

Climate Change Data Management

**ASEAN Socio-Cultural Community Trend
Report No. 7 (2024)**

ASCC Research & Development Platform on Climate Change



one vision
one identity
one community



ASEAN Socio-Cultural Community Trend Report

ASCC Research and Development Platform Programme

The ASEAN Secretariat
Jakarta

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The ASEAN Secretariat is based in Jakarta, Indonesia.

For inquiries, contact:

The ASEAN Secretariat

Community Relations Division (CRD)

70A Jalan Sisingamangaraja

Jakarta 12110, Indonesia

Phone: (62 21) 724-3372, 726-2991

Fax: (62 21) 739-8234, 724-3504

E-mail: public@asean.org

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ASCC Research and Development Platform on Climate Change

VGR Chandran Govindaraju (Universiti Malaya), **Abul Quasem Al Amin**, **Sarpaneswaran Subramaniam**
(C&G Analytica), and **J.S. Keshminder** (Universiti Teknologi MARA)

Executive Summary

A SEAN Member States (AMS) have largely extended their Nationally Determined Contribution (NDC) commitments on greenhouse gases emission reduction, mitigation, and sectoral coverage.

Readiness to implement the NDCs requires AMS to mitigate climate risks over time while addressing existing data gaps.

To drive scientific and evidence-based policy interventions and strategies, data availability is critical.

While improvements in climate change data collection and sharing at various levels, especially with the existence of ASEAN Centre for Climate Change, continue to be made, there is strong consensus among AMS on the need to further strengthen capacities to improve the information base, build capacities for modelling and projection, and for risk and vulnerability assessment.

However, current progress in managing climate data in AMS is still limited and key areas for capacity building need to be identified.

AMS therefore need to address a wide range of issues related to climate data management, including improving information sharing and capacity building, data transparency and provision, and capacity for data management, and monitoring and reporting.

Addressing data management requires regional knowledge transfer, technological advances, cross-sectoral engagement, and the development of a robust data management framework and system. There is also a need to consider differences in approaches and uses of climate data among actors with different priorities and interests.

The way forward for ASEAN is to build on ASEAN's leadership in climate change data management, establish regional cooperation, improve data management, transparency frameworks, and harness the power of big data.

Further, the political will to share data and information and the establishment and operationalisation of ASEAN coordination mechanisms (e.g. clearinghouse mechanisms and transparency procedures) is crucial.



1. Introduction

The whole world relies on climate data to predict current and future climatological events. Climate data can tell us a lot about the atmospheric environment, which affects almost all areas of human activity. Most long-term climatological analyses depend on a variety of non-climatic variables. These variable measurements are also subject to changes in equipment, observing procedures, station locations, methods of calculating averages, and station environments. Similarly, socio-economic variables are becoming increasingly important in assessing the relationship with climate and its impacts.

The basic objective of climate data management is to preserve, collect, and make available climate data and products for use by planners, decision makers, and researchers. Climate data of appropriate quality and accessibility can be used for many reasons, including monitoring climate variability and change, disaster risk reduction, and future climate projections (Australian Bureau of Meteorology and CSIRO, 2011). In the context of climate change, historical climate data describe observed climate variability and provide context for future climate change projections.

To determine the success of any reform or intervention, it is important to conduct an assessment that includes a snapshot of performance before and after the reform. In this aspect, “baseline data” refers to measurements of important circumstances (indicators) before the start of a project that can be used to assess change and progress and serve as a basis for evaluation and impact assessment. Establishing the baseline situation is a common action that takes place in the project identification phase, where the problem is analysed. Usually, a reform measure starts with a ‘diagnostic phase’, which includes a thorough investigation (both qualitative and quantitative) of the nature and scope of the problem. Thereafter, a follow-up measurement should be carried out when results can be expected (e.g. six months after the introduction of the optimised procedure), to assess whether the adjustments made have led to real improvements. Consistent monitoring of the indicators from the beginning of the reform measure allows for the collection of real

baseline data. Thus, project teams need to ensure that performance is measured from the beginning of the reform programme to ensure that performance targets are met. While this process is often considered part of the implementation activities, it is often funded separately from monitoring and evaluation (M&E). However, diagnostics are an integral part of the M&E process and should be integrated into the M&E framework as a baseline.

Therefore, to develop sound and evidence-based policies, the identification of the current or prevailing situation (e.g. the impact of climate change in the ASEAN region) should be included in the policymaking process. To this end, this trend report discusses ASEAN’s Nationally Determined Contributions (NDC) commitments and climate data requirements and management needs, as well as provides an assessment on the progress of climate data management in ASEAN. Suggestions for the way forward are offered at the end of this report.

2. The Need for Climate Data

ASEAN needs pragmatic climate change adaptation and mitigation measures to address climate change risks. Due to the large geographical extent of the ASEAN region, predicted climate change varies from country to country, knowledge of local behaviours, and impacts of climate change are critical. Therefore, access to climate change data at the regional level is important because:

- i. The visible impacts of climate change can vary greatly within a country. Therefore, it is necessary to understand and consider regional behaviours and characteristics when designing and implementing appropriate adaptation methods.
- ii. People and economic resources are concentrated near the coast, making them particularly vulnerable to coastal flooding and rising sea levels.
- iii. In addition to increasing severe weather events, such as excessive rainfall and extreme heat days, the behaviour of typhoons and droughts has also changed.
- iv. The region's economy will be significantly impacted by rising sea levels but there is limited data available on expected loss and damage. For instance, crop productivity in the ASEAN region has been significantly affected by climate change.
- v. In countries such as Myanmar, the Philippines, Thailand, and Viet Nam, the widespread impacts of heat stress will be exacerbated, requiring immediate use of heat stress adaptation techniques.

