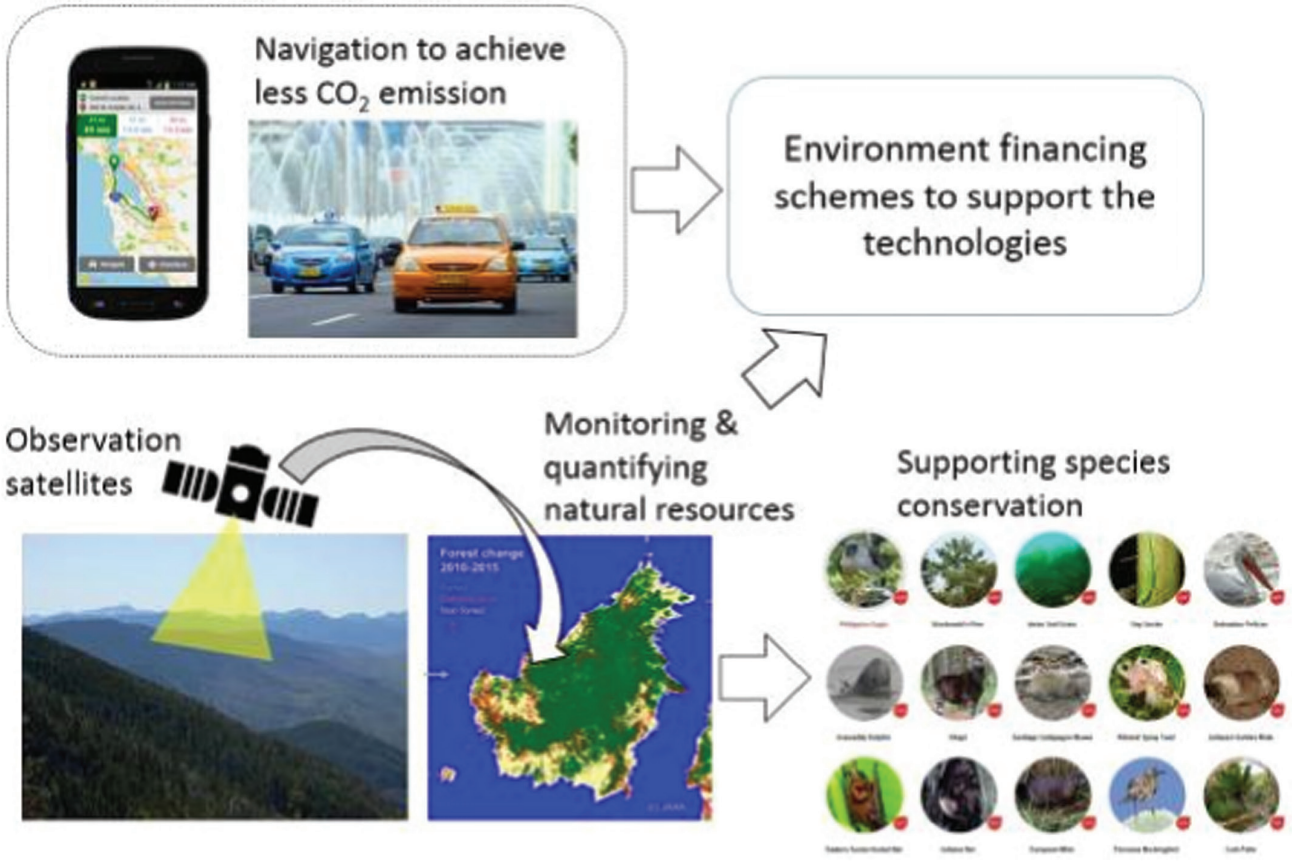
(Source: ERIA, 2018)

Figure 7: Estimating energy needs through night satellite observation

Infrastructure needs for integrating the technologies for improved resilience

To benefit from the full potential of integrated digital technologies, Asia-Pacific countries will need to adopt coordinated policies aimed at establishing both a strong infrastructure supporting the use of digital technologies and a legal framework to organize digital data utilization.

1. Physical infrastructure:
   - Space systems: observation, positioning, and communication; and



CO_2 = carbon dioxide, SGT = space and geospatial technology.

(Source: ERIA, 2018)

Figure 8: Digital and space technologies for environmental resources management

- Ground-based systems: base station networks, satellite communication points, and ground data networks.

2. Data policies and associated public/industrial policies:
   - Sustainable value creation from data by respecting the rights and concerns of data producers and associated stakeholders.
   - Separation of data holdings/ownership and advanced usage by value creators/producers; and
   - Sharing benefits among data producers and value creators.

Concerning the use of earth observation technologies, different policy approaches could be recommended , depending on the kind of application requested.

In the case of global earth observation, the cost of establishing a large constellation of expensive satellites would be unbearable for developing countries, even if they are united behind this goal. Therefore, it would be beneficial for countries to join global earth observation open data clubs such as the *Group on Earth Observations*. In the case of local observation, countries develop indigenous capabilities through the establishment of regional policies, balancing between competition and collaboration.

A strong focus has been made on the importance of the establishment of an Asia-Pacific constellation. Facing the same challenges on a relatively similar environment and having digital technology as a solution, transcending national boundaries for climate resilience. It would be highly inefficient for member countries to develop in parallel similar technologies without collaborating. Beyond regional utilization, the data produced by satellites could then be shared in a previously mentioned global earth observation open data club.

Conclusion

The rise of digital, information and communication and space technologies has had a deep impact on all layers of society. By combining a highly technological space infrastructure (earth observation, positioning, and communication) with new technologies for data utilization (Artificial Intelligence, IoT, etc.), the contribution of integrated technologies to the climate resilience economy is already visible but should be further promoted.

More specifically, digital technologies could participate in the realization of the Resilient supply chains—a vision of increased climate risk adaptation. It is therefore primordial for industries and policy makers to create a regional cooperation policy framework policy with a focus on four areas of action. First, separating data holdings/ownership and advanced data usage, and integration by value creators, as well as respecting the rights and concerns of data producers/stakeholders. In other words, ensuring a smoother flow of data and a clearer responsibility for data usage. Second, sharing the benefits of value creation from data among data producers and value creators. Third, monitoring and assessing the risks and benefits of data usage and data market competition/concentration in a coherent manner and the fourth, accelerating human resource development of value creation.

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Adaptation Fund

The Adaptation Fund was established under the Kyoto Protocol of the UN Framework Convention on Climate Change. The Fund finances projects and programmes that help vulnerable communities in developing countries adapt to climate change. Initiatives are based on country needs, views and priorities. The Fund gives developing countries full ownership of adaptation projects, from planning through implementation, while ensuring monitoring and transparency at every step.

For more information, access:

https://www.adaptation-fund.org/

Indigenous, Traditional and Local Knowledge for Bottom-up Adaptation Innovation

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Abstract

Adaptation technologies are location- and sector-specific. The process of their development, transfer, and adoption are complex and are not usually guided by established market mechanism. At the local level, uses of adaptation technology are usually guided by coping or autonomous response to climate impacts. Adoption of appropriate adaptation technologies requires fulfillment of a number of conditions not only at the point of application but also in the broader market and policy spectrum. Given impending risks of climate change beyond 1.5°C global warming, additional adaptation consideration will be necessary to design and apply a suit of adaptation technologies considering multi- and systemic risk scenario. This paper proposes a bottom-up approach for adaptation technology development, transfer and adoption stressing the importance of indigenous, traditional and local knowledge (ITLK) systems, local innovations, efforts, and initiatives. The paper explains how communities, government, scientific community, and private sector could be a part for creating local markets of appropriate adaptation technology and related services.

Introduction

Adaptation is the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities (IPCC, 2014). Adaptation technologies in the form of hardware, techniques, knowledge, or skill sets are critical in facilitating adjustment to expected climate changes and impacts in incremental manner or to achieve transformative adaptation before confronting adaptation limits. Transformative adaptation allows changes in the fundamental attributes of a socio-ecological system and creates a new setting capable of withstanding adverse climate impacts. Adaptation technology innovation and deployment therefore should not only target short-term "quick-fixes" but they should be also geared towards creating market-oriented solutions allowing rapid up-scaling and diffusion and subsequently integrated as a part of systemic change. The systems transition consistent with adapting to and limiting global warming to 1.5°C requires the widespread adoption of new and possibly disruptive technologies and practices and enhanced climate-driven innovation in the areas of innovation capabilities, industry, and finance (IPCC, 2018).

Technology transfer is one of the core elements of climate change discourse. The Paris Agreement recognizes strengthening cooperation on development and transfer of adaptation and mitigation technologies and facilitation of the process through Technology Mechanism (UNFCCC, 2015). The Technology Mechanism consists of policy body (i.e., Technology Executive Committee) and implementation body (i.e., Climate Technology Centre and Network, CTCN) (UNFCCC/TEC, 2021b). CTCN supports accelerated development and transfer of technologies through technical assistant, creating accessible climate information and technologies, and fostering collaboration. Further, under Poznan Strategic Program (UNFCCC COP14), the Global Environment Facility (GEF) provides funding to climate technology development and transfer activities through Technology Needs Assessments (TNAs), piloting priority technologies identified under TNAs and dissemination of lessons and good practices. Capitalizing such mechanisms and processes, including other initiatives within or outside UNFCCC, requires addressing key barriers of technology innovation and transfer at the local level where adaptation technologies are needed.

Methodological and operational aspects of adaptation technologies are relatively underdeveloped. Challenges exist in defining and operationalizing the concept of adaptation technologies, develop methodologies to assess and prioritize adaptation technologies and ensuring full use and integration of available information and knowledge (Trærup and Bakkegaard, 2015). So far, the development and deployment of new technologies are skewed towards supporting climate change mitigation, while development and transfer of adaptation technologies are lagged behind woefully in the absence of policy focus and finances. There are relatively few funding covering research and development (R&D) initiatives on adaptation technologies (UNFCCC/TEC, 2021a). For instance, there was stagnation of R&D efforts towards adaptation between 1995 and 2015 and only limited to select countries (e.g., China, Germany, Japan, United States, or the Republic of Korea), while during the same period R&D doubled in the case of climate change mitigation technologies (Dechezleprêtre et al., 2020). Unlike mitigation which relies on single metrics, i.e., greenhouse gas (GHG), adaptation

involves multi-dimensional metrices comprised of both qualitative and quantitative indicators, which are inherently difficult to measure, assess, and aggregate thereby limiting establishment of direct connection with the final outcomes (UNEP, 2017). Moreover, adaptation is ubiquitous, diverse, location-specific, dispersed across all socio-economic sectors and usually involving specific challenges, myriad stakeholders, and overlapping interest groups (UNFCCC, 2006b). The outcomes of adaptation could be overlapping with other kinds of interventions and requiring a longitudinal evaluation extending to years. These complexities limits transfer of technologies increasing the risk of adoption due to mismatch in adaptation needs and technology absorption capacity in countries or areas other than the point of innovation (Dechezleprêtre et al., 2020). Meanwhile market demands and incentives for developing and transferring are either underdeveloped or nonexistent, especially, at the local level where such technologies are needed. The available climate finances are not suited for small-scale and distributed direct investments to local levels (Soanes et al., 2017). There is a need for paradigm shift in the way adaptation technologies are mainstreamed into policies, financial support mechanisms, and actions, inclusive of both state and nonstate actors. Innovation policies need to combine public support for research and development with policy mixes that provide incentives for technology diffusion (IPCC, 2018).

Given this general background, this paper presents a bottom-up approach for accelerating adaptation innovations and their transfer. The essence of the approach is that major innovative disruptions should happen at the point of their application while the external technology transfer should be need-based to supplement key deficiencies at the local level. The paper advocates for a growing need to recognize indigenous, traditional and local knowledge (ITLK) system as a key foundation for progressing appropriate technological innovations. The paper starts by clarifying the scope of adaptation technologies followed by the importance of a bottom-up approach. It then presents a bottom-up approach of technology innovation targeting systemic transformation needed to adapt and build resilience against worsening climate change impacts.

Adaptation technologies and their typologies

Adaptation measures and strategies are diverse in scope (Figure 1). As a process, adaptation actions are characterized by many uncertainties and extended project cycles. Technology can play an important role in the effective adoption of particular measure or strategy in a given situation. As technology is more about implementation of solutions, it can bring tangible benefits. For instance, information and communication technologies (ICT) could be deployed in almost all adaptation measures listed in the Figure 1. Similarly, a particular technology, such as drip irrigation, could be used as no-regret adaptation strategy against seasonal water scarcity as well as to maximize water use efficiency purely out of economic consideration. Such no-regret adaptation strategies are cost-effective at present (including, without significant climate impacts) as well as under climate change scenarios. Technology could be distinguished into hardware, software (process and know-how involved in uses), and orgware (organizational or institutional processes involved in adoption and diffusion) (Haselip et al., 2019).

Identifying, assessing, and evaluating technologies for climate change adaptation is a complex, dynamic process that cuts across scales, sectors, and levels of intervention (Trærup and Bakkegaard, 2015). Broadly, technologies for adaptation can comprise "hard" technologies, such as seawalls and water storage dams, and "soft" technologies, such as crop

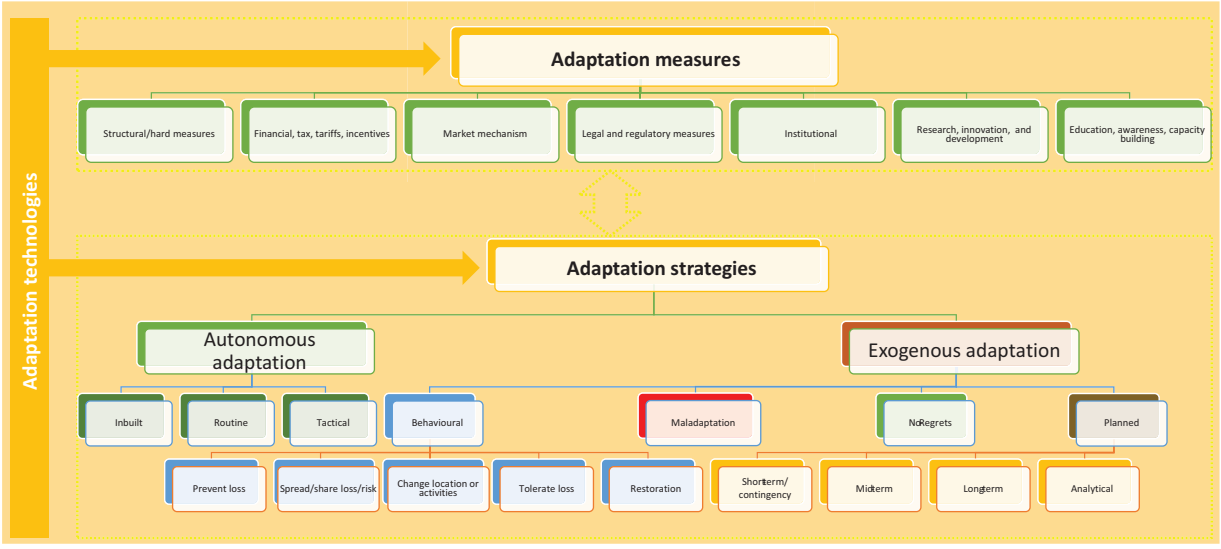

Figure 1: Contribution of technology to various adaptation measures and strategies (developed based on IPCC, 1994)

rotation, climate information falling under traditional, modern, high technology, and future technology (UNFCCC, 2006a). While an exhaustive list of adaptation technology is hard to comprehend, both CTCN and TNA process suggest broad classes of technology based on the experiences working in different countries and stakeholders. CTCN webpage lists seven broad technology classes (agriculture and forestry, coastal area, early warning and environmental assessment, human health, infrastructure and urban planning, marine and fisheries, and water) for adaptation. Meanwhile, TNA adaptation taxonomy reorganizes the technology into six broad classes (agriculture and livestock, water, forest and land, marine, fisheries, and coastal zones, health, climate change forecast and monitoring) (Woo et al., 2021). These broad classes could be further subclassified into specific technologies. For instance, agriculture and livestock class could include technologies related to new crop varieties, farming system, irrigation, conservation, soil management, etc.

Besides sectoral focus, there could be several alternatives or considerations for technology classification to reflect local circumstances. It could done based on regional specificity (such as technologies for coastal and low-lying islands, for mountains, for arid and semi-arid region, temperate regions), scale of application (local scale, subnational, national, regional, or international), risk and impacts (help understand climate risks, help to reduce risks or impacts, help to communicate risks), cross-cutting impacts (disaster risk reduction, ecosystem conservation, adaptation-mitigation synergistic), or targeting vulnerable group (gender, differently abled, old and children, indigenous people, those under poverty).

The main goal of classifying adaptation technologies is to assist identification of appropriate technological options as well as to avoid selecting those contributing maladaptation. For instance, existing guideline from TNA suggests three components to do that in a systematic manner: identify or prioritization of technologies, barrier analysis, and development of technology action plan (Haselip et al., 2019). While TNA under UN are usually done at the national level, there is a need for further consideration to trigger action and create an environment of adaptation innovations at the local level. While technology plays a pivotal role to enable adaptation actions, its ease of access, affordability, acceptability, and capacity to implement at the local level are even more critical. In particular, the technological options developed and introduced from outside face the risk of rejection or abandonment when one or more of operational conditions are not fulfilled or when the learning curve is steep. To overcome such situation, technological choices should be guided by adaptation needs and priorities considering the future risks at the local level. There is a strong need of 180 degrees reversal of technology innovation and development from existing largely top-down to the bottom-up in future. Local areas should be viewed as the locus of technological innovations to trigger locally led adaptation. Such a shift in direction could guide effective channeling of technology transfer along with needed supports (i.e., finance, capacity building) directly to the local level. Within the scope, adaptation technology should be viewed as an integral part of transformative adaptation process and hence properly aligned with the local adaptation planning and implementation framework.

ITLK as a foundation of bottom-up adaptation innovation

Communities employ various measures and strategies to cope with and adapt to climate change impacts based on ITLK systems. ITLK systems also refer to the understanding, skills and philosophies developed by societies with long histories of interaction with their natural surroundings (UNESCO, 2020). ITLK is often the only means available in the absence of planned adaptation interventions (Shivakoti et al., 2021). For many, ITLK informs decision-making about fundamental aspects of day-to-day life, including responses to climate change impacts. ITLK stems from generations of on-the-ground climate observations and interactions with the environment; it enables better understanding of the impacts at finer spatial scale and a greater temporal depth.

The learning curve is minimal and the risk of nonadoption is lower because ITLK forms an integral part of livelihood strategies. What is lacking, however, is their proper recognition as a valid technological choice for adaption since assessments are limited regarding the robustness to withstand future climate impacts. It is hampering further promotion and development of ITLK to adjust according to changing socio-economic and climate change condition. As future climate impacts can also increase the vulnerability of ITLK, proper reinforcement of ITLK through scientific validation and integration of modern technologies will be still relevant. It is important to modernize the ITLK through innovations while maintaining the core cultural and value system intact.

In recent times there is widespread recognition and appreciation including in the major assessment reports (such as IPCC, IPBES) and agreements (such as the Paris Agreement) to utilize and promote ITLK for climate adaptation (Shivakoti et al., 2021). TNA as well as climate finance (such as GCF) also emphasize proper acknowledgements of ITLK and safeguarding rights of indigenous people holding ITLK (GCF, 2018; Trærup and Minjauw, 2021). What is necessary is the proper identification, documentation, and incorporation of potential ITLK into local adaptation plans and actions. Adaptation should build on existing practices and approaches, including ITLK, so that introduced technological choices could act as reinforcement and at the same time easily adoptable. ITLK can be viewed as an obvious entry point for planning adaptation intervention as well as for developing appropriate technological solutions. The developed technology, due to their grounding to local reality and needs, fares a good chance of success triggering needful investments from local as well as other sources.

Realizing bottom-up innovations

Adaptation is a continuous process involving various elements of socio-ecological system that interact with worsening

climate change in a complex manner. The existing mechanism of technology innovation, transfer, and adoption in the upstream are found less effective to bring meaningful and enduring changes at the local level, the ultimate point of implementation, due to various financial and non-financial barriers. The blanket approach of technology transfer risk rejection or discontinuity, especially, after the termination of external supports. Usually the main limitation of external support, such as through projects or programs, is that necessary capacity and mechanism needed to produce, supply, use, maintain, and manage introduced technologies could not be established in a few years (Khan et al., 2018).

Given climate uncertainty, people and communities as end-users cannot expect scientists and external supports to solve the problem, instead they have to change the way of decision-making and preparing themselves accordingly (Hallegatte, 2009). A systemic approach of locally led adaptation is necessary involving public, civil society, and private institutions (Soanes et al., 2021). The approach demands a technology prioritization based on multi- and systemic risk assessment (Figure 2).

Instead of selecting standalone technological choices, a packaged solution such as climate smart agriculture (CSA), addresses multiple risks by combining mutually reinforcing technological options. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible (FAO, 2021). Packaging of the technological options can consider addressing three adaptation concerns. First, technological option needs to address gaps in climate information to understand as well as for decision support regarding the level of expected impacts (in future or real-time) and resultant vulnerability. Indigenous practices such as observation of wind speed and deep seas wave size, dense cloud formation, behavior of animals (crabs climbing walls) are used to forecast cyclones in Bangladesh (PROSHAR, 2014). Similar cases such as flood forecasting in the Gandaki River Basin relying on clouds in upstream, changes in noise and/or color of river water, ants leaving the river banks or climbing trees (Acharya and Poddar, 2016). Integration of such ITLK with modern forecasting or early warning could greatly assist reduce the level of uncertainty and hence minimize potential losses from the impacts. Second, technological option will act to reduce the exposure and impacts such as building dikes to prevent floods or enhance water storage for drought mitigation. Number of ITLKs are employed in the Asia-Pacific regions such as stilt houses, floating garden, water harvesting, flood mitigation, indigenous food/farming systems (Shaw, Uy, and Baumwoll, 2008; SAARC, 2008; Song et al., 2016; Trærup and Minjauw, 2021; FAO, Alliance of Bioversity International, and CIAT, 2021). There is a potential to infuse technological innovation with ITLK in such cases too. In Guangxi, China, scientist worked with communities under participatory plant breeding to develop drought and pest resistant hybrid maize by combining traits of traditional varieties and high-yielding hybrids (Song et al., 2016). Final, technological option helps reducing vulnerability and building resilience such as diversifying livelihood and income generation options. For instance, it could involve promotion of adaptation through ecotourism by integrating tradition, culture, and indigenous tools or crafts.

Local technological innovations demand creation of proper delivery mechanism that is inclusive of gender, youth, indigenous group and vulnerable groups, and key sectors. For instance, women usually play major role in selecting and saving seeds of indigenous varieties (Song et al., 2016). Their know-how will be crucial not only designing solutions but also transferring to future generation. Local innovations are critical for building technological solution that builds on existing practices such as ITLK. Local innovation does not have to be technically advanced (such as genetic engineering or climate downscaling) but appropriate and effective. However, technical experts, scientists, or researchers are important partners to co-develop solution to apply latest technological advances such as uses ICT, accessing information from satellites, or designing nature-based solutions related to ITLK.

The evolution of local solutions can trigger built-up of institutional capacity, local expertise, and entrepreneurship such as training or extension facilities, repair shops such as for sprinklers or solar irrigation, local manufacturing of spare parts, seed bank, etc. The role of private finance as well as public funds for local development could be mobilized to finance technological options based on their merits or performance such as likelihood on the return of investment. Promotion of innovative, flexible and devolved financing scheme can result in built-up of local capacity to mobilize funds for climate change adaptation and resilience building. It could serve as an effective channel for administrating supports from external sources (both national and international).

The final requirement for bottom-up adaptation technological innovation is the communication of adaptation progress, gaps, and needs for support. Locally appropriate benchmarks or indicators could be developed to keep track of issues, results, and outcomes which are important for demonstrating performances, transparency, recognition of local efforts and capacity, and trust building. Local institutions, local government, NGOs, or CBOs can play an important role in this regard.

A multilevel governance inclusive of state and nonstate actors, such as industry, civil society, and scientific institutions, cross-sectoral coordination at various governance levels needs to be established to ensure participation, transparency, capacity building, and learning among different players enhancing access to finance and technology and enhancing capacities. Government bodies at the national level, development partners, INGOs, UNFCCC bodies, climate finances can respond to remove barriers by establishing fast-track for technical, financial, and capacity supports to the local level.

