SECTION 1

The Making of the 30-Year Science, Technology, and Innovation Foresight and Strategic Plan

SECTION 1.1
THE SCIENCE, TECHNOLOGY, AND INNOVATION FORESIGHT FRAMEWORK

A Foresight, as defined by the European Commission (2002) is "the application of systematic, participatory, future intelligence gathering, and medium-to-long-term vision-building processes to informing present-day decisions and mobilizing joint actions. It brings together key agents of change and various sources of knowledge in order to develop strategic visions and anticipatory intelligence."

With this in mind, the National Academy of Science and Technology, Philippines (NAST PHL) undertook Pagtanaw 2050, a foresight project consisting of a Philippine-focused science, technology, and innovation (STI) strategic plans and roadmaps covering a period of 30 years from 2019-2050.

United and Inclusive, Prosperous, and Sustainable Archipelagic, Maritime Nation

This framework builds on aspirations and initiatives expressed in the 1987 Philippine Constitution, the past and present Philippine Development Plans, the United Nations (UN) Sustainable Development Goals (SDG) 2015–2030, the Department of Science and Technology (DOST) Harmonized National Research and Development Agenda, and AmBisyon Natin 2040. Further adjustments have been made in the wake of the COVID-19 pandemic and its impact on the nation's socioeconomic and political condition.

The aspirations embodied in the aforementioned references can be achieved by actively building on our nation's archipelagic resources and extensive maritime heritage, even as we diplomatically assert our rights over our surrounding marine environment. Such an archipelagic, maritime nation should care for its citizens by fostering unity, inclusivity, prosperity, and sustainability through STI.

The objectives of this STI Foresight are as follows:

- To present an insightful review of key trends, needs, and gaps in STI as it relates to the inclusive growth and competitiveness of the Philippines.
- To propose a 30-year strategic plan using available data and information along with key targets/indicators, delivery mechanisms, and policies gathered from various stakeholders.
- To establish an STI framework and 30-year strategic plan by integrating transformative thinking, planning, monitoring, and inclusive implementation towards an STI supported and encultured Philippines.

The Foresight Process

The Foresight project involves participatory and inclusive ideation and validation to explore diverse perspectives at the national and international levels. A schematic overview of the NAST PHL STI Foresight Framework is shown in Figure 1.1_1. A more detailed representation of expected Inputs and the Outputs is in Figure 1.1_2.

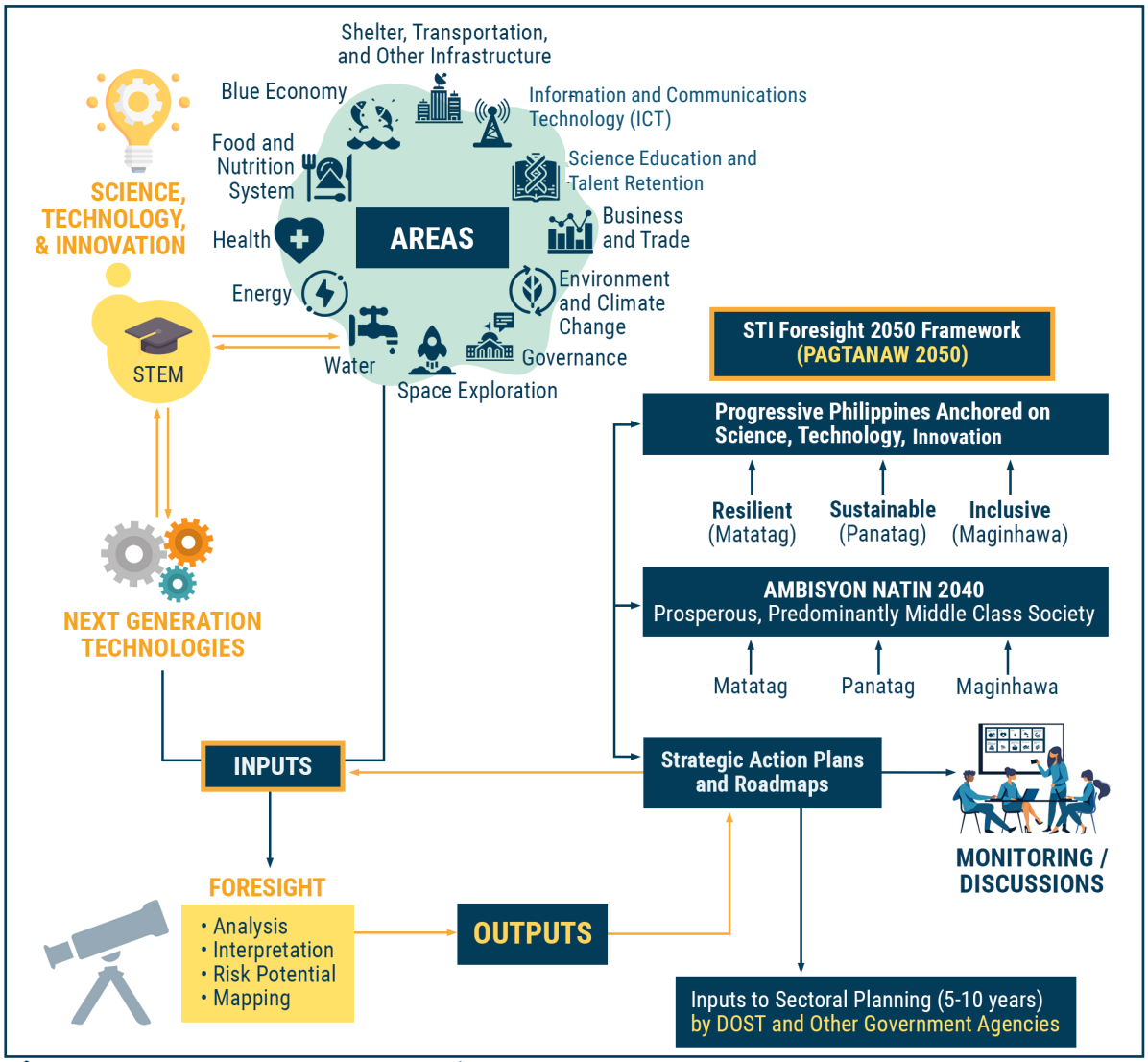


Figure 1.1_1. The NAST PHL STI Foresight Framework: Pagtanaw 2050

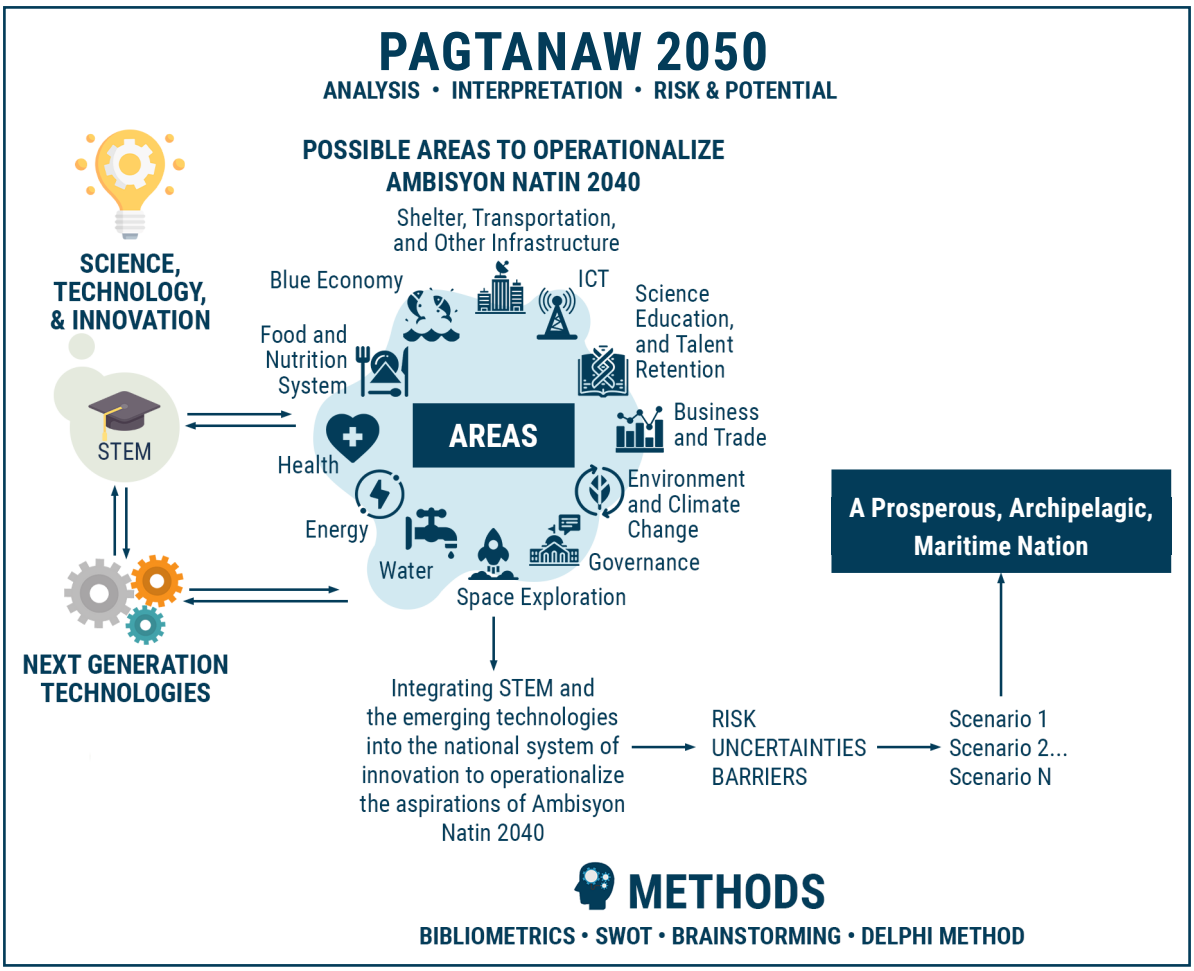


Figure 1.1_2. Inputs and Outputs of the NAST PHL STI Foresight Framework: Pagtanaw 2050

The proposed inputs and outputs herein are initial listings and may undergo refinement and modification as the foresight exercise progresses through the years. It is thus important to be able to determine the needs and trends, opportunities, and drivers of change.

The inputs (Fig. 1.1_1 and Fig. 1.1_2) shall consist of the present and next-generation tools that Science, Technology, Engineering, and Mathematics (STEM) and Emerging Technologies may provide to address the operational areas by exploiting the synergies across technologies that will best contribute to the realization of the aspirations in the following references:

- The 1987 Constitution of the Republic of the Philippines
- NEDA Report on AmBisyon Natin 2040 (NEDA 2016)
- Philippine Development Plans (NEDA 1987, 1993, 1999, 2004, 2011, 2017)
- RA 8425: An Act Institutionalizing the Social Reform and Poverty Alleviation Program, Creating for the Purpose the National Anti-Poverty Commission, Defining Its Powers and Functions, and for Other Purposes (signed into law on 28 July 1997). This law defines the components of the Minimum Basic Needs.
- DOST Harmonized National Research and Development Agenda (DOST 2016)
- UN Sustainable Development Goals 2015-2030

The outputs indicated in Figures 1.1_1 and Figure 1.1_2 were the results of several data gathering and analytical methods. First, megatrends and other relevant information on Philippine STI and foresight methods were culled following a thorough review of available bibliometric sources. This was followed by a series of workshops and meetings (from January 2020 to March 2021) with experts and relevant stakeholders that considered futures thinking/foresight methodology for Philippine STI and strategic, long-term, comprehensive policy and action plans for inclusive development, security, and governance.

The 2020 NAST PHL Annual Scientific Meeting (ASM) and Regional Scientific Meetings (RSM) were of particular importance to this Foresight in that they solicited and collated the perspectives of the broad scope of researchers and topic experts that comprise the science community. Close to a thousand participants attended each two-day meeting, which served as the initial stakeholders' consultation on the operational areas of the STI foresight. Paper presentations and commissioned papers from the ASM and RSMs served as sources of data and information and recommendations for the STI Foresight.

Strengths, Weaknesses, Opportunities, and Threats (SWOT) & Threats, Opportunities, Weaknesses, and Strengths (TOWS) Analysis. A SWOT and TOWS workshop was undertaken involving the problem tree analysis wherein the experts enumerated and discussed the causes (root), problems (trunk), and effects or consequences (branches) for the identified science and technology (S&T) areas. The SWOT paved the way for the internal and external analyses of the National Innovation System wherein internal analysis was done by enumerating the system's strengths and weaknesses. External analysis was made by reviewing political, economic, environmental, socio-cultural, technological, and legal factors that could pose threats or provide opportunities. Through TOWS, experts managed to determine ways to use the strengths of the STI community to actualize opportunities and cope with threats. Similarly, they also came up with ways to use opportunities in minimizing weaknesses and use threats in correcting weaknesses.

Delphi Survey. A two-round Delphi survey was conducted to arrive at a consensus on the following:

(1) Expected changes in aspirations outlined in AmBisyon Natin 2040 due to COVID-19 pandemic
(2) Sociocultural, technological, economic, environmental, and political megatrends for consideration in the foresight
(3) Expected black swans or disruptions as Filipinos journey to 2050
(4) Additional areas for consideration in the foresight
(5) Perceived areas of current strength in Philippine STI
(6) Additional areas in the future that Philippine STI should be leading in
(7) Private and public institutional changes to enhance the role of STI in development and the lives of Filipinos
(8) Talent development and retention in STI

(9) Harnessing STI in asserting our sovereignty and identity as a maritime nation
(10) Public investments and interventions in STI to reduce poverty or the conditions associated with poverty

A total of 243 respondents answered the first round of the Delphi survey, while 206 managed to participate in the second round. Respondents came from various academic institutions, civil society, government agencies, government-owned and controlled corporations, government think tanks, industry, international organizations, non-government organizations, professional organizations, and research and development (R&D) institutions (Table 1.1_1).

Table 1.1_1. Profiles of Delphi Survey Respondents by Institution

Round 1 Respondents		Round 2 Respondents	
Affiliation	**Frequency**	**Affiliation**	**Frequency**
NAST PHL	46	NAST PHL	33
Outstanding Young Scientists, Inc.	18	Academe	97
Higher Education Institutions	40	Executive Department	8
DOST	33	Industry	9
Philippine American Academy of Science and Engineering	37	International Organizations	3
Philippine Science High School	12	Non-Government Agencies/Organizations	45
Professional Organizations in the Basic Sciences	4	Others	7
		Government Think Tanks	1
Private Business/Industries	7	Government Think Tanks	2
RDI	28	Professional Organizations	1
		RDI	1
STEM Institutes/Organizations	8	Government-Owned and Controlled Corporations	1
Food Industry	2		
Unknown	4	Law	1
		Civil Society	1
Others	4		
Total	**243**	**Total**	**202**

Scenario Planning. In addition to the Delphi survey, the NAST PHL also conducted scenario planning exercises for major STI operational areas, which were then grouped into clusters based on their interrelatedness and interactions (see Section 6.1), to wit:

Cluster I: Health, Food Systems, Nutrition
Cluster II: Energy and Water
Cluster III: Environment and Climate Change and Space Exploration
Cluster IV: Shelter, Transportation, and Other Infrastructure

In the said workshop, participants came up with a futures triangle, wherein the pull factors of the future, push factors of the present, and weight of the past were scrutinized. Drivers of change and potential threats were also mapped in the process. Four scenarios were discussed: disowned futures,

outlier futures, preferred futures, and integrated futures. The disowned futures scenario showed more dysfunctions and unintended consequences and was considered to result in an unsustainable and non-resilient future, Meanwhile, the outlier futures scenario was described as a “strange, unusual, and improbable” but somewhat “beautiful” future. The preferred scenario was the one that the participants looked forward to by 2050. After discussing these futures scenarios, the preferred and integrated futures scenarios were used to guide the causal layered analysis wherein experts crafted a hypothetical news headline and named underlying systems, worldviews, myths and metaphors governing the clusters. The last step in the scenario planning was the backcasting. This was necessary as this required the experts to delineate steps that would help the country achieve the integrated futures scenario per cluster.

SECTION 1.2
THE SCIENCE, TECHNOLOGY, AND INNOVATION FORESIGHT OF OTHER COUNTRIES

The quality and impact of decision-making are greatly improved by going through an exercise in foresight. Foresight serves as a beacon light in the preparation of strategies and prepares institutions and individuals to react to the challenges that are yet to come (EFP 2010).

This section will analyze the foresight documents of Japan, South Korea, and Malaysia. Due to constraints in the availability of the above reports in English, we shall cover only the 10th Science and Technology (S&T) Foresight of Japan (NISTEP 2015), the 5th Science and Technology Foresight (2016-2040) of South Korea (KISTEP 2017), and the Science and Technology Foresight Malaysia 2050 (ASM 2017).

Basis of the Foresight

All three S&T foresight reports were initiated and implemented by the governments of the countries concerned. Japan has been engaged in S&T foresight since 1971 and every five years thereafter, under the leadership of the Science and Technology Foresight Center (Japan). For South Korea, their S&T foresight was developed on a five-year interval in compliance with Articles 13 and 22 of the "Framework Act on Science and Technology", while the Malaysian foresight report was derived from the Emerging Science, Engineering &Technology (ESET) Study.

Societal Goals

The foresight reports all start with an assessment of the aspirations of their respective citizenry as indicated in Table 1.2_1. Although they vary in terms of their specific articulation, the reports cover the basic aspects of societal well-being, such as health, food security, access to livelihood opportunities, and concern about the impact of climate change and human activities on the environment.

Methodology

All three foresight exercises used more than one method to gather ideas for their report (Table 1.2_1). The choice of methods regarding the scope of foresight in S&T vary slightly among the three foresight reports. However, the foresight reports of Japan, Korea, and Malaysia all indicated the use of consultations with experts and other stakeholders.

Japan and Korea conducted Delphi surveys and undertook scenario-planning for various topics. Korea used the tipping point method to narrow down their technological choices. Malaysia relied primarily on working groups organized by priority areas, and involved foreign institutions and experts, focusing their discussions on five areas: biotechnology, digital technology, green technology, nanotechnology, and neurotechnology.

The megatrends and uncertainties identified by the three countries can be clustered into the following:

- increasing dominance of the digital age and the disruptive technologies
- climate change
- concern for the impact of man's activities on the environment
- impending global changes in the economic systems
- changing demographics especially the increase of ageing communities
- and the rapid developments in international cooperation

Since all the three reports were written before the COVID-19 pandemic, there is almost no reference to the same, or to the possible recovery activities when the pandemic has been brought under control (Table 1.2_1).

