Climate Change-Related Meteorological Events in the Southern Philippines

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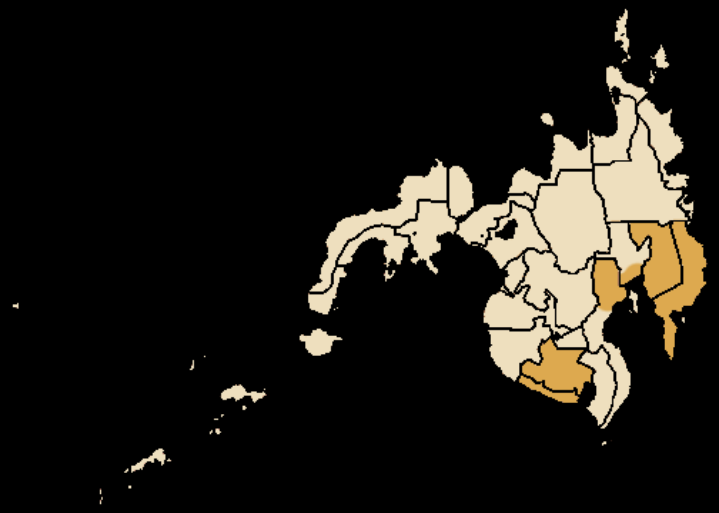
JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png

A Note on the Philippines

- South of Hong Kong & Taipei, north of Indonesia, east of peninsular Southeast Asia
- 11.3333°N, 123.0167°E
- Three regions: Luzon, Visayas and Mindanao
- We'll focus on **Southern Mindanao**
  - north of equator
  - 7.0644°N, 125.6078°E

JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png

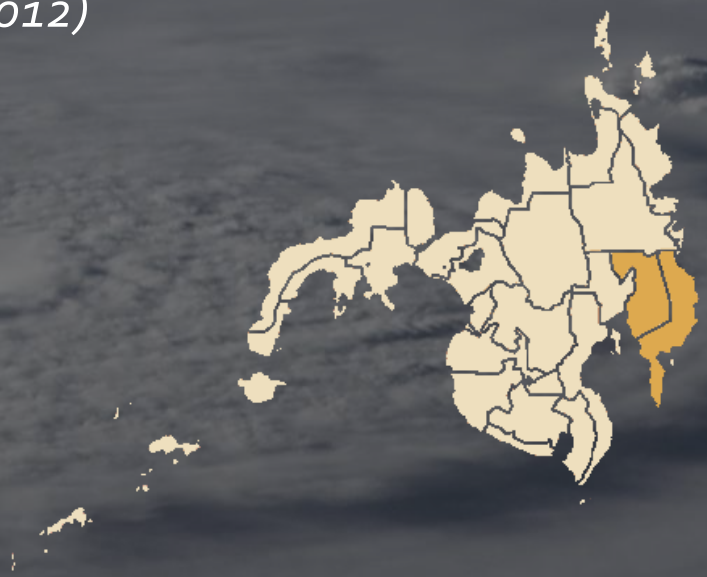
Extreme Events (Pablo & Matina Pangi)
Unusual Weather Patterns
Adaptation Activities



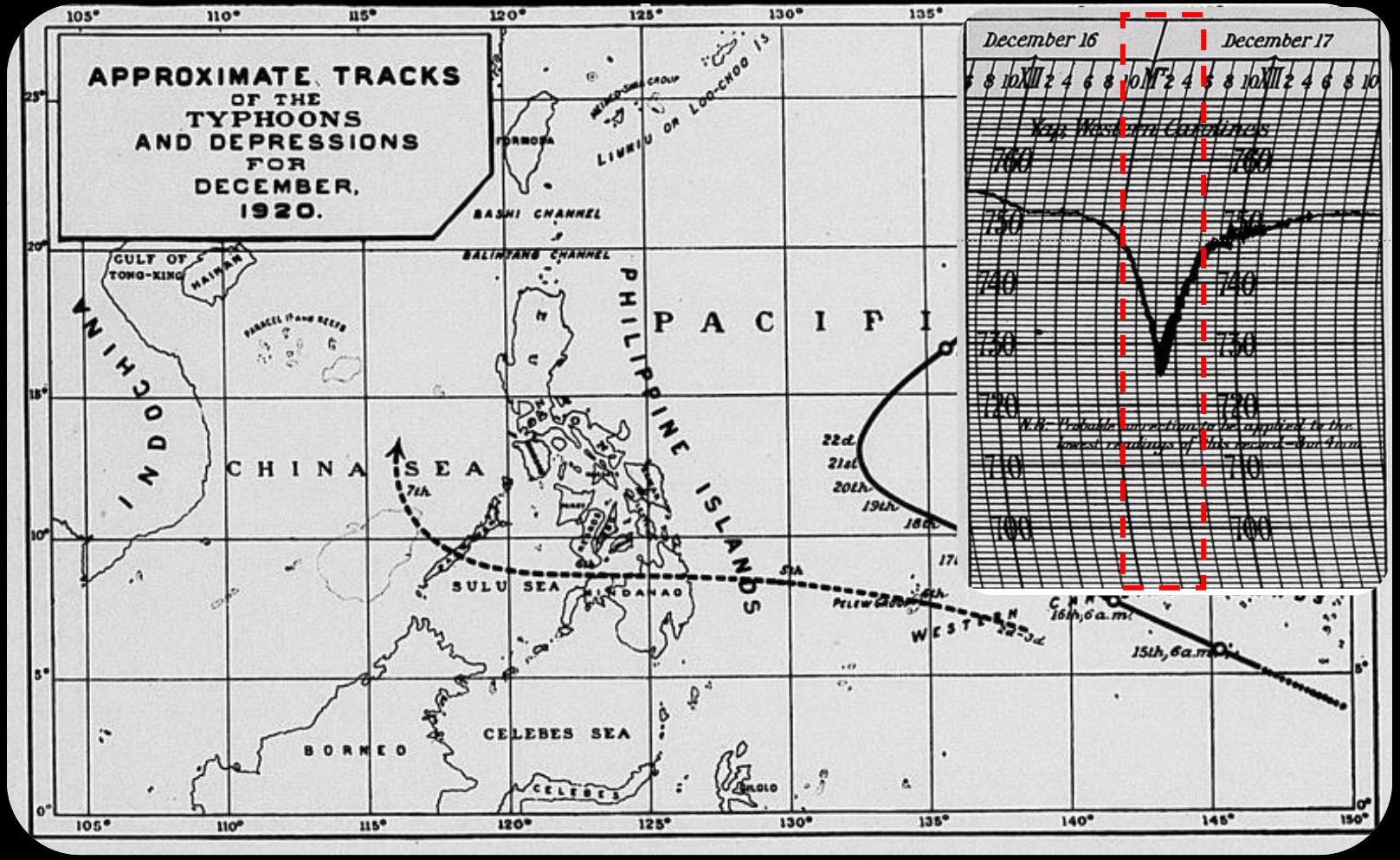
JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png