Conclusion

Innovation and technology have a major role in driving adaptation interventions

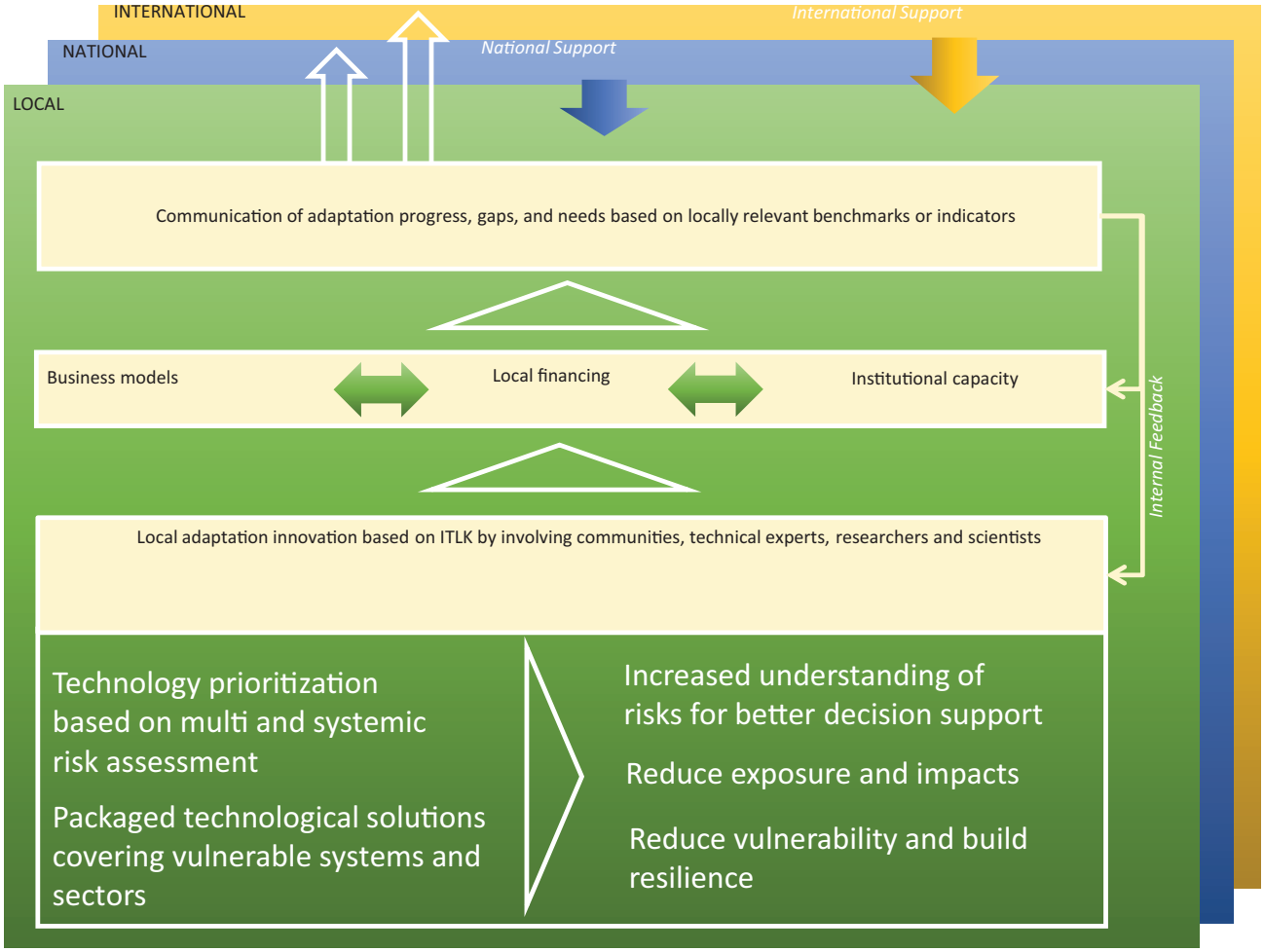

Figure 2: A generalized conceptual framework of bottom-up adaptation innovation

(Source: Author)

in the Asia-Pacific. Since adaptation decisions are often based on imperfect knowledge, the role of appropriate technology can be instrumental in reducing uncertainty as their outcomes are immediate and tangible. Despite a major recognition and call for development, transfer, and wider adoption of adaptation technologies, rate of technology diffusion is lagging behind due to institutional, financial, and market barriers. International climate finance is less flexible towards smaller scale interventions specific to particular local areas adaptation needs and circumstances. Meanwhile a blanket approach of technology transfer to a larger scale are prone to risk of nonadoption such as due to steep learning curve involved or mismatch in priorities. While the external finances and technology transfer are critical to support on-the-ground adaptation needs, a proper setup capable of attracting and absorbing such supports is urgently needed. The paper suggests substantial reorientation of focus on bottom-up approach of adaptation innovation such that developed adaptation technologies are appropriate, grounded to the local needs and that builds on ITLK. Further, bottom-up adaptation innovation can attract local investments for the creation markets solutions, build-up of local expertise, and institutional capacity. To enable bottom-up adaptation, involvement of relevant stakeholders such as technical experts and researchers, local government, financial institutions, NGOs, CBOs, local media are critical. It is hoped that promoting bottom-up approach eventually encourage creation of flexible national and international channels for the transfer of technology, finance, and capacity building supports as envisioned in the Paris Agreement.

Acknowledgement

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Mekong Drought and Crop Watch in the Context of a Changing Climate

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Abstract

Anticipating the impacts of climate change in agriculture and agriculture water management, it is now amply getting clearer that long-term climate risk will have direct impacts on agriculture and food security in Southeast Asia. Over the years, it has been seen that the frequency of natural disasters too has been on the rise. Several studies have stated that one of the most frequently occurring natural disasters is drought. Drought being a slow onset disaster is difficult to detect. However, 'prolonged dry periods' results in loss of crops leading to direct impacts on farmers' livelihoods and increase in food insecurity. Over the years, it has been seen that the frequency of drought is on an increasing trend in Southeast Asia with most countries in the Lower Mekong facing severe dry conditions.

This article, therefore, talks about enhancing drought resilience in the Lower Mekong through implementation of Mekong Drought and Crop Watch that provides drought nowcasts and forecasts at the regional, national, and provincial level using hydrological and crop simulation model information through the Regional Hydrologic Extremes Assessment System (RHEAS), a state-of-the-art water resources nowcast and forecast framework.

Introduction

Southeast Asia is frequented by dry periods in concurrence with the El Niño phenomenon. In the recent years, the increasing frequency of dry periods has resulted in severe dry conditions leading to extreme droughts with the Lower Mekong countries bearing the brunt of it. Drought affects many sectors of life, especially agriculture, which can lead to a food insecurity (Syaukat, 2011). 'Prolonged drought' will result in water scarcity and household access to clean drinking water and sanitation, as a result affecting large number of populations.

Over the past 30 years, droughts have affected over 66 million people in South-East Asia (UNESCAP, 2019). The most severe events have been during the El Niño years. Most of the economic impact of drought which is around four-fifths is absorbed by agriculture. However, the impact is found to extend beyond agriculture based on both demand and production, as it is linked with industry and services as well. Drought being a slow onset disaster, occurring as a result of prolonged deficient precipitation, its scale of the impact depends on the extent, intensity, and duration. The outcome also varies according to local conditions, land use patterns, and water usage (UNESCAP, 2019).

According to the findings of the Intergovernmental Panel on Climate Change (IPCC), across Southeast Asia, temperature has been increasing at a rate of 0.14°C to 0.20°C per decade since the 1960s, coupled with a rising number of hot days and warm nights, and a decline in cooler weather (IPCC, 2013: WGI AR5 Section 14.8.12). If droughts intensify in lowland Southeast Asia, the synergies between warmth, drought, logging, fragmentation, fire, and tree mortality would make the conditions to further worsen resulting in deforestation, smoke aerosols, and reduced rainfall, that could greatly increase the vulnerability of fragmented forest landscapes.

Droughts may also lead to wildfires and smoke exposure, with increased morbidity and mortality, as observed in Southeast Asia (Johnston et al., 2012). It can disrupt food security, increasing malnutrition (Kumar et al., 2005) and thus susceptibility to infectious diseases. For much of Southeast Asia, increase in drought stress as a result of declining rainfall trends or rising temperatures is a major concern. Frequent droughts could negatively affect agricultural production, increase water demand for irrigation, and exacerbate the already existing water crisis and human-induced desertification. Livelihoods are also likely to be impacted by droughts while also disproportionately impacting small farmers, agricultural laborers, and small businessmen who have least access to rural safety net mechanisms, including financial services.

The Lower Mekong River Basin (LMB) covers an area of approximately 606,000 km^2 across the countries of Thailand, Laos, Cambodia, and Vietnam (IPCC, 2014). More than 60 million people are heavily reliant on natural resources, particularly agriculture and fisheries, for their well-being and livelihood. However, in recent years it has been observed that there has been an increased frequency in the occurrence of drought in the region leading to prolonged dry periods. The effects of 2015/2016 El Niño further compounded the already fragile agricultural ecosystem of the region. The El Niño outlook for 2015/2016 considered the event to be one of the strongest El Niño events since 1997–1998. El Niño Advisory Notes prepared by United Nations Economic and Social Commission

for Asia and the Pacific (UNESCAP, 2015) and the Regional Integrated Multi-Hazard Early Warning System (RIMES) suggest that the effects were severe in certain locations such as Cambodia, Central and Southern India, Easter Indonesia, Central and Southern Philippines, Central and Northeast Thailand, Papua New Guinea, and other Pacific Island countries.

This article discusses about the implementation of the Mekong Drought and Crop Watch (MDCW) through SERVIR-Mekong program of Asian Disaster Preparedness Center (ADPC) that addresses the Lower Mekong countries need in appropriately monitoring and forecasting drought for effective decision-making while considering the context of climate variability and its impacts on agriculture and food security for the region.

Geographical scope

The Lower Mekong region comprises of five countries namely Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam (Figure 1).

Cambodia (FAO AQUASTAT 2011): It is situated in Southeast Asia on the coast of the Gulf of Thailand and has a total area of 181,040 km2. It is bordered by Thailand in the west, Lao People's Democratic Republic in the north, and Vietnam in the east. Together, with these countries and China and Myanmar, Cambodia shares the Mekong river basin. Water surfaces, including Lake Tonle Sap, occupy approximately 2.2% of the total area of the country. Cambodia has a tropical monsoon climate and is influenced by various factors, including its location within the Inter-Tropical Convergence Zone and the monsoon. There are two distinct seasons: (1) dry season from November to April and (2) wet season from May to October.

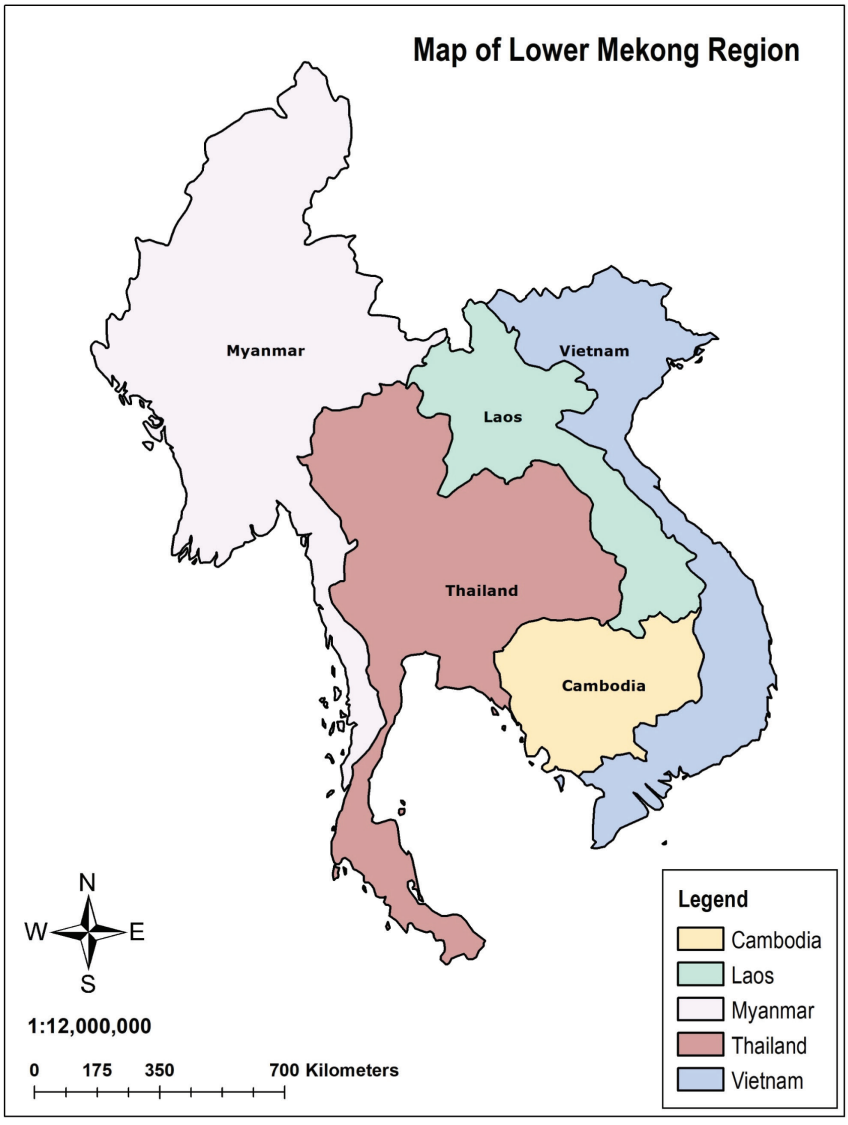

Figure 1: Map of Lower Mekong countries (Source: Nature Earth Data)

Lao PDR (FAO AQUASTAT 2011): The Lao People's Democratic Republic is a landlocked country in the mainland Southeast Asia with a total area of 236,800 km^2. The country is bordered by China to the north, Vietnam to the east, Cambodia to the south, Thailand to the west and Myanmar to the northwest. The cultivable area is an estimated 2 million ha, composed of narrow valleys and the flood-prone plain of the Mekong river and its tributaries. In 2009, the total cultivated area accounted for 1468,000 ha, around 6% of the total area of the country. Arable land was an estimated 1360,000 ha and the area under permanent crops was 108,000 ha. Lao PDR has a tropical climate with a rainy season from mid-April to mid-October dominated by the humid southwest monsoon. The average annual rainfall is 1,834 mm but ranges from 1,300 mm in the northern valleys to over 3,700 mm at high elevations in the south. About 75% of the rainfall occurs during the rainy season. The water level in the Mekong river may fluctuate by up to 20 m between wet and dry seasons.

Myanmar (FAO AQUASTAT 2011): Myanmar has a total area of 676,590 km^2. The country's southern coastline lies on the Andaman Sea and to the southwest the Bay of Bengal; it is bordered by Bangladesh to the west, India to the northwest, China to the northeast, and Lao People's Democratic Republic and Thailand to the east. Myanmar's climate is tropical monsoon. Rainfall is highly seasonal, being concentrated in the hot humid months of the southwest monsoon (May–October). In contrast, the northwest monsoon (December–March) is relatively cool and almost entirely dry. The total cultivable area is almost 18.3 million

ha. Total cultivated area in 2009 was around 12.1 million ha of which 11.0 million ha or 91% was for annual crops and 1.1 million ha or 9% for permanent crops.

Thailand (FAO AQUASTAT 2011): Thailand covers an area of 513,120 km^2 and is located in the southeastern region of the continent of Asia. Its immediate neighbors are Myanmar to the north and the northwest, Lao People's Democratic Republic to the northeast, Cambodia to the east, and Malaysia to the south. The climate is mainly governed by the alternation between the southwest monsoon, which brings heavy rainfalls (May–October), and the northeast monsoon, which is comparatively dry and cool (October–February). The transitional period (March–April) is characterized by heavy thunderstorms. The average annual rainfall is about1 622 mm. It ranges from 1 100 mm in the central plain and the northeast of the country to 4,000 mm in the southern peninsula near the Andaman Sea. About 26.79 million ha are considered as cultivable, which represents 52% of the country. In 2009, the cultivated area was an estimated 18.995 million ha. Of this total, 15.300 million were under annual crops (mainly paddy rice) and the remaining 3.695 million ha were under permanent crops.

Vietnam (FAO AQUASTAT 2011): Viet Nam is located in the eastern part of the Indochina peninsula, bordered by China in the north, the South China Sea in the east and south, the Gulf of Thailand in the southwest, and Cambodia and Lao People's Democratic Republic in the west. The total area of the country is 331,052 km^2. Viet Nam is located in a complicated climatic zone: hot, humid, and rainy. It is characterized by a subtropical climate with four separate seasons, spring, summer, autumn, and winter in the north and a tropical climate with only two seasons, dry and wet in the south. Average annual precipitation is around 1,820 mm. Agriculture plays a very important role in socio-economic development, in poverty alleviation, and in food security. The country has recently become one of the three top countries in the world for rice exports, together with Thailand and the United States.

SERVIR-Mekong

Through a unique partnership between United States Agency for International Development (USAID) and the United States National Aeronautics and Space Administration (NASA), SERVIR-Mekong[1] is harnessing space technology and

Figure 2: Map showing the global hubs of SERVIR (Source: SERVIR-Global)

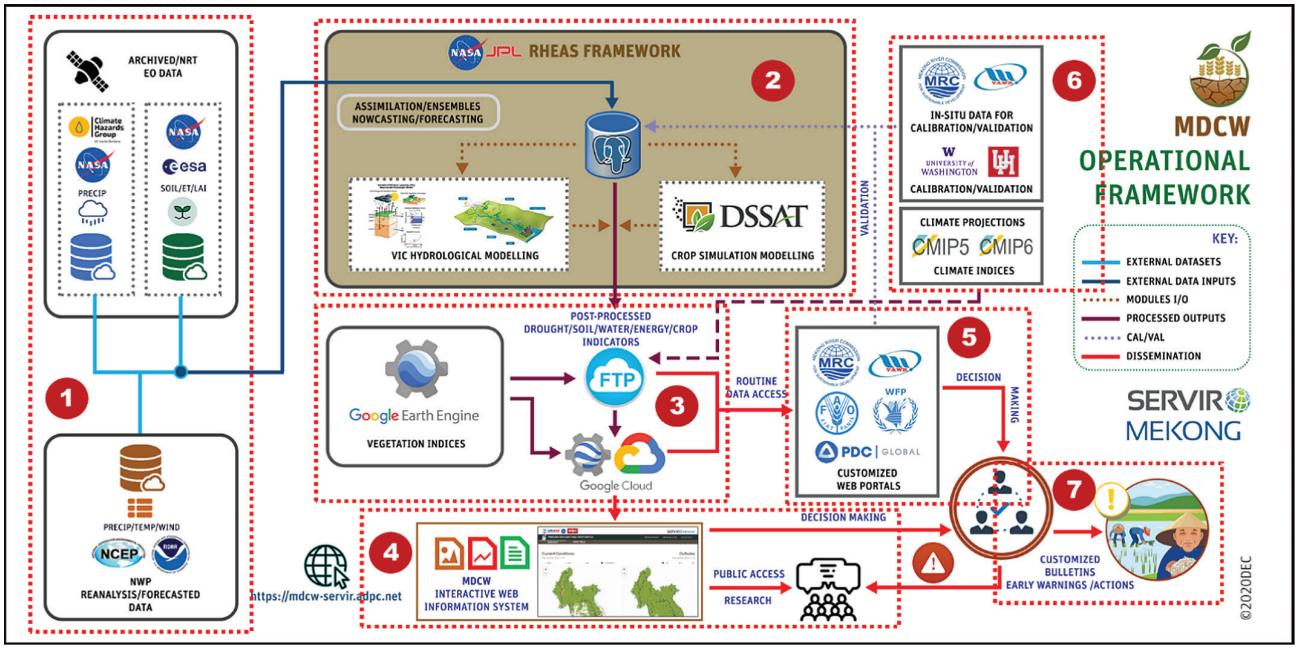

Figure 3: Mekong Drought and Crop Watch (MDCW) (Source: ADPC/SERVIR-Mekong)

[1] https://servir.adpc.net/

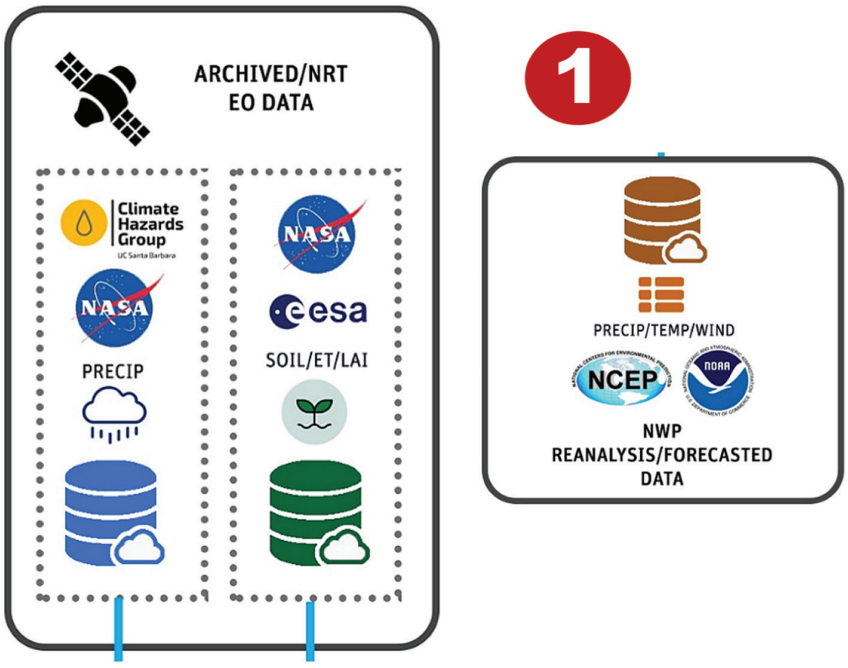

Figure 3a: Earth observation data component

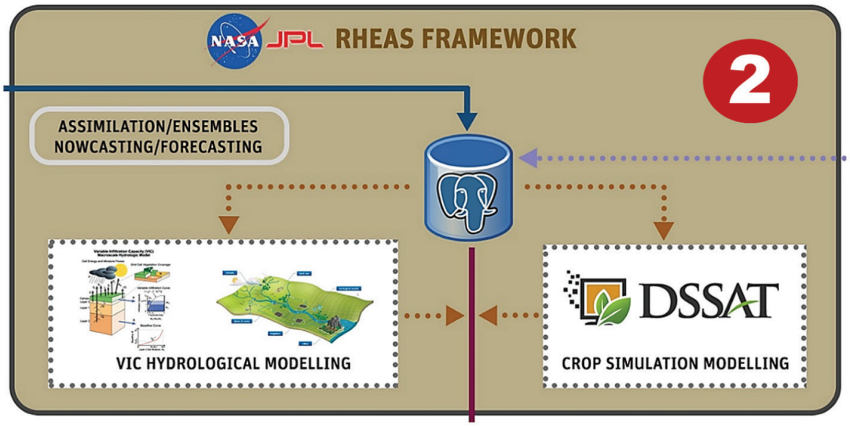

Figure 3b: RHEAS framework

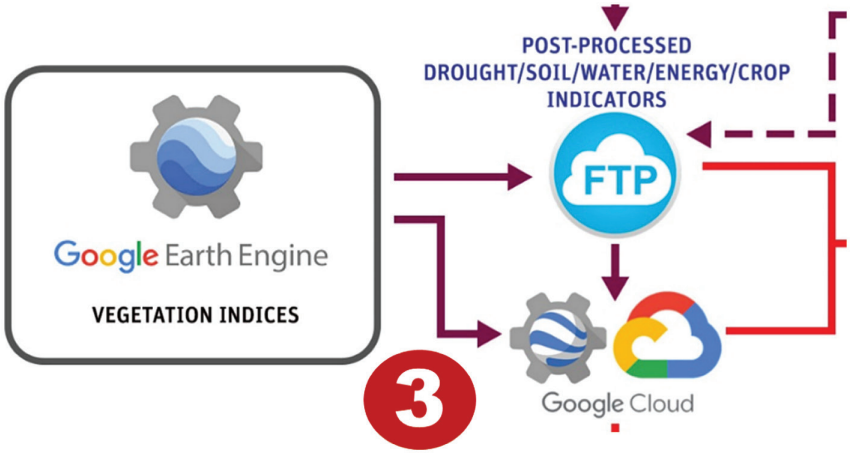

Figure 3c: Cloud computing platform

open data to help address developmental challenges related to climate change by bringing in technologies that could help monitor sea levels rise, floods, and droughts whose frequency and intensity have increased thus threatening ecosystems and people's livelihoods. SERVIR-Mekong works in partnership with leading regional organizations to help the five countries in the Lower Mekong Region that includes Cambodia, Lao PDR, Myanmar (Burma), Thailand, and Vietnam, use information provided by Earth observing satellites and geospatial technologies to manage climate risks. The program activities are designed to meet the overall regional objectives of:

i. Building and institutionalizing the technical capacity of government decision-makers and key civil society groups to integrate geospatial information into their decision-making, planning, and communication.
ii. Improving the sharing of user-tailored geospatial data, products, and services.
iii. Developing new high-quality user-tailored data, tools, applications, and models to address on-the-ground priorities.
iv. Strengthening the SERVIR-Mekong hub as a regional provider of geospatial data, analyses, and capacity building services

The SERVIR-Mekong hub is hosted at Asian Disaster Preparedness Center (ADPC) in Thailand and is designated to be the fourth global hub focusing on the Mekong region (Figure 2).

Mekong Drought and Crop Watch

The Mekong Drought and Crop Watch (MDCW) (https://mdcw-servir.adpc.net/) is an integrated web-based information system intended to (1) improve the operational, technological, and institutional capabilities to prepare for and respond to droughts in the Lower Mekong region; (2) support local decision-makers in drought monitoring, analysis, and forecasting; (3) provide policy makers and growers with current and forecast drought indices to facilitate decision-making within the current growing season; and (4) provide

ecological and financial forecasting information to inform seasonal cropping decisions.

MDCW can be used to assist local governments and the agricultural sector with seasonal drought forecasting and in implementing short- and long-term mitigation measures during and in advance of droughts. It can also be used to characterize droughts through accurate, reliable, and timely estimates of their severity and impacts. In addition, the system can inform assessments of the economic, social, and environmental impacts of drought on vulnerable people and water-related resource systems. And finally, it can help develop critical regional and local thresholds reflecting increasing levels of risk and vulnerability to drought, as agreed by stakeholders (Figure 3).

MDCW comprises of seven components that includes

i. Earth Observation Data Component (Figure 3a)
ii. The RHEAS Framework (Figure 3b)
iii. Cloud Computing Platforms (Figure 3c)
iv. MDCW Interactive Web Information System and Public Access (Figure 3d)
v. Customized Web Portals (Figure 3e)
vi. Climate Impact Map (Figure 3f)
vii. Information Dissemination (Figure 3g)

MDCW deploys the Regional Hydrologic Extreme Assessment System (RHEAS) that is an integration of hydrological and crop simulation models developed by NASA-Jet Propulsion Laboratory. The core of the RHEAS framework is the Variable Infiltration Capacity (VIC) model and the Decision Support System for Agrotechnology Transfer (DSSAT) model that automates the deployment of nowcast and forecast hydrologic simulations and ingests satellite observations through data assimilation. It also allows coupling of other environmental models and facilitates the delivery of data products to users via a GIS enabled database. The system's ability to carry out nowcast and forecast within the framework at the same time gives an upper edge to the present existing resources or systems available for drought monitoring (Figure 4).