Baseline data is used to better understand the process and cause of climate problem . It enables the identification of areas or components that need improvement as well as setting of achievable and realistic outcome targets and indicators in the design of a sustainable intervention, and the monitoring and adjustment of progress towards these targets and associated outcomes. Monitoring and evaluation make it possible to determine the most beneficial and effective use of available resources. They are crucial in determining the extent to which policies and programmes can be described as 'successful'. A sound data basis for monitoring and evaluation is important because it serves as:

- Benchmarking indicators in quantitative terms;
- Data on hard facts and perceptions;
- A framework for monitoring the actions of a programme; and,
- A measure of the implementation of policy and regulatory reforms by partner institutions.

A baseline may be inextricably linked to diagnostic measures undertaken in the context of the problem being addressed. For example, when a map of regulatory processes is drawn up in advance to determine what changes should be made, or when a time and cost assessment is carried out for a particular regulatory process. It is critical to include quantitative and qualitative data on facts, processes, and attitudes to capture baselines towards climate impacts both globally and locally. Project-wide baselines and project-specific baselines are two

ways to create baselines, but they are not the only options. Baselines can also be created using either an existing methodology or a new one. If the baseline standards state that project-specific or multi-project baselines can be used in certain situations, this could be the case. Further, project developers could choose the best option for their own project but would then have to explain why they made this choice. For example, they would have to demonstrate that the recommended baseline meets the requirements of the project.

Planning: The baseline will assist in defining and concretizing objectives, as well as the type of assistance required. Additionally, it may specify particular activities that will be undertaken to fulfil these goals. This will entail identifying locally recognised resources, as well as local stakeholders' demands and challenges. Monitoring: The data gathered can be utilised to monitor progress and make required changes during the deployment phase. Evaluation: Because baselines include program- or project-specific benchmarks and indicators, the data can be utilised to evaluate a program's achievement of its objectives and impact.

A baseline survey should be conducted immediately after the initial needs assessment and design. However, in emergency scenarios, the baseline study can be conducted after the project has started. The method used to establish the baseline and the assumptions on which each method is based are important parts of the process. There are many different methods and assumptions that one can use to establish baselines for both individual projects and groups of projects. These methods and assumptions are likely to be different for different types of projects and a comprehensive advice that covers all possible methods and assumptions may not be available. Ideally, climate data should address a range of issues from data management to the gap between policy and implementation in terms of avoiding additional climate effects, and recommended ways to address existing gaps. Taking these issues into consideration, AMS need to assess the following information:

- a) Access to data;
- b) Adaptation methods and tactics;
- c) Data for climate change adaptation strategies;
- d) Data for mitigation strategies;
- e) Monitoring and reporting of data;
- f) Gaps in sectoral data management;
- g) Mapping out the scenarios for climate change and gaps; and,
- h) Institutional arrangements for climate data management.

2. Mitigation and Adaptation Plans and Data Requirements

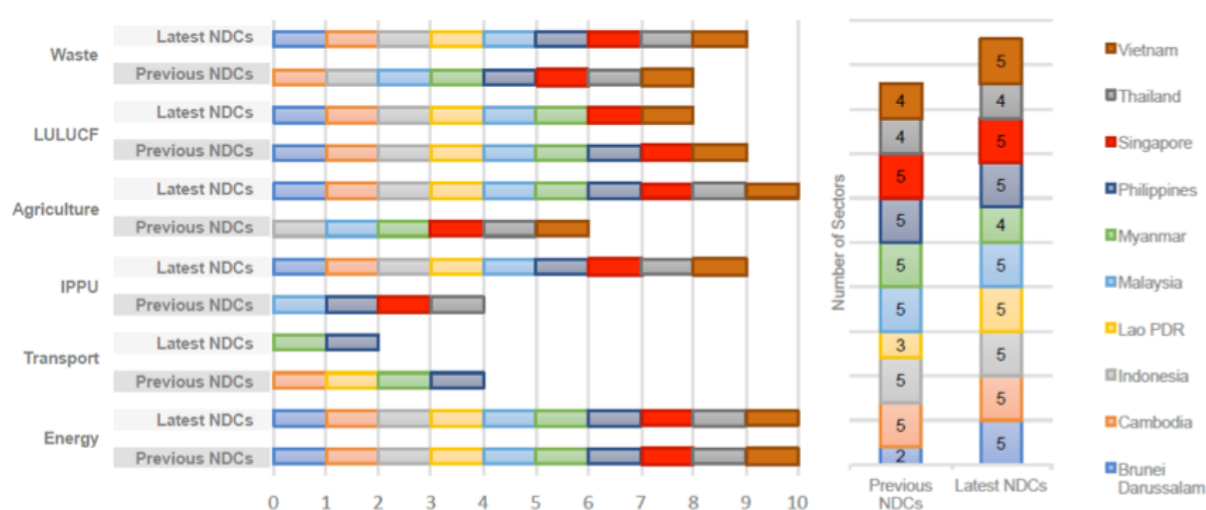
A The AMS have put in place various mitigation and adaptation plans. Understanding these plans is critical for the AMS to be able to prepare the data requirements and to be able to ensure data readiness to drive science and evidence-based policy interventions and strategies. Table 1 summarises the by AMS. All AMS have submitted their updated NDCs in 2020 and 2021 respectively. In most cases, AMS have made changes to their commitments and targets by expanding their mitigation targets, greenhouse gases (GHG) coverage, and sectoral coverage (Merdekawati, Suryadi, Suwanto, & Ienanto, 2021). Most AMS target an economy-wide sector covering industrial processes and product use, agriculture, energy, transport, and others. Figure 1 shows the sectoral coverage of NDCs. Few NDCs have committed to long-term low-emission development strategies. There are also plans to introduce market-based instruments such as the carbon tax. All these not only necessitate a data management system, but also create opportunities for climate data services in the public and private sectors. A legal framework is crucial to enable the participation of different stakeholders in the provision of climate-related data and services.