Extreme Events: Typhoon Pablo

- *International name: Bopha*
- *Landfall: December 2011, southeastern end of Mindanao*
- *The category 5 storm in numbers (AGU, 2012)*
  - ~1500 fatalities
  - ~150,000 damaged houses
    → ~61,000 "total loss" houses
  - ~USD 350 million in economic losses
  - ~5.5 million people affected



National Aeronautics and Space Administration. (2012) Super Typhoon Bopha. [Online image.] *Flickr*. Retrieved from: https://farm9.staticflickr.com/8058/8241228681_8c4931cb78_o.jpg
JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png



Why Mindanaoans Were Unprepared for Pablo

Manila Observatory. (1921). Approximate Tracks of the Typhoons and Depressions for December 1920. Retrieved from the Manila Observatory Archives.

Pablo's Effects: Agriculture - Banana Industry

Manuta, J. (2013). Enhancing Regional Capacity in Reducing Disaster Risk to Climate Related Hazards. [Untitled Monograph Series], 1. Davao City: Ateneo de Davao University.

Pablo's Effects: Agriculture – Coconut/Palm Industry

Manuta, J. (2013). Enhancing Regional Capacity in Reducing Disaster Risk to Climate Related Hazards. [Untitled Monograph Series], 1. Davao City: Ateneo de Davao University.

Pablo's Effects: Agriculture – Coconut/Palm Industry

Manuta, J. (2013). Enhancing Regional Capacity in Reducing Disaster Risk to Climate Related Hazards. [Untitled Monograph Series], 1. Davao City: Ateneo de Davao University.

Pablo's Effects: Homes & Fisheries

Manuta, J. (2013). Enhancing Regional Capacity in Reducing Disaster Risk to Climate Related Hazards. [Untitled Monograph Series], 1. Davao City: Ateneo de Davao University.

Extreme Events: Matina Pangi River

Flood Monitoring Report

Date	Monitoring Time	Water Level/Current	Time Evacuated	Evacuated Puroks	Evacuation Area	No. Of Families	Time Subsided	Remarks
28-Jun	9:31 PM	Level 3 S.C.		Teachers Village	Jesus is Lord Chapel	28		
	9:55 PM	Level 6.5 S.C.		Golden Valley	Higher ground area	35	4:15 of June 29	8:05 PM heavy rain started
	10:30 PM	Level 8 S.C	9:55 PM	Conception	Barangay Hall 74-A	15		11:17 PM Balusong Bridge over flow
	11:03 PM	Level 13 S.C.		Lastima Compound	Km. 6 San Isidro Chapel	26		
	11:17 PM	OVERFLOW S.C.		Guadalupe		23		
				Santiago		14		

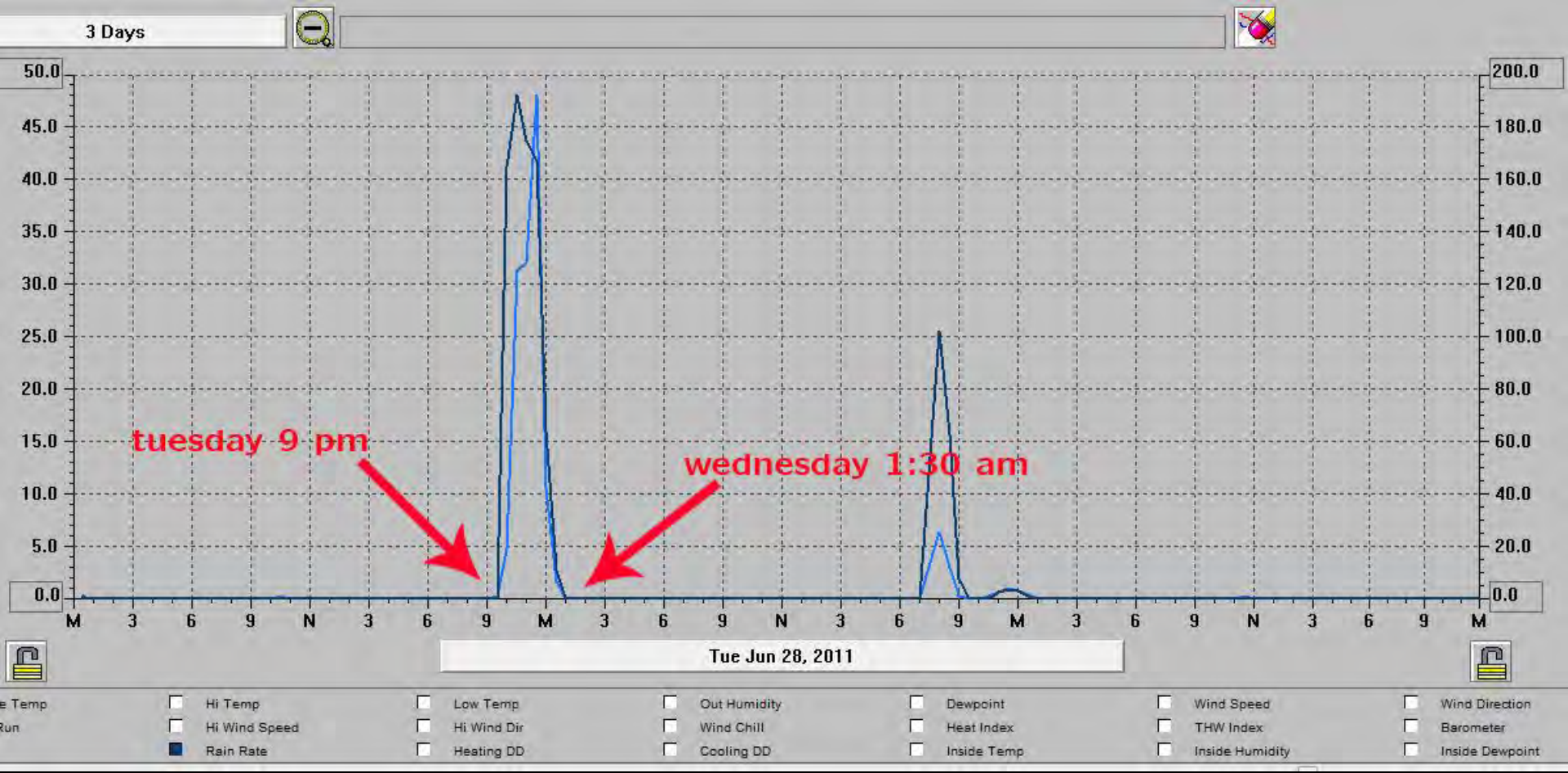
Source: Brgy. Disaster Risk Reduction Management Committee
Disaster Operation Center 74-A