Table 1.2_1. Foresight Reports of Japan, Korea, and Malaysia

Components	Japan (2015) 10th S&T Foresight Plan	Korea (2017) The 5th Science and Technology Foresight (2016-2040)	Malaysia (2017) Science and Technology Foresight Malaysia 2050 Emerging Science, Engineering, & Technology (ESET) Study
Basis	The Technology Foresight Survey has been conducted every five years since 1971, engaging S&T experts in Japan to suggest a future path of technological development in the next 30 years and to contribute to government policy decision-making and decisions on research allocation in S&T. The survey is conducted by the Science and Technology Foresight Center.	Framework Act on Science and Technology Article 13 and Article 22 of the Enforcement Decree of the Framework Act on Science and Technology (Science and Technology Forecasting, etc.)	ESET Study focused on biotechnology, digital technology, green technology, nanotechnology, and neurotechnology.

Table 1.2_1. Continued

Components	Japan (2015) 10th S&T Foresight Plan	Korea (2017) The 5th Science and Technology Foresight (2016-2040)	Malaysia (2017) Science and Technology Foresight Malaysia 2050 Emerging Science, Engineering, & Technology (ESET) Study
Societal Goals/ Aspirations	• Connected society • Knowledge-based and service-oriented society • Healthy long-life society • Sustainable regional society • Manufacturing-based society • Resilient society • Japan in global context	• Responsiveness to changes in future social demand • Development of science and technology • Social Infrastructure, e.g., nuclear safety, safety infrastructure • Ecosystem and environment friendliness, e.g., weaponization of food, ecosystem change due to climate change • Transportation and robotics, e.g., unmanned vehicles, home service robots • Medical and Life, e.g., new infectious diseases, weaponization of vaccines • Manufacturing and convergence, e.g., new materials, transition from traditional manufacturing • Information and Communication e.g., cybercrime, educational system reform	• Make Malaysia a powerhouse for high value chain activities in Electrical and Electronics sector • Make Malaysia a regional leader in Agrotechnology and Agribusiness • Make Malaysia a premier global Halal hub • Ensure well-being and health of the people of Malaysia • Accelerate socio-economic transformation leveraging the digital tsunami • Move towards a low waste, resource-efficient society
Methodology	• Visioning • Delphi Survey • Scenario Planning • Evaluation of importance, certainty/uncertainty, non-continuity, morality, international competitiveness, expected year for technology realization and real-world implementation • Challenges/Policy measures	• Brainstorming • Delphi Survey • Horizon scanning • Scenario Planning • Tipping Point Analysis • Social, Technological, Environmental, Economic, and Political (STEEP) analysis	• Working Groups: biotechnology, digitla technology, green technology, nanotechnology, neurotechnology • Horizon scanning and bibliometrics • Surveys • Strategic consultations • Engaged international and Malaysian experts
Megatrends	• Open science and innovation • Data science • Applied use of big data • Support for decision making • Artificial Intelligence • Ethical, legal, and social implications (ELSI) issues • National security and safety, etc. • Cyber-physical system enables new coalescence of humans and machines • Information is automatically analyzed and selected • Aging population • Collaborative start-up • Occupation is free from physical capability like aging and physical disability • New jobs	• Human Empowerment • Innovation through Hyper-connectivity • Deepening Environmental Risk • Intensification of Social Complexity • Reorganization of the Economic System	• Shift in global economic power • Emergence of disruptive technology • Rapid urbanization • Demographic and social change • Climate change • Global risks (extreme weather events, large-scale involuntary migration, natural disaster, terrorist attacks, data fraud or theft).

Table 1.2_1. Continued

Components	Japan (2015) 10th S&T Foresight Plan	Korea (2017) The 5th Science and Technology Foresight (2016-2040)	Malaysia (2017) Science and Technology Foresight Malaysia 2050 Emerging Science, Engineering, & Technology (ESET) Study
Findings/ Recommendations	• Examined 312 items with high importance • Combined scores for uncertainty and discontinuity to extract items within top 10% (30 items) and bottom 10% (30 items) • Global competitiveness to finalize the ranking to top 10% and bottom 10% Thematic scenarios include: • Advanced manufacturing platform • Future co-creating services • Improvement of physical and mental health towards realization of a healthy, longevity society • Maintaining food production and ecosystem services by using regional resources • Resilient social infrastructure to respond to large scale disasters and aging population with fewer children • Energy, environment and resources for a sustainable future • Integrated scenarios form the viewpoint of globalization • S&T topics and thier forecaster year of realization	Indentified 287 technologies that are expected to emerge by 2040 and group them into 18 short-term issues, 14 short-to-mid-term issues, and 8 long-term issues.	• Identified 95 emerging technologies as reference to facilitate discovery of new knowledge, advancing technology platforms and realizing innovation in the form of new products and services and technologies for a harmonious, prosperous and sustainable Malaysia. • Developed timelines into present future (2015-2020), probable future (2021-2035), and possible future (2036-2050).

Findings and Recommendations

Finally, the findings and recommendations of the reports consist primarily of the inventory of technologies that are expected to be developed in response to societal needs and interests. The foresight report of Japan listed 312 technologies of high importance and narrowed its list down to the top and bottom 10%; Korea identified 287 technologies that are expected to be available by 2040, and grouped those into short-term issues, short to medium – term issues and into a very short list of eight long–term issues. Malaysia identified 95 technologies that were finally narrowed down to 25.

The inventory of present and prospective technologies that could respond to the unique societal needs of each of the three countries were gathered into scenarios described in varying degrees of detail, including the list of prioritized technologies expected to form the basis of a time-bound strategic plan for developing and harnessing S&T to serve their needs.

SECTION 1.3
SCIENCE AND TECHNOLOGY INDICATORS ON COMPETITIVENESS AND INNOVATION

World Economic Forum Global Competitiveness Index

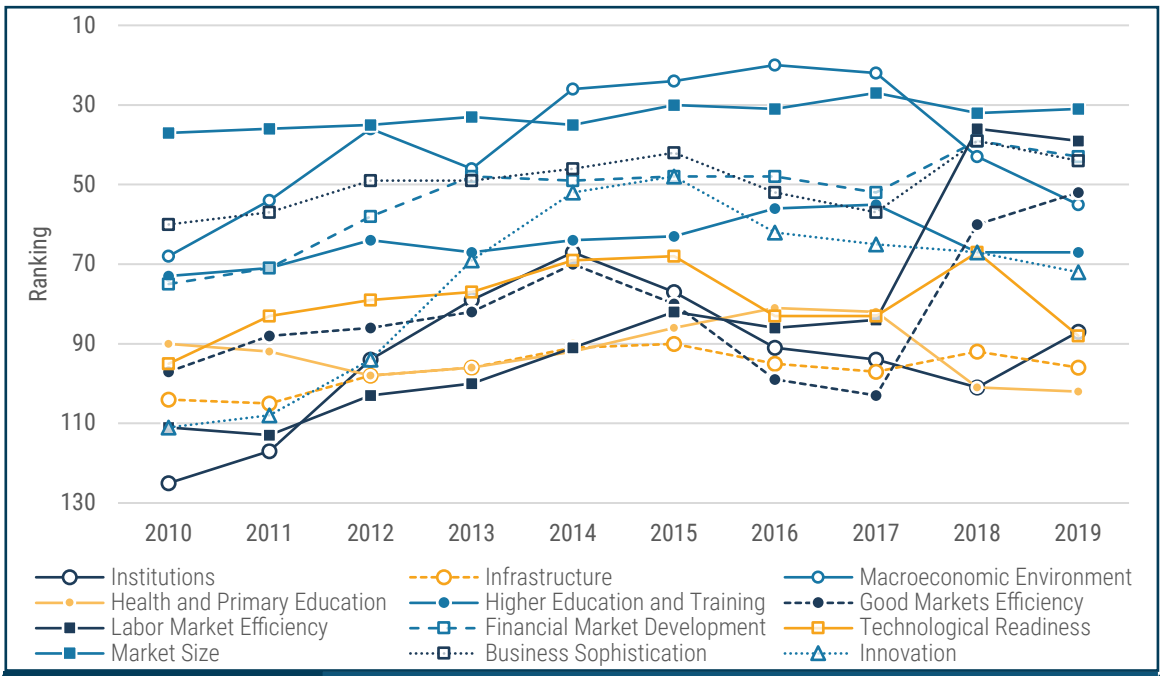
The World Economic Forum (WEF) publishes the Global Competitiveness Report annually to provide insights into the factors and attributes that drive productivity, growth, and human development for over 140 countries. The report also reviews promising policy options to achieve inclusive growth and sustainability. The Global Competitive Index (GCI) is based on the data from international organizations and the WEF's Executive Opinion Survey. The GCI is a comprehensive measure of the microeconomic and macroeconomic foundations of national competitiveness. It uses 12 pillars to leverage points in defining economic success (Dutta et al. 2020).

We observed a steady rise in the Philippines' overall rank from 2010 until 2016 when rankings began to decline (Table 1.3_1). In comparison with other countries in Association of South East Asian Nations (ASEAN), Singapore has remained on the top rank, Malaysia in the top 30, Indonesia and Thailand in the top 40. In 2019, the Philippines ranked 64th out of 141 economies, which was eight ranks lower than the previous year (WEF 2019). Given the effects of the pandemic, results for 2020 are expected to decline.

In the WEF Global Competitiveness Report of 2019, among the 12 pillars of competitiveness (Figure 1.3_1), the three lowest-scored pillars of the Philippines are in Health and Primary Education, Infrastructure, and Technological Readiness. The Philippines appears to have performed well in Market Size, Labor Market Efficiency, and Business Sophistication.

Table 1.3_1. Global Competitiveness Index (GCI) for ASEAN Countries (2010-2019) Overall Rank

Country	Overall Ranking									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Singapore	3	2	2	2	2	2	2	3	2	1
Malaysia	26	21	25	24	20	18	25	23	25	27
Brunei Darussalam	28	28	28	26	-	-	58	46	62	56
Thailand	38	39	38	37	31	32	34	32	38	40
Indonesia	44	46	50	38	34	37	41	36	45	50
Philippines	85	75	65	59	52	47	57	56	56	64
Vietnam	59	65	75	70	68	56	60	55	77	67
Cambodia	109	97	85	88	95	90	89	94	110	106



Pillar	Rank									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Institutions	125	117	94	79	67	77	91	94	101	87
Infrastructure	104	105	98	96	91	90	95	97	92	96
Macroeconomic Environment	68	54	36	46	26	24	20	22	43	55
Health and Primary Education	90	92	98	96	92	86	81	82	101	102
Higher Education and Training	73	71	64	67	64	63	56	55	67	67
Good Markets Efficiency	97	88	86	82	70	80	99	103	60	52
Labor Market Efficiency	111	113	103	100	91	82	86	84	36	39
Financial Market Development	75	71	58	48	49	48	48	52	39	43
Technological Readiness	95	83	79	77	69	68	83	83	67	88
Market Size	37	36	35	33	35	30	31	27	32	31
Business Sophistication	60	57	49	49	46	42	52	57	39	44
Innovation	111	108	94	69	52	48	62	65	67	72

Figure 1.3_1. Ranking and Trend of the Twelve Pillars of Competitiveness of the Philippines

Global Innovation Index

The Global Innovation Index (GII) has been published annually since 2007, a collaboration between Cornell University, Institut Europeen d' Administration des Affaires (INSEAD), and the World Intellectual Property Organization (WIPO). The GII report presents global innovation trends and the innovation performance of 131 economies.

In 2019, out of 131 economies, the Philippines ranked 54th in innovation, besting Indonesia, Brunei Darussalam, and Cambodia among ASEAN countries (Table 1.3_2) (Dutta et al. 2020). In terms of the seven pillars of innovation, the Philippines has shown a consistent rise in the pillars of Knowledge and Technology Outputs and Business Sophistication (Table 1.3_3). A significant improvement in ranking is seen in the pillars of Infrastructure and Creative Outputs.

It is to be noted that in 2019, the Philippines improved its GII significantly, but declined in its ranking in the GCI.

Table 1.3_2. Global Innovation Index (GII) for ASEAN Countries (2010-2019) – Overall Rank

Country	Overall Ranking									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Singapore	7	3	3	8	7	7	6	7	5	8
Malaysia	28	31	32	32	33	32	35	37	25	35
Brunei Darussalam	48	75	53	74	88	-	-	71	67	71
Thailand	60	48	57	57	48	55	52	51	44	43
Vietnam	71	51	76	76	71	52	59	47	45	42
Philippines	76	91	95	90	100	83	74	73	73	54
Indonesia	72	99	100	85	87	97	88	87	85	85
Cambodia	102	111	129	110	106	91	95	101	98	98

Table 1.3_3. Ranking of the Seven Pillars of Innovation for the Philippines (2010-2019)

Pillar	Rank									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Institutions	106	101	132	128	108	102	88	89	93	89
Human Capital and Research	75	116	121	116	121	123	95	95	86	83
Infrastructure	103	68	69	78	94	83	72	72	67	58
Market Sophistication	107	98	106	95	93	101	94	92	100	110
Business Sophistication	81	61	72	96	113	81	74	45	44	32
Knowledge and Technology Outputs	32	76	59	61	68	53	44	42	49	31
Creative Outputs	96	90	108	91	98	101	96	94	92	63

United Nations Conference on Trade and Development Readiness for Frontier Technologies Index

The United Nations Conference on Trade and Development (UNCTAD) (2021) ranked 158 countries in a "Readiness for Frontier Technologies Index" based on the following:

- Level of Information and Communications Technology (ICT) infrastructure
- Skills to adopt and adapt frontier technologies
- Research and development (R&D) activity to adjust and modify frontier technologies for local use
- Ongoing industry activities related to use, adoption and adaptation of frontier technologies
- Access to finance by the private sector to accelerate the use, adoption, and adaptation of frontier technologies

The Philippines ranked 44th, higher than all other ASEAN countries except Malaysia, which ranked 31st. The top five countries, in descending order, were the United States, Switzerland, United Kingdom, Sweden, and Singapore.

The report also notes that the Philippines has a high ranking in industry, reflecting the high levels of foreign direct investments in high-technology manufacturing, particularly electronics. Furthermore, the report cites the existence of pro-business policies; the availability of a skilled, English-speaking workforce; and the presence of a network of economic zones.

Although the top frontier-technology-ready countries are high-income nations, there are outliers: "countries that perform better than their per capita GDPs would suggest," according to the report. This "overperformance" is determined by calculating "the difference between the actual index rankings and the estimated index ranking based on per capita income". The top overperformer is India, with a score of 65, followed by the Philippines with a score of 57. The Ukraine, Vietnam, and China occupy the 3rd, 4th, and 5th spot, respectively.

The Philippines' ranking as the second highest overperforming country in this report augurs well for the nation's ability to take advantage of the window of opportunity to harness frontier technologies towards increasing productivity and creating more industries for employment and livelihood.

Critical Factors in Science and Technology

According to WEF, during the period 2010–2019, four factors were critical to the improvement in the Science and Technology (S&T) domain. These were as follows:

Innovation Capability. The first critical indicator for improving competitiveness is the capacity for innovation (Table 1.3_4), since it is the foundation of S&T development (WEF 2019). The sub-pillars of interaction and diversity, research and development, and commercialization are likewise deemed critical for S&T competitiveness.

Table 1.3_4. Parameters of the WEF GCR Innovation Index for the Philippines

Indicator	Rank									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Company Spending on R&D	85	85	58	51	42	36	44	51	99	102
University-Industry Collaboration in R&D	85	83	79	69	55	55	61	59	27	26
Utility Patents Granted Per Million Population	71	68	83	84	86	85	86	83	80	79
Capacity for Innovation	80	95	86	48	30	33	41	45	49	63
Availability for Scientists and Engineers	96	97	91	87	71	67	78	74	15	9
Quality of Scientific Research Institutions	108	106	102	91	75	69	72	75	71	72
Government Procurement of Advanced Technology Products	129	126	107	85	53	59	74	91	57	56

Innovation capability is seen to be increasing over the last five years. Specifically, the increase is attributed to sub-indices of capacity for innovation, quality of scientific research institutions and its publications, patent applications and developments, international co-inventions, government procurement of advanced technology and products, and availability of workforce such as scientists and engineers—factors that are relevant for science, technology, and innovation (STI).

This indicator is supported by government projects such as the Philippine Innovation Act, whole-of-government approach, and other Department of Science and Technology (DOST)-funded projects (Dutta et al. 2020). The improvement in the number of Research Engineers and Scientists is attributed to two human resource development programs administered by the Science Education Institute of DOST. These are the Engineering Research and Development for Technology and the Accelerated S&T Human Resource Development Program both of which provide scholarships for engineers and scientists to obtain master's and doctoral degrees. Positive results of increased government support can be seen in the significant rise in the Philippines' ranking in the aspects of availability of scientists and engineers, university-industry collaboration in R&D, and government procurement of advanced technology products (Table 1.3_4)

Business Dynamism (previously known as Business Sophistication). The second indicator associated with S&T performance is business dynamism (Table 1.3_3), which belongs to the same Innovation Ecosystem overview as the innovation capability (WEF 2019). Previously known as the Business Sophistication pillar, the Philippines was able to improve its standing because of the sub-pillars of administrative requirements and entrepreneurial culture. Thus, the Philippines is ranked 44th in Business Dynamism, one of the 12 pillars of the 2019 WEF World Competitiveness Index.

S&T development is critical given that this values the framework and resources needed to start businesses and cultural practices such as delegation, risk involvement, and embracing disruptive ideas.

The government embraced the importance of business dynamism with its rollout of Innovative Startup Act, Business Innovation through S&T, and Collaborative Research and Development to Leverage Philippine Economy Program for Industry Program. These projects aim to support local entrepreneur partnerships for STI.

Intellectual Property Rights and ICT Adoption. Better implementation of intellectual property rights and ICT adoption are also crucial to ramping up Philippine S&T's global competitiveness, particularly when exercised in complement with institutionalized government support for innovation and entrepreneurship (DOST 2017), e.g., through RA 10055 or the "Philippine Technology Transfer Act of 2009".

All in all, the above four factors are critical for S&T development and performance. Pro-active efforts in the public and private sector are needed to support and to sustain the development process.

Policy Recommendation

To sustain its improved competitiveness ranking and gains achieved insofar as S&T development is concerned, the Philippines needs to continue to place innovation at the center of the government's economic and development policy, embracing a whole-of-government approach (Uriarte et al. 2013).

SECTION 1.4
TIMES HIGHER EDUCATION, QUACQUARELLI SYMONDS RANKINGS OF PHILIPPINE HEIs, AND SCOPUS INDEXED RANKINGS

The quality of the higher education system always exerts a significant influence—if not the most significant influence—on the state of a country's science, technology, and innovation. There have been numerous attempts to assess the standing of higher education institutions (HEIs) globally. Some of the most widely recognized and well-regarded ranking systems include:

- Times Higher Education (THE) World University Rankings by Times Higher Education based in London
- Quacquarelli Symonds (QS) World University Ranking by the Quacquarelli Symonds based in London
- Academic Ranking of World Universities (ARWU) by the Shanghai Ranking Consultancy
- Performance Ranking of Scientific Papers for World Universities by the Higher Education Evaluation and Accreditation Council of Taiwan
- Ranking Web of World Universities by Cybernetics Lab, a unit of the Spanish National Research Council
- Center for Higher Education-Excellence Ranking by the Center for Higher Education Studies based in University College London
- University of Texas Dallas Top 100 Business School Research Rankings by the University of Texas Dallas School of Management

This Foresight will deal only with the ranking of selected Philippine HEIs in the THE World University Rankings and the QS World University Rankings, these two systems being the most frequently cited in academic and popular literature. The ARWU, though comparably as prestigious and recognized as the THE and QS systems, unfortunately has no Philippine HEIs listed in its website as of 2021 and is therefore not included in this Foresight.

