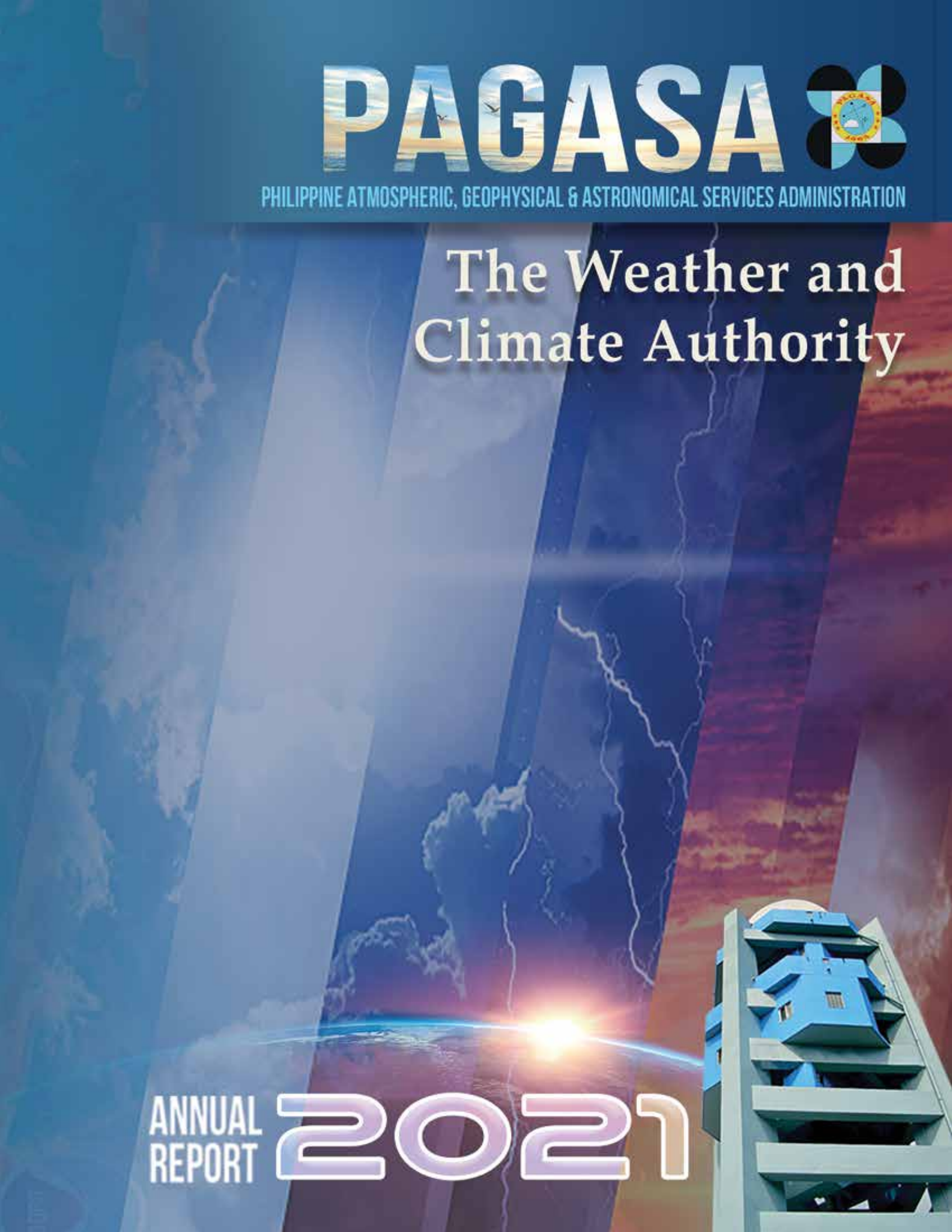
PAGASA

PHILIPPINE ATMOSPHERIC, GEOPHYSICAL & ASTRONOMICAL SERVICES ADMINISTRATION

The Weather and Climate Authority



ANNUAL REPORT 2021

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FOREWORD

Hope is in the heart of PAGASA.

The impact of the global pandemic on the health care systems and economies worldwide became a test of faith, unity, and solidarity for humanity. For PAGASA, no amount of challenge prevented the Agency from performing its function and achieving feats that manifest the sacrifice and dedication of the men and women of the organization. The ongoing pandemic highlighted the importance of quick, accurate, and effective public service and response from the government to address many pressing concerns affecting the nation. Considering the country is prone to disasters and hazards brought by inclement weather, the PAGASA, notwithstanding the pandemic, unceasingly provides the public with services through reliable and timely advisories, forecasts, warnings, and information on weather, climate, and flood.

PAGASA is committed to fulfilling its mission for the common good of the people. Each personnel perform at their best and shares in the sacrifice of public service. The pandemic will never dampen the morale of every individual whose hearts are filled with hope, looking forward to what the future will bring. The Agency will continuously strengthen and improve its capabilities and systems and will never stop because the country needs its "weather and climate authority."

Acronyms and abbreviations

ACIAR - Australian Center for International Agricultural Research
AOR - Area of Reference
API - Antecedent Precipitation Index
ASEANCOF - ASEAN Climate Outlook Forum
ASEP - Association of Structural Engineers of the Philippines
ASMC - ASEAN Specialised Meteorological Centre
ARTC - Annual Report on Philippine Tropical Cyclone
BSP - Bangko Sentral ng Pilipinas
CCC - Climate Change Commission
CDI - Climate Decomposition Index
CEDAW - Convention on the Elimination of all Forms of Discrimination Against Women
CMO - Chief Meteorological Officers
CReSS - cloud-resolving storm simulator
DA-ATI - Department of Agriculture – Agricultural Training Institute
DOST – Department Of Science and Technology
DSD - drop size distribution
ENSO - El Niño-Southern Oscillation
FFWS - Flood Forecasting and Warning System
FTE - forecast-track error
GAM - Global Astronomy Month
GFA - general flood advisories
GEFS - Global Ensemble Forecast System
GPC - Global Producing **Centres**
HFR - High Frequency Radars
HMD - Hydrometeorology Division
HPC - High-Performance Computing
IATF Inter-Agency Task Force
IAU - International Astronomical Union
IAU OAO - International Astronomical Union-Office of Astronomy Outreach
IDF- Intensity-Duration-Frequency
IEC - Information, Education, and Communication
IPCC - Intergovernmental Panel on Climate Change
IT - Information Technology
JICA - Japan International Cooperation Agency
LGU - Local Government Unit
LMS - Learning Management System
MCW - Magna Carta of Women
MJO - Madden Julian Oscillation
NAST - National Academy of Science and Technology
NAW - National Astronomy Week
NCAR - National Center for Atmospheric Research
NDRRMC - National Disaster Risk Reduction and Management Council
NMHS - National Meteorological Hydrological Services
NSCP - National Structural Code of the Philippines
NURTURING - Northern Luzon Unified RWS Tool and Universal RWS INfoGraphics
NWP - numerical weather prediction
OCD - Office of Civil Defense
PAGASA – Philippine Atmospheric Geophysical and Astronomical Services Administration
PAGASA-MIS PAGASA-Meteorological Information System
PAR – Philippine Area of Responsibility
P-CliFS - PAGASA Climate Forecast System
PDRF - Philippine Disaster Resilience Foundation
PhilCCA - Philippine Climate Change Assessment
PHIVOLCS - Philippine Institute of Volcanology and Seismology
PNP - Percent of Normal Precipitation
PPGD - Philippine Plan for Gender-Responsive Development
PRIME-HRM - Program to Institutionalize Meritocracy and Excellence in Human Resource Management
PSCP - Public Service Continuity Plan
PWEA - PAGASA Weathermen Employees Association
QC LGU - Quezon City Local Government Unit
QPE - Quantitative Precipitation Estimation
RCC-SEA - Regional Climate Monitoring System for Regional Climate Center Southeast Asia
RB - River Basins
R & D - Research and Development
RIDF - Rainfall Intensity Duration Frequency
SPI - Standard Precipitation Index
SSAS - Space Sciences and Astronomy Section
SWERVE - Severe Wind Estimation of Risk using Vulnerability and Exposure
TC – Tropical Cyclone
TCR - tropical cyclone rainfall
ToT - Training of Trainers
WMO - World Meteorological Organization
WMO-RCC - World Meteorological Organization-Regional Climate Center
WRF - Weather Research Forecasting
WSW - World Space Week

CITIZEN'S CHARTER

I. Mandate/Mission/Vision/Values/Functions

1. Mandate

Provide adequate, up-to-date data, and timely information on atmospheric, astronomical and other weather-related phenomena using the advances achieved in the realm of science to help government and the people prepare for calamities caused by typhoons, floods, landslides, storm surges, extreme climatic events, and climate change, among others, to afford greater protection to the people.
Provide science and technology-based assessments pertinent to decision-making in relevant areas of concern such as in disaster risk reduction, climate change adaptation and integrated water resources management, as well as capacity building.
Ensure that the country fulfills its commitments to international meteorological and climate change agreements.

2. Mission

We deliver reliable and relevant weather-related information, products and services to develop communities resilient to typhoons, floods, rain-induced landslides, storm surges, extreme climatic events, climate change and astronomical hazards.

3. Vision

The Center of Excellence for weather-related information and services helping develop a disaster and climate-resilient nation

4. Values

Spirituality	Innovation
Patriotism	Commitment
Integrity	Excellence

5. Functions

- Maintains a nationwide network pertaining to observation and forecasting of weather and flood and other conditions affecting national safety, welfare and economy;
- Undertake activities relative to observation, collection, assessment and processing of atmospheric and allied data for the benefit of agriculture, commerce and industry;
- Engage in studies of geophysical and astronomical phenomena essential to the safety and welfare of the people;
- Undertake researches on the structure, development and motion of typhoons and formulate measures for their moderation; and
- Maintain effective linkages with scientific organizations here and abroad and promote exchange of scientific information and cooperation among personnel engaged in atmospheric, geophysical, astronomical and space studies.

II. Performance Pledge and Feedback and Redress Mechanisms:

1. Performance Pledge

We, the professional and dedicated officials and employees of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), commit to:
Provide service promptly, efficiently and with utmost courtesy by authorized personnel with proper identification from Mondays to Fridays. 8:00 AM to 5:00 PM, without noon break; for Administration support and other similar services and 24/7 whole year round for forecasting services,
Adhere to strict compliance with service standards, with written explanation for any delays in the services we offered;
Give timely response to complaint about our services the soonest and take corrective measures accordingly;
Assure that every client's comments, suggestions and needs are given importance.
Satisfy our customers' needs by acting on their feedback and informing them of any developments first hand;
Allow the public access to information on our programs, activities and services through our website (http://bagong.pagasa.dost.gov.ph) or through SMS, and our trunk line (02) 8284-0800, follow us on twitter @dost-pagasa, https://twitter.com/dost_pagasa. Like us on facebook DOST_pagasa https://www.pagasa.facebook.com/ PAGASA.DOST.GOV.PH
Above all, we pledge to serve everyone with utmost honesty, dedication, respect and understanding, for we believe that in so doing, we are also serving and honoring our country and God Almighty.

2. Feedback and Redress Mechanisms

Please let us know how we have served you by:

a. Accomplish our Feedback Form available at the lobby and put it in the drop box located at the front desk or give the form to the division concerned.
b. Sending your feedback through our website (http://bagong.pagasa.dost.gov.ph) or call our trunk line (02) 8284-0800, follow us on twitter @ dost-pagasa, https://twitter.com/dost_pagasa. Like us on facebook DOST_pagasa https://www.facebook.com/PAGASA.DOST.GOV.PH

Your written/verbal complaints shall immediately be attended to. Thank you for helping us improve our service.

**For full details of the PAGASA's Citizens Charter, kindly visit our official website at www.bagong.pagasa.dost.gov.ph*

Message

BY THE DOST SECRETARY

The prevalent occurrence of natural disasters especially typhoons, accompanied by hazards like extreme winds, flooding, storm surge, and lightning, has always been a challenge to the nation. Thus, science-based assessments for accurate and timely information on atmospheric and other weather-related events are critical for on-the-ground decision-making to minimize disaster risks.

The Department of Science and Technology (DOST) commends how PAGASA contributed to safeguarding human lives during the presence of threats brought about by climate change.

As the government embarks on a dynamic response in providing services, I admire PAGASA's initiatives on the digitization of some technical and support services to respond quickly, considering the challenges we continue to face because of the pandemic.

Since DOST championed the importance of research and development programs and projects, I am delighted that PAGASA has exerted efforts in its research with eight published papers in 2021. R&Ds are drivers of improvement and advancement of operational competence in providing services. Furthermore, these baseline efforts have resulted in a 45.6 km forecast track error at a 24-hour lead time in 2021.

Indeed, a public service conveyed in its most truthful and concise manner demonstrates professionalism and credibility. PAGASA's workforce synergy once again resulted in exemplary performance. Thus, I extend my warmest commendation to the men and women of PAGASA for being recognized as one of the Bangko Sentral ng Pilipinas (BSP) outstanding stakeholders.

The DOST will always remain supportive of the future endeavors of PAGASA. Mabuhay!

FORTUNATO T. DELA PEÑA
Secretary

Message

BY THE DOST UNDERSECRETARY

DOST-PAGASA successfully fulfilled its functions and delivered its services despite the continuing difficulties brought by the covid-19 pandemic and the challenges due to the devastation caused by the Typhoon Odette last December 2021. The Agency performed at its best achieving commendable forecast with 45.6 km forecast track error for tropical cyclone in 2021 which is 5.6 km lower lower than 2020. This is a testament to the organization's unwavering resolve to provide reliable services.

Mindful that weather, climate, and flood information are critically important in increasing awareness and capability of the people to react against hazards brought by inclement weather, DOST-PAGASA continuously improved its capability with the establishment of three additional X-Band radars, seven high-frequency radars, two field weather stations, and two local instrumental centers. DOST-PAGASA is tirelessly seeking ways to fulfill its commitment to provide reliable and timely forecasts and warnings.

The unwavering hard work, dedication and collaborations od DOST-PAGASA were recognized by stakeholders with the 2021 Outstanding Bangko Sentral ng Pilipinas Stakeholders Award and the Plaque of Recognition from the Career Executive Service Board. In addition, the increasing number of DOST-PAGASA followers and viewers on popular social media platforms proves the importance of forecast and warnings to the people towards disaster preparedness.

Congratulations DOST-PAGASA for the job very well done. Keep in mind that these recognitions and feats also signify a challenge for the Agency to continuously develop strategies and programs that sustain and strengthen public and stakeholders trust and confidence. Keep on embracing and resolve to do more and aim for the common good and safety of the people through reliable and prompt fulfillment of your mandate. I am grateful and proud of your contributions for making the country and its people disaster resiliency stronger than ever.

Kudos to the men and women of DOST-PAGASA!

Dr. Renato U. Solidum, Jr.
Undersecretary for S&T Services

Message

BY THE DOST ADMINISTRATOR

"Therefore, my beloved brethren, be ye steadfast, unmovable, always abounding in the work of the Lord, forasmuch as ye know that your labor is not in vain in the Lord."
1 Corinthians 15:58

As public servants, it is our duty to deliver our services with excellence and integrity even in times of crisis. In PAGASA, we are tasked to provide science-based, accurate, and timely information relevant to weather and climate disaster management and response to help save lives and resources.

In 2021, 15 typhoons entered the Philippine Area of Responsibility (PAR), of which the Tropical Cyclone (TC) Odette was the strongest. It has devastated several areas in the country including Siargao Island, Dinagat Islands, Surigao Del Norte, Southern Leyte, Bohol, Cebu, Negros Provinces, other parts of Visayas and Mindanao, and the Central and Southern Islands of Palawan. PAGASA tracked and monitored these typhoons, coordinated with the NDRRMC, continuously issued weather bulletins and conducted press releases on all available platforms.

Over the years, our forecasts have significantly improved. The margin of error against the actual track of a particular Tropical Cyclone has decreased. In 2020, the forecast track error was recorded at 51.2km and it dropped to 45.6km in 2021.

We continuously strive to improve our services by enhancing our physical infrastructures and capacitating our workforce. In 2021, we have established three more X-Band Radars in Davao, Cotabato and Isabela; seven more High Frequency Radars in coastal areas of Cebu specifically in Daan Bantayan, Catmon, Danao, Poro, and Madridejos and also in coastal areas of Placer, Masbate and Cadiz, Negros; two additional field weather stations in Laguindingan and Isabela, and two local instrumentation centers in Tuguegarao and in Davao. In order to translate data derived from these systems into action, the Agency committed to capacitating engagements. Some of these are trainings on Impact-Based Forecasting, Quality Control Techniques and Data Assimilation for Numerical Weather Prediction, Flood and Hydrological Forecasts and Warnings, Satellite Data and Products, Application of Radar in nowcasting High Impact Weather and Short-Term Climate Monitoring and Prediction in Disaster Prevention and Mitigation.

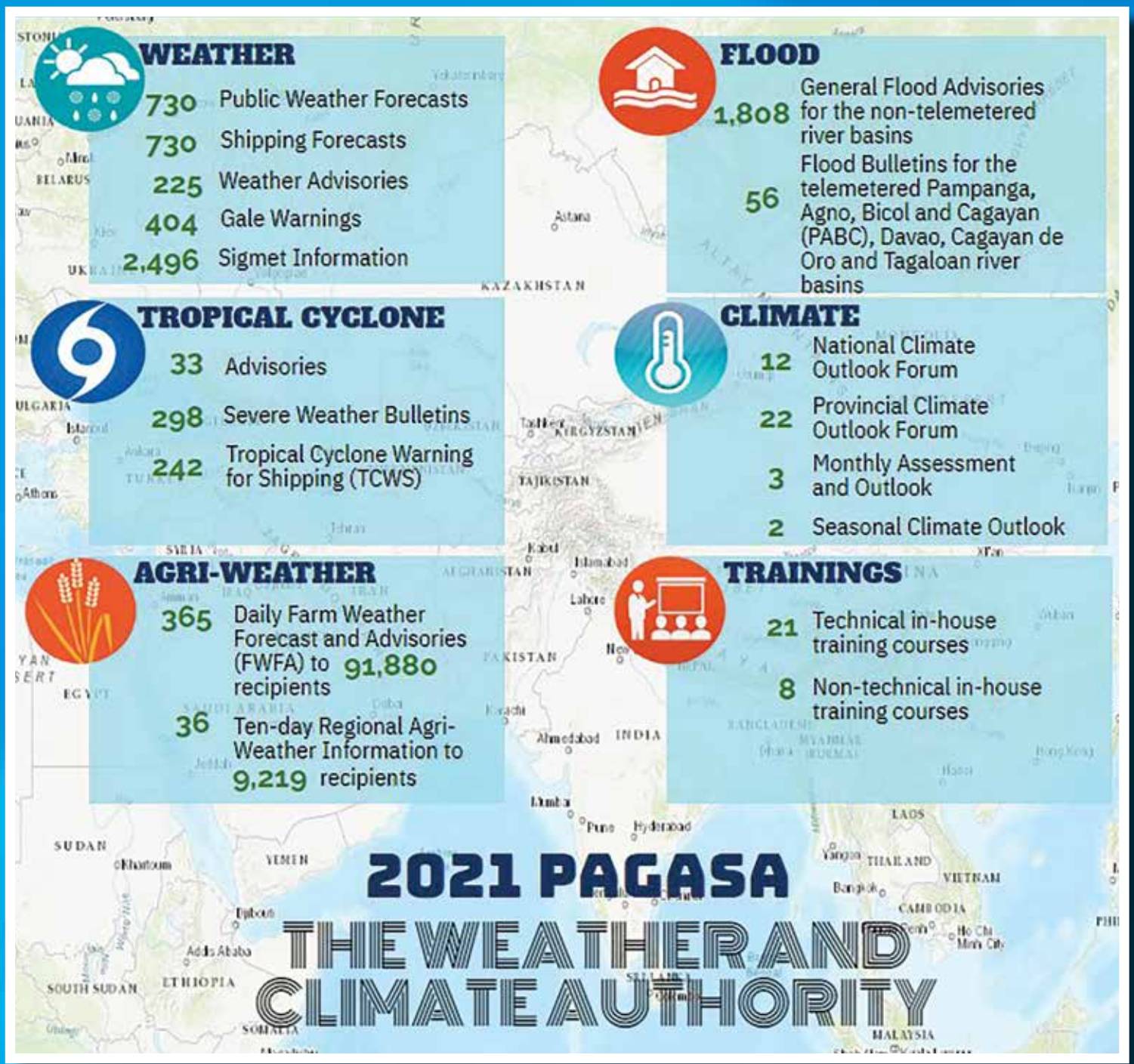
We are pleased with the growing number of supports we've been receiving on our social media platforms. We would like to believe that the increased number of our followers and subscribers signify the increasing trust and confidence of the public to the agency. We are thankful to Bangko Sentral ng Pilipinas (BSP) for giving us their token of appreciation as one of the 2021 Outstanding BSP Stakeholders and to the Career Executive Service Board for recognizing our continued support, exceptional commitment and invaluable contribution in updating the CES database.

