Developing a Prototype of Geospatial Data Sharing System for Disaster Management in the Philippines

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Japan–Philippine Urgent Collaborative Projects
regarding "Typhoon Yolanda" within the J-RAPID Program

Japan Science and Technology Agency

DOST PCIEERD

Work by DOST-ASTI: Establishing a meteorological sensor network over the Philippines

This program aims to complement projects and develop related applications by providing technology that will enhance capabilities in observation, collection, and transmission of environmental data.

Objectives:

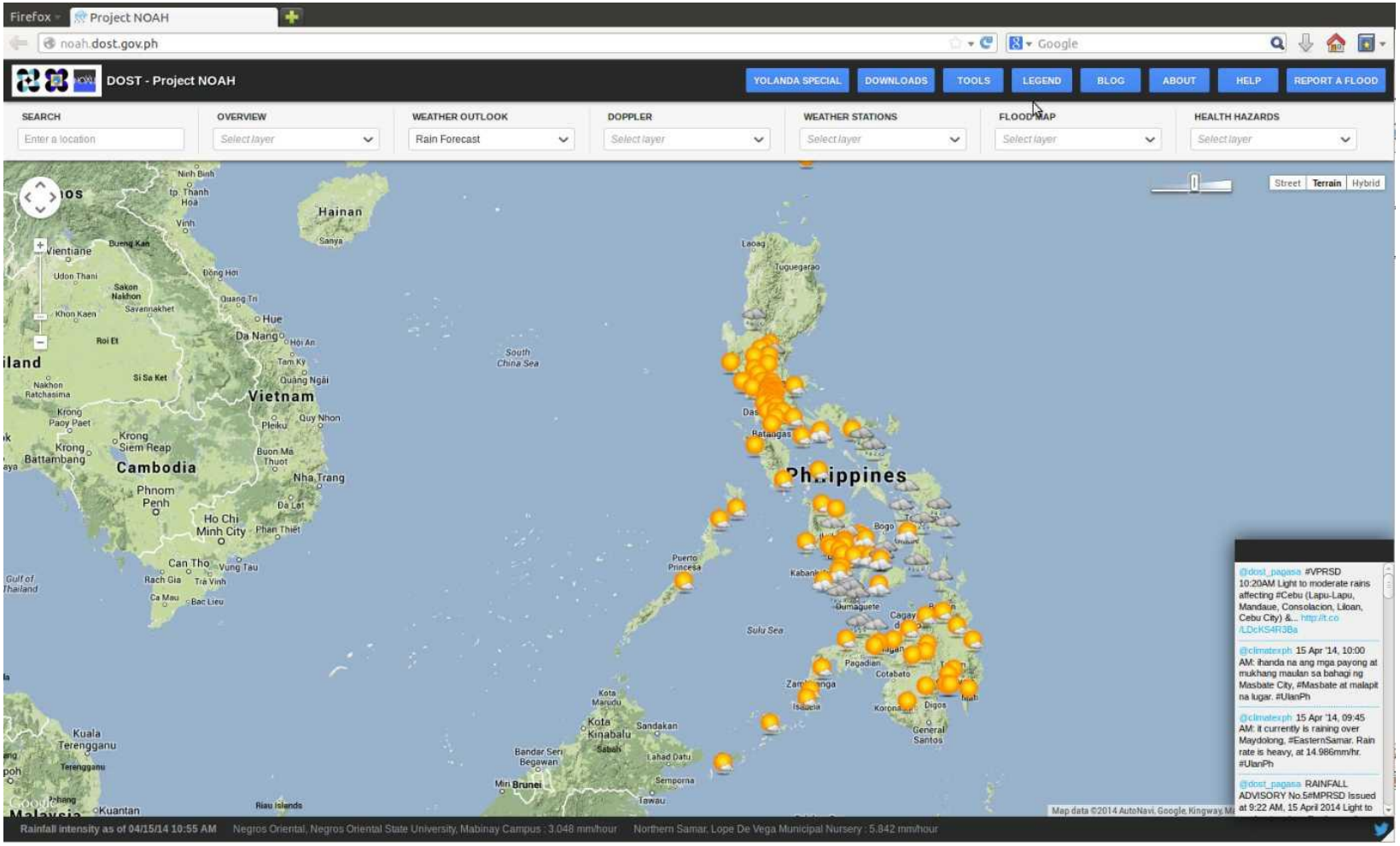
- To produce locally developed instruments for weather monitoring and forecasting
- To develop cost-effective platforms and applications for real-time data gathering of environmental parameters

Advantages over Commercially Available Instruments:

- Much lower cost for the same or even higher performance
- Available technical support locally
- Utilize local suppliers of components and parts

Our Sensors

State of Sensor Deployment



http://noah.dost.gov.ph/

State of Sensor Deployments

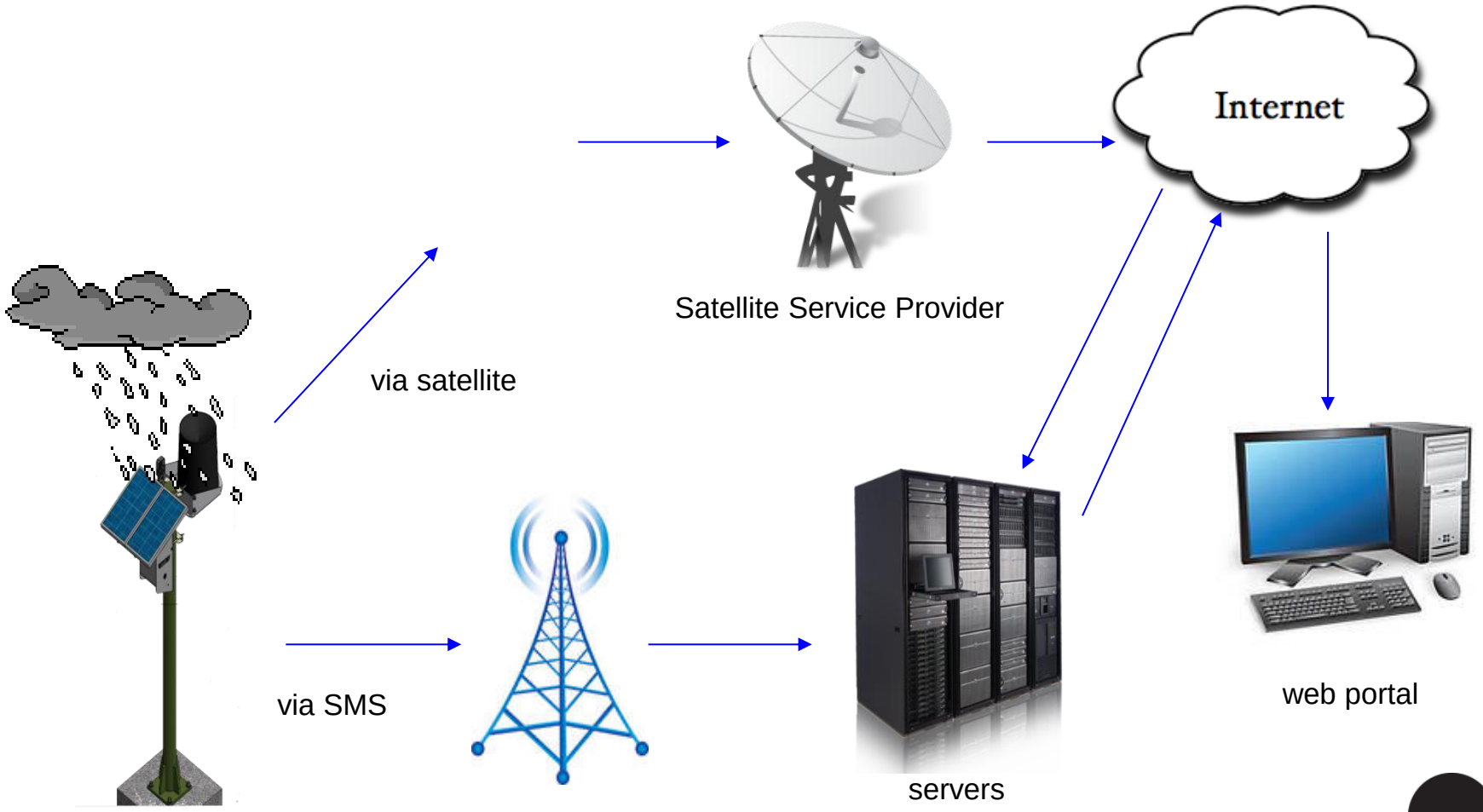
- As of March 2015

Type of Station	Parameters Measured	Quantity
ARG	Rainfall, air pressure	686
WLMS	Water level	332
Tandem	Water level, rain fall, air pressure	134
AWS	Rain fall, rain intensity, rain duration, air pressure, temp, humidity, wind speed/direction	111
Agromet	Same as AWS + soil moisture, soil temp, sunshine duration, sunshine count, solar radiation	80

State of Sensor Deployment

- Data collection started in 2011
- Data is available via downloadable CSVs and APIs
- Request for access to data is easily obtainable – just send formal letter to our director!

How Sensor Data are Collected



Data Sharing

- CSVs
  - Available through http://repo.pscigrid.gov.ph
  - Some directories require a username/password. For access, please email us!
- API
  - List of installed meteorological stations
  - All data of meteorological stations
  - Historical data
  - In JSON format

Lessons Learned

- Secure the stations!
  - If left unsecured, the stations will be vandalized, or at worst stolen and sold for scrap metal.
  - Stations are being used as homes for insects and bats.
- Have backups for everything!
  - Communication (SMS and Satellite communication)
  - Servers in highly redundant configuration
    - RAID disk configuration
    - Multiple server setup
    - Implement best practices for system architecture

Lessons Learned

- Engage the community
  - IECs are key!
  - Secure stakeholder buy in
- Ask for advice
  - Collaborate!

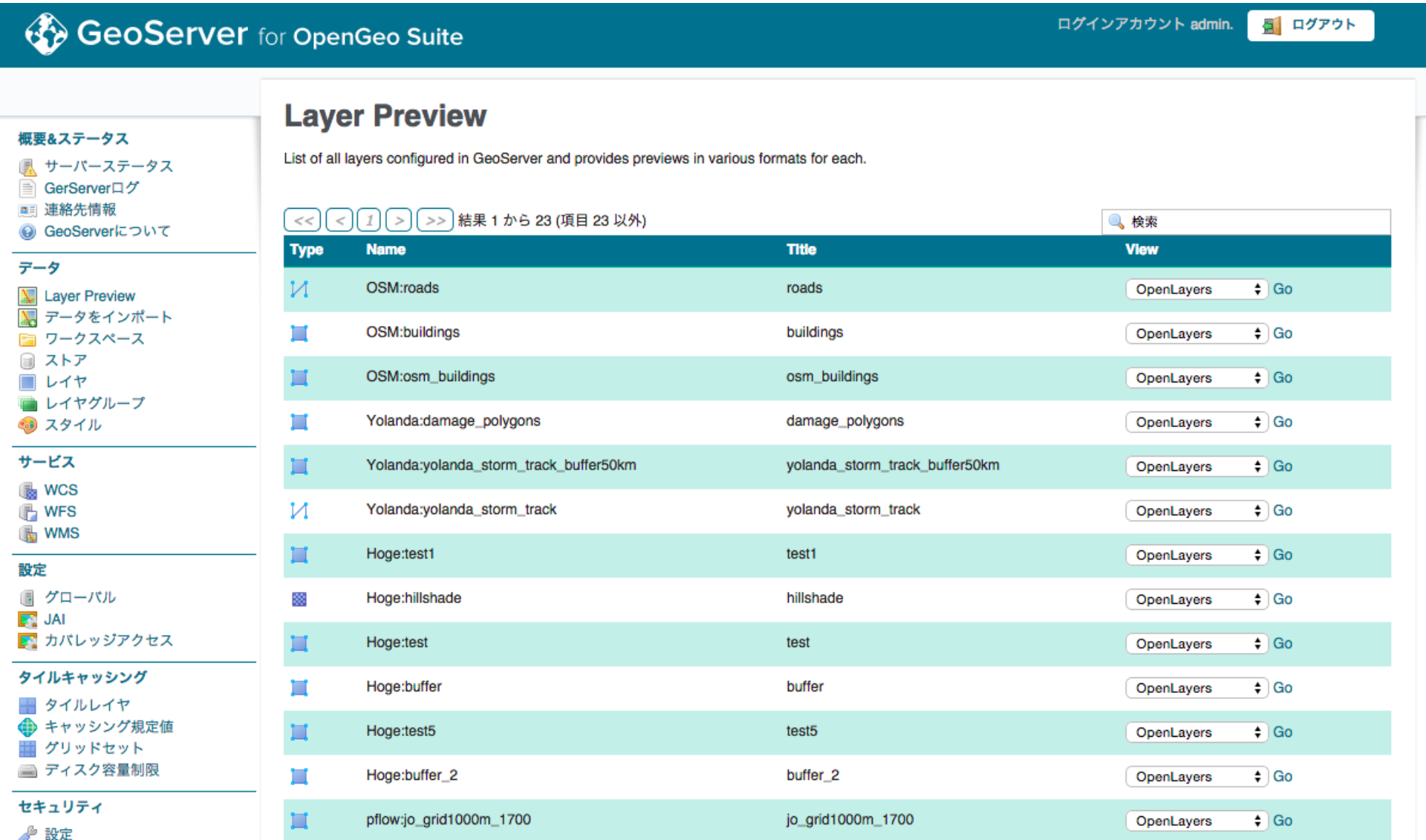
Collaboration with CSIS, Univ. Tokyo

- CSIS has provided help on the followings:
  - Geospatial analysis on sensor data especially on Typhoon Yolanda (Haiyan)
  - Performance analysis and recommendations for improvement
  - Recommendations on current GIS architecture to implement a prototype of geospatial data sharing systems

Work by CSIS:
Construction of a Web-GIS Server and Applications to Spatial Analysis

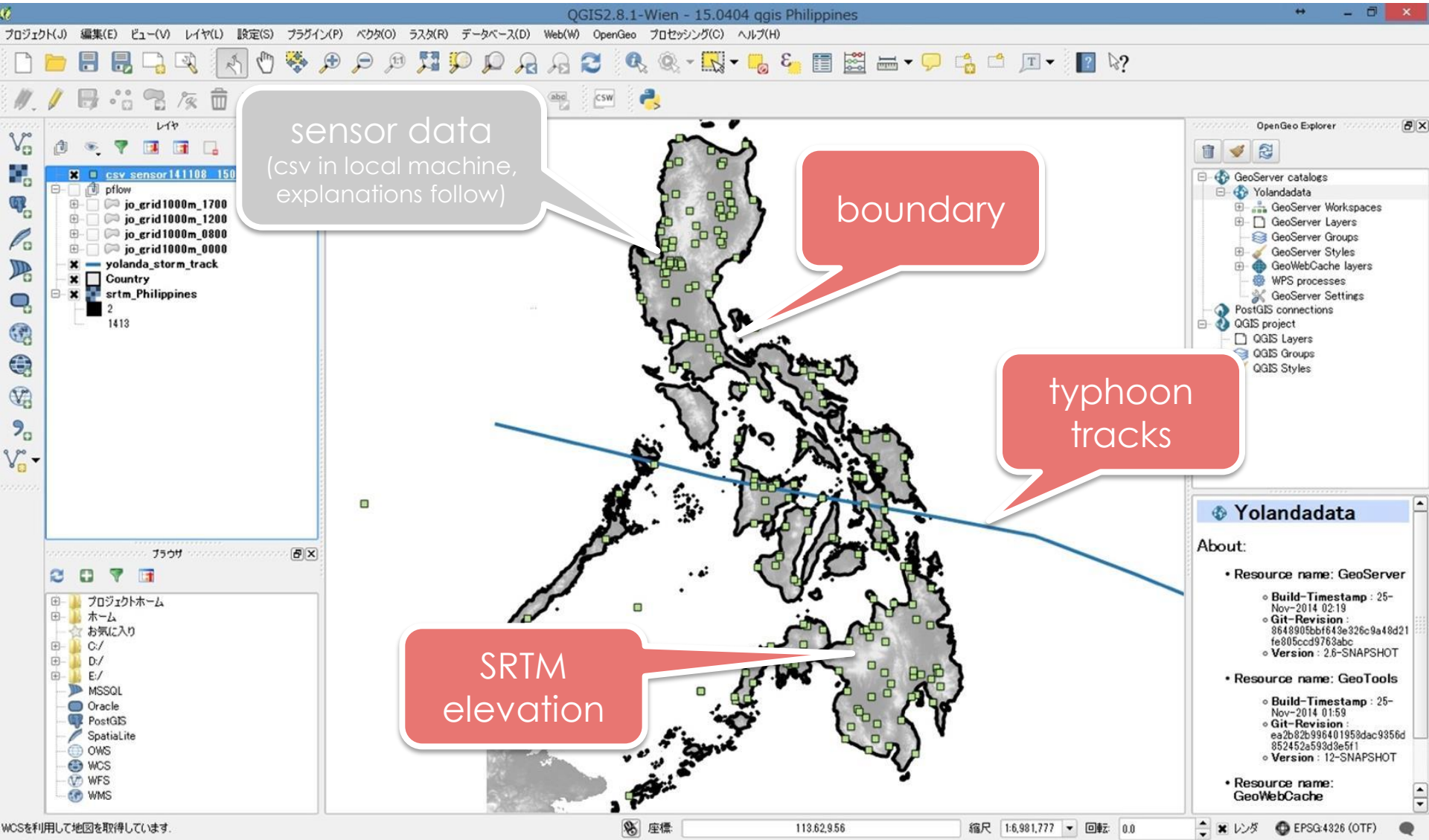
GeoServer with ASTI & Open Data

Including OpenStreetMap (road, building, boundaries), Yolanda typhoon data, SRTM digital elevation model etc.