Extreme Events: Matina Pangi River

August 24, 2011

January 20, 2012

JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png



Extreme Events: Matina Pangi River - Water Level Gauge at Matina Bridge

Accumulated Rainfall during June 28, 2011: 127 mm

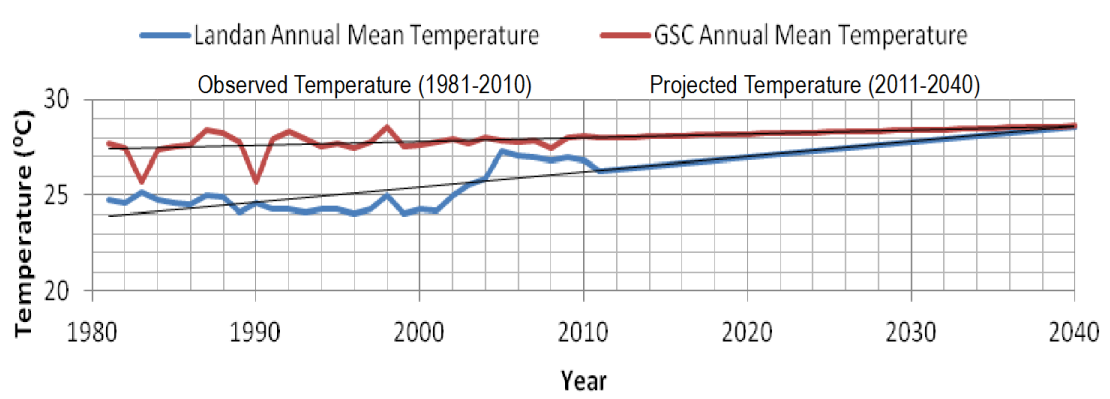
Unusual Rain Patterns

- *Usual Weather in Mindanao region*
  - warm sunny days
  - light rain at sundown that stops by nightfall
  - no storms or extreme events
  - *great* weather for agriculture
- *With climate change, first generation to not know a steady weather pattern*

Bacongco, K. (2008) Mt. Matutum. [online image]. *Flickr*. Retrieved from https://farm4.staticflickr.com/3261/2606612270_5404e4c64f_o.jpg
JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png

Unusual Rain Patterns

b.2) Climate Projections



Projected Temperature Change for 2011-2040

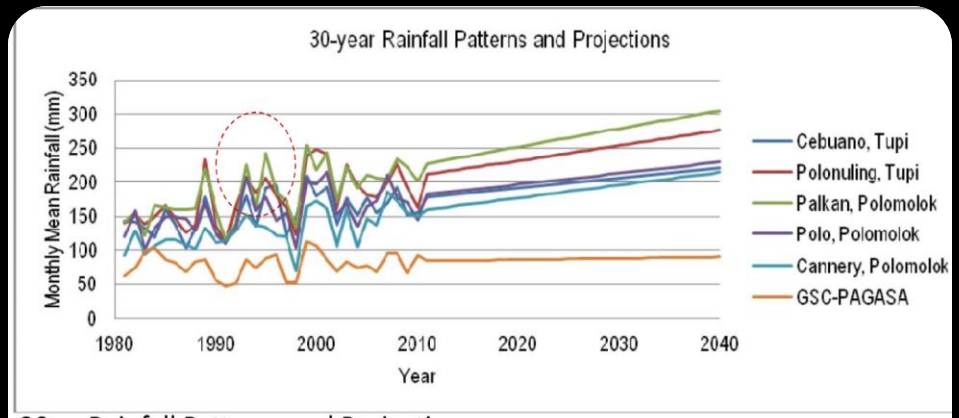
- The temperature is projected to increase by 0.69 °C in Landan compared to 0.18 °C in GSC for the next 30 years (2011-2040).
- Brgy. Landan will get warmer, more so in the relatively warmer summer months from periods 3-6. These increases are quite consistent in all parts of the country based on PAGASA projections.

(Tubigon, 2012)

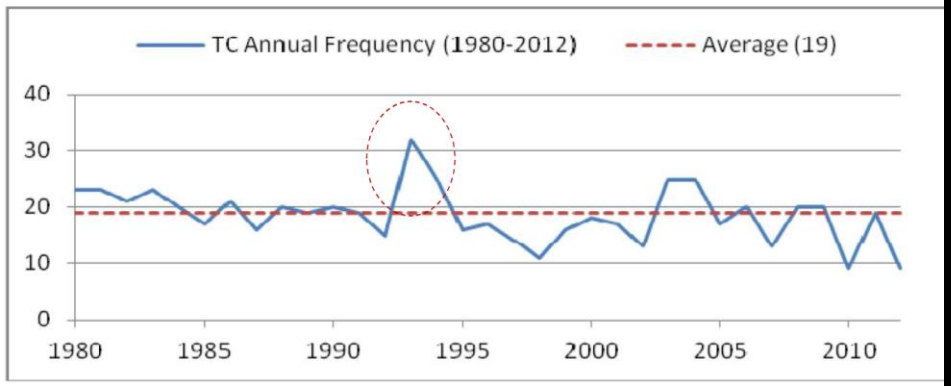
<u>Possible scenario:</u>
city temperature (General Santos City) expected to be the same as agricultural area (Polomolok, South Cotabato) over time

Unusual Rain Patterns

- *Polomolok weather stations: increasing rainfall → increasing floods*
- *Issues: density and frequency*
  - Can have high rainfall at only one time in a month
  - Unusual events: Ondoy, Pablo