With regard to scientific publications in refereed journals, the ranking of the Philippines based on Scopus Indexed Journals will be covered in this report.

Times Higher Education World University Ranking

Only two Philippine HEIs appear in the list of universities ranked by THE as of 2021: De La Salle University (DLSU), and University of the Philippines (UP). Table 1.4_1 shows the ranking of the two institutions from 2017-2021.

As indicated in Table 1.4_1, DLSU and UP generally rank in the lower half of surveyed universities. It should be noted that UP moved up from rank 801+ out of 981 universities in 2017 to rank 401-500 out of 1526 participating universities in 2021. Meanwhile DLSU moved slightly down the list, from rank 801-1000 out of 1259 universities in 2019 to 1001+ out of 1526 universities in 2021.

These rankings reflect both institutions' weaknesses in all five ranking criteria.

Table 1.4_1. THE World University Ranking of Selected Philipinne HEIs 2017-2021

Year	Top Score	Overall Ranking (values in parentheses are the overall scores)		Total number of universities covered
		DLSU	UP	
2017	95		801+ (8.3-18.5)	981 (79 countries)
2018	94.3		601-800 (21.5-30.6)	1103 (77 countries)
2019	96	801-1000 (19.0-25.9)	501-600 (33.5-37.0)	1258 (86 countries)
2020	95.4	1001+ (10.7-22.1)	401-500 (38.8-42.3)	1397 (92 countries)
2021	95.6	1001+ 10.3-25.0	401-500 (39.8-43.5)	1526 (93 countries)

Source: Times Higher Education (2020)
Notes: Philippines was represented in the Times Higher Education rankings from 2017 only.
The University of Oxford was the top scorer in all included years.

Table 1.4_2. THE World University Rankings Criteria

THE World University Rankings Criteria	
(1) Teaching (the learning environment)	**30%**
◦ Reputation survey	15%
◦ Staff-to-student ratio	4.5%
◦ Doctorate-to-bachelor's ratio	2.25%
◦ Doctorates-awarded-to-academic-staff ratio	6%
◦ Institutional income	2.25%
(2) Research (volume, income, and reputation)	**30%**
◦ Reputation survey *(university's reputation for research excellence among its peers)*	18%
◦ Research income *(scaled against academic staff numbers and adjusted for purchasing-power parity (PPP))*	6%
◦ Research productivity *(number of publications published in the academic journals indexed by Elsevier's Scopus database per scholar, scaled for institutional size and normalised for subject)*	6%
(3) Citations (research influence)	**30%**
◦ Citations to journal articles, article reviews, conference proceedings, books and book chapters published over five years are examined	
(4) International outlook (staff, students, research)	**7.5%**
◦ Proportion of international students *(ability of a university to attract undergraduates, postgraduates, and faculty from all over the planet)*	2.5%
◦ Proportion of international staff	2.5%
◦ International collaboration *(proportion of a university's total research journal publications that have at least one international co-author and reward higher volumes)*	2.5%
(5) Industry income (knowledge transfer)	**2.5%**
◦ The category suggests the extent to which businesses are willing to pay for research and a university's ability to attract funding in the commercial marketplace—useful indicators of institutional quality.	

Source: Times Higher Education (2020)

Notes: The Teaching and Research criteria are based on the responses to the annual Academic Reputation Survey.

Exclusions: Universities can be excluded from the World University Rankings if they do not teach undergraduates or if their research output amounted to fewer than 1,000 relevant publications between 2014 and 2018 (with a minimum of 150 a year). Universities can also be excluded if 80% or more of their research output is exclusively in one of our 11 subject areas.

Quacquarelli Symonds World University Ranking

The Quacquarelli Symonds (QS) World University Ranking has consistently ranked four Philippine HEIs since 2010:

- Ateneo de Manila University (ADMU)
- De La Salle University
- University of the Philippines
- Univeristy of Santo Tomas (UST)

Only UP is state supported; the rest are private sectarian universities (Table 1.4_3).

The latest version of the criteria used by the QS World University Ranking as of 2021 are indicated in Table 1.4_4.

The QS rankings of the four Philippine HEIs show that UP's ranking is in the range of 300-400, but is consistently improving in its percentile rank. Meanwhile, the number of universities in the list has been increasing from 500 in 2010 to 1,003 in 2021. ADMU ranked 307 out of 500 in 2010, and 601–

650 out of 1003 in 2021, placing in the same percentile rank albeit lower in absolute terms. DLSU and UST slipped significantly in their rankings between 2010 and 2021. A review of the latest ranking criteria can explain these shifts in the institutions' rankings.

Table 1.4_3. The Quacquarelli Symonds World University Ranking of Selected Philippine HEIs 2010-2021

	Overall Ranking											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
ADMU	307	360	451-500	451-500	501-550	461-470	501-550		551-600	651-700	601-650	
DLSU	451-500	-	-	601+	601-650	651-700	701+		701-750	701-750	801-1000	
UP	314	332	348	348	380	367	401-410	374	367	384	356	396
UST	-	-	-	601+	701+				801-1000			
Tota Number of Universities Covered	500	499	500	726	833	863	891	916	959	1000	1002	1003

Source: QS World University Rankings (2020a)

Table 1.4_4. Quacquarelli Symonds World University Rankings Criteria

QS World University Rankings Criteria
(1) Academic Reputation..... 40% ◦ Based on QS Academic Survey, which collates expert opinions of over 100,000 individuals in the higher education space regarding teaching and research quality at the world's universities.
(2) Employer Reputation..... 10% ◦ Based on almost 50,000 responses to QS Employer Survey, and asks employers to identify those institutions from which they source the most competent, innovative, effective graduates.
(3) Faculty/Student Ratio..... 20% ◦ Proxy metric for teaching quality. It assesses the extent to which institutions are able to provide students with meanigful access to lecturers and tutors, and recognizes that a high number of faculty members per student will reduce the teaching burden on each individual academic.
(4) Citations per faculty..... 20% ◦ Institutional research quality is measured. To calculate it, we take the total number of citations received by all papers produced by an institution across a five year period by the number of faculty members at that institution.
(5) International Faculty Ratio..... 5% ◦ It demonstrates an ability to attract faculty and students from across the world, which in turn suggests that it possesses a strong international brand
(6) International Student Ratio..... 5% ◦ It demonstrates an ability to attract faculty and students from across the world, which in turn suggests that it possesses a strong international brand

Source: QS World University Rankings (2020b)

Scopus Indexed Rankings

As of April 2020, the Philippines is ranked 69 out of 240 countries in the World ranking of countries with the most number of Scopus indexed journals covering the period 1996–2019 (Scimago 2020, Scopus 2020). However, the Philippines is ranked 14th in the Asian regional ranking of Scopus indexed journals, with Singapore, Malaysia, Thailand, Indonesia and Vietnam ranked higher, as shown in Table 1.4_5 (Scimago 2020, Scopus 2020).

Table 1.4_5. Regional Ranking of Asian Countries Based on the Number of Publications in Scopus Indexed Journals, 1996-2019

Rank	Country	Documents	Citable documents	Citations	Self-citations	Citations per document	H index
1	China	716540	679955	2882171	1912222	4.02	1010
2	India	206648	182018	506414	202580	2.45	691
3	Japan	144883	125986	463150	130436	3.2	1118
4	South Korea	94142	87007	366234	85265	3.89	762
5	Indonesia	47432	46644	55764	28730	1.18	259
6	Taiwan	40516	36865	150418	28289	3.71	585
7	Malaysia	38228	36402	114103	32121	2.98	373
8	Hong Kong	26001	22985	161233	22610	6.2	639
9	Singapore	25537	21647	159129	23110	6.23	646
10	Pakistan	25343	23571	107369	33279	4.24	323
11	Thailand	20629	19322	57005	11702	2.76	369
12	Viet Nam	13068	11997	58466	18270	4.47	248
13	Bangladesh	8444	7865	26260	7275	3.11	225
14	Philippines	5888	5458	15786	3052	2.68	274
15	Kazakhstan	5214	4821	12175	3685	2.34	126
16	Sri Lanka	2937	2637	10372	1372	3.53	206
17	Macao	2378	2211	13037	1207	5.48	155
18	Nepal	2042	1805	6751	1132	3.31	159
19	Uzbekistan	1624	1473	3872	2184	2.38	105
20	Myanmar	787	728	2212	324	2.81	88
21	Mongolia	689	594	2203	349	3.2	110
22	Brunei Darussalam	609	555	2212	377	3.63	95
23	Cambodia	539	477	1972	277	3.66	119
24	Kyrgyzstan	454	391	2099	128	4.62	90
25	Laos	361	321	1299	167	3.6	95
26	Afghanistan	329	309	921	61	2.8	66
27	North Korea	245	213	695	133	2.84	37
28	Tajikistan	237	228	994	131	4.19	50
29	Bhutan	145	132	409	48	2.82	53
30	Maldives	47	42	193	27	4.11	35

Sources: Scimago (2020), Scopus (2020)

Important Developments Concerning the Rankings

These rankings are now being reviewed by the International Network of Research Management Societies to address concerns over the need for "fairer and more responsible university rankings." The indicators used are being challenged as not being representative of the universities' missions and may possibly "overlook societal impact or teaching quality." Twenty principles have been transformed into a tool to assess rankings, qualitatively and quantitatively (Gadd 2020).

With regard to the evaluation of scientific output, a group of editors and publishers have expressed the need to improve the evaluation process and the indicators used, including the Journal Impact Factor whose transparency is under question. These concerns are now articulated in the San Francisco Declaration on Research Assessment, signed as of 08 March 2021 by 19,254 individuals and organizations in 145 countries and the Leiden Manifesto with the following recommendations (Hicks et al. 2015; DORA 2020):

- Elimination of the use of journal-based metrics in "funding, appointment and promotion considerations."
- Assessment of research on the basis of its merits "rather than on the basis of the journal in which the research is published."
- Harness the advantage provided by online publication such as "relaxing unnecessary limits on the number of words, figures, and references in articles, and exploring new indicators of significance and impact."

It cannot be overemphasized that the Philippines' science community must actively participate in these discussions, to improve both the overall performance of university programs in global rankings and—more importantly—the quality and quantity of the programs' scientific outputs.

SECTION 1.5
THE PHILIPPINE INNOVATION SYSTEM

The linchpin of our national innovation system is the Intellectual Property Code (Republic Act 8293), signed into law on 06 June 1997. Republic Act (RA) 8293 protects the exclusive rights of scientists, inventors, artists, and other gifted citizens to their Intellectual Property (IP) and creations. The effective implementation of our national innovation strategy rests heavily on public-private partnership, while recognizing the role of government, especially the Department of Science and Technology (DOST), in strengthening linkages among key sectors. Public awareness of the benefits of innovation and entrepreneurial mindset are likewise important.

Even prior to the enactment of RA 8293, the value of inventions and their utilization was already recognized in RA 7459, the Inventors and Inventions Act of the Philippines, which was enacted into law on 28 April 1992. RA 7459 provides protection of inventors' exclusive rights to their inventions and grants them incentives in its development and commercialization.

The government continues to engender a policy environment conducive to innovation through such laws as the Philippine Technology Transfer Act (RA 10055), signed into law on 27 July 2009. RA 10055 lays down the policy that the state shall facilitate the transfer and promote the utilization of IP for the national benefit. It shall likewise establish the means to ensure greater public access to technologies and knowledge generated from government-funded research and development (R&D). This law explicitly gives the IPs and intellectual property rights (IPRs) generated by R&D institutions (RDIs) using funds provided by government funding agencies to the RDIs. It also allows various modalities for public-private collaboration to speed up the commercialization and utilization of the IP.

The fact that RA 10055 facilitated technology transfer from the RDIs to the private sector is evident in the increase in the number of technologies that had been commercialized since the passage of the law. In the University of the Philippines (UP) System, the Revised IPR Policy based on RA 10055 enabled the creation of offices and programs whose main purpose is to assist students and personnel in securing protection, licensing, and marketing of their creative outputs. The Office of the Vice-Chancellor for Research and Development of the University of the Philippines (UP) Diliman has listed

several technologies for deployment for commercialization (as of 2014), one of which is "CoaTiN", an enhanced titanium nitride coating process that is environment friendly and low-cost, and which increases the lifetime of tools. Another award-winning technology being offered for commercialization is an effective oral vaccine for fish involving a novel process for microencapsulation of inactivated pathogens.

Recently, RA 11293, also known as the Philippine Innovation Act of 2018 was enacted with the following primary objectives:

- promoting a strategic planning and innovation culture
- improving innovation governance; coordinating and eliminating fragmentation of innovation policies and programs across levels of the government
- strengthening the position of micro, small, and medium enterprises (MSMEs) in the innovation system
- removing obstacles to innovations
- encouraging entrepreneurial culture; exploring, promoting, and protecting traditional knowledge, traditional cultural expressions, genetic resources
- strengthening interactions and partnerships among public and private sectors, academe, MSMEs, RDIs, and communities

The enactment of RA 11293 has paved the way for the establishment of the National Innovation Council, which adopts a “whole of government approach” that involves all government agencies to drive innovation across all areas.

In addition to RA 11293, the Congress also enacted RA 11337 or the Innovative Startup Act, whose development plan includes programs, incentives, and benefits for startups and startup enablers. The Philippine Council for Industry, Energy and Emerging Technology Research and Development (DOST-PCIEERD) serves as one of the host agencies along with the Department of Trade and Industry (DTI) and the Department of Information and Communications Technology (DICT). This law complements RA 11293 through its emphasis on MSMEs and its role in fostering the country’s innovation economy.

The Harmonized National Research and Development Agenda

The DOST applies the enacted laws through the Harmonized National Research and Development Agenda (HNRDA) 2017-2022, which harnesses R&D for the country’s economic and social benefit. The HNRDA was conceptualized in consultation with government agencies, private institutions, academic institutions, and industry. The HNRDA is also aligned with the Filipino people’s aspirations in the 1987 Philippine Constitution, Philippine Development Plans, and AmBisyon Natin 2040.

Guided by the three pillars of AmBisyon Natin 2040—Malasakit (i.e., enhancing the Philippine social fabric), Pagbabago (reducing inequality), and Kaunlaran (increasing potential growth)—the HNRDA focuses on the following sectors (Figure 1.5_1):

(1) National Integrated Basic Research Agenda (NIBRA)
(2) Health
(3) Agriculture, Aquatic, and Natural Resources (AANR)
(4) Industry, Energy, and Emerging Technology
(5) Disaster Risk Reduction and Climate Change Adaptation (DRR CCA)

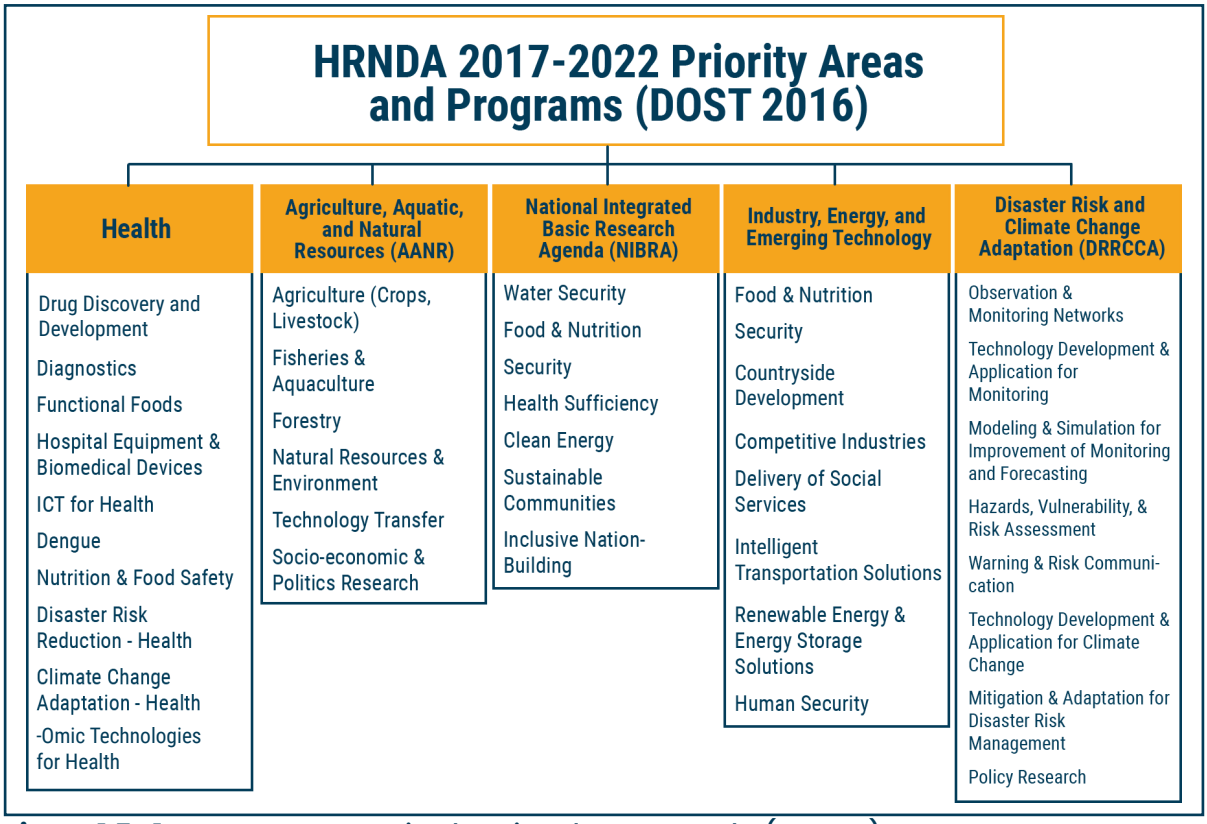


Figure 1.5_1. DOST's Harmonized National R&D Agenda (HRNDA)

The National Research Council of the Philippines (NRCP) is in charge of the NIBRA. For the years 2017-2019, the NRCP funded research on sustainable communities, inclusive nation-building, and health sufficiency. The NIBRA-related research studies have yielded scholarly publications, policy advisories, patent applications, and knowledge products. Meanwhile, the Philippine Council for Health Research and Development manages and coordinates health-related R&D studies. Their main priorities are diagnostics, drug discovery and development, and functional foods.

For the AANR, the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) focuses on advanced and emerging technologies, organic agriculture, food production and safety, and genetically modified organism development. Aside from these, PCAARRD seeks to modernize agriculture and fisheries through mechanization as mandated by RA 10601 or the Agricultural and Fisheries Modernization Law.