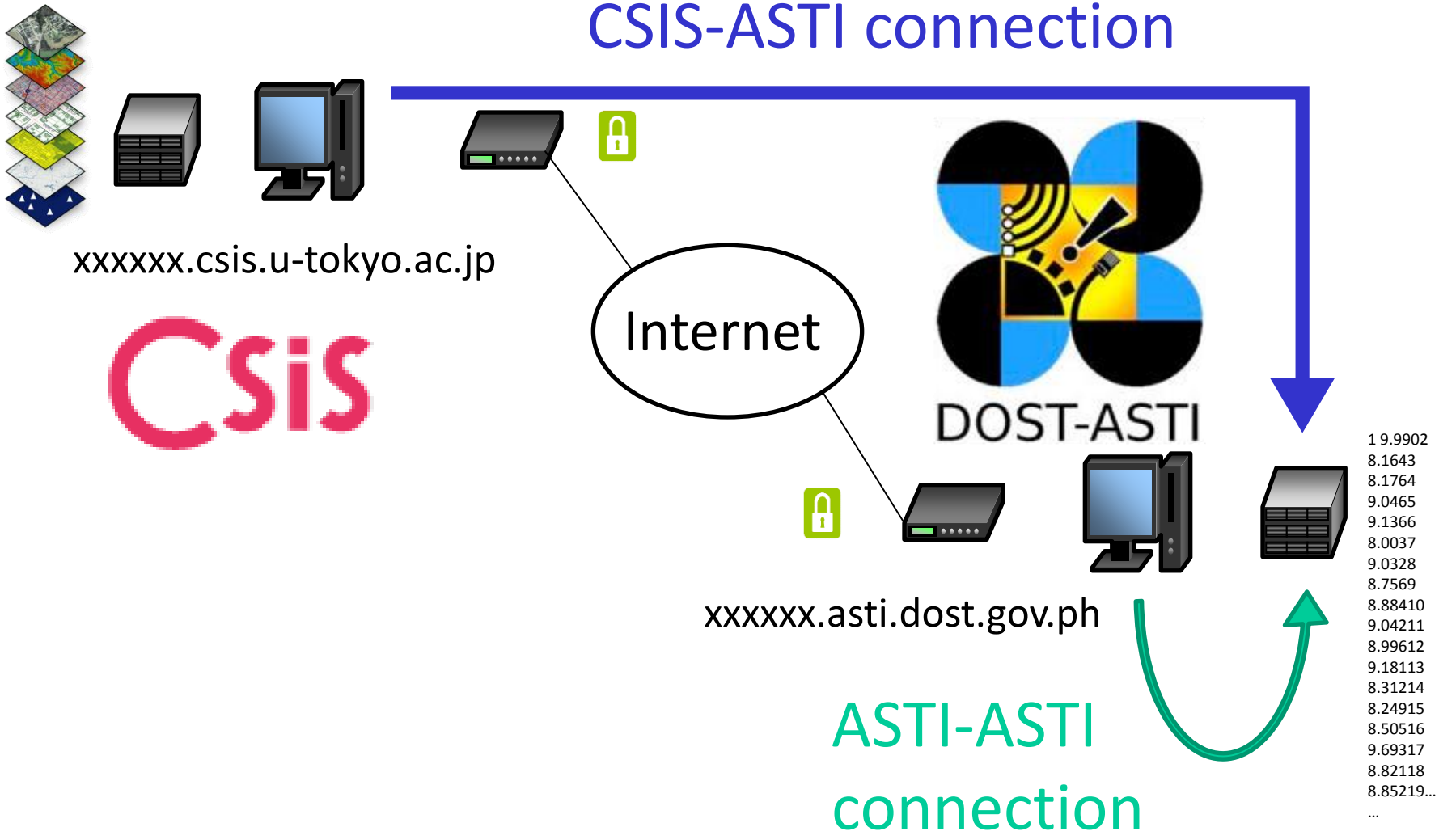


Data Analysis using GeoServer & GIS

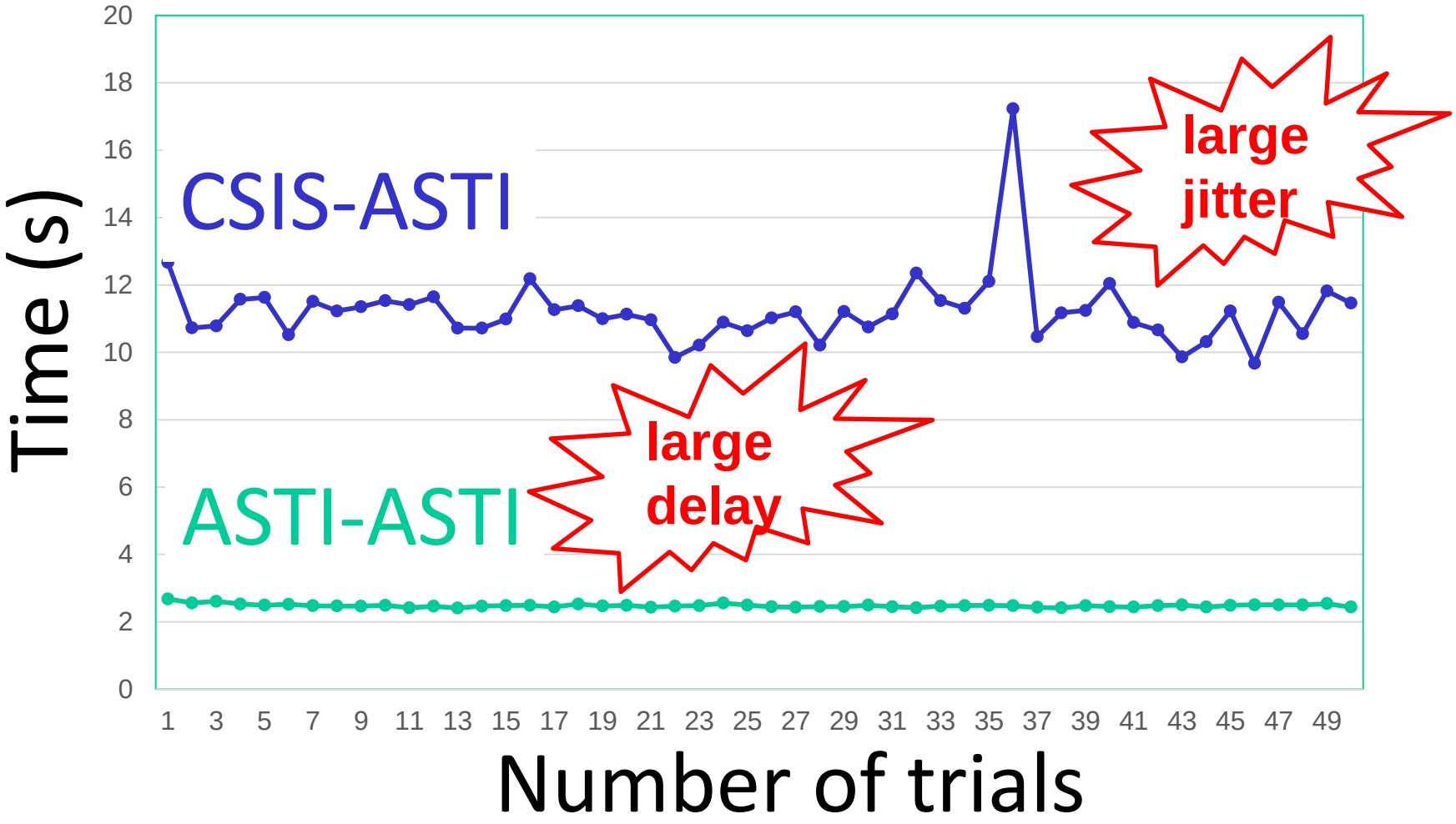
QGIS retrieves layers in the WebGIS server to perform visualization & spatial analysis



Experiment to Directly Connect the CSIS system and the ASTI Data Server Using API

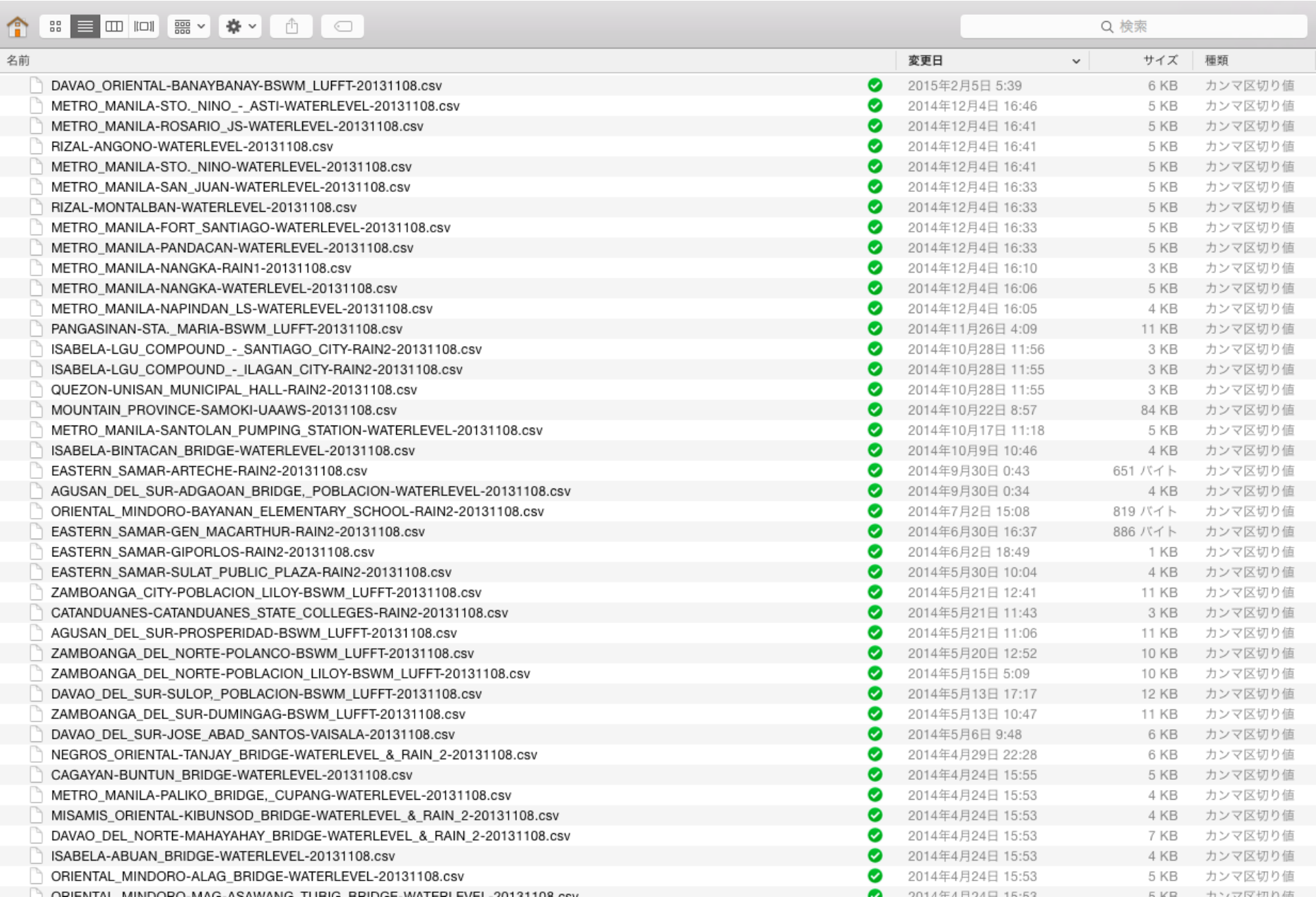


Spatial Data Transfer with Delay Packet



Switch to Offline Experiments

>700 CSV Files (Sensor Data) Everyday



検索

名前	変更日	サイズ	種類
DAVAO_ORIENTAL-BANAYBANAY-BSWM_LUFFT-20131108.csv	2015年2月5日 5:39	6 KB	カンマ区切り値
METRO_MANILA-STO._NINO_-_ASTI-WATERLEVEL-20131108.csv	2014年12月4日 16:46	5 KB	カンマ区切り値
METRO_MANILA-ROSARIO_JS-WATERLEVEL-20131108.csv	2014年12月4日 16:41	5 KB	カンマ区切り値
RIZAL-ANGONO-WATERLEVEL-20131108.csv	2014年12月4日 16:41	5 KB	カンマ区切り値
METRO_MANILA-STO._NINO-WATERLEVEL-20131108.csv	2014年12月4日 16:41	5 KB	カンマ区切り値
METRO_MANILA-SAN_JUAN-WATERLEVEL-20131108.csv	2014年12月4日 16:33	5 KB	カンマ区切り値
RIZAL-MONTALBAN-WATERLEVEL-20131108.csv	2014年12月4日 16:33	5 KB	カンマ区切り値
METRO_MANILA-FORT_SANTIAGO-WATERLEVEL-20131108.csv	2014年12月4日 16:33	5 KB	カンマ区切り値
METRO_MANILA-PANDACAN-WATERLEVEL-20131108.csv	2014年12月4日 16:33	5 KB	カンマ区切り値
METRO_MANILA-NANGKA-RAIN1-20131108.csv	2014年12月4日 16:10	3 KB	カンマ区切り値
METRO_MANILA-NANGKA-WATERLEVEL-20131108.csv	2014年12月4日 16:06	5 KB	カンマ区切り値
METRO_MANILA-NAPINDAN_LS-WATERLEVEL-20131108.csv	2014年12月4日 16:05	4 KB	カンマ区切り値
PANGASINAN-STA._MARIA-BSWM_LUFFT-20131108.csv	2014年11月26日 4:09	11 KB	カンマ区切り値
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ISABELA-LGU_COMPOUND_-_ILAGAN_CITY-RAIN2-20131108.csv	2014年10月28日 11:55	3 KB	カンマ区切り値
QUEZON-UNISAN_MUNICIPAL_HALL-RAIN2-20131108.csv	2014年10月28日 11:55	3 KB	カンマ区切り値
MOUNTAIN_PROVINCE-SAMOKI-UAAWS-20131108.csv	2014年10月22日 8:57	84 KB	カンマ区切り値
METRO_MANILA-SANTOLAN_PUMPING_STATION-WATERLEVEL-20131108.csv	2014年10月17日 11:18	5 KB	カンマ区切り値
ISABELA-BINTACAN_BRIDGE-WATERLEVEL-20131108.csv	2014年10月9日 10:46	4 KB	カンマ区切り値
EASTERN_SAMAR-ARTECHE-RAIN2-20131108.csv	2014年9月30日 0:43	651 バイト	カンマ区切り値
AGUSAN_DEL_SUR-ADGAOAN_BRIDGE,_POBLACION-WATERLEVEL-20131108.csv	2014年9月30日 0:34	4 KB	カンマ区切り値
ORIENTAL_MINDORO-BAYANAN_ELEMENTARY_SCHOOL-RAIN2-20131108.csv	2014年7月2日 15:08	819 バイト	カンマ区切り値
EASTERN_SAMAR-GEN_MACARTHUR-RAIN2-20131108.csv	2014年6月30日 16:37	886 バイト	カンマ区切り値
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ZAMBOANGA_DEL_NORTE-POBLACION_LILOY-BSWM_LUFFT-20131108.csv	2014年5月15日 5:09	10 KB	カンマ区切り値
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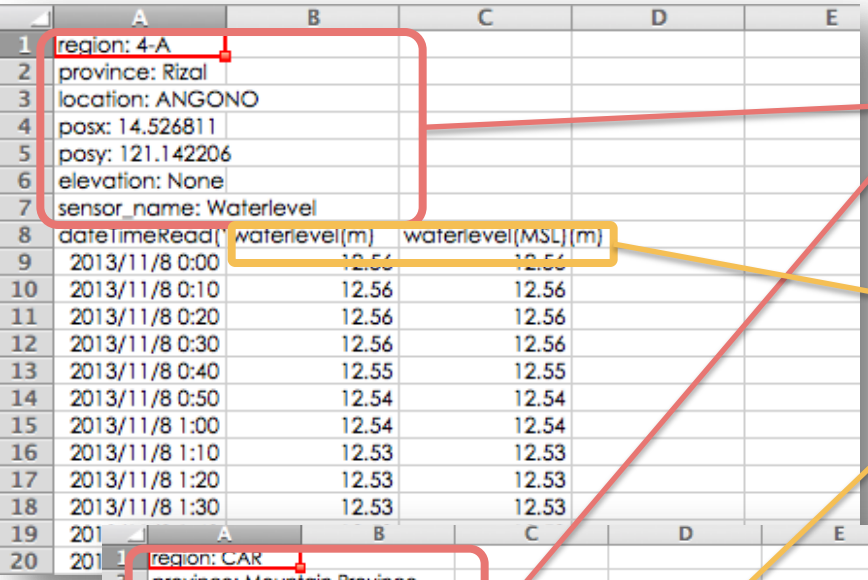
NEGROS_ORIENTAL-TANJAY_BRIDGE-WATERLEVEL_&_RAIN_2-20131108.csv	2014年4月29日 22:28	6 KB	カンマ区切り値
CAGAYAN-BUNTUN_BRIDGE-WATERLEVEL-20131108.csv	2014年4月24日 15:55	5 KB	カンマ区切り値
METRO_MANILA-PALIKO_BRIDGE,_CUPANG-WATERLEVEL-20131108.csv	2014年4月24日 15:53	4 KB	カンマ区切り値
MISAMIS_ORIENTAL-KIBUNSOD_BRIDGE-WATERLEVEL_&_RAIN_2-20131108.csv	2014年4月24日 15:53	4 KB	カンマ区切り値
DAVAO_DEL_NORTE-MAHAYAHAY_BRIDGE-WATERLEVEL_&_RAIN_2-20131108.csv	2014年4月24日 15:53	7 KB	カンマ区切り値
ISABELA-ABUAN_BRIDGE-WATERLEVEL-20131108.csv	2014年4月24日 15:53	4 KB	カンマ区切り値
ORIENTAL_MINDORO-ALAG_BRIDGE-WATERLEVEL-20131108.csv	2014年4月24日 15:53	5 KB	カンマ区切り値