Table 1. NDC target summaries

Countries	NDC Targets
Brunei Darussalam	Reduce GHG emissions by 20% below Business-As-Usual (BAU) levels by 2030, while maintaining their previous target of a 63% reduction in overall energy consumption by 2035.
Cambodia	By 2030, the goal is to reduce GHG emissions by 41.7% compared to the baseline scenario. Climate change mitigation in agriculture and waste; more detailed action in energy efficiency; and a commitment to halve the pace of deforestation by 2030 are all included.
Indonesia	GHG reduction objectives of 29% and up to 41% of business as usual are defined by 2030, with no restrictions on the amount of reduction. In 2025, at least 23% of new and renewable energy will be generated, and in 2050, at least 31%. It should be at least 30% by 2025 and 25% by 2050 for coal to be a major source of energy. In 2025, oil's market share should be less than 25%, and in 2050, it should be less than 20%. There has to be a minimum of 22% gas in 2025 (and a minimum of 24% in 2050). Peatland restoration and degraded land restoration are both targeted for completion by 2030.
Lao PDR	A decrease in GHG emissions of 60% by 2030 compared to the baseline scenario is the unqualified goal. Increase the percentage of land covered by forest to 70%. Increase the capacity of renewable energy by 1 GW of solar and wind energy, as well as 300 MW of biomass energy. Develop enhanced water management practices for 50,000 hectares. By 2050, the objective is to achieve net zero emissions.
Malaysia	To achieve a 45% reduction in its economy-wide GHG emissions intensity from 2005 levels by 2030, it has made an unambiguous commitment to do so. This goal represents a 10% increase over the previous commitment (35% unconditional basis, additional 10% with support). The number of GHGs covered has increased to seven. CO ₂ , CH ₄ , HFCs, N ₂ O, PFCs, SF ₆ , and NF ₃ are all examples of greenhouse gases.
Myanmar	Goals for 2030: 105.24 mt CO ₂ e reduction relative to BAU, and 144 mt CO ₂ e reduction by 2030, if possible. Increase the total contribution of renewable energy (solar and wind) to 53.5% while reducing coal's share to 73.5%. Reduce deforestation by 25% by 2030, or 50% over the same time frame (conditional). By 2037, there will be no net emissions on a yearly basis, and then only on a periodic basis after that. 5.1 million fuel-efficient cookstoves will be distributed, resulting in a total reduction of roughly 12.99 million tCO ₂ e in emissions between 2021 and 2030.
Philippines	GHG emissions are expected to be reduced and avoided by 75%, with 2.71% being unconditional and 72.9% being conditional.

Singapore	Reduce emissions intensity by 36% from 2005 levels and maintain emissions to achieve a peak around 2030. In 2020, there will be the following updates: Instead of the prior intensity target peaking level (ie, 65 MCO ₂ e) around 2030, the economy-wide absolute GHG emissions restriction target will be used. Nitrogen fluoride is now included in the scope of GHGs.
Thailand	By 2030, cut GHG emissions by 20% below what is considered “business as usual.” As part of national initiatives like the Alternative Energy Development Plan, Power Development Plan, and Energy Pool Price, the NDC should be included into the national energy strategy such as Energy Efficiency Plan.
Viet Nam	GHG emissions will be reduced by 41.7% compared to the baseline scenario by 2030, according to the plan. Climate change mitigation in agriculture and waste; more detailed action in energy efficiency; and a commitment to halve the pace of deforestation by 2030 are all included.

Figure 1. Sectoral coverage in NDCs of AMS



Source: Monika Merdekawati, Beni Suryadi, Suwanto, and Gabriella Ienanto (2021)

To achieve the 2030 NDC targets, strategies/plans have been developed with a legal framework. In addition, AMS specified other activities to be implemented after 2030 and indicated the path each AMS will take after achieving its NDCs. A review of the selected strategies and plans also shows that AMS set ambitious medium and long-term targets covering various activities and sectors (Table 2), from waste management to public transport, energy use, job creation, and the like.

A long-term strategy is essential to achieve the long-term temperature targets of the AMS as well as to conduct a global inventory. Furthermore, the creation of a long-term strategy is essential to define a country's commitment to a zero-emission policy. Singapore (Government of Singapore, 2020) and Indonesia (UNFCCC) have presented a long-term strategy to achieve net zero emissions by 2050 (Government of Indonesia, 2021). The movement has spread to countries such as Cambodia, the Lao

PDR, and Myanmar. The Lao PDR and Viet Nam, for example, are now developing their own long-term strategy. Following the finalisation of the national long-term strategy, there may be valuable opportunities to systematically synthesise at the ASEAN level on how the national goals could align with the regional goals, and how to advance collective long-term strategy ambitions through regional cooperation in sharing information, best practises and expertise, practical mechanisms for mobilising finance, and promoting technological development. Plans to mitigate mid-century climate change do not currently exist. It will be necessary to revise modelling techniques and assumptions to prepare for a long-term regional climate vision based on net zero greenhouse gas emissions. Many AMS pointed to concerns about the scientific input for long-term strategy development, particularly on analytical capacity for modelling long-term scenarios and insufficient technical ability and information (ASEAN Secretariat, 2021). The efforts by ASEAN in undertaking the scoping study on laying

the groundwork for the development LTS can be a critical starting point (ASEAN Secretariat, 2021). Data gaps and capacity management issues can be further deliberated and addressed with the scoping study as a reference.

First, it is important to note that different countries take different approaches to formulating long-term climate action. These initiatives fall into three categories, depending on whether the focus is on climate change, energy and green growth. Several policies are planned to promote electric vehicles (EVs), hydrogen, Carbon Capture, Utilisation, and Storage (CCUS), and the use of the ASEAN power grid for sharing renewable energy. Second, some plans include numerical targets in addition to NDCs, which affects the direction and scale of mitigation activities in 2050 and beyond. Third, many AMS include medium-term plans linked to the Sustainable Development Goals (SDGs), and progress towards

the targets is assessed on a monthly basis. In this way, climate action and the SDGs are expected to benefit from greater synergies. Improving and updating these plans will provide the basis for significantly raising the ambition of NDC targets and initiatives. Critical to the implementation and execution of these plans is the creation of baseline and other related data so that the effectiveness of the plan and policy can be monitored and evaluated. One way for AMS to do this is to establish data management procedures and plans when preparing such plans and policies. Data management plans can be used at different levels and are particularly critical for data collection and management at the project and programme level. For example, AMS have proposed various energy efficiency programmes for energy saving initiatives. Data management plans should be included to assess, monitor and evaluate such programmes. This provides an opportunity to collect more data to develop effective strategies and plans.