One of the most comprehensive programs in the HNRDA is on industry, energy, and emerging technologies which is being managed by Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD). Industry competitiveness is deemed as the most imperative priority area as it aids in countryside development. Moreover, DOST-PCIEERD has updated its R&D priority areas to include emerging industries such as space technology applications, artificial intelligence, human security and defense, and creative industries.

The Philippine Institute of Volcanology and Seismology (PHIVOLCS) and Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) spearhead the program on DRR CCA. Guided by the United Nations Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction (2015–2030), PHIVOLCS and PAGASA give equal priority R&D to (1) monitoring and forecasting; (2) hazard and risk assessment; (3) warning; and (4) proper and timely response.

R&D Budget of Philippine Government Departments

Based on the General Appropriations Act, the allocation of public funds for R&D from 2017 to 2021 amounted to PHP92,426,672,708.00 for an average of PHP18,485,334,541.60 per year (Table 1.5_1). This resulted in an annual average ratio of 0.58% of the national budget. For the year 2020 alone, public R&D funding was a scant 0.105% of GDP, based on official data from the Bangko Sentral ng Pilipinas (BSP 2020).

For 2021, the DOST received the bulk of funds along with the Department of Agriculture (DA), with State Universities and Colleges (SUCs) also receiving substantial R&D funding. It is noted that the DICT did not receive any R&D budget for 2021, but was allocated substantial R&D funding from 2018 to 2020.

Table 1.5_1. R&D Budget of Government Departments Based on Unified Accounts Code Structure, 2017–2021

Name of Department	2017	2018	2019	2020	2021 GAA
DOST	6,310,249,000	8,185,719,000	6,154,983,000	7,086,628,000	10,173,078,000
DA	1,791,572,000	2,359,161,000	2,812,423,000	2,770,316,000	2,733,025,000
DENR	635,519,000	778,174,000	761,904,000	457,761,000	727,527,000
DOE	38,648,019	98,658,000	104,129,000	82,411,000	244,433,000
DND	130,155,000	132,567,000	137,298,000	189,125,000	249,375,000
DepEd	73,784,000	1,526,094,000	1,909,794,000	1,938,493,000	575,760,689
DILG	77,881,000	84,317,000	86,680,000	82,546,000	139,079,000
DOF	34,107,000	40,359,000	41,676,000	38,624,000	34,413,000
DOH	75,896,000	215,653,000	134,446,000	129,598,000	179,127,000
DOLE	31,696,000	33,887,000	18,782,000	18,853,000	45,859,000
DTI	40,071,000	29,144,000	38,694,000	66,868,000	63,749,000
ARMM	27,791,000	0	27,544,000	0	NAD
SUC's**	2,632,001,000	2,049,227,000	2,148,481,000	2,009,300,000	2,841,085,000
BSGC	693,219,000	482,347,000	992,736,000	1,226,990,000	809,129,000

Table 1.5_1. Continued

Name of Department	2017	2018	2019	2020	2021 GAA
Other Executive Offices*	835,485,000	921,579,000	767,909,000	755,487,000	804,594,000
DPWH	158,321,000	173,848,000	187,428,000	171,728,000	185,702,000
DICT	NA	2,645,012,000	3,289,139,000	1,600,479,000	0
DOTr	50,000,000	113,652,000	596,691,000	285,000,000	0
Total National R&D Budget	13,636,395,019	19,869,398,000	20,210,737,000	18,910,207,000	19,799,935,689
Total GAA (National Budget)	2,499,486,952,000	2,861,527,550,000	2,685,485,754,000	4,100,000,000,000	4,506,000,000,000
Ratio of National R&D Budget against National Budget (GAA)	0.55%	0.68%	0.75%	0.46%	0.44%

Source: DOST/M. Sahagun (personal communication, 21 July 2021)
For acronyms, please refer to List of Acronyms.

'Filipinnovation'

Aside from the HNRDA, the DOST has also adopted the "Filipinnovation" framework to improve science, technology, and innovation (STI) outputs. Filipinnovation is another whole-of-government approach to inclusive innovation that ensures coherent policies, aligned priorities, and collaboration among government agencies, academic institutions, industry, and civil society organizations. This framework also integrates the efforts of stakeholders such as the local government units, startups, MSMEs, R&D laboratories, S&T parks, incubators, fabrication laboratories, and investors (de la Peña 2020).

One of the first Filipinnovation collaborations is between the DOST and the DTI. The two agencies established several regional inclusive innovation centers (RIICs) with funding from the United States Agency for International Government. The RIICs work in tandem with Niche Centers in the Regions for Research and Development (NICER), with the former providing commercialization-related support to the universities that are part of the NICER Program. Other activities organized under the Filipinnovation framework are as follows (Guevara 2018):

(1) **Filipinovation Entrepreneurship Corps** – enables researchers to assess the commercial and societal value of their research
(2) **Funding Assistance for Spin-off and Translation of Research in Advancing Commercialization Program** – bridges the gap between R&D and commercialization particularly for DOST-PCIEERD funded technologies
(3) **Intellectual Property Management Program for Academic Institutions Commercializing Technologies** – aids Higher Education Institutions (HEIs) in setting up their technology transfer processes and facilitate commercialization of university-owned technologies
(4) **Venture Financing Program** — provides financial assistance for start-ups and technology-based expansion projects
(5) **Technicom** – fast tracks the market-readiness of local and supported communities' technologies

(6) **Small Enterprise Technology Upgrading Program (SETUP)** – helps MSMEs level up their industries
(7) **OneSTore** – allows customers to shop and retailers to reach customers and sell products by MSMEs
(8) **PCAARRD Innovation and Technology Center** – supports the implementation of Technology Transfer Act, Innovation Act, and IP Code

It is noted that the SETUP, a DOST program initiated over 15 years ago, has assisted MSMEs in acquiring technological innovations to improve their products, services, and operations in order to increase their productivity and competitiveness.

Science for Change Program

The DOST further strengthens its commitment to R&D with the Science for Change (S4C) program (DOST 2018) which focuses on Human Resource Development and R&D capacity-building and improvement. To sustain the efforts on capacity-building, the DOST has established the following (Figure 1.5_2):

(1) NICER Program (Figure 1.5_3)
(2) R&D Leadership (RDLead) Program
(3) Collaborative R&D to Leverage Philippine Economy (CRADLE) Program
(4) Business Innovation through S&T (BIST) for Industry Program

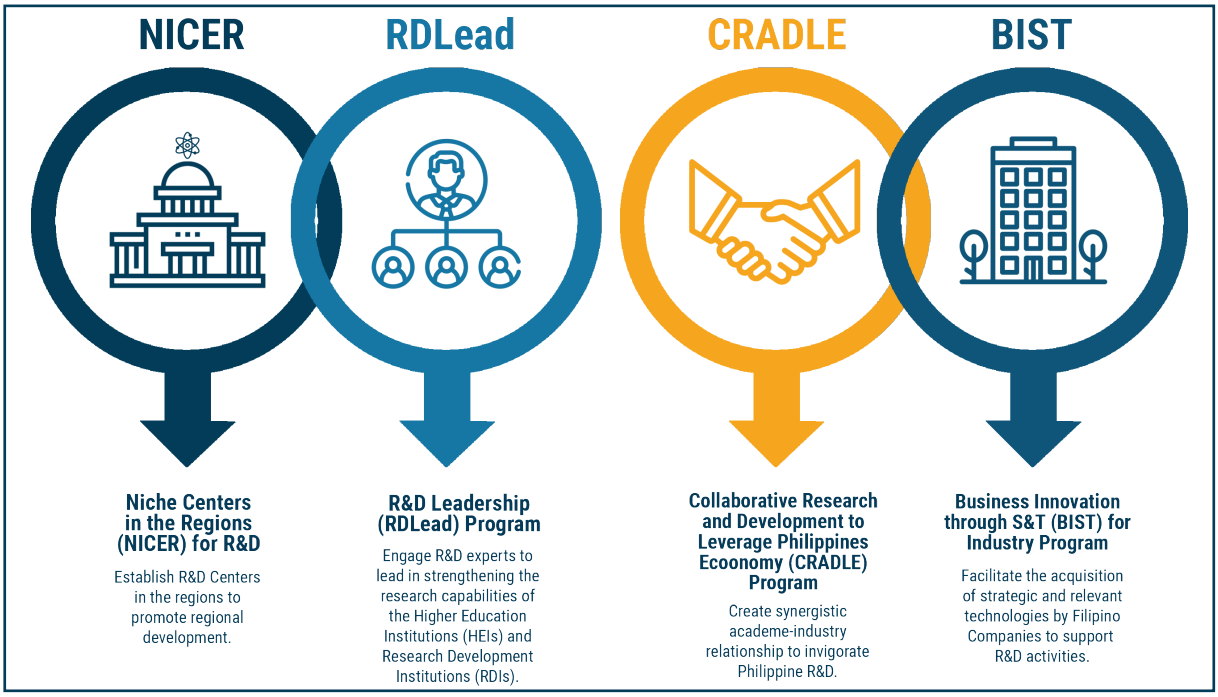


Figure 1.5_2. The Four Components of the DOST S4C Program
Source: DOST (2020) with modifications

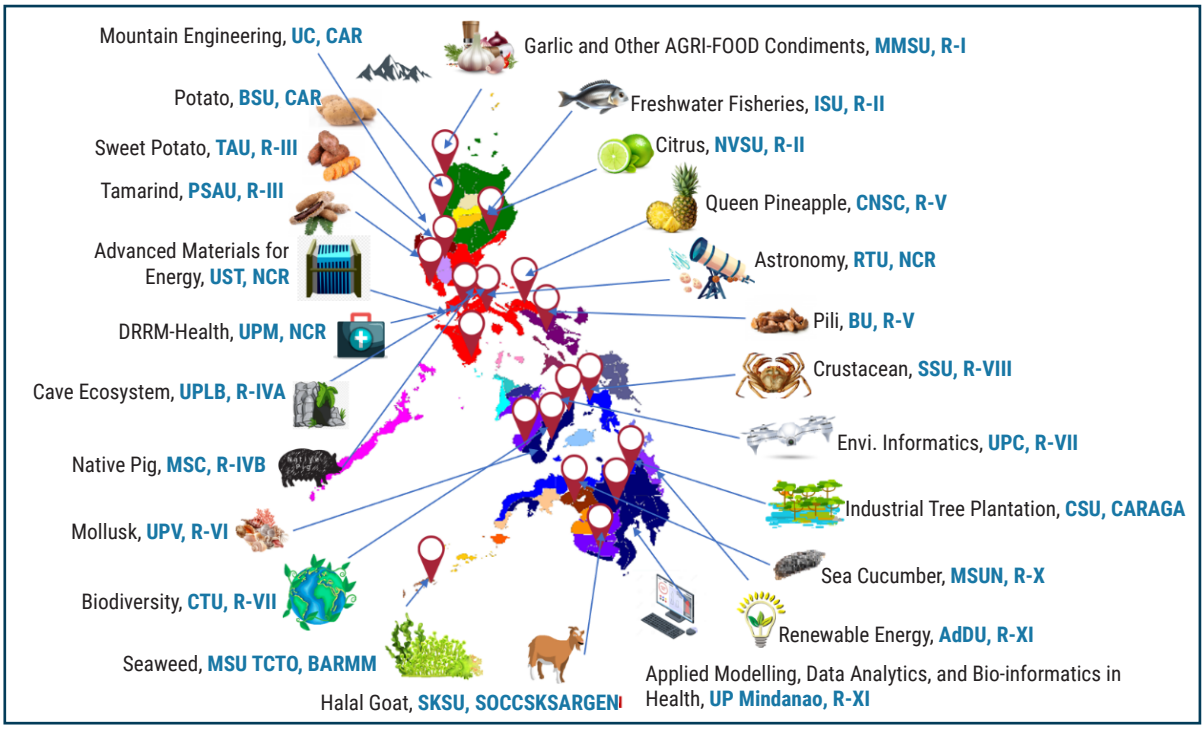


Figure 1.5_3. DOST-assisted Niche Centers in the Regions
Source: DOST (2020)
For acronyms, please refer to List of Acronyms.

The NICER Program seeks to improve the competitiveness of HEIs in the regions by establishing R&D centers and providing R&D institutional grants. Related to the NICER program is the RDLead Program that helps HEIs and RDIs upgrade their facilities and ensure the use of research results in policymaking and other development programs. Meanwhile, the DOST connects the HEIs and RDIs with the industry through the CRADLE Program. Industry identifies the problem while the HEIs and RDIs are given funding to undertake the R&D. The collaboration provides an opportunity for technology commercialization. The DOST also aids the industry by facilitating their acquisition of technologies as part of the BIST for Industry Program. Similar to the RDLead program, the BIST Program also provides R&D and technology acquisition funding for the industry.

Since its commencement, the S4C Program has doubled the number of HEIs that conduct R&D from 74 in 2014 to 149 in 2019. Funding had also increased for regions beyond Manila from 7% in 2014 to 20% in 2019. Moreover, the S4C Program, mainly through the CRADLE Program, has helped improve the country's Global Innovation ranking in terms of University-Industry research collaboration from 56th in 2018 to 27th in 2020. The country expects more research outputs, partnerships, and technology acquisition under the S4C Program in the coming years (de la Peña 2020).

R&D Infrastructure: The RDIs (excluding DOST RDIs)

In addition to RDIs and Niche Centers under the DOST, significant strides in the development of the country's R&D capacity were made through the establishment of specialized RDIs in HEIs. Most of these RDIs are recognized

for their research productivity, to enable stronger collaboration between the research personnel of the RDI and the faculty of the HEI. The RDIs were created by Philippine laws, Presidential issuances, or the HEIs' Governing Boards orders.

University of the Philippines (UP) Los Baños hosts several of these RDIs. Notable among them is the Institute of Plant Breeding established on 05 June 1975 by PD 729. It is mandated to develop new and improved varieties of agricultural crops, except rice, through biotechnology and other breeding technologies. Its other important responsibility is to conserve plant genetic resources. Another RDI based in UP Los Baños is the National Institute of Molecular Biology and Biotechnology, established on 20 December 1979 by the UP Board of Regents. It specializes in agricultural, environmental, food and feeds, and health biotechnology to enhance agro-industrial productivity. Its products that have been commercialized include biofertilizers, biopesticides, vaccines, and diagnostic kits.

In UP Diliman, the oldest RDI is the Natural Sciences Research Institute, which was established in 1964 by RA 3887 and given the mandate to undertake research in biology, chemistry, environmental and atmospheric sciences, and mathematics, as well as to organize interdisciplinary research programs.

Other than DOST, DA and Department of Health (DOH) also have RDIs affiliated with them. The DA has the Philippine Carabao Center (PCC) and the Philippine Rice Research Institute (PHILRICE). Their main laboratories are located in the Science City of Munoz, Nueva Ecija, close to the Central Luzon State University. PHILRICE was established on 05 November 1985 through EO 1061 to develop high-yielding and cost-reducing rice technologies to help farmers produce sufficient rice for all Filipinos. The PCC was created by RA 7307 in 1992 with the responsibility of conserving, propagating, and promoting the carabao as a source of milk, as well as a draft animal.

The DOH Research Institute for Tropical Medicine was established in 1981 through EO 674 to conduct research in the diagnosis, control, and prevention of infectious and tropical diseases. Its research outputs have been utilized in the crafting of a national health policy and strategy.

Human Resources Development

Unleashing the benefits of science and technology for national development depends largely on the human resources that can be used to plan, implement, monitor, and evaluate the science and technology activities that will promote national well-being. The public and private sectors in the Philippines have been implementing programs to provide opportunities for those who would like to pursue careers in science, technology, engineering, and mathematics (STEM).

We shall discuss highlights on these initiatives in this section covering the period from the administration of President Corazon C. Aquino in 1986 to the conclusion of the term of President Benigno S. Aquino III in 2016.

It was during the term of President Corazon C. Aquino that the DOST was elevated to full cabinet status. This development triggered a series of initiatives to strengthen existing human development programs such as scholarships and to improve the teaching of STEM in basic education (K-12). Included in these initiatives is the upgrading of the skills of the workforce through technical and vocational education.

To better prepare students for careers in STEM, scholarships were offered for elementary and high school teachers who would like to specialize in STEM subjects. This was complemented by in-service training programs to update basic education STEM teachers. The Science Education Institute led in this effort by sustaining its support for the Regional Science Teaching Centers. In 1997, UP's science teaching program was further strengthened by the organization of the National Institute for Science and Mathematics Education Development. Gifted students interested in STEM careers were encouraged to study in the Philippine Science High School System. Science high schools and special science sections were established in the public schools and private schools. The construction and equipping of science laboratories in 110 public high schools were made possible from 1992–1998 through the Engineering and Science Education Project (ESEP). When the basic education program was reformed in 2013, STEM was offered as one of the four tracks at the senior high school level (Grades 11 and 12).

Building on the gains of past initiatives such as the undergraduate and graduate scholarships and training programs of the forerunners of the DOST—the National Science Development Board and the National Science and Technology Authority, the Philippine government availed of a loan of USD 85 million funded by the World Bank and the Overseas Economic Cooperation Fund of Japan to implement ESEP which was approved in the latter part of the administration of President Corazon C. Aquino and implemented during the term of President Fidel V. Ramos. Aside from the high school science laboratories that were constructed and equipped, ESEP supported the faculty development and upgraded research facilities in science and engineering programs in selected universities.

The "Science and Technology Scholarship Act of 1994" (RA 7687) expanded the scholarship slots for undergraduate degrees in STEM.

Programs were established to sustain the gains achieved in ESEP, to cope with the rapid developments in STEM, and enhance local capacity to undertake research and development. This involved expanding the pool of experts with master's and doctoral degrees in STEM to respond to the needs of academe and industry. Thus, the Engineering Research and Development for Technology and the National Science Consortium were put in place. This was expanded to the Accelerated Science and Technology Human Resource Development Program.

The former National Manpower and Youth Council was merged with the Bureau of Technical and Vocational Education into the Technical Education and Skills Development Authority by virtue of the "Technical Education and Skills Development Act of 1994" (RA 7796), which aims to develop the skills for various occupational areas, production, services, and livelihoods. As part of the STEM workforce, learners of trades and crafts supply competent apprentices by studying technologies and related sciences, and acquiring skills of practical value to the economy.

Retaining Highly-Trained Individuals

In addition to the earlier creation in 1976 of the Scientific Career System by Presidential Decree 997, the "Magna Carta for Scientists, Engineers, Researchers and other S&T Personnel in Government" (RA 8439) was enacted in 1997. The law provides for government S&T personnel a share of royalties, as well as hazard allowance, subsistence allowance, longevity pay, and funds for an annual medical examination, among others. Furthermore, in order to encourage and enable highly-trained Filipinos abroad to get involved in short-term and long-term STEM activities in the Philippines, the "Balik Scientist Act" (RA 11035) was enacted into law in 2018.