Original Format of CSV Files



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1	region: 4-A				
2	province: Rizal				
3	location: ANGONO				
4	posx: 14.526811				
5	posy: 121.142206				
6	elevation: None				
7	sensor_name: Waterlevel				
8	dateTimeRead(	waterlevel(m)	waterlevel(MSL)(m)		
9	2013/11/8 0:00	[illegible]	[illegible]		
10	2013/11/8 0:10	12.56	12.56		
11	2013/11/8 0:20	12.56	12.56		
12	2013/11/8 0:30	12.56	12.56		
13	2013/11/8 0:40	12.55	12.55		
14	2013/11/8 0:50	12.54	12.54		
15	2013/11/8 1:00	12.54	12.54		
16	2013/11/8 1:10	12.53	12.53		
17	2013/11/8 1:20	12.53	12.53		
18	2013/11/8 1:30	12.53	12.53		

header: sensor info

sensed data

	A	B	C	D	E	F	G	H	I	J	K	L
1	region: CAR											
2	province: Mountain Province											
3	location: Samoki											
4	posx: 17.091361											
5	posy: 120.983583											
6	elevation: 860.0											
7	sensor_name: UAAWS											
8	dateTimeRead	rain_value(mm)	rain_intensity(mr	rain_duration(se	air_temperature	air_pressure(hPa	wind_speed(kpl	wind_direction(°	air_humidity(%)	solar_radiation(\	wind_speed_mc	rain_cur
9	2013/11/8 0:00	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
10	2013/11/8 0:02	0	0	0	20.6	920.0366	6.8	326	77.6	-25897	None	
11	2013/11/8 0:04	0	0	0	20.7	920.0366	6.4	353	77.9	-25897	None	
12	2013/11/8 0:06	0	0	0	20.7	920.0366	3.6	347	77.7	-24793	None	
13	2013/11/8 0:08	0	0	0	20.7	920.0366	5.4	352	77.5	None	None	None
14	2013/11/8 0:10	0	0	0	20.7	920.0366	7.7	324	78.2	-25897	None	
15	2013/11/8 0:12	0	0	0	20.7	920.0366	10.2	354	77.3	-25897	None	
16	2013/11/8 0:14	0	0	0	20.7	920.0366	6.4	13	77.8	-25065	None	
17	2013/11/8 0:16	0	0	0	20.7	920.0366	8.3	342	77.6	-25849	None	
18	2013/11/8 0:18	0	0	0	20.7	920.0366	6.8	341	77.7	-25881	None	
19	2013/11/8 0:20	0	0	0	20.7	920.0366	8.8	344	77.4	-25257	None	
20	2013/11/8 0:22	0	0	0	20.8	920.0366	8.7	345	77.5	-25689	None	
21	2013/11/8 0:24	0	0	0	20.8	920.0366	10.1	347	76.7	None	None	None
22	2013/11/8 0:26	0	0	0	20.9	920.0366	7.9	355	76.3	-25897	None	
23	2013/11/8 0:28	0	0	0	20.9	919.9033	11	350	76.1	-25817	None	
24	2013/11/8 0:30	0	0	0	20.9	919.9033	11.5	353	75.5	-25833	None	
25	2013/11/8 0:32	0	0	0	20.9	919.9033	11.5	343	76.1	-25897	None	
26	2013/11/8 0:34	0	0	0	20.9	919.9033	11.5	346	76.2	-25897	None	
27	2013/11/8 0:36	0	0	0	20.9	919.9033	11.4	359	76.2	-25897	None	
28	2013/11/8 0:38	0	0	0	20.9	919.9033	7.4	343	76.6	-25785	None	
29	2013/11/8 0:40	0	0	0	20.9	919.9033	7.4	354	77	-25897	None	
30	2013/11/8 0:42	0	0	0	20.9	919.9033	10.2	345	76.5	-25769	None	
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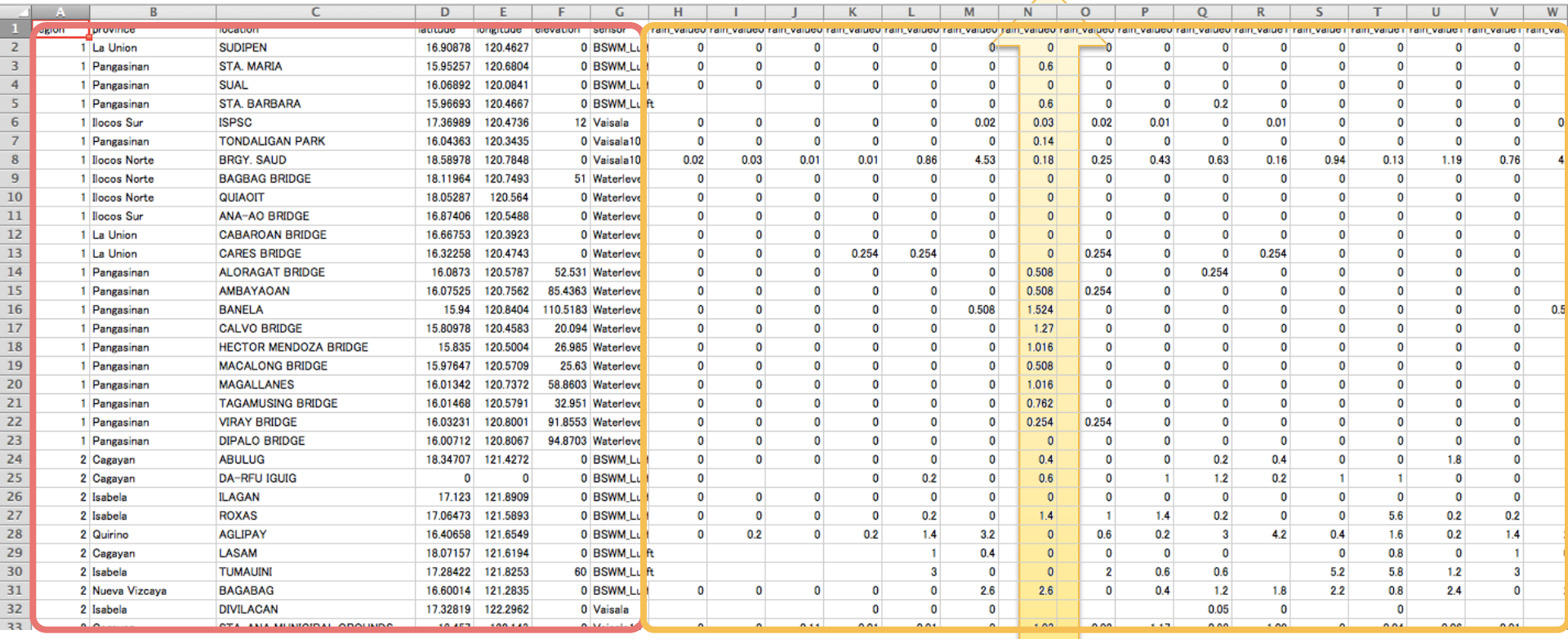
Selected & Reformatted CSV

header: sensor info

sensed data



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	region	province	location	latitude	longitude	elevation	sensor	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_valueO	rain_va
2	1	La Union	SUDIPEN	16.90878	120.4627	0	BSWM_Lu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	1	Pangasinan	STA. MARIA	15.95257	120.6804	0	BSWM_Lu	0	0	0	0	0	0	0.6	0	0	0	0	0	0	0	0	
4	1	Pangasinan	SUAL	16.06892	120.0841	0	BSWM_Lu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	1	Pangasinan	STA. BARBARA	15.96693	120.4667	0	BSWM_Lu	ft				0	0	0.6	0	0	0.2	0	0	0	0	0	
6	1	Ilocos Sur	ISPSC	17.36989	120.4736	12	Vaisala	0	0	0	0	0	0.02	0.03	0.02	0.01	0	0.01	0	0	0	0	0
7	1	Pangasinan	TONDALIGAN PARK	16.04363	120.3435	0	Vaisala10	0	0	0	0	0	0	0.14	0	0	0	0	0	0	0	0	
8	1	Ilocos Norte	BRGY. SAUD	18.58978	120.7848	0	Vaisala10	0.02	0.03	0.01	0.01	0.86	4.53	0.18	0.25	0.43	0.63	0.16	0.94	0.13	1.19	0.76	4
9	1	Ilocos Norte	BAGBAG BRIDGE	18.11964	120.7493	51	Waterleve	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	1	Ilocos Norte	QUIAOIT	18.05287	120.564	0	Waterleve	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11	1	Ilocos Sur	ANA-AO BRIDGE	16.87406	120.5488	0	Waterleve	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12	1	La Union	CABAROAN BRIDGE	16.66753	120.3923	0	Waterleve	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	1	La Union	CARES BRIDGE	16.32258	120.4743	0	Waterleve	0	0	0	0.254	0.254	0	0	0.254	0	0	0.254	0	0	0	0	
14	1	Pangasinan	ALORAGAT BRIDGE	16.0873	120.5787	52.531	Waterleve	0	0	0	0	0	0	0.508	0	0	0.254	0	0	0	0	0	
15	1	Pangasinan	AMBAYAOAN	16.07525	120.7562	85.4363	Waterleve	0	0	0	0	0	0	0.508	0.254	0	0	0	0	0	0	0	
16	1	Pangasinan	BANELA	15.94	120.8404	110.5183	Waterleve	0	0	0	0	0	0.508	1.524	0	0	0	0	0	0	0	0	0.5
17	1	Pangasinan	CALVO BRIDGE	15.80978	120.4583	20.094	Waterleve	0	0	0	0	0	0	1.27	0	0	0	0	0	0	0	0	
18	1	Pangasinan	HECTOR MENDOZA BRIDGE	15.835	120.5004	26.985	Waterleve	0	0	0	0	0	0	1.016	0	0	0	0	0	0	0	0	
19	1	Pangasinan	MACALONG BRIDGE	15.97647	120.5709	25.63	Waterleve	0	0	0	0	0	0	0.508	0	0	0	0	0	0	0	0	
20	1	Pangasinan	MAGALLANES	16.01342	120.7372	58.8603	Waterleve	0	0	0	0	0	0	1.016	0	0	0	0	0	0	0	0	
21	1	Pangasinan	TAGAMUSING BRIDGE	16.01468	120.5791	32.951	Waterleve	0	0	0	0	0	0	0.762	0	0	0	0	0	0	0	0	
22	1	Pangasinan	VIRAY BRIDGE	16.03231	120.8001	91.8553	Waterleve	0	0	0	0	0	0	0.254	0.254	0	0	0	0	0	0	0	
23	1	Pangasinan	DIPALO BRIDGE	16.00712	120.8067	94.8703	Waterleve	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
24	2	Cagayan	ABULUG	18.34707	121.4272	0	BSWM_Lu	0	0	0	0	0	0	0.4	0	0	0.2	0.4	0	0	1.8	0	
25	2	Cagayan	DA-RFU IGUIG	0	0	0	BSWM_Lu	0			0	0.2	0	0.6	0	1	1.2	0.2	1	1	0	0	
26	2	Isabela	ILAGAN	17.123	121.8909	0	BSWM_Lu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
27	2	Isabela	ROXAS	17.06473	121.5893	0	BSWM_Lu	0	0	0	0	0.2	0	1.4	1	1.4	0.2	0	0	5.6	0.2	0.2	
28	2	Quirino	AGLIPAY	16.40658	121.6549	0	BSWM_Lu	0	0.2	0	0.2	1.4	3.2	0	0.6	0.2	3	4.2	0.4	1.6	0.2	1.4	
29	2	Cagayan	LASAM	18.07157	121.6194	0	BSWM_Lu	ft				1	0.4	0	0	0	0		0	0.8	0	1	
30	2	Isabela	TUMAUINI	17.28422	121.8253	60	BSWM_Lu	ft				3	0	0	2	0.6	0.6		5.2	5.8	1.2	3	
31	2	Nueva Vizcaya	BAGABAG	16.60014	121.2835	0	BSWM_Lu	0	0	0	0	0	2.6	2.6	0	0.4	1.2	1.8	2.2	0.8	2.4	0	
32	2	Isabela	DIVILACAN	17.32819	122.2962	0	Vaisala					0	0	0			0.05	0		0			

extraction of
rainfall & **air pressure**

201 Records / day

Error Removal

Lack of Location

region	province	location	latitude	longitude	elevation	sensor	rain_value0	rain_value0	rain_value0	rain_value0	rain_value0	rain_value0	rain_value0
2	Cagayan	DA-RFU IGUIG	0	0	0	BSWM_Lufl	0			0	0.2	0	0.6
7	Negros Oriental	BAIS	0	0	0	BSWM_Lufft					5.2	2.6	2.6
9	Zamboanga del Norte	POBLACION LILOY	0	0	0	BSWM_Lufl	0	2	0	0	1	1.2	1.8
ARMM	Lanao del Sur	KAPATAGAN	0	0	0	BSWM_Lufl	0	0	0	0	0	0	0

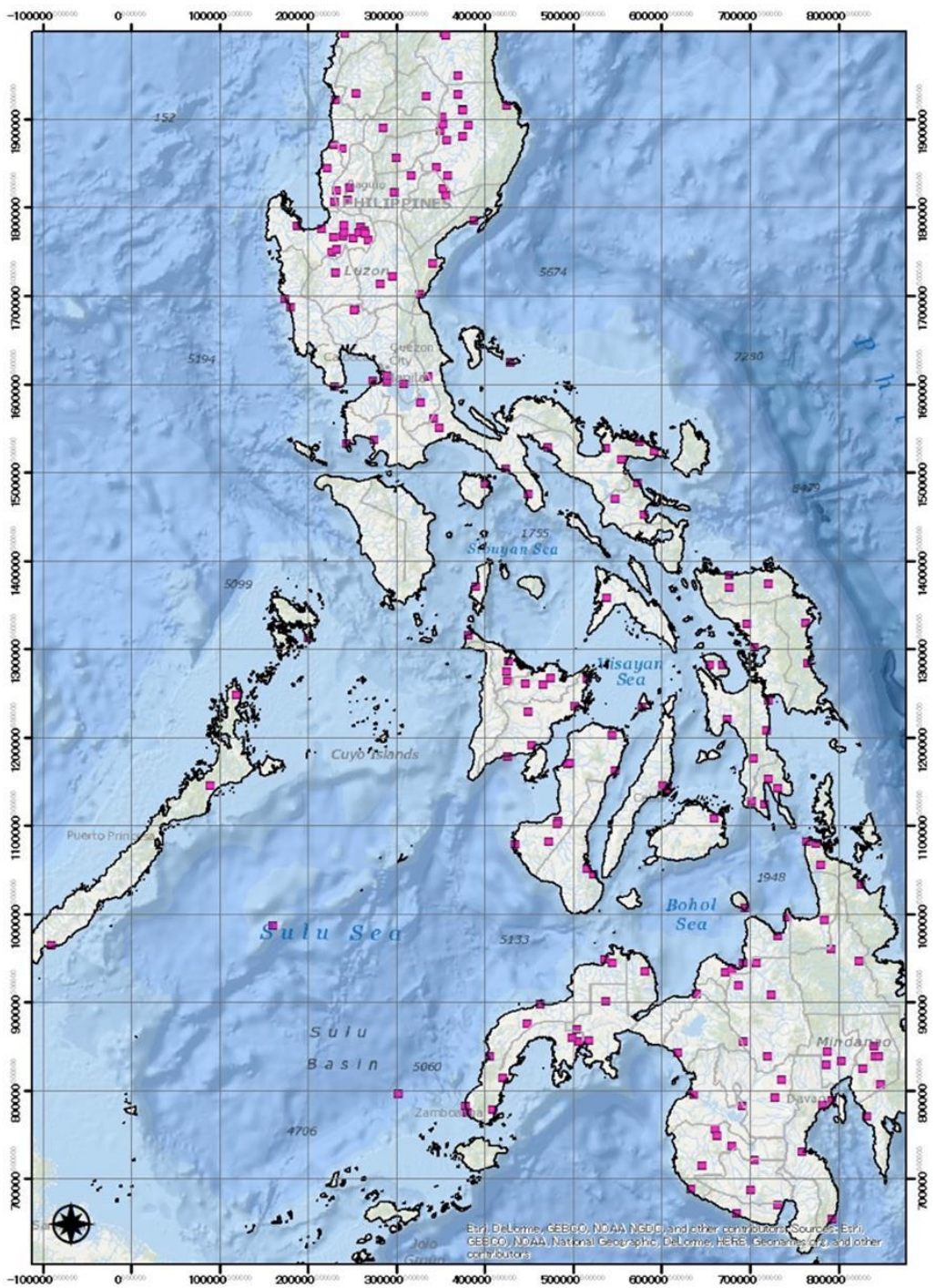
Duplication & Erroneous Values

13	Agusan del Norte	PROSPERIDAD	8.552306	125.9434	49	BSWM_Lufl	0	0	0	0	0	0	0
13	Agusan del Sur	PROSPERIDAD	8.552306	125.9434	49	BSWM_Lufl	1001.3	999.775	999.15	998.7	1000.137	1000.475	1001.375