Table 2. AMS medium to long-term mitigation strategies, vision, and plans

Countries	Plan/Policy	Target Year	Mitigation strategies/plans/areas	Reference(s)
Brunei Darussalam	Brunei Darussalam National Climate Change Policy	2035	Industry, forest, electric vehicle, renewable energy, energy management, carbon pricing, waste management, carbon inventory, and public awareness and education are all options for mitigating carbon dioxide emissions in the atmosphere.	Brunei Climate Change Secretariat (2020)
Cambodia	2013–30 National Green Growth Strategy	2030	Mitigation efforts will be concentrated on the following areas: 1) green employment creation and investment (RE); and 2) sustainable green economy management (low carbon emission, green finance procurement), 3) Environmental and Natural Resource Management (renewable energy in rural areas, and green public transit infrastructure); 4) Green Technology Management (trade, transfer, R&D)	National Council on Green Growth (2013)
	National Policy and Action Plan on Energy Efficiency 2018–2035	2035	This strategy aims to save energy and increase efficiency. Reduce energy usage by 20% (1 million tonnes oil equivalent (toe)) and CO ₂ emissions by 3 Mt by 2035.	Royal Government Cambodia (2019)
Indonesia	Government Regulation No. 79/2014 on National Energy Policy	2050	The following table summarizes the primary energy supply mix: 1) By 2025, new and renewable energy sources must account for at least 23% of total energy production; by 2050, they must account for at least 31% of total energy production. 2) oil to account for less than 25% of total energy in 2025 and less than 20% in 2050 3) Coal should account for at least 30% of total energy in 2025 and 25% in 2050. 4) Gas should account for at least 22% of total energy in 2025 and at least 24% in 2050.	Government of Indonesia (2016)
	Indonesia's Long-Term Strategy for Climate Resilience and Low Carbon Development (LTS-LCCR) 2050	2050	Indonesia has a long-term strategy with the goal of achieving net-zero emissions by 2060 or sooner	Government of Indonesia (2021)

Lao PDR	National Strategy for Green Growth (NGGS)	2030	The NGGS is the primary long-term national vision and plan that details the Resolution of the Tenth Party Congress, Vision 2030, the Ten-Year Strategy (2016–2025), and the Eighth and Ninth Five-Year National Strategic Economic Development Plans (2016–2020; 2021–2026). The NGGS is organized around four primary themes: i) green cities; ii) sustainable landscapes; iii) sustainable energy; and iv) cross-cutting concerns. There are various objectives for 2030, including CO2 emissions per capita (no more than eightfold what they were in 2014), the percentage of renewable energy use (hydroelectricity, solar energy, and wind energy) (40%), and the pace of forest cover increase (70%)	Secretariat for Formulation of National Green Growth Strategy (2018)
	A long-term plan is being developed	2050	Lao PDR is continuously modifying its INDC, aiming for net-zero emissions by 2050.	National Report
Malaysia	Plan for Renewable Energy Policy	2030	3,484 MW of renewable energy capacity to be achieved by large-scale solar, hydropower, biomass, geothermal, and biogas, as well as a FIT program	National Report
	Master Plan for Land Use and Transit	2030	By 2030, public transportation will account for 40% of travel, and rail service will be enhanced.	National Report
	Auto Policy 2014 and National E-Mobility Blueprint	2030	By 2030, fuel-efficient automobiles will be developed, alternative fuels will be used, and there will be 1,683 electric cars and 322,532 hybrid cars	National Report
	Malaysia's Zero Single-Use Plastics Roadmap for 2018–2030	2030	The plan outlines strategies for reducing plastic pollution and gives guidance to local firms on how to implement environmentally friendly alternative manufacturing techniques. Several proposals included the countrywide adoption of biogas and the imposition of a government pollution tax and pollution penalty on plastic producers by 2022	National Report
	National Forestry Policy 1978, Biodiversity Policy at the Federal Level, REDD Plus Strategy	2030	The plan outlines strategies for reducing plastic pollution and gives guidance to local firms on how to implement eco-friendly alternative manufacturing practices. Several proposals included the countrywide adoption of biogas and the imposition of a federal pollution tax on plastic producers and a pollution fee by 2022	National Report
	Numerous national strategies are in the works	2040	Malaysia plans to update its 2040 National Energy Policy, Green Technology Masterplan, Low Carbon Mobility Blueprint, and National Mitigation Plan.	National Report
Myanmar	Myanmar Climate Change Policy (2019)	2030	Achieving climate resilience and a low-carbon growth path by 2030 is set as a goal for Myanmar.	National Report Ministry
	Myanmar Climate Change Master Plan (2018–2030)	2030	Agribusinesses, cities, and communities may all benefit from climate-smart agriculture, fisheries, and livestock practices that promote food security and livelihoods while reducing carbon emissions.	Ministry of Natural Resources and Environmental Conservation (2019)
	Myanmar Climate Change Strategy (2018-2030)	2030	Sections of the plan include increasing clean and indigenous energy sources, improving energy efficiency and conserving resources.	Ministry of Natural Resources and Environmental Conservation (2019)
Philippines	Philippine Energy Plan (2018–2040)	2030	On the one hand, the plan aims to increase the use of clean energy sources while balancing the need for affordable energy with economic growth and environmental protection.	Department of Energy (2020)
	National Energy Efficiency and Conservation Programme (NEECP) (second version)	2040	The program's main goal is to reduce energy intensity and total consumption by 24% by 2040. The curriculum is directed at a variety of stakeholders, most notably those in the transportation, industrial, and commercial sector	Department of Energy (2021)