Our success in 2021 would not be possible without the cooperation of the men and women of PAGASA. We must continue to work hand-in-hand to solidify our role and our mandate for the benefit of the Filipino people.

Thank you and God bless!

Dr. Vicente B. Malano
Administrator

A Quick Look on PAGASA's Accomplishment for 2021



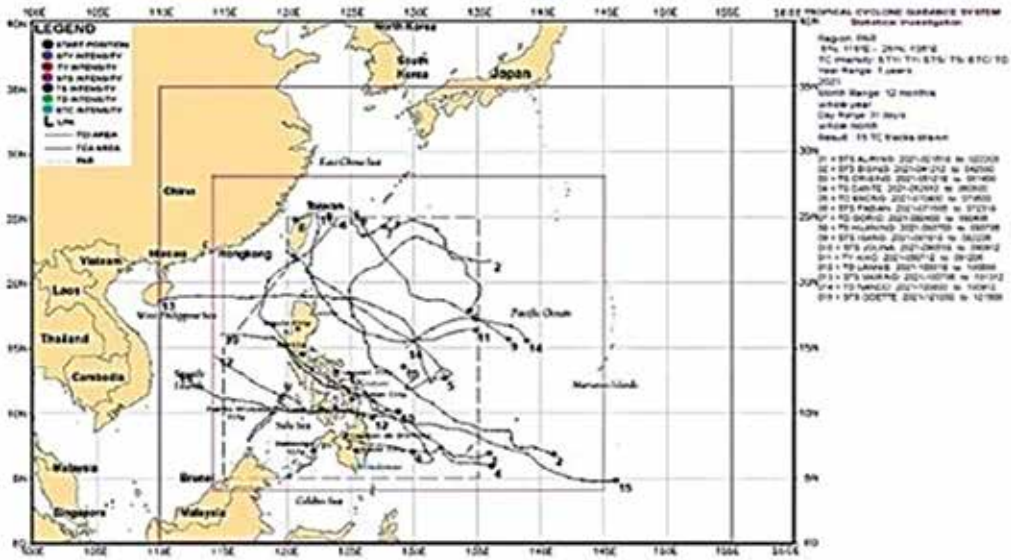
Weather and Climate Monitoring Forecasting And Warning Program

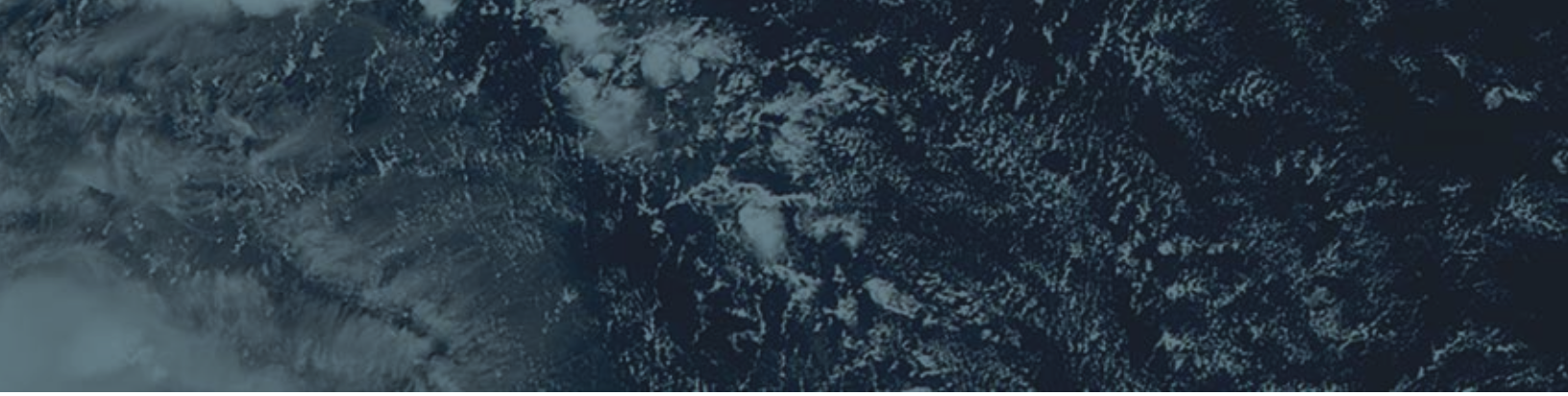
Significantly Improved Forecast Track Error

Atmospheric conditions are unstable, such that weather, by its nature, is complex and unpredictable. It makes predictions and forecasts of the exact track of a particular Tropical Cyclone (TC) prone to errors. Considering an average of 19-22 TCs that enter the Philippine Area of Responsibility (PAR) every year, with about 8-9 landfalls, an improved forecast-track error (FTE) is a milestone for the Agency.

In 2021, PAGASA recorded an average of 45.6 kilometers FTE for tropical cyclones (TCs) against less than or equal to 100 kilometers target. It demonstrates efficacy as it outperformed the FTE average recorded in the previous year with 51.2 kilometers at a 24-hour lead time.

Annual Mean 24-hour Forecast Track Error

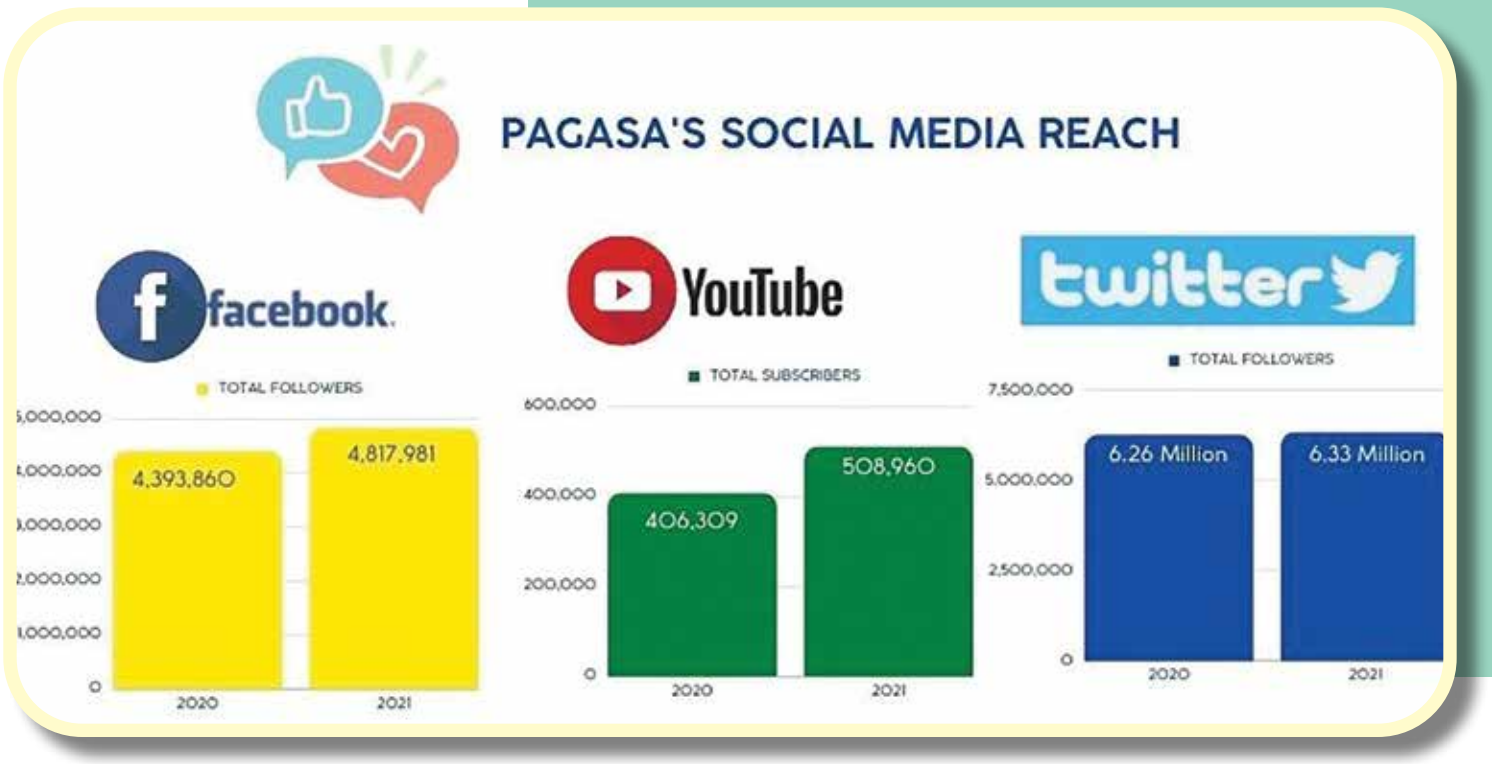




Our Nationwide Reach through Social Media

As a warning agency, PAGASA communicates and reaches out to people and groups of different classes, especially those directly affected by impending inclement weather. With the widespread use and popularity of various online social media platforms, serving as an accessible and convenient source and vehicle of information, the Agency made efforts to conform with the said developments.

Since PAGASA created its social media accounts, the number of followers and subscribers ballooned as 2021 ended. The Agency's Facebook and Twitter accounts had 4.8 million and 6.33 million followers, respectively. Its YouTube account already had 508,960 subscribers, and a TikTok account was created in June 2021, thereby maximizing the app's popularity in bringing and providing information to people.



Chasing Odette: Doppler Weather Radar Observation during "Typhoon Odette" (RAI)

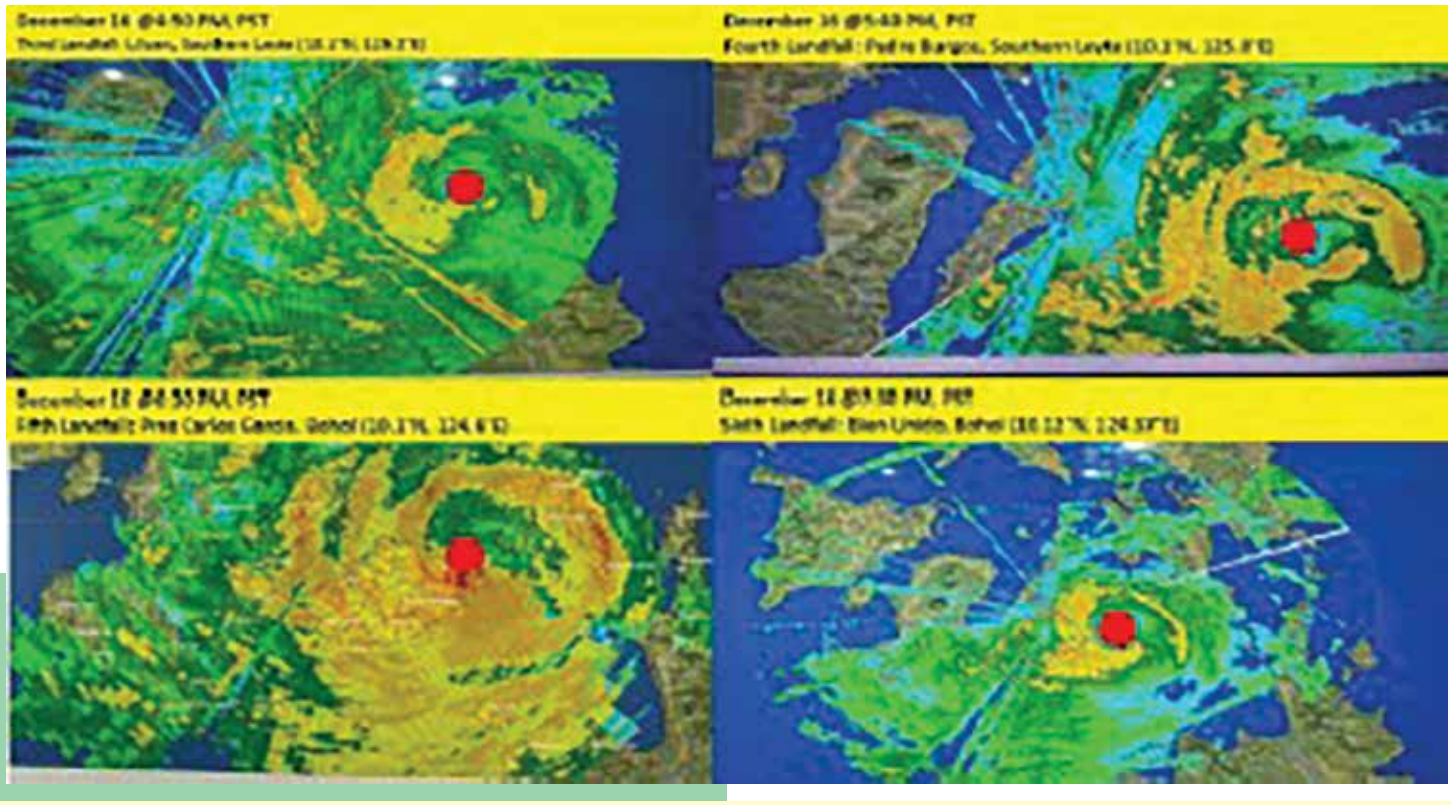
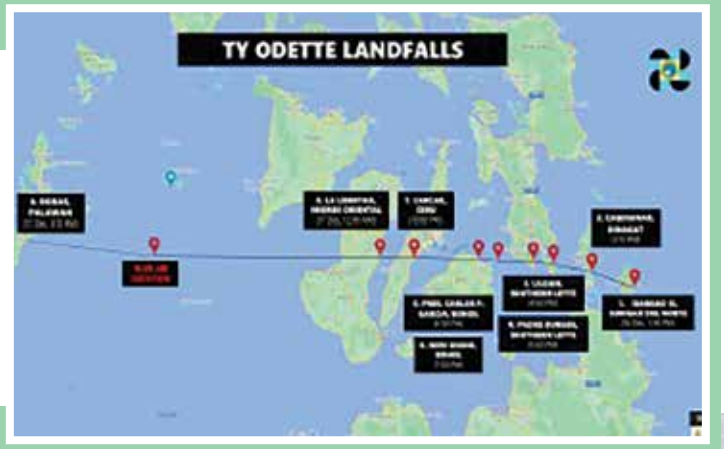


Figure 1. Doppler Radar Reflectivity (dbZ) product of Mactan Doppler Radar which captured the eye of Typhoon "Odette" marked as solid red circle on December 16 to 17, 2022.

Typhoon "Odette" (TY Odette) is the 15th tropical cyclone that entered the PAR in 2021, devastating the country, especially the Visayas and the Northern Mindanao last 14 to 18 December 2021.

"Radar Fix" is tracking the eye of a typhoon using the most dependable and state-of-the-art equipment, the Doppler Weather Radar. The three doppler weather radars utilized during the TY Odette event were radars in Guiuan, Bohol, and Cebu.



PAGASA issued the third up to the eighth landfall of the said event using the radar fix. The third and fourth landfalls were in Liloan and Padre Burgos, respectively. The fifth and sixth landfalls were in Bohol, specifically in Pres. Carlos Garcia and Bien Unido. It was in Carcar, Cebu where TY Odette made its seventh landfall, and lastly, in La Libertad, Negros Oriental made the eighth landfall dated 17 December 2021.

Forecasting the movement of a particular TC becomes easier when radars capture the center of a TC. Thereby, determining the probable time and ensuing landfall areas encompassing as small as a municipality is possible.
This vital information was cascaded through various channels to reach the stakeholders such as the DRRM and LGUs for them to undertake actions and policies that will reduce impact of disasters to the public

Nurturing System of the Northern Luzon PRSD

The Rainfall Warning System (RWS) is an end-to-end decision support tool that provides critical information to decision-makers, stakeholders, and communities to save lives, livelihoods, and property from heavy rainfall events causing flooding.

The Northern Luzon PAGASA Regional Services Division (NL-PRSD) RWS operation comprises three radar stations: Benguet Radar, Aparri Radar, and Baler Radar. Each radar can detect an occurring weather system and has its respective Area of Reference (AOR), covering and monitoring the 16 provinces under the NL-PRSD's jurisdiction. Further, it leads to the provision of rainfall, thunderstorm, and color-coded heavy rainfall advisories.

The NURTURING (Northern Luzon Unified RWS Tool and Universal RWS INfoGraphics) System is a couple-system developed by the PAGASA Aparri Station in coordination with the local weather forecasting and nowcasting unit aiding the nowcasting service of NL-PRSD.

The Unified RWS tool is the primary automation tool warning formulation used by NL-RWS teams (Aparri, Benguet, and Baler) to organize and formulate warnings in a shorter period adhering to standard formats and procedures simultaneously. Meanwhile, the Universal RWS InfoGraphics is a tool designed to create unique descriptive visualizations of the RWS for the 16 provinces under the NL-PRSD.

Completed Projects:

- **Enhancement of Tropical Cyclone Warning System**

  Access to the official information on TCs in the PAR, particularly the postseason reanalysis by the public, disaster managers, researchers, policymakers, and other PAGASA stakeholders, is essential.

  The main output of this project is the provision of the Annual Report on Philippine Tropical Cyclone (ARTC), print (ISSN 2672-3190), and digital (ISSN 2799-0575) versions. These serve as a viable method and channel for information dissemination and accelerating the development and provision of technical publications.

  ARTC is a technical report published annually. It serves as the official source of information for Philippine TCs during the 2019 season; unless superseded by another reanalysis report by the agency. It also provides a compendium of official information about the interest TC season, the TCs within the PAR for the season, and the forecasts and warnings issued by the agency with each TC event.

- **Advancing Climate Monitoring and Prediction System**

  The system facilitates the performance of mandatory climate diagnostics and issuance of climate watch for Southeast Asia (Res. 5 of WMO to establish 2 WMO RCC-Networks in RA V, one network for the SEA sub-region and one network for the Southwest Pacific sub-region). It enables efficient servicing of the needs of National Meteorological Hydrological Services (NMHS) in Southeast Asia.

  The project has two subsystems. The first is the Development of Regional Climate Monitoring System for Regional Climate Centre Southeast Asia (RCC-SEA) Network, and the other is the Development of PAGASA Climate Forecast System (P-CliFS).

  The first subsystem improved the SEA-RCC web portal, shifted to homogenized color schemes for maps and graphs consistent with other RCC-network nodes, and created additional datasets from Global Producing Centers. Also, the said system enables participation in ASEANCOF and ASEAN consensus forecast and RCC training on the web portal.