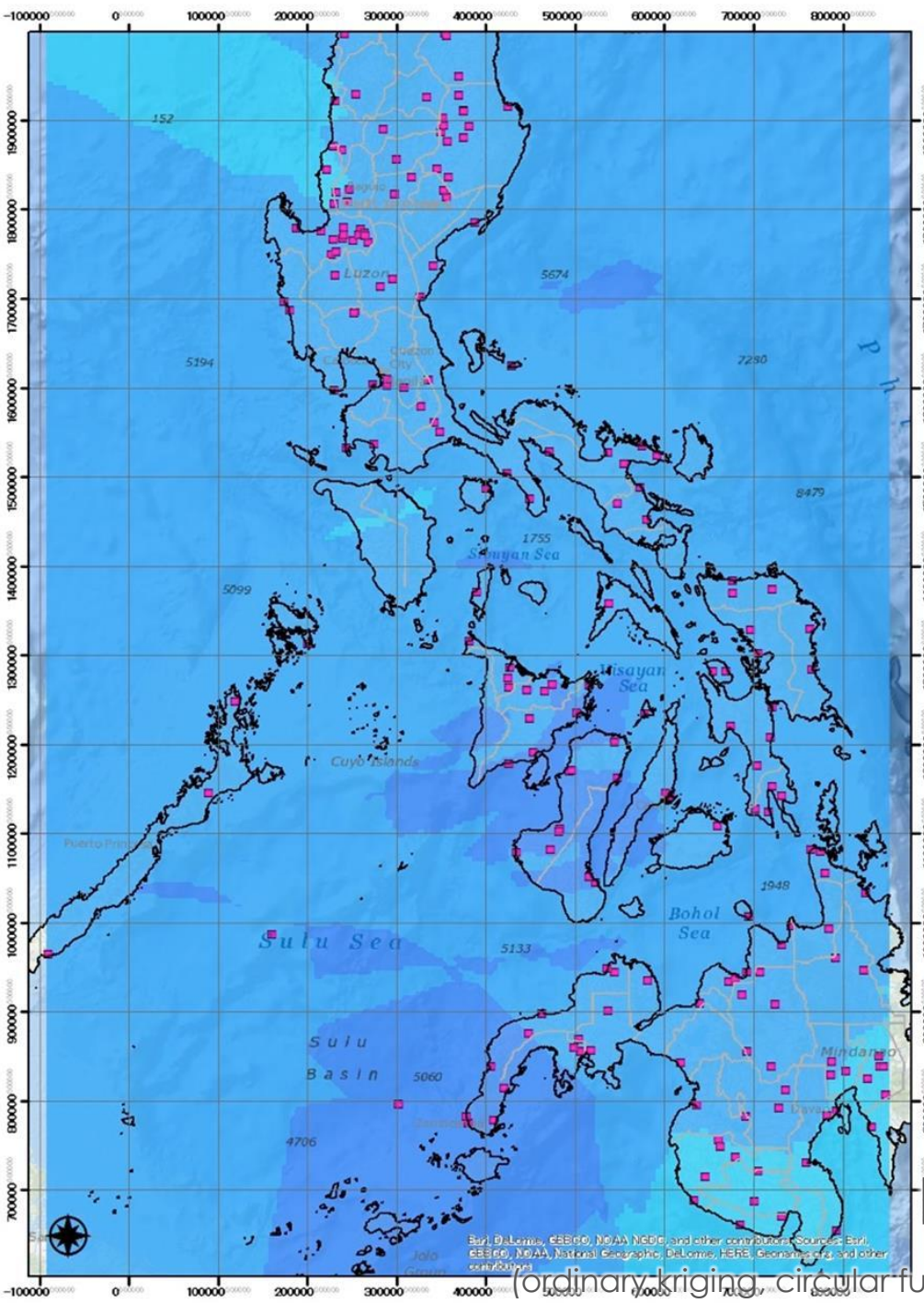
- 13 Agusan del Sur PROSPERIDAD: air pressure in rainfall columns
- 4-A Quezon LUCBAN: duplicate of name

Map Visualization: Example of Interpolated Hourly Rainfall on 2013-11-08 (FRI), the Yolanda Day

Base map


PHILIPPINES
Luzon
Quezon City
Manila
Sibuyan Sea
Visayan Sea
Cuyo Islands
Puerto Princesa
Sulu Sea
Sulu Basin
Bohol Sea
Mindanao
Davao
Zamboanga
Jolo
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors | Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Rainfall 00 AM



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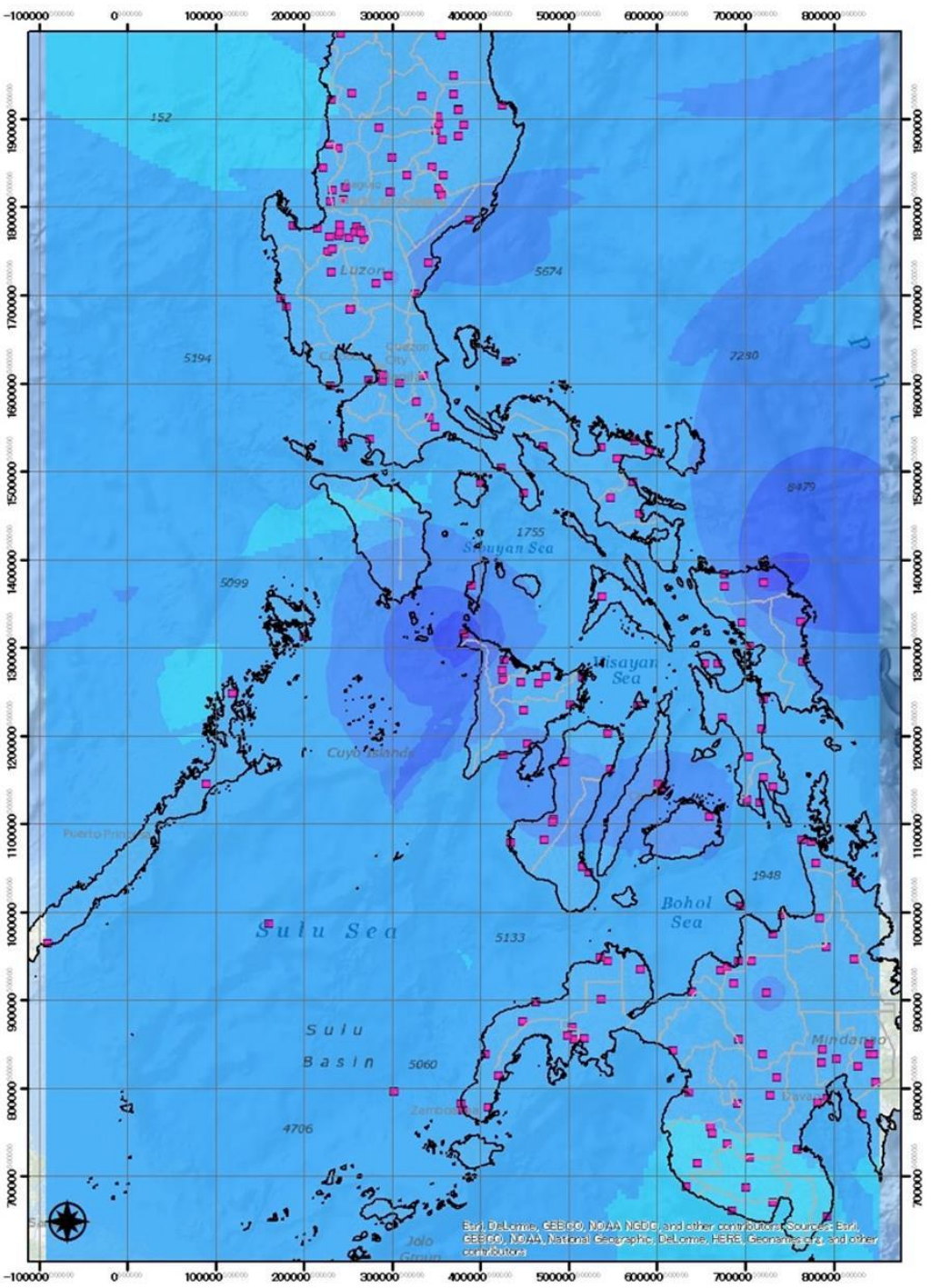
mm

hourly rainfall

kriging interpolation
(ordinary kriging, circular function, 12 neighborhoods)

Rainfall 01 AM



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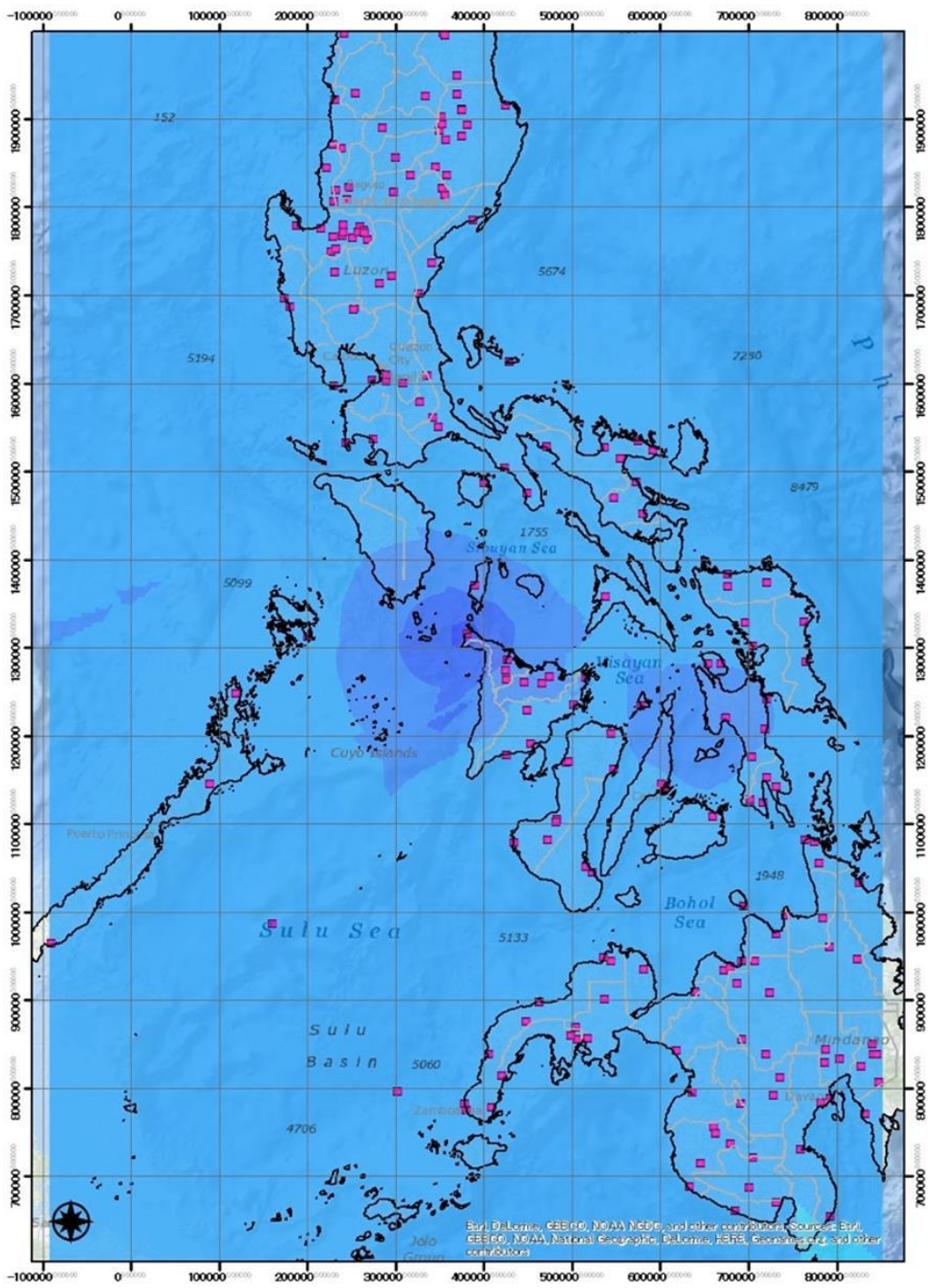
Rainfall 02 AM



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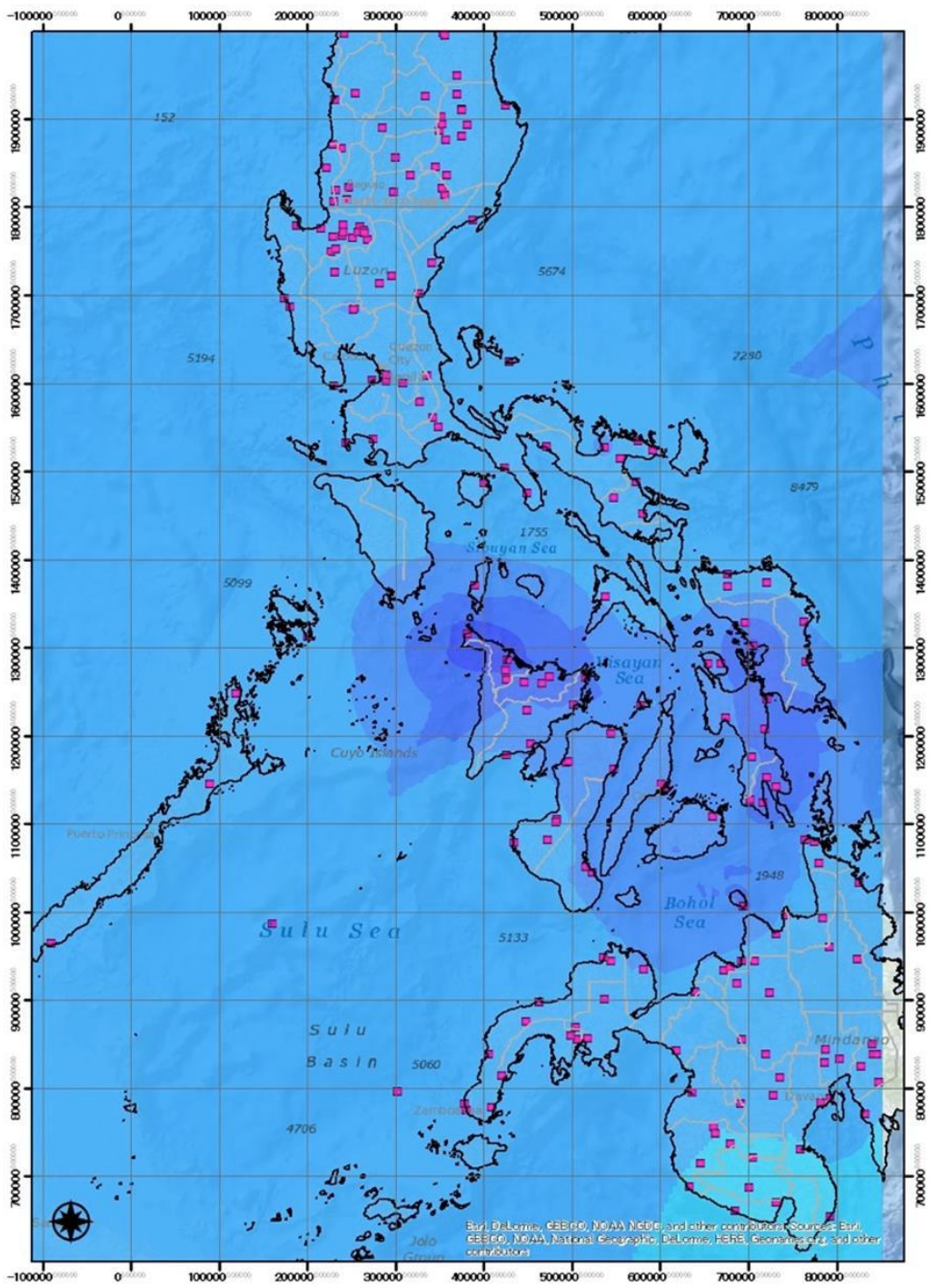
Rainfall 03 AM