Singapore	Singapore's Long-Term Strategy for Low-Emission Development	2050	To achieve net-zero emissions by 2050, Singapore must reduce its GHG emissions by half from their high in 2030.	National Climate Change Secretariat (2020)
	Singapore's 2030 Green Plan	2030	This plan is a nationwide sustainability program to fight climate change.	Ministry of Sustainability and the Environment (2021)
	Elimination of ICE cars and conversion of ICE buses to electric	2040	This strategy asks for the advancement of EVs, electric buses, and associated infrastructure, as well as the phase-out of internal combustion engines by 2040. This proposal was introduced as part of Budget 2020 and is scheduled to take effect in 2040	National Report
	Singapore's 2030 Green Plan	2060	Part of the government's RIE2025" initiative. In the RIE2025 Plan, Singapore promises to investing in renewable energy, low-carbon technology, revolutionary CCUS technologies, nature-based solutions, and multifunctional greenery, among other things.	National Report
	The Energy Story of Singapore	-	This plan explains Singapore's Four Switches for a future where energy is reliable, generated efficiently, and utilized efficiently.	Energy Market Authority (2019)
Thailand	Master Plan for Climate Change, 2015–2050	2050	Mitigation measures include reducing national GHG emissions and developing low-carbon growth models, as well as increasing awareness of and capacity for climate change-related policies and initiatives at all levels of government.	ONEP (2015)
Viet Nam	Climate Change National Strategic Plan	2050	It aims to increase energy efficiency, transform the fuel structure of industry and transportation, increase the amount of renewable and novel energy sources, and promote organic agriculture.	Government of Viet Nam (2011)
	National Green Growth Strategy	2050	The goal for 2050 is to reduce greenhouse gas emissions by 1.5–2% each year	Government of Viet Nam (2012)
	Viet Nam's 2050 Vision for Low-Emission Development and Green Growth	2050	The target for the percentage of renewable energy in TPES is 15–20% in 2030 and 25–30% in 2045. Energy savings targets are 7% by 2030 and 20% by 2045.Reduced energy use is expected to reduce GHG emissions by 15% by 2030 and 20% by 2045 compared to the status quo.	Government of Viet Nam (2011)

Source: (ASEAN Secretariat, 2021)

4. State of Climate Data Management and Monitoring

At the suggestion of the World Meteorological Organisation (WMO) Regional Association working group on climate services, the ASEAN Regional Climate Data, Analysis, and Projections (ARCDAP) group seeks to address gaps in country-specific climate monitoring and data services by leveraging regional synergies. Since 2018, the ASEAN Specialised Meteorological Centre (ASMC) (hosted by the Singapore Meteorological Service) has sponsored an annual ARCDAP workshop funded by the WMO under the Canada-funded Climate Risk and Early Warning Systems initiative (Canada- CREWS). The ASMC seeks to bring together climate data from ASEAN National Meteorological and Hydrological Services, climate scientists and policy makers to discuss and identify best practices on climate change communication, data use and management, and scientific progress, among others. The ARCDAP group is currently analysing the latest ensemble of climate simulations from the Coupled Model Intercomparison Project (CMIP6) using CMIP-recommended tools such as ESMValTool. This will help ASEAN climate experts understand the latest global climate model database. On the other hand, ASEAN is not able to use HadEX3² and ClimPACT2³ (used by the majority of advanced nations) to find climate change monitoring and reporting data in AMS. It is therefore important that ASEAN authorities take appropriate measures for effective climate data monitoring and reporting.

Monitoring and evaluation are critical in identifying progress and making necessary course corrections, as well as determining whether desired outcomes have been achieved. Due to the challenges associated with quantifying impact, the progress in establishing a framework for monitoring and evaluation has slowed down, resulting in a lack of accurate monitoring and evaluation procedures in several AMS (Al Amin, Alam, & Doberstein, 2021). In the absence of country-specific climate databases of AMS, ad hoc methods such as project reporting to national and local governments and financial tracking systems should be used judiciously to achieve monitoring and assessment objectives.

The assessment of AMS readiness to implement the NDCs are presented in Table 3. The assessment was based on four dimensions, namely mainstreaming climate action into national policy; national coordination; resource mobilisation, including finance and investment; and monitoring and verification of

NDC commitments. As the Enhanced Transparency Framework (ETF) provides a clear framework for NDC reporting and implementation, it is important that AMS strengthen their capacity to collect and analyse data, establish institutional arrangements for monitoring and reporting, and set up a monitoring system to track climate risks and finance (UN ESCAP, 2020). AMS readiness for measurement, reporting and verification is assessed using proxy indicators to assess AMS capacity and capability to achieve NDC targets. The result shows that Singapore is relatively the best performer in measurement, reporting, and verification (MRV), while other countries are able to implement and participate in the implementation of the NDCs in the MRV dimensions. The results suggest that AMS need to do more to ensure proper recording, measurement, reporting and verification of climate commitments, which requires the establishment of appropriate data management systems.

² HadEX3 is a dataset of moderate temperature and precipitation (rainfall) extremes indices.

³ ClimPACT2 is an R software package that calculates the ET-SCI indices as well as additional climate extremes indices from data stored in text.

Table 3. AMS NDC implementation readiness

Countries	Mainstreaming	Coordination	Finance and Resources	Measurement reporting and verification (MRV)*
Brunei Darussalam	Nascent	Engaged	Nascent	Nascent
Cambodia	Engaged	Capable	Capable	Nascent
Indonesia	Capable	Capable	Capable	Capable
Lao PDR	Capable	Engaged	Engaged	Engaged
Malaysia	Engaged	Engaged	Engaged	Engaged
Myanmar	Engaged	Capable	Engaged	Engaged
Philippines	Engaged	Capable	Capable	Nascent
Singapore	Capable	Capable	Capable	Effective
Thailand	Capable	Nascent	Capable	Capable
Viet Nam	Capable	Capable	Capable	Capable

Source: (UN ESCAP, 2020); The categorisation is based on a scale score: Nascent (Scores 0 to 0.5) , Engaged (Scores 0.6-1.5), Capable (Scores 1.5-2) and Effective (Scores 2.1 -3) Note: * Since MRV capacities are not directly observable proxy indicators were used.