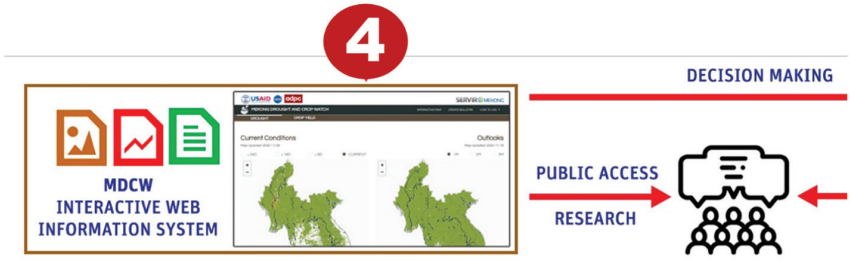

Figure 3d: MDCW interactive web information system and public access

Figure 3e: Customized web portals

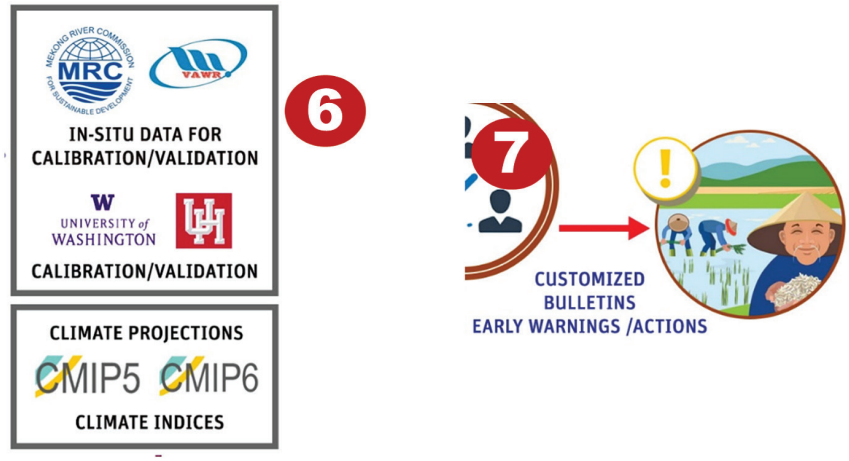

Figure 3: (f) Climate Impact Map (g) information dissemination

A number of earth science datasets are available to be used in RHEAS representing many hydro-meteorological variables such as precipitation, with each being defined as a class within the datasets package. The PostGIS database, where the RHEAS datasets are stored, is a spatial extension to the widely used PostgreSQL object-relational database system. The overall RHEAS software follows a hybrid

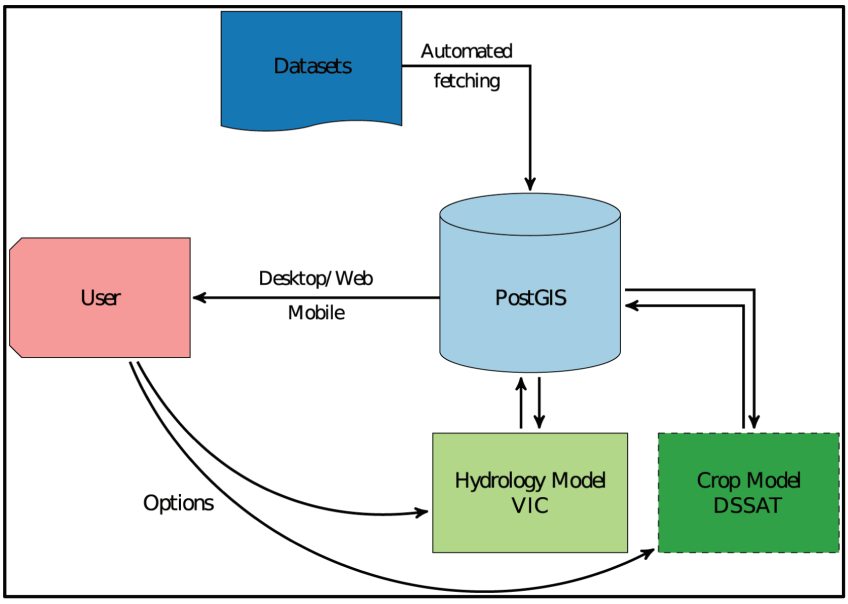

Figure 4: Simplified schematic of the RHEAS software architecture (Andreadis et al., 2017)

approach that combined modular and object-oriented programming with the functionalities of the software broken down into a set of components: (i) configuration, (ii) database operations (I/O and processing), (iii) model simulations, and (iv) data assimilation.

The overall outputs of RHEAS are made available through a web portal called the MDCW Portal whose webpage together with an integrated interactive map allows users to access all drought-related products in the form of charts and figures.

Integrated climate scenarios in Mekong drought and crop watch

It is a plausible and simplified representation of the future climate, which is projected based on an internally consistent set of climatological relationships and assumptions of radiative forcing (Santoso et al., 2008). Scenarios[2] that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover are called Representative Concentration Pathways (RCPs). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome. Four RCPs were produced from Integrated Assessment Models that were used in the IPCC Fifth Assessment Report (AR5). The brief details of the RCPs are given below:

- RCP2.6 is one pathway where radiative forcing peaks at approximately 3 W m^{-2} before 2100 and then declines (the corresponding ECP assuming constant emissions after 2100).
- RCP4.5 and RCP6.0 are the two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 4.5 W m^{-2} and 6.0 W m^{-2} after 2100 (the corresponding ECPs assuming constant concentrations after 2150).
- RCP8.5 is one high pathway for which radiative forcing reaches greater than 8.5 W m^{-2} by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250).

However, the future scenarios considered for the Lower Mekong region includes RCPs 4.5 and 8.5 to understand the projected drought conditions based on near-future (2030s), middle-future (2050s), and far-future (2080s) periods.

Overview of MDCW and its functionalities

Drought Nowcast and Forecast Information

The MDCW (https://mdcw-servir.adpc.net/home/) provides near-real-time drought information for the entire Lower Mekong region by ingesting multiple satellite data through its RHEAS model and deriving drought information both at nowcast and forecast (Figure 5). The nowcast information is available for the following period as given below:

- < 24 days
- < 16 days
- < 8 days
- Current Conditions

The forecast conditions can be obtained as future "Outlooks" and are available for the following period as given below:

- 1-Month
- 2-Month
- 3-Month

The MDCW portal tends to provide drought conditions based on its intensity categorized as:

- No drought
- Moderately dry
- Severely dry
- Extremely dry
- No data

The outlooks information is available as

- None
- Watch
- Warning alert

These information guides the users to get an instant update on the prevailing drought situations in the Lower Mekong region be it an individual country or the region as a whole.

[2] https://www.ipcc-data.org/guidelines/pages/glossary/glossary_r.html

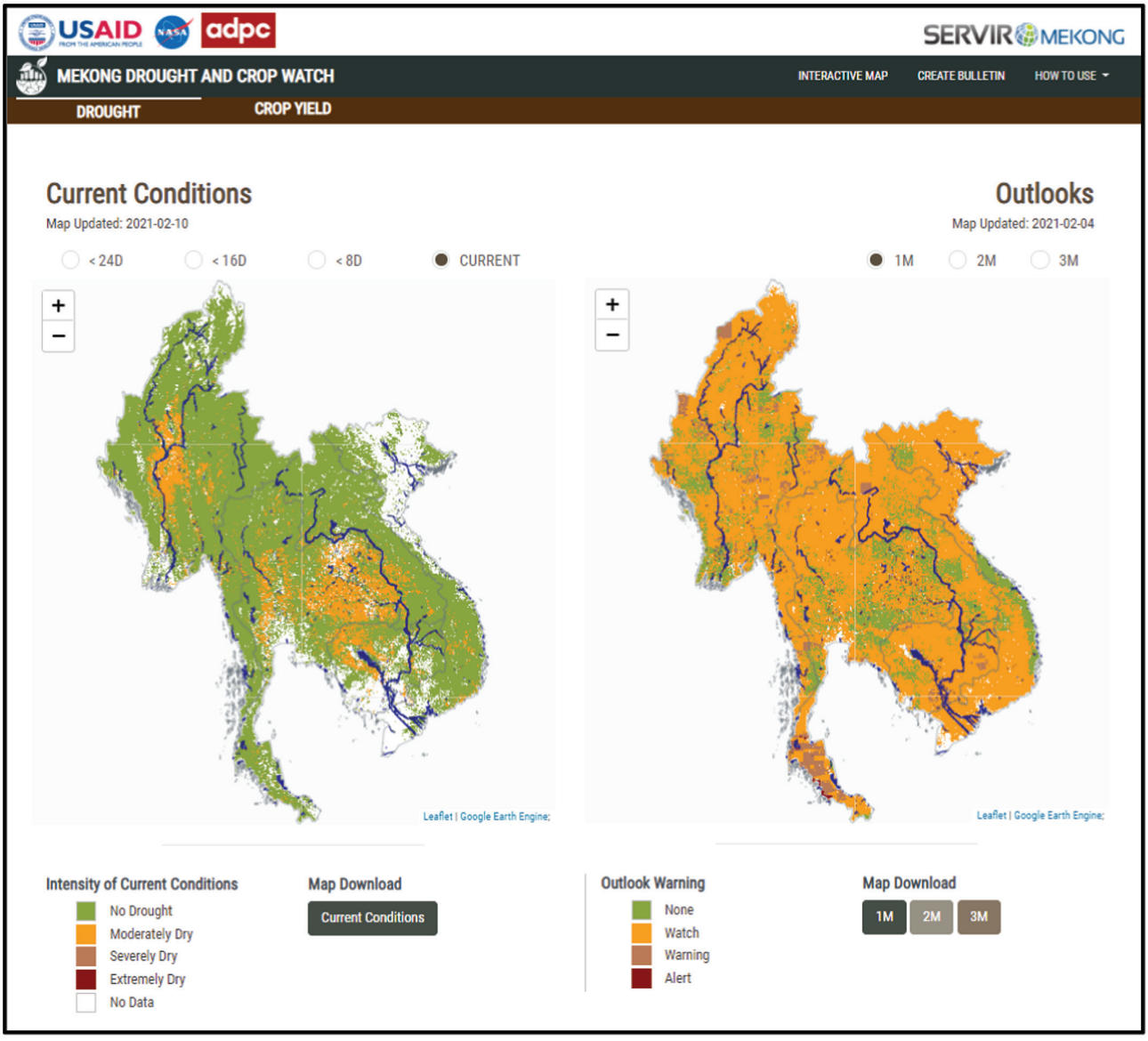

Figure 5: Front-end of Mekong Drought and Crop Watch (MDCW)

Interactive map with model-based and satellite-based indicators

The interactive map (https://mdcw-servir.adpc.net/map/) of the Mekong Drought and Crop Watch (MDCW) allows users to visualize a number of satellite- and model-based drought indicators together with other indicators in an interactive manner. All these indicators are derived from the RHEAS model and are available for observations at the regional level, country level, provincial levels, and local levels.

The interactive map provides a series of model-based indices (Figure 6) that include:

- Keetch-Byram Drought Index (KBDI)
- Combined Drought Index (CDI)
- Drought Severity (DS) (%)
- Dry Spell Events
- Soil Moisture Deficit Index (SMDI)
- Standardized Precipitation Index (SPI) 1-Month
- Standardized Precipitation Index (SPI) 3-Month
- Standardized Runoff Index (SRI) 1-Month
- Standardized Runoff Index (SRI) 3-Month
- Root Zone Soil Moisture (mm)
- Soil Moisture (mm)
- Soil Temperature (C)
- Rainfall (mm)
- Average Surface Temperature (C)
- Relative Humidity (%)
- Evaporation (mm)
- Potential Evapotranspiration (PET) (mm)
- Baseflow (mm/day)
- Surface Runoff (mm)

The satellite-based indices (Figure 7) from MDCW include:

- Visible and Shortwave Infrared Drought Index (VSDI)
- Moisture Stress Index (MSI)

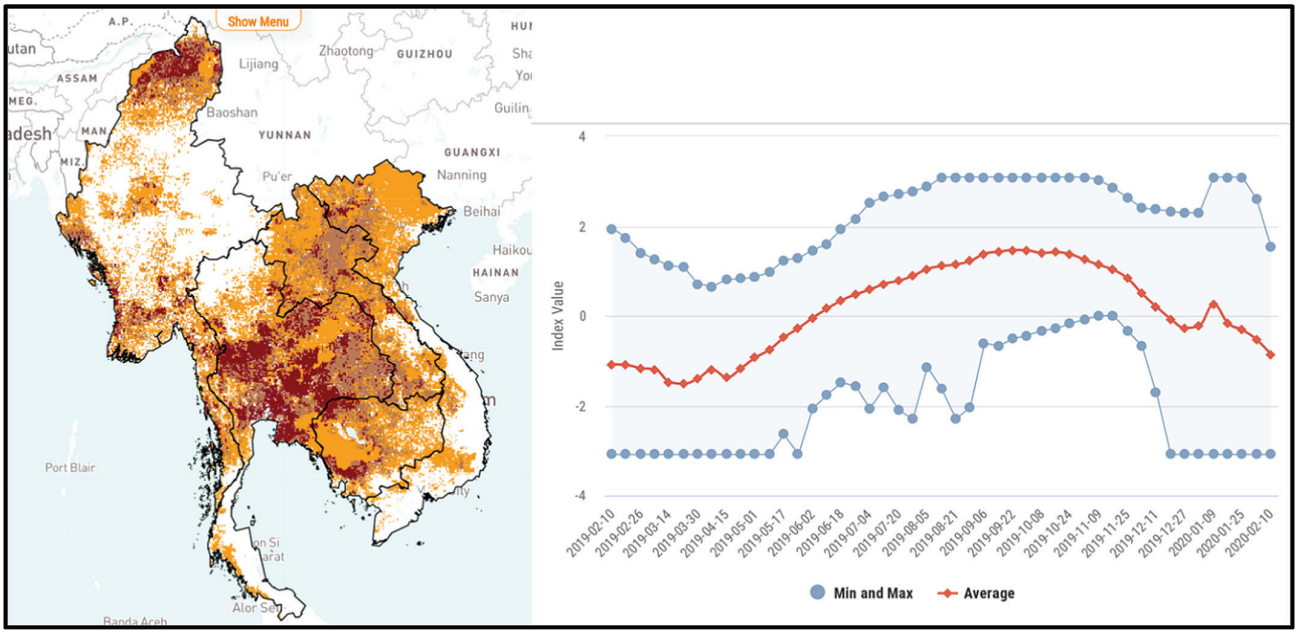

Figure 6: Model-based Standardized Precipitation Index (SPI) of Lower Mekong: 3-Month for February 2020

- Atmospherically Resistant Vegetation Index (ARVI)
- Soil Adjusted Vegetation Index (SAVI)
- Enhanced Vegetation Index (EVI)
- Normalized Difference Vegetation Index (NDVI)

Remote sensing-based indices are an effective tool for water and nutrient requirement monitoring including crop growth and yield estimation through various phenological stages while also monitoring vegetation health status and abiotic stresses. Vegetation indices are derived by combining remote sensing data and the reflectance of monitored surfaces within different wavelengths, mainly visible and Near Infrared (NIR) portion of the visible spectrum. Vegetation indices also provide consistent spatial and temporal comparisons of global vegetation conditions over time and space using data from different sensors and allow users to perform useful geospatial operation and functionalities addressing various weather- and climate-related problems.

Both satellite-based indices and mode-based indices play an important role in comparative evaluation of ground conditions that allows users to appropriately monitor conditions on the ground related to drought and its impact on agricultural productivity.

The MDCW can also provide country-level drought outputs using both satellite-based and model-based indicators. The same indices can be derived for country-level drought monitoring and forecasting (Figure 8).

While all the indices shown above can be easily accessed from the MDCW Interactive Portal, the portal also allows users to directly download such data and information for reporting and research purposes as these data and products are publicly available for free.

Climate impact map of Mekong drought and crop watch

The Climate Impact Map (https://mdcw-servir.adpc.net/climate-studies/) of Mekong Drought and Crop Watch (MDCW) enables users to visualize and explore climate variables and indices derived from CMIP5 projections from different timeframes and emission scenarios for ensemble mean of selected climate models. The climate scenarios included in the portal are regionally calibrated to meet with the regional conditions and are available at near-future (2030s), middle-future (2050s), and far-future (2080s). Representative Concentration Pathways (RCPs) 4.5 and 8.5 were included for the region to understanding the future drought severity in the Lower Mekong.

Under the different scenarios, the indicators used includes,

- Amount of Cold Nights (%)
- Amount of Hot Days (%)
- Consecutive Dry Days (days)
- Consecutive Wet Days (days)
- Daily Mean Temperature (C)
- Daily Minimum Temperature (C)
- Daily Maximum Temperature (C)
- Drought Susceptibility (based on SPEI) (%)
- Drought Susceptibility (based on SPI) (%)
- Growing Degree Days (degree-days)
- Growing Season Length (days)
- Number of Very Heavy Rain Days (days)

How Mekong drought and crop watch will help lower Mekong countries?

The system has been used to assist local governments and the agricultural sector with seasonal drought forecasting and in implementing short- and long-term mitigation measures during and in advance of droughts. It can also be used to characterize droughts through accurate, reliable, and timely estimates of their severity and

impacts. In addition, the system can inform assessments of the economic, social, and environmental impacts of drought on vulnerable people and water-related resource systems. And finally, it helps develop critical regional and local thresholds reflecting increasing levels of risk and vulnerability to drought, as identified by regional stakeholders.

Customization of Mekong drought and crop watch at regional level

The Mekong River Commission (MRC) Secretariat has been one of the direct beneficiaries of the Mekong Drought and Crop Watch (MDCW) where the customized version of the MDCW is being used to provide weekly drought forecast and early warning for the Lower Mekong Basin using Combined Drought Index (CDI) (http://droughtforecast.mrcmekong.org/maps) (Figure 11).

This helps MRC Member States to receive advanced information on drought situation enabling decision-makers and farmers to take appropriate measures. The MRC Drought Management Strategy 2020–2025 considered MDCW as a strategic focus to further strengthen MRC's drought forecasting and early warning by customizing the Regional Hydrologic Extreme Assessment System (RHEAS) model of MDCW to develop an MRC stand-alone drought forecasting system (MRC, 2019).

Customization of Mekong drought and crop watch in Viet Nam

At the national level, Vietnam has been provided with the customized version of MDCW for drought monitoring, forecasting, and decision-making (Figure 12). With the technical support from SERVIR-Mekong, the Vietnam Academy of Water Resources (VAWR), under Ministry of Agriculture and Rural Development (MARD), calibrated and customized the MDCW which is now been used for monitoring and forecasting drought conditions in South and South-Central Vietnam. VAWR is using this drought information in their monthly drought bulletins, which is then disseminated locally through the Department of Agriculture and Rural Development (DARD) informing the farmers of the prevailing drought conditions.

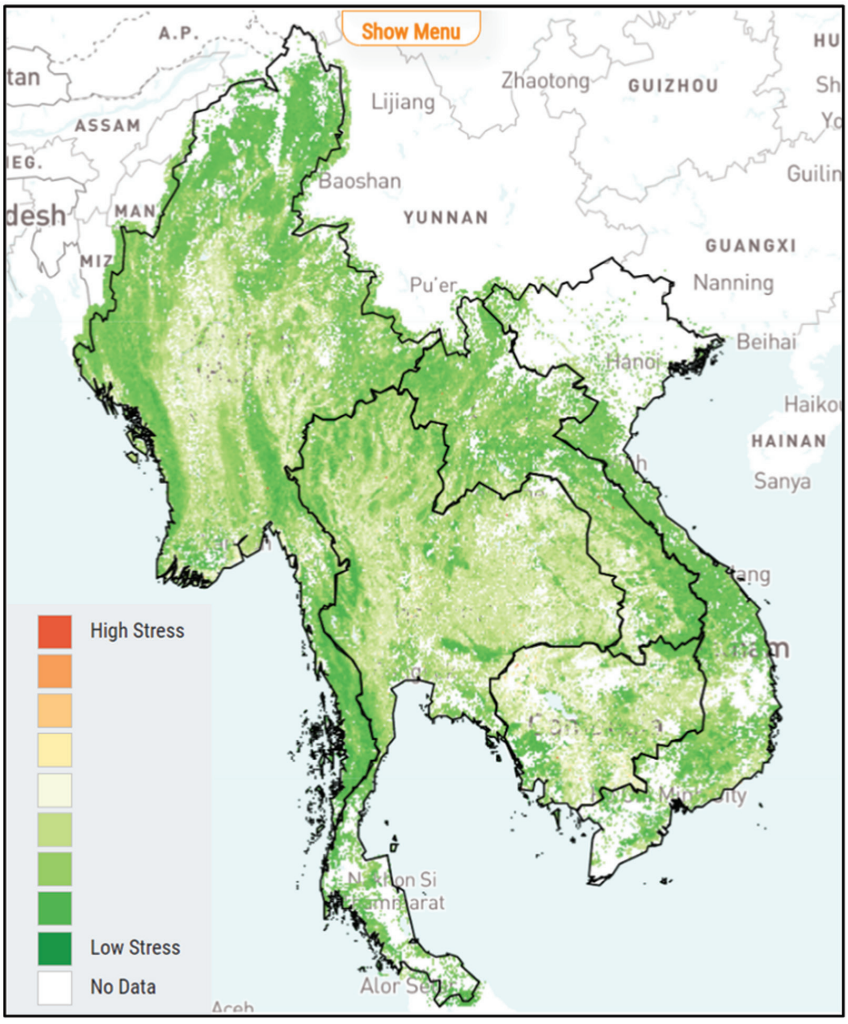

Figure 7: Satellite-based Moisture Stress Index map of Lower Mekong for February 2020 showing prevalence of stress conditions (Source: Interactive Map of SERVIR-Mekong)

Improving the drought monitoring and early warning systems (EWS)

Over the years significant advances have been made towards drought monitoring and early warning. With the occurrences of several severe drought events in the Lower Mekong region, it is very well acknowledged that countries need to set-up effective drought monitoring and early warning mechanism for improved decision-making. National and international agencies have come together to improve their ability to predict food insecurity in the region while also working closely with national governments to implement a number of early warning systems to monitor drought that may indicate the likelihood and magnitude of food insecurity. However, the region still lacks a comprehensive system where drought monitoring tools becomes part of an early warning system that could provide decision-makers with improved and timely information. Moreover, an EWS using improved drought monitoring tools can trigger timely and appropriate preventive measures if a country has adequate institutional capacity to communicate and implement recommendations or advisories. This will allow decision-makers to assess food security indicators to detect major changes in

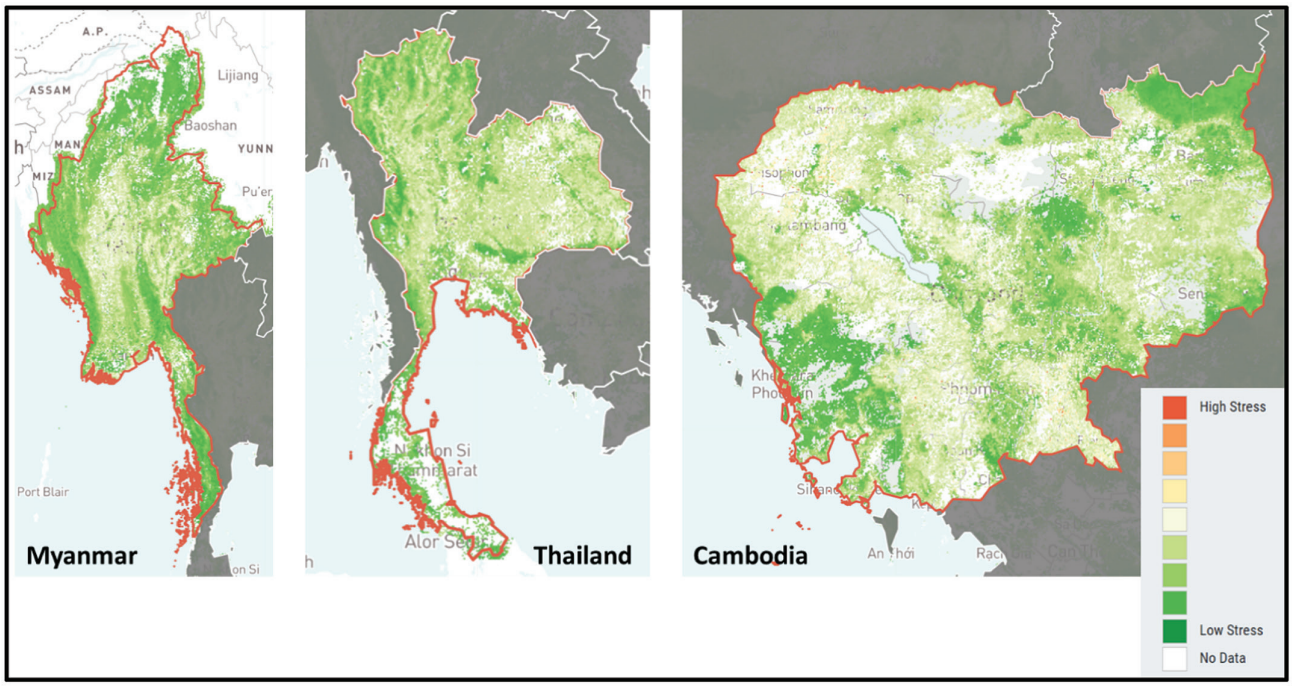

Figure 8: Country-level satellite-based Moisture Stress Index maps for February 2020 showing prevalence of stress conditions (Source: Interactive Map of SERVIR-Mekong)

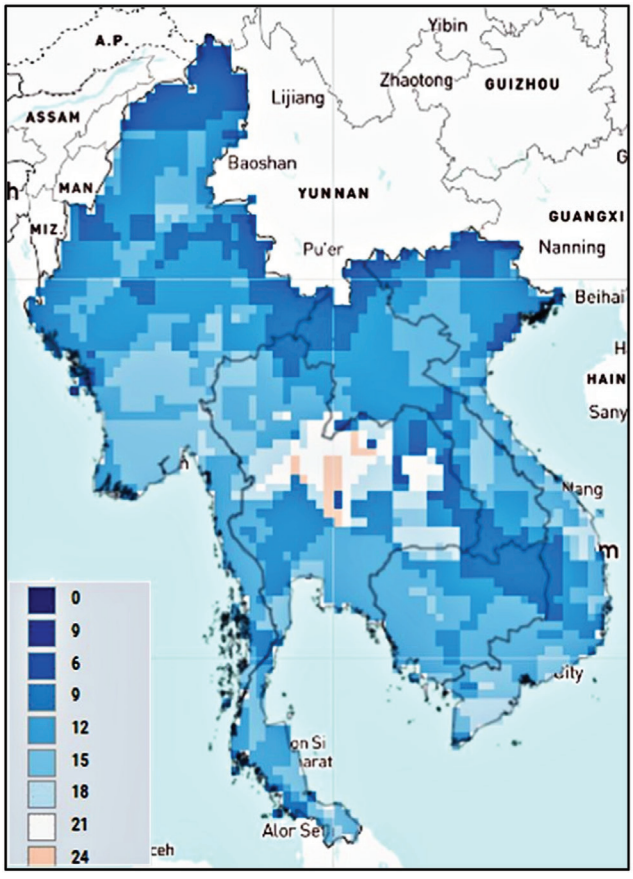

Figure 9: Standardized Precipitation Index (SPI) based on present climate scenario (Source: Climate Impact Map of SERVIR-Mekong)

food availability and advise on the likely occurrence of food crises due to drought in advance of a severe event.

Every country in the Lower Mekong region should have their own drought monitoring and early warning systems. Such system would help alert key sectors such as agriculture while also providing social protection to the low-income groups that are vulnerable to the direct impacts of drought. With accurate meteorological observations, risk can also be reduced by providing weekly, 14-days, and monthly forecast that will allow decision-makers to provide necessary advisories to the farmers for their early response to drought in terms of mitigation measures and the required changes to their cropping cycle/calendar. Further, longer-range forecasting can be complemented with near-real-time and in-season monitoring that can offer additional warnings several days ahead.