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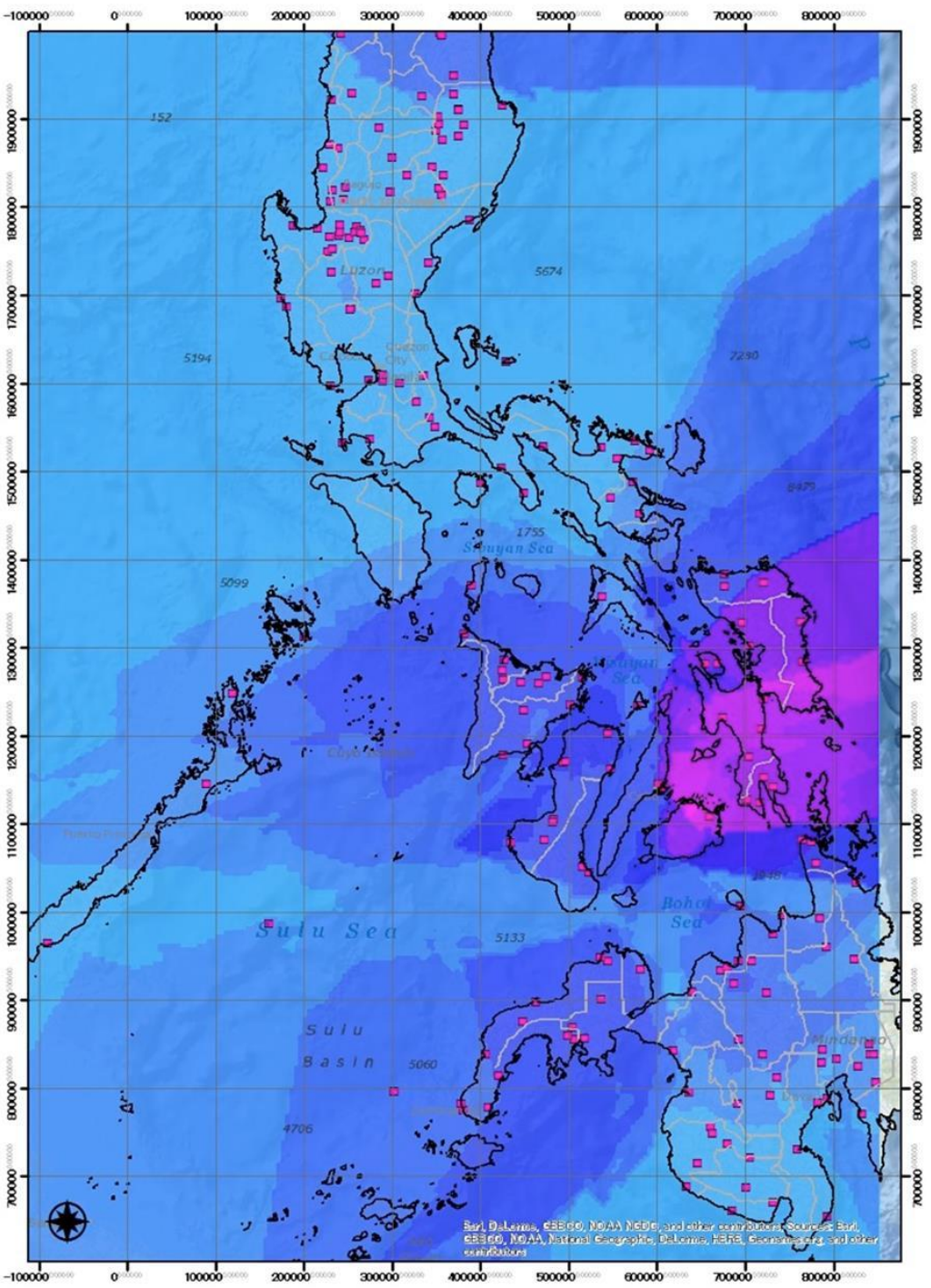
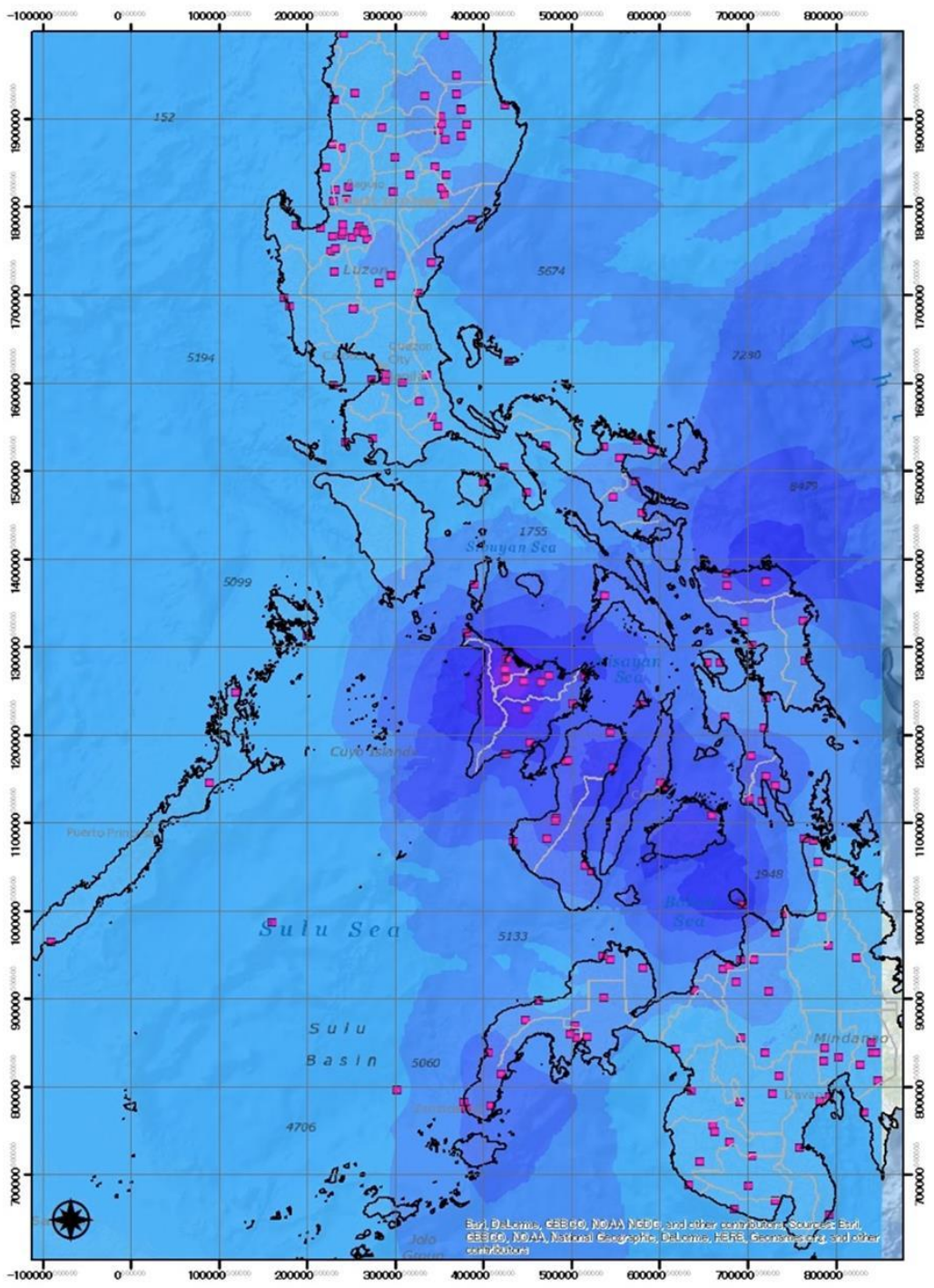
Rainfall 04 AM



Rainfall 05 AM



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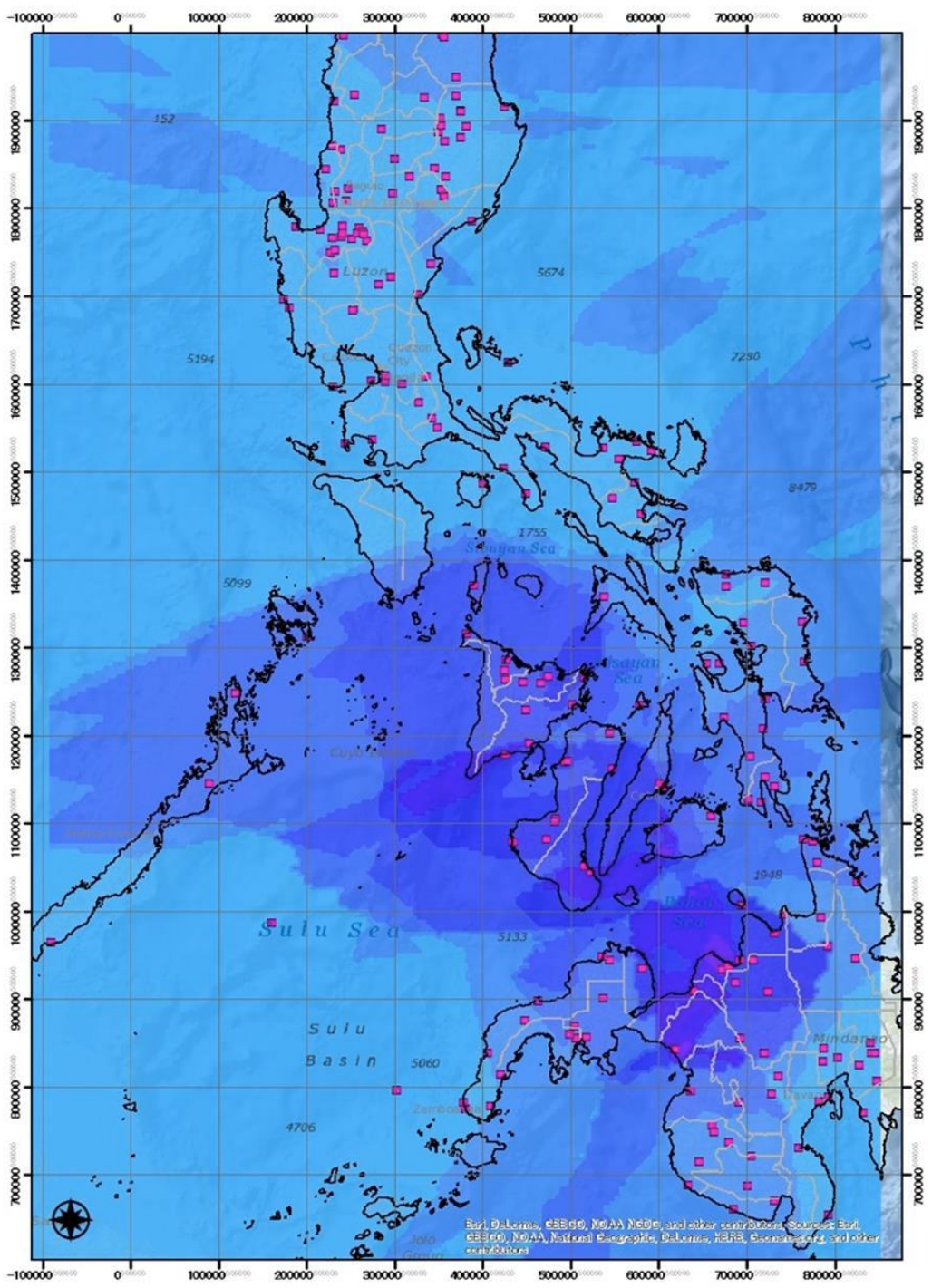
Rainfall 06 AM



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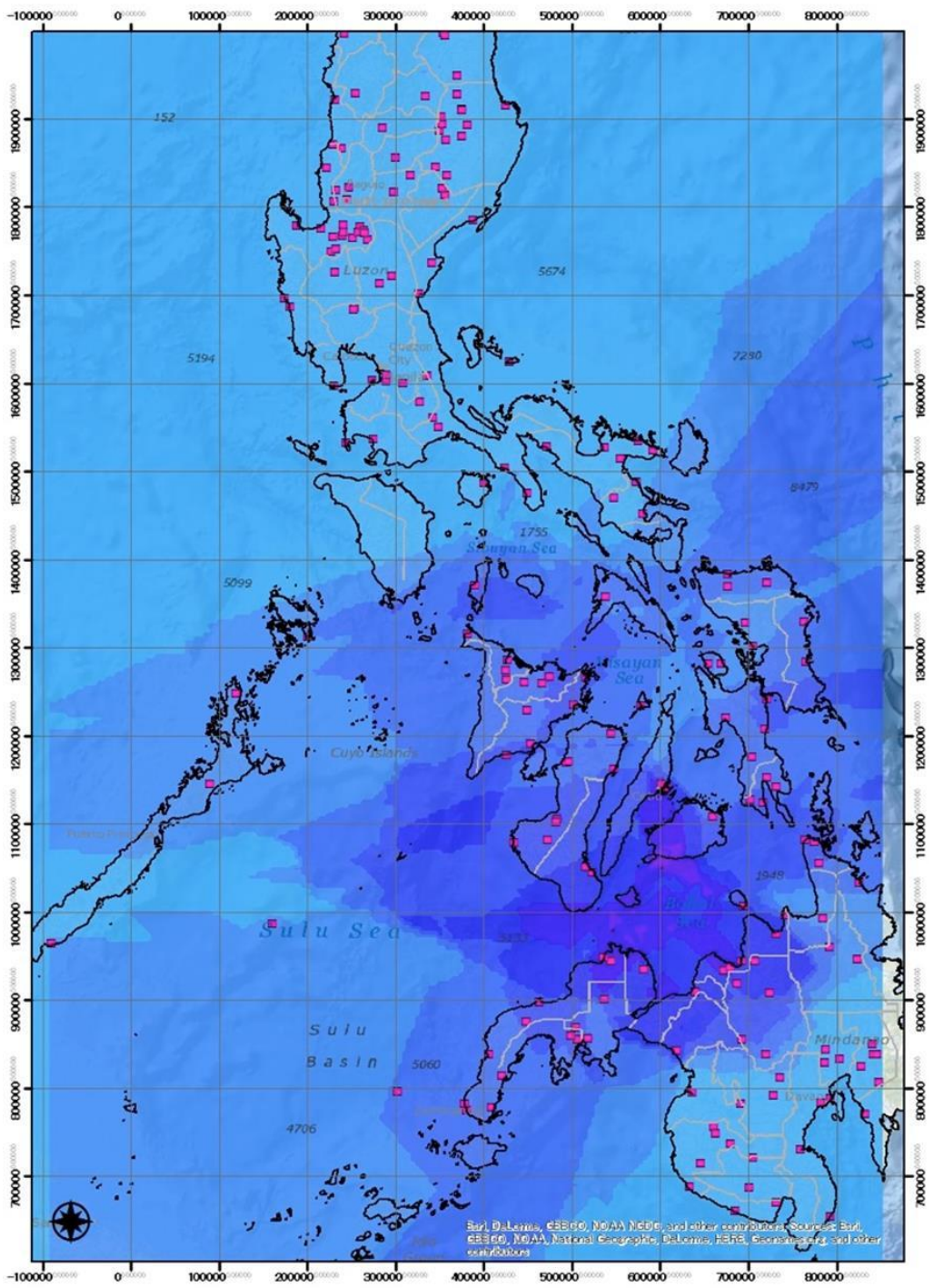
Rainfall 07 AM



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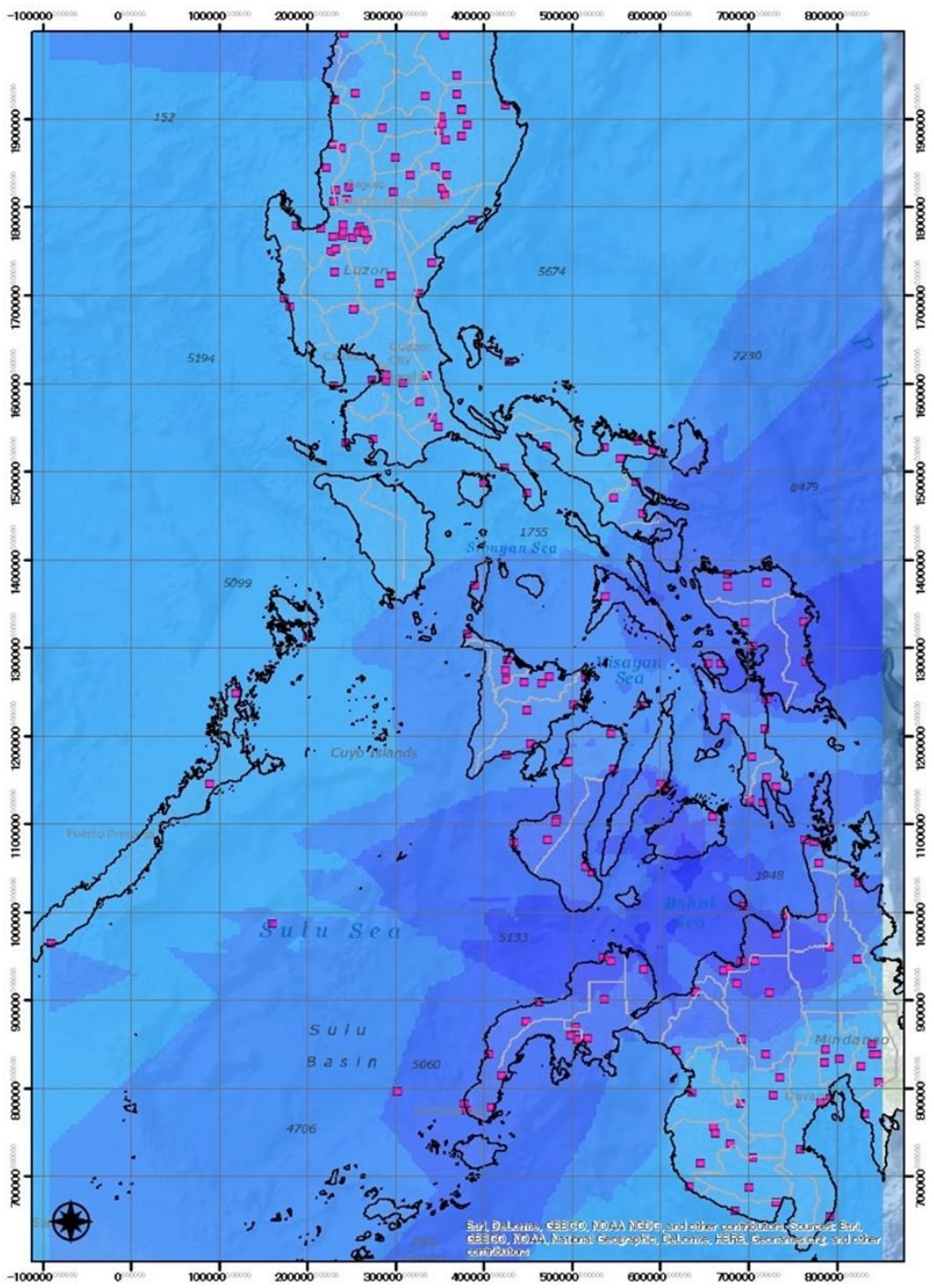
Rainfall 08 AM