The ASEAN State of Climate Change report points to the need to improve the information base for the necessary mitigation of climate change and the promotion of effective action through information management. These include:

1. Improving the information base by establishing a sectoral database on GHG and other climate pollutants. Other data include socioeconomic data and natural resources information including RE potential; and GIS information on land-uses.
2. Creating co-benefits by enhancing collaboration and joint research actions to engage in scientific based actions.
3. Knowledge sharing by establishing a knowledge hub on MRV for ASEAN and AMS. The focus can be on capacity development on data management by knowledge sharing on best practices and guidelines as well as framework.
4. Strengthen modelling capacity for long-term projections especially in identifying modelling needs and techniques in collaboration with larger research communities.

The assessment of capacity needs related to data management for adaptation and mitigation based on the priorities of each AMS is shown in Table 4. It shows that there is consensus on data management, monitoring and evaluation needs across AMS. Priorities vary, but most AMS have identified the need for a strong information system and climate risk assessment, including climate risk projection. In this regard, ASEAN countries need to establish a framework for sharing scientific knowledge and for data management and assessment. Institutional arrangements and policy coordination may also be needed to create more transparency around data and monitoring at the central and ASEAN levels. Strengthening the information base, developing modelling and projection capacity, and risk and vulnerability assessment capacity are becoming critical needs, among the top five ranked, for most AMS. It is therefore timely for ASEAN to capitalise on this priority need and commit AMS to a data management framework to develop these capacities. Without data and action, these activities will be difficult to implement.

Table 4. NDC target summaries

Countries	Mitigation	Adaptation
Brunei Darussalam	Strengthen Information Based (database) (Rank 1) Strengthen the modelling capacity for long-term projections (Rank 2) Establish a knowledge centre hub on MRV for ASEAN and AMS (Rank 4)	Strengthen climate change impact projections and their downscaling (Rank 1)
Cambodia	Strengthen the modelling capacity for long-term projections (Rank 9)	Promote risk assessments as a basis for adaptation planning (Rank 1) Conduct vulnerability assessments (Rank 3) Promote evidence-based adaptation (Rank 4) Strengthen climate change impact projections and their downscaling (Rank 7)
Indonesia	Strengthen the modelling capacity for long-term projections (Rank 3)	Strengthen the scientific information base (Rank 1) Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics (Rank 5)
Malaysia	Strengthen the information base (e.g. database) (Rank 1) Strengthen the modelling capacity for long-term projections (Rank 2) Monitor and track regional actions targeted at REDD+ and carbon trading (Rank 5)	Conduct vulnerability assessments (Rank 1) Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics (Rank 2) Strengthen climate change impact projections and their downscaling (Rank 3) Strengthen the scientific information base (Rank 4)
Myanmar	Strengthen the modelling capacity for long-term projections (Rank 2)	Strengthen climate change impact projections and their downscaling (Rank 1) Socio-economic scenario development in the context of adaptive capacity enhancement (Rank 2) Conduct vulnerability assessments (Rank 3)
Philippines	Not ranked as top 10 prioritised national actions	Promote risk assessments as a basis for adaptation planning (Rank 2) Strengthen the scientific information Base (Rank 3) Strengthen climate change impact projections and their downscaling (Rank 4)
Singapore	Not ranked as top 10 prioritised national actions	Strengthen climate change impact projections and their downscaling (Rank 1) Strengthen the scientific information base (Rank 2) Promote risk assessments as a basis for adaptation planning (Rank 4)
Thailand	Not ranked as top 10 prioritised national actions	Conduct vulnerability assessments (Rank 1) Promote risk assessments as a basis for adaptation planning (Rank 2) Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics (Rank 3) Strengthen loss and damage information and decision support systems (Rank 6)
Viet Nam	Strengthen the information base (e.g. database) (Rank 1) Strengthen the modelling capacity for long-term projections (Rank 10)	Promote risk assessments as a basis for adaptation planning (Rank 1) Strengthen the scientific information Base (Rank 4) Promote monitoring and evaluation (M&E) of adaptation including adaptation metrics (Rank 6)

Source: (ASEAN Secretariat, 2021)

Note: The rank indicates the priority of the respective AMS.

5. Addressing Climate Data Management Issues

5.1 Expanding ASEAN's Leadership in Data Management

While all AMS have committed to reducing global carbon emissions in line with the Paris Agreement, action on data management and systems has remained limited. Although the ASEAN Working Group on Climate Change (AWGCC) is one of the main technical working groups addressing climate change needs, climate change issues are increasingly intertwined and affect a number of ASEAN sectoral organisations. The activities of the AWGCC may need to go beyond the purely environmental sector in identifying and linking relevant sectoral bodies. This body would need to produce an action plan, policy proposal or policy approach, particularly regarding the need for standard protocols for information sharing and data requirements among ASEAN sectoral bodies, ASEAN institutions and the ASEAN Secretariat as a whole.