Conclusion

Current efforts to promote STI in the public and private sector are gradually being enhanced. Laws have been enacted to improve the environment for doing R&D. Unfortunately, there are still remnants of the inertia that have retarded the progress of STI in the country. We have been wanting in talent, and our knowledge infrastructure needs some overhauling. The challenge is to develop our capabilities in STI even while we are simultaneously developing our economy.

SECTION 1.6
GEOGRAPHIC FEATURES AND NATURAL RESOURCE ENDOWMENTS

Geographic Features

The Philippines is a Southeast Asian archipelago with 7,641 islands, and ranked 5th among the world's largest island countries. It is located north of the equator between 3° to 22°N and 113° to 130°E. The Pacific Ocean bounds it on the east and many smaller water bodies, including Luzon Strait to the North, Sulawesi Sea to the south, and the South China Sea and the West Philippine Sea to the West (Figure 1.6_1). Administratively, it is divided into 17 regions and as of June 2020, there are 81 provinces; 146 cities; 1,488 municipalities; and 42,046 barangays (DILG 2020). In terms of land masses, there are three island groups—Luzon, Visayas, and Mindanao—with a total land area of 30 million ha classified into 15.8 million ha of forest land, and 14.2 million ha of certified alienable and disposable land (DENR-FMB 2019).

Sloping lands, comprised of mountains and hills, occupy 55% of the country's land area. The longest mountain range is the Sierra Madre in Luzon, which stretches some 540 km. There are about 24 active volcanoes. Meanwhile, there are at least 18 watersheds with an area of at least 100,000 ha that are classified as major river basins; 421 principal river basins; and 142 priority watersheds, of which 113 are proclaimed watershed forest reserves with an aggregate area of 2.46M ha (DENR-FMB 2019). There are also 216 lakes and 22 marshes, swamps, and reservoirs. Luzon's Laguna de Bay (900 km^2) is the largest lake in the country.

The country is generally tropical and maritime, and is characterized by relatively high temperatures, high humidity, and abundant rainfall. The mean annual temperature is 26.6°C. January is the coldest month, with a mean temperature of 25.5°C. May is the warmest month, with a mean temperature of 28.3°C. Mean annual rainfall varies between 965 and 4,064 millimeters.

The Philippine climate results from the interaction of the Asian Monsoon and many mountain ranges scattered across the country. The prevailing wind system is dominated by the Northeast Monsoon (locally called "amihan") from November to March, and the Southwest Monsoon ("habagat") from

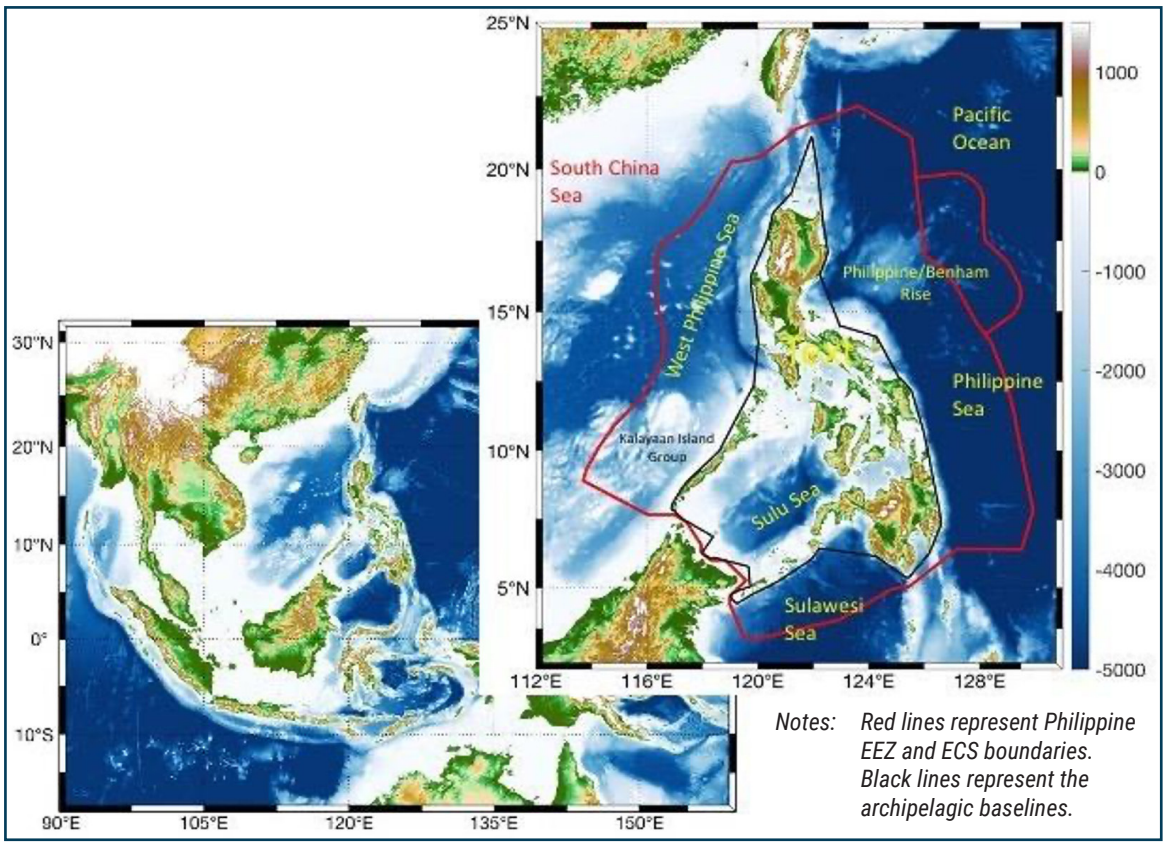


Figure 1.6_1. Location of the Philippines Relative to Southeast Asia and Surrounding Bodies of Water.
Material prepared by: Acd. Villanoy
Note: EEZ - Exclusive Economic Zone, ECS - Extended Continental Shelf

June to October. The climate map in Figure 1.6_2 shows rainy conditions on the windward side of the mountain ranges. The seasonal reversal of the monsoons brings with it shifts in rainfall patterns. Fair weather dominates the monsoon transition months (April-May and October).

The country lies along the Pacific Typhoon Belt where an average of 20 tropical cyclones pass into area of responsibility annually, five of which are usually destructive. The tropical cyclones season lasts from June to November, but tropical cyclones do occur throughout the year (Figure 1.6_3).

The Philippines has a coastline measuring 36,389 km, ranked the 6th longest coastline worldwide. The entire sea area within all the maritime zones shown in Figure 1.6_1 is seven times greater than the land area. One can readily see several ocean bottom features. These include Benham (or Philippine) Rise, a 3,000 m deep underwater plateau found off the eastern coast of Luzon; the reef systems of the Kalayaan Islands, west of Palawan; and the broad shelf areas in northern Palawan and north of the Bicol Peninsula.

The topography of the sea bottom is as rugged, if not more so, than that of the land. The range of ocean depths (10,000 m) is about five times that of land (2,000 m). The shelf area (<100 m depth) accounts for about 8% of the total sea area. Half of the entire water sea is deeper than 4,000 m. The deepest points (>6,000 m) are within the Philippine Trench, located off Mindanao's eastern coast.

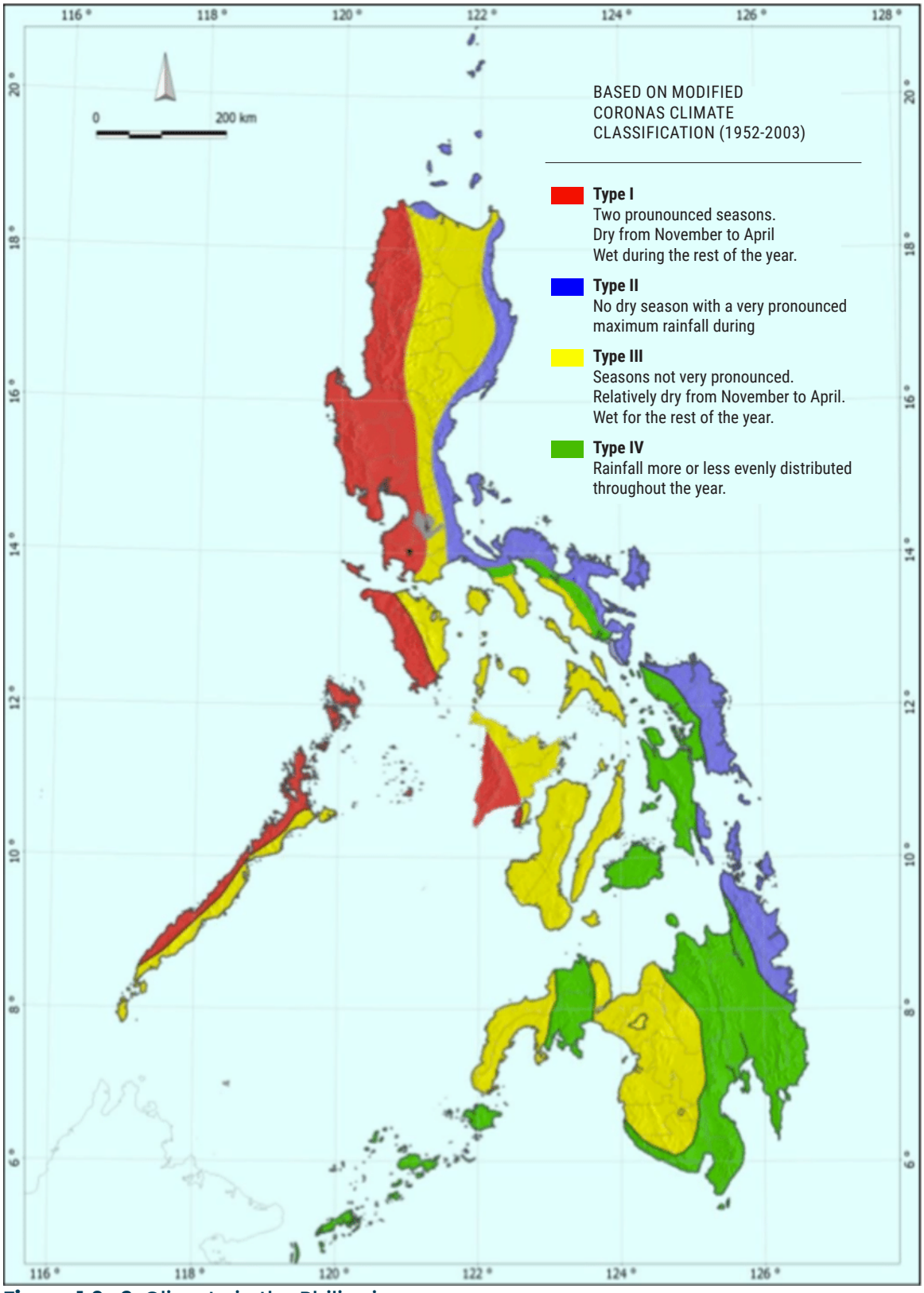
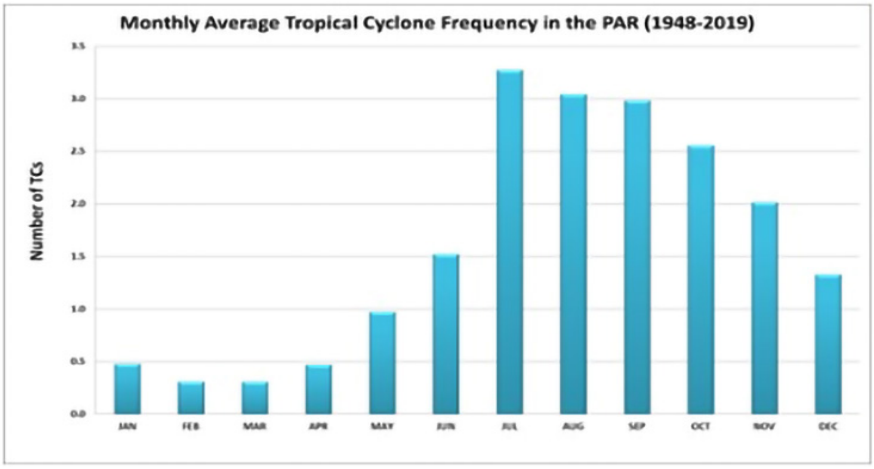


Figure 1.6_2. Climate in the Philippines
Source: DOST-PAGASA (2014)

FORECAST TROPICAL CYCLONE	
Month	**Number of TC**
DECEMBER 2020	1-2
JANUARY 2021	0-1
FEBRUARY 2021	0-1
MARCH 2021	0-1
APRIL 2021	0-1
MAY 2021	0-1



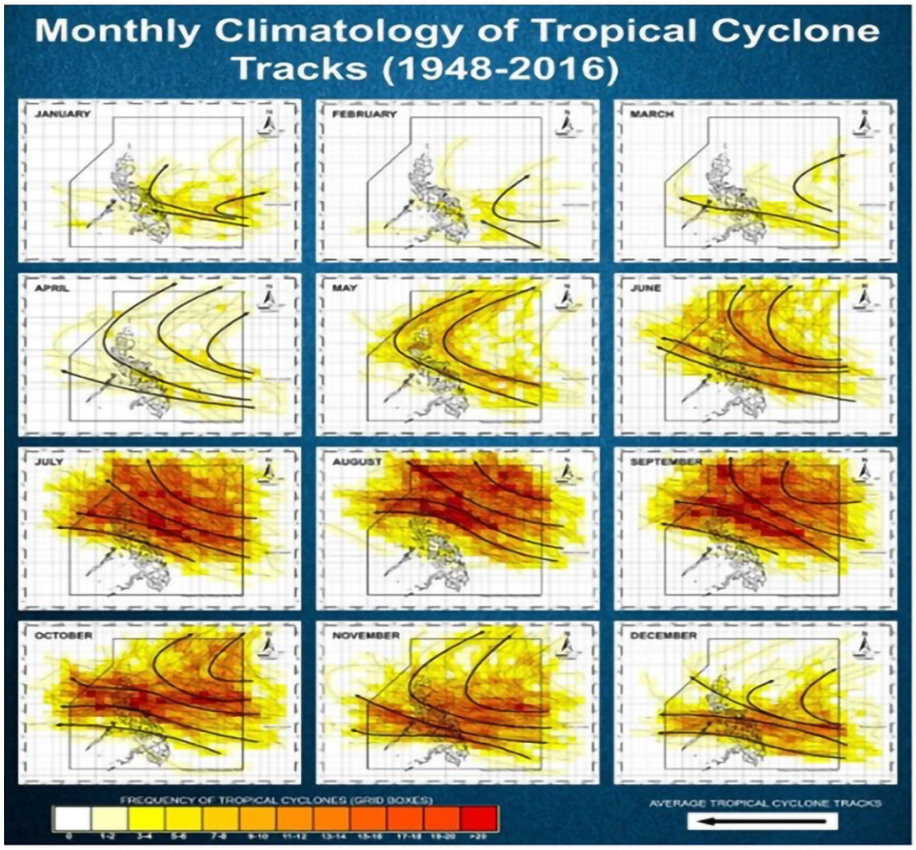


Figure 1.6_3. Historical and Projected Tropical Cyclone Activity in the Philippines as of December 2020
Source: DOST-PAGASA (2020)
TC - Tropical Cyclone

The complex seascape of the seafloor around the Philippines is the product of the area's very active geologic history and ongoing tectonic processes. Sandwiched between the Pacific Plate and the Eurasian plate, both sides of the archipelago are active collision plates with subduction within trenches and extensive faulting. Between the trench systems is an actively deforming region known as the Philippine Mobile Belt (PMB). The Philippine Fault System, a multi-branched left lateral strike-slip fault, cuts through the PMB from Pujada Bay to the Luzon Strait, with a length of about 1,400 km.

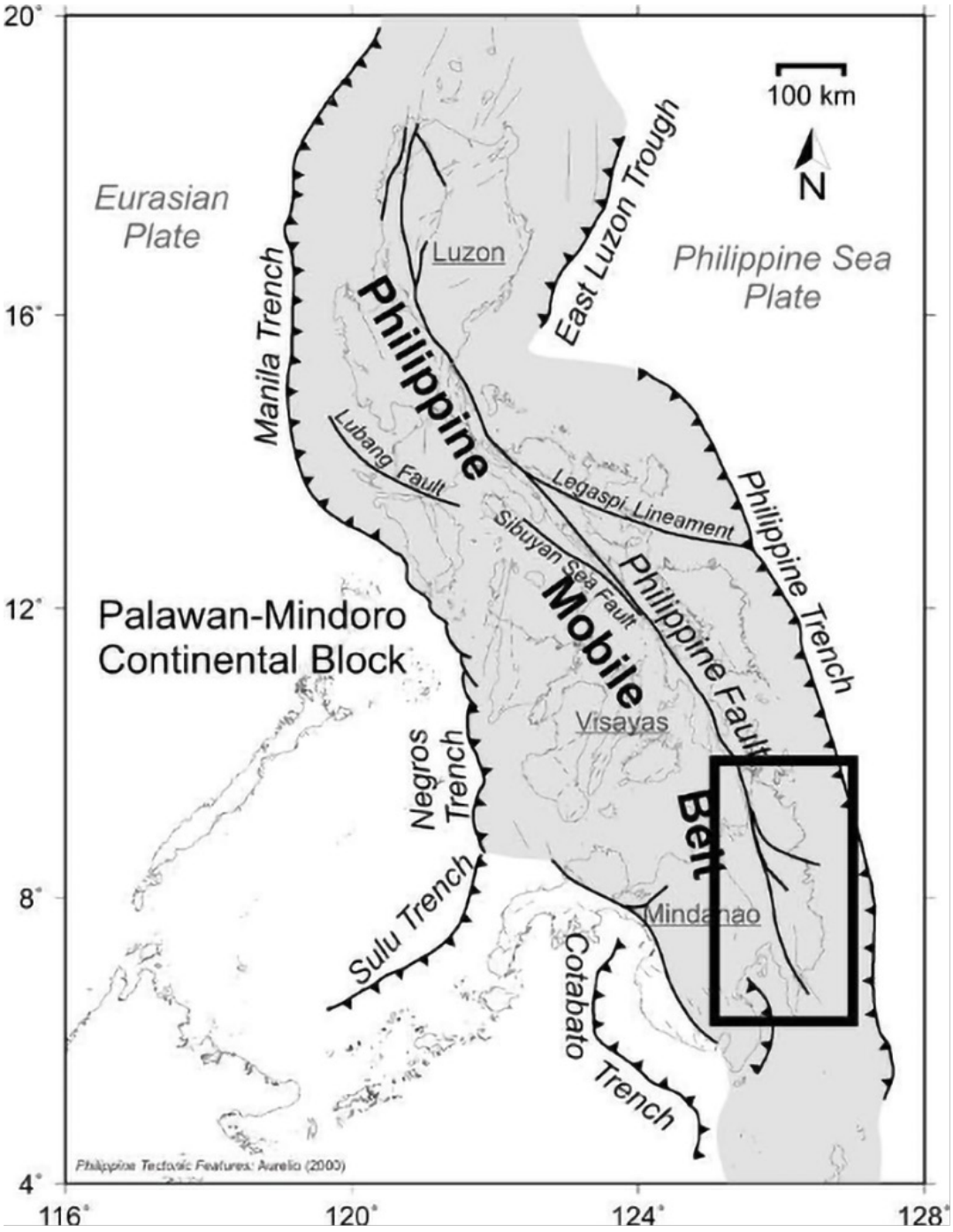


Figure 1.6_4. Map Showing Trenches Bounding the Philippine Mobile Belt
Source: Taguibao and Takahashi (2018)

The Philippines straddles the Pacific Ocean and the South China Sea. The large-scale currents of the Pacific influence the ocean currents on the Pacific side, and are usually persistent year-round (Figure 1.6_5). The stronger effects of the monsoon winds along the western coast drive ocean currents at seasonally-varying strengths.