  The second subsystem conducted 12 provincial fora. Its goal and intention are to make participants primarily understand weather, flood, and climate and provide updates on its status and identify the impacts and consequences. The forum highlighted the need for precise weather and flood mitigation strategies and climate risk management, considering PAGASA's current forecasting and early warning capabilities. Also, it aims at communicating climate information and forecasts to various stakeholders and decision-makers in building the capacity of professionals at the local level; to use the information

Improvement of SEA-RCC web portal

in decision-making related to agriculture, water resource management, public health, and disaster risk reduction and management.

- **Operationalization of Agrometeorological Information System**

  This project aimed to operationalize the Farm Weather Forecast Information System, making it accessible to farmers by linking it to communication media and other specialized information networks. The target was to achieve a maximum reach (multiplier effect) for the information, expanding across smaller-scale communities or at the barangay level. The conduct of an intensive Information, Education, and Communication (IEC) campaign program was considered a practicable tool to achieve the intended result.

  A webinar was held on 26 March and 01 June 2021 on the PAGASA Agrometeorological Products and Services for the Department of Agriculture – Agricultural Training Institute (DA-ATI). These helped participants learn the application of the PAGASA weather information in farming activities and decision-making regarding weather and climate risk management.

  Part of the project is the Training of Trainers (ToT) on KlimAgrikultura. It is a training program led by the Department of Agriculture – Agricultural Training Institute (DA-ATI) and developed in partnership with the Australian Centre for International Agricultural Research (ACIAR) partners, where PAGASA is part of the project in the development of the module. Several ToT on KlimAgrikultura were held in 2021: on 15-19 March and 21-25 June. The activity intended to train the PAGASA Chief Meteorological Officers (CMO) of the different PAGASA regional field centers and the agricultural extension workers for them to be able to apply and teach the KlimAgrikultura modules.

FLOOD MONITORING, FORECASTING *and* WARNING PROGRAM

Mitigating Disastrous Effects of Floods through Hydrometeorological Products

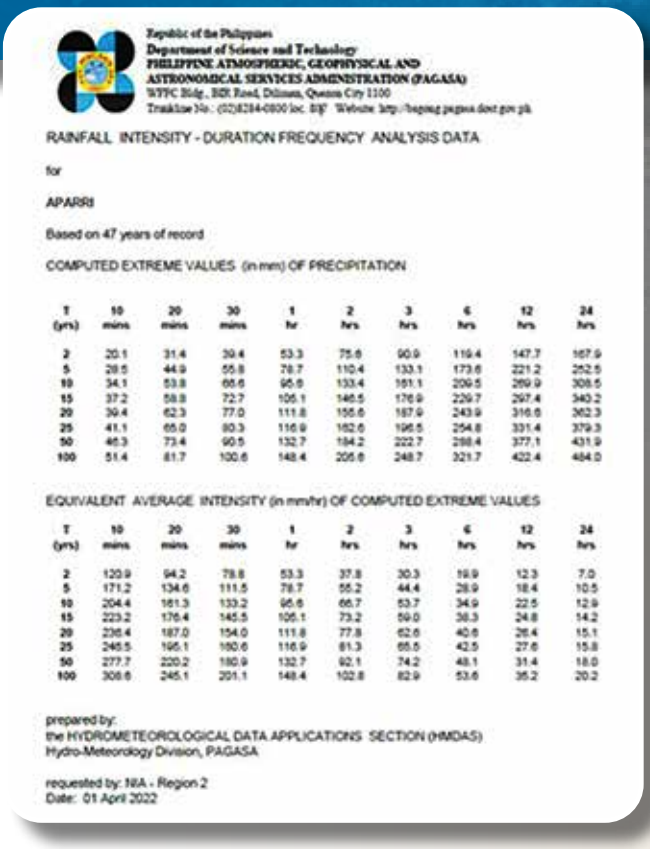
The occurrence of inundation, or in simple terms called flooding, its frequency, is noticeable nowadays and increasing in both urban and rural areas. Extreme weather and climate events, together with detrimental changes in the environment's landscape, amplify the negative impacts of floods in the country.

The Hydrometeorology Division (HMD) of PAGASA monitors and provides information on the hydrometeorological status and condition in the country; information that is critical in preventing and mitigating the disastrous impacts and effects of flooding; and indispensable in the development and management of water-related infrastructures nationwide. HMD issues products such as flood bulletins, general flood advisories, and Rainfall Intensity Duration Frequency (RIDF).

Flood bulletins provide more detailed flood information against general flood advisories (GFA). Through the continuous establishment of Flood Forecasting and Warning Systems (FFWS) along major and principal river basins across the country, installing hydrometeorological sensors and monitoring equipment, formulation and development of accurate and timely flood bulletins are more feasible.

RIDF products are specialized outputs from analyzed rainfall data. They are usually presented as curves (known as Intensity-Duration-Frequency (IDF) curves) or in numerical values. Generally, RIDF is useful in hydrologic design applications, benefiting stakeholders such as engineers, hydrologists, urban planners, and the like.
Other typical applications are assessing rainfall events, classifying climatic regimes, deriving design storms, assisting in designing urban drainage systems, and others.

In 2021, a total of 1,808 GFAs were issued. There were 41 flood bulletins from the Pampanga, Agno, Bicol and Cagayan River Basins (RBs), 3 from Davao RB, 7 from Cagayan de Oro RB and 5 from Tagoloan RB. Furthermore, a total of 209 RIDF products were provided to clients generating the amount of 83,600 pesos.



Republic of the Philippines
Department of Science and Technology
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RAINFALL INTENSITY - DURATION FREQUENCY ANALYSIS DATA

for

APARRI

Based on 47 years of record

COMPUTED EXTREME VALUES (in mm) OF PRECIPITATION

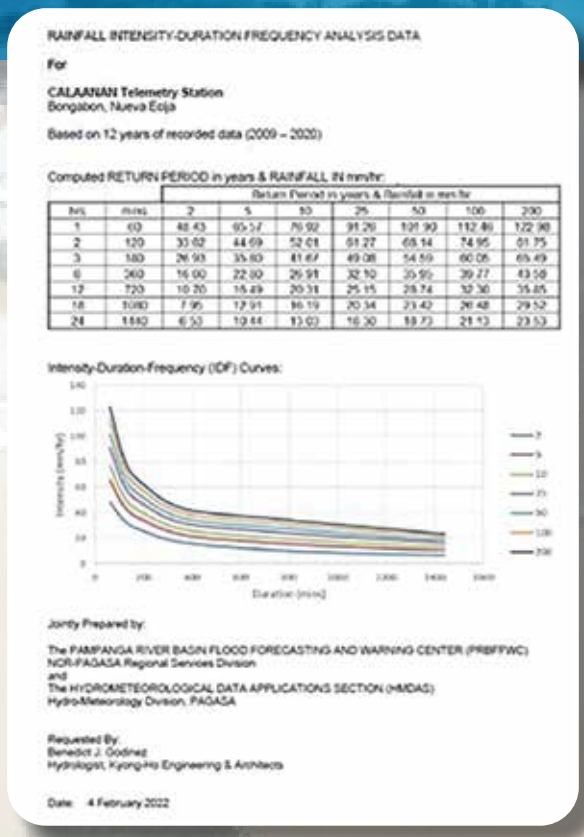
T (yrs)	10 mins	20 mins	30 mins	1 hr	2 hrs	3 hrs	6 hrs	12 hrs	24 hrs
2	20.1	31.4	39.4	53.3	75.6	90.9	119.4	147.7	167.9
5	28.5	44.9	55.8	78.7	110.4	133.1	173.6	221.2	252.5
10	34.1	53.8	66.6	95.6	133.4	161.1	209.5	269.9	308.5
15	37.2	58.8	72.7	105.1	146.5	176.9	229.7	297.4	340.2
20	39.4	62.3	77.0	111.8	155.6	187.9	243.9	316.6	362.3
25	41.1	65.0	80.3	116.9	162.6	196.5	254.8	331.4	379.3
50	46.3	73.4	90.5	132.7	184.2	222.7	288.4	377.1	431.9
100	51.4	81.7	100.6	148.4	205.8	248.7	321.7	422.4	484.0

EQUIVALENT AVERAGE INTENSITY (in mm/hr) OF COMPUTED EXTREME VALUES

T (yrs)	10 mins	20 mins	30 mins	1 hr	2 hrs	3 hrs	6 hrs	12 hrs	24 hrs
2	120.9	94.2	78.8	53.3	37.8	30.3	19.9	12.3	7.0
5	171.2	134.6	111.5	78.7	55.2	44.4	28.9	18.4	10.5
10	204.4	161.3	133.2	95.6	66.7	53.7	34.9	22.5	12.9
15	223.2	176.4	145.5	105.1	73.2	59.0	38.3	24.8	14.2
20	236.4	187.0	154.0	111.8	77.8	62.6	40.6	26.4	15.1
25	246.5	195.1	160.6	116.9	81.3	65.5	42.5	27.6	15.8
50	277.7	220.2	180.9	132.7	92.1	74.2	48.1	31.4	18.0
100	308.6	245.1	201.1	148.4	102.8	82.9	53.6	35.2	20.2

prepared by:
the HYDROMETEOROLOGICAL DATA APPLICATIONS SECTION (HMDAS)
Hydro-Meteorology Division, PAGASA

requested by: NIA - Region 2
Date: 01 April 2022



RAINFALL INTENSITY-DURATION FREQUENCY ANALYSIS DATA

For

CALAANAN Telemetry Station
Bongabon, Nueva Ecija

Based on 12 years of recorded data (2009 – 2020)

Computed RETURN PERIOD in years & RAINFALL IN mm/hr:

hr(s)	mins	Return Period in years & Rainfall in mm for 2	5	10	25	50	100	200
1	60	48.43	60.57	70.92	91.26	101.90	112.86	122.98
2	120	33.02	44.69	52.08	61.27	68.14	74.95	81.75
3	180	26.93	35.80	41.67	49.08	54.59	60.05	65.49
6	360	16.00	22.80	26.91	32.10	35.90	39.77	43.58
12	720	10.20	14.49	20.31	25.15	28.74	32.30	35.85
18	1080	7.96	12.91	16.19	20.34	23.42	26.48	29.52
24	1440	6.50	10.44	13.03	16.30	18.73	21.13	23.53

Intensity-Duration-Frequency (IDF) Curves:

Jointly Prepared by:

The PAMPANGA RIVER BASIN FLOOD FORECASTING AND WARNING CENTER (PRBFFWC)
NOR-PAGASA Regional Services Division
and
The HYDROMETEOROLOGICAL DATA APPLICATIONS SECTION (HMDAS)
Hydro-Meteorology Division, PAGASA

Requested By:
Benedict J. Godinez
Hydrologist, Kyong-Ho Engineering & Architects

Date: 4 February 2022

New Project

- **Establishment of an Integrated Hydrological Data Management System (HDMS) for Flood Forecasters**

  PAGASA continuously establishes flood forecasting and warning systems in various river basins nationwide. Consequently, this entails an increase in volume and number of hydrologic data from monitoring equipment and facilities; thus, a robust Information Technology (IT) infrastructure is necessary for proper managing, processing, and safeguarding said data that is vital in hydrologic analysis.

  The Integrated HDMS includes the procurement of Time Series software that enables storing, editing, and retrieving hydrometeorological data with ease and utmost efficiency. The system also consists of visualization software to improve the dissemination of hydrologic information through various communication mediums to the concerned public, disaster risk reduction officers and planners, and other beneficiaries.

  HDMS will provide hydrologists with the tools to establish reliable and quality-controlled hydrologic data for flood bulletin production. Hence, bulletins inform and warn the public about the flood, its hazards and negative impacts, and benefit areas concerning structural designs, water resources development, land-use planning, etc.

ASTRONOMICAL OBSERVATION AND MONITORING PROGRAM

28th National Astronomy Week

Presidential Decree No. 130 mandates PAGASA to spearhead the annual celebration of the National Astronomy Week (NAW), observed every 3rd week of February.

For 2021, PAGASA celebrated the 28th NAW on 14-20 February with the theme Innovations and Development of Philippine Astronomy Under the New Normal. Due to the covid-19 pandemic and the strict implementation of health regulations, protocols, and standards, PAGASA recalibrated its usual activities concerning NAW.

Among the activities conducted in celebration of NAW were: an online planetarium show, astrophotography, a contest on Mobile Phone Moon Silhouette Photography, and lectures and seminars related to Astronomy posted and made available on the official Facebook page of PAGASA. Through these activities, the public appreciates the significance of Astronomy in their daily lives, marveling at the knowledge it brings to the minds of every individual.

Global Astronomy Month

Global Astronomy Month (GAM) is the world's largest annual event occurring for the entire month of April to celebrate Astronomy. GAM is a flagship event by Astronomers Without Borders to encourage everyone to go outside and enjoy the beauty of the sky.

For GAM 2021, PAGASA posted the "Ask an Astronomer" Special Podcast Episode to share astronomical information, which gathered 3,548 views from the PAGASA official Facebook page.

Meet the International Astronomical Union (IAU) Astronomer

The program "Meet the IAU Astronomer" is offered for free by the International Astronomical Union - Office of Astronomy Outreach (IAU-OAO). This program aims to connect teachers, informal educators, and amateur astronomer groups with IAU-Member astronomers through a virtual platform. The requesting party may choose from a wide selection of astronomy-related topics, and IAU-OAO will pick an IAU member based on the indicated preferences.

The activity was held online on 09 July 2021 and 24 September 2021 via Google Meet. The two IAU astronomers who graced the said activity were Dr. Diana Besliu-ionescu of Romania, who spoke about the sun and its impact on Earth, and Dr. Salvador Ribas of Spain, who tackled Light pollution and its Multidisciplinary Effects. Their discussion on the said topics aimed to address and manage the rapid sprawl of light pollution regarding its effect on astronomical observations and the quality of data derived from it and to have an awareness of the impact of the sun's activity on our everyday lives. A total of 208 professionals, students, teachers, and PAGASA personnel participated in the event.

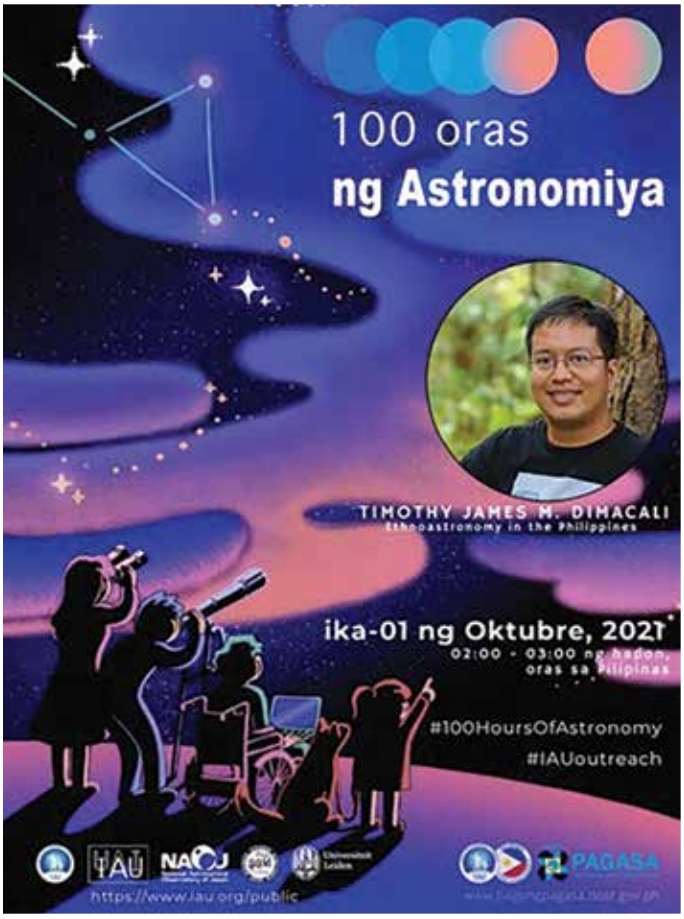
Webinar on Space Weather and Its Effects on Earth

Understanding the activity and changes in the Sun is important as it plays a vital role in maintaining the balance in Earth's weather and climate. The observed changes in the solar activity are known to significantly affect space weather, as it can consequently affect the Earth by influencing the performance reliability of space-borne and ground-0-based technological systems and endangering human life and health. Just like the ground weather, forecasting space weather is also possible through thorough analysis of the current condition of the Sun and comparing it with the past circumstances and numerical models.

On 15 July 2021, a webinar on "Space Weather and its Effect on Earth" was conducted and participated by 43 PAGASA personnel which aimed to strengthen the human resource capability of the Space Sciences and Astronomy Section (SSAS) of the Agency.

The main objective of the activity is to enhance the knowledge of SSAS personnel in Astronomy, particularly in current trends in space weather and the direct and indirect impact on Earth. Also, it aimed to familiarize the personnel with possible research topics that apply the sunspot observation data archive obtained at the PAGASA Astronomical Observatory and improve the production of space weather forecasts using the available data resources.

Webinar on Ethnoastronomy in the Philippines in Celebration of 100 Hours of Astronomy



Ethnoastronomy, according to wordnik.com, is the study of knowledge, interpretations, and practices of contemporary cultures regarding celestial objects or phenomena.

Motivating the astronomy enthusiasts to pursue learnings in astronomy, especially in the field of Ethnoastronomy, and understanding the rich astronomy culture in the Philippines among ethnic groups is the main aim of the webinar on "Ethnoastronomy in the Philippines" in celebration of 100 hours of Astronomy.

The said webinar was conducted on 01 October 2021 via Google Meet and was participated by 181 professionals, teachers, and students.

Aside from the main objectives of the activity, it also intends to share Filipino culture with the international audience.

World Space Week

The World Space Week (WSW) is a week-long international space celebration of Science and Technology, signifying its contribution to the continuing improvement of the human condition. It is regarded as the largest annual space event celebrated globally, every 4-10 October, and in 2021, it was themed Women in Space.

Over the years, WSW has been celebrated through various activities ranging from space education to outreach events. However, due to the pandemic, events and activities were conducted online, aiming for a broader audience reach.

PAGASA participated in the WSW and prepared several activities. The Online Astronomy Seminar for Science Teachers, consisting of lectures and hands-on sessions, was attended by 92 teachers. Other activities were The AstroQuiz with 36 participants, virtual telescope viewing, and a webinar entitled Roles and Contributions of Filipinas in Space with resource speakers: Engr. Josephine Santiago-Bond, Chief of the Institutional Division Safety and Mission Assurance of NASA's Kennedy Space Center; Dr. Gay Jane Perez, Deputy Director General of the Philippine Space Agency; and Ms. Stephanie Tumampos-Copernicus, a Master in Digital Earth graduate and a Ph.D. student at the Technical University of Munich in Germany. A total of 156 participants joined the webinar.

The objectives of the said activities were: to introduce astronomy learning tools/software that is applicable in teaching astronomy; to introduce PAGASA astronomical services and products; to showcase the facilities of PAGASA Astronomical Observatory, particularly the 45cm telescope thru live stream viewing of visible astronomical objects; and to provide inspiration through the experiences and contributions of the renowned Filipinas working in the space sector in the Philippines and overseas.

Completed Research Projects:

- **The Effects of Three Solar Cycle Phases on the Intensity and Frequency of Tropical Cyclones and Meteorological Parameters in the Philippines**

The Sun undergoes an 11-year cycle of increase and decrease in solar activity. The observed small change in the incident solar radiation produced by the 11-year solar variability remains debatable whether or not it can significantly affect weather and climate.

This study aimed to understand the local-specific effect of the 11-year solar cycle on TC frequency and intensity and meteorological parameters in the Philippines and how it can be utilized and integrated to provide a more accurate TC, weather and climate forecast beneficial to the public.