MDCW towards improving regional and national linkages and supporting adaptation

Drought being a slow onset disaster has always brought long-term and cumulative environmental changes to the Mekong

region with issues raising from soil degradation and desertification processes to changes in ecosystems and habitat fragmentation to coastal erosion, among others. Such kind of changes normally do not get the attention of policymakers to cope with the emerging crises that results in situations that becomes costlier to deal with once it goes beyond the critical thresholds limits of irreversible and irreparable changes. Early Warning Systems (EWS) in such contexts becomes important to understand the onset of the event beyond the exceeded threshold, its intensity and duration from a single season to months and years and spatially from a few hundreds to thousands of square kilometers. Therefore, under such situations, a drought monitoring system such as the Mekong Drought and Crop Watch (MDCW) may help assess and analyze the risk and communicate the risk to decision-makers for operational decision-making. As change detection is a critical phenomenon in natural resources management, a comprehensive and integrated approach would help users consider numerous indicators that is required for drought monitoring and early warning with location-specific information on environmental changes. With the availability of high to medium resolution satellite data providing multiple, synoptic, global coverage having multi-spectral imagery, any changes related to the ground conditions can be obtained near-real to real-time allowing users to understand the drought extent and its impacts.

Not many countries in the Lower Mekong have developed drought monitoring and forecasting tools that are capable of integrating earth observation and geospatial information from various sources and providing warnings related to drought situations. SERVIR-Mekong's MDCW not only provide farmers with advanced information to mitigate the impact of droughts on their crops but also give policymakers access to better data and tools to implement drought risk reduction strategies while also adapting to the adverse climate change impacts. MDCW uses innovative approaches to generate indicators using

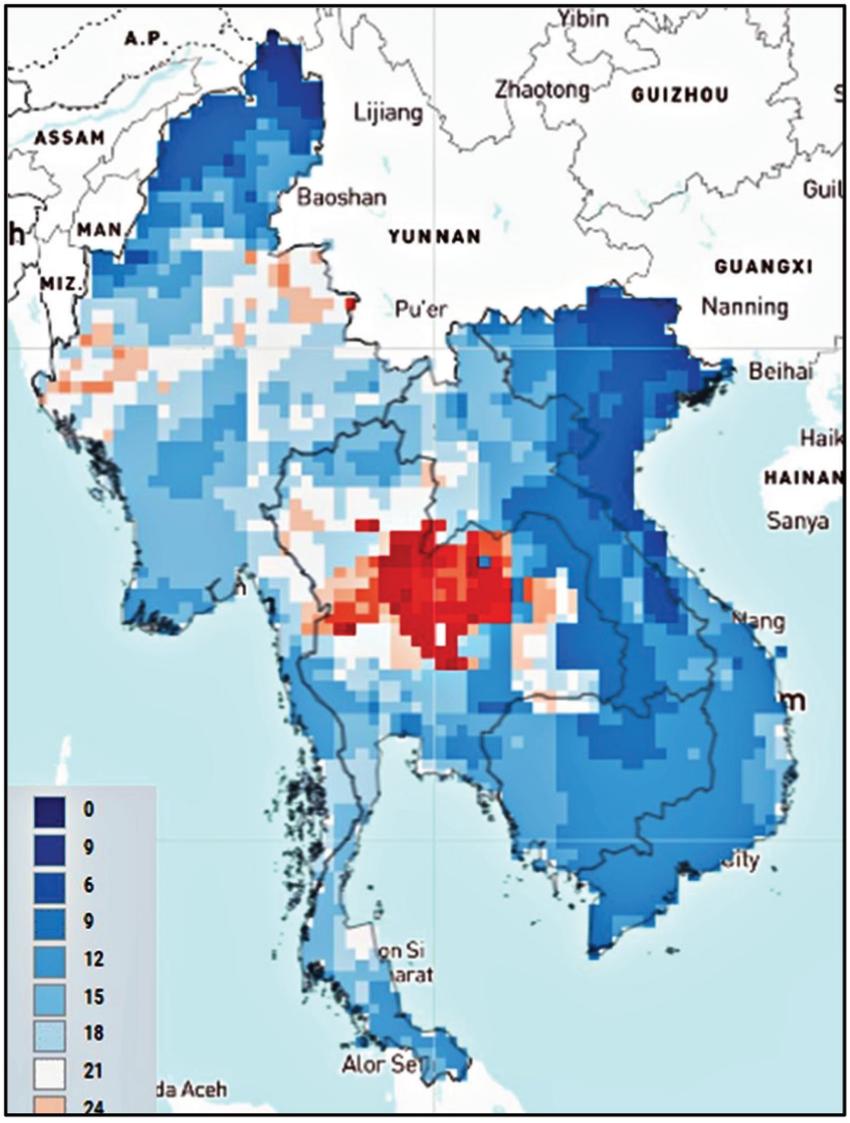

Figure 10: Standardized Precipitation Index (SPI) based on future climate scenario (RCP4.5, Near-Future (2030s)) showing extreme drought conditions towards Northern Thailand (Source: Climate Impact Map of SERVIR-Mekong)

earth observation and geospatial data to understand drought patterns and its severity in the Lower Mekong, henceforth helping the farming community in providing credible information that is nowcast and forecast based to help mitigate the direct impacts of drought by re-adjusting their cropping schedules or adapting alternative cropping schemes.

Tools such as the MDCW are important for the region, government, and the community to achieve adaptation as an output to sustainable practices. Indicators can help identify when and where policy interventions could be made and how historical and institutional level analysis can help understand the processes and entry points that could be a way forward to reduce vulnerability. Therefore, leveraging the experience gained in deploying and operationalizing Mekong Drought and Crop Watch in the Lower Mekong, it makes us realize the importance of local knowledge and practices, acceptability to the information

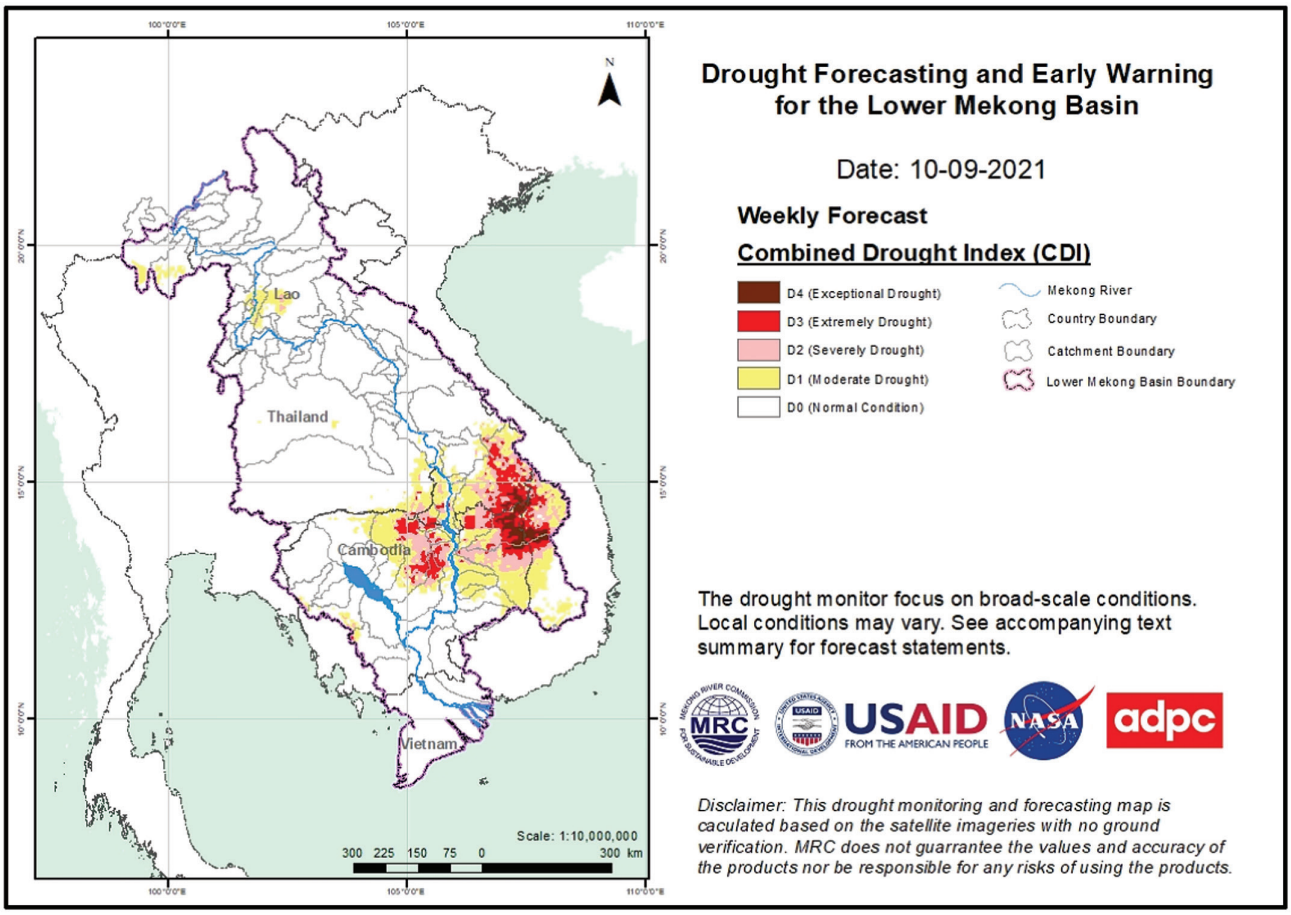

Figure 11: Weekly drought forecast of Mekong River Commission for the Lower Mekong Basin (Source: Mekong River Commission)

shared, having a good and common understanding about the tool and information and a sense of self-confidence and ownership among the community members. These forms an important set of indicators for calibrating and customizing a tool like MDCW to the extent that the advisories sent out to the farming communities are people-centered including addressing the last-mile connectivity.

Conclusion

The MDCW being integrated with the Regional Hydrologic Extreme Assessment System (RHEAS) is the only drought monitoring tool in the Mekong region having both nowcast and forecast capabilities. The MDCW allows drought to be easily monitored near-real-time using satellite-based and model-based indicators to observe changes in precipitation, temperature, and the status of surface water. It helps decision-makers understand the drought impacts while also providing information to update policies and strategies related to drought risk management. MDCW is a user-friendly interactive web-based interface that allows the users to display, analyze, and download the necessary drought- and crop yield-related information that can be accessed by anyone from anywhere around the world. The public access to data and information can be done through two steps that include decision-making and research. For decision-makers, the MDCW tends to address the much-needed drought preparedness, monitoring, and forecasting while also assessing the economic, social, and environmental impacts in the Lower Mekong countries. The system not only provide insurers with spatially explicit, documented drought condition records but also allows targeted decisions to be taken in the context of drought warnings, crop subsidies, and insurance programs. Similarly, the Climate Impact Map integrated within MDCW will help to visualize, evaluate, and analyze climate change data that is intended for audience such as the climate research scientists, meteorologists, hydrologists, and anyone who needs to understand past and future climate patterns.

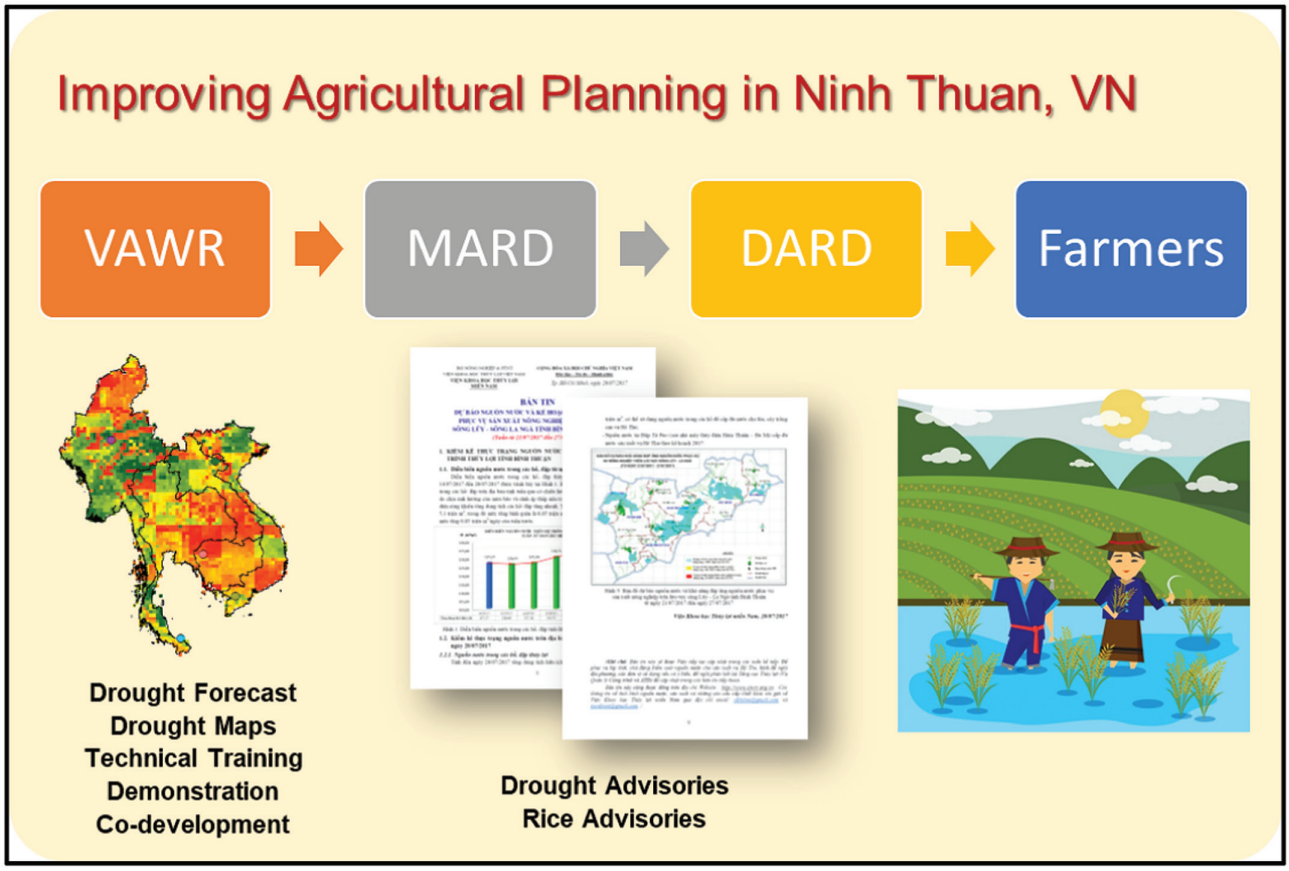

Figure 12: Country-level customization of Mekong Drought and Crop Watch in Vietnam (Source: SERVIR-Mekong)

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Guidelines for Integrating Ecosystem-based Adaptation into National Adaptation Plans

The Guidelines for Integrating Ecosystem-based Adaptation into National Adaptation Plans published by the United Nationa Environment Programme (UNEP) aims to show national and local officials around the world how to integrate ecosystem-based adaptation into national plans designed to counter the effects of climate change.

The guidelines detail the benefits as well as the challenges of adopting ecosystem-based approaches to climate change adaptation. They also cover what information planners should collect, what expertise is needed and which stakeholders they should engage to successfully integrate ecosystem-based adaptation into national adaptation plans.

The guidelines were developed under the National Adaptation Plan-Global Support Programme, implemented jointly by UNEP and the United Nations Development Programme. The initiative, funded by the Global Environment Facility, assists least-developed and developing countries to identify technical, institutional and financial needs to integrate climate change adaptation into medium- and long-term national planning.

The programme supports the process to formulate and implement national adaptation plans under the UN Framework Convention on Climate Change. In doing so, it works with development partners to implement the Nationally Determined Contributions and promotes ambitious climate action in alignment with the Sustainable Development Goals.

The Guidelines aim to guide adaptation practitioners at national and local levels on how to take different steps when factoring ecosystems functions and services into countries' NAP processes and instruments. The Guidelines detail the multiple benefits as well as the challenges of adopting ecosystem-based approaches to climate change adaptation; what information to collect and generate; what expertise to seek; and which stakeholders to engage for successfully integrating EbA into NAP formulation, implementation and review processes. The Guidelines have been developed under the NAP-Global Support Programme (NAP-GSP), implemented jointly by UNDP and UNEP that supports the Least Developed Countries (LDCs) in advancing their NAPs.

For more information, access:

https://www.unep.org/news-and-stories/story/new-guidelines-help-states-adapt-climate-change

Enabling Mechanisms for the Adoption of Energy Storages and Hydrogen for Responding to Climate Change in Southeast Asia

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Abstract

Realizing the countries' Nationally Determined Contributions (NDCs) under the Paris Agreement is one of the critical solutions in accelerating the world's path toward a green future. This article aims to analyze and review enabling technologies adaptations for addressing climate change, particularly within the ASEAN countries. These initiatives seem to be a significant step for the region's sustainability. In this article, the challenges, opportunities, best practices, and policy recommendations to deploy and utilize two innovative technologies; energy storage and hydrogen, for climate change mitigation, based on the available data and brief analysis.

Introduction

Throughout Earth's history, the climate has changed every day. Climate change is a change in the physical condition of the Earth's atmosphere that can be identified (e.g., by using statistical tests) through changes in the average and/or variability of its properties and does not occur just for a moment but over a long period (IPCC, 2018). The United Nations Framework Convention on Climate Change (UNFCCC) makes a distinction between climate change caused by human activities that alter the composition of the atmosphere and climate variability caused by natural causes. Today's causes of climate change are primarily human activities, such as burning fossil fuels (coal, oil, and gas) and cutting down forests (deforestation). Carbon dioxide produced from burning and cutting trees is released directly into the atmosphere, causing the Earth's average temperature to increase. The increase in the temperature of the planet is called global warming. Natural processes can also contribute to climate change, including internal variability (e.g., ocean cycle patterns like El Nino, La Niña, and the Pacific Decadal Oscillation) and external forcing (e.g., volcanic activity, changes in the Sun's energy output, variations in Earth's orbit) (NASA, 2021).

With the carbon dioxide elevating in the atmosphere each day, global sustainability is threatened. The polar ice shield is melting, and the sea level is rising. In some areas, extreme weather events and rainfall are becoming more common, while others are undergoing extreme heat waves and droughts (Climate change consequences, 2017). These effects are projected to escalate in the coming years. The Intergovernmental Panel on Climate Change (IPCC), which includes more than 1,300 scientists from the United States and other countries, foretells a warming of about 0.2°C per decade is projected for a range of Special Report on Emission Scenarios (SRES) over the next two decades. According to IPCC, the extent of climate change impacts on individual regions will differ (IPCC, 2013).

Therefore, the urgency to address future impacts is currently being encouraged under the Paris Agreement. Many initiatives are undertaken in order to limit global warming to below 1.5°C. Battery storage is considered one of many technological solutions in alleviating the intermittency issues of electricity generation from renewable energy. When the first oil crisis took place in the mid-1970s, the United States initiated a number of energy storage Research and Development (R&D) programs, particularly establishing the rechargeable battery focused. The first storage-related program in 1978 was titled "*Batteries for Specific Solar Applications.*" This renewable-based program incorporated development and testing of the state-of-the-art as well as advanced battery technologies, systems analysis, and research on the integration of batteries with photovoltaic (PV) and wind energy systems (ESS History | Energy Storage Systems, n.d.).

The use of hydrogen also has high prospects in technological innovation for the energy transition. But for hydrogen to make a significant contribution to clean energy transitions, it needs to be adopted in sectors where it is almost absent, such as transport, buildings, and power generation (IEA, 2019). Today, Hydrogen technologies are also being considered as an opportunity to develop national industrial sectors, in a recovery perspective after the COVID-19 pandemic.

Energy storage: The key for renewable energy penetration

Trend and opportunity

The role of power storage, especially the battery system, is progressively

being highlighted. Storage, from batteries in solar powered systems to batteries in electric vehicles (EVs), is pivotal to accommodating renewable energy integration. As in ASEAN, the region has set targets of 23% of renewable energy in total primary energy supply (TPES) and 35% of renewable energy in ASEAN's installed capacity by 2025 (APAEC, 2020).

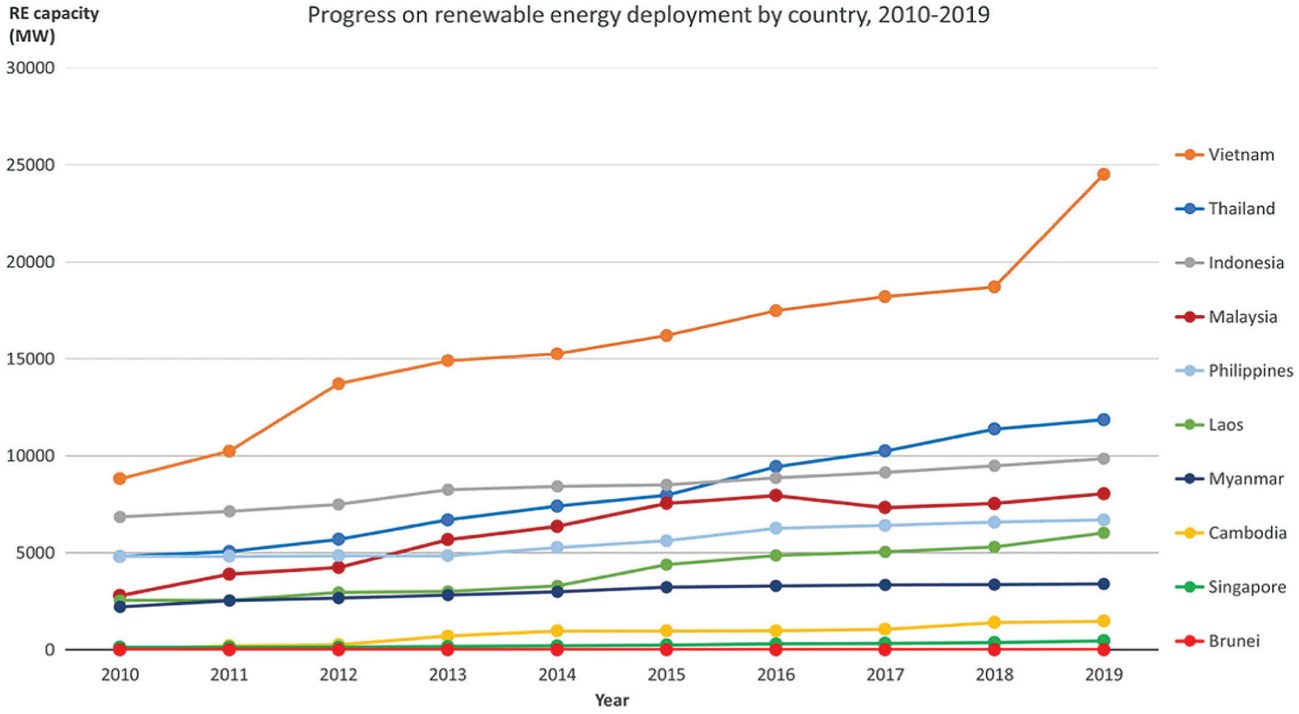

Figure 1: Renewable energy in ASEAN 2010–2019 (IRENA, 2020)

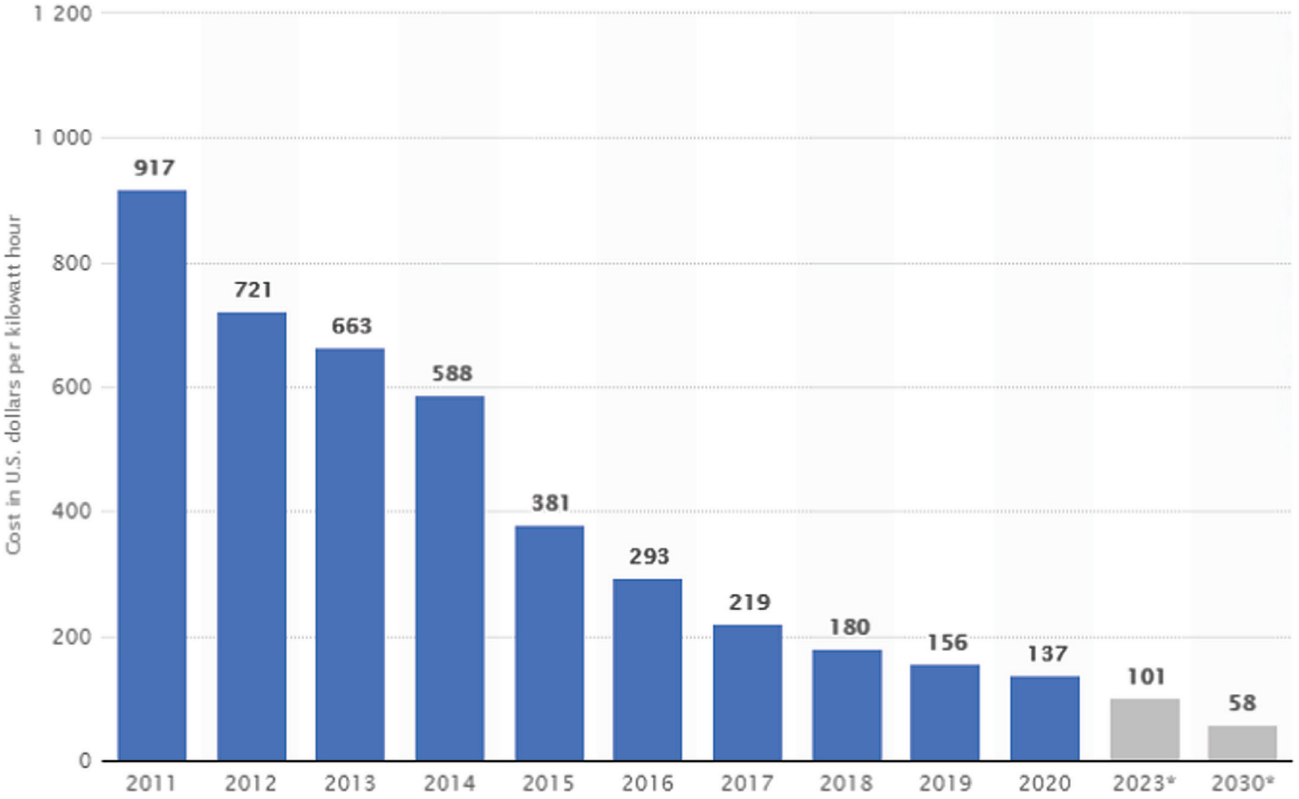

Figure 2: Global lithium-ion battery costs (in USD/kWh) between 2011–2030 (Statista, 2021)