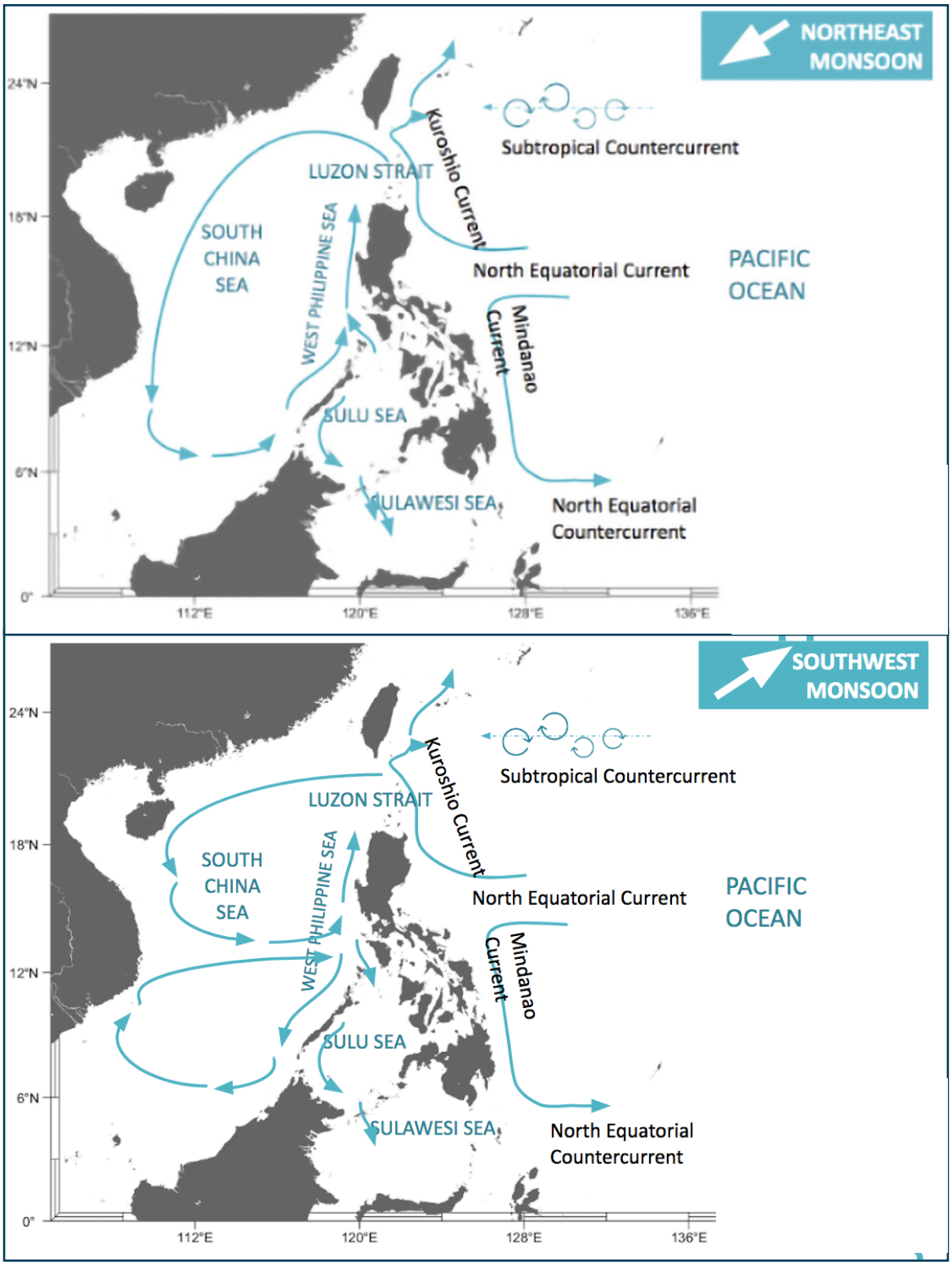


Figure 1.6_5. Schematic of Major Ocean Currents within Philippine Waters during the Northeast Monsoon (top), and Southwest Monsoon (bottom).
Source: Gordon et al. (2011)

The seas around the Philippines are very warm, except during the northeast monsoon (Figure 1.6_6). Some cooling is observed along straits and passages between islands during the peak monsoon months with strong vertical mixing driven by the wind's funneling effect. This mechanism also pumps nutrients from below the surface, enhancing phytoplankton production, and increasing biological productivity. These productive areas (and potentially-productive fishing grounds) appear in Figure 1.6_6 as areas with elevated chlorophyll concentration levels.

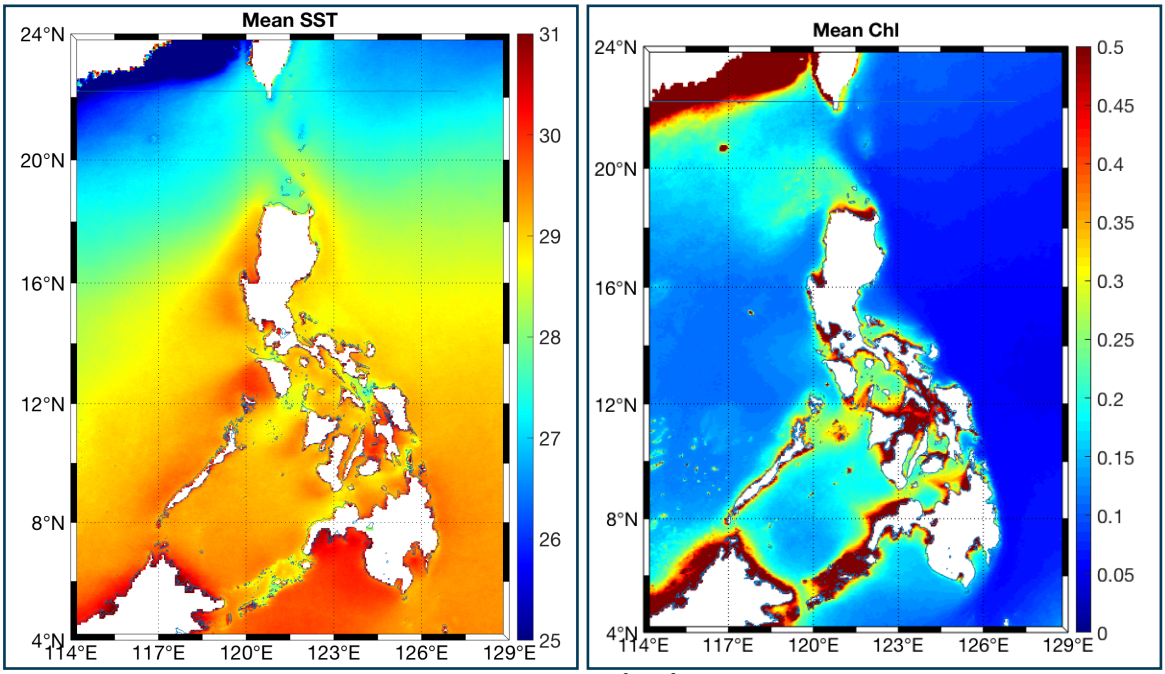


Figure 1.6_6. Mean Sea Surface Temperature (left) and Chlorophyll a Concentration (right) Averaged Over 2003-2019.
Source: MODIS
Material prepared by: Acd. Villanoy

Terrestrial Resources

Forests

Of the declared 15.8 million ha of the country's forest lands, only 7.01 million ha are covered with forests (DENR-FMB 2019). The remaining forest lands are classified as: closed forests (more than 40% of ground continuously covered by trees); open forests (10%-40% of the ground is discontinuously covered by trees); and mangrove forests (unique coastal forests). Closed forests cover 2.03 million ha of the remaining forest cover. Open forests share the greatest area, with as much as 4.68 million ha (see Figure 1.6_7). Mangroves only span 303,373 ha of the existing forest cover.

Minerals

The Philippines ranks fifth among the world's most mineralized countries, with nine million hectares of land that have high mineral content (DENR-MGB 2016). Major metallic minerals include gold, nickel, chromite, and copper. The major non-metallic minerals are limestone, marble, and coal.

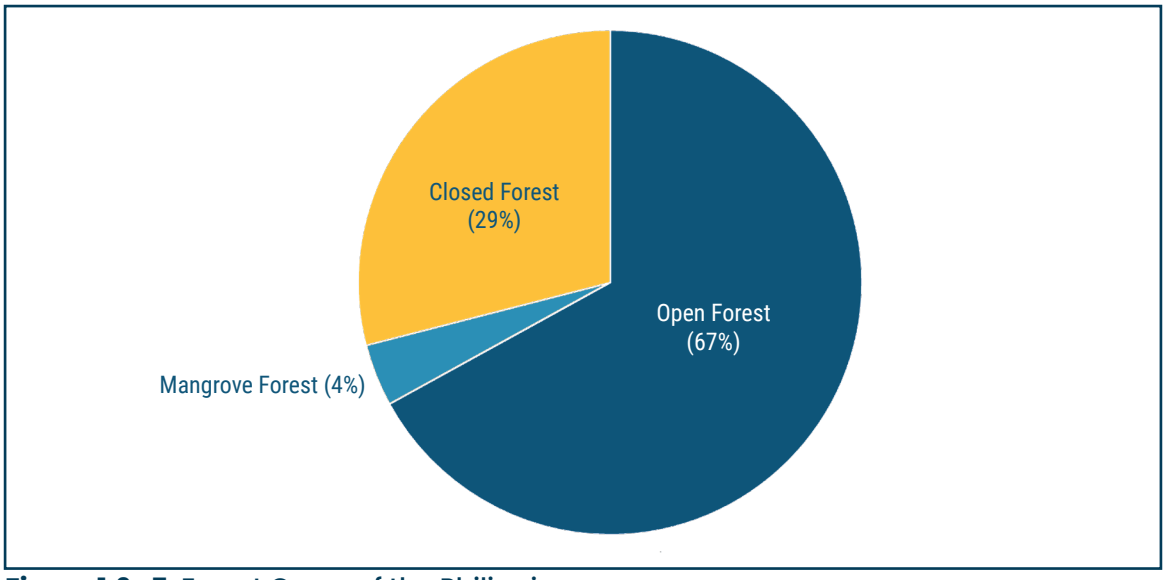


Figure 1.6_7. Forest Cover of the Philippines
Source: DENR-FMB (2019)

Table 1.6_1 shows the estimated mineral reserves for major metallic minerals and suggests the potential contribution of mining to the national economy, if sustainably managed. The country has concessions and infrastructure for:

- eight operating sites and two processing plants for gold
- 30 operating mines and two processing plants for nickel
- four operating sites for chromite
- three operating sites with one smelter plant for copper (PSA 2018e)

Table 1.6_1. Estimated Metallic Mineral Reserves from Year 2014 to 2018

Mineral	Reserve Volume				
	2014	2015	2016	2017	2018
Gold (Million kg)	4.859	4.840	4.831	4.887	4.894
Nickel (Billion mt)	1.985	1.991	1.962	1.957	2.051
Chromite (Million T)	40.288	40.237	40.247	44.904	44.859
Copper (Million mt)	1135.3	1135.3	1135.2	1135.1	1135.1

Source: PSA (2018e)

Water resources

The Department of Environment and Natural Resources (DENR) data shows the country's water supply is about 146 billion cu m, with 86% of piped-water supply systems supported by groundwater sources (DENR 2014).

The groundwater resources are estimated at 180 cu km/year, of which 80% (145 cu km/year) constitute the base flow of the river systems.

Groundwater reservoirs span 50,000 sq km which are freely recharged by rain, and seepage from rivers and lakes. It is estimated that rivers and lakes cover 61% of the country's total land area, and are potential water sources.

There 438 major dams, and 423 smaller dams (total of 861 impounding dam and reservoir sites) identified as sites with water surface and water storage potential. Recent estimates indicate that the total allocation rate for various water uses is 6.1 million liters per second.

Biodiversity

The Philippines is one of the world's 18 mega-biodiverse countries. It ranks 5th in the number of plant species, and maintains 5% of the world's flora. Species endemism is very high, with at least 25 genera of plants and 49% of terrestrial wildlife, while the country ranks fourth in bird endemism.

With habitat degradation, the country is considered as a biodiversity hotspot with at least 700 threatened species. Based on 2004 records, as many as 42 species of land mammals, 127 species of birds, 24 species of reptiles, and 14 species of amphibians were listed to be threatened. Fish biodiversity accounts to as much as 3,214 species, of which 76 are also threatened while 121 are endemic.

The estimated value for ecosystem services related to biodiversity conservation is about PhP 2.3 trillion. Ecosystem services related to crop production are worth about PhP 1.4 trillion. Carbon sequestration is valued at PhP 453 billion. Ecotourism is worth as much as PhP 157 billion (Table 1.6_2).

These values imply the need for more serious conservation for biodiversity resources.

Table 1.6_2. Ecosystem and Biodiversity Values (PhP Billion)

Ecosystem service	Estimated Value (PhP)
Ecotourism	157.0
Water provision	50.9
Carbon offset	453.0
Flood prevention	41.0
Soil erosion	10.0
Mangrove	7.4
Coral reef	62.1
Timber and fuelwood production	1.1
Fishery production	111.0
Crop production	1,416.0
Total	**2,309.5**

Source: DENR-BMB (2016)

Agricultural and Forestry Production

Agriculture. Agricultural lands are estimated at 14.48 million ha (PSA 2019). Major agricultural crops include: rice, corn, coconut, sugar cane, and banana. Major livestock include cattle, carabao, goat, hog, and poultry. The agriculture sector contributed 8.1% to the country's gross domestic product (GDP) in 2018. The country's GDP is estimated to have increased by 6.2% in 2020. The agriculture and fishing sectors recorded a 0.8% increase in production.

Forest Productions. In terms of timber products, roundwood production is estimated around 1.27M cu m in 2019 (DENR-FMB 2019). Of this, 5,021 cu m was exported. In terms of lumber, the country has produced about 246,000 cu m in the same year.

Of these, 89,000 cu m was exported. Further, 2019 records also showed that veneer and plywood products were as much as 285,000 cu m and 210, 000 cu m, respectively. Only the veneers were exported with a volume of 15,000 cu m.

Common non-timber forest products (NTFP) sold in the market are Almaciga resin (*Agathis philippinensis*), Anahaw leaves (*Saribus rotundifolius*), Bamboo poles (*Bambusa spp.*), Buri midribs (*Corypha elata*), Hingiw (*Ichnocarpus ovatofolius*), Nipa shingles (*Nypa fruticans*), Salago fiber (*Wikstroemia ovata*) and Rattan (*Calamus spp.*) Exported NTFPs in 2019 was worth as much as USD 940,000.

In terms of wood fuel, the rate of production (in '000 cu m) has increased over the years from 112,000 cu m in 2000, to more than double in 2005 (269,000 cu m), and continued increasing in the years 2010 (425,000 cu m) and 2015 (475,000 cu m). The country's annual wood fuel consumption rate is estimated at 57 milion tons.

Coastal and Marine Resources

Biodiversity

The country sits at the apex of the Coral Triangle and is reported to be the center of marine shorefish biodiversity. It is host to the highest number of marine fish per square area (Carpenter and Springer 2005, Sanciangco et al. 2013). Based on 2009 estimates, the number of fish species in the country is greater than 3,244, majority of which live in the marine areas (~80%), with 4% being endemic (Froese and Pauly 2009 in Alava et al. 2009).

The consensual Maximum Sustainable Yield (MSY) estimate for small pelagics is about 800,000 metric tons. The estimated MSY demersals is about 600 000 metric tons. Studies have indicated that most pelagic stocks, and demersal stocks are over-fished (Barut et al. 2003).

Commercially-important marine invertebrate resources include squids and cuttlefish, octopi, and crabs. Oceanic squid and deep-sea shrimp inhabit

Philippine territorial waters. Sharks, including chimaeras, true sharks, and flat sharks or batoids, make up 116 species, eight of which are new species descriptions (i.e., within the past five to 10 years), while 39 are considered potentially new species, possibly endemics, and require description (BFAR-NFRDI 2017).

There are 27 cetacean species, including a subspecies and one sirenian, reported and confirmed. They are all listed in Convention in International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendices, and are fully-protected under RA 8550. Five turtle species are known to occur in the country. Their exploitation is banned under Ministry of Natural Resources Administrative Order No. 12, Series of 1979.

There are more than 400 species and 70 genera of hard coral, all of which are fully-protected under Philippine laws. Recent estimates indicate a continued decline in coral cover, where about a third of the reef coral has been lost over the last decade (Licuanan et al. 2019).

The country has about 18 seagrass species, which provide nurseries for certain aquatic species, export nutrients to adjacent habitats, and promote the settlement of waterborne silt, reducing the impact of siltation (Fortes 2013). About 824 species of marine macrobenthic algae–consisting of 214 species of green algae (*Chlorophyta*), 134 species of brown algae (*Phaeophyta*), and 472 red algae (*Rhodophyta*)—are found in the Philippines (Trono 1999).

Marine Protected Areas

A marine protected area (MPA) is a defined area of the sea established by law, administrative regulation, or other means, to conserve and protect an enclosed environment, in part or entirely, by establishing management guidelines. MPAs are categorized either as nationally-established and locally established. They can have several forms: marine sanctuary, marine reserve, fish sanctuary, marine park, protected seascape, etc. Cabral et al. (2014) pegged the total number of MPAs in the country at 1,800 (Figure 1.6_8).

Fisheries Production

In 2018, total fish production was reported as 4,356,874 metric tons, broken down into 946,437 metric tons from commercial fisheries; 1,106,071 metric tons from municipal fisheries; and 2,304,365 metric tons from aquaculture—all contributing about 1.2% (at current prices) and 1.3% (at constant prices) to the country's GDP (Table 1.6_3) (PSA 2018e).

The marine ecosystem alone (excluding the continental shelf) was conservatively valued to be about USD 966.6 billion/year, based on primary and available secondary data (Azanza et al. 2017).