The study had presented the following:

- That among the three solar cycle phases, namely WNmin, WNmax, and the entire solar cycle, the latter yields the weakest correlation to the TC and meteorological parameters;
- That a distinct enhancement in the correlation is observed when the extreme sunspot years are used;
- That the solar variability apparently affects TC and meteorological parameters but with lag time or delay;
- That determining the direct cause-and-effect relationship (lag time 0) of solar variability with the TC and meteorological parameters is not ideal.

Also, the study obtained interesting results but still requires further studies on the effects of solar variability on TC and meteorological parameters. These will strengthen the notion that sunspots can be considered and utilized as one of the predictors for seasonal forecasting and can be a vital driver of climate variability.

RESEARCH AND DEVELOPMENT PROGRAM FOR WEATHER AND ALLIED SCIENCES

Research and development (R&D) is a vital component of an organization, especially in dealing with climate change and disaster management. It connotes the continuous discovery and application of new and updated scientific knowledge and information to improve systems and effectively and efficiently respond to issues and problems brought by the changing environment.

Completed Research Projects:

- **Probability Estimation of Tropical Cyclone Landfalls in the Philippines**

  Landfalling tropical cyclones have both societal and economic impacts. In the country, those affected and vulnerable are most of the population situated and living in typhoon-prone and low-elevated coastal areas. The possibility of a Tropical Cyclone causing multiple fatalities and incurring economic losses is most likely to happen considering its strong winds and associated hazards such as storm surges, flooding, and landslides. Studies analyzing their variability either-or long-term change are necessary. In particular, information on their frequency or statistical chance of landfall in a given year or season is important to the public, researchers, forecasters, and emergency planners.

  This study aimed to identify the underlying distribution in relation to the frequency of landfalling tropical cyclones. It also aimed to estimate the landfall probability of TCs in the Philippines on annual and seasonal timescales and to analyze the impacts of El Niño-Southern Oscillation (ENSO) on TC landfall probabilities.

  The project is in its final phase of completing a paper for publication.

- **Severe Wind Hazard Mapping of the Philippines and Cebu City**

  Tropical Cyclone is a natural hazard, but its threat to devastate and affect lives can be reduced and managed through the proper and correct application and use of hazard information.

  Severe wind hazard assessments consider the likelihood and intensity of wind speeds occurring over a long period expected at any given attention. The project's design is to determine the severe wind hazards brought by TCs in the Philippines, wherein hazard maps, serving as the project's output, are communicated to the public, serving as guides when an extreme weather event occurs.

  Overall, the project had produced 567 maps for local and regional severe wind hazard maps of the Philippines with 20, 50, 100, 200, 500, 700, and 1000-year return periods.

  Under the project, the PAGASA conducted several capacity-building activities. The Virtual Technical Training on TC Severe Wind Hazard and Risk Assessment capacitated PAGASA personnel with the development and assessment of severe wind hazards, held on 08-10 June 2021 via Zoom.

  Subsequently, conducted on 21-22 July via Zoom was the Virtual Technical Training on TC Severe Wind Hazard and Risk Assessment using the Severe Wind Estimation of Risk using Vulnerability and Exposure (SWERVE) Tool. Some project collaborators, PHIVOLCS and UPD-ICE personnel, trained on the simulation and assessment of severe wind hazards and on integrating exposure data and vulnerability curves into the SWERVE tool.

Another was the Virtual Endorsement of Severe Wind Hazard Maps to the Association of Structural Engineers of the Philippines (ASEP), organized in partnership with the ASEP to update the wind zone map of the Philippines using the wind hazards developed by the project. Also, this officially endorses the severe wind hazards at different return periods (RP) used in updating the wind zone map for the National Structural Code of the Philippines (NSCP) 2022.

Lastly, the virtual IEC training for the Cebu City LGUs on 01-03 September capacitated personnel on developing severe wind hazards and risk assessments using the SWERVE tool.

- **Severe Wind Hazard and Risk Assessment for the Philippines: Exposure Data Development and Severe Wind Risk Assessment for Cebu City**

Widespread disasters in the Philippines were caused mainly by TC-related activities. Several affected populations were recorded yearly with billions of economic losses, particularly in the agriculture and infrastructure sectors. Extreme winds and related phenomena such as storm surges are great contributors to the extensive damages suffered by the country. The occurrences of Typhoon Pablo (Bopha, 2012), Super Typhoon Yolanda (Haiyan, 2013), Typhoon Glenda (Rammasun, 2014), and Super Typhoon Lawin (Haima, 2016) highlighted the need for mitigation measures that take into consideration the physical and social effects of TC winds. Hazard and risk assessments play a vital role in helping the communities identify short and long-term disaster mitigation plans. An appropriate example is enabling managers and planners to implement building codes and proper zoning toward becoming a disaster-resilient community.

The project's main objective is to decrease Cebu City's vulnerability against TC's severe winds and increase resilience by strengthening the capacities of LGUs and other disaster risk stakeholders. Specifically, it aimed for the following: develop a risk calculation tool and integrate severe wind hazard information, exposure database, and vulnerability information for both probabilistic and event-based severe wind risk; estimate the risk and impact from TC severe wind in terms of physical damage, economic loss and affected population in Cebu City for both probabilistic and event-based severe wind risk assessment and conduct validation; and conduct training on severe wind calculation.

The project developed the SWERVE Tool for risk calculation. It also generated severe wind risk maps of Cebu City, 63 risk maps (PSA exposure) of Cebu City (9 return periods and 7 risk information), and 42 risk maps (REDAS survey data) of 6 Cebu City barangays (7 risk information). In addition, the project also developed 3 e-SWERVE modules on risk assessment (Learning Management System).

- **Drought and Crop Assessment and Forecasting (DCAF) Phase 2**

Percent of Normal Precipitation (PNP) and Standard Precipitation Index (SPI) are the measures presently used by PAGASA to address drought events in the country. These are mainly rainfall-based measures of meteorological drought, in line with the premise of providing timely and accurate information on atmospheric, astronomical, and other weather-related phenomena. However, meteorological droughts do not always coincide with periods of agricultural drought, according to Wilhite and Glantz (1985). Normal precipitation may occur after a long dry period, manifesting the end of meteorological drought. However, the amount of rainfall may still be insufficient to provide crops with the needed water.

Researching the different aspects of drought entail history and contemporary records of weather and climate parameters that cause crop damage. Remotely-sensed observations are indispensable in developing drought indices; hazard and exposure maps help monitor and characterize drought and statistical device models for drought forecasts.

The DCAF project is co-implemented by PAGASA and the Bureau of Soils and Water Management (BSWM). It aimed to monitor and forecast the occurrence of agricultural drought based on satellite-derived data. It also aimed to complement current drought forecasts with statistically downscaled dynamical climate models and develop a practicable protocol for monitoring, predicting agricultural drought, and disseminating warnings.

Under the project, PAGASA personnel underwent training on generating Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Standardized Vegetation-Temperature Ratio (SVTR), and corresponding anomaly maps; installed and operated a centralized online database; automated downloading of Moderate Resolution Imaging Spectroradiometer (MODIS) data; and generated Climate Decomposition Index (CDI) and SVTR forecast maps. In addition, PAGASA got involved in the analysis of historical drought events and participated in the process of formulating recommended drought warning policies.

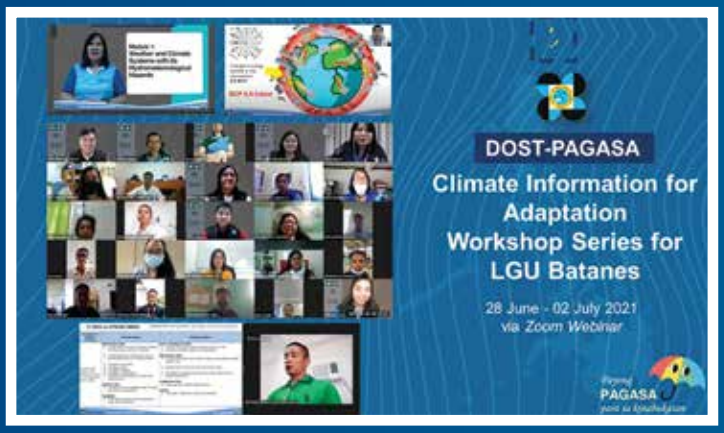
- **Providing High Resolution (5km) Climate Change Projections in the Philippines using Weather Research and Forecasting Model**

Climatologists have strived to increase the accuracy of the climate change modeling since the Intergovernmental Panel on Climate Change (IPCC) first report in 1990. PAGASA is one of the pillars in the Philippines involved in climate change studies, where different regional downscaling models are used to produce climate projections under different climate scenarios. Over several decades of development and modernization, climate models have consistently provided a powerful and clear picture of significant climate warming. However, continued greenhouse gas emissions above current rates would cause a further increase in temperature contributing to the many changes in the climate system during the 21st century that would likely be larger than those observed during the 20th century. Thus, simulations and downscaling of climate projections under different climate scenarios are imperative considering the growing demand for climate change information.

Simulations with various downscaling techniques offer challenges, including the run-time of higher resolution climate models. The higher the resolution, the higher the core nodes are needed to have a faster run-time. Thus, the system will provide a thousand nodes to address the deficiency in the run-time simulation of climate projection.

The said project intended to simulate climate projection in the Philippines at 5km resolution in faster run-time utilizing the Weather Research Forecasting (WRF) Model of the National Center for Atmospheric Research (NCAR), which outputs would eventually help decision-makers, LGUs, and researchers in their study, planning, and other activities inclined to climate change and climate science.

The project had produced maps for climate change projection in four island provinces, namely Tawi-Tawi, Biliran, Marinduque, and Batanes, with a 2041-2060 timeline.



In addition, PAGASA conducted a series of climate information and adaptation workshops for LGUs in Tawi-Tawi, Biliran, and Batanes. It aimed to enhance user knowledge of the present and future climate change information, assess the uptake of climate information over the participating provinces, establish local climate conditions using local knowledge and

perception by participants, and either-or develop and revalidate the LCCAP of participating LGUs using the high-resolution climate projection output of the project. The workshop dates are 07-11 June, 14-18 June, and 18 June to 02 July 2021 via the Zoom platform.

- **The Establishment of Rainfall Threshold for Landslide in Albay and Sorsogon**

In recent years, landslides have caused immense damage to the natural resources in the Bicol Region. In Albay and Sorsogon Province, landslides have been considered an issue and concern for warning and mitigation. Thus, landslide occurrence prediction or forecast became a vital task and component in the hazard monitoring and warning system. Hazards are mitigated mainly through precautionary means—for instance, by restricting or even removing populations from areas with a history of landslides, by restricting certain types of land use where slope stability is in question, and by installing early warning systems based on the monitoring of ground conditions such as strain in rocks and soils, slope displacement, and groundwater levels (Highland and Bobrowsky, 2008).

Moreover, rainfall is the most common triggering factor for landslides, and rainfall data is indispensable in establishing a reliable science-based early warning system for susceptible areas. Several studies have focused on monitoring the hydrologic response of a soil slope under the effect of infiltration in the development of a rainfall-induced landslide early warning system, which is not practical in this study due to the unavailability of data.

Nonetheless, there are studies indicating the hydrologic response of soil slopes to rainfall is describable by using the measurement of soil moisture content, which is by the Antecedent Precipitation Index (API). Thus, the intended early warning system is dependent on the empirical rainfall thresholds that describe the interaction between the primary cause (rainfall) and the final effect (landslide).

The study aimed to develop a rainfall threshold using the antecedent and cumulative rainfall employing various combinations of these parameters. It included the identification of weather systems that mobilize a landslide as well. Furthermore, the localized alert criterion for landslide warning was established in Albay and Sorsogon Provinces.

The study was conducted from March to September 2021, wherein the targeted outcome of establishing an early warning system for landslides in Albay and Sorsogon is completed.

DERIVED RAINFALL THRESHOLD

Municipality	Threshold (mm)	No. of Rainfall-triggered days	No. of Landslide Events	Weather System
Province of Albay				
Libon	≥ 130	1	2	TC
Oas	> 140	1	2	TC
Sto. Domingo	≥ 460	- 1 day with hourly rate of >100 mm/hr.	1	TC
	≥ 240	1	1	TC
Manito	≥ 490	- 1 day with hourly rate of >100 mm/hr.	1	TC
	> 250	1	1	TC
Tivi	> 680	1	1	TC
Province of Sorsogon				
Magallanes				
MAY	≥ 350	2	1	TC
NOV-FEB	≥ 240	1	2	LPA/TECF
Bulan				
MAY	≥ 230	1	1	TC
NOV-FEB	≥ 240	1	4	TC/TECF
	≥ 420	16	1	TC/TECF
Matnog	≥ 190	1	3	TC
	> 300	1	2	TEFS

PHYSICAL RESOURCE AND OPERATIONAL TECHNIQUES PROGRAMS

Modern, efficient, and reliable infrastructure is essential to run an organization, especially in the government that works or is responsible for mitigating the impacts of an impending disaster and saving people's lives. Thus, PAGASA must invest in state-of-the-art facilities and systems to strengthen its current capabilities in weather, flood, and climate monitoring and warning systems.

Synoptic Station

Field weather stations are PAGASA stations where observations of almost all meteorological elements are made at fixed observation times and transmitted to the Central Office. It is also a fundamental component in public weather forecasts, tropical cyclone bulletins, warnings and advisories, and other related information development and dissemination.

In 2021, PAGASA completed the synoptic-airport station in Laguindingan and the synoptic-agromet station in Isabela. These added to the 80 field weather stations established and operated by PAGASA nationwide.

Laguindingan Synoptic Station

X-Band Rain Radar in Kabacan

Installation of server at the Weather and Flood Forecasting, Quezon City

X-Band Radar

Due to the rugged terrain of some areas of the country, traditional radars may result in clutter or noise, such as mountain ranges and tall buildings that obstruct the field of view of radars, resulting in false echoes reflecting on the radar scope. These rugged terrains are the catchments of some rivers, potentially flooding the downstream flood plains. Traditional gauges are almost nil in these areas where access and communication are impenetrable. X-band radar units are a cost-effective way to augment the capabilities of existing radar infrastructure, thus establishing new observation systems.

X-band radar systems and networks proved valuable in Quantitative Precipitation Estimation (QPE), nowcasting, hydrometeor classification and wind detection. These inputs are essential to weather monitoring alerts, hydrological models, water management, fleet and traffic management, and broader emergency management.

The required shorter range of X-band radars allows to keep the radar beam close to the ground and overcome the shadow effect of the earth's curvature while maintaining a high range and azimuth resolution. The appropriate low-level coverage has a considerable impact in improving the data products. The capability of X-band radars is of key importance in monitoring all lower troposphere weather phenomena, including QPE applications.

PAGASA completed the three X-band radars in Davao, Cotabato and in Isabela. Establishment of four more X-band radars are ongoing including the conversion of two previously mobile X-Band radars to fixed stations in Nueva Ecija and Camarines Sur

High Frequency Radar

High-Frequency Radar
Malimono, Surigao Del Norte

High-Frequency Radar
Dipaculao, Aurora

Several countries nowadays, especially in the Southeast Asian region where coastal areas are prone to catastrophes brought by destructive storm surges, utilize High-Frequency Radars (HFRs). HFRs can automatically observe coastal threshold weather conditions and transmit it to the PAGASA meteorological offices for the issuance of gale warnings and advisories to the coast guard as a basis for sea travel permission and fishing activities.

PAGASA installed a total of 36 HFRs in coastal areas nationwide; seven of which were in 2021. They are in Daan Batayan, Cebu; Catmon, Cebu; Danao, Cebu; Poro Cebu; Placer, Masbate; Cadiz, Negros and Madridejos, Cebu.

Doppler Weather Radar

Doppler Radars are used for cloud detection, storm prediction, and weather forecasting. Using radar data, a forecaster can determine the nature of any existing weather systems and follow their movement and development.

Radar stations are where doppler radars are installed. Aside from an independent radar station, PAGASA also adopted combining a synoptic and a radar station into one station called a synoptic-radar station.

Generally, PAGASA radar stations conduct regular observations twice a day. However, if a TC enters the PAR, all radar stations may be required to observe on a 24-hour basis. These depend on the proximity to the TC or the effective range of the radar station. Radar data is then reported to the Central Office every hour or 30 minutes if possible.

PAGASA established a total of 17 Doppler Radar Stations nationwide, and these are utilized by forecasters whenever a weather disturbance is present. The Agency is looking forward to the completion of three more radar stations.

Flood Forecasting and Warning System

Tagum-Libuganon River Basin FFWC

Davao River Basin FFWC

Buayan-Malungon River Basin FFWC

Flood Forecasting and Warning System (FFWS) provides early warning for potential hydrometeorological threats to the public, business sector, transportation, infrastructure, etc.

PAGASA has a total of 15 Flood Forecasting and Warning Centers established nationwide. Each FFWC gathers data from the hydrometeorological facilities such as rain gauges, water level sensors, and AWSs installed in major river basins nationwide. These facilities are crucial components that constitute an FFWS. In 2021, the Agency already had 13 FFWCs complemented with said hydrometeorological monitoring facilities.

Moreover, the establishment of four (4) more FFWCs is ongoing, and six (6) more FFWCs are to be complemented with the monitoring facilities

Automatic Weather Stations

These are automated stations with built-in weather instruments with electronic sensors to measure surface-level air temperature pressure, solar radiation, rainfall, wind velocity, and other weather parameters. The stations have integrated data banks for recorded data retrievable and available anytime.

The installation of AWSs aids in providing data from data-sparse areas where observations via human intervention are impracticable. With the installation of these stations, PAGASA can reach more area coverage and a denser collection of data necessary for forecasts and warnings generation.

Overall, PAGASA installed 169 AWSs nationwide, 31 of which are in 2021.

Aviation Weather Observing System

AWOS is an airport weather system that helps the agency provide adequate and reliable weather forecasts through Meteorological Aerodrome Reports (METAR) reports generated automatically through the AWOS server.

It supports many operational user groups at the airport, including air traffic controllers, meteorological observers, and maintenance personnel. It provides accurate and reliable data to ensure airport safety and operational efficiency.

PAGASA has seven (7) AWOS installed in synoptic-airport stations.

Establishment of PAGASA-MIS Storage Expansion in Central Office and Disaster Recovery Site in Cebu

PAGASA established the PAGASA-Meteorological Information System (PAGASA-MIS) in 2016. It integrates real-time the Agency's current observing facilities, such as satellite, radar, AWS, upper air, wind profiler, synoptic/agromet/climat station, marine buoys, etc., into one centralized database. The main objective is to have a single point of access and archive of all meteorological data (historical, present, and future climate information).

Currently, PAGASA archived its data products at the PAGASA-MIS. However, considering the present rate of processing and ingesting data into the PAGASA-MIS, it can hold only until one-and-a-half years.

The storage expansion will provide hybrid and scalable storage, composite on both sites, allowing a platform to burst on preferred cloud storage providers.

The PAGASA-MIS Infrastructure is located in two sites: one is at the PAGASA Central Office, serving as the active site, and the other is at the Cebu Data Center, as the backup and recovery site.

New Projects:

- **Integrated Digital Weather Forecasting Project**

  As PAGASA continues its modernization, an increase of data amasses from the different facilities such as radars, rain gauges, AWSs, HFRs, satellite imageries, etc. The accumulation of these data is massive; thus, data analysis requires automation. It will enhance the ability of weather forecasters to rigorously identify the timing and severity of typhoons, floods, and other weather events.

  This project aims to enhance and improve the computing hardware facility of the Agency's weather forecasting and other operations. It will also advance the collaboration tools for weather forecasting operation, processing, and digital weather information dissemination.

  The project focuses on advancing weather analysis and visualization, enhancing the IT infrastructure for network, databases, and archiving capability, and providing high-availability and systems security of the Weather Division's operations and services.