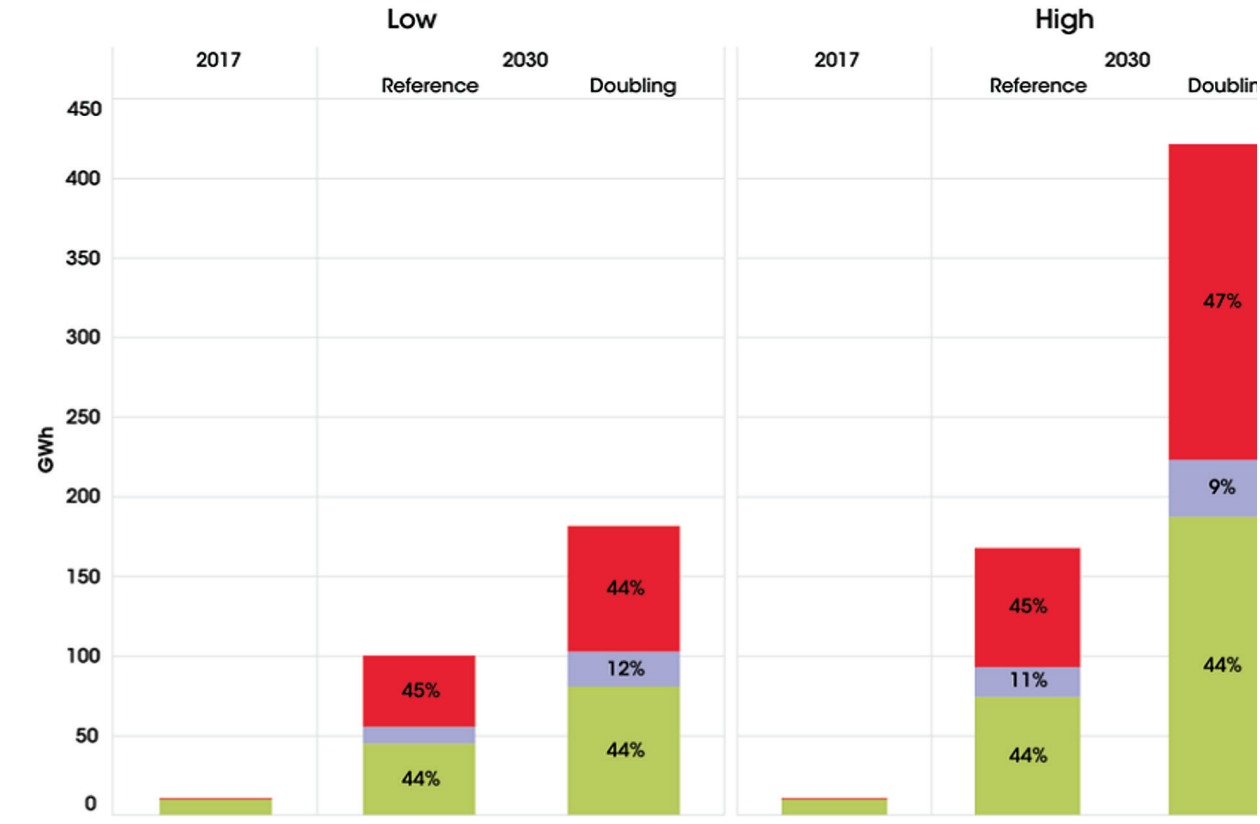

Figure 3: Battery electricity storage energy capacity growth in stationary applications by sector, 2017–2030 (IRENA, 2017)

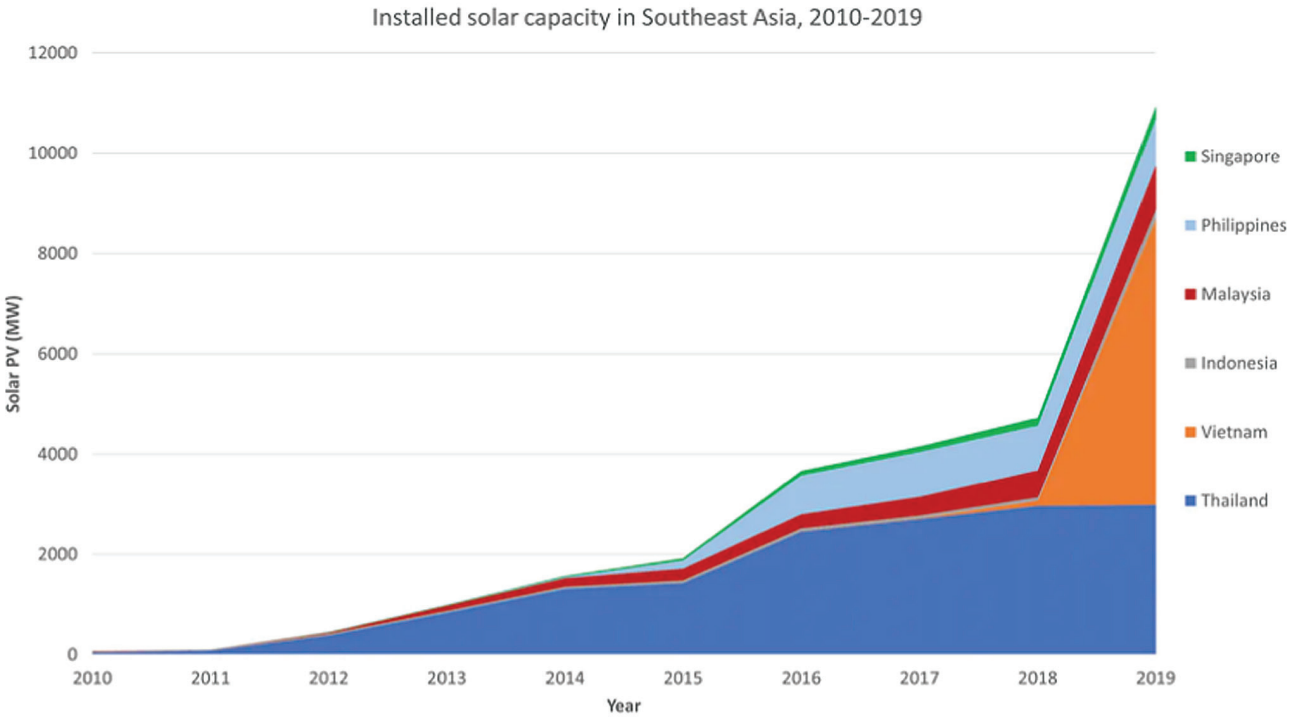

Figure 4: ASEAN solar capacity growth 2010–2019 (IRENA, 2020)

Figure 5: Akuo Energy Indonesia (AEI), Solar GEM® and Storage GEM® in Kalimantan (Akuo Energy, 2018)

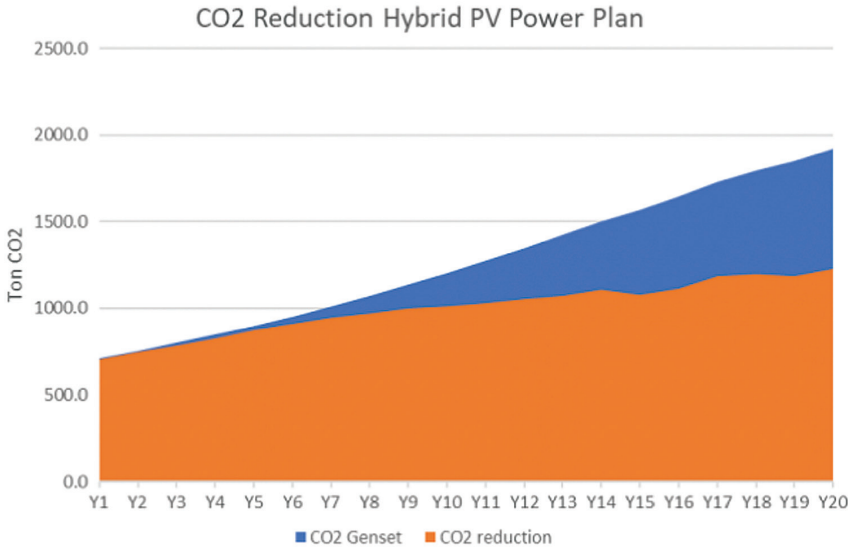

Figure 6: Carbon dioxide reduction Akuo hybrid PV power plant (AEDS, 2021)

This energy storage provides some of the flexibility that power systems need to alleviate the fluctuating availability of solar and wind energy. In the long run, the importance of energy storage will only grow as the ASEAN's decarbonization efforts strive to reduce carbon emissions from the fossil fuels power generation substantially.

Battery storage is considered one of the most essential tools for ASEAN in addressing climate change's global issue. As the electric vehicle market expands and the demand for uninterrupted renewable energy continues to thrive (Figure 1), the battery such as lithium-ion batteries may experience significant growth until 2025. This battery storage system is used to regulate voltage and frequency, reduce peak demand, as well as aforementioned integrate and store renewable energy.

Due to the fact that the lithium-ion batteries' prices are significantly declining (Figure 2), the battery market has witnessed a massive demand in the global storage market. In 2020, the average price for the lithium-ion battery was about USD 137/kWh and is estimated to fall approximately to USD 58/kWh by 2030 (Statista, 2021). With the decreasing cost and increasing demand of the battery market for renewable projects, lithium-ion batteries are likely to grow in the ASEAN energy storage market at a Compound Annual Growth Rate (CAGR) of around 9.5% from 2020 until 2025 (Mordor Intelligence, 2020). Furthermore, falling battery costs will also open up several new economic potentials for the storage technologies to provide a wide range of grid services and uplift the economic value of using distributed batteries to increase the self-consumption of rooftop solar PV.

According to the report developed by International Renewable Energy Agency (IRENA), total battery capacity in stationary applications could increase from a current estimate of 11 GWh to between 100–167 GWh by 2030 in the Reference case and to as much as 181–421 GWh in the REmap Doubling case (Figure 3). Since the extent of storage used in each application remains uncertain, hence this uncertainty is explored in the high and low cases. However, both low and high cases still imply that utility-scale batteries would be rapidly growing to increase the self-consumption share of the output from rooftop solar PV. As shown in Figure 4, the increasing number of installed solar capacity within the region thus far confirms that the largest market for battery storage in the period until 2030 (Figure 3) is foretold to be the pairing of battery storage systems with the installation of new small-scale solar PV.

Case study—Solar PV + Battery storage best practice

Local Community Minigrid, Hybrid PV Power Plant in Berau, East Kalimantan, Indonesia.

Looking at the great prospect and benefits in installing the pair of solar PV and battery storage, Akuo Energy Indonesia, a subsidiary of Akuo Energy, the leading French Independent Power Producer (IPP), has developed a renewable hybrid power plant facility incorporating the distribution network in three villages at Berau Regency, East Kalimantan, Indonesia.

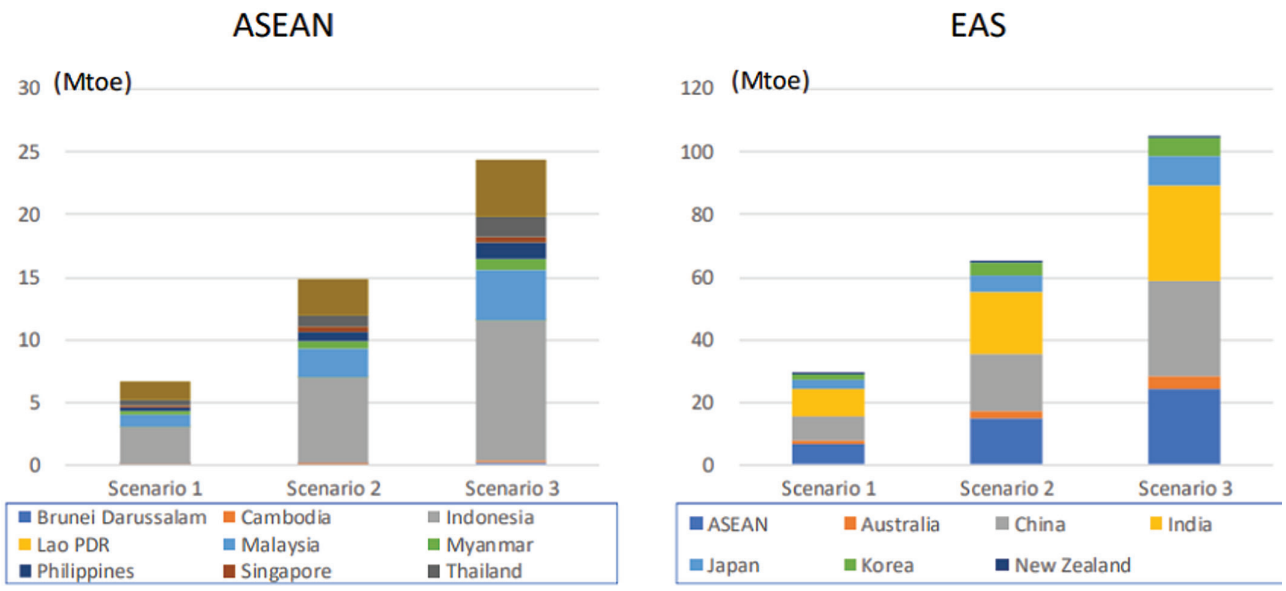

Figure 7: Hydrogen demand potential in 2040, by country (ERIA, 2019)

The power plant and distribution network are owned, managed, maintained, and operated by local communities for their self-energy consumption.

The three villages are Merabu, Long Beliu, and Teluk Sumbang. In total of 460 homes consisting mostly of farmers, beekeepers, laborers, and fishermen, the three villages usually had a few diesel generators which supplying pollutions and unstable energy. In addition, the cost of fuel was quite high because of these villages' remoteness, and fuel expenditure could represent up to 30% of these villagers' monthly income. Also, the generators only operated for 4 hours a day because of recurrent breakdowns and their prohibitive cost.

Akuo Energy Indonesia has deployed its two innovative flagship products Solar GEM® and Storage GEM® in these villages to address the issues. With a combined solar capacity of 1.2 MWp and a storage capacity of 2.1 MWh entirely integrated, the three minigrids supply these rural communities with renewable electricity fully 24 hours a day. Solar GEM® provides the flexibility and portability of solar PV, whereas Storage GEM® allows the excess solar PV energy generated during the day to be stored. Fortunately, the villages now can continue to reap the benefits from uninterrupted green electricity throughout the night (Akuo Energy, 2018).

The system itself is fully operated in 24 hours in 365 days for a year. The PV module generates electricity throughout the day to supply the demand and charge the battery. When the battery is fully charged in the afternoon, the electricity from PV module will be curtailed equivalent to the electricity demand. Most of the electricity is used for household consumption and public facilities. After the sunset, the electricity is supplied by the battery. In the evening, electricity consumption is much bigger rather than during the afternoon. The peak load occurred around 6 pm to 8 pm about 35 kW. The battery will keep supply the electricity until the Sun rise at the next day.

As Figure 6 shown, the Akuo Solar hybrid PV power plants were built to cover 20-year growth energy demand which according to Electricity Supply Business Plan (RUTPL) by Indonesia's State Electricity Company (PLN) is 6% per year. Thus, it is calculated that after 20 years long of running, the solar hybrid PV could help contributing to the fight against climate change by reducing approximately 20,000-ton CO_2. Furthermore, with the electricity from PV systems, the villagers do not have to use diesel generators, hence, not only it helps reducing the carbon emissions yet also the noise pollution. Raising the awareness from rural community toward sustainability to preserve the planet as well as raising its social-economic potentials seem to be a prominent effort for the Southeast Asia region in regard to fighting the climate change (AEDS, 2021).

Challenges

However, the adaptations of these battery storage technologies are still not equally implemented in other ASEAN countries. There are several factors behind the lack of the region's development. Many battery storage developers still believe that tons of knowledge are needed because many industry players, including utilities, regulators, and financiers, are often not familiar with the battery storage, technology's advantages, and how it should be properly deployed. Also, in most regions, including Southeast Asia, storage systems have not been fully recognized in competitive markets for being able to offer both energy capacity and ancillary services. Many battery storage developers and vendors believe that this enabling technology should have their own set of rules and be considered as a pivotal technology in countries' regulatory frameworks for the sake of human's future.

In addition, although significant reductions in system costs that have been achieved over the years, utility-scale battery storage remains a high-priced technology. The initial cost for systems is one of the major obsta-

cles for the market's growth. Furthermore, critical factors enabling this market are the programs supporting solar PV that compensate system owners for excess generation. Yet, many utilities are opposed to these programs, including the net metering and Feed-in Tariffs (FITs), which can be disruptive to the entire power industry and may not agreeably worth the price of maintaining enabling grid infrastructure owned by the utility. The removal of these programs would significantly restrain the energy storage market, due to the fact that how closely it is tied to the development of the solar PV market. The distributed storage industry knows it cannot expect to follow the same path as solar PV by relying on subsidies to prop up the industry. Thus, there must be a sustainable value proposition regardless of subsidies, and this may require changes in rate structures and regulations that effectively quantify the value created by distributed energy and battery storage while accurately accounting for the underlying grid system cost to support this new distributed system.

Lastly, the issuance of restrictive regulations and resistance from existing utilities. Utilities in some areas have eagerly worked to intercepted users from using the Behind-The-Meter (BTM) storage to consume more of the electricity they generate on-site. These efforts have included enactment of regulations prohibiting third-party system ownerships, which have driven market growth in leading markets, as well as ones imposing special fixed charges or tariffs for self-consumption of power generated on-site. Although the fact that these systems, when properly coordinated and incentivized, can increase the stability of the grid

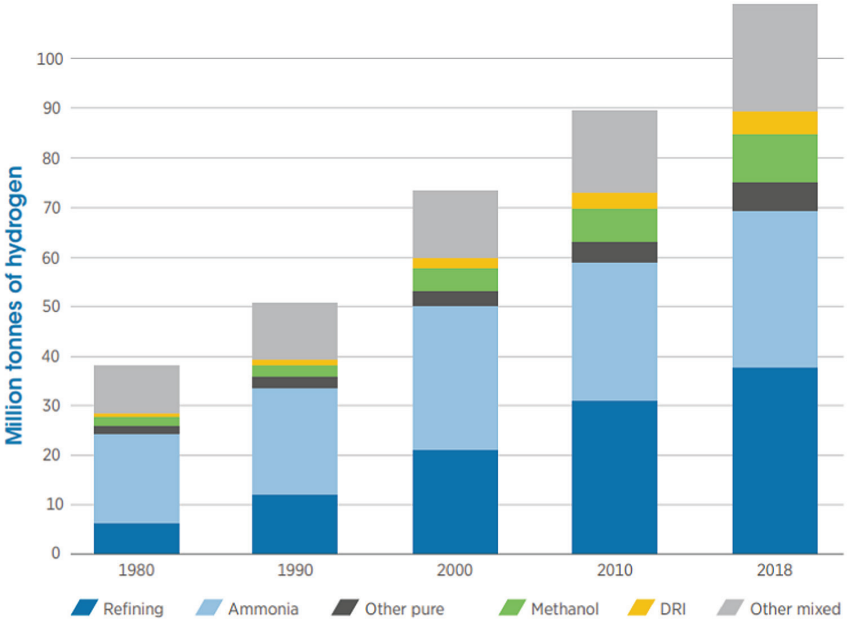

Figure 8: Global annual demand for hydrogen since 1980 (IEA, 2019)

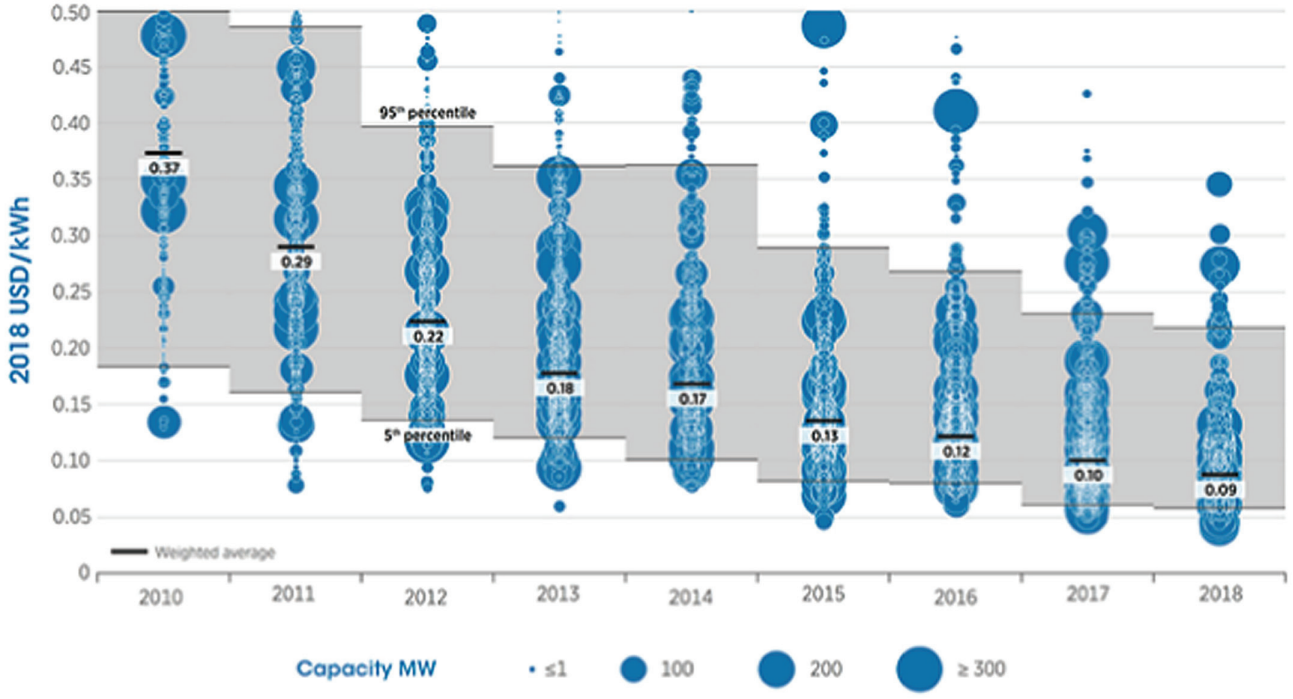

Figure 9: LCOE from utility-scale solar PV projects, global weighted average, and range, 2010–2018 (IRENA, 2019)

and allow for more renewables to be added effectively, they are viewed by some utilities as a direct threat to their business since it could allow some clients to defect from the grid or greatly reduce the amount of energy they purchase from the grid (ESMAP, 2017).

Recommendations

Therefore, several recommendations are made to help enhancing further deployment and adaptation of battery storage in Southeast Asia, such as:

- Establish a specific institution to conduct further Research, Development, & Demonstration (RD & D).
- This recommendation is hoped to be helpful, particularly in raising the little knowledge and awareness of how essential battery storage is. Also, since numerous advanced battery storage technologies within ASEAN are still in a pre-commercialized stage, the costs of battery storage devices are aforementioned expected to decrease in the future. RD & D reduces the high capital costs of battery storage, increases the potential revenue streams through increased applications in ancillary services markets, and also helps to show the battery's viability of advanced and next-generation. Additionally, demonstration projects are crucial in order to show the viability of newer technologies. Successful demonstrations will reduce the risk of investing in these technologies and help in securing private investor funding for large-scale battery storage systems.
- Create an Investment Tax Credits (ITCs) for the battery developers' incentives.

  It is believed to be an effective method of reducing capital costs and limiting exposure to technological and capital risk. ITCs also promote a more rapid increase in storage capacity for services such as frequency regulation. For instance, United States has been implementing this regulation. Research has shown that with a possible 20% federal ITCs for storage in the country over a10-year period, total capacity could triple compared to a scenario without the ITCs itself. An effective implementation of ITCs will promote battery storage expansion in the short run while accelerating long-run capital cost reductions. A dynamic battery storage market characterized by stable supply and low costs is important to reach the full potential of further ASEAN's smart grids.
- Encourage market formation and support for battery storage.

  As the growth of deregulated markets, significant opportunities appear to expand the markets to exploit battery storage services more fully and significantly on the grid. Deregulated electricity markets provide the best opportunity for further developing battery services. The deregulation of utilities and energy markets and support for greater regulatory and market structure will accelerate participation by storage owners and allow third parties and independent access to energy markets. Energy markets will also become more diversified in terms of the services available for exchange and eligible participants. Therefore, by allowing storage to capture its full value in competitive markets may be among the most effective tools in supporting as well as promoting the deployment and adaptation of storage technologies in ASEAN (Zame et al., 2018).

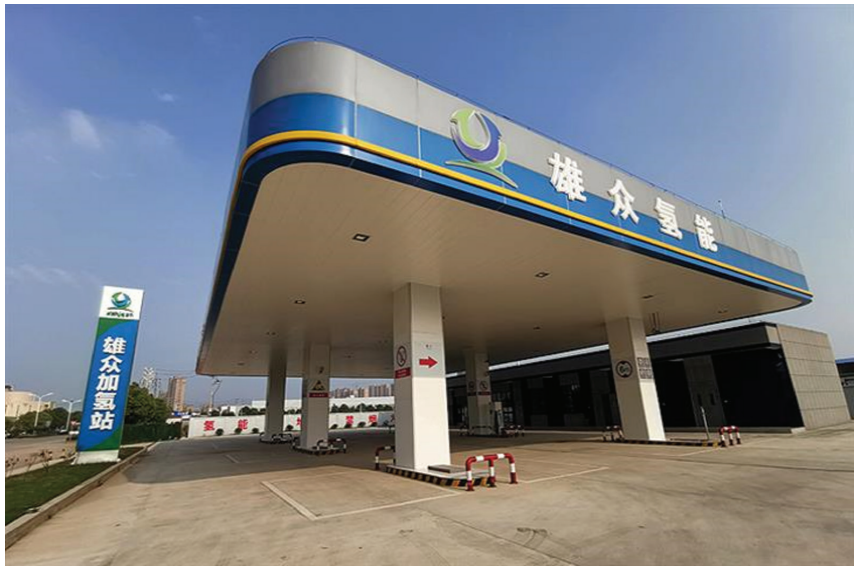

Figure 10: Refueling stations in Guangdong, China (Yicai Global, 2021)

Hydrogen: The key for decarbonization

Current trends and situations

The development and deployment of conventional green technologies have mostly been carried out in the context of national green growth strategies and energy transition. The increasing energy demand can be met by the supply of energy produced by renewable energy and other clean energy alternatives such as hydrogen and clean technologies. Hydrogen is the most abundant chemical element available in the atmosphere and can be a viable source to electrify homes, transport, and industry. Hydrogen is being pursued as a potential form of clean energy given its wide usage in areas such as ammonia production, petrochemical and oil refining industries, and many others. Adopting renewable hydrogen would bring more renewables into the energy mix and could be a game-changer in the transition from fossil dependence to a cleaner energy system in ASEAN. However, in the ASEAN region, hydrogen as an alternative fuel is not yet on the policy agenda. Nevertheless, policy measures are likely to be addressed on emerging and alternative technologies, as hydrogen and energy storage by ASEAN Plan of Action for Energy Cooperation (APAEC) Phase 2 is under preparation for endorsement at ASEAN Ministers on Energy Meeting (Phoumin et al., 2020).