Filipino fisherfolk, farmers, and children posted the highest poverty incidences in 2015 at 34.0%, 34.3%, and 31.4%, respectively (PSA 2019b). Fisherfolk belong to the poorest of the poor in Philippine society.

The University of the Philippines Marine Science Institute

Figure 1.6_8. Location of Marine Protected Areas in the Philippines
Source: Cabral et al. (2014)

Table 1.6_3. Volume of Fisheries Production by Sector, Philippines: 2016–2018 in Metric Tons

Sector	2016	2017	2018
All Sectors	4,355,792.42	4,312,089.51	4,356,874.77
Commercial Fisheries	1,016,948.05	948,281.45	946,437.62
Municipal Fisheries	1,137,931.03	1,126,017.30	1,106,071.84
Marine	976,941.19	962,146.84	941,870.86
Inland	160,989.84	163,870.46	164,200.98
Aquaculture	2,200,913.34	2,237,790.76	2,304,365.31
Brackishwater Fishpond	337,582.24	343,793.25	325,503.98
Brackishwater Fish cage	978.88	927.79	1,248.65
Brackishwater Fish pen	2,086.18	2,765.27	2,882.17
Freshwater Fishpond	145,655.32	156,465.15	161,519.66
Freshwater Fish cage	97,568.86	95,699.48	103,348.98
Freshwater Fish pen	56,610.84	62,805.43	57,644.07
Marine Fish cage	106,257.36	106,770.58	108.951.71
Marine Fish pen	11,307.24	11,019.69	9,867.59
Oyster	19,512.36	22,944.37	28,708.15
Mussel	18,774.55	19,208.62	26,302.77
Seaweed	1,404,519.23	1,415,320.79	1,478,300.85
Small Farm Reservoir	56.68	66.86	83.25
Rice Fish	3.59	3.49	3.47

Source: PSA (2019b)

Threats and Opportunities

The Philippines is richly endowed with terrestrial, coastal, and marine resources. While some of its precious resources have been badly exploited over time—forests, minerals, biodiversity, and fisheries—the country's natural resource base continues to support the needs of its increasing population, and its quest for development.

The next several decades will be crucial, as pressures from climate change, natural hazards, land and natural resource use, population, and economic growth intensify. This will heavily impact the country's natural resource endowments.

The act of balancing between development and protection of the environment and natural resources will become more challenging as more people require the use of our finite resources for livelihood and economic gains.

For terrestrial resources, a confluence of natural and anthropogenic pressures continue to threaten the sustainable production of various ecosystems' services that are vital to human well-being, and the pursuit of sustainable development.

While the Philippines has a significant fisheries sector and unique marine biodiversity, it is also a global hotspot for marine conservation, being right at the apex of the Coral Triangle of the Indo-Pacific Region–primarily due to several threats including overfishing, especially illegal, unregulated and unreported fishing (IUUF [date unknown]), habitat degradation, pollution, alien and invasive species, and climate change (Roberts et al. 2012).

In fact, the Philippines is one of the top 10 countries considered most vulnerable to the negative impacts of climate change (Santos et al. 2011).

Considering the current and anticipated threats to the country's natural resources, continuing assessment and monitoring of these resources will ensure their protection and sustainable management.

Science, technology, and innovation can, and should, play an important role in conservation and sustainable use of these resources.

SECTION 1.7
DEMOGRAPHICS AND DEVELOPMENT

The country's development, resilience, and sustainability depend greatly on the wise utilization of its natural endowments. A burgeoning population and rapid urbanization are just the tip of the iceberg when it comes to the Philippines' demographic and development trends. The country's annual population growth rate is currently 1.73%, while its annual urbanization rate is 1.32% (PSA 2015a), resulting in the overutilization and overexploitation of natural resources. This accelerated population growth translates into increased demand for food production and shelter.

The Philippines is blessed with abundant natural resources. Demand for access and use of natural resources, such as land and water resources across regions, also varies among different social classes based on their income and/or lifestyle. For example, water use in urban areas tends to be higher than in rural areas.

The resilience of households, communities, regions and countries is directly related to their adaptive capacity. Some indicators or measures of adaptive capacity include demographic variables such as age, level of education, income, human development index, etc. (IPCC 2014; Cruz et al. 2017). These indicators vary across regions, as well as within the regions themselves.

Demographics: Regional Distribution and Trends

The projected Philippine population by age group from 2020 to 2045 is shown in Table 1.7_1. The 0-24 age group, which is almost half (48.6%) of the population in 2020, will account for almost a third (36.5%) of the projected population by 2045.

Conversely, there is a steady increase in the percentage of population in the older age group from 2020 to 2045, which is more pronounced in the 45 to 80 age range. From a little more than a fifth (22.6%) in 2020, the 45 to 80 age group is projected to grow to a third (34.2%) of the projected population in 2045.

Table 1.7_1. Population Projection by Age Group, Philippines: 2020 - 2045

Age Group	2020	%	2025	%	2030	%	2035	%	2040	%	2045	%
All Age Groups	109,948	100.0	117,959	100.0	125,338	100.0	131,904	100.0	137,532	100.0	142,095	100.0
Under 5 Years	11,476	10.4	11,361	9.6	11,044	8.8	10,622	8.1	10,120	7.4	9,524	6.7
5 - 9 Years	11,234	10.2	11,386	9.7	11,274	9.0	10,958	8.3	10,536	7.7	10,032	7.1
10 - 14 Years	10,602	9.6	11,162	9.5	11,313	9.0	11,198	8.5	10,879	7.9	10,453	7.4
15 - 19 Years	10,209	9.3	10,524	8.9	11,081	8.8	11,227	8.5	11,108	8.1	10,783	7.6
20 - 24 Years	10,045	9.1	10,118	8.6	10,432	8.3	10,985	8.3	11,127	8.1	11,003	7.7
25 - 29 Years	9,540	8.7	9,944	8.4	10,017	8.0	10,329	7.8	10,878	7.9	11,016	7.8
30 - 34 Years	8,229	7.5	9,436	8.0	9,841	7.9	9,915	7.5	10,225	7.4	10,771	7.6
35 - 39 Years	7,239	6.6	8,127	6.9	9,334	7.4	9,742	7.4	9,819	7.1	10,130	7.1
40 - 44 Years	6,574	6.0	7,134	6.0	8,024	6.4	9,231	7.0	9,645	7.0	9,728	6.8
45 - 49 Years	5,787	5.3	6,450	5.5	7,016	5.6	7,909	6.0	9,116	6.6	9,537	6.7
50 - 54 Years	5,186	4.7	5,630	4.8	6,296	5.0	6,868	5.2	7,762	5.6	8,968	6.3
55 - 59 Years	4,319	3.9	4,971	4.2	5,421	4.3	6,087	4.6	6,665	4.8	7,557	5.3
60 - 64 Years	3,445	3.1	4,046	3.4	4,685	3.7	5,138	3.9	5,799	4.2	6,378	4.5
65 - 69 Years	2,472	2.2	3,110	2.6	3,684	2.9	4,301	3.3	4,750	3.5	5,397	3.8
70 - 74 Years	1,668	1.5	2,110	1.8	2,686	2.1	3,218	2.4	3,795	2.8	4,230	3.0
75 - 79 Years	967	0.9	1,313	1.1	1,689	1.3	2,183	1.7	2,653	1.9	3,170	2.2
80 Years and Above	958	0.9	1,138	1.0	1,501	1.2	1,993	1.5	2,657	1.9	3,421	2.4

Sources: PSA (2014a, 2018c)

Note: Median assumption in thousands ('000); Details may not add up to totals due to rounding.

The highest grade completed by household members 15 years old and above is depicted in Table 1.7_2. On the average, from 2013 to 2017, 44% had a high school education while a quarter (25%) reached college and graduate school level. Likewise, a quarter had elementary education, and a meager 2% had not completed any level of education at all.

It is also interesting to note the demographic differentiation of males and females in the workforce across regions in terms of educational attainment. Males outnumber females among those who attained only an elementary education, while the percentages of males and females across regions who completed secondary-level education are almost the same. However, there are more females than males in the labor workforce with baccalaureate degrees across all regions (PSA 2015a). This information is an important consideration in linking gender in development planning as educated and young people are more receptive to innovation.

Household income is another measure of resilience and adaptive capacity. Figure 1.7_1 shows the average annual income for a family of five members over a three-year interval, from 2006 to 2018. An increasing trend can be observed for all regions with the National Capital Region (NCR) consistently emerging with the highest family income followed by Region IV-A. Region III consistently came in third from 2006 to 2015, but lost its spot to the Cordillera Administrative Region (CAR) in 2018.

Table 1.7_2. Household Population for ages 15 Years Old and Above by Highest Grade Completed, Philippines: 2013–2017 (In Thousands)

Highest Grade Completed	2013		2014		2015		2016		2017	
Philippines	**64,173**	**%**	**64,033**	**%**	**64,936**	**%**	**68,311**	**%**	**69,891**	**%**
No Grade Completed	**1,158**	1.8	**1,126**	1.8	**1,108**	1.7	**1,127**	1.6	**1,235**	1.8
Elementary	16,340	25.5	15,629	24.4	15,616	24.0	16,673	24.4	16,729	23.9
Undergraduate	*7,974*		*7,436*		*7,583*		*8,494*		*8,779*	
Graduate	*8,367*		*8,192*		*8,033*		*8,180*		*7,950*	
SPED 1	NA		NA		NA		10	0.0	-	
SPED Undergraduate	*NA*		*NA*		*NA*		*8*		-	
SPED Graduate	*NA*		*NA*		*NA*		*2*		-	
High School 2	27,771	43.3	27,790	43.4	28,462	43.8	30,054	44.0	-	
Undergraduate	*10,267*		*9,875*		*10,206*		*11,518*		-	
Graduate	*17,504*		*17,915*		*18,256*		*18,535*		-	
Junior High School	NA		NA		NA		NA		30,214	43.2
Undergraduate	*NA*		*NA*		*NA*		*NA*		*10,852*	
Graduate	*NA*		*NA*		*NA*		*NA*		*19,362*	
Senior High School	NA		NA		NA		NA		1,013	1.4
Undergraduate	*NA*		*NA*		*NA*		*NA*		*953*	
Graduate	*NA*		*NA*		*NA*		*NA*		*60*	
Post Secondary	2,598	4.0	2,759	4.3	2,744	4.2	2,970	4.3	2,842	4.1
Undergraduate	*651*		*464*		*429*		*404*		*349*	
Graduate	*1,947*		*2,294*		*2,315*		*2,566*		*2,493*	
College	16,306	25.4	16,730	26.1	17,007	26.2	17,476	25.6	17,858	25.6
Undergraduate	*7,959*		*8,004*		*8,236*		*8,738*		*9,116*	
Graduate and Higher	*8,347*		*8,726*		*8,771*		*8,738*		*8,743*	

Source: PSA (2020c)

Notes:

1. Details may not add up to totals due to rounding.
2. Data averages of the four survey rounds (January, April, July and October).
3. Annualized data for 2014 refer to the average of estimates for April, July and October survey rounds. The estimates for these rounds exclude Leyte province.
4. Annualized data for 2015 refer to the average of the four survey rounds that exclude Leyte. The use of the four survey rounds that exclude Leyte was based on the results of the referendum conducted among members of the Interagency Committee on Labor and Productivity Statistics (IACLPS).
5. Starting April 2016 round, the Labor Force Survey (LFS) adopted the 2013 Master Sample Design as well as the population projections based on the 2010 Census of Population and Housing (2010 CPH) while previous survey rounds were derived using the 2000 CPH population projections.
6. Annualized data for 2016 was computed as the average of the four survey rounds using the January 2016 round that was based on the 2010 CPH population projections.

* Less than 500.
NA Not available.
1 Starting 2017, data for SPED is included under Elementary.
2 Starting 2017, High School data is broken down into Junior and Senior High School.

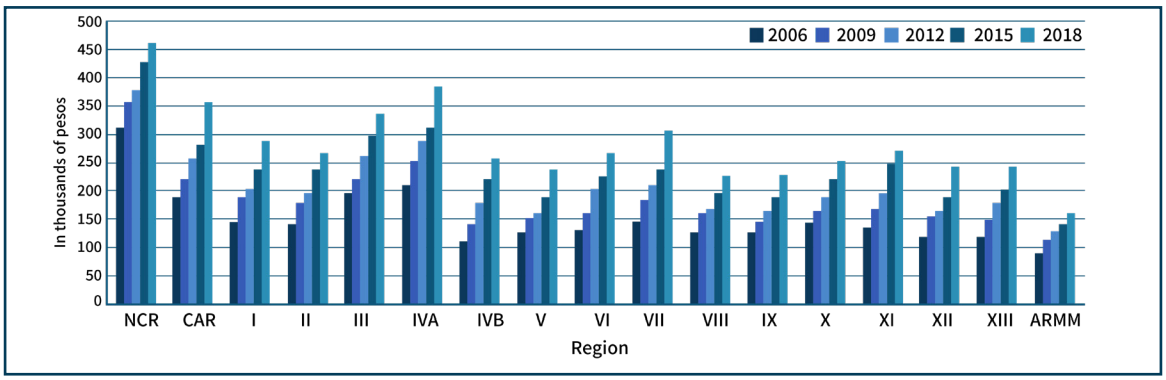


Figure 1.7_1. Average Annual Family Income by Region, 2016–2018
Sources: NSO (2006, 2009, 2012), PSA (2015a, 2018d)

On the other hand, the now-defunct Autonomous Region in Muslim Mindanao (ARMM), which has been replaced by the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) consistently showed the lowest reported annual family income from 2006–2018. The second lowest-ranked was Region IV-B (2006–2009), the Region V (2012–2015), and Region VIII (2018) while Region XII (2006, 2012, and 2015) and Region IX (2009 and 2018) came in third from the lowest during the indicated years.

Table 1.7_3 shows the per capita poverty threshold (i.e., the minimum income required for an individual to meet his/her basic food and non-food needs) and poverty incidence by region and province for the first semester of 2015 and 2018 (PSA 2018a, 2018b). Overall first quarter poverty incidence in the country decreased from 22.2% in 2015 to 16.1% in 2018. The NCR had the lowest first-quarter poverty incidence for both years (i.e., 4.6% in 2015 and 4.9% in 2018), while the ARMM had the highest poverty incidence: 56.2% in 2015 and 55.4% in 2018.

This trend is echoed by the annual per capita poverty threshold 1991 to 2015: all regions saw reduced poverty thresholds—by as much as 25.6 percentage points, in the case of Region II, from 37.3% to 11.7%—except for the ARMM, which saw an increase of 21.3 percentage points, from 26.9% to 48.2%. The NCR posted both the lowest thresholds and the smallest decrease over the period, from 5.3% in 1991 to 2.7% in 2015. As a whole, the poverty incidence in the Philippines decreased from 29.7% in 1991 to 16.5% in 2015 (PSA 2015c, 2018a).

Table 1.7_3. First Semester Per Capita Poverty Threshold and Poverty Incidence among Families with Measures of Precision, by Region and Province: 2015 and 2018

Region/Province	First Semester Per Capita Poverty Threshold (in PhP)		Poverty Incidence among Families (%)		Coefficient of Variation		Standard Error		90% Confidence Interval			
									2015*		2018	
	2015*	2018	2015*	2018	2015*	2018	2015*	2018	Lower Limit	Upper Limit	Lower Limit	Upper Limit
PHILIPPINES	**11,344**	**12,577**	**22.2**	**16.1**	**4.8**	**1.1**	**1.1**	**0.2**	**20.4**	**24.0**	**15.8**	**16.4**
National Capital Region (NCR)	**12,605**	**14,102**	**4.6**	**4.9**	**7.5**	**5.3**	**0.3**	**0.3**	**4.0**	**5.2**	**4.5**	**5.3**
1st District (City of Manila)	12,605	14,102	4.8	5.7	19.8	19.0	1.0	1.1	3.2	6.4	3.9	7.5
2nd District (City of Mandaluyong, City of Marikina, City of Pasig, Quezon City, City of San Juan)	12,605	14,102	3.9	3.5	14.9	12.6	0.6	0.4	3.0	4.9	2.7	4.2
3rd District (City of Caloocan, City of Malabon, City of Navotas, City of Valenzuela)	12,605	14,102	6.5	8.1	13.1	6.5	0.9	0.5	5.1	8.0	7.2	9.0
4th District (City of Las Piñas, City of Makati, City of Muntinlupa, City of Parañaque, Pasay City, Pateros, City of Taguig)	12,605	14,102	3.8	3.9	16.1	6.5	0.6	0.3	2.8	4.8	3.5	4.3
Cordillera Administrative Region (CAR) b/	**11,583**	**12,352**	**22.7**	**13.8**	**20.1**	**4.0**	**4.6**	**0.6**	**15.2**	**30.2**	**12.9**	**14.7**
Abra	11,361	12,406	36.8	29.5	9.1	6.1	3.4	1.8	31.2	42.3	26.5	32.5
Apayao	11,776	11,523	46.8	23.2	8.3	12.6	3.9	2.9	40.4	53.2	18.4	28.0
Benguet b/	10,778	11,820	5.2	6.1	20.1	10.4	1.0	0.6	3.5	6.9	5.1	7.2
Ifugao b/	12,553	12,944	43.9	15.5	21.7	11.4	9.5	1.8	28.2	59.6	12.6	18.5
Kalinga b/	10,679	11,864	26.6	12.3	22.1	10.1	5.9	1.2	16.9	36.2	10.2	14.3
Mt. Province	11,900	13,343	41.8	24.4	11.3	8.1	4.7	2.0	34.0	49.6	21.2	27.7
Region I (Ilocos Region)	**11,386**	**12,821**	**20.4**	**8.7**	**8.7**	**8.0**	**1.8**	**0.7**	**17.4**	**23.3**	**7.5**	**9.8**
Ilocos Norte b/	11,750	12,709	16.9	5.5	20.1	16.5	3.4	0.9	11.3	22.5	4.0	7.0
Ilocos Sur	11,865	11,907	15.0	8.8	19.5	11.2	2.9	1.0	10.2	19.8	7.2	10.4
La Union b/	10,923	10,866	19.0	3.7	21.6	18.7	4.1	0.7	12.2	25.8	2.6	4.8
Pangasinan	11,373	13,160	23.0	10.5	7.8	10.6	1.8	1.1	20.0	26.0	8.7	12.4
Region II (Cagayan Valley)	**11,328**	**12,142**	**17.3**	**15.3**	**5.4**	**5.5**	**0.9**	**0.8**	**15.7**	**18.8**	**13.9**	**16.7**
Batanes a/	15,314	19,249	10.0	13.3	0.0	11.9	0.0	1.6	0.0	0.0	10.7	15.9
Cagayan	10,841	12,199	18.4	15.1	11.3	8.9	2.1	1.3	15.0	21.8	12.9	17.3
Isabela	11,642	12,190	16.0	15.6	7.9	9.2	1.3	1.4	14.0	18.1	13.3	18.0
Nueva Vizcaya	11,525	11,934	17.6	16.9	17.5	10.0	3.1	1.7	12.5	22.7	14.1	19.7
Quirino	11,086	11,194	21.8	9.5	14.5	11.6	3.2	1.1	16.6	27.0	7.7	11.3