- **All Weather Communication System (Phase 2)**

  This project aims to build a robust meteorological and hydrological telecommunication infrastructure network for PAGASA. It will provide digital connectivity to all regional services, synoptic and agromet stations, doppler radars, upper-air and hydrological river basin centers, and other specialized observing stations. Also, the provision of valuable weather data/variables essential in forecasts, advisories, and warnings will be in real-time.

  Specifically, it will establish Internet Protocol (IP) radio connections from the PAGASA central office to the regional services divisions in Tuguegarao, Legaspi, Mactan, and Cagayan de Oro. The Visayas and Mindanao segment of the network will utilize the existing telecommunication repeater facilities of the Department of Information and Communication (DICT) in the co-location of the microwave equipment and other facilities. The upgrading of the bandwidth capacity of the selected DICT backbone network in Visayas and Mindanao to 1Gbps is a requisite.

  In the end, the project will produce systematic weather products and automate the processing of data and information. It will provide a direct communication link with all field stations and enable access to hydro-met decision-support information systems. Last is the establishment of an IP-based communication structure.

- **Data Rescue and Digitization of Climatological and Agrometeorological Archive**

  The Climate and Agrometeorology Data Section (CADS), where data is collected, processed, and stored, is the official data bank of the PAGASA. The CADS collects synoptic data, such as rainfall, temperature, wind direction, etc. It also collects agromet data such as solar radiation, evaporation, soil moisture, etc., and climate/rain data. These data come from PAGASA's monitoring stations located in different parts of the country, where each data differs in the frequency of observation and acquisition. Field observing stations use standard observation forms for recording each type of data and regularly send it to the PAGASA's data bank for processing, recording, analysis, and storage at the climate data bank.

  This project aims to transform handwritten data into machine-readable form with substantial relevance to weather, climate, hydrological research, and other activities. Specifically, it targets the following: digitize hourly, 3-hourly, and 6-hourly data in support of the vulnerability and risk assessment studies in the Philippines; develop and maintain the necessary databank in support of climate change activities; improve the potential for within-country services, e.g., seasonal climate prediction, and mitigation of the potential effects of climate change; and provide essential climate information for climate change research at the national, regional, and global levels

CLIMATE CHANGE ADAPTATION, DISASTER PREPAREDNESS AND RISK REDUCTION PROGRAM

Information, Education and Communication campaigns strengthened amidst pandemic

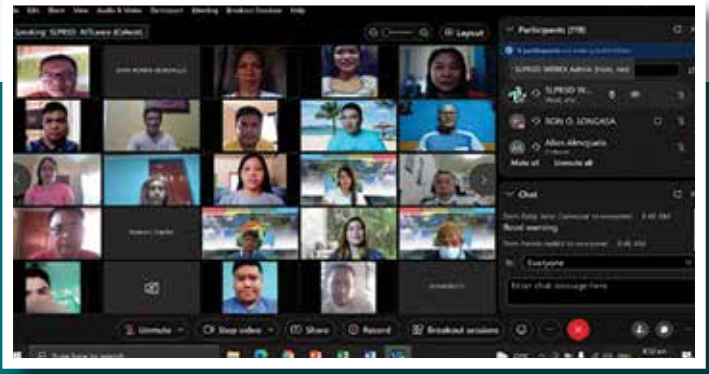
Being a partner of the National/Regional Risk Reduction Management Council, PAGASA is actively involved in pre-disaster and community preparedness and planning activities in mitigating the adverse effect of hydrometeorological hazards. PAGASA, through its Regional offices, is actively engaged in public awareness programs and activities concerning disastrous circumstances brought by typhoons, floods, and extreme climatic events such as El Niña and La Niña phenomena, including climate change.

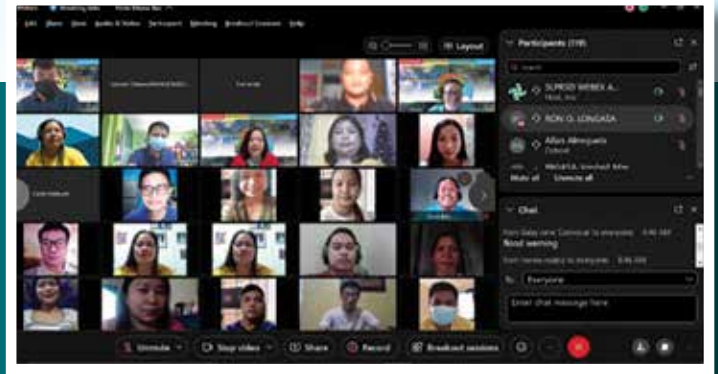
Last November 3 to 5, PAGASA conducted an informative webinar about weather and climate to public elementary teachers and disaster risk reduction coordinators, who also have critical roles and responsibilities in disseminating information to students and other vulnerable sectors of the society.

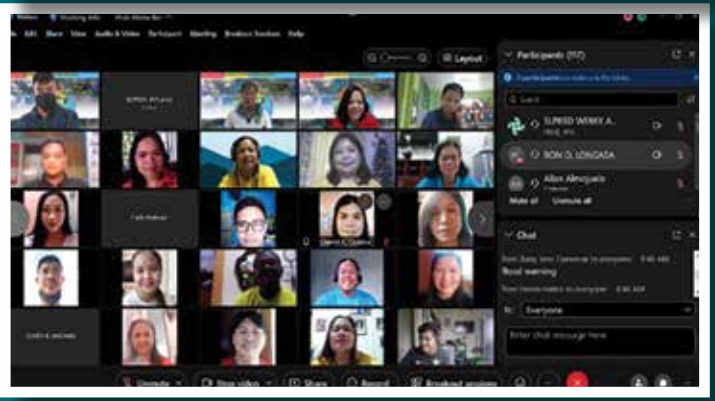
The activity intends to help the Disaster Risk Reduction Elementary Coordinators learn basic knowledge of weather, climate, and other related information. School communities will benefit through information sharing and equip students with the right tools to better understand and react to disasters and risks brought by extreme weather and climate events. Among the topics provided to participants are the following

- Hydrometeorological Hazards
- Weather Instruments and Observation
- Weather Nowcasting & Forecasting
- La Niña Update and Climate Outlook (for 6 months) – CLIMPS
- Scheme of DRR Elementary Teacher Coordinators in Teaching/Disseminating Weather & Climate Information to Teachers & Students
- Drafting of Resolution for future and expansion activities between DepEd-Albay & PAGASA - SLPRSD

Indeed, the Agency prioritizes educating the populace, gearing toward disaster preparedness and awareness, and constantly reaching out and finding ways to share and transfer vital information on weather, climate, and flood.





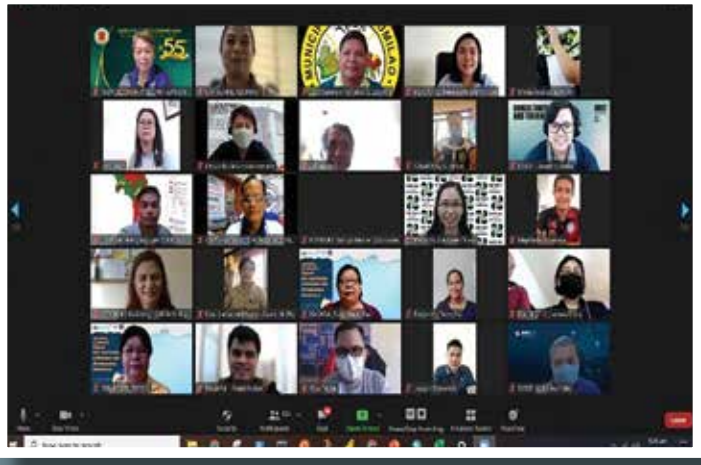


PAGASA strengthened the capacity of local clients to maximize the utilization of climate information and forecasts in decision-making related to agriculture, water resource management, public health, and disaster risk reduction and management through different information and education communication campaigns in Mindanao. The Agency conducted training on-site and in the Mindanao PRSD office. Thanks to the aid of online meeting platforms giving significant benefit in executing campaigns to reach PAGASA's stakeholders despite the restrictions due to Covid-19.

March 12 and 15 and December 6 and 9, 2021
Multiple locations across Malaybalay, Cagayan de Oro, Libona, Baungon and Talakag Ocular inspection of Project sites, clarification of some land issues, and confirmation of entry protocols per LGU

11 May 2021; 03 June 2021; 08 July 2021 - MPRSD Office
Local DRRM Officers in the following municipalities of Bukidnon: Impasug-ong, Lantapan, Pangantucan, San Fernando

September 9, 2021: Climate Resilient Farmer's Field School Elementary School of Banbanon, Surigao del NorteLecture presentations to farmers on climate and weather-related information and forecasts



October 13, 2021 (via Zoom platform)
Local stakeholders and decision makers in Northern Mindanao and Zamboanga Peninsula

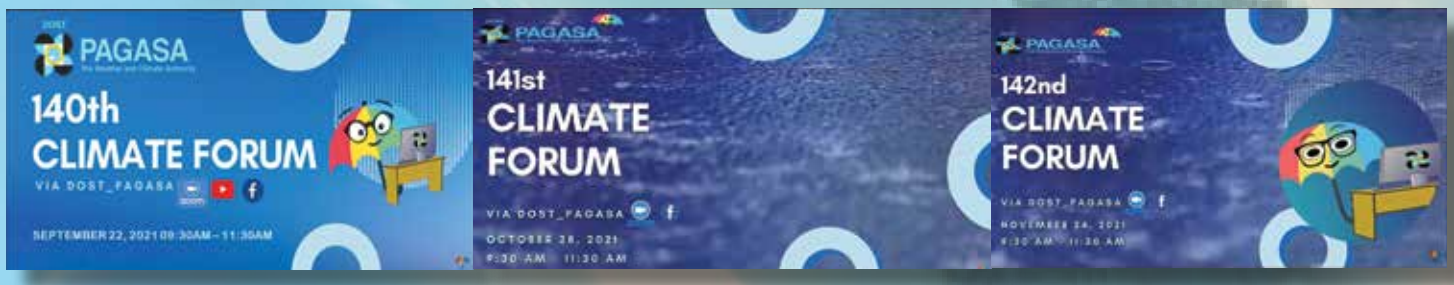
October 20, 2021 (via Zoom platform)
Local stakeholders and decision makers in Caraga and Davao Region

October 27, 2021 (via Zoom platform)
Local stakeholders and decision makers in BARMM and SOCCSKSARGEN

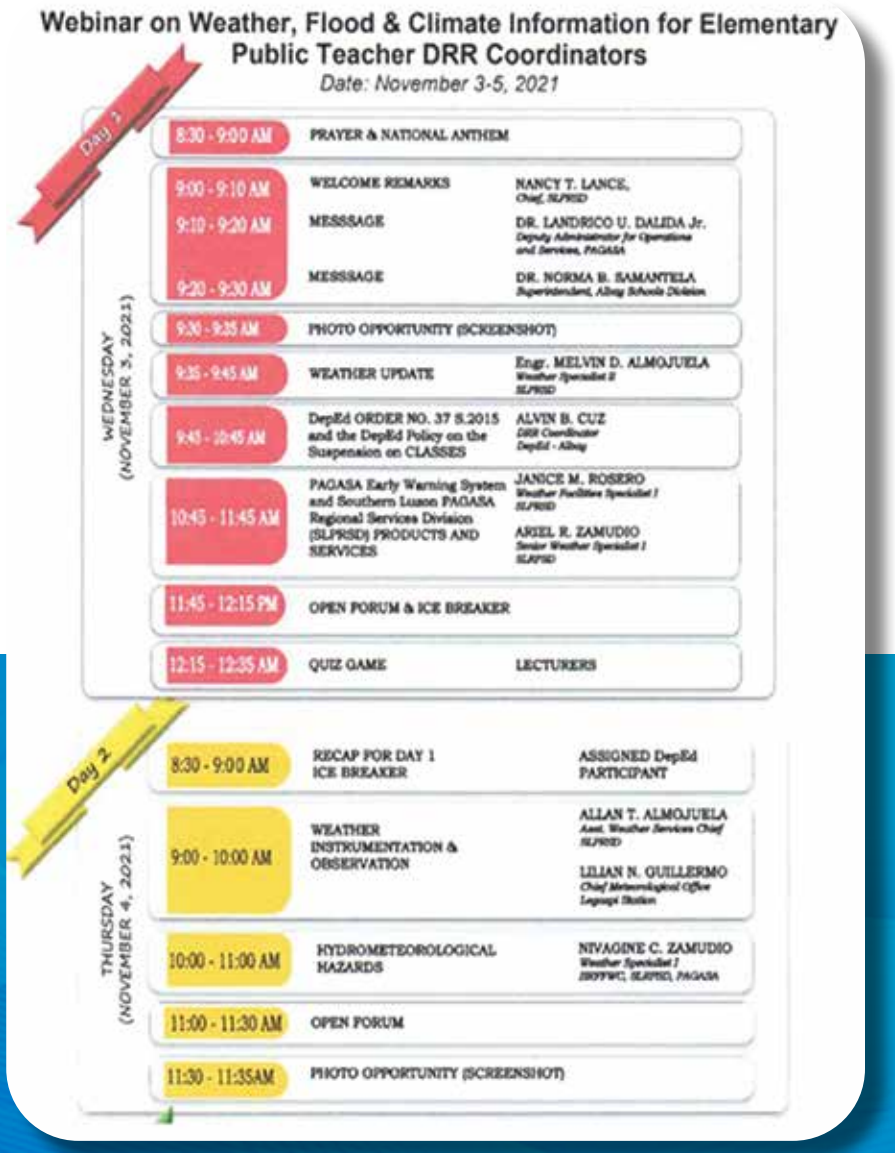
November 1 -12, 2021
Seventh WMO International Training Workshop on S2S Prediction of Monsoons
A forum for researchers and forecasters to discuss recent advances and current issues involving monsoons as an example of an earth-system phenomenon covering weather-to-climate time scales affecting large populations around the world.

Strengthened Climate Outlook Forums

Climate outlook forums bring together experts in various fields such as local meteorologists and end-users of forecasts in an environment that boosts collaboration and learning, delivering consensus-based, user-relevant climate outlook products, in real-time, through cooperation and partnership. PAGASA invariably extends its effort in bringing pertinent information and reaching out to the public, encouraging resilience despite surmounting challenges.



Webinar on Weather, Flood, and Climate Information for Elementary Public Teachers DRR Coordinators in Albay



Webinar on Weather, Flood & Climate Information for Elementary Public Teacher DRR Coordinators

Date: November 3-5, 2021

Day 1 — WEDNESDAY (NOVEMBER 3, 2021)

8:30 - 9:00 AM	PRAYER & NATIONAL ANTHEM	
9:00 - 9:10 AM	WELCOME REMARKS	NANCY T. LANCE, Chief, SLPRSD
9:10 - 9:20 AM	MESSSAGE	DR. LANDRICO U. DALIDA Jr. Deputy Administrator for Operations and Services, PAGASA
9:20 - 9:30 AM	MESSSAGE	DR. NORMA B. SAMANTELA Superintendent, Albay Schools Division
9:30 - 9:35 AM	PHOTO OPPORTUNITY (SCREENSHOT)	
9:35 - 9:45 AM	WEATHER UPDATE	Engr. MELVIN D. ALMOJUELA Weather Specialist II SLPRSD
9:45 - 10:45 AM	DepEd ORDER NO. 37 S.2015 and the DepEd Policy on the Suspension on CLASSES	ALVIN B. CUZ DRR Coordinator DepEd - Albay
10:45 - 11:45 AM	PAGASA Early Warning System and Southern Luzon PAGASA Regional Services Division (SLPRSD) PRODUCTS AND SERVICES	JANICE M. ROSERO Weather Facilities Specialist I SLPRSD ARIEL R. ZAMUDIO Senior Weather Specialist I SLPRSD
11:45 - 12:15 PM	OPEN FORUM & ICE BREAKER	
12:15 - 12:35 AM	QUIZ GAME	LECTURERS

Day 2 — THURSDAY (NOVEMBER 4, 2021)

8:30 - 9:00 AM	RECAP FOR DAY 1 ICE BREAKER	ASSIGNED DepEd PARTICIPANT
9:00 - 10:00 AM	WEATHER INSTRUMENTATION & OBSERVATION	ALLAN T. ALMOJUELA Asst. Weather Services Chief SLPRSD LILIAN N. GUILLERMO Chief Meteorological Office Legazpi Station
10:00 - 11:00 AM	HYDROMETEOROLOGICAL HAZARDS	NIVAGINE C. ZAMUDIO Weather Specialist I ISSFWC, SLPRSD, PAGASA
11:00 - 11:30 AM	OPEN FORUM	
11:30 - 11:35AM	PHOTO OPPORTUNITY (SCREENSHOT)	

The Southern Luzon PAGASA Regional Services Division (SL-PRSD) is proactive in conducting public awareness programs on natural hazards such as typhoons, floods, and extreme climatic events such as El Niño and La Niña phenomena, including climate change products and services.

SLPRSD, as part of their IEC program and to engage stakeholders in DRR-related IECs, organized a webinar on weather and climate information in the Bicol Region for public elementary teacher DRR coordinators.

Choosing the public school teachers is ideal considering their responsibility which is crucial to disseminating weather and climate-related information to students being part of the vulnerable groups. The activity meant helping the elementary teachers/coordinators understand the basic information on weather, climate, and weather-related information and obtain the knowledge to apply in decision-making whenever there is a presence of weather and climate risks in their respective areas/communities/schools.

New Project :

Scaling Up Climate Information Services for Societal Benefits Program (CLIM'UP)

Climate information services (CIS) ensue from analyzing historical data and gathering relevant information from the past to translate them into usable applications and predict the future climate. It acts as an aid for decision-makers and encourages innovations in various sectors and individuals to address climate-related risks. These make the CIS a very challenging field, making the information relevant, understandable, reliable, and accessible to target recipients. Accessible and user-oriented climate information is critical in reducing climate-related risks. Thus, it increases the resilience and preparedness of society for changes in climate and its associated extreme events.

The CLIM'UP program is a three-year program that aims to improve the CIS and increase the country's resilience to changes in climate and extreme events associated with the monsoons.

Specifically, it aims to fill the gap in the current available historical climate data in the Philippines by developing a set of observation-based gridded daily and sub-daily surface climate parameters. It would also identify the most suitable interpolation technique for each surface climate parameter applicable in the Philippines. Moreover, the program will also facilitate an improved user uptake of climate information to encourage an increased number of climate-related research undertakings in the country and enhanced preparedness for climate-related risks. It would also involve the simulation and determination of the predictability of the observed structure of the weather disturbance associated with the enhanced southwest and northeast monsoon surge and the associated rainfall. Likewise, it will further develop the Southwest Monsoon Forecast Index (SMFI) and Northeast Monsoon Forecast Index (NEMFI) to monitor and predict the strength of the monsoon using model simulations, observational data, and derived climatological normal.

The program will be producing scientific publications and high-resolution gridded climate datasets of the country, SMFI, NEMFI, and IEC/training materials.