In the most recent ASEAN Joint Statement to the United Nations Climate Action Summit 2022, ASEAN acknowledged “the principle of shared but differentiated responsibilities and respective capacities (CBDRRC)” in light of climate concerns and national conditions. ASEAN has the convening power to urge its Dialogue Partners to prioritise climate action, channel public funds, and provide capacity-building as a regional organisation dedicated to collectively tackling transboundary challenges. ASEAN’s leadership and convening role is an important resource that can help AMS advance their climate discussions under the UNFCCC and secure important capacity-building and information-sharing resources at the global level. In this regard, ASEAN can take a leadership role given the AMS’ strong commitment to building data management capacity

Another institutional gap is that there is no place for civil society and industry to work together on climate change. It is possible for ASEAN to act as a bridge to facilitate discussions between business, civil society organisations, academic institutions, and governments on critical climate change issues and identify the need for a collective data management system. For instance, engagement with non-governmental organisations (NGO) networks can create the path for ASEAN in knowing the climate issues and data requirements for designing solutions. ASEAN aims to lift hundreds of millions of its people out of poverty by meeting the SDGs. Civil society organisations (CSOs) supported by the business community are crucial in considering evidence-based, data-driven climate policies simultaneously with other empowerment initiatives to ensure that the underprivileged are not left behind.

ASEAN’s vulnerability to the impacts of climate change requires access to data and technology, which is still in its infancy in the region. Access to new and emerging technologies is critical for the ASEAN region in areas such as climate change risk assessment, impact prediction, climate change assessment, development of drought and flood tolerant crops, development of climate resilient infrastructure such as energy efficient yet climate resilient urban housing, construction of coastal infrastructure, mitigation and management of severe events, early warning systems, and disease surveillance. Moreover, soft technologies for policymaking have not yet been developed. Complexity-aware decision support systems need to be adapted regionally.

Most AMS have implemented climate policies and developed strategies and action plans to address climate change at the national level. Prioritising the critical role against climate change (e.g. those on the frontline and directly affected by climate change) requires AMS to collectively act but the lack of collective information related to climate action on the ground, data management, and M&E methods to assess the performance of policy/plan/strategy implementation will limit progress on climate change action. The lack of a framework for data management and reporting makes it necessary for ASEAN to work together to establish such a framework. Research shows that coordination on climate change adaptation and mitigation among agencies in different AMS is weak due to barriers in sectoral laws and the emerging state of institutional arrangements. For example, intensive coordination is needed when water management, land use, forestry, meteorology, and disaster management are regulated by different laws and authorities (Arino, Svrk, Ikeda, Matsui, & Lee, 2020). With proper framework for data management and reporting, effective coordination can be fostered across AMS on climate change mitigation and adaptation.

Although AMS are making headway in preventing climate change through emission reductions, the regional climate change framework needs to be

better managed across sectors when it comes to data availability. Specific programmes that are designed and planned should consider integrating data management initiatives within the programme at national and regional levels. The framework may target specific priority areas and focus on individual sectors and programmes. A common reporting mechanism should be established for some of the key parameters and indicators. This includes the development of a regional climate database in collaboration with individual AMS, the research community and other stakeholders. For example, ASEAN has made progress on energy efficiency initiatives/programmes (EE) such as building codes, EE standard and labelling, and minimum energy performance standards (MEPS). Yet, key data from such initiatives are not collected, monitored and even analysed to derive better policy implications. Identifying a common framework that fits some of these programmes would enable better data management and make the programmes more effective in addressing the impacts of climate change. Finding commonalities and building a framework for urban climate data management would also be a possible area to consider. The following case studies illustrate how data management is being handled at regional and national levels, which could provide guidance for ASEAN.

Case 1: INSPIRE Directive in the European Union (EU)

In 2007, the EU created a spatial data infrastructure that deals primarily with regional environmental policies that could potentially have an impact on the environment. The data infrastructure serves as a legal framework in the EU region that enables the sharing of environmental spatial data between public sector organisations while improving public access to spatial data. In general, the Directive covers more than 30 spatial data themes needed for environmental applications, with key components specified through technical implementing rules. Importantly, the Directive is subject to several guiding principles that ensure that data protection and transparency are highly considered. The main guiding principles include the following:

1. Data collection and storage should be done in the most efficient way.
2. The data platform should be able to seamlessly merge spatial data from different sources.
3. The data platform should serve as an open data platform by sharing data with a wide range of users and applications.
4. The collected data should effectively serve for in-depth investigations and be generalisable for planning purposes across Europe.

Source: (INSPIRE European Union, 2022)

Case 1: Sweden Climate Change Data Management

The Swedish government is introducing open access to research data to collaborate with other ministries or agencies producing related information and to ensure a coherent approach. The Environmental Protection Agency, the Maritime and Water Agency and the provincial administrations have jointly developed an environmental data management strategy to guide the improvement of the availability and use of environmental data and information in Sweden. The focus was on ensuring that environmental data fulfil the principles FAIR (Findable, Accessible, Interoperable and Reusable).

Source: (Swedish Environmental Protection Agency, 2020)

Critical to such cooperation is a comprehensive policy framework capable of addressing the challenges of data governance at different levels. Institutional capacity building in data management is indeed crucial, especially when it comes to obtaining technological, financial and technical support for the establishment of data management systems.

5.3 Expanding ASEAN's Leadership in Data Management

The global overview of data management from climate change focuses on the free availability of data around the world. Data management plans have emerged as the expected way for data providers to formalise and communicate their intentions to stakeholders, including their funders. However, data sharing in ASEAN presents a number of challenges such as complexity of data, difficulty in data collection, storage and dissemination, lack of investment in data collection and different data format and standards. However, the importance of data sharing is not limited to the research ecosystem, but also extends to open data efforts in government agencies. Moreover, implementers of open data projects should assess stakeholder readiness for open data and link data sharing processes to appropriate collaboration and

communication techniques (Verhulst & Young, 2018) - data visualisations, web platforms, social media communication channels or apps (World Bank, 2018). Similarly, commonality and fitness for use principles are a critical mechanism for improving data provision. AMS can agree on common data and fitness for use to identify suitable data for use. It is worth noting that not all datasets fall under 'open data' or can be shared on public platforms due to their confidentiality and sensitivity. Therefore, there are a plethora of options developed based on best practices to enhance the provision and management of data through the mechanism of commonality and usability. Table 5 shows some examples of common data that would allow consolidation of data and wider use of that data.