30-yr Rainfall Patterns and Projections



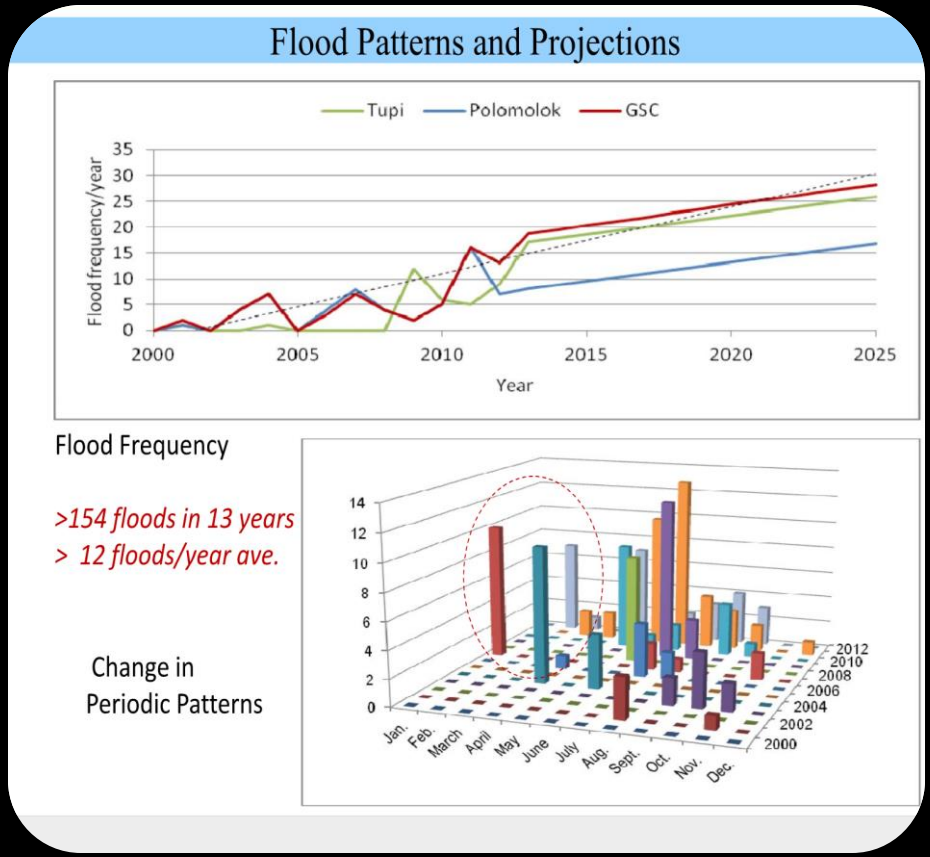
30-yr Annual Tropical Cyclone Frequency

(Tubigon, 2012)

Tubigon. (2012) Untitled. [Figures]. Images provided by the Ateneo de Davao University Tropical Institute for Climate Studies.

Unusual Rain Patterns

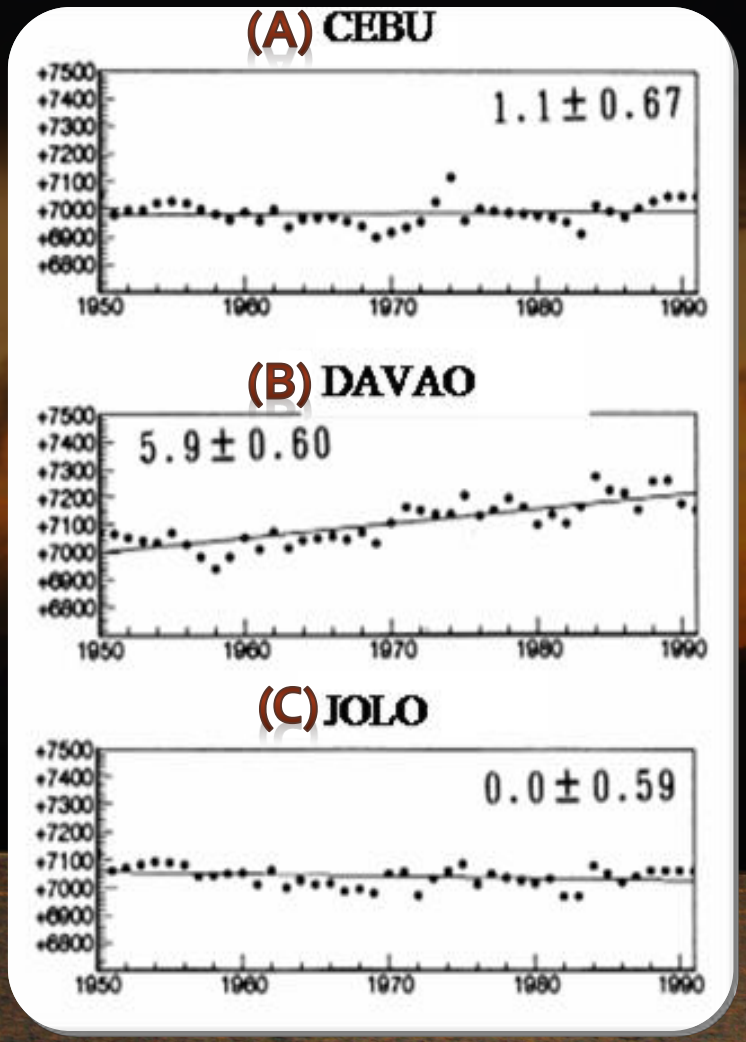
- *Regular flooding pattern in Polomolok: June – August*
- *Recent Polomolok flooding: two periods*
  - January – March
  - June – August
- *Flooding has increased in past ten years*
- *Different sectors affected*