The potential of hydrogen as an energy carrier and complementary development for large-scale expansion of renewable energy in ASEAN and East Asian countries should be studied. The ERIA report (2019)

Table 1: Central and local subsidies for fuel cell electric vehicles in China, as of 2019 (ERIA, 2020)

	Central Government	Guangdong Province
FC passenger vehicle	CNY6000/kW (up to CNY200,000 per vehicle)	CNY200,000 per vehicle
FC light truck or bus	CNY300,000 per vehicle	CNY300,000 per vehicle
FC heavy truck or bus	CNY500,000 per vehicle	CNY500,000 per vehicle
HRS		Up to CNY 8 million per station

CNY = yuan, FC = fuel cell, kW = kilowatt, HRS = hydrogen refueling station.

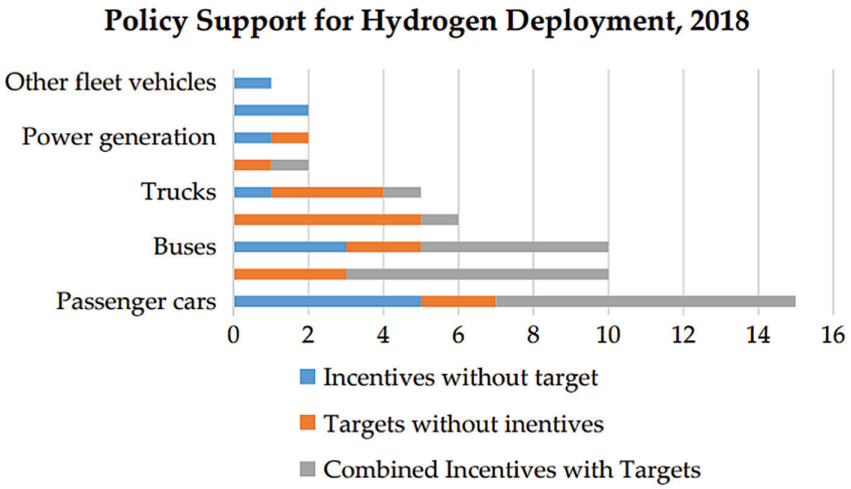

Figure 11: Support policies for hydrogen development (Muradov and Veziroğlu 2005)

estimates the prospect of hydrogen demand by 2040 in ASEAN and East Asia Summit countries as shown in Figure 7.

ASEAN = Association of Southeast Asian Nations, EAS = East Asia Summit, Lao PDR = Lao People's Democratic Republic, Mtoe = million tonnes of oil equivalent.

Indonesia has the largest potential for hydrogen demand among ASEAN member countries, followed by Malaysia. Meanwhile, China has the largest potential for hydrogen demand in the EAS region, followed by India and ASEAN.

It is also supported by the hydrogen use trends in the IEA report (Figure 8) that global demand for hydrogen has increased from less than 30 Mt H_2 in 1975 to 115 Mt in 2018, including both hydrogens in pure form and mixed with other gases (with pure hydrogen summing up to more than 70 Mt in 2018).

Currently, around 95% of hydrogen is produced from coal and gas, also called "grey hydrogen," and a small portion is produced with carbon capture, sequestration, and storage (CCS), called "blue hydrogen." Less than 5% of total hydrogen production is produced from renewables, also known as "green hydrogen." Green hydrogen obtained through the electrolysis of water could be a non-polluting alternative for energy. Green hydrogen could be adopted in sectors such as transport, power generation, construction buildings, and energy storage as it can make a remarkable contribution to clean energy transitions. Hydrogen has the characteristics of being light, storable, and energy-dense, and no direct emissions of greenhouse gases make it an important part of a clean and secure energy future (Nepal et al., 2021).

The increasing scope and continued decline of renewables (such as solar and wind) in the costs demanded innovative green technology, could develop hydrogen storage facilities. As shown in Figure 9, shows the global weighted-average cost of energy (LCOE) of utility-scale solar PV declined by 77% between 2010 and 2018, from USD 0.371/kWh to USD 0.085/kWh.

With lower renewable energy costs, it is possible to create an economical and sustainable (low emission) process for "green" H_2 production; in particular, the market has shown a substantial reduction in the cost of electricity production from renewable energy, "green energy." In addition, the increase in electrolysis capacity is expected to have another additional impact in reducing the cost of producing green H_2.

Then, the cost of hydrogen is also considered competitive due in 2040 will fall by more than 50%. Indeed, the current cost of supplying renewable energy is about five times higher than gas, but the costs will come down with investments in the hydrogen supply chain. By 2023, many hydrogen projects in Organization for Economic Cooperation and Development (OECD) countries are expected to be launched, including electrolysers and pipelines for distribution to end-users. Island countries, especially in the ASEAN region, will benefit since hydrogen itself is a clean energy carrier that will provide the best prospects for accelerating its storage (ERIA, 2020).

Challenges

Despite its benefits and potential, hydrogen technology in developing economic regions such as Southeast Asia faces several challenges that impede its immediate broad-scale application. Clean hydrogen technologies are available, but costs remain challenging. Producing hydrogen from low-carbon energy is currently costly yet the cost of producing hydrogen from renewable electricity is falling rapidly. Combining wind power and hydrogen storage systems for power generation is also considered economically unfeasible, as mixed wind-hydrogen systems will increase investment costs in component infrastructure and significantly reduce profits.

Besides costs, the development of hydrogen infrastructure such as storage is a challenge and hinders the spread of hydrogen fuel technology adoption. Hydrogen is a

light element that is several times less dense than conventional fuels. For example, in the gas phase, preventing leakage due to the permeability of pressurized gases requires premium materials used in the construction of storage vessels. Finding the right balance between the durability and weight of a hydrogen storage system is a challenge. Storage solutions that efficiently and economically require further development and deployment.

Last but not least, the other important challenge is the different government regulations, technological gaps, and the lack of progress in terms of regional cooperation in key areas such as physical infrastructure that challenge the country's energy security itself. Currently, the regulations of several countries limit the development of the clean hydrogen industry. Governments and industry must work together to ensure that the existing regulations do not become unnecessary barriers to investment (IRENA, 2019).

Lesson learned from China

Developing a cost-effective hydrogen supply chain such as the production of both hydrogen and hydrogen-based products requires the site-specific aspects of different technology options to be considered. Countries in the ASEAN region such as Singapore, Malaysia, Thailand, Indonesia, and the Philippines can take lessons from the OECD countries, to guide the economy such as investment and in terms of government policies on the development of hydrogen produced from both renewable and non-renewable.

China has abundant renewable energy resources are often located in sparsely populated vast areas far from the large industrial cluster. In some places, renewable energy has been used so rapidly that grid electricity has difficulty adapting in real-time. This provides an opportunity for producers of hydrogen and hydrogen-rich chemicals to utilize renewable resources and makes China one of the highest producers and consumers of hydrogen energy. The country has accelerated hydrogen investment support for local industry of which approximately US$ 2 billion was injected. In addition, as of 2019, the central government had issued more than 10 policy documents, and of 34 provincial administrative areas, had issued policies to develop hydrogen energy-related industries and infrastructure.

Hydrogen fuel has great potential to combat climate change by facilitating the transition to low-carbon energy sources. For the development of hydrogen fuel, infrastructure had a role of pivotal thing. Guangdong Province in Southeast China has devised a plan to accelerate the development of hydrogen fuel cell electric vehicles (FCEV) and also provides the most generous subsidies for FCEVs and hydrogen refueling stations (HRSs), in addition to central government subsidies. As shown in Table 1, a summary of central and local subsidy policies as of 2019.

Policy recommendations

Until now, ASEAN has not had a hydrogen road map. But in APAEC, mentions alternative technologies and clean fuels such as hydrogen and energy storage. APAEC will help AMS increase the share of hydrogen in its energy mix. The ASEAN hydrogen roadmap is needed to guide the national roadmap. Many developing countries have started to adopt strategies related to green growth into their economic development agenda. Effective policies can assist in accelerating hydrogen development and adoption, increasing economies of scale, cost competitiveness in hydrogen production, and attract investors.

The policy recommendations include:

- Hydrogen has been used as a feedstock in several key industrial segments for decades. The availability of hydrogen in the ongoing energy transition can help supply large amounts of renewable energy into sectors that otherwise is difficult to decarbonization. In this case, power-to-hydrogen can provide some of the additional flexibility needed to accommodate the large VRE stock expected to be online in the next decade (IRENA, 2018).
- The technologies are ready. A rapid scaling-up is now needed to reduce costs and ensure the economics of hydrogen's long-term viability. Initial efforts could focus on transitioning to a hydrogen carbon economy with minimal infrastructure requirements, and in sectors where hydrogen from renewable energy is prominent such as industries and transportation. The hydrogen economy is an economy that relies on hydrogen as a commercial fuel that can replace conventional fuels such as diesel and gasoline which can cause environmental pollution (The Edge Market, 2021).
  ASEAN countries can emphasize the efficient interaction between energy, environment, and the economy is moving towards a hydrogen carbon economy. As for the ASEAN region, Malaysia, Sarawak Local Government started to operate hydrogen buses immediately. Singapore is also working with companies from Japan to explore the development of hydrogen as new clean fuel to decarbonize emissions. Similarly, Brunei is also a leader in the hydrogen supply chain as it has been supplying liquid hydrogen to Japan since 2019. As shown in Figure 11, that investment support for hydrogen technology has increased recently in many countries with around 50 targets, mandates, and some policy incentives mainly focused on the transport sector.
- To achieve rapid improvement, a stable and supportive policy framework must be needed to encourage private investment. In terms of achievement of significant expansion, capital requirements may be beyond the ability of the operator, and additional funds from public and private sources of capital may be required.

Conclusion

With the carbon emissions increasing each day, the urgency to minimalize future climate impacts is significantly encouraged. Green technologies are one of the critical solutions in accelerating the world's path toward the greener future. The development of advanced technologies such as battery storage and hydrogen fuel cells was initiated when the first oil crisis struck

in the 1970s. Battery storage has been utilized as the key to the renewable energy penetration. As the electricity generated from the renewables is intermittent depending on the external factors such as the weather, battery storage might be one of the tools for climate change mitigations that needs to be further adapted. In addition, hydrogen fuel cells can also be used as an alternative fuel which is the key to decarbonizing energy systems. Adopting hydrogen can reduce dependence on fossil fuels in this transition period. Therefore, this article has discussed the availability of such existing technologies, forecasts of demand potential including its competitiveness, projects of production potential including its costs of supply and infrastructure, economic feasibility analysis, as well as the potential applicable policies.

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Technology and Innovation Report 2021

Recent developments in frontier technologies, including artificial intelligence, robotics and biotechnology, have shown tremendous potential for sustainable development. Yet, they also risk increasing inequalities by exacerbating and creating new digital divides between the technology haves and have-nots. The COVID-19 pandemic has further exposed this dichotomy. Technology has been a critical tool for addressing the spread of the disease, but not everyone has equal access to the benefits.

The UNCTAD Technology and Innovation Report 2021 examines the likelihood of frontier technologies widening existing inequalities and creating new ones. It also addresses the national and international policies, instruments and institutional reforms that are needed to create a more equal world of opportunity for all, leaving no one behind.

The report shows that frontier technologies already represent a $350 billion market, which could grow to $3.2 trillion by 2025. This offers great opportunities for those ready to catch this technological wave. But many countries, especially the least developed and those in sub-Saharan Africa, are unprepared to equitably use, adopt and adapt to the ongoing technological revolution. This could have serious implications for achieving the Sustainable Development Goals.

The report urges all developing nations to prepare for a period of deep and rapid technological change that will profoundly affect markets and societies. All countries will need to pursue science, technology and innovation policies appropriate to their development stage and economic, social and environmental conditions. This requires strengthening and aligning Science, Technology and Innovation systems and industrial policies, building digital skills among students and the workforce, and closing digital divides. Governments should also enhance social protection and ease workforce transitions to deal with the potential negative consequences of frontier technologies on the job market.

The report also calls for strengthened international cooperation to build innovation capacities in developing countries, facilitate technology transfer, increase women's participation in digital sectors, conduct technological assessments and promote an inclusive debate on the impact of frontier technologies on sustainable development.

For downloading the report, please access:

https://unctad.org/system/files/official-document/tir2020_en.pdf

Tech Events

2021

Nov 17–19, Virtual
13th Asian Conference on Machine Learning (ACML 2021)
Contact: Secretariat
E-mail: acml21-conf@googlegroups.com
http://www.acml-conf.org/2021/

Nov 26–28, Shenzhen, China
2021 6th International Conference on Renewable Energy and Conservation (ICREC 2021)
Contact: Ms. Rachel Cao
Conference Secretary
Tel: +86-13880104217
E-mail: icrec_conf@163.com
http://www.icrec.org/

Dec 8–10, Virtual
Second Annual Asia-Pacific Hydrogen Summit
Contact: Rob Arthur
Tel: +44 20 7978 0095
E-mail: AsiaHydrogen@sustainableenergycouncil.com
https://asia-hydrogen-summit.com/

Dec 5–8, Brisbane, Australia
2021 Innovative Smart Grid Technologies Conference Asia (ISGT Asia 2021)
Contact: Arinex Pty Ltd
ABN.28 000 386 676
S3, The Precinct 12 Browning Street
West End, QLD 4101, Australia
Tel: +61 7 3226 2800
E-mail: isgt2021@arinex.com.au
https://ieee-isgt-asia.org/

2022

Jan 7–9, Kuala Lumpur, Malaysia
2022 The 8th International Conference On Renewable Energy Technologies (ICRET 2022)
Contact: Amber Tseng, Conference secretary
Tel: +86-28-8777-7577
E-mail: icret@young.ac.cn
http://www.icret.org/

Feb 7–9, Virtual
Virtual Water Expo & Conference 2022
Contact: WATER TODAY PVT.LTD.
3D, 3rd Floor,
Bhagheeratha Residency,
124, Marshall's Road, Egmore
Chennai - 600 008, Tamil Nadu, India
https://www.waterex.biz/

Feb 25–27, Hanoi, Viet Nam
2022 8th International Conference on Environment and Renewable Energy
Contact: Ms. Alice Lin
Conference Secretary
Tel: +86-(0)28-88220101
Mobile: +86-15908122414
E-mail: icere@ieet.ac.cn
http://www.icere.org/

Feb 25–27, Shiga, Japan
2022 12th International Conference on Renewable and Clean Energy (ICRCE 2022)
Contact: Ms. Penny P. L. Gan
Conference Secretary
Tel: 86-132-9000-0003
E-mail: icrceconf@126.com
http://www.icrce.org/

Mar 4–6, Singapore
2022 The 6th International Conference on Green Energy and Applications
Contact: Secretary of ICGEA 2022
Tel: +86-28-8777-7577
E-mail: icgea@young.ac.cn; http://www.icgea.org/

Mar 11–13, Chengdu, China
The 4th International Conference on Robotics and Intelligent Systems (ICRIS 2022)
Contact: Ms. Sharon Liu
Conference Secretary of ICRIS
Tel: +86-28-6302-3585/+86-15902806624
E-mail: icris@academic.net
http://www.icris.net/

Mar 18–21, Tianjin, China
2022 8th International Conference on Computing and Artificial Intelligence (ICCAI 2022)
Contact: Ms. Olia Lai
Conference Secretary
Tel: +852-3500-0799
E-mail: iccai@cbees.net
http://www.iccai.net/

Mar 23–25, New Delhi, India
7th Smart Cities India Expo
Contact: Pramit Kumar, Vice President
Exhibitions India Group
C-103, Okhla Industrial Estate
Phase III, New Delhi - 110 020, India
Mob: +91 98110 78179
E-mail: pramitk@eigroup.in
https://www.smartcitiesindia.com/

Mar 27–29, Singapore
2022 3rd Asia Conference on Renewable Energy and Environmental Engineering (AREEE 2022)
Contact: Nancy Liu
Conference Secretary
AREEE Conference Secretariat
Tel: +86-28-86512185
E-mail: areee@iacsitp.com
http://www.areee.org/

Mar 29–31, Kuala Lumpur, Malaysia
ASIAWATER 2022
Contact: Informa Markets Malaysia Sdn. Bhd.
Suite 5-01, Level 5, Sunway VISIO Tower,
Lingkaran SV, Sunway
Velocity, 55100 Kuala Lumpur, Malaysia
Tel: +603 - 9771 2688
E-mail: asiawater-my@informa.com
https://www.asiawater.org/

May 20–22, Suzhou, China
2022 6th Workshop on Energy Conservation Technologies (IWECT 2022)
Contact: Ms. Yury Yu
Secretary office of IWECT 2022
Tel: +852-30506939(HK)/+86-19136072802
E-mail: iwect@apise.org; https://www.iwect.org/

Jul 20–22, Bangkok, Thailand
Future Energy Asia
Contact: Yuyuan Chen
Head of Energy Transition – Asia
dmg events Asia Pacific Pte Ltd
138 Market Street, #05-01, CapitaGreen
Singapore 048946
Tel: +65 6856 5205
E-mail: YuyuanChen@dmgevents.com
https://www.futureenergyasia.com/

Sep 15–18, Colombo, Sri Lanka
8th Asian Vaccine Conference
Contact: Conference Organiser
2nd Floor PICO Creative Centre
20 Kallang Avenue, Singapore 339411
Tel: +65 6389 6644
Fax: +65 6292 4721
E-mail: info@asianvaccine.com
https://asianvaccine.com/

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- Waste plastics into industrial fuel
- Solar chimney for electricity generation
- Wind energy
- Kitozan biofertilizer

Startup development in Philippines

Department of Trade and Industry, Philippines
http://innovate.dti.gov.ph/

The Startup ecosystem in the Philippines is young, vibrant, and full of potential. Startups introduce innovative products and create new business models that address changing societal and market needs. As such, it is important for the government to support the development of the startup ecosystem to foster an innovative and entrepreneurial culture in the country. DTI, DOST, and DICT, together with other government agencies are working together in order to further develop the Philippine Startup Ecosystem through the implementation of the implementation of R.A. 11337 or the Innovative Startup Act.

The Innovative Startup Act provides benefits, incentives, and other forms of support to the startup ecosystem including the provision of startup visas, expedited processes, establishment of the Startup Venture Fund, Grants-In-Aid, the crafting of the Startup Ecosystem Development Program, and the establishment of Startup Ecozones, among others.

The nurturing of Startup Ecosystems are at the forefront of the government's initiatives in forging partnerships, bridging gaps, and enabling stakeholders to ensure a competitive, innovative, and inclusive Philippines.

SMART (Strategic MSMLE & Startup) Link

SMART Link aims to match leading-edge innovative startups in the Philippines with commercial products to traditional enterprises (MSMLEs) through conducting business-to-business matching sessions or Smart Link Sessions. The objective of this program is to facilitate partnerships and collaborations between startups and traditional enterprises to: (i) provide startups an opportunity to access different markets across different industries thereby increasing revenue streams; (ii) expose traditional enterprises to startups and engage in innovative activities (e.g., through acquisition of digital solutions); and (iii) drive digitalization in traditional enterprises to increase firm productivity, competitiveness, and business resiliency.

Startup Acceleration and Incubation by DTI (startupAID)

The startupAID program aims to assist innovative startups in their product launch, commercialization, and scaling up. It helps accelerate the growth of viable technological startups by undergoing a specialized training program co-developed with partnered startup enablers.

DTI partners with local and international startup enablers to provide a specialized incubation/acceleration program designed to enable tech startups pursue business development, fundraising, and other strategic opportunities. Program participants will be exposed to the enabler's extensive network of corporate, technology and investment partners as well as mentors and advisors.

International and Local Exposure Assistance Program (ILEAP for Startups)

As one of the lead host agencies of the Innovative Startup Act, the DTI is mandated to support the growth of local startups and the development of the country's startup ecosystem as a whole. By doing so, more entrepreneurial opportunities are facilitated and more job-generating businesses are established. Among the benefits and incentives that host agencies can provide to qualified startups is support to their participation in local or international startup events or competitions.

Global Acceleration Program

The Global Acceleration Program (GAP) aims to assist startups survive their early stages, scale up, and globalize. It seeks to help accelerate the growth of viable technological startups with priority given to those startups that address the challenges brought about by the covid-19 pandemic. Startups will be immersed in the global ecosystem to enable them to pursue global business development, fund-raising, and other strategic opportunities. The program will help startups get across the tail-end of the "Valley of Death" and further increase their market reach and valuation by expanding into regional and global markets.

Enterprising Ideas - A Guide to Intellectual Property for Startups

This publication introduces startups to IP. Through step-by-step guidance, useful case studies and simple checklists, it illustrates how small businesses can use IP to remain competitive and manage risks. Written for startups bringing an innovative technology-based solution to market, the guide will be useful to any entrepreneur wanting to get to grips with the IP system.

For more information, access:

https://www.wipo.int/edocs/pubdocs/en/wipo_pub_961.pdf

Vietnam's startup ecosystem

National Innovation Enterprise General Portal Education Board, Viet Nam

http://startup.gov.vn/

Overview

The innovative startup has become a national topic for Vietnam, with the Prime Minister calling 2016 the Year of Innovative startups. Proposals and support policies have been initiated since then to promote innovative startups, and at the same time, specialized departments and units were formed with the goal of supporting the innovative startup ecosystem.

Key government entities supporting the ecosystem includes the Ministry of Science and Technology (MOST), which is charged by the government to lead the National Program 844 (ISEV) and also hosts the Office of ISEV, National Agency for Technology Entrepreneurship and Commercialization Development (NATEC), The Office of National Programmes on Science and Technology (ONPOST), and Vietnamese representative of Science & Technology in foreign countries.

National Program 844

The National Program 844 is tasked with supporting the development of the startup ecosystem. The program provides support for organizations within the ecosystem such as incubators, accelerators, universities, and so on. The program has been running since 2016, with 52 localities/provinces having plans to implement the program locally. Nationally, there are 61 programs that are supporting the ecosystem, carried out through the participation of 50 lead organizations, 37 partner organizations, as well as supporting incubators, accelerators, legal, financial, intellectual property services to expand markets for startup businesses and also promote startups through media communications in Vietnam.

Until 2019, the program has supported 202 training courses on innovative startups and in 2019, helped incubators and support centers such as the Business Startup Support Center (BSSC) & Business Studies & Assistance Center (BSA), which has facilitated investments worth 37 billion VND and 8 billion VND respectively. It has also supported over 140 startup events in the ecosystem and also hosted TECHFEST Vietnam 2019 in the US, South Korea, and Singapore in order to connect the Vietnamese ecosystem and Vietnamese startups with these ecosystems.

National Program 844 is also involved in the development and revision of policies to create a favorable environment for startups such as tax benefits, financial support for startups, investors and policy mechanisms to implement pilot support programs in municipal and provincial governments.

At the local level, support programs and initiatives are also being implemented by the local People's Committee through the creation of professional startup support units. Fifty-two provinces have created a variety of supporting programs. These can be categorized into 3 different implementation strategies:

1. Direct support through the local People's Committees such as in Ha Tinh and Dong Thap Provinces.
2. Establishment of steering committees and working groups to design and implement support program such as in Quang Nam, Ba Ria-Vung Tau & Hung Yen.
3. Assigned responsibility for ecosystem support to the local Department of Science and Technology (35 provinces) and Department of Planning and Investment (13 provinces).

Other programs

Additionally, the government has programs to help support startups and entrepreneurs through National Program 1665, headed by the Ministry of Education and Training (MOET) which provides support for students, youth entrepreneurs, startups and National Program 939, Headed by Vietnam Women's Union which supports female entrepreneurs.

National Program 1665

Across the country, 90% of Departments of Education and Training has issued plans to implement National Program 1665, actively introducing students to the information system supporting startups; The Ministry has also organized a Students Entrepreneurship Contest in 2019 attracting nearly 300 projects and has also signed agreements with businesses to mobilize resources and media to enhance communication for National Program 1665.

The Ministry of Education and Training (MOET) has cooperated with partners such as the British Council, NOVA Education Technology Joint Stock Company and JA Vietnam to develop guidelines and instructions on supporting entrepreneurial students, entrepreneurial training guidelines for high school students and has also organized training courses to raise awareness for government leadership, managers, educators, and students about entrepreneurship at educational institutions.

Furthermore, MOET has assigned 3 training institutions to carry out a pilot program designed to develop university innovative ecosystems in 3 regions, development of 2 coworking spaces inside the training centers in the Central and Southern Vietnam and the building of a Career Support Portal to help students have an overview of training institutions and startup support systems within institutions and training facilities.

National Program 939

National Program 939's main activities aim at supporting Female Entrepreneurship in business development by providing training for provincial support staff and direct support for female entrepreneurs in the form of facilitating access to capital and investments, connecting with investors, customers, and the market.

The program has provided over 100 billion VND to support entrepreneurship through the Union, including:

1. Guidance documents on business planning, a series of guide books intended for ethnic minority women by topics and case study of successful female entrepreneurs.
2. 10 training courses for lecturers on guidance on business planning, skills to build a memorable brand name, digital business skills, etc. for 380 Women's Union officials of 63 provinces/cities in Hanoi, Son La, Da Nang, Bac Kan, Can Tho, Ha Tinh, and Ho Chi Minh City. At the provincial and district level, 34,342 Union members and officials of some provincial departments and agencies have been provided with briefing and training within the program.
3. Facilitated women's access to credit and loans through cooperation with the Social Policy Bank of Vietnam, Agribank, Microfinance Institutions, and other businesses, international and domestic organizations.
4. Organized many product introductions and promotional events such as organizing sales points, product trade fair, and putting products into supermarkets. Typically, the Hanoi Women's Union has supported over 300 female businesses to participate in trade promotion at home and abroad, developing contracts to consume Vietnamese goods worth billions of dong in Laos, China, and South Korea.

Other activities of the program in 2019 include helping to set up 42 Women Entrepreneur Clubs, 48 business incubators, organizing a Regional Entrepreneurship Day in 3 regions, exhibition and fair to sell safe agricultural products; "Women's Entrepreneurial Journeys" exhibition and support the establishment of co-operatives in Vietnam, with 196 Co-ops and 1,067 Co-op groups established; more than 4,000 managers and executives of Co-ops and co-op groups have been provided training.