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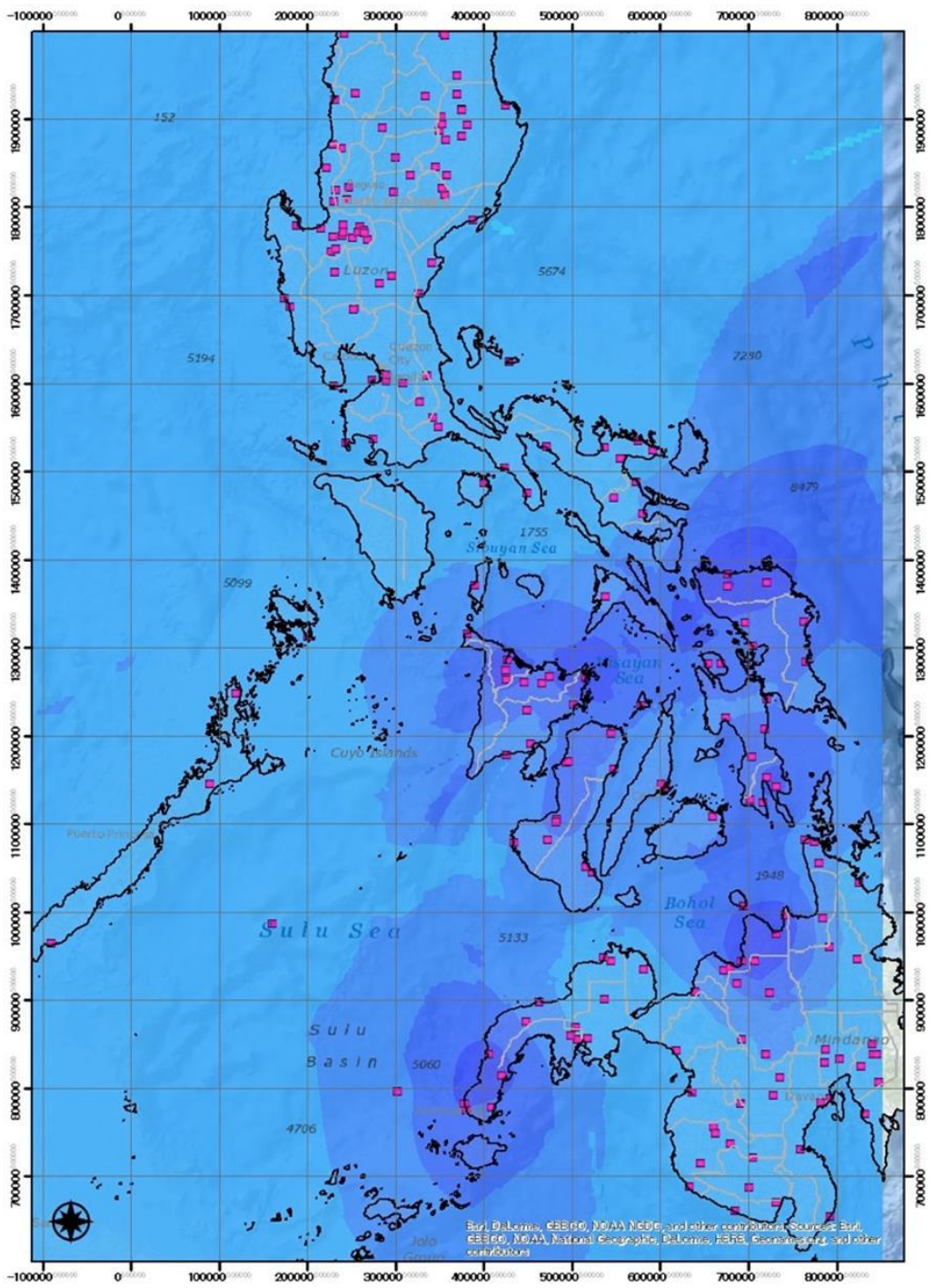
Rainfall 09 AM



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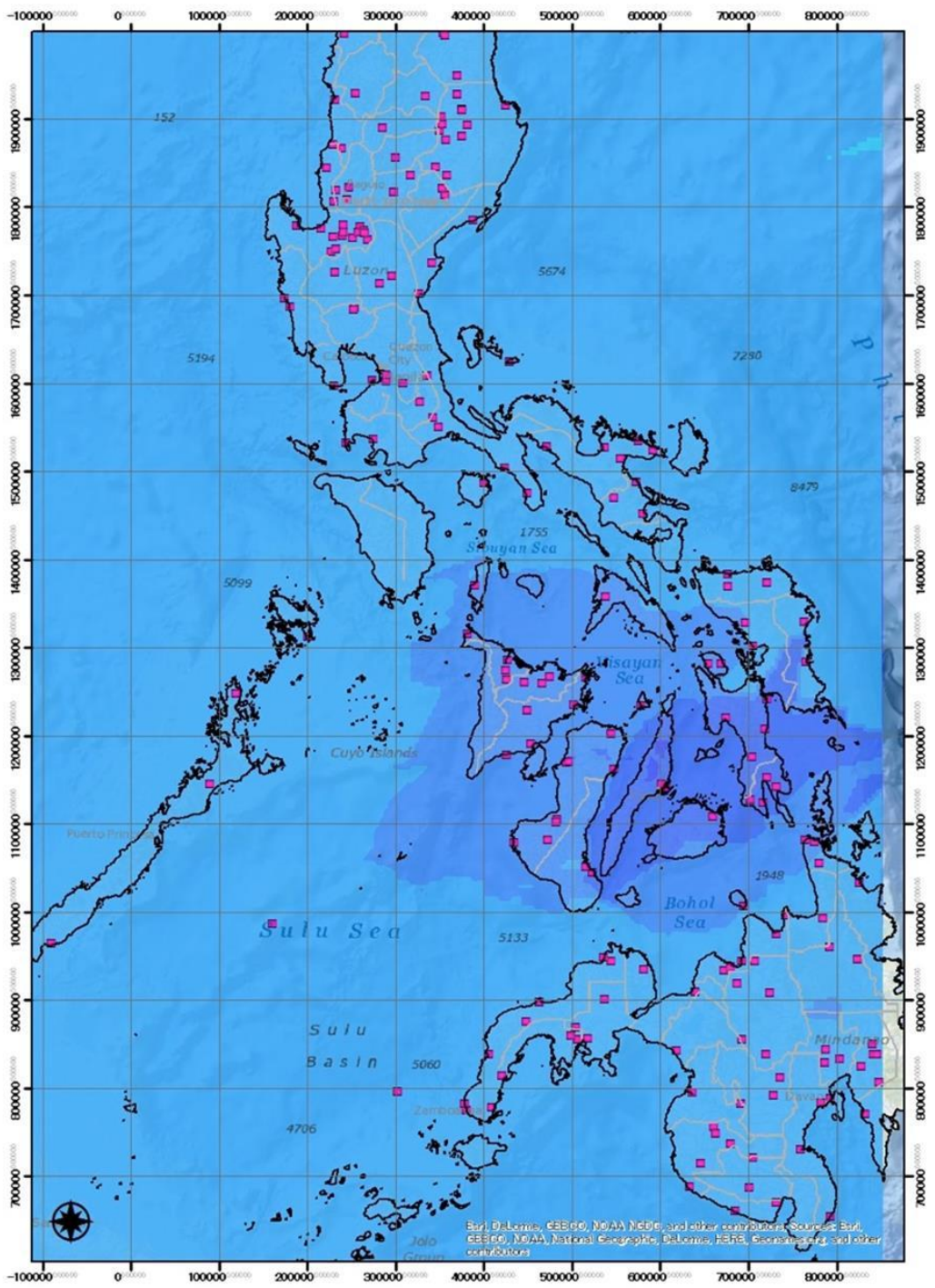
Rainfall 10 AM



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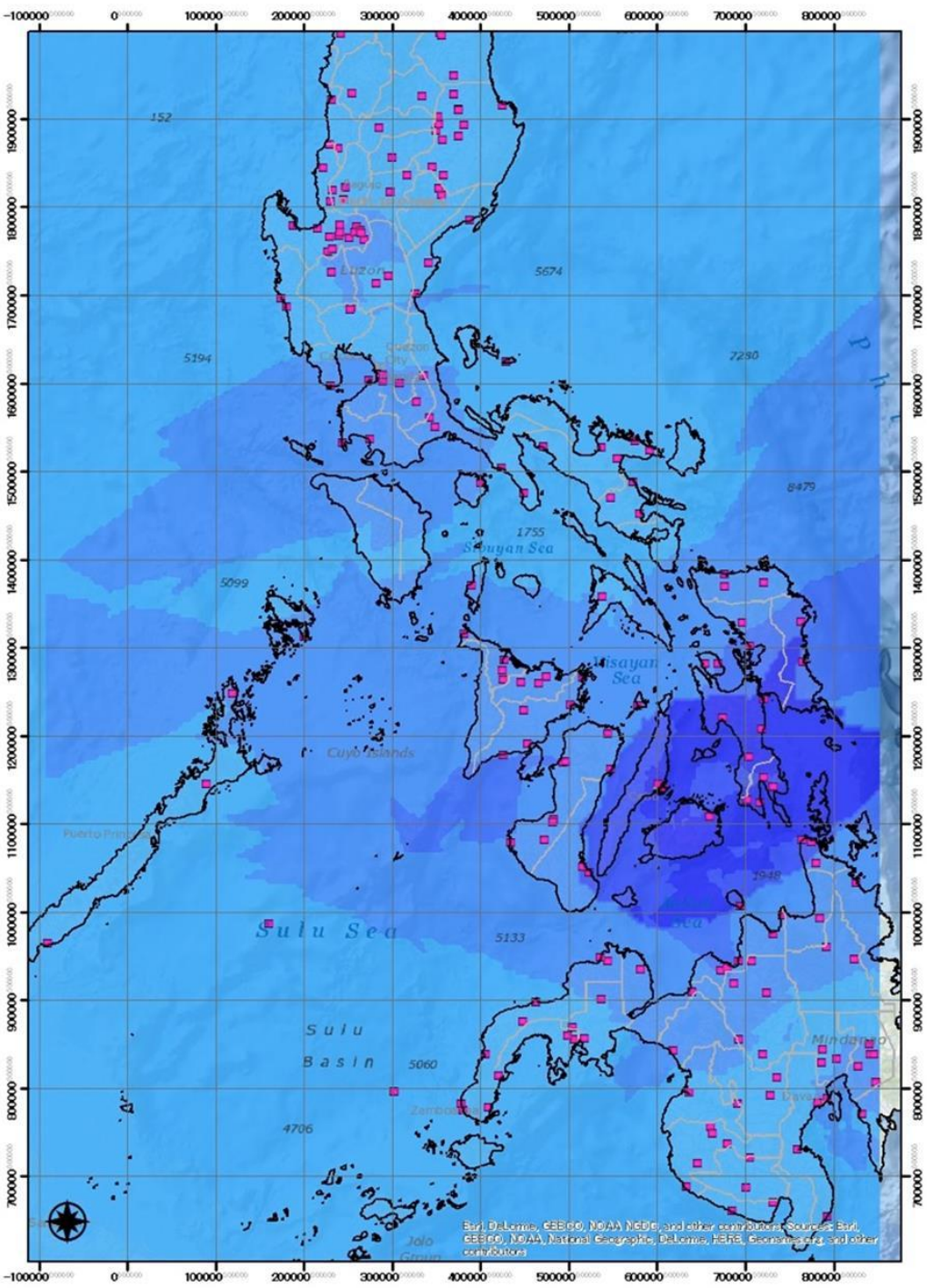

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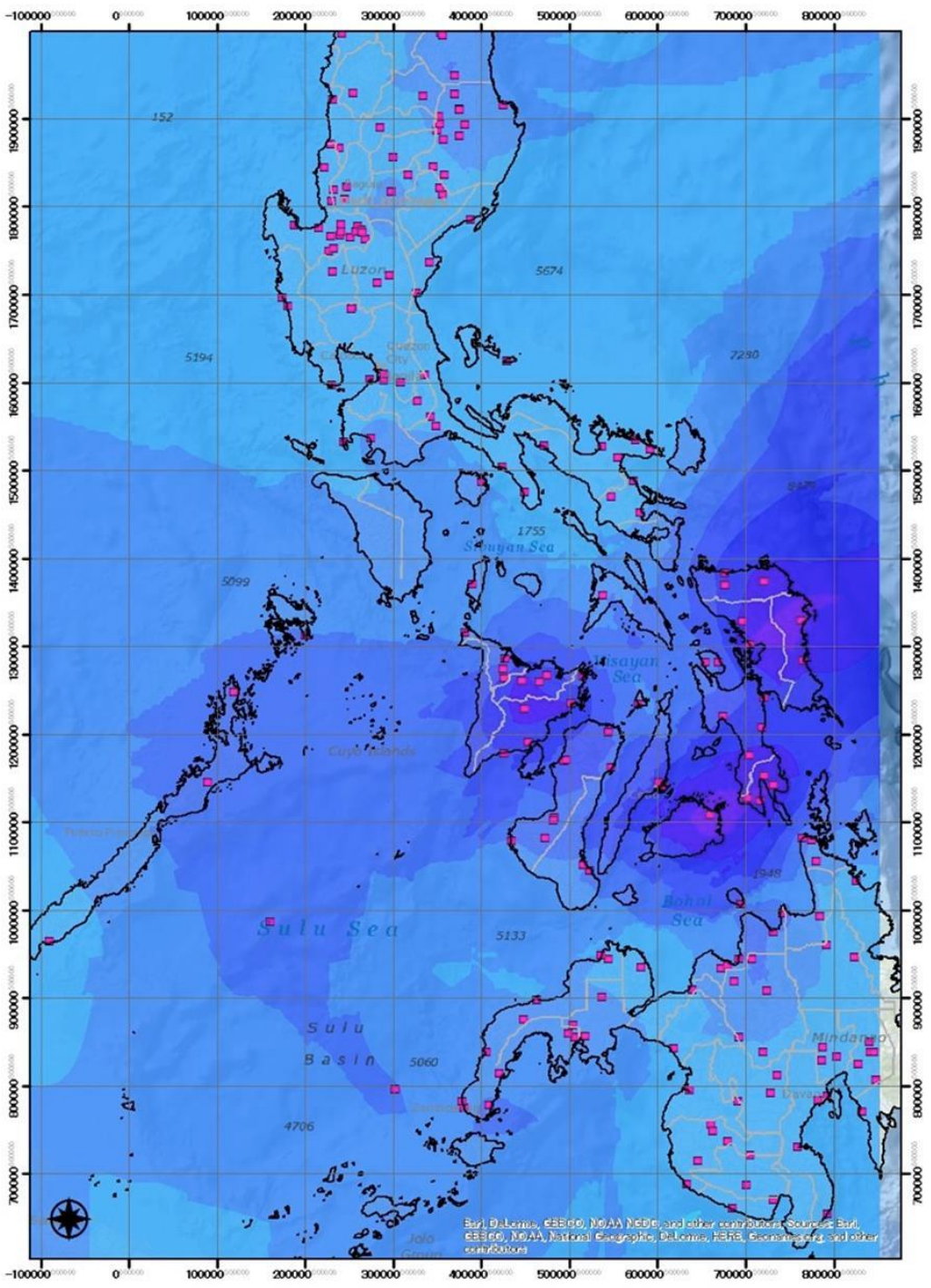

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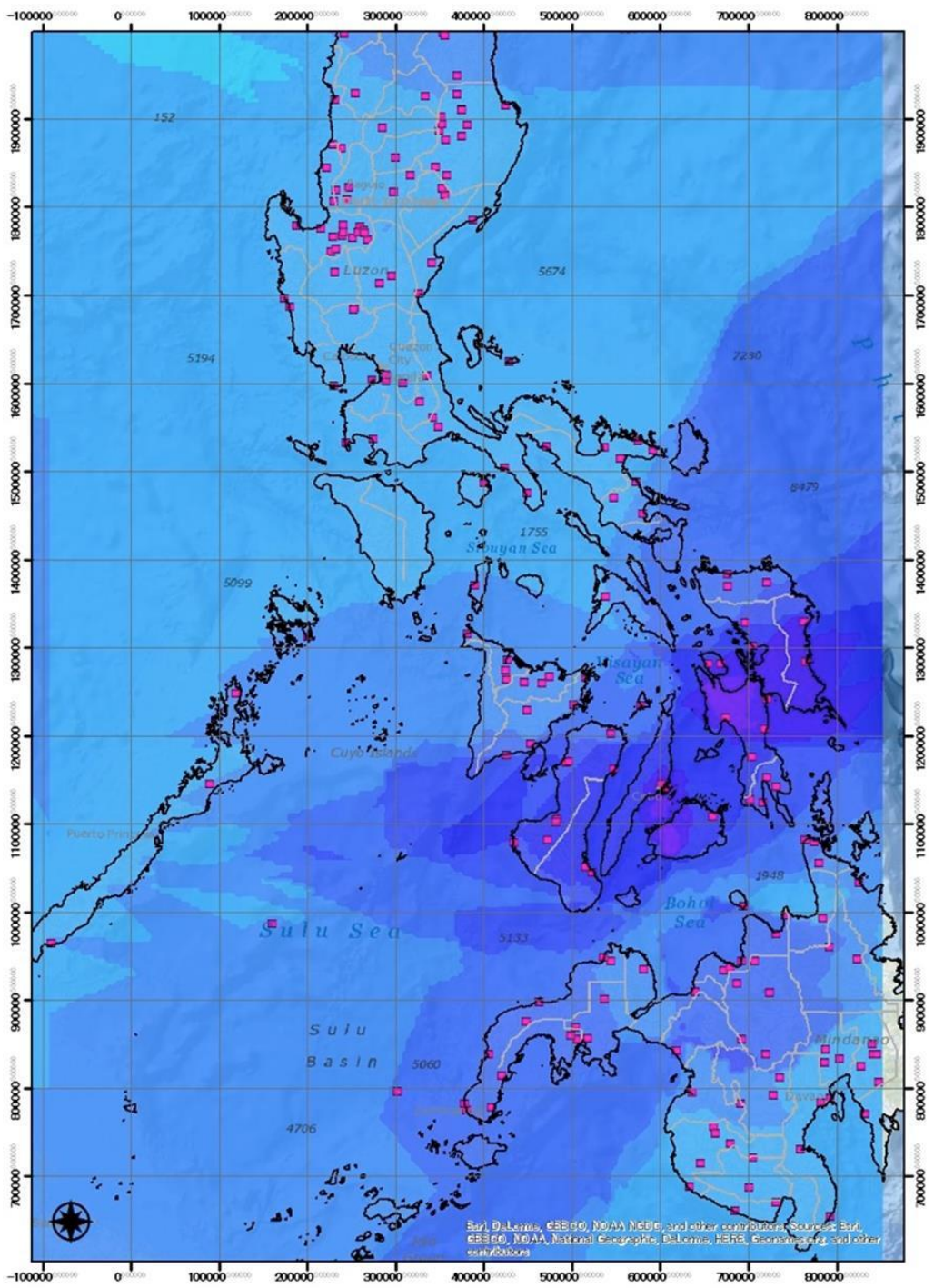
Rainfall 01 PM