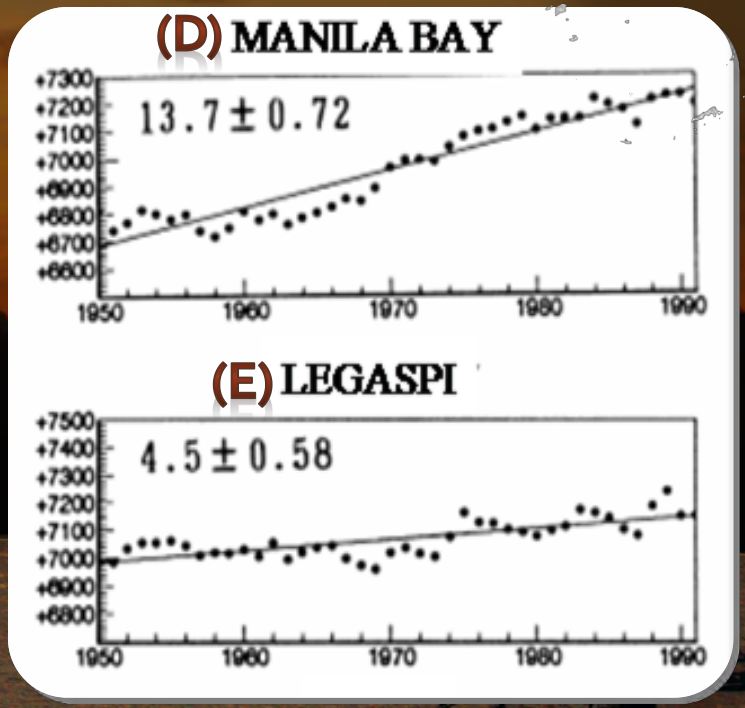


(Tubigon, 2012)

Tubigon. (2012) Untitled. [Figures]. Images provided by the Ateneo de Davao University Tropical Institute for Climate Studies.

Sea Level Rise: 1950 - 1990





(Yanagi & Akaki, 1994)

Pioquinto, J. (2013) Flood in Davao City January 20, 2013. [online image]. *Flickr*. Retrieved from https://secure.flickr.com/photos/90412460@N00/8405813168/sizes/o/in/photostream/
JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png

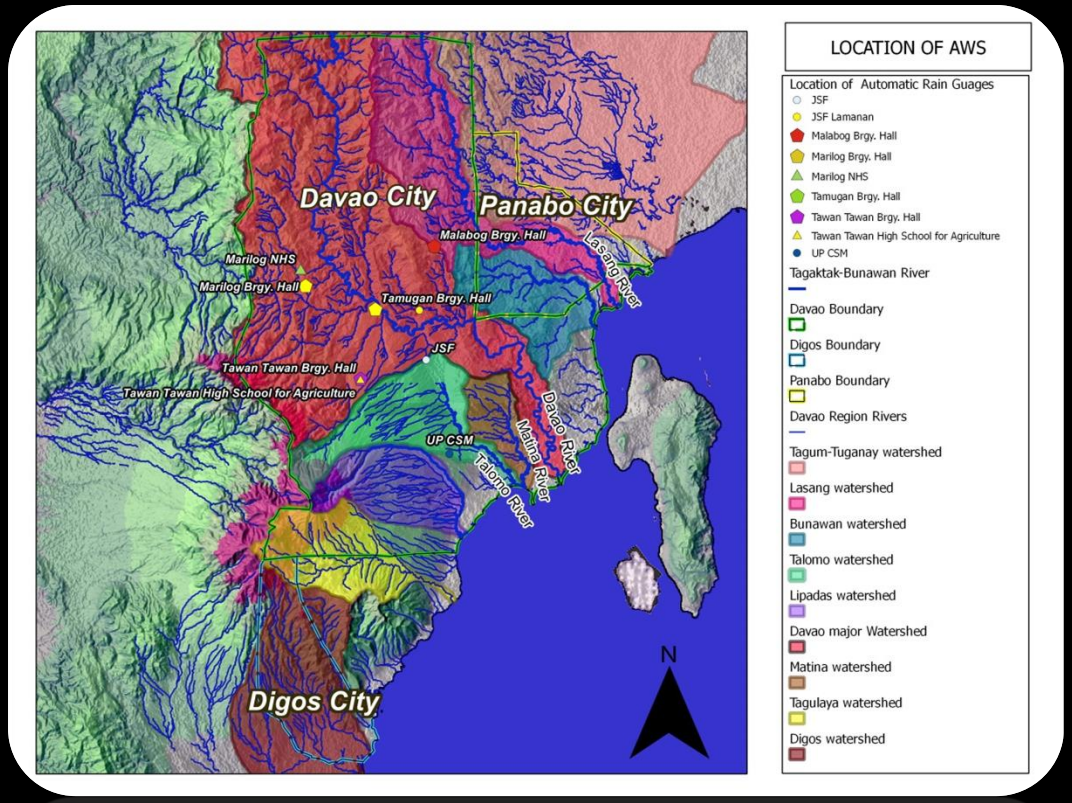
JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png

Sea Level Rise

Adaptation Activities

- Local weather stations to increase local rainfall data for pattern prediction
  - Locally produced weather stations
  - ADDU TROPICS and DOST, with local state and national universities

- Atmospheric vapor research
  - SCINDA
  - GPS
  - World Wide Lightning Location Network (University of Washington, Seattle)



JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png
Ateneo de Davao University Tropical Institute for Climate Studies. (2013) Untitled. [Map].

Adaptation Activities

- Masters in Tropical Risk Management due to Climate Change
  - 2013: 2nd graduating class of government planning officials
  - Student project data collected into centralized databank for Mindanaoan science
  - Conducted in South Cotabato province
    - province is susceptible to climate change
    - Province is also known for tourism and agriculture (pineapple plantations)

Ateneo de Davao University Tropical Institute for Climate Studies. (2013) Untitled. [Personal photograph].
JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png

Mindanao (Davao) Station
Current Observatory Space Weather Studies

JL 09. (2011) Mindanao_red. [online image]. *Wikimedia*. Retrieved from https://upload.wikimedia.org/wikipedia/commons/thumb/c/ce/Mindanao_Red.png/656px-Mindanao_Red.png

Manila Observatory – Davao Station

- *Established: 1965*
- *Location: 7 ° 4 ′ N; 125 ° 36 ′ E; 133 m elevation*
- *Branch of the Manila Observatory (MO)*
  - MO was established in 1865 in downtown Manila
  - MO functioned as the official Philippine weather bureau until 1948

Morales E. (2010). Untitled. [personal photograph].