Nationally, the program has allowed 6,076 women with startup ideas to be provided with funding worth 151,296 billion VND; 17,615 female-led businesses were consulted, trained, connected with a loan of 148,697 million VND and 15,352 women started new business ventures with 504 newly established businesses.

Technology Bank for Least Developed Countries

The United Nations Technology Bank for Least Developed Countries is a global organization dedicated to enhancing the contribution of science, technology and innovation for sustainable development in the world's least developed countries. The UN Technology Bank supports national and regional technological efforts, reinforces partnerships across sectors and helps nations identify and use appropriate technologies to transform their economies and improve livelihoods. To ensure that LDCs are not left behind in achieving the 2030 Agenda on Sustainable Development, the UN Technology Bank undertakes initiatives to stimulate the production of high-quality research and its work directly supports a wide range of SDGs.

The UN Technology Bank assists least developed countries by building capacity of these nations to access and use science, technology and innovation. The UN Technology Bank is taking steps to stimulate the production of high-quality research in these countries through capacity development and fostering international research collaboration, both South-South and South-North. The Bank works to strengthen the capacity of Academies of Science in least developed countries so that these institutions can act as advisors to the government and industry on science, technology and innovation.

For more information, access:

https://www.un.org/technologybank/

Commercialization of IPRs in India

Office of the Controller General of Patents, Designs & Trade Marks (CGPDTM), Government of India

https://ipindia.gov.in/

The value and economic reward for the owners of IP rights comes only from their commercialization. A concerted effort should be made for capitalizing the existing IP assets in the country. Entrepreneurship should be encouraged so that the financial value of IPRs may be captured. Existing mechanisms including Incubators and Accelerators set up to promote entrepreneurship should be strengthened with IP-oriented services.

Financing is a major impediment for entrepreneurs and therefore it is necessary to connect investors and IP creators. Another constraint faced is valuation of IP and assessment of the potential of the IPRs for the purpose of marketing it. There is an urgent need to take stock of existing IP funding by different departments and bodies of the Government like BIRAC, NRDC, and TIFAC, and take measures to consolidate the same, scaling up successful models while avoiding duplication of efforts.

Public-funded research laboratories, academia, and other institutions should stimulate commercialization of their research outcomes. They ought to be suitably state-supported in the development and deployment of their IPRs. While certain larger organizations have the intent and capabilities to commercialize their technology/IPRs, several others do not. Hence, it becomes imperative to establish facilitate mechanisms that can address such limitations, especially in terms of MSMEs, academic institutions, and individual innovators. One of the effective ways of achieving this would be by synergizing the activities of IP facilitation centers with the industry, especially industrial clusters. This would also include sensitization regarding licensing arrangements.

Efforts should be made for creation of a public platform to function as a common database of IPRs. Such a platform can help creators and innovators connect to potential users, buyers, and funding institutions. It would also be helpful in scouting the technology landscape to identify white spaces and thereby help promote innovative activities in uncovered areas. Significant potential for innovation exists in new and emerging technologies like nanotechnology, biotechnology, agribiotech, life sciences, green technologies, telecommunications, new materials, space technologies, etc. The steps to be taken towards attaining this objective are outlined below:

5.1. CIPAM shall also undertake the following tasks:

5.1.1. Provide a platform for IPR owners and users of IPRs by acting as a facilitator for creators and innovators to be connected with potential users, buyers and funding agencies;

5.1.2. Undertake a study to examine the feasibility of an IPR Exchange;

5.1.3. Establish links among different organizations for exchange of information and ideas as also to develop promotional/educational products and services;

5.1.4. Facilitate access to databases on Indian IP and global databases of creators/innovators, market analysts, funding agencies, IP intermediaries;

5.1.5. Study and facilitate implementation of best practices for promotion and commercialization of IP within the country and outside;

5.1.6. Promote public sector initiatives for IPR commercialization.

5.2. Promote licensing and technology transfer for IPRs; devising suitable contractual and licensing guidelines to enable commercialization of IPRs; promote patent pooling and cross licensing to create IPR based products and services.

5.3. Provide support for MSMEs, Individual Inventors and Innovators from the informal sectors with enablers like facilitation centers for single window services to help them commercialize their IPRs.

5.4. Incentivize Indian inventors, MSMEs and start-ups to acquire and commercialize IPRs in other countries also.

5.5. Examine availability of Standard Essential Patents (SEPs) on fair, reasonable and nondiscriminatory (FRAND) terms.

5.6. Identify opportunities for marketing Indian IPR-based products, especially GIs, and services to a global audience.

5.7. Promote collaborate IP generation and commercialization efforts between R&D institutions, Industry, Academia and Funding Agencies.

5.8. Ensure enhanced access to affordable medicines and other healthcare solutions by (a) encouraging cross-sector partnerships between public sector, private sector, universities and NGOs; (b) promoting novel licensing models, and (c) developing novel technology platforms.

5.9. Streamline regulatory processes to ensure timely approval for manufacturing and marketing of drugs while maintaining safety and efficacy standards.

5.10. Make efforts to reduce dependency on active pharmaceutical ingredients (API) imports, including incentivizing manufacture of APIs in India and revitalizing public sector undertakings in health care sector.

5.11. Support the financial aspects of IPR commercialization by:

5.11.1. Enabling valuation of IP rights as intangible assets by application of appropriate methodologies and guidelines; facilitating

securitization of IP rights and their use as collateral by creation of enabling legislative, administrative and market framework;

5.11.2. Facilitating investments in IP driven industries and services through the proposed IP Exchange for bringing investors/funding agencies and IP owners/users together;

5.11.3. Providing financial support to the less empowered groups of IP owners or creators like farmers, weavers, artisans, craftsmen, artists etc. through financial institutions like rural banks or co-operative banks offering IP friendly loans;

5.11.4. Providing financial support for development and commercialization of IP assets through links with financial institutions including banks, venture capital funds, angel funds, crowd funding mechanisms;

5.11.5. Utilizing Technology Acquisition and Development Fund under the Manufacturing Policy for licensing or procuring patented technologies;

5.11.6. Taking stock of all IP funding by the Government and suggesting measures to consolidate the same to the extent possible; scaling up the funding as needed and avoiding duplication; enhancing the visibility of IP and innovation related funds so that utilization is increased; performance based evaluation for continued funding.

5.12. Promote use of Free and Open Source Software along with adoption of open standards; possibility of creating Indian standard operating environments will be examined.

5.13. Promote going-to-market activities by:

5.13.1. Creating mechanisms to help MSMEs and research institutions to validate pilots and scale up through market testing;

5.13.2. Providing seed funding for marketing activities such as participating in trade fairs, industry standards bodies and other forums;

5.13.3. Providing guidance and support to IPR owners about commercial opportunities of e-commerce through Internet and mobile platforms;

5.13.4. Encouraging enterprises to create brand equity from their IP rights, such as Trademarks and GIs.

(Source: National Intellectual Property Rights (IPR) Policy, 2016)

COVID-19 Technology Access Pool

In May 2020, WHO and partners launched the COVID-19 Technology Access Pool (C-TAP) to facilitate timely, equitable and affordable access of COVID-19 health products by boosting their supply. C-TAP provides a global one-stop shop for developers of COVID-19 therapeutics, diagnostics, vaccines and other health products to share their intellectual property, knowledge, and data, with quality-assured manufacturers through public health-driven voluntary, non-exclusive and transparent licenses. This enables manufacturers that currently have untapped capacity to produce COVID-19 health products by giving them the legal rights to manufacture and sell the products; the technological know-how required to develop high-quality products effectively and efficiently; and access to clinical data needed to obtain regulatory approval for their products. This enables manufacturers that currently have untapped capacity to produce COVID-19 health products by giving them the legal rights to manufacture and sell the products; the technological know-how required to develop high-quality products effectively and efficiently; and access to clinical data needed to obtain regulatory approval for their products

C-TAP was launched by WHO, in partnership with the Government of Costa Rica, under a global Solidarity Call to Action endorsed by nearly 40 Member States. WHO C-TAP implementing partners include the Medicines Patent Pool, Open COVID Pledge, UN Technology Bank and Unitaid. Developers of COVID-19 health technologies and holders of related knowledge, intellectual property and data are invited to "share their intellectual property, knowledge and data, and join the Solidarity Call to Action."

By sharing intellectual property and know-how through the pooling and these voluntary agreements, developers of COVID-19 health products can facilitate scale up production through multiple manufacturers that currently have untapped capacity to scale up production.

C-TAP works through its implementing partners, the Medicines Patent Pool, Open COVID Pledge, UN Technology Bank and Unitaid to facilitate timely, equitable and affordable access to COVID-19 health technologies. Developers of COVID-19 health technologies and holders of related knowledge, intellectual property and/or data are invited to voluntarily share with C-TAP by joining the Solidarity Call to Action.

For more information, access:

https://www.who.int/initiatives/covid-19-technology-access-pool

Renewal of patents in Thailand

Department of Intellectual Property, Thailand

http://www.ipthailand.go.th/

Consideration criteria

The protection period of petty patent lasts 6 years, starting from the application date in the Kingdom of Thailand. The petty patent owner may renew the petty patent twice, 2 years each time. To renew a petty patent, the applicant shall submit a request to the competent officer within 90 days before the expiring date. After the submission of the renewal application within the specified period, it shall be deemed that the Petty Patent Registration is still protected under the laws.

Conditions of application submission

1. A petit patent shall have a tern of six years from the date of filing of the applications in the country. The owners of a petit patent may request that the term of his petit patent be extended for two periods, each period shall be valid for two years, by submitting a request to the competent officer within 90 days before the expiring date. If the request is submitted within the said period, the petit patent shall be regarded as validly registered until it is otherwise ordered by the competent officer. The request shall be made by using the form010-Kor
2. Authorization
    2. In case the applicant of the patent does not reside in the Kingdom of Thailand, he shall authorize the patent agent/patent attorney registered with the Director-General of the Department of Intellectual Property to act on his behalf. In this regard, the power of attorney shall be presented to the Director-General in accordance with the following regulations;
        (1) If the authorization is done outside the Kingdom of Thailand, the signatures in the authorization letter or power of attorney shall be certified by the authorized official of the Thai embassy or consulate or Director of the office of the Ministry of Commerce located in the country where the principal or power grantor resides, or the person authorized to act on behalf of the said officials or the person authorized to certify the signature according to the law in that country, or
        (2) In case the authorization is done in the Kingdom of Thailand, the applicant shall submit a copy of passport or temporary residence certificate of the principal or power grantor, or any evidence indicating that at the time the authorization was made, the principal or power grantor was in Thailand.
    2.2 The Power of Attorney shall be attached with the revenue stamp of 30 Baht/patent agent/patent attorney/application.

Proceeding according to the official's instruction

1. In case that the official finds a correctable defect in the application, the official shall notify the applicant or his patent agent/patent attorney for the correction. The applicant shall finish the correction within 90 days of the notification reception date. After such period, without the correction, the applicant shall be deemed to have abandoned the application, except the Director-General extends the period for correction as deemed appropriate due to any necessity.
2. After the applicant corrected the application, the applicant shall submit the correction application and the fee to the Department of Intellectual Property or the provincial office of the Ministry of Commerce. The corrected application shall enter the consideration and initial inspection processes respectively, similarly to the re-submission of the application.
3. In case of application submission via the website of the Department of Intellectual Property, the inspecting official shall check the completeness of information and details in the patent/petty patent application, request or other applications based on information and details appearing in the e-patent filing system. In this regard, the applicant shall present the application and supporting documents to the Department of Intellectual Property within 15 days of application number reception date and patent/petty patent application filing date via internet. The inspection of application submitted via internet shall be in accordance with the Notification of the Department of Intellectual Property Re: Principles and conditions for submission of patent/petty patent application, requests or other applications via internet.

Notes

1. The working process starts after the inspection of the documents is completed, as specified in the manual of the public service.
2. In case the application or documentary evidence is not correct or incomplete, the official shall record the defect of the document or indicate the required additional documentary evidence (Record of conditions on application reception). The applicant shall correct the document and/or submit

the additional document within 90 days of the application filing date. If the applicant fails to submit all additional documents within the specific period of time, the applicant shall be deemed to have abandoned the application. The official shall return the application to the applicant and inform the reason of the return and his appeal right.

3. Any person fee paid to the Department of Intellectual Property shall not be refunded in all cases, except

   (1) The law stipulates that the fee must be refunded, or

   (2) The applicant double-paid or overpaid the fee, by which the faulty payment resulted from the mistake of the state official, not the payer. In this regard, the Department of Intellectual Property shall consider the refund case by case.

4. In case the applicant is required to submit many additional documentary evidences, the applicant shall submit all additional documentary evidences in the same time.

5. In case the applicant submits the copy of the documentary evidence, the applicant shall certify the copy of the documentary evidence.

6. In case the applicant submits the document in foreign language, the applicant shall submit the document with Thai translation and the correct translation certification of the translator.

7. In case the applicant or the authorized patent agent/patent attorney does not submit the application by himself, and granted power to the other person to submit the application, the application submitter shall present a sub power of attorney or temporary power of attorney, so that he is eligible to submit the application and sign in the record of conditions on application reception. If it appears that the application and the documentary evidence is not correct or incomplete, and the application submitter is not authorized to sign on the said record, the official shall not receive the application.

8. The working period does not include the time period when the applicant follows the official's instruction or corrects the application, or the period of temporary suspension of registration.

Relevant laws

- The Ministerial Regulation Re: Fees and fee exemption for patent and petty patent B.E. 2547
- The Patent Act B.E. 2522 as amended by the Patent Act (No. 2) B.E. 2535 and the Patent Act (No. 3) B.E. 2542

CSIR Compendium of Technologies 2021

The CSIR Compendium of Technologies 2021 has been compiled by CSIR-National Institute of Science Communication and Policy Research of the Council of Scientific and Industrial Research (CSIR-NIScPR) of the Ministry of Science and Technology, Government of India. The compendium is based on the technology details provided by different CSIR laboratories at TRL 6 and above.

The compendium is based on the validation of these technologies by experts in eight CSIR themes. Selected technologies for this compendium are those that have been validated by the experts at TRL 6 and above. This compendium contains a total of 313 technologies. Many technologies are protected by Intellectual Property Rights (IPR) filed in the US. Among them, 61 % are most promising (TRL 6 and TRL 7), and 39% are ready for market (TRL 8 and TRL 9) with huge potential for further innovation and commercialization. More than half of the technologies identified are from Agriculture, Nutrition and Biotechnology (ANB) (28%) and Mining, Minerals, Metal and Materials (4M) (24%) combined.

For more information, access:

https://drive.google.com/file/d/10VWMxkKo3La83ea0r2_NNY-ksHomIpk2/view

Startup India Seed Fund Scheme

Startup India Seed Fund Scheme, Government of India

https://seedfund.startupindia.gov.in/

Startup India initiative

The Startup India initiative of the Government of India envisages building a robust Start-up ecosystem in the country for nurturing innovation and providing opportunities to budding entrepreneurs.

An Action Plan with 19 action points for the Startup India initiative was unveiled on January 16, 2016. This Action Plan laid down a roadmap for the creation of a conducive ecosystem for Startups in India. Subsequently, many activities have been undertaken to encourage Startups. Startup India Seed Fund Scheme (SISFS) is one such scheme provides financial assistance to early-stage startups.

Startup India Seed Fund Scheme

Easy availability of capital is essential for entrepreneurs at the early stages of growth of an enterprise. Funding from angel investors and venture capital firms becomes available to startups only after the proof of concept has been provided. Similarly, banks provide loans only to asset-backed applicants.

It is essential to provide seed funding to startups with an innovative idea to conduct proof of concept trials.

Startup India Seed Fund Scheme (SISFS) aims to provide financial assistance to startups for proof of concept, prototype development, product trials, market entry, and commercialization.

This would enable these startups to graduate to a level where they will be able to raise investments from angel investors or venture capitalists or seek loans from commercial banks or financial institutions.

The Indian startup ecosystem suffers from capital inadequacy in the seed and "Proof of Concept" development stage. The capital required at this stage often presents a make-or-break situation for startups with good business ideas.

Many innovative business ideas fail to take off due to the absence of this critical capital required at an early stage for proof of concept, prototype development, product trials, market entry, and commercialization.

Seed Fund offered to such promising cases can have a multiplier effect in validation of business ideas of many startups, leading to employment generation.

An Experts Advisory Committee (EAC) has been constituted by Department for Promotion of Industry and Internal Trade (DPIIT), which will be responsible for the overall execution and monitoring of the Startup India Seed Fund Scheme.

The EAC will evaluate and select incubators for allotment of Seed Funds, monitor progress, and take all necessary measures for efficient utilization of funds towards fulfillment of objectives of Startup India Seed Fund Scheme.

ASEAN-India Science and Technology Development Fund

The ASEAN-India Science and Technology Development Fund (AISTDF) supports R&D projects and associated project development activities. The activities/ projects under AISTDF are ASEAN centered, action-centric and are aligned with the ASEAN Plan of Action on Science, Technology and Innovation 2016-2025. The key requirements of AISTDF are:

1. The contribution will be in the form of grant to research institutions/universities and not-for-profit research/academic entities/organisations.
2. The collaborative R&D project must include participants from India and at-least two ASEAN member states. The collaborative R&D project partners shall agree on the IP rights and the commercialization strategy of the product or process before implementation of project.
3. Researchers/Scientists/Faculty from: public funded research laboratories; academic institutes/universities (private/public); public funded research hospitals; or other public funded scientific research institutions which operate and located in India and ASEAN member states are eligible for support for joint collaborative R&D activities under the Fund.
4. The participation and involvement of industry in the R&D project will be highly encouraged in order to facilitate technology commercialisation and marketing the products developed out of the R&D project. However, private industry will have to bring in their own funds to support their participation in the R&D projects, and is not eligible to receive any grants through AISTDF for their participation in R&D projects.
5. The private entities involved in innovation, technology transfer and commercialisation from ASEAN to India or from India to ASEAN could be supported with maximum of 50% of the total eligible project cost with regard to only for technology transfer/ demonstration/ commercialisation projects.

For more information, access:

https://www.aistic.gov.in/ASEAN/HomePage

Business finance in Malaysia

Malaysian Technology Development Corporation (MTDC), Malaysia
https://www.mtdc.com.my/

Business Start-up Fund

Business Start-up Fund (BSF) is established to fund early-stage technology-based companies. The Fund incorporates elements of loan and equity, offering companies flexible funding via Convertible Promissory Notes (CPN) and/or Preference Shares.

BSF is designed to provide funding to scalable and viable technology-based early-stage companies with the objective to remove the financial blockages in achieving the business goals and matching the business standard and high level of competition, particularly in the growth sectors of the economy.

Business Growth Fund

Business Growth Fund (BGF) is a funding program that focuses on growing the company not only on its production output and reach, but also on internal preparedness towards professionalism, corporate governance, and all the necessary tools to escalate the company to the next level.

Peer-to-Peer (P2P) Financing Programme

MTDC-microLEAP Peer-to-Peer (P2P) Financing Programme is a social lending programme that aimed to facilitate local technology-based companies to obtain financing directly from the mass public; either individual or organization via crowdfunding platform. The programme will enable local technology-based companies to obtain capital through peer-to-peer (P2P) lending from a relatively large number of investors, using an online platform.

The P2P partner, microLEAP (Microleap PLT), is a Recognised Market Operator by the Securities Commission of Malaysia who operates a P2P financing platform that allows businesses to raise crowd-sourced funds in which the issuers (borrowers) may raise financing from as little as RM1,000 while P2P investors may invest in "Investment Notes" issued by them from as little as RM50.

Equity Crowdfunding (ECF) Programme

MTDC-pitchIN Equity Crowdfunding (ECF) Programme is an equity crowdfunding programme aimed to facilitate fundraising for local technology-based companies through crowdsourcing. The programme will enable local technology-based companies to obtain capital through equity investment from a relatively large number of public investors, using an online platform.

The ECF partner, pitchIN (Pitch Platforms Sdn Bhd), is a Recognised Market Operator by the Securities Commission of Malaysia who operates an Equity Crowdfunding platform for companies to raise their funding from the public.

National Technology & Innovation Sandbox Fund

The National Technology & Innovation Sandbox Fund (NTIS) is a national initiative which serves as a "safe place" to allow innovators to test their products, services, business models, and delivery mechanisms in a live environment with relaxations on all or specific processes and/or regulatory requirements. In support of the NTIS programme, MTDC offers the NTIS Fund which will finance relevant activities under the programme.

Asia and the Pacific Renewable Energy Status Report

This report provides a comprehensive overview of renewable energy developments in Asia and the Pacific. It covers 18 countries in the region considered fundamental to the clean energy transition. Covering five subregions in Asia and the Pacific, the report presents the current status of renewable energy by examining the policy landscape, investment flows, and how renewables are increasing energy access.

The report was produced by REN21 in collaboration with the Asian Development Bank and the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). The report builds on the success and lessons learned in producing the Renewables Global Status Report and other REN21 regional status reports, to inform on the current status of renewable energy in the region, focusing on those countries where data is currently available.

For more information, access:

https://www.adb.org/sites/default/files/publication/611911/asia-pacific-renewable-energy-status.pdf

Inclusive innovation industrial strategy of Philippines

Department of Trade and Industry, Philippines

http://innovate.dti.gov.ph/

In support of President Rodrigo Duterte's Zero+10-Point socio-economic agenda, the Department of Trade and Industry (DTI) is implementing the Inclusive Innovation Industrial Strategy (i^3S)[1] which aims to grow innovative and globally competitive manufacturing, agriculture, and services industries, while strengthening their linkages in the global value chain to achieve an inclusive and sustainable growth that generates more opportunities for employment and entrepreneurship in the country.

i^3S envisions the government to act as the facilitator in addressing the most binding constraints in preventing the industries from growing. It aims to create globally competitive and innovative industries through (1) building an innovation and entrepreneurship ecosystem that will help in forming new industry clusters; (2) removing obstacles to growth that will allow the Philippines to attract more investments; (3) strengthening domestic supply chain to encourage inclusivity and promote self-sufficiency; and (4) deepening the participation of the industries in global and regional value chains to maximize economic benefits.

The i^3S is based on six strategic actions aimed at pursuing coordination with other government agencies, industry, and academe:

- Embrace Industry 4.0: Embrace Industry 4.0 technologies to make our industries more competitive with manufacturing as a major driver of industrial development and inclusive and sustainable growth.
- Innovative SMEs & Startups: Promoting the development of more innovative MSMEs and startups.
- Integrate Production System: Integrating our production system by linking manufacturing with agriculture & services, address gaps in our domestic supply chain, and deepen our participation in GVCs.
- Ease of Doing Business: Improving our infrastructure by streamlining & automating regulatory processes and investing in digital & other physical infrastructure including power & logistics.
- Upskill/Reskill Workforce: Building our human capital, upgrade and reskill and equip our workforce with new digital skills to prepare them for future production.
- Innovation and Entrepreneurship Ecosystem: Build our innovation and entrepreneurship ecosystem through strong collaboration between government, academe, and industry, pursue more market-oriented research & acceleration of research commercialization.

The current innovation strategy that is being pushed for by the DTI has both domestic and export market orientation, emphasizing the need for Filipino entrepreneurs to capitalize on the consumer market of the country while linking it to the regional hubs.

The DTI, through the BOI, identified the following emerging & strategic clusters as priority industries: (a) auto & auto parts, (b) electronic manufacturing service, (c) aerospace parts and aircraft maintenance, repair & overhaul, (d) chemicals, (e) Shipbuilding & ship-repair, (f) furniture, garments, creative industries, (g) Tool & Die, Iron & Steel, (h) Construction, (i) IT-BPM & E-Commerce, (j) Transport & Logistics, (k) Tourism & (l) Agribusiness.

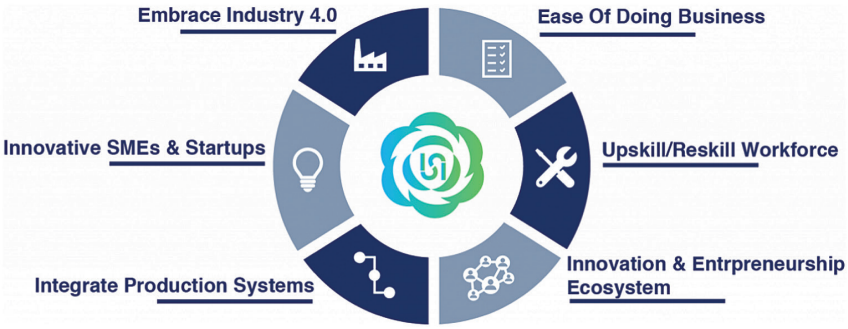

Figure 1: Strategic actions of the inclusive innovation industrial strategy

[1] Asec. Aldaba's Concept Note: DTI Research Project on Innovation and Industry 4.0 in the Philippines, pp. 14–18.

Inclusive Filipinnovation and entrepreneurship roadmap

Department of Trade and Industry, Philippines
http://innovate.dti.gov.ph/

In line with i³S, the DTI, in cooperation with the Department of Science and Technology (DOST) formulated the Draft Inclusive Filipinnovation and Entrepreneurship Roadmap (IFER). The draft roadmap has the following elements: (1) Innovation Policy and Commercialization; (2) Entrepreneurship Program and Making MSMEs Competitive; (3) Government-Academe-Industry; (4) Industry Clusters for Growth; (5) Skilled Workforce and; (6) Funding and Finance.

Below are the major recommendations gathered during the workshops on strengthening innovation and entrepreneurship in the country:

Establishment of regional inclusive innovation hubs

Through the establishment of Regional Inclusive Innovation Hubs will support and fill-up the local industry needs be established across the Philippines, as these will connect the players, networks, and stakeholders within the Inclusive Innovation and Entrepreneurship Ecosystem.

The hubs will also function as organic platforms for the emergence of local champions and leaders and will be the medium in organizing, expanding, and mobilizing local communities of innovators and entrepreneurs. More importantly, hubs shall collectively serve as the corner stone of i³S and will play a vital role in economic transformation.

Development of human capital towards innovation and entrepreneurship

To reach this state of culture, programs to improve MSME competitiveness and innovation upscale their performance, and provide technology adoption skills shall be undertaken. Likewise, support programs for start-ups that would encourage the growth of mentors, advisors, incubators, accelerators, and professional services shall be pushed.

Moreover, HRD shall be more focused on innovation, with experts and researchers in government, education, and industry sectors working closely together on research and development collaborations and technology transfer training programs for our current workforce to further boost our creative talent pool.