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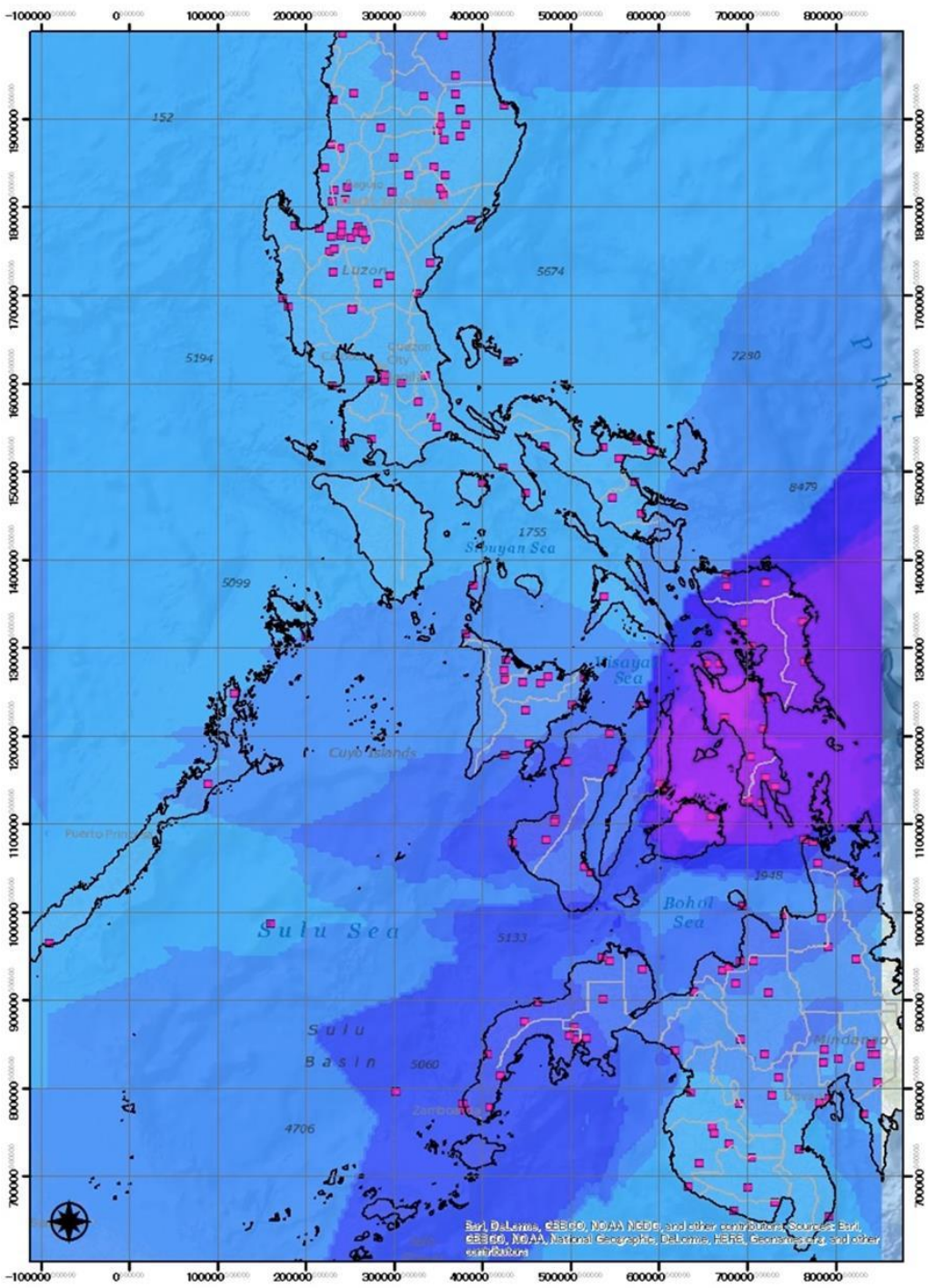
Rainfall 02 PM



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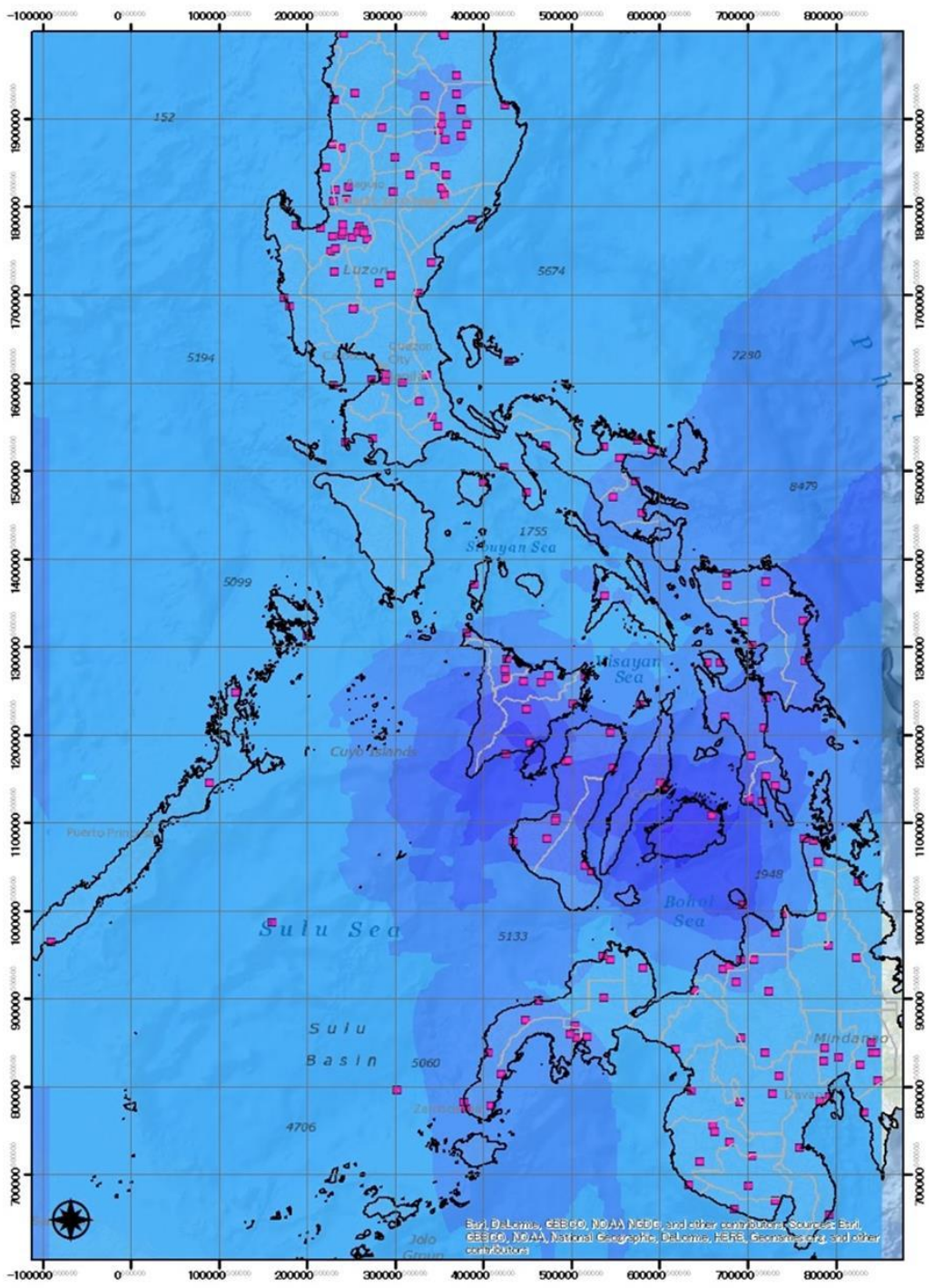
Rainfall 03 PM



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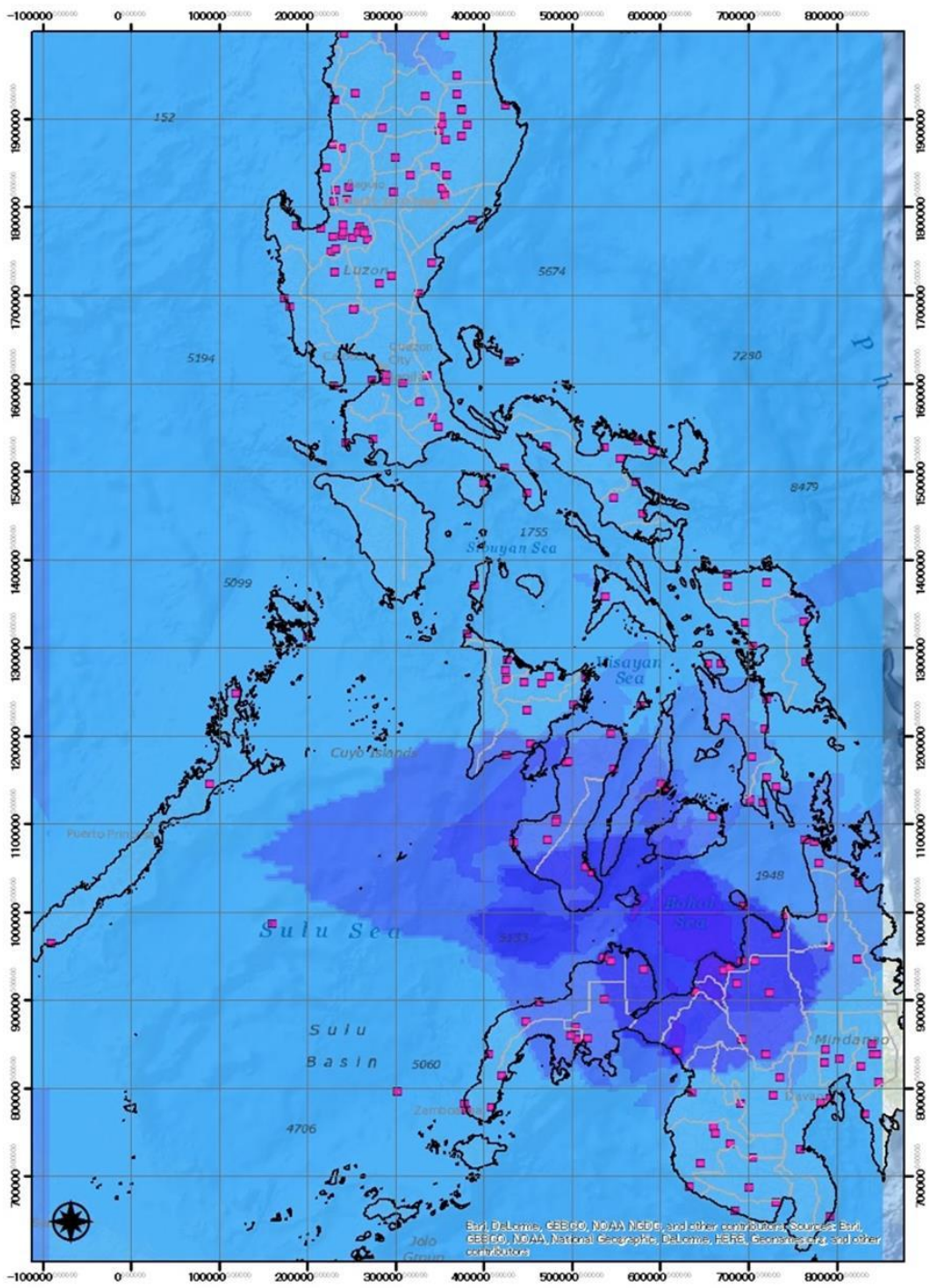
Rainfall 04 PM



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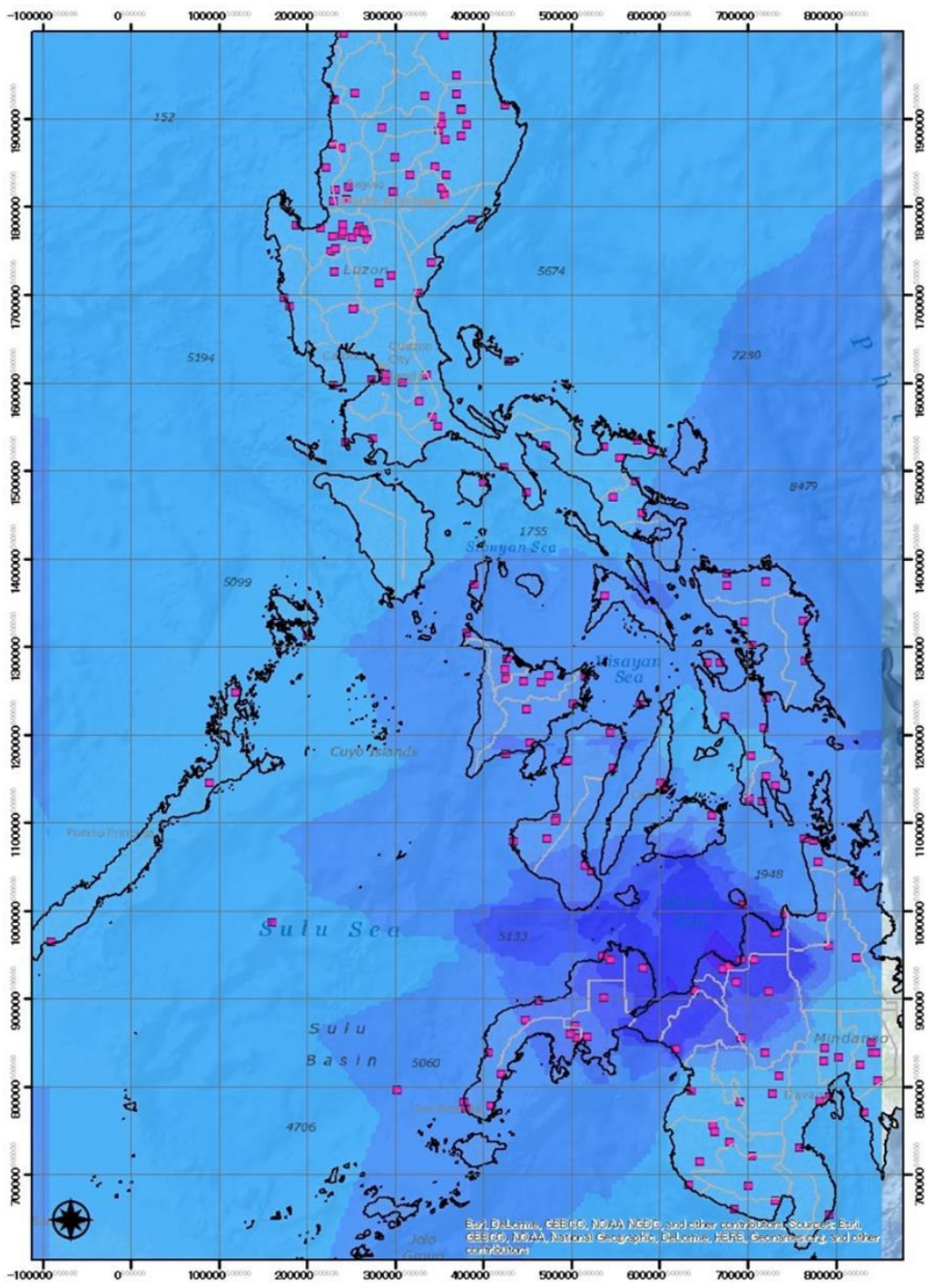
Rainfall 05 PM