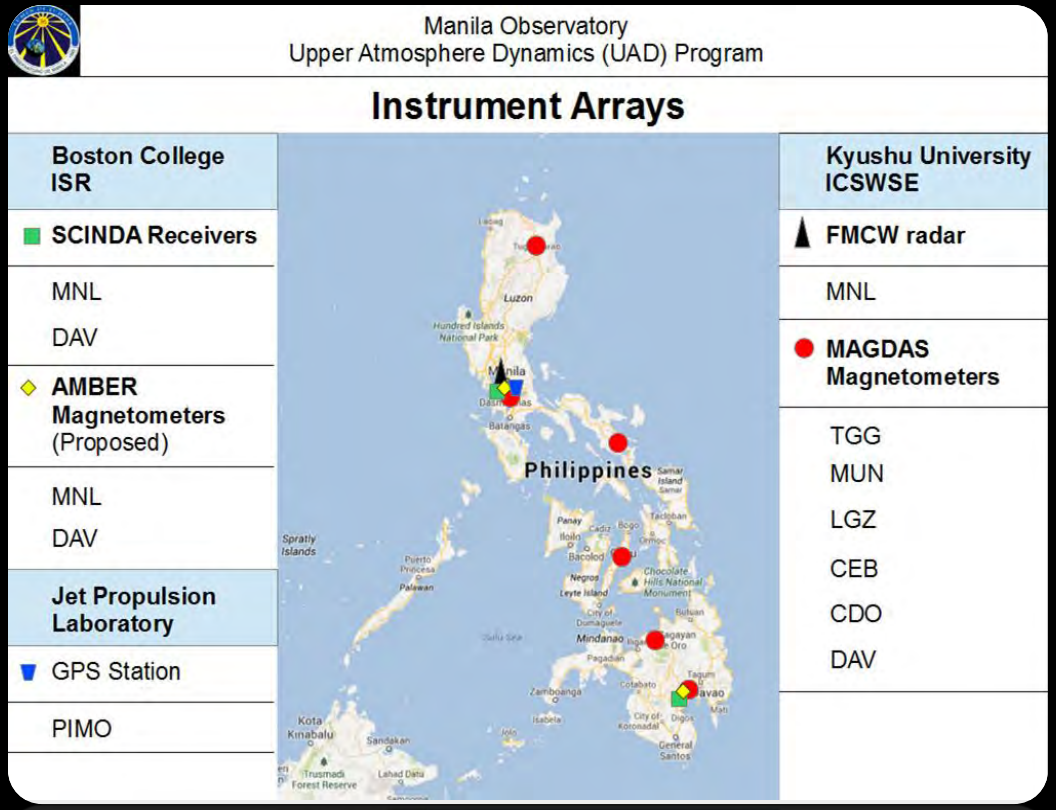
Manila Observatory – Davao Station

- *Current MO Davao Station studies and connections*
  - IRIS (early tsunami warning system for the Pacific)
  - MAGDAS (Kyushu University with Prof. Yumoto)
  - World Wide Lightning Location Network
  - Weather station
  - SCINDA station

Morales E. (2010). Untitled. [personal photograph].

Manila Observatory Current Space Weather Studies

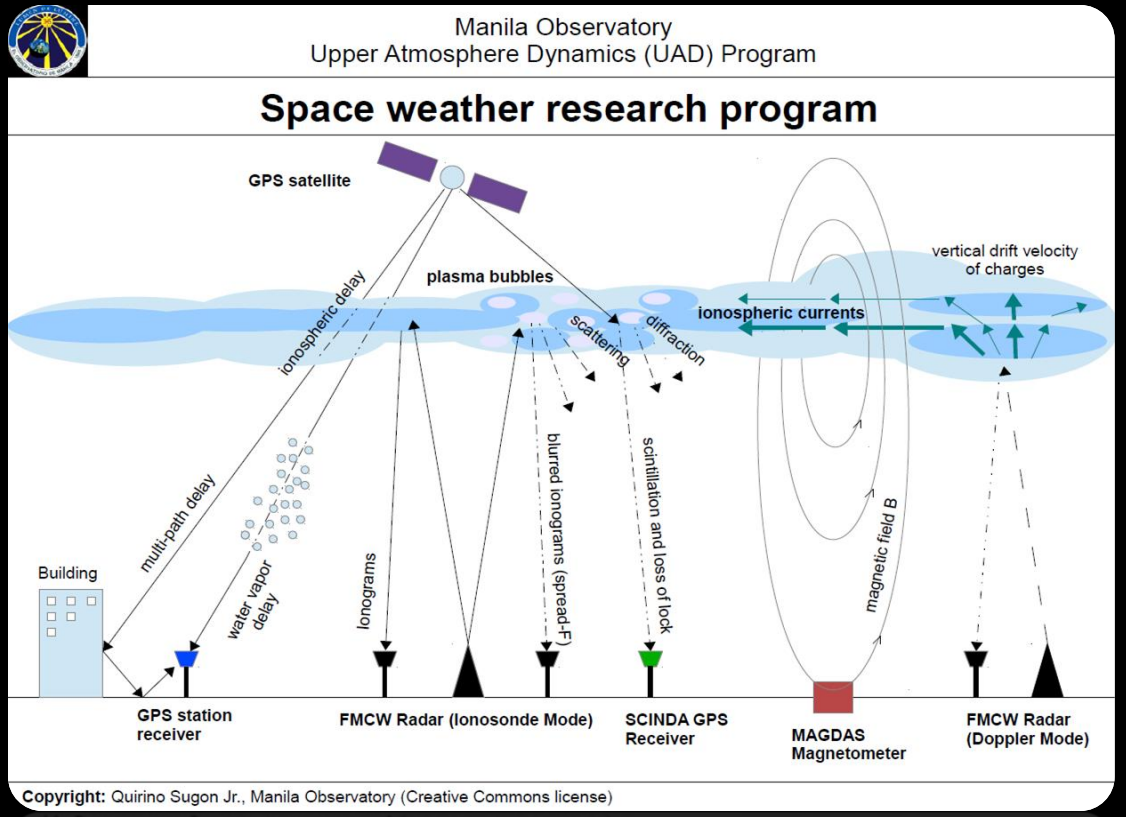
- *MAGDAS*
  - Kyushu University with Prof. Yumoto
  - Part of the nationwide network includes a Philippine government station
- *Weather station*
- *SCINDA station*
- *Upper Atmosphere/Space Weather (Boston College)*
- *GPS station (JPL)*



Manila Observatory. (n.d.) Untitled. [map].