Table 1.7_3. Continued

Region/Province	First Semester Per Capita Poverty Threshold (in PhP)		Poverty Incidence among Families (%)		Coefficient of Variation		Standard Error		90% Confidence Interval			
									2015*		2018	
	2015*	2018	2015*	2018	2015*	2018	2015*	2018	Lower Limit	Upper Limit	Lower Limit	Upper Limit
Region III (Central Luzon)	**11,224**	**12,885**	**12.2**	**7.8**	**7.8**	**4.7**	**0.9**	**0.4**	**10.6**	**13.7**	**7.2**	**8.4**
Aurora a/	10,289	12,050	24.6	16.7	0.0	9.9	0.0	1.6	24.6	24.6	13.9	19.4
Bataan b/	11,234	14,333	5.5	11.3	29.9	9.6	1.7	1.1	2.8	8.3	9.5	13.1
Bulacan	10,620	12,545	5.3	4.9	17.6	14.9	0.9	0.7	3.8	6.8	3.7	6.1
Nueva Ecija	11,346	12,287	23.4	10.3	9.7	10.1	2.3	1.0	19.7	27.1	8.6	12.1
Pampanga	10,668	12,795	4.8	3.5	16.8	19.7	0.8	0.7	3.5	6.1	2.4	4.6
Tarlac	11,024	11,917	19.8	10.3	12.1	9.1	2.4	0.9	15.9	23.8	8.8	11.9
Zambales	13,333	14,638	14.5	16.4	16.4	7.8	2.4	1.3	10.6	18.4	14.3	18.5
Region IV-A (CALABARZON)	**12,775**	**13,528**	**12.8**	**7.6**	**10.1**	**6.0**	**1.3**	**0.5**	**10.7**	**15.0**	**6.9**	**8.4**
Batangas	14,957	15,754	21.8	12.7	10.7	10.1	2.3	1.3	17.9	25.6	10.6	14.8
Cavite	13,669	14,440	9.7	6.0	14.1	13.2	1.4	0.8	7.4	11.9	4.7	7.3
Laguna b/	10,701	11,471	5.6	5.0	24.1	16.8	1.4	0.8	3.4	7.8	3.6	6.4
Quezon	10,530	11,357	23.5	12.2	16.5	12.9	3.9	1.6	17.1	29.9	9.6	14.8
Rizal	12,443	13,951	7.7	4.8	17.1	15.4	1.3	0.7	5.5	9.9	3.6	6.1
MIMAROPA Region	**10,189**	**11,420**	**22.9**	**15.0**	**7.7**	**4.7**	**1.8**	**0.7**	**20.0**	**25.8**	**13.9**	**16.2**
Marinduque	9,963	11,672	23.9	14.2	12.4	9.2	3.0	1.3	19.0	28.8	12.1	16.4
Occidental Mindoro	10,176	10,577	32.4	22.0	16.1	9.6	5.2	2.1	23.8	40.9	18.5	25.5
Oriental Mindoro	10,369	12,032	21.7	12.8	14.3	10.6	3.1	1.4	16.6	26.8	10.6	15.0
Palawan	9,833	11,339	17.9	11.2	17.9	10.1	3.2	1.1	12.6	23.2	9.4	13.1
Romblon b/	10,777	11,862	26.8	24.3	22.1	7.4	5.9	1.8	17.1	36.6	21.3	27.2
Region V (Bicol Region)	**11,431**	**11,946**	**33.7**	**21.4**	**6.8**	**3.6**	**2.3**	**0.8**	**29.9**	**37.5**	**20.1**	**22.6**
Albay	11,378	12,208	24.8	15.9	12.0	8.0	3.0	1.3	19.9	29.7	13.8	18.0
Camarines Norte	12,015	12,117	40.1	24.6	16.6	7.0	6.6	1.7	29.1	51.0	21.8	27.5
Camarines Sur	11,420	11,575	31.3	19.2	8.6	8.7	2.7	1.7	26.8	35.7	16.5	22.0
Catanduanes	11,297	12,144	37.3	19.4	8.5	8.3	3.2	1.6	32.1	42.5	16.7	22.0
Masbate	10,398	11,285	33.0	29.4	16.9	7.0	5.6	2.1	23.8	42.2	26.0	32.8
Sorsogon	11,907	13,114	46.7	24.5	13.5	6.7	6.3	1.6	36.3	57.1	21.8	27.2
Region VI (Western Visayas)	**0,932**	**11,937**	**25.0**	**15.9**	**7.5**	**4.9**	**1.9**	**0.8**	**21.9**	**28.1**	**14.6**	**17.2**
Aklan	11,056	12,069	25.4	14.6	16.7	10.2	4.2	1.5	18.4	32.4	12.2	17.0
Antique	10,226	11,680	27.0	18.3	19.3	9.6	5.2	1.7	18.4	35.6	15.4	21.1
Capiz b/	10,326	10,984	18.3	5.9	27.4	13.1	5.0	0.8	10.0	26.6	4.6	7.2
Guimaras a/ b/	11,501	12,602	19.4	12.4	37.6	11.5	7.3	1.4	7.4	31.4	10.1	14.8
Iloilo	11,471	12,590	22.0	15.8	14.1	7.5	3.1	1.2	16.9	27.2	13.8	17.7
Negros Occidental	10,763	11,604	29.5	18.5	8.2	8.5	2.4	1.6	25.5	33.5	15.9	21.1

Table 1.7_3. Continued

Region/Province	First Semester Per Capita Poverty Threshold (in PhP)		Poverty Incidence among Families (%)		Coefficient of Variation		Standard Error		90% Confidence Interval			
									2015*		2018	
	2015*	2018	2015*	2018	2015*	2018	2015*	2018	Lower Limit	Upper Limit	Lower Limit	Upper Limit
Region VII (Central Visayas)	**11,210**	**12,696**	**28.5**	**19.0**	**4.8**	**4.2**	**1.4**	**0.8**	**26.2**	**30.7**	**17.7**	**20.3**
Bohol	11,200	12,613	25.9	21.1	12.1	8.3	3.1	1.8	20.7	31.1	18.2	24.0
Cebu	11,451	12,859	24.1	16.5	6.6	5.9	1.6	1.0	21.5	26.7	14.9	18.1
Negros Oriental	10,835	12,396	40.6	26.1	9.2	8.4	3.8	2.2	34.4	46.8	22.5	29.7
Siquijor a/	10,658	12,454	49.7	10.0	0.0	15.8	0.0	1.6	49.7	49.7	7.4	12.6
Region VIII (Eastern Visayas)	**11,227**	**12,201**	**39.9**	**30.4**	**6.4**	**3.4**	**2.6**	**1.0**	**35.7**	**44.1**	**28.7**	**32.1**
Biliran	10,831	12,037	16.1	18.0	7.7	7.9	1.2	1.4	14.0	18.1	15.7	20.4
Eastern Samar	12,971	14,112	42.9	43.0	16.0	5.0	6.9	2.2	31.5	54.2	39.4	46.5
Leyte	10,819	11,732	38.4	29.4	8.1	6.5	3.1	1.9	33.3	43.5	26.2	32.6
Northern Samar	11,502	12,648	53.8	30.0	8.9	6.6	4.8	2.0	45.9	61.6	26.7	33.3
Southern Leyte	11,863	12,672	31.7	22.8	18.3	7.2	5.8	1.6	22.1	41.2	20.1	25.5
Western Samar	10,634	11,238	43.9	32.2	13.8	6.6	6.0	2.1	34.0	53.9	28.7	35.6
Region IX (Zamboanga Peninsula)	**11,038**	**12,388**	**33.9**	**32.4**	**10.8**	**3.4**	**3.7**	**1.1**	**27.8**	**39.9**	**30.5**	**34.2**
Zamboanga del Norte	12,028	13,609	51.7	41.2	7.2	5.9	3.7	2.4	45.5	57.9	37.2	45.2
Zamboanga del Sur	10,120	11,829	23.2	25.2	17.2	5.8	4.0	1.5	16.6	29.7	22.8	27.6
Zamboanga Sibugay	10,602	11,436	39.4	36.0	12.6	7.1	5.0	2.5	31.2	47.6	31.8	40.2
Isabela City a/ b/	10,518	12,607	20.7	52.6	30.2	6.2	6.2	3.3	10.4	30.9	47.3	58.0
Region X (Northern Mindanao)	**11,426**	**12,232**	**35.9**	**25.4**	**6.8**	**3.1**	**2.4**	**0.8**	**31.9**	**39.9**	**24.1**	**26.7**
Bukidnon	11,886	12,678	54.1	32.1	5.6	6.3	3.0	2.0	49.1	59.1	28.7	35.4
Camiguin a/	11,883	2,671	40.0	23.2	6.0	8.8	2.4	2.0	36.0	44.0	19.8	26.5
Lanao del Norte	11,346	12,114	42.2	23.6	11.7	6.0	4.9	1.4	34.0	50.3	21.3	26.0
Misamis Occidental	10,697	11,994	36.9	32.4	11.9	6.3	4.4	2.0	29.7	44.2	29.1	35.8
Misamis Oriental	11,007	1,838	18.4	18.5	15.8	5.1	2.9	0.9	13.6	23.2	16.9	20.1
Region XI (Davao Region)	**11,585**	**12,709**	**21.4**	**17.7**	**7.1**	**4.0**	**1.5**	**0.7**	**18.9**	**23.9**	**16.6**	**18.9**
Davao del Norte	12,016	12,720	27.2	14.5	17.6	10.3	4.8	1.5	19.3	35.1	12.1	17.0
Davao del Sur	11,603	12,968	12.1	10.7	13.7	10.2	1.7	1.1	9.4	14.9	8.9	12.6
Davao Oriental	11,404	12,643	28.0	32.6	16.0	6.6	4.5	2.1	20.6	35.3	29.1	36.2
Compostela Valley	11,386	12,502	29.2	25.8	8.7	6.7	2.6	1.7	25.0	33.4	23.0	28.7
Davao Occidental	11,332	12,510	51.2	36.7	9.0	6.7	4.6	2.5	43.6	58.7	32.6	40.8
Region XII (SOCCSKSARGEN)	**10,576**	**12,067**	**37.4**	**27.2**	**6.5**	**3.7**	**2.4**	**1.0**	**33.4**	**41.4**	**25.5**	**28.9**
North Cotabato	10,452	11,773	42.3	25.6	8.1	8.3	3.4	2.1	36.7	48.0	22.1	29.1
Saranggani	10,051	11,043	53.0	40.5	12.0	7.3	6.4	3.0	42.5	63.5	35.6	45.4
South Cotabato	10,661	12,504	23.6	18.9	12.1	8.1	2.9	1.5	18.8	28.3	16.4	21.4
Sultan Kudarat	10,543	11,555	49.0	32.4	14.7	7.2	7.2	2.3	37.1	60.9	28.6	36.3
Cotabato City b/	12,730	14,804	39.9	42.3	27.3	5.8	10.9	2.5	21.9	57.9	38.3	46.4

Table 1.7_3. Continued

Region/Province	First Semester Per Capita Poverty Threshold (in PhP)		Poverty Incidence among Families (%)		Coefficient of Variation		Standard Error		90% Confidence Interval			
									2015*		2018	
	2015*	2018	2015*	2018	2015*	2018	2015*	2018	Lower Limit	Upper Limit	Lower Limit	Upper Limit
Region XIII (Caraga)	**11,299**	**12,314**	**35.2**	**28.3**	**5.7**	**3.2**	**2.0**	**0.9**	**31.9**	**38.5**	**26.8**	**29.8**
Agusan del Norte	10,119	11,430	28.4	23.5	12.2	5.7	3.5	1.3	22.7	34.1	21.3	25.7
Agusan del Sur	11,490	12,095	45.0	32.4	7.6	6.8	3.4	2.2	39.4	50.6	28.8	36.0
Surigao Del Norte	12,253	13,742	32.8	32.2	13.1	6.8	4.3	2.2	25.7	39.9	28.7	35.8
Surigao Del Sur	11,361	11,945	32.8	23.9	11.1	7.4	3.6	1.8	26.8	38.8	21.0	26.8
Dinagat Islands	12,132	13,177	45.4	36.7	18.8	6.8	8.5	2.5	31.3	59.4	32.6	40.8
Autonomous Region in Muslim Mindanao (ARMM)	**11,183**	**13,578**	**56.2**	**55.4**	**5.8**	**2.4**	**3.3**	**1.3**	**50.8**	**61.5**	**53.2**	**57.6**
Basilan	9,856	12,671	28.8	65.3	12.8	3.4	3.7	2.2	22.7	34.9	61.6	68.9
Lanao del Sur	12,021	14,769	73.8	68.0	4.9	3.2	3.6	2.2	67.8	79.8	64.5	71.5
Maguindanao	9,979	12,653	47.4	47.9	8.2	6.6	3.9	3.1	41.0	53.8	42.8	53.1
Sulu	11,494	13,830	71.8	65.8	8.5	3.4	6.1	2.3	61.7	81.8	62.1	69.6
Tawi-tawi b/	8,895	9,817	10.9	17.2	32.8	9.1	3.6	1.6	5.0	16.8	14.7	19.8

Source: PSA (2020c)

Notes:

a/ Caution in utilizing the estimate for these provinces must be observed due to its very small sample size.

b/ Coefficient of variation of first semester 2015 provincial poverty incidence among families is greater than 20%.

* Food Thresholds are estimated using actual prices collected by PSA for the estimation of the Consumer Price Index (CPI). In consonance with the updating of the market basket for the collection of prices for CPI, First Semester 2015 Poverty Statistics were revised accordingly.

Urbanization

Meanwhile, population growth is exerting pressure on available land and water resources. Rapid urbanization often leads to land use and cover changes due to unregulated land conversion and unsustainable production systems. Figure 1.7_2 shows that the urban communities increased from 45.3% in 2010 (PSA 2010) to 51.2% in 2015 (PSA 2015a) especially in Region IV-A (CALABARZON) including the provinces of Mindoro Oriental, Mindoro Occidental, and Palawan.

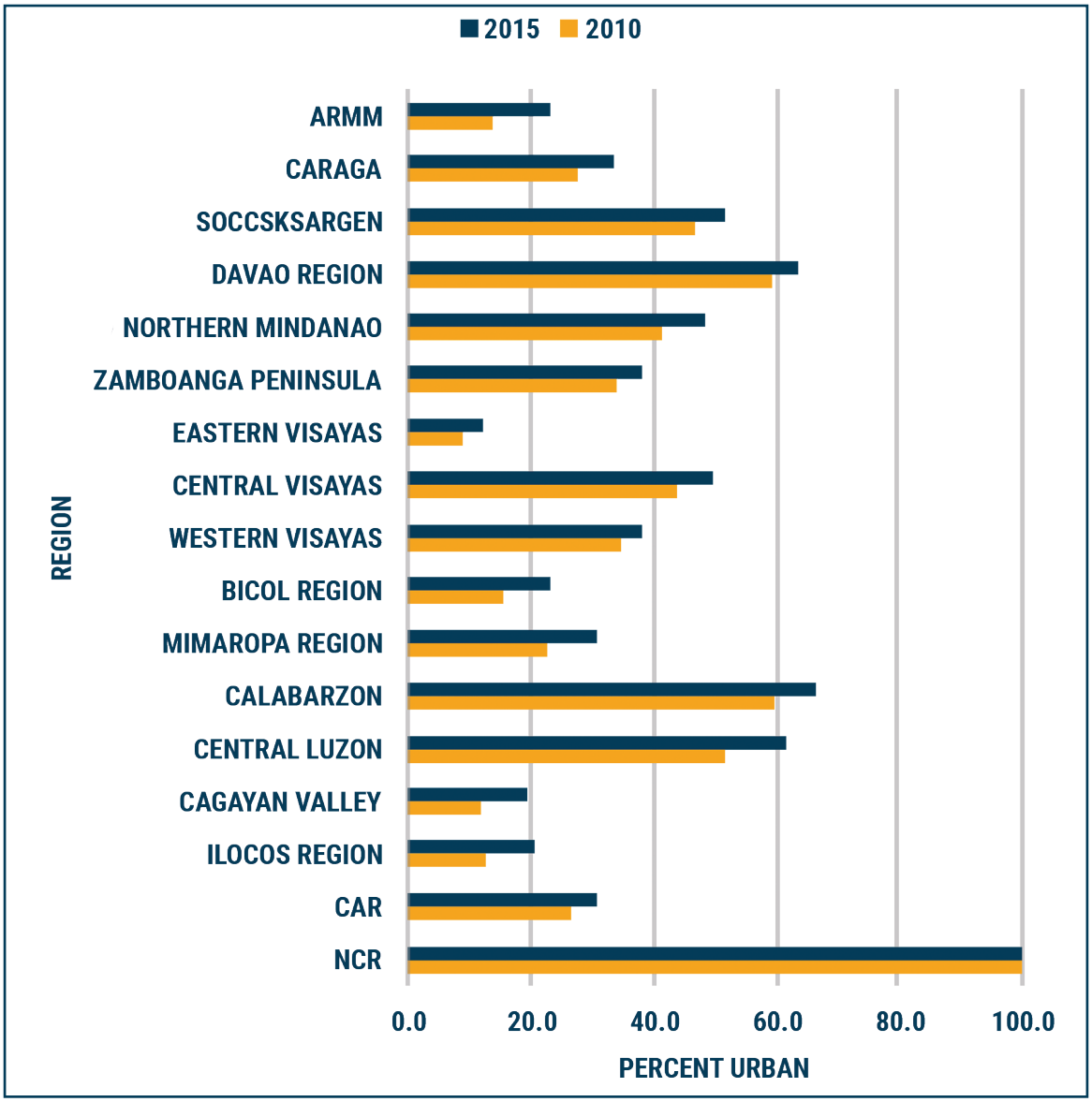


Figure 1.7_2. Level of Urbanization by Region in 2010 and 2015.
Sources: PSA (2010, 2015a)

Implication of Demographics to Science, Technology, and Innovation Development

Almost half of the population currently belongs to the age group 0-24 and will be a potential source of the talent pool for science, technology, and innovation (STI). Access to formal education and skills training will be a crucial factor in our ability to maintain a critical mass of highly trained and skilled workers, and those who will engage in STI activities especially in research and development and science and technology services. However, by 2045, only a third of the population will be in this age bracket. Measures should be instituted to manage this decrease.

The differences in the demographics of the regions will require targeted STI interventions calibrated to the characteristics and needs of the regions, especially for livelihood, education, and health services.

Abrigo et al. (2020) attribute the progress made by the Philippines in improving average incomes and consumption in the past 25 years to the country's favorable demography. This demographic dividend should be provided with opportunities to contribute to sustainable growth.