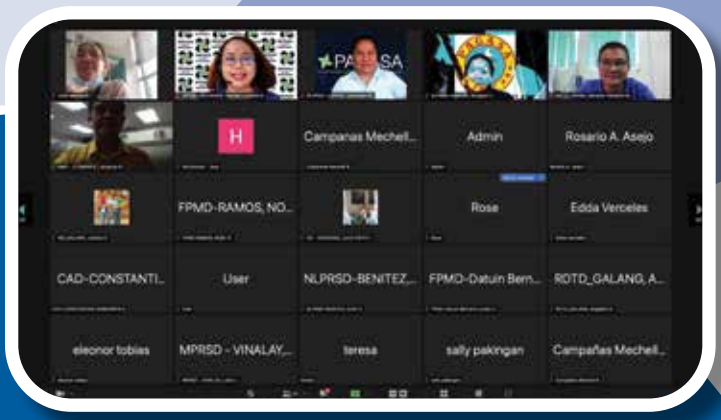
Human Resource Development Program (HRDP)

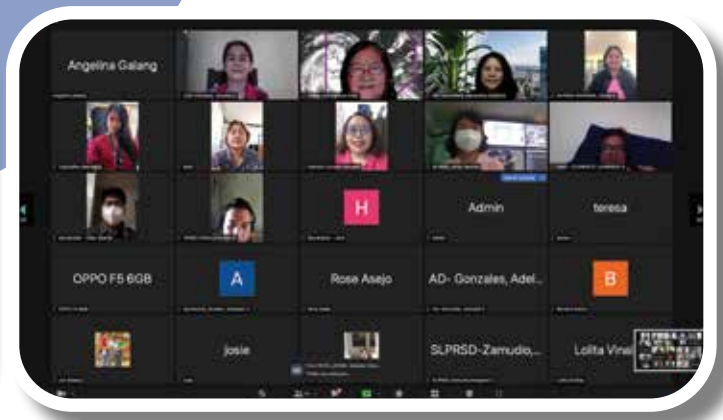
With the implementation of the "The PAGASA Modernization Act," and pursuant to the Civil Service Commission Memorandum Circular No. 2, s. 2012, Program to Institutionalize Meritocracy and Excellence in Human Resource Management (PRIME-HRM), this Agency is continuously improving its services through various developmental interventions by upgrading its physical and human resources capacities.

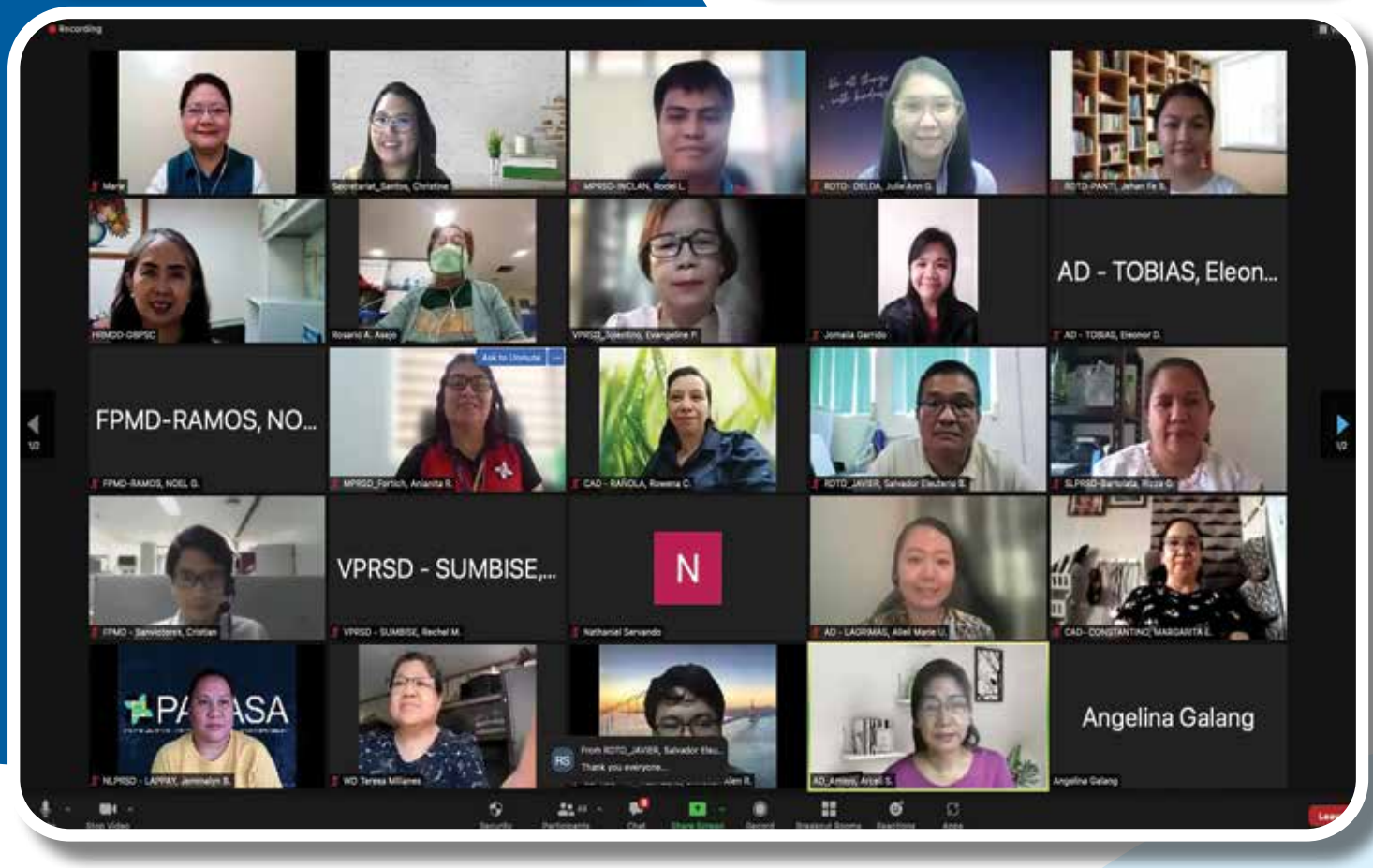
The HR Development Plan is anchored on the vision of our Agency to be the Center of Excellence for weather-related information and services helping develop a disaster and

HR in the New Normal

The Agency conducted the seminar to help officials and employees to thrive at work under the new normal and to cope with the challenges and adversities in the alternative work arrangements implemented in organizations. The activity encouraged the participants to utilize different technology and innovation that will hasten processes and communication among colleagues. The session also discussed how to take care of one's physical, mental, and socio-emotional health.



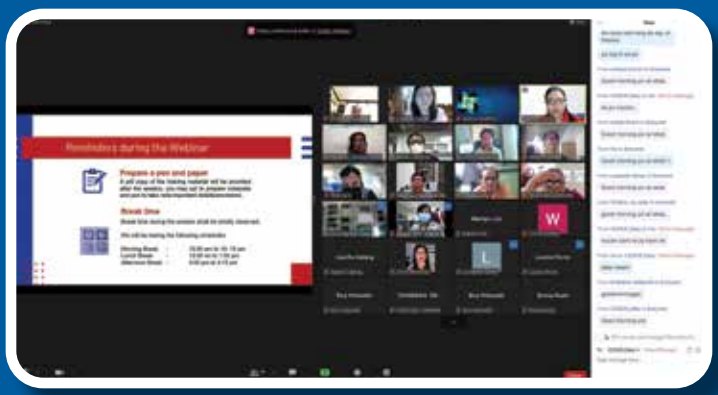


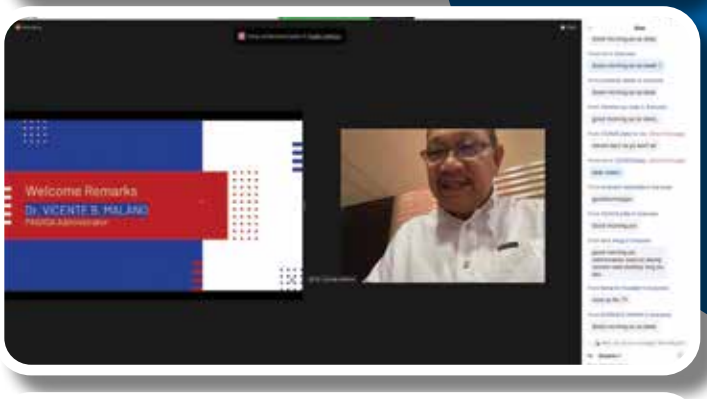


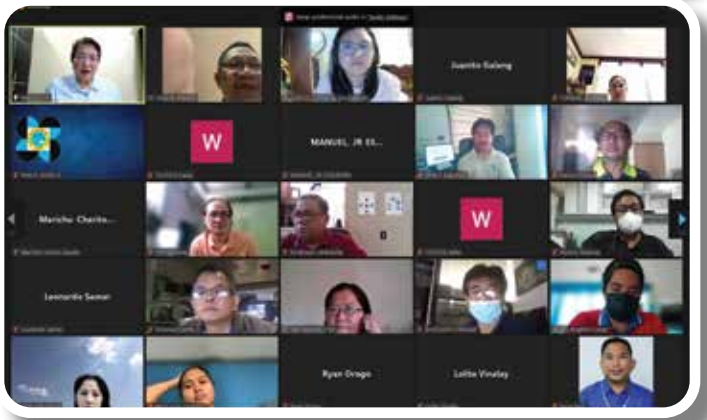
Supervisory Development Course

To provide the right direction in transforming the employees and becoming a high-performing organization, managers and supervisors will undergo SDC (Track 1). The course imparted an enabling tool towards understanding one's self and career, handling responsibilities, becoming better leaders, and learning essential communication processes. Competencies such as personal effectiveness, commitment to public service, and other leadership needs were also integral to the course.

Thirty-eight (38) supervisors (25 Male and 13 Female) participated in the e-Supervisory Development Course.







PAGASA's sustainable support to Gender And Development

The promotion of gender equality has been a buzzword in the different spheres of the society, most especially in private and public governance. The role of women in nation-building has been recognized; hence women empowerment has increasingly felt. Indeed, it is interesting to note that the Philippines have made the Convention on the Elimination of all Forms of Discrimination against Women (CEDAW) as part of the Constitution, Section 14 of Article II that states "it recognizes the role of women in the nation-building, and shall ensure the fundamental equality before the law of women and men."

In addition to this, a number of laws and policies promoting gender equality were issued, namely, the Philippine Plan for Gender-Responsive Development (PPGD), Women in Development and Nation-Building Act (Republic Act (RA) 7192), Magna Carta of Women (MCW), Anti-Sexual Harassment Act (RA 7877) and many others.

Celebration of 2021 National Women's Month: Women in Science

The promotion of gender equality has been a buzzword in the different spheres of society, most especially in private and public governance. The role of women in nation-building received acclaim, leading to the escalation of women's empowerment. Indeed, it is interesting to note that the Philippines made the Convention on the Elimination of all Forms of Discrimination against Women (CEDAW) part of the constitution. Section 14 of article II states that "it recognizes the role of women in nation-building, and shall ensure the fundamental equality before the law of women and men."

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PAGASA celebrated the 2021 National Women's Day with the theme, "Women in Science," highlighting the noteworthy contributions of PAGASA women in their field of specializations. PAGASA-GAD featured the Women in the science of Meteorology as early as 1915 up to the present, narrating their achievements, the challenges they faced, and the different eras of their service, which form part of what PAGASA is today.

FIRST LADIES *of* Meteorology

By Rey K. Lirios, who was the News Editor of the Ang Tagamasid PAGASA Newsletter which has since ceased circulation

The first Filipina weather observer was hired during the US -Philippine Commonwealth era. She is listed in the bureau's 1915 roll of employees as Señora Juana B. Redula, trained as observadores auxillares, Estacioñes Premiera Clase, weather observer aid of first class stations.

Many Filipina Philippine Weather Bureau employees were hired in the midst of World War II during the Japanese occupation. They worked as weather observers, clerks or telephone operators. After the war, batches of the brightest Filipino men and women candidates were selected through a rigorous nationwide Civil Service examination for meteorology scholarship in United States universities, many from the Philippine Weather Bureau were the top qualified.

The first Filipina meteorologist from this batch of weather bureau pensionado scholars was Celia Gallego-Bantegui. She also had the distinction of being the first Filipina member in the American Meteorological Society in 1948. She married her co-worker in the weather bureau and meteorology pensionado Bernardino G. Bantegui who aside from a career in meteorology, became a founding pillar in national government statistics. She is seen here in the photo at the right during the WMO 42nd IMO prize awarding of her weather co-pensionado, Dr. Mariano Estoque.

After the iconic TV weather forecaster, Amado Pineda retired from the government service, his spot was briefly taken over by Nanette Lomarda, as PAGASA's official televised weather forecaster. She resigned to accepted a position to the World Meteorological Organization's head office in Geneva Switzerland, and in that capacity continued to be the highest ranking WMO Filipina scientist concerned with research and international policy coordination of meteorology, tropical cyclones and climate issues.

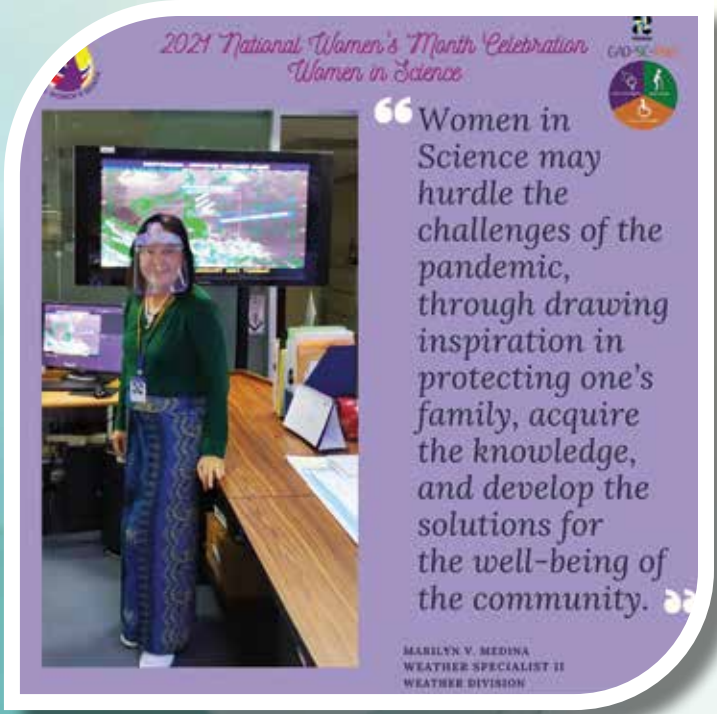
Dr. Aida Jose - PAGASA's "First lady of Philippine climatology" and pioneer of the drought early warning and climate change studies in the country.

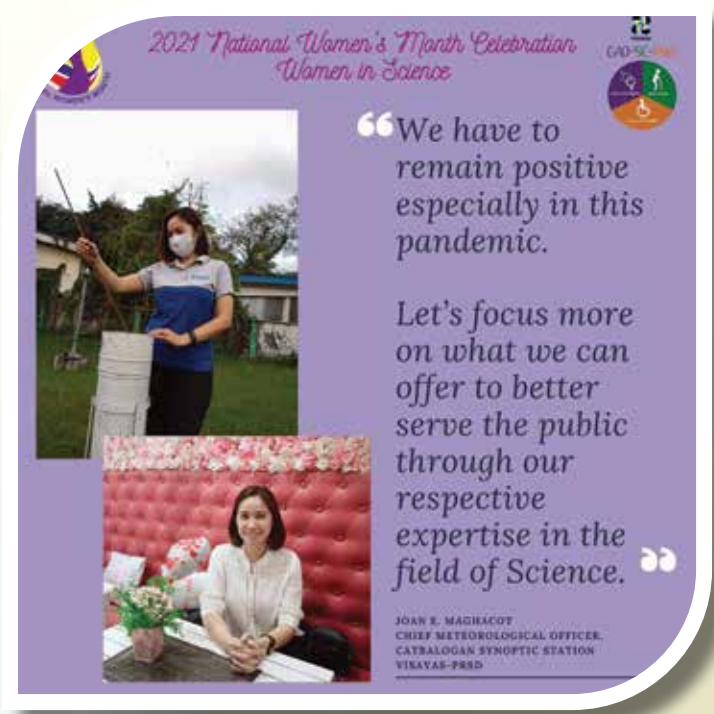
Dr. Flaviana Hilario - (left), was the first Deputy Administrator for R&D, after her retirement her position was filled by Dr. Esperanza Cayanan - (right) the first woman Chief of the Weather Forecasting Division

Loriedin Dela Cruz - a weather specialist is the fresh new face of the PAGASA millennial woman, there are many competent professionals like her today. The nostalgic photo below is of the PAGASA Women's Circle of a bygone era.

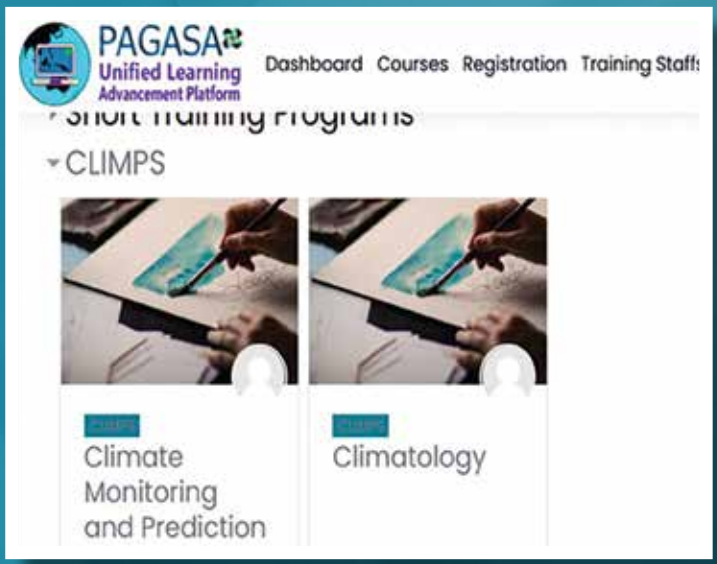
PAGASA-GAD also featured Women in Science showcasing the roles of women in the midst of pandemic, asking the women of PAGASA:

"How can a woman in the field of Science hurdle the challenges of the pandemic and empower others to remain hopeful?"





Development of Learning Management System (LMS) for Climatology and Climate Monitoring and Prediction under PAGASA Unified Learning Advancement Platform



PAGASA aims to make its learning and development programs more cost-efficient, effective and available, thus, it will utilize a learning and management system (LMS) that augments the initiative to continuously develop a brilliant, highly qualified and integrated workforce.

The objective of the LMS is to create a Moodle site (the world's most widely used open-source LMS) for PAGASA, which can be used readily and can maximize the learning and development courses and activities.

In partnership with the Nephila Web Technology, PAGASA in-house training instructors and content managers were capacitated in using the system. Three trainings were already conducted for the development and implementation of the Learning Management Systems (LMS) namely the Moodle Training for Teachers, H5P Interactive Content Training and Instructional Design in Moodle.

List of Graduates

"An investment in knowledge pays the best interest."
— Benjamin Franklin

PAGASA gives high regard to continuous learning and acquiring of skills to attain one's dream and passion. To all the PAGASA employees who pursue higher education towards improving knowledge as public servants, Mabuhay kayong lahat!

This achievement is also a testament of healthy relationships with both local and international schools and organizations who partnered with PAGASA.