Manila Observatory Current Space Weather Studies (UAD program)

- *in cooperation with Kyushu University*
- *looks at scintillation phenomenon, especially plasma bubbles*
- *makes use of ionosonde radar*

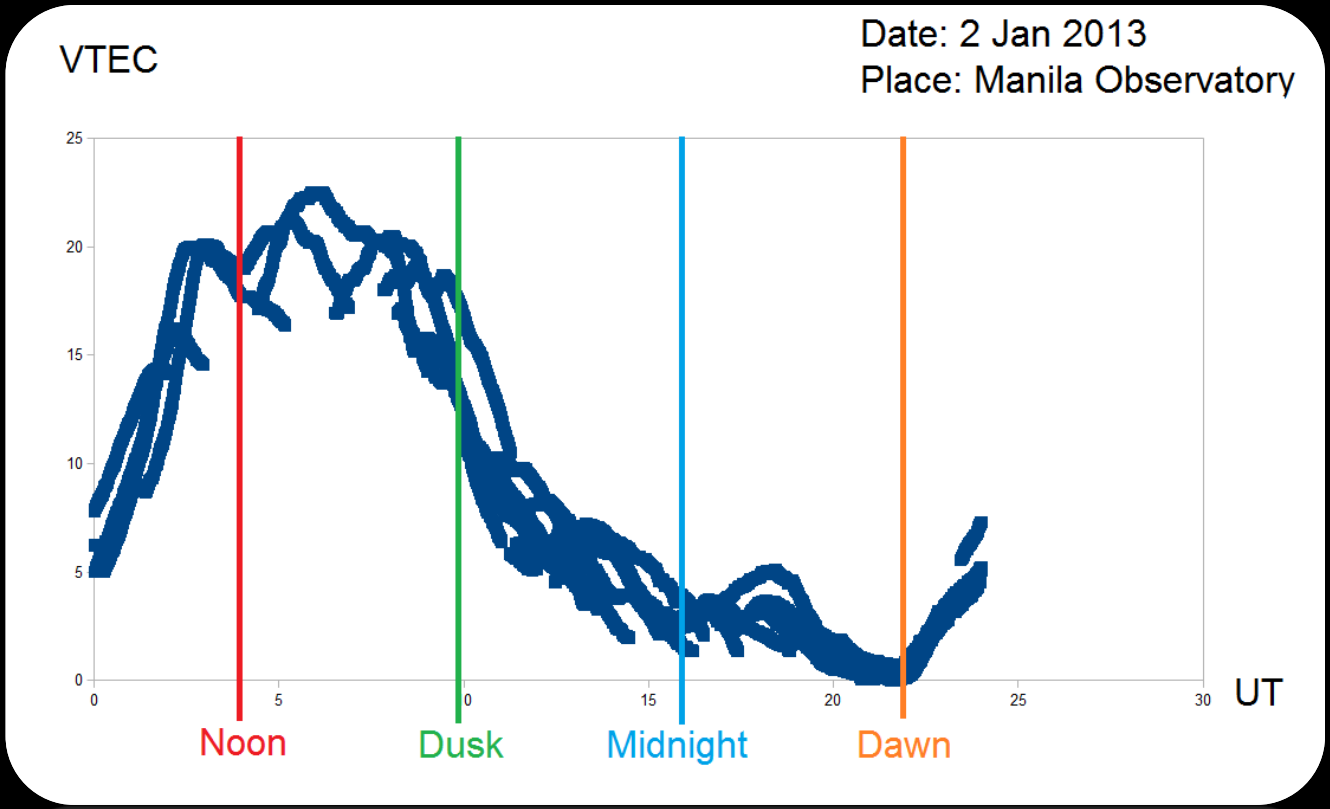


Sugon, Q. (n.d.) Space Weather Research Program. [graphic].

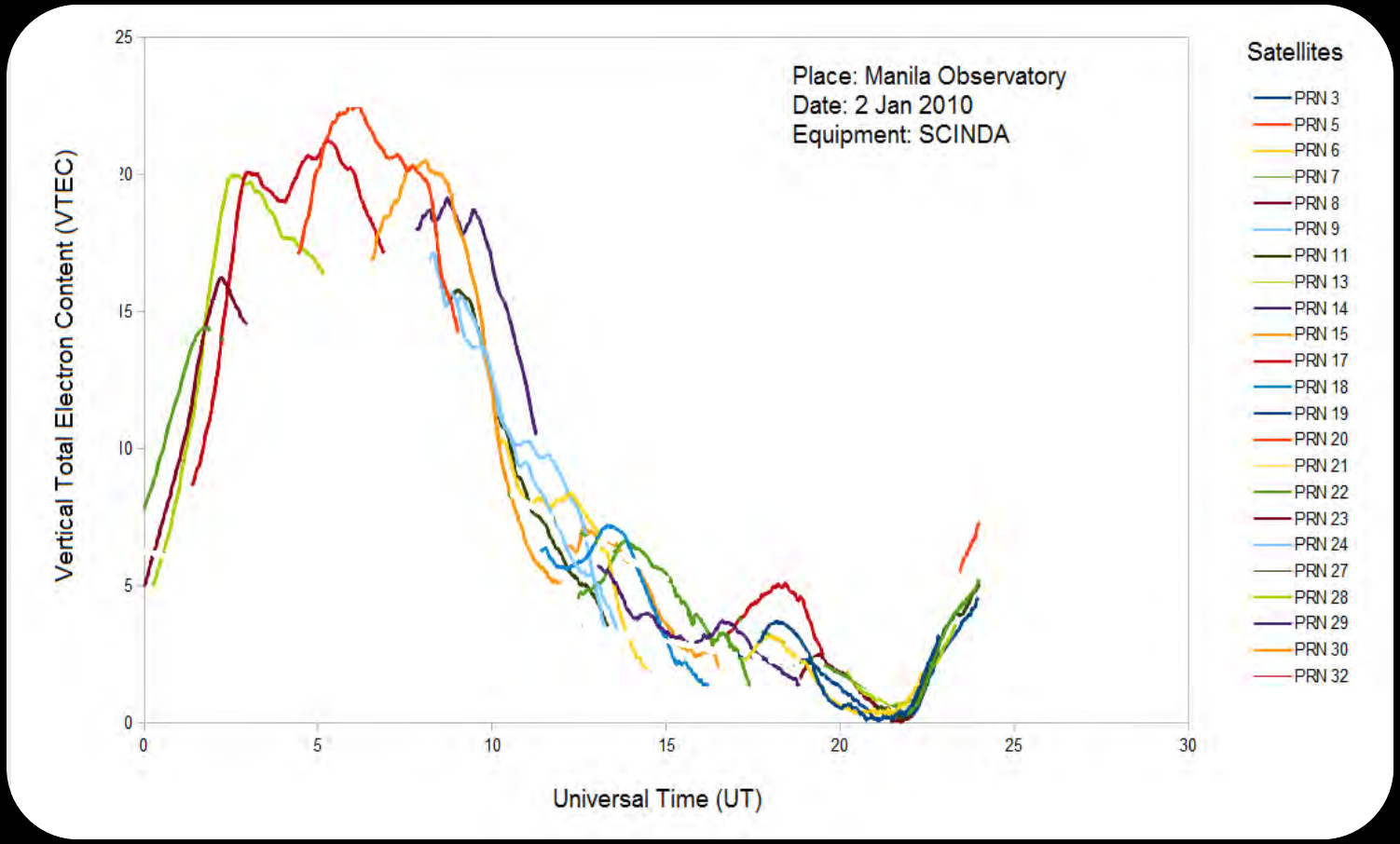
Manila Observatory Current Space Weather Studies