Government–Academe–Industry convergence

Above all, and to sustain innovation and entrepreneurship efforts, the strong convergence and coordination between and among the government, academe, and industry stakeholders should be strengthened. This shall be done through the revival of the Filipinnovation council composed of the different stakeholders from the three sectors. From there, more technical collaborations may be established that would pave the way for shared facilities, relevant market-oriented research, more job-ready graduates, and entrepreneur-specific training programs. The linkage would also lead to more responsive curricula by our education sector to align with the needs of the industry.

Global Innovation Index 2021

The 2021 edition of the Global Innovation Index (GII) presents the latest global innovation ranking of 132 economies, relying on 81 different indicators. While tracking the most recent global innovation trends in the new Global Innovation Tracker, this edition also focuses on the impact of the COVID-19 pandemic on innovation.

The Global Innovation Index 2021 is published by the World Intellectual Property Organization (WIPO), in partnership with the Portulans Institute and with the support of our corporate partners: the Brazilian National Confederation of Industry (CNI), Confederation of Indian Industry (CII), Ecopetrol (Colombia), and the Turkish Exporters Assembly (TIM).

The GII 2021 is calculated as the average of two sub-indices. The Innovation Input Sub-Index gauges elements of the economy that enable and facilitate innovative activities and is grouped in five pillars: (1) Institutions, (2) Human capital and research, (3) Infrastructure, (4) Market sophistication, and (5) Business sophistication. The Innovation Output Sub-Index captures the actual result of innovative activities within the economy and is divided in two pillars: (6) Knowledge and technology outputs and (7) Creative outputs.

For more information, access:

https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021.pdf

Green technology incentives in Malaysia

Malaysian Investment Development Authority (MIDA), Malaysia

https://www.mida.gov.my/

Green technology presents a solution in balancing the needs for economic development and responsibility towards the environment. As there is a growing global need in dealing with climate change; sustainable development and green technology need to go hand in hand in driving the economy, creating jobs, and attracting investments.

In 2015, at the United Nations Climate Change Conference (Conference of Parties, COP21) in Paris, the Government has committed to reducing Greenhouse Gas (GHG) emissions by 45% by 2030, based on 2005 GDP. This target was set for 35% on an unconditional basis and 10% on a conditional basis upon receipt of climate finance funding, technology transfer, and capacity building from developed countries.

The green technology agenda in Malaysia consists of a range of initiatives and policies which aim to increase the use of environment-friendly approaches in every sector to reduce the reliance on fossil fuels and environmental impact. This agenda will not only spur Malaysia's economy and social well-being but also drives the by services/system providers as well as to motivate companies to acquire assets that have been verified as green. As part of Budget 2020 measures, the Government continues to prioritize green adoption to spur economic multiplier effects by extending the Green Investment Tax Allowance for the purchase of green technology assets and Green Income Tax Exemption on the use of green technology services until 2023. The ITE has also been extended for companies which undertake solar leasing activities so as to increase interest and participation in the Net Energy Metering Scheme (NEM) which was introduced by the Sustainable Energy Development Authority (SEDA). Green Technology Incentives: Towards Achieving Sustainable Development in Malaysia nation's development trajectory on a low carbon and climate resilience pathway.

The National Green Technology Policy (NGTP), which was launched in 2009 recognized green technology as a driver to accelerate the national economy and promote sustainable development. It emphasizes on four focus areas of green initiatives: energy, building, transportation, and waste management.

Provisions of an Investment Tax Allowance (ITA) for the purchase of green technology assets and an Income Tax Exemption (ITE) on the use of green technology services and system were necessary to strengthen the utilization of green applications. These initiatives serve to encourage investments in green equipment production and the adoption of green technology by services/system providers as well as to motivate companies to acquire assets that have been verified as green.

As part of Budget 2020 measures, the Government continues to prioritize green adoption to spur economic multiplier effects by extending the Green Investment Tax Allowance for the purchase of green technology assets and Green Income Tax Exemption on the use of green technology services until 2023. The ITE has also been extended for companies which undertake solar leasing activities so as to increase interest and participation in the Net Energy Metering Scheme (NEM) which was introduced by the Sustainable Energy Development Authority (SEDA).

Companies are advised to submit application for Investment Tax Allowance before incurring the first qualifying capital expenditure (CAPEX) on the related project or assets. As for Income Tax Exemption, companies are advised to submit application to MIDA before issuing the first invoice of qualifying business sale.

In 2019, a total of 427 green technology projects were approved with the investment amount of RM4.33 billion and 12 green services projects of a total investment of RM31.67 million.

As of January to September 2020, MIDA has approved 479 green technology projects with investments amounting to RM2.23 billion despite the challenging global economic environment; an encouraging indicator of potential high investment flows and interest in green technology in Malaysia. Over the past 5 years of the incentive initiatives, MIDA sees positive outcomes in increased renewable mix of power generation, green technology services providers, and better waste management.

Amid the COVID-19 pandemic, MIDA received more than 900 applications from January to December 2020. This reflects a positive trend in companies that are committed to minimize the degradation of the environment, reduce greenhouse gas emission, promote a healthy life, and increase the use of renewable energy as well as natural resources. It is certainly in line with the Government's aspiration towards sustainable development goals (SDGs), aspired by the United Nations.

(Source: MIDA e-Newsletter December 2020)

Clean Technology Fund

The Clean Technology Fund (CTF), one of two multi-donor trust funds under the Climate Investment Funds (CIF) framework, promotes scaled-up financing for demonstration, deployment and transfer of low-carbon technologies with significant potential for long-term greenhouse gas emissions savings implementation in renewable energy, energy efficiency, and clean transport in emerging market middle-income and developing economies.

For more information, access:
https://www.climateinvestmentfunds.org/topics/clean-technologies

Bio-Circular-Green economy in Thailand

National Science and Technology Development Agency (NSTDA), Thailand
https://www.nstda.or.th/

A new model called Bio-Circular-Green (BCG) has been conceptualized to underpin Thailand 4.0 policy as a strategy to drive the economic and social development. BCG is an integration of bioeconomy, circular economy, and green economy,

- **Bioeconomy** involves the production of renewable biological resources and the conversion of these resources into value added products.
- **Circular economy** aims at reusing and recycling resources.
- **Green economy** determines to keep economy, society, and the environment in balance, leading to sustainable development.
- It is believed that BCG model will **enable Sustainable Development Goals (SCGs)** through the promotion of sustainable agriculture, clean energy, and responsible consumption and production, ensuring the conservation and sustainable utilization of biodiversity, and protecting environment and ecosystem.

Thailand's competitive advantage in bioeconomy

Fundamental concept of bioeconomy is the value creation of resources. As Thailand is blessed with robust agricultural activities, rich natural resources, and diversity in term of both biological resources and physical geography, the country is in an excellent position to take on bioeconomy.

Thailand is among top producers and exporters of several agricultural commodities and aquacultures such as rice, cassava, sugarcane, para rubber, and shrimp. Some of these crops are of significant importance to both food and energy security. In addition to strong biomass production sector, food industry and other related industry in the value chain also represent a large industrial sector in Thailand. The food industry contributed approximately 23% of the country's GDP and the value of Thailand's food industry, including local consumption and exports, is expected to reach USD102 billion in 2017.

Thailand is situated in "Indo-Burma"—a biodiversity hotspot that is ranked as the eighth most biodiverse region in the world. Hosting several forest types and aquatic habitats, Thailand is estimated to support about 10% of all species of living organisms in the world. Significant investment has been made to support biodiversity research and establish world-class infrastructure for preserving microorganisms with the purpose of utilization study, making the country No. 6 in the world in term of microbial collection.

Thailand's vision and national policy

In November 2019, Thailand's Ministry of Higher Education, Science, Research and Innovation (MHESI) unveiled a proposal entitled "BCG in Action: The New Sustainable Growth Engine" mapping out strategies to drive BCG agenda forward.

Blessed with rich natural resources and strong agricultural activities, Thailand will apply the BCG model to focus on four s-curve industries—namely agriculture and food; bioenergy, biomaterial, and biochemical; medical and wellness; and tourism and creative economy. Science, technology, and innovation have enormous roles to play in this BCG movement. Innovations can be employed to enhance the capacity and competitiveness of players across the value chain, both upstream and downstream, in all four s-curve industries. With proper agricultural innovations, farm productivity and efficiency can be raised, benefiting the whole bioeconomy as biomass is the foundation of all industries in the bioeconomy model. Farm production improvement also boosts income of farmers and communities, and thereby reducing social disparity. Innovative technology can be applied to add value to resources and agricultural products, and thereby enhancing the competitiveness of downstream industries. High-value products for the agriculture and food industry could be, for examples, functional food ingredients; for health and medicine industry are biopharmaceuticals and precision medicine treatment; for energy and chemicals industry are valorized fuels and chemicals, and for tourism industry a medical or knowledge-based tourism.

The four target industries currently have a combined economic value of 3.4 trillion THB (21% of GDP). BCG model has a potential to increase the economic value to 4.4 trillion THB (24% of GDP) in the next 5 years.

BCG strategy consists of 4 drivers and 4 enablers, involving close collaborations among the government, industry, communities, academia, and international organizations.

Clean Energy Transitions Programme

The Clean Energy Transitions Programme (CETP) of International Energy Agency (IEA) leverages the IEA's unique energy expertise across all fuels and technologies to accelerate global clean energy transitions, particularly in major emerging economies. CETP activities include collaborative analytical work, technical cooperation, training and capacity building and strategic dialogues.

For more information, access:
https://www.iea.org/programmes/clean-energy-transitions-programme

Technology Offers

HUNGARY

L(-) Malic acid production technology

The malic acid is one of the hydroxy acids that are produced by aerobic organisms in the so-called citric acid cycle (Szent-Gyorgyi – Krebs cycle). As natural organic acid, L(-) malic acid exists in various fruits and vegetables, giving fresh acidic taste. It is recognized as an acidic agent which has high additional value in different foods, from the feature of non-volatility, easy-to-cook, and less hygroscopic nature. According to Fuso Chemical (the biggest world producer of DL malic acid), it is known as a result of the panel test of many times that equivalent acidity is left from malic acid of a few quantities as compared with citric acid. Because of its lower melting point, it is preferably prescribed than other food acid for candy manufacture. Malic acid's synergism with certain food ingredients and flavors makes it a versatile and flexible acid of choice to create new taste sensations and to add new twists to existing products. Malate is widely used by the pharmaceutical and food industries and has a potential to be used for production of biodegradable polymers that could replace plastics.

The new technology of the Hungarian leading biotechnology center produces only the biologically active L(-) form. This new biosynthesis process of L(-) malic acid has proved to be more efficient and cost-effective than the presently used ones. Genetically altered micro-organisms and a continuous flow-through conversion assure the efficiency of this method. The method uses genetically enhanced, immobilized, and killed micro-organisms that have highly elevated (1,000-fold) catalytic potential over the unaltered cells. This modification pushes the chemical equilibrium towards the required 98% conversion; consequently this new method enables an 80% conversion in industrial scale while the existing technologies have maximum 70% conversion capacity.

Area of Application

- Food industry
- Chemical industry
- Pharmaceutical industry

Advantages

This technology has some significant advantages in comparison with the traditional fermentation and chemical production. Firstly, downstream operations become cheaper by the high conversion rate and lack of bypass products. Secondly, the very intensive technology decreases the investment expenditures. Thirdly, it is an environment-friendly production, which does not have any effect on human health. There are no environmental risks or contraindications to use this technology, because the genetically modified cells are killed before use. No huge amount of wastewater, no bypass salts (e.g., NaCl, CaSO4). The bioreactors are working as enzyme reactors during the process.

Environmental Aspects

Cleaner production

Development Status

Laboratory Model

Transfer Terms

Technology Licensing, Research Partnerships

Target Countries

Worldwide

Contact

Laser Consult Ltd (Hungary)
H-6701 PO Box 1191
Szeged
Hungary

INDIA

Virgin coconut oil

Virgin Coconut Oil (VCO) is the oil obtained from fresh, mature endosperm (kernel-meat) of the coconut by mechanical or natural means, with or without use of heat, no chemical refining, bleaching or deodorizing and maintains the natural aroma and nutrients.

Area of Application

Many potential applications in food, health, and cosmetics sectors.

Development Status

Pilot Plant, Commercial Prototype

Transfer Terms

Consultancy, Technology licensing

Sugarcane juice powder technology

A process for preparation of spray dried sugarcane juice powder/granule formulation. It is a general food product. The spray dried sugarcane juice possesses consumer acceptable qualities and commercial value.

Area of Application

Food Processing/Preservation, Sugarcane Juice drying

Advantages

Sugarcane juice powder is a novel substitute to replace the commercially available soft drinks that contain only sugar, artificial chemicals, colors and flavoring agents and devoid of nutrients.

Environmental Aspects

Cleaner Production

Development Status

Pilot plant, Commercial prototype, Fully commercialized

Transfer Terms

Consultancy, Technical services, Technology licensing

For the above two offers, contact

Central Institute of Fisheries Technology, CIFT Junction,
Matsyapuri, Willingdon Island
Cochin 682029
India

Novel transducer matrix and its application in biosensors

The principal objective of the present invention is to provide a process for the synthesis of nanostructured conducting polymer (NSCPs) by using structure directing agents. ● In addition, this

invention also provides a process to develop a nanostructured conducting polymer with high electrical conductivity. Another objective of the present invention is to use the synthesized nanostructured conducting polymers as a transduction matrice for the development of biosensor. Yet another objective of the present invention is to provide a method for the development of optical biosensor by using synthesized nanostructured conducting polymers as a transduction matrix. Last, but not the least, this invention also intends to provide an optical biosensor having possible application in the testing of biological samples.

Area of Application
An optical glucose biosensor has a potential application in the testing of biological samples.

Environmental Aspects
Bio-degradable and environmentally friendly

Development Status
Laboratory model

Legal Protection
Patent

Transfer Terms
Consultancy, Technical services, Technology licensing

Bacterial lipase and its application in food industry

We could offer a technology to synthesize bacterial lipase that has potential applications in the food industry. Brief description of the process/product/technology developed- se to various polar and non-polar organic solvents for 2 h elucidates that the enzyme was stable to all organic solvents tested. The highest relative activity was achieved with chloroform (400%) followed by toluene (250%) and 1-The present invention provides an extracellular bacterial lipase from *Pseudomonas mendocina* M-37 (MTCC 7054) with high stability and substrate specificity. The bacteria were isolated from oil industry effluent showing high activity on olive oil. The substrate specificity of *Pseudomonas mendocina* M-37 lipase shows that the lipase was especially more active towards the synthetic triglycerides and fatty acids esters that possesses butyryl group like benzyl butyrate (1,120% relative activity), tributyrin (744%), and amyl butyrate (550%), respectively. The stability of lipase in organic solvents offers advantages for ester synthesis. Exposure of M-37 lipaoctanol (215%).

Area of Application
The bacterial lipase showing high activity in organic solvents and substrate specificity for butyrated esters has possible significant applications in food industry for ester synthesis. The esterification reactions in food industry are carried out in organic solvents and uses butyrated substrates. *Pseudomonas mendocina* lipase has possible applications in synthesis of flavor and fragrance esters; for organic synthesis and modification of fats and oils.

Advantages
Pseudomonas mendocina lipase possessing high stability in organic solvents, high substrate specificity mainly for butyrated esters has possible significant applications in food industry for ester synthesis.

Environmental Aspects
Bio-degradable and environmentally friendly

Development Status
Laboratory model

Legal Protection
Patent

Transfer Terms
Consultancy, Technical services, Technology licensing

For the above two offers, contact
Amity University Uttar Pradesh Sector-125, Noida
Distt Gautam Buddha Nagar 201303
India

Bio-fertilizers, bio-pesticides, and vam fungi

Indian well-established innovative company engaged in R&D and low-cost production of bio-agricultural products offers bio-fertilizer, bio-pesticide, and vam fungi technologies. Bio-fertilizers—Nitrogen in the main nutrient element to plant growth. More than 78% of Nitrogen is available in the atmospheric air, but it cannot be consumed by plants directly. Only bacteria can consume the atmospheric Nitrogen, convert it into Nitrate and fix it into soil. Afterwards it can be consumed by plants. Nitrogen content in chemical fertilizers such as urea is around 40%. It should be consumed by a plant within 3 hours; otherwise, it will be lost through leaching, volatilization, and N2 gases into the atmosphere. Microbial biosphere adds as much as 275 million tons of Nitrogen to soil annually through biological fixation, that is more that the quantity of industrially produced fertilizers. Besides Nitrogen, Phosphate is another major element for growing of flowers, fruits, vegetables, and grains. Presently Phosphate content in chemical fertilizers consumable by plants is around 16–18% and the rest is in insoluble form which can be converted into soluble one with the help of phospho-bacteria. Thus over 50% of the remaining phosphate can be made available to the plant in this way. Vam Fungi—Vam is a single cell that supplies Phosphorus and micronutrients viz. Co, Mb, Cu, Fe, and Zn to the plant. It increases plants' disease and drought resistance. Vam can be consumed by the plant through the root system only. Bio-pesticides—Continuous use of chemical pesticides results in accumulation of toxic substances in the soil. This contaminates harvest, destroys soil and ecological balance. Bio-pesticides offer alternative environment-friendly method to control pest infestation. In this case, bacteria or virus infect the spurious pest by rupturing its skin or attacking its nervous system, which ultimately kills the pest.

Area of Application
Agriculture, horticulture, forestry

Advantages
Bio-fertilizers: multi-strain concept; Vam fungi: due to multi-strain concept, the use of chemical fertilizers can be reduced by 30 to

50%, while increasing the yield by 10 to 20%. Bio-pesticides: multi-strain concept along with N.P.V. virus; Environment-friendly products, reduce use of chemicals in agriculture. Bio-fertilizers provide disease-free and healthy for consumption agro-products, increase crop production, eliminate contamination of agro-products by chemicals, help in replenishment of essential elements in soil, supplies essential growth hormones into plant body and regulates the supplies to the optimum level, increases resistance towards pathogens, help in utilization of barren waste land.

Development Status
Fully commercialized

Technical Specifications
Production capacity: 500 tons per annum;

Inputs required: Manpower: 12; Land/building: 3,000 sq.m./1,000 sq.m.

Raw materials: lignite, vermiculture, potatoes, water.

Transfer Terms
Consultancy, Equipment supply, Turnkey

Target Countries
Worldwide

Contact
Mr. C.V. Rao, Managing Partner, Sneha Bio Research and Development Services. D.No. 49-10-11, Near Ramavarappadu Ring, Currency Nagar, Vijaywada 521 108, India.
Tel: (91-866) 545 015; 630 316; Fax: (91-866) 471 386
E-mail: bhaent@hotmail.com

EcoKiln for small-scale burnt brick production

The TARA EcoKiln is the world's most energy efficient and environment-friendly technology to produce burnt clay bricks. It is based on the vertical shaft brick technology process and uses coal and waste organic residues as a primary fuel. The EcoKiln has vertical shafts of rectangular cross section well insulated to arrest heat loss. The kiln works as a counter-current heat exchanger, with heat transfer taking place between the air moving up (continuous flow) and bricks moving down (intermittent movement). Green bricks are loaded in batches from kiln top. Bricks move down the shaft through preheating, firing and cooling zones before being unloaded from the bottom. The combustion of fuel takes place at the middle of the shaft. Combustion air enters from the bottom, gets preheated by the hot fired bricks in the lower portion of the shaft before reaching the combustion zone. They in turn preheat the green bricks in the upper portion of the shaft before exiting from the kiln through chimney.

Area of Application
The TARA EcoKiln technology is used to produce burnt clay bricks. Best results are obtained from equivalent soil qualities. The technology is applicable in areas where land costs are high. The technology is suitable for all types of investment capacity due to its scalability. However, it is most suitable for small-scale brick producers and entrepreneurs.

Environmental Aspects
Cleaner production, Waste utilization, Energy efficiency

Development Status
Fully commercialized

Technical Specifications
The kiln is a civil structure made of brick and mortar. The shafts are lined with refractory bricks. A two-shaft kiln has a nominal dimension of 10 m x 15 m with a height of 7 m. Two chimneys per shaft

Transfer Terms
Consultancy, Technical services, Technology licensing, Turnkey, Research partnerships

Target Countries
Worldwide

Contact
Technology Action for Rural Advancement
B-32, TARA Crescent Qutab Institutional Area
New Delhi 110016
India

Waste plastics into industrial fuel

We offer plants for converting non-recyclable waste plastics into industrial fuel. Fuel quality far superior to the conventional industrial fuels such as furnace oil or light diesel oil. ALL types of plastics can be processed. We can also supply technology. Serious customers can get their waste plastics tested on our Demo Plant. Plants as small as 1 TPD of plastics up to 30 TPD can be supplied. Plants are custom-made to specific requirements. Municipal bodies, industries involved in generation of non-recyclable plastic scrap, plastic scrap dealers who have access of non-recyclable cheap plastic scrap, entrepreneurs most welcome.

Area of Application
Converting waste plastics (non-recyclable cheap plastic scrap) into industrial fuel.

Advantages
Disposal of non-recyclable waste plastics keeps environment clean, gets excellent monetary returns, for the industries that have their own plastic scrap generation can generate fuel at a very low price.

Environmental Aspects
Cleaner production, Waste utilization, Energy efficiency, Systems integration

Development Status
Pilot plant, Commercial prototype

Legal Protection
Trade mark, Patent

Technical specifications
Plants having capacity as low as 1 TPD of plastics offered. No upper limit on higher capacities.

Transfer Terms
Consultancy, Joint venture, Technology licensing, Turnkey

Contact
Atharva ProcTek
Pune 411052
India
E-mail: response@aproctek.com

THAILAND

Solar chimney for electricity generation

A Thai university offers solar chimney technology for electricity generation. By this technology, solar energy is converted into wind energy that is used by a turbine generating electric power.

Area of Application
Large scale electricity generation

Advantages
Cheap and clean renewable energy generation technique

Environmental Aspects
Energy efficiency

Development Status
Pilot plant

Transfer Terms
Consultancy, Others

Target Countries
Worldwide

Contact
Mr. Tawit Chitsomboon
Suranaree University of Technology Muang District
Nakornratchasim 30000
Tel: (6244) 22 4264; Fax: (6244) 22 4224

Wind energy

Natural Energy Co., Ltd. Innovative designed small wind turbine combined with aerodynamic design able to operate from low wind speed and able to withstand stormy wind with self-regulated design as functions of the main-blade. The rots and moving parts are constructed with light-weight aluminum. The unique vertical-axis design ensures a robust performance in the urban environment, where wind speed is lower and wind directions change frequently. Natural Energy wind turbines operate in low wind speed (3 m/s), quiet operation, unlimited high wind performance. It is the development for area with low and medium wind speed. We deliver three main models: 500 W, 1,000 W, and 2,000 W. Moreover, we also offer VT2000 which is used for water mechanical pumping.

Area of Application
Renewable energy industry

Advantages
Aero dynamic design; Light aluminum material; Low wind performance-self start; Unlimited high wind performance (storm); Self regulated; Quiet operation—Simple structure-minimized moving parts

Environmental Aspects
Cleaner production, Waste utilization, Energy efficiency, Systems integration

Development Status
Fully commercialized

Legal Protection
Trade mark, Patent, Copyright

Transfer Terms
Equipment supply, Others

Contact
Natural Energy Co., Ltd
17th Floor, S.P. Building 388 Phaholyothin Road Phayathai
Bangkok
Thailand

Kitozan biofertilizer

We are 5 years experience to produce Kitozan which we helped people to save environment and produce organic fruits and vegetable to feed people. which low cost and fast result. We had more than 3 million users in Thailand.

Area of Application
Biotechnology

Advantages
It can use with any chemical and fertilizer. It can mix with water and feed for animal. It can change bad soil to be good soil also.

Environmental Aspects
Cleaner production, Waste utilization, Energy efficiency, Systems integration

Development Status
Fully commercialized

Legal Protection
Trade mark, Copyright

Transfer Terms
Turnkey, Others

Target Countries
Worldwide

Contact
Aloe Life Co., ltd Thailand
24/548 Vibhawadee Road Donmuang
Bangkok
Thailand 10210

Selected Analytical Reports and Technology Platforms & Databases of APCTT

Analytical Reports (available online)

1. National Assessment Framework on Enabling Environment, Technology Innovation Ecosystem for Making Sustainable Energy Options Affordable and Accessible (For Indonesia and Lao People's Democratic Republic), January 2014

   http://apctt.org/nis/sites/all/themes/nis/pdf/National-assessment-framework_-final_ESCAP.pdf

2. Report on the National Assessment Framework of Enabling Environment and Technology Innovation Eco-system for Making Sustainable Energy Options Affordable and Accessible – Indonesia, May 2014

   http://apctt.org/nis/sites/all/themes/nis/pdf/Indonesia_Report-on-National-Assessment-of-Sustainable-Energy_optimized.pdf

3. Indonesia National Sustainable Energy Strategy Report on Enabling Environment and Technology Innovation Ecosystem for Affordable Sustainable Energy Options, May 2014

   http://apctt.org/nis/sites/all/themes/nis/pdf/Indonesia-National-Strategy-Report_final.pdf

4. Report on the National Assessment Framework of Enabling Environment and Technology Innovation Ecosystem for Making Sustainable Energy Options Affordable and Accessible - LAO PDR, May 2014

   http://apctt.org/nis/sites/all/themes/nis/pdf/Lao_Report-on-National-Assessment-of-Sustainable-Energy.pdf

5. Lao People's Democratic Republic National Sustainable Energy Strategy Report on Enabling Environment and Technology Innovation Ecosystem for Affordable Sustainable Energy Options, May 2014

   http://apctt.org/nis/sites/all/themes/nis/pdf/Lao-National-Strategy-Report_final.pdf

6. National Innovation System (NIS) training manual - "NIS Diagnosis and STI Strategy Development to Achieve National Sustainable Development Goals", 2016

   http://apctt.org/nis/sites/all/themes/nis/pdf/NIS%20Training%20Manual.pdf

Technology Platforms and Databases

1. APCTT's Technology4SME Database

   The Technology4SME Database serves as an online platform for information exchange on the availability and sourcing of technologies for small and medium enterprises in countries in the Asia Pacific region.

   http://apctt.org/technology-transfer

2. Renewable Energy Technology Bank

   The primary objective of the Renewable Energy Cooperation-Network for the Asia Pacific (RECAP) established by APCTT is to facilitate technology transfer cooperation among countries in the Asia-Pacific region in the area of renewable energy. RET-Bank provides tested and proven renewable energy technologies (RETs) initially in the areas of solar, biomass, wind, mini-hydro power and geo-thermal energy.

   http://apctt.org/recap/renewable-energy-technology-bank

3. Global Technology Databases

   APCTT has compiled a list of global as well as country-wise technology databases that deal with the technology transfer related services for SMEs and entrepreneurs.

   http://apctt.org/aptitude/