Full name: Lory Jean L. Canillo
Course: Master in Information Systems
Date Covered: June 2018-February 2021
School: Technological Institute of the Philippines
Date of Graduation: June 2021

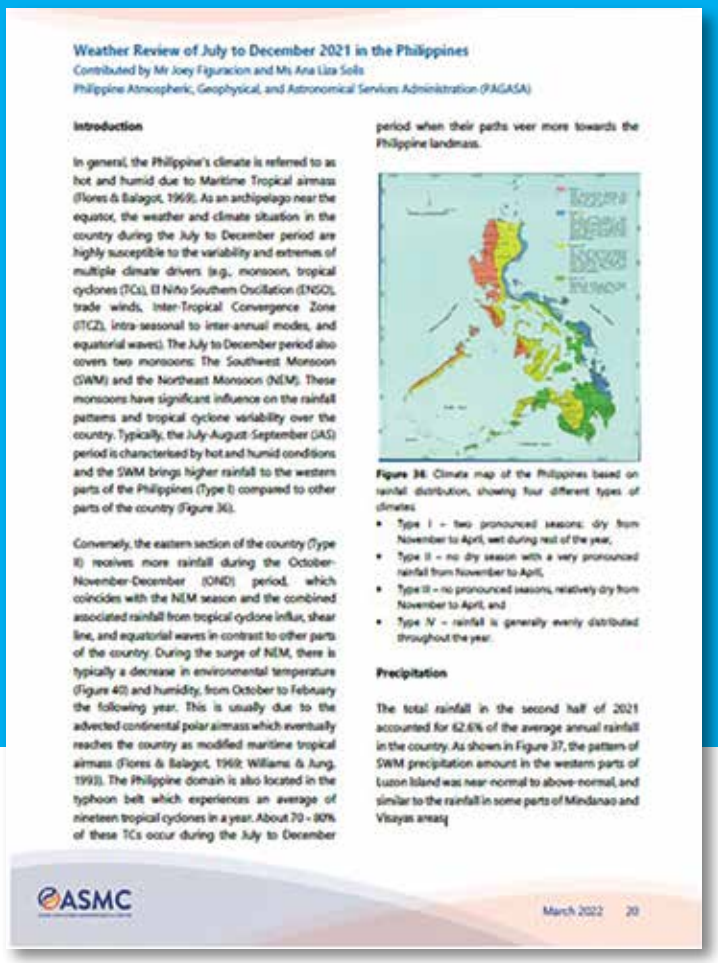
Full name: Jehan Fe S. Panti
Course: Master of Civil and Environmental Engineering
Date covered: October 2019 - September 2021
School: Tohoku University
Date of Graduation: September 24, 2021

REGIONAL AND INTERNATIONAL COOPERATION PROGRAM

17th Session of ASEANCOF

The 17th session of the ASEAN Climate Outlook Forum (ASEANCOF-17) was organized by the ASEAN Specialised Meteorological Centre (ASMC) in collaboration with the ASEANCOF working group. Representatives from the different ASEAN National Meteorological and Hydrological Services (NMHS) created a consensus forecast in the ASEAN region for the boreal winter monsoon 2021/2022. The consensus for December-January-February (DJF) 2021/2022 outlooks was achieved through an online session.

The activity was held on 22-26 November 2021, highlighting the presentations from NMHSs and Global Producing Centres (GPCs) on seasonal outlooks and discussions on the current conditions and predictions for the Southeast Asia region.



Weather Review of July to December 2021 in the Philippines

Contributed by Mr Joey Figuracion and Ms Ana Liza Solis

Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA)

Introduction

In general, the Philippine's climate is referred to as hot and humid due to Maritime Tropical airmass (Flores & Balagot, 1969). As an archipelago near the equator, the weather and climate situation in the country during the July to December period are highly susceptible to the variability and extremes of multiple climate drivers (e.g., monsoon, tropical cyclones (TCs), El Niño Southern Oscillation (ENSO), trade winds, Inter-Tropical Convergence Zone (ITCZ), intra-seasonal to inter-annual modes, and equatorial waves). The July to December period also covers two monsoons: The Southwest Monsoon (SWM) and the Northeast Monsoon (NEM). These monsoons have significant influence on the rainfall patterns and tropical cyclone variability over the country. Typically, the July-August-September (JAS) period is characterized by hot and humid conditions and the SWM brings higher rainfall to the western parts of the Philippines (Type I) compared to other parts of the country (Figure 36).

Conversely, the eastern section of the country (Type II) receives more rainfall during the October-November-December (OND) period, which coincides with the NEM season and the combined associated rainfall from tropical cyclone influx, shear line, and equatorial waves in contrast to other parts of the country. During the surge of NEM, there is typically a decrease in environmental temperature (Figure 40) and humidity, from October to February the following year. This is usually due to the advected continental polar airmass which eventually reaches the country as modified maritime tropical airmass (Flores & Balagot, 1969; Williams & Jung, 1993). The Philippine domain is also located in the typhoon belt which experiences an average of nineteen tropical cyclones in a year. About 70 - 80% of these TCs occur during the July to December period when their paths veer more towards the Philippine landmass.

Figure 36. Climate map of the Philippines based on rainfall distribution, showing four different types of climates

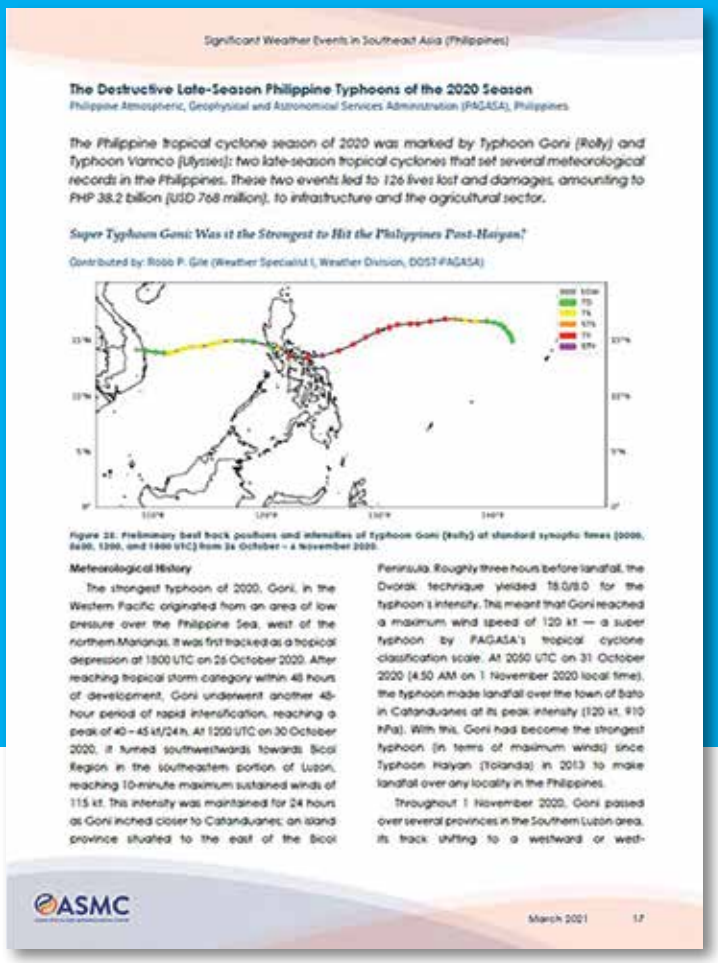
- Type I – two pronounced seasons: dry from November to April, wet during rest of the year,
- Type II – no dry season with a very pronounced rainfall from November to April,
- Type III – no pronounced seasons, relatively dry from November to April, and
- Type IV – rainfall is generally evenly distributed throughout the year.

Precipitation

The total rainfall in the second half of 2021 accounted for 62.6% of the average annual rainfall in the country. As shown in Figure 37, the pattern of SWM precipitation amount in the western parts of Luzon Island was near-normal to above-normal, and similar to the rainfall in some parts of Mindanao and Visayas areas.

ASMC

March 2022 20



Significant Weather Events in Southeast Asia (Philippines)

The Destructive Late-Season Philippine Typhoons of the 2020 Season

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Philippines

The Philippine tropical cyclone season of 2020 was marked by Typhoon Goni (Rolly) and Typhoon Vamco (Ulysses): two late-season tropical cyclones that set several meteorological records in the Philippines. These two events led to 126 lives lost and damages amounting to PHP 38.2 billion (USD 768 million), to infrastructure and the agricultural sector.

Super Typhoon Goni: Was it the Strongest to Hit the Philippines Post-Haiyan?

Contributed by: Rosa P. Gile (Weather Specialist I, Weather Division, DOST-PAGASA)

Figure 28. Preliminary best track positions and intensities of Typhoon Goni (Rolly) at standard synoptic times (0000, 0600, 1200, and 1800 UTC) from 26 October – 1 November 2020.

Meteorological History

The strongest typhoon of 2020, Goni, in the Western Pacific originated from an area of low pressure over the Philippine Sea, west of the northern Marianas. It was first tracked as a tropical depression at 1800 UTC on 26 October 2020. After reaching tropical storm category within 48 hours of development, Goni underwent another 48-hour period of rapid intensification, reaching a peak of 40 – 45 kt/24 h. At 1200 UTC on 30 October 2020, it turned southwestwards towards Bicol Region in the southeastern portion of Luzon, reaching 10-minute maximum sustained winds of 115 kt. This intensity was maintained for 24 hours as Goni inched closer to Catanduanes, an island province situated to the east of the Bicol Peninsula. Roughly three hours before landfall, the Dvorak technique yielded T8.0/8.0 for the typhoon's intensity. This meant that Goni reached a maximum wind speed of 120 kt — a super typhoon by PAGASA's tropical cyclone classification scale. At 2050 UTC on 31 October 2020 (4:50 AM on 1 November 2020 local time), the typhoon made landfall over the town of Bato in Catanduanes at its peak intensity (120 kt, 910 hPa). With this, Goni had become the strongest typhoon (in terms of maximum winds) since Typhoon Haiyan (Yolanda) in 2013 to make landfall over any locality in the Philippines.

Throughout 1 November 2020, Goni passed over several provinces in the Southern Luzon area, its track shifting to a westward or west-

ASMC

March 2021 17

Sample of articles contributed by PAGASA to the ASMC Biannual Bulletin

ASEAN Specialized Meteorological Centre (ASMC) Biennial Bulletin

The ASEAN Specialized Met Center (ASMC) supports the ASEAN NMHSs to benefit fully from the advances in meteorological science and technology and provide steadfast support possible through weather and climate services to critical economic sectors.

The ASMC biannual bulletin comprises a review and outlook of haze, weather, and climate relevant to the ASEAN region. It aims to provide necessary information to users in ASEAN's NMHSs' water resources management, disaster risk reduction, agricultural, environmental, and forestry sectors. It is published every March and September of each year to align the outlook and assessment with the quarterly seasons of March-May & June-August (MAM & JJA) and September-November & December-February (SON & DJF).

PAGASA, as the network node for Climate Monitoring in Southeast Asia under the World Meteorological Organization-Regional Climate Center (WMO-RCC) Network (demonstration phase), contributes/ provides articles about the significant weather events affecting the Philippines during the review period. This cooperation demonstrates PAGASA's capability to perform its mandatory function as a climate monitoring node for SEA under WMO-RCC.

New Project

JPOW Project

The Capability Enhancement for High-Quality Weather Observation, Forecasting, Warning and Information in the Philippines or the JPOW-2 project is a three-year technical cooperation project between the Japan International Cooperation Agency (JICA) and PAGASA, which started in February 2021. It aims to provide high-quality and enhanced weather observation forecasts, warnings, and information through knowledge transfer from JICA experts to PAGASA forecasters.

The project includes capacity-building activities that will enhance the knowledge of target recipients, especially PRSDs, on calibration and maintenance of surface meteorological observation systems. It will also develop a high-quality Quantitative Precipitation Estimation (QPE) through the improved data quality in three target radar sites. In addition, the precipitation guidance will be incorporated into weather forecast operation, and the understanding of selected LGUs on the forecast, warning, and information will be enhanced and can be translated into appropriate actions.

Improvement of Forecast Capability on Weather, Marine Meteorology and Short-Range Climate (Phase II) DOST MECO-TECO VOTE Program

This three-year program is a continuation of the first phase program between the Meteorology Community of Taiwan and the Philippines, which started in 2016 and ended in 2019. During the first phase, the meteorology community in Taiwan, including academic scientists from various universities in Taiwan, namely National Taiwan University, National Central University, National Taiwan Normal University, and National Chung Cheng University, and operational agencies, namely Central Weather Bureau and Soil and Water Conservation Bureau have established close linkage with academic scientists from universities such as UP Diliman and UP Los Baños and operational agencies such as the Manila Observatory, PAGASA, and PHIVOLCS. The collaboration among the mentioned institutions includes training programs on modern radar data processing technology, high-resolution numerical modeling technology, the science of precipitation, how to make better usage of ensemble forecast products, etc.

The primary goal of the second phase of the MECO-TECO VOTE Program is to improve the forecast capability for Severe and Extreme Weather Events and Ocean Hazards in Taiwan and the Philippines and to enhance the TC sub-seasonal to seasonal prediction in Taiwan and the Philippines and the surrounding oceans, through capacity building programs, data exchange, and science and technology collaboration.

The program involves three significant projects necessary to achieve the main objective of the program:

Project 1: Enhancement of Typhoon and Tropical Cyclone (TC)-related Monsoon Surge Monitoring and Forecasting

It is vital to ensure that the methodologies associated with TC analysis, forecast, and warning remain efficient even during time-critical situations, such as during the three-hourly issuance of Severe Weather bulletins. The forecasters must remain confident in issuing forecasts and warnings by ensuring the availability of quality and reliable forecast guidance tools.

The project will develop a gridded quantitative precipitation estimate (QPE), quantitative precipitation forecast (QPF) from radar observations, and Z-R relationship from radar stations. The derived and validated Z-R relationship will enhance the confidence of operational forecasters, particularly in the Rainfall Warning System, in providing better rainfall warnings. Likewise, the QPF will be used to either estimate or track the movement or direction of a particular weather system, especially the convective precipitation types.

Moreover, high-resolution quality-controlled radar and surface observation networks will be assimilated to improve the numerical weather prediction (NWP) system. The products generated by the data assimilation system will add value to the operational forecasts.

Project 2: Radar Data Application and High-quality resolution Quantitative Precipitation Forecast (QPF) for Complex Terrain

This study will analyze the microphysical characteristics of precipitation systems. The microphysical process of various precipitation systems can be examined through the use of the drop size distribution (DSD) of rain observed by a ground disdrometer.
In 2018, PAGASA acquired 22 PARSIVEL laser-based optic disdrometers as part of the PAGASA Modernization Program. This project will harness the disdrometers to contribute in optimizing the use of the existing PAGASA radar network. A combination of DSD and radar data in precipitation monitoring and QPE is the final product of this project.

Moreover, for high resolution probabilistic QPF over complex terrain, the cloud-resolving storm simulator (CReSS) model will be used to perform hindcast experiments that will investigate several selected landfalling typhoons and heavy rain over mountainous areas. The experiments will be evaluated for its ability to provide quantitative forecasts in probabilistic form using the time-lagged ensemble technique.

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Project 3: Sub-seasonal to Seasonal (S2S) Prediction of Climate Extremes

S2S prediction is a subject of research considering models are continuously improving. Madden Julian Oscillation (MJO), a core component of intra-seasonal variability (30 to 100 days), and El Niño Southern Oscillation (ENSO), a dominant mode of seasonal variability in tropical maritime climate (such as Philippines and Taiwan), have a strong influence on tropical cyclone genesis. However, tropical cyclone rainfall (TCR) and rainfall extremes may vary at different MJO phases, spatial patterns and propagation, and ENSO phases and intensities. Thus, it is necessary to identify the essential features of MJO and ESO in controlling TCR variability, which may serve as guidance in improving TC forecast and rainfall extremes in the Philippines at sub-seasonal to seasonal time scale.

The potential benefits of skillful S2S are high, but its forecasts require better accuracy. This project will maximize the use of the High-Performance Computing (HPC) facility of PAGASA to produce high-resolution, representative land surface states, downscaled Climate Forecast System (CFS), and Global Ensemble Forecast System (GEFS) at the S2S time scale.

The project will produce two publications, S2S forecast products (Week1, Week2, Weeks3-4) and web-based extended-range TC forecast products. It will also have capacity-building training related to S2S in partnership with the CWB, Tamkang University, and NTU. A policy on providing S2S rainfall forecasts with lead times extending to one month and on TC forecasts for lead times extending to one month will also be developed.

GENERAL ADMINISTRATION AND SUPPORT PROGRAM

PAGASA's effort to a safer workplace: Let's get vaxxed!

Along with proper hygiene, nutrition and healthy living, vaccines have contributed significantly to reducing the deadly effects and impacts of the pandemic. As responsible frontline workers in the government sector, PAGASA believes that vaccines work.

With the development of the National COVID-19, Deployment and Vaccination Program to prioritize Group A4 frontline personnel in essential sectors of the National Government Agencies, employees of PAGASA were vaccinated on June 27 (first dose) and September 17 (2nd dose).
PAGASA extends its gratitude to the Department of Science and Technology (DOST) through the support and guidance of Undersecretary Renato U. Solidum, Jr., the PAGASA Weathermen Employees Association (PWEA), the Quezon City Local Government Unit (QC-LGU), and the medical front liners and volunteers for the successful implementation of the vaccination program.
Let's get vaxxed!

PAGASA's endeavor to sustainable Public Service Continuity Plan (PSCP)

The PSCP is an all-hazard plan that aims to ensure uninterrupted delivery of services to the public amid any disruption. It works by determining an agency's mission essential functions, matching and highlighting its internal capacities, recovery requirements, and strategies to minimize damage and loss to essential processes, ensure smooth succession of leadership, and improve continuity capabilities of all government entities, delivering public service as normal.

With the help and guidance of the Office of Civil Defense (OCD) in partnership with Philippine Disaster Resilience Foundation (PDRF), PAGASA strives to improve its initial PSCP submitted in March 2021 together with other pioneer agencies who completed the initial draft of their public service continuity plan. Moreover, to check in detail the contents of each section of PAGASA PSCP, PAGASA participated in an online preparatory meeting held on October 12, 2021 to enjoin the government agencies, LGUs and other organizations in the finetuning of the its respective Public Service Continuity Plans.

Looking forward to 2022, the Office of Civil Defense is planning to launch its second PSCP Guidebook where PAGASA Technical Working Group members will take part as content writers.

Mid-year and Year End PRA with USec Renato Solidum

The mid-year and year-end performance review allows PAGASA to evaluate the agency's performance for the entire year, preparing the executive staff and planning officers with necessary adjustments and decisions towards accomplishing plans, targets, and goals.

The Plans and Programs Development Unit facilitated the performance reviews highlighting notable accomplishments and feats of the agency, as well as areas that need ample attention and careful planning. DOST Undersecretary Renato Solidum Jr., Executive Staff, and Planning Officers of PAGASA attended the activity in a hybrid format (virtual and face-to-face) in adherence to the minimum health standards set by Inter-Agency Task Force on Emerging Infectious Disease (IATF).

Year End Assessment with Media

One of the many ways the public attains information is through the media, which publicizes information to all possible recipients. PAGASA's definitive goal of empowering the people through information dissemination, with the help of the media, will make it easier to achieve.

Via virtual setup, PAGASA and some media in the different networks discussed concerns on information sharing and ways forward for the continuous improvement of services provided by PAGASA.

The activity ended with fun games and raffles as a way of PAGASA's gratitude to the media family for its valuable contribution to public information communication.