Table 5. Types of open data based on commonality and fitness for use principle

Indicators	Sector	Frequency	Coverage
GHG emissions disaggregated by sector, as reported to UNFCCC	All	Annual	National
Emission intensity of agricultural commodities	Agricultural	Annual	National
Geospatial data on locations and types of disturbance (fire, deforestation, timber harvesting, and forest management activities such as thinning) that impact ecosystem carbon cycling	Forestry	Annual	National
Electricity production by fuel Source & CO2 emissions	Industry	Annual	National
Share of renewable energy in total energy use and generation	All	Annual	National

Average passenger vehicle travel distance (km/year)	Transport	Annual	National
Waste disposition rates (solid waste, biologically treated waste, incineration (non-energy), recycling)	All	Annual	National
Historical temperature and precipitation data	N/A	Annual	National
Historical data on economic loss as a result of natural extreme events (% of GDP)	N/A	Annual	National
Data on population access to early warning systems for disease vectors and extreme weather events	Public	Annual	National
Domestic climate relevant expenditures by source (domestic vs. external) and specific activity funded	Finance	Annual	National

Promoting access to open data to a wider community, including the civil society, can have the following potential benefits (Grinspan & Worker, 2021):

- (1) Expose weaknesses in data standards and duplication.
- (2) Facilitate decision-making by reducing data destruction, raising user awareness of available data, and facilitating the integration of data from different sources. Aclimate Colombia, for example, uses open government data to help farmers understand and adapt to changing weather patterns. It has supported research institutes and farmer associations in developing more effective planting dates, crop varieties and other agricultural recommendations.
- (3) Improved coordination and the formation of new partnerships. For example, after the 2016 earthquake in Aceh, Indonesia, scientists, local and national government officials, and community members worked together to identify potential threats to communities and infrastructure. It also helped disaster management prioritise response and recovery efforts.
- (4) Using local and national data to scale down regional or global models makes climate modelling more visible, available, accessible, simple, and context specific.
- (5) Improve monitoring of policies and programmes: open data enables citizens to engage in formal and informal monitoring practices. Furthermore, open data standards help in the development of climate change indicators and increase the transparency of analyses used to support policy recommendations. By promoting the exchange of information and data between agencies, these projects can help strengthen national and global reporting frameworks under the Paris Agreement. For example, the Spanish group Futuro en Comn has used a variety of open datasets to examine government development towards achieving the SDGs, particularly SDG 13 on climate action (Grinspan & Worker, 2021).

In the long run, ASEAN cannot neglect the potential benefits of climate-related data accessibility through open data practises. Experiences with open data applications from other countries based on ‘usability’ could serve as guiding principles to address disaster risk management, urban resilience, waste reduction, agricultural adaptation and water management, among others. It is important that ASEAN recognises the role of open data to improve data quality for decision-making, foster new partnerships and innovative use of data, and improve climate policy monitoring. In a nutshell, it is undeniable that greater access to certain datasets brings benefits, despite the significant contribution based on the principle of open data. Overall, it is time for ASEAN to raise the awareness and capacity of stakeholders across the data value chain to effectively and transparently manage open data to address regional environmental policies that could potentially impact the environment.

5.4 Big Data Opportunities

Building resilience and mitigating climate change should be seen as a joint effort. Drawing on their knowledge and experience, AMS can set goals, promote ownership and create and manage investment programmes that meet local needs. ASEAN and successful development outcomes require high-level political, technical and financial support. To mitigate climate hazards over time, it is critical to use climate data management to analyse the readiness of AMS to implement the determinants enshrined in the NDCs, while reducing the complications of building resilience, climate-resilient socio-cultural communities and addressing climate change. Climate data and technology can help build more resilient and robust communities. The combination of cloud computing and big data could help farmers make better decisions. Big data, for example, can transform agriculture by enabling the building of a cloud-based ecosystem with multiple data sources, tools, and applications.

These methods, such as big data analytics, allow researchers to monitor the future effects of climate change. This is just one example of how important these areas are in addressing climate change

and future threats. In addition to climate change research, big data analytics can help organisations develop effective solutions to climate change. To combat climate change, we need to analyse pollution data to better target our efforts and find solutions. How can we fight climate change? We need a better knowledge of reality and what is causing the most severe environmental changes. With the help of big data management, we can measure our global carbon footprint and quantify emissions of carbon and other greenhouse gases.

The ASEAN Digital Masterplan 2025 (ASEAN Secretariat, 2021) was launched in 2021 to improve data governance and protect the digital rights of consumers across the ASEAN region, but implementation of the plan is still in its infancy. This is due to an unclear data protection framework, which remains a key challenge for regional coordination and cooperation on climate data and services in the ASEAN region. Ultimately, ASEAN can use ADM as a guide to further improve the availability of climate data and services and provide practical and climate risk-based analytical solutions to AMS in the long term.

6. Conclusion

ASEAN addresses climate change through a variety of policies and activities based on the development of different institutional frameworks for action on climate change and sectoral areas. Each AMS has formed a lead council or committee to manage the creation and implementation of national climate change policies (e.g. technical working groups for adaptation and mitigation). In AMS, the lead council is chaired by the Prime Minister or Deputy Prime Minister, reflecting the high-level nature of national climate change action systems. While AMS set important climate change strategies and NDCs, there is little evidence of progress in the areas of climate data management. For AMS to be productive, there is a need for a solid understanding of the context and dynamics, as well as improved information sharing and capacity building, environmental change data management, baseline environmental data management, climate data monitoring and reporting, regional knowledge transfer, technological advancement, mitigation issues and data management portfolio with the aim of developing a robust climate change mitigation and adaptation framework to achieve the SDGs goals with integrated system components. There are potential opportunities for ASEAN in creating a better data ecosystem by promoting regional collaboration in climate data management, improving data governance, transparency, and data sharing as well as exploring big data opportunities.

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**The ASEAN Secretariat
ASEAN Socio-Cultural Community (ASCC) Department
Jalan Sisingamangaraja 70A
Jakarta 12110, Indonesia**

www.asean.org