The Vertical Total Electron Content (VTEC) is obtained from GPS satellite measurements.

VTEC peaks at around 2 pm local time and goes to zero at around dawn (6 am local time).

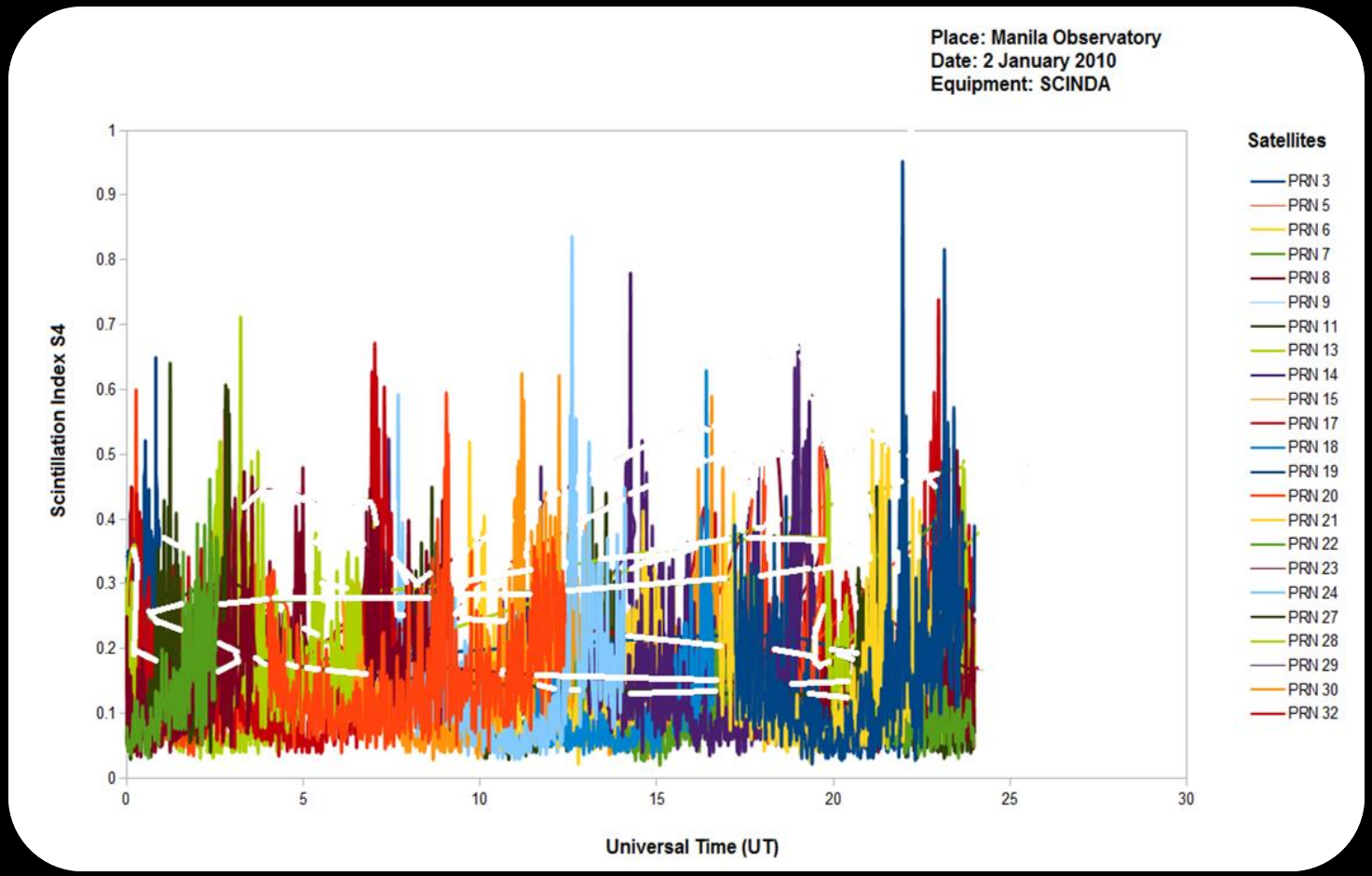


Sugon, Q. (2013) Untitled. [graph].



Manila Observatory Current Space Weather Studies

Sugon, Q. (2013) Untitled. [graph].



Manila Observatory Current Space Weather Studies

Sugon, Q. (2013) Untitled. [graph].

Discussion Session

Further Questions

- Could our weather phenomena be related to space weather? What connections are there between the ionosphere and troposphere?
- Given our station, developing country status and location, what other research could we undertake?
- Are we in the zone immediately affected by El Niño?
- Can the satellite data monitoring SST include temperatures as far east as Mindanao (125°E)?
- Should we be looking for upper atmosphere vapor currents, like the ones recently reported in Europe? (EOS, August 2013)

Anonymous. (n.d..) Kalahi. [online image]. *Kapit-Bisig Laban sa Kahirapan-Comprehensive and Integrated Delivery of Social Services*. Retrieved from http://ncddp.dswd.gov.ph/userlibraries/img/map_ph.png

References

- Tubigon, J. C. Watershed Governance in Silway - Klinan River Systems. M.S. Thesis, Ateneo de Davao University, Davao City, Philippines, March 2013.
- Yanagi, T.; Akaki, T. Sea Level Variation in the Eastern Asia. *Journal of Oceanography*. **1994,** *50*, 643-51.

Thank you!

Questions?