Published Research Papers

Title	Author	Publication or Journal
Sensitivity of tropical cyclones to convective parameterization schemes in the RegCM4	M.Q. Villafuerte II J.C.R. Lambrento K.I. Hodges F.T. Cruz T.A. Cinco G.T. Narisma	Climate Dynamics 56: 1625-1642 https://doi.org/10.1007/s00382-020-05553-3
An improved method to estimate actual vapor pressure without relative humidity data	R. Qiu L. Li S. Kang C. Liu Z. Wang E. P. Cajucom B. Zhang E. Agathokleous	Agricultural and Forest Meteorology, Volumes 298–299, 108306 https://doi.org/10.1016/j.agrformet.2020.108306
Recent increase in the occurrences of Christmas typhoons in the Western North Pacific	J. Basconcillo I.J. Moon	Scientific Reports 11, 7416 (2021) https://www.nature.com/articles/s41598-021-86814-x
The effect of urbanization on temperature indices in the Philippines	J.A. Manalo J. Matsumoto H.G. Takahashi M.Q. Villafuerte II L.M. Olaguera G. Ren T.A. Cinco	International Journal of Climatology https://doi.org/10.1002/joc.7276
Tropical cyclone climatology and variability in Taiwan and Philippine Region during 1979 - 2018	Lu, M.-M C.-H. Sui C.-H. Wu A. L. S. Solis M.-D. Cheng	Terrestrial, Atmospheric and Oceanic Sciences Journal http://tao.cgu.org.tw/index.php/articles/archive/atmospheric-science/item/1743-2020113001avote
Characterizing the highest tropical cyclone frequency in the Western North Pacific since 1984	J. Basconcillo EJ. Cha IJ. Moon	Scientific Reports 11, 14350 (2021 https://doi.org/10.1038/s41598-021-93824-2)
Assessing the potential predictability of tropical cyclone activity in the Philippines on weekly timescales	M.Q. Villafuerte II T-T. Lo H-C. Tsai E.O. Cayanan	Terrestrial, Atmospheric and Oceanic Sciences DOI:10.3319/TAO.2021.08.23.03
Possible influence of the warm pool ITCZ on compound climate extremes during the Boreal Summer	J. Basconcillo IJ. Moon B. Wang M. Mistry	Environmental Research Letters 16 114039 https://iopscience.iop.org/article/10.1088/1748-9326/ac30f8

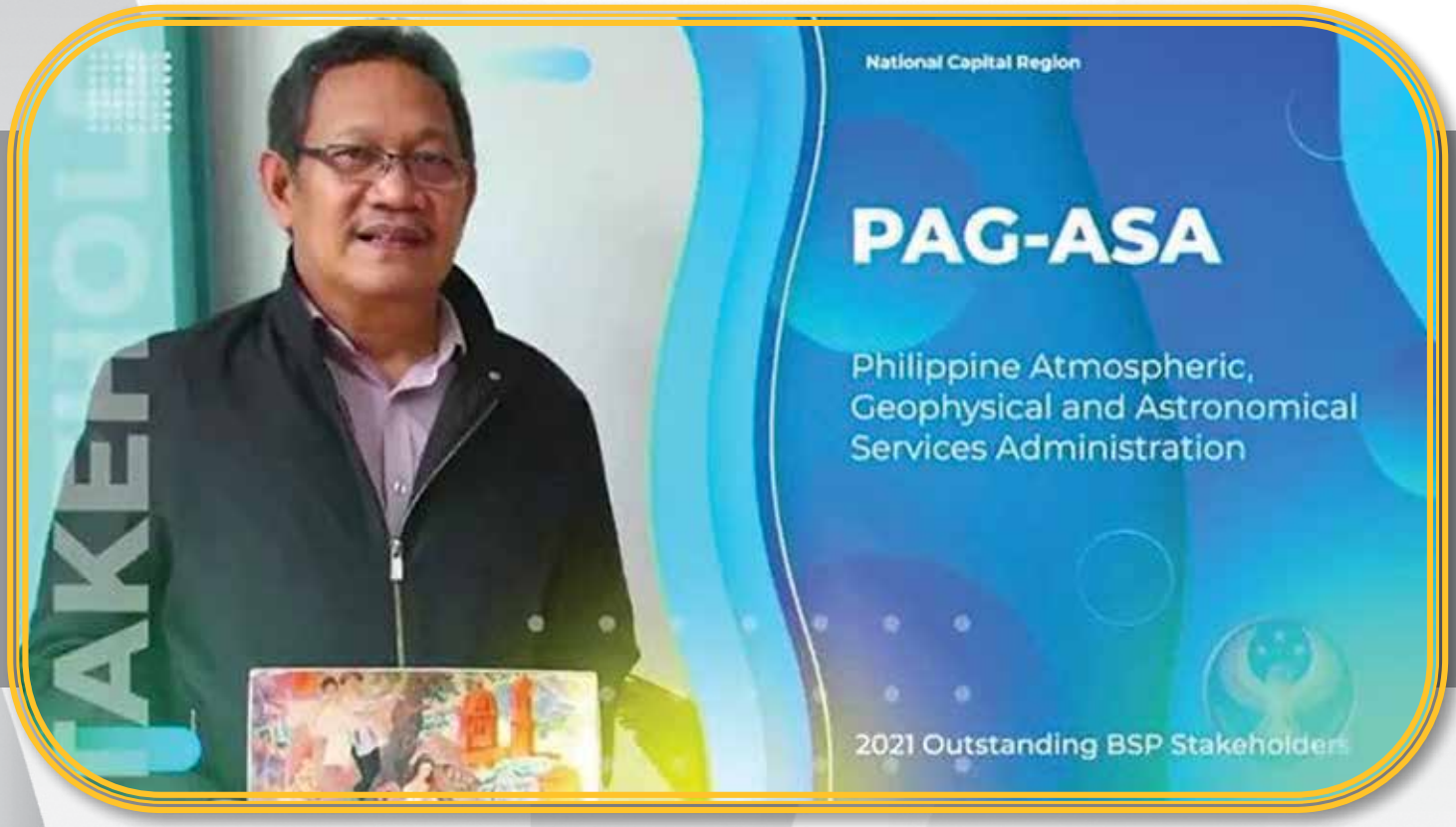
Awards and Recognitions

(BSP, CESB)

BSP honors PAGASA as one of the 2021 Outstanding Stakeholder Awardees

Through the Virtual BSP Stakeholders Appreciation Ceremony held on July 30, 2021, Bangko Sentral ng Pilipinas once again honored the agencies, organizations, and stakeholders for their unwavering support in the endeavors of BSP. With the theme "Pagpupugay at Pagkilala: Sa Gitna ng Hamon ng Pandemya," PAGASA was selected as one of the stakeholders who remarkably support BSP in achieving its goals amid the pandemic.

BSP is vigorously grateful to all the stakeholders who imparted their best interests and efforts in answering the call of public service for the welfare of the people. "Today, we give due recognition to partners who have gone beyond the call of duty in the name of service at the height of the global health crisis," BSP Gov. Diokno said.



PAGASA's recognition from Career Executive Service Board

On November 29, 2021, PAGASA received recognition from the Career Executive Service Board for its continued support, exceptional commitment, and invaluable contribution to updating the CES database through consistent submission of the Agency's updated CES Occupancy Reports.

The Career Executive Service is the "third level" or the managerial class in the group of career positions in the Philippine civil service. The CES was created by Presidential Decree No. 1 to "form a continuing pool of well-selected and development-oriented career administrators who shall provide competent and faithful service."

PAGASA as part of Philippine Climate Change Assessment (PhilCCA) : Recipient of the 2021 OUTSTANDING BOOK and MONOGRAPH AWARDS - Special Citation

ML Center representatives and authors from PhilCCA Working Group Report 1 during the launch in 2016 (left to right: Ms. Marianne G. Quebral, Mr. John Leo C. Algo, Dr. Faye Abigail T. Cruz, Dr. Flaviana D. Hilario (PAGASA), Fr. Jose Ramon T. Villarin, Ms. Lourdes V. Tibig, Ms. Sandee G. Recabar, Ms. Perlyn Pulhin-Yoshida, Ms. Rafaela Jane P. Delfino, and Dr. Rodel D. Lasco).

The National Academy of Science and Technology (NAST) annually honors Filipino publishers based in the Philippines for the books and monographs published and were adjudged to be outstanding in the field of Agricultural Sciences, Biological Sciences, Mathematical and Physical Sciences, Engineering Sciences and Technologies, Health Sciences, and the Social Sciences. In 2021, the Philippine Climate Change Assessment Report (PhilCCA) was a recipient of a Special Citation for Outstanding Book/Monograph. Out of the individuals in the Working Group Report, one is Dr. Flaviana D. Hilario of PAGASA.

Special Award

The Philippine Climate Change Assessment (PhilCCA) has been chosen as the recipient of the 2021 OUTSTANDING BOOK and/or MONOGRAPH AWARDS-Special Citation.

[Working Group 1] Jose Ramon T. Villarin, John Leo C. Algo, Thelma A. Cinco, Faye Abigail T. Cruz, Rosalina G. De Guzman, Flaviana D. Hilario, Gemma Teresa T. Narisma, Andrea Monica D. Ortiz, Fernando P. Siringan, Loudes V. Tibig;

[Working Group 2] Rex Victor O. Cruz, Porfirio M. Aliño, Olivia C. Cabrera, Carlos Primo C. David, Laura T. David, Felino P. Lansigan, Rodel D. Lasco, Wilfredo Y. Licuanan, Fely Marilyn E. Lorenzo, Samuel S. Mamauag, Eileen L. Penaflor, Rosa T. Perez, Juan M. Pulhin, Rene V. Rollon, Maricar S. Samson, Fernando P. Siringan, Lourdes V. Tibig, Noralene M. Uy, Cesar L. Villanoy;

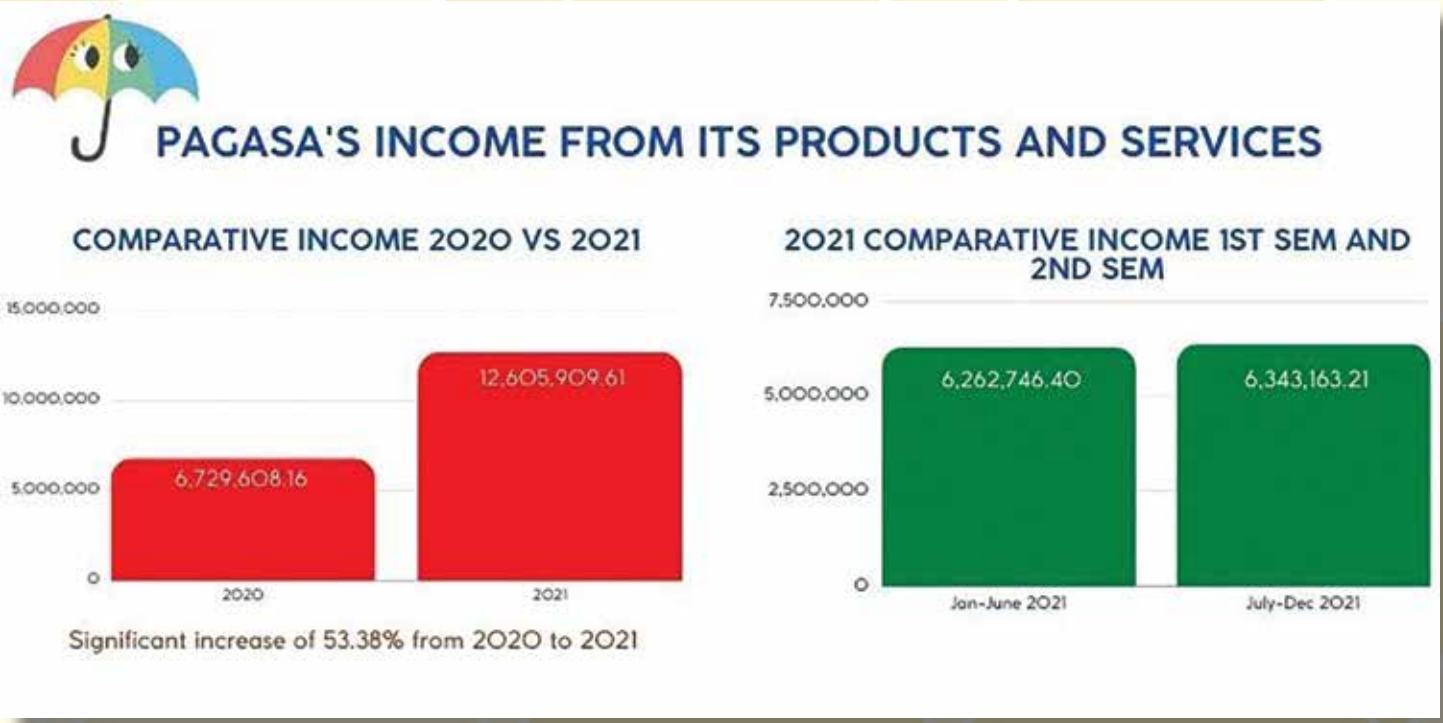
[Working Group 3] Leandro V. Buendia, Rodel D. Lasco, Joe Buenvenido B. Biona, Robert B. Badrina, Maria S. Baviera, Agnes C. De Jesus, Daniel Marc G. Dela Torre, Rex B. Demafelis, Florencia B. Pulhin, Sandee G. Recabar, Clarissa D. Ruzol, Everlyn Gayle T. Tamayo, Maricel A. Tapia, Benradette Tongko-Magadia, Lorena L. Sabino, Noel G. Sabino

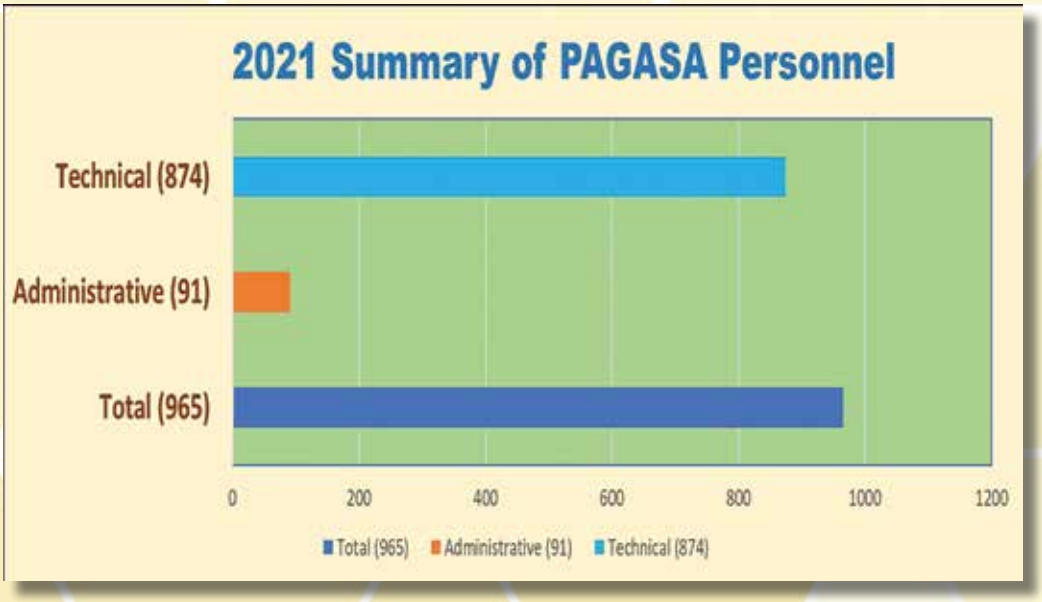
ISSN/ISBN: 2508-089X

Formed with the Climate Change Commission (CCC) from 2016 to 2018, the PhilCCA Report contains inclusive material on climate change science in the Philippines. Patterned after the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports, the PhilCCA synthesizes the state of scientific knowledge on climate change in the Philippines, offers an assessment of impacts, and classifies gaps in scientific literature. Prepared by Filipino IPCC authors and other leading scientists and experts in their field of study, the report consists of three working groups (1) the physical science basis, (2) impacts, adaptation, and vulnerability, and (3) mitigation of climate change.

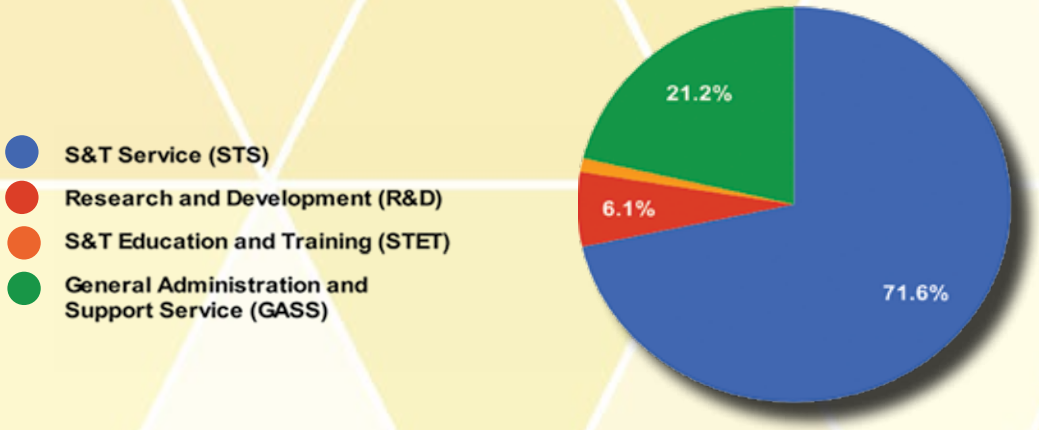
The commission has also produced the PhilCCA Sectoral Snapshots as companion materials highlighting the climate vulnerabilities of Philippine forests and the public health sector. Derived from the findings of the PhilCCA, the sectoral snapshots present the effects of climate change, as well as the mitigation potential of these sectors and adaptation strategies, in a more visual method

Comparative Income





Distribution of Personnel by S&T Function



DISTRIBUTION OF PERSONNEL BY S&T FUNCTION
Reference: PLANTILLA OF PERSONNEL as of DECEMBER 31, 2021

CATEGORY OF PERSONNEL	LEVEL OF EDUCATION				TOTAL	%
	Below BS	BS/BA	MS/MA	PhD		
S&T Service (STS)	124	416	44	2	586	71.6%
Research and Development (R&D)	2	26	20	2	50	6.1%
S&T Education and Training (STET)	2	6	1	0	9	1.1%
General Administration and Support Service (GASS)	42	107	21	4	174	21.2%
TOTAL	170	555	86	8	819	100%

Hall of Honor

2021 PAGASA COMPULSORY RETIREES

JESSIE B. ARCE
38 years of service

RUTH O. BALATBAT
37 years of service

ANABELLA B. BALOSA
38 years of service

MARGARET P. BAUTISTA
42years of service

SALVADOR B. BORAL JR
42 years of service

DARIO L. DELA CRUZ
44 years of service

REYNALDO B. DIMALALUAN
43 years of service

CARMELITA S. DUQUE
38 years of service

LEON G. ECHAVEZ III
37 years of service

NELLY C. EMBALSADO
38 years of service

REYNALDO D. GABBUAT
44 years of service

HERMES H. HINLAYAGAN
39 years of service

NORMA G. LANGARA
44 years of service

TEODORA M. LLARENA
46 years of service

NOLI A. LOPEZ
39 years of service

FELICIANO L. MADRAZO
31 years of service

JOSE C. MENDOZA IV
28 years of service

IMELDA O. OFALLA
42 years of service

NESTOR B. PARIÑAS
43 years of service

EULALIA G. SUGUILON
41 years of service

REYNALDO M. TABUZO
41 years of service

ORENCIA E. TUBLE
38 years of service

NESTOR S. YUNGCO
26 years of service

2021 PAGASA OPTIONAL RETIREES

MA. ELENITA C. CHI
42 years of service

ANELITA T. DIMAISIP
38 years of service

LANE S. FABREGAS
35 years of service

CEFERINO T. HULIPAS
38 years of service

LORNA DJ. LIRIOS
32 years of service

RENITO B. PACIENTE
35 years of service

SHEIRREL G. TEÑOSO
37 years of service

2021 PAGASA POSTHUMOUS RECOGNITION

FERDINAND M. CASTILLO
35 years of service

JOSE P. CRUZ JR.
35 years of service

DENNIS V. LAURINO
3 years of service

MARINO L. MENDOZA
32 years of service

CYNTHIA R. MIGUEL
39 years of service

RODELO A. ORMIDES
31 years of service

MA. LUISA R. SALVATIERRA
18 years of service

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The PPDU Production Staff extends their sincerest thanks to the unwavering support and tireless efforts of everyone who contributed in the completion of the 2021 PAGASA Annual Report. This would not be possible without the full support of the FPMD Chief, Mr. Jose Daniel C. Suarez.

Whatever you do, work at it with all your heart, as working for the Lord, not for human masters.
Colossians 3:23

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