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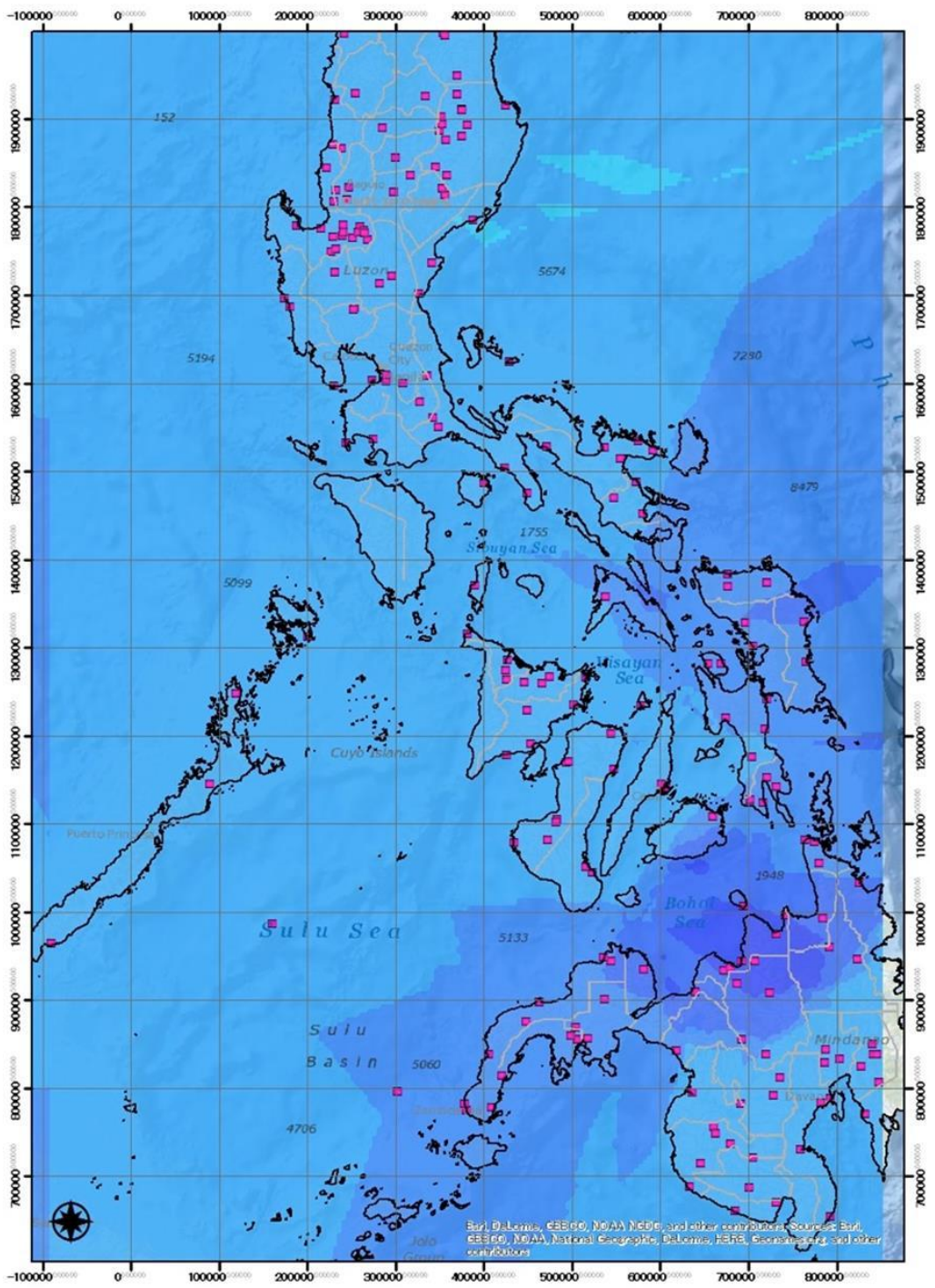
Rainfall 06 PM



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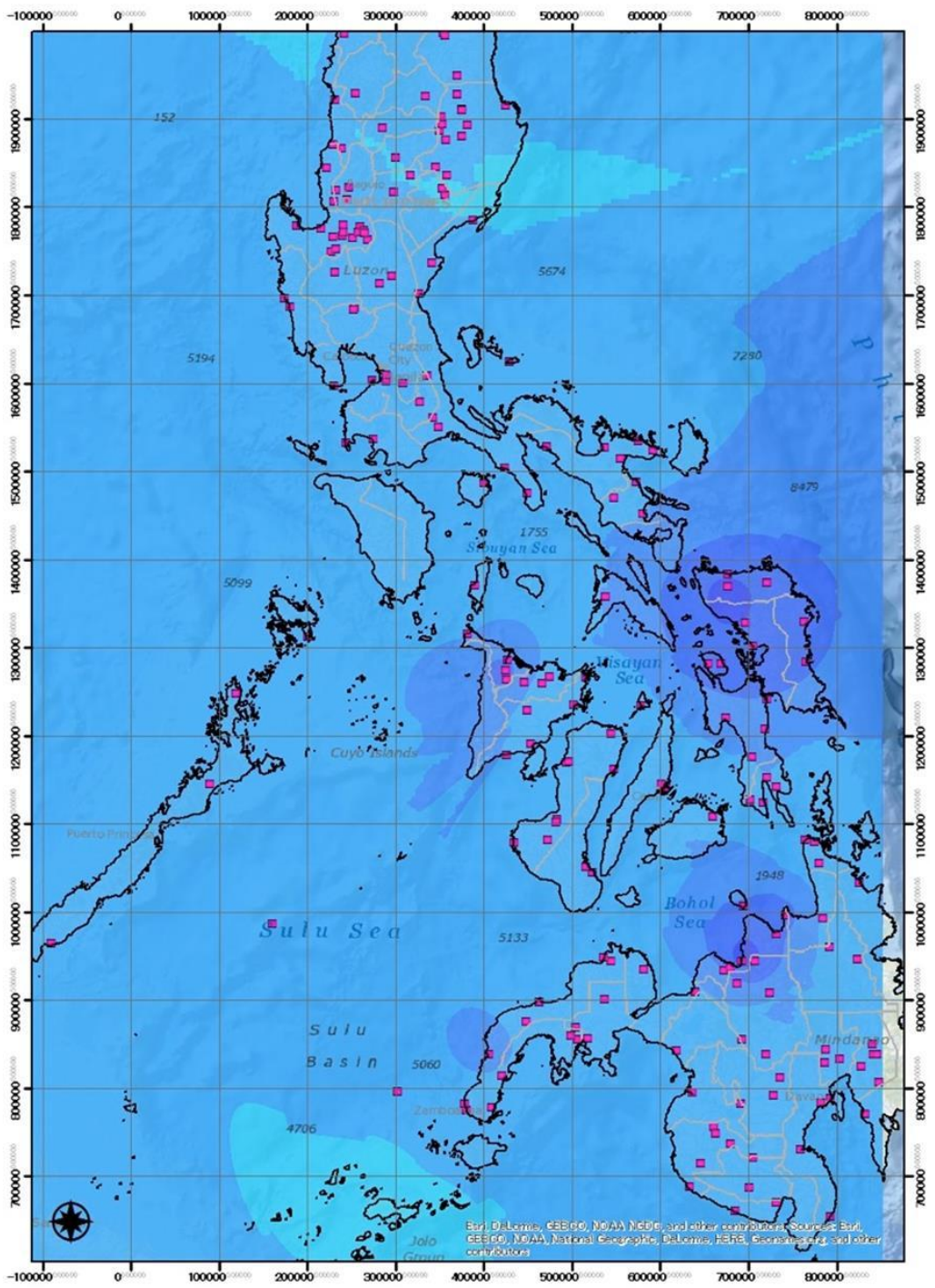
Rainfall 07 PM



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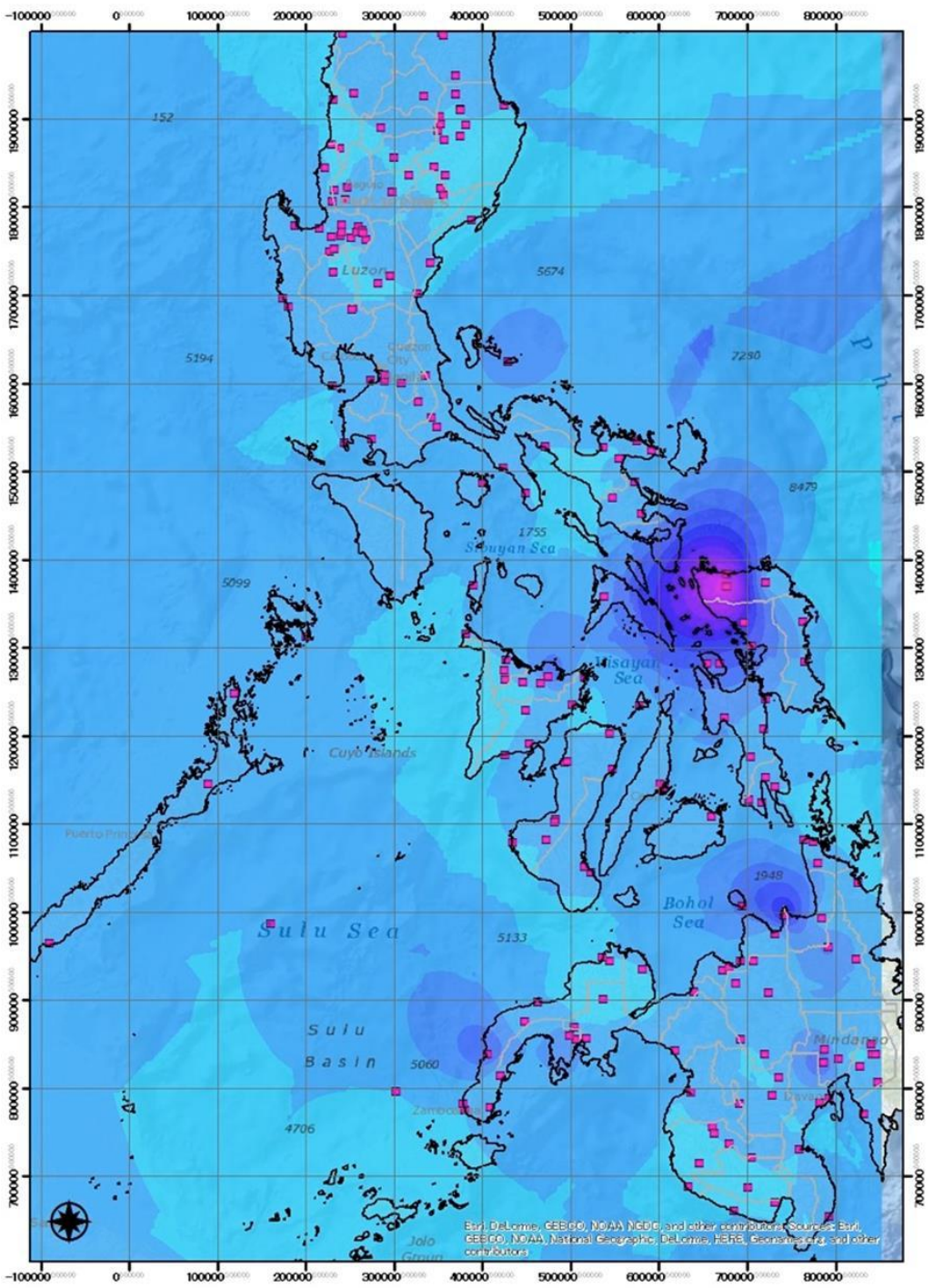
Rainfall 08 PM



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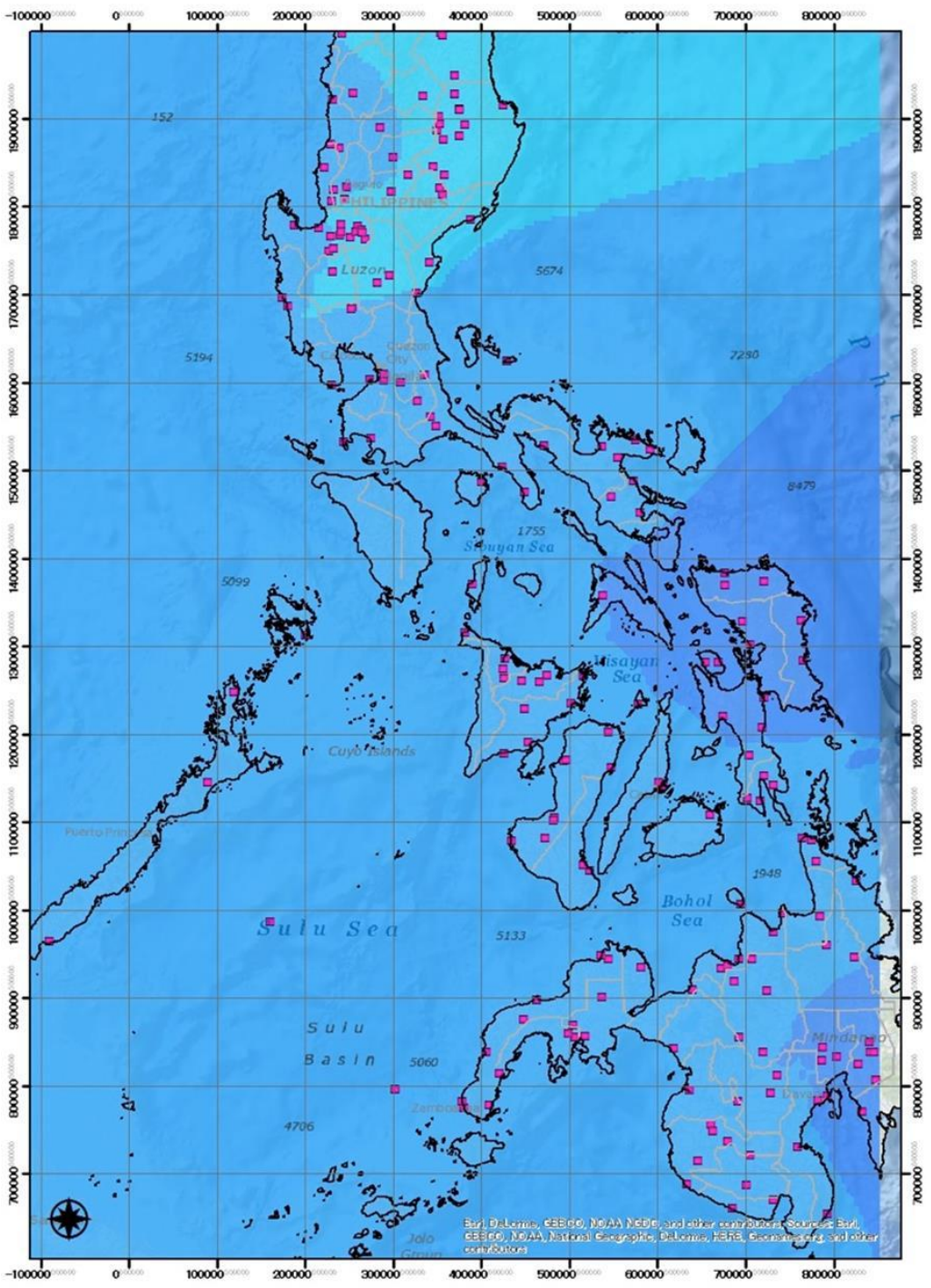
Rainfall 09 PM



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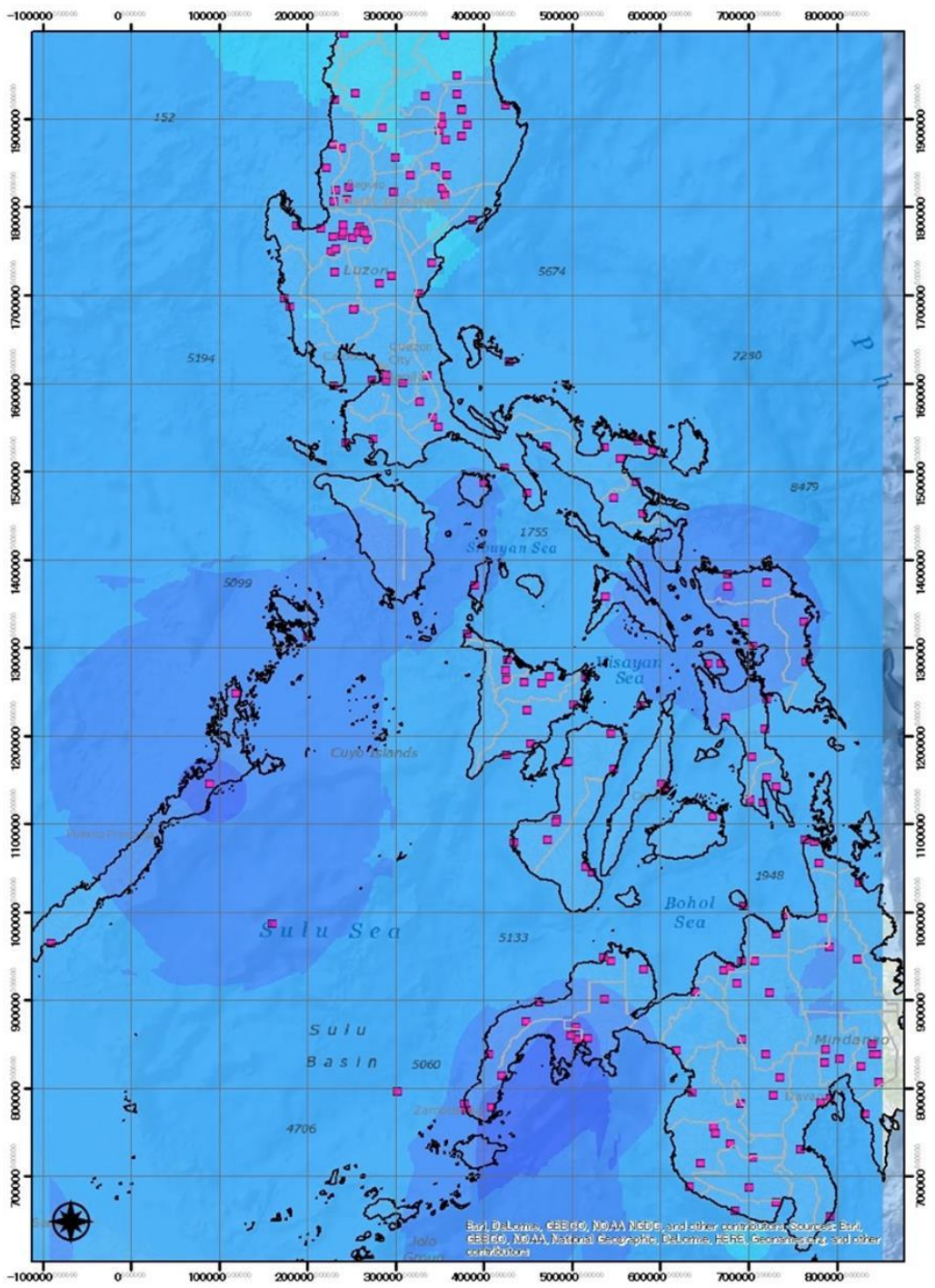
Rainfall 10 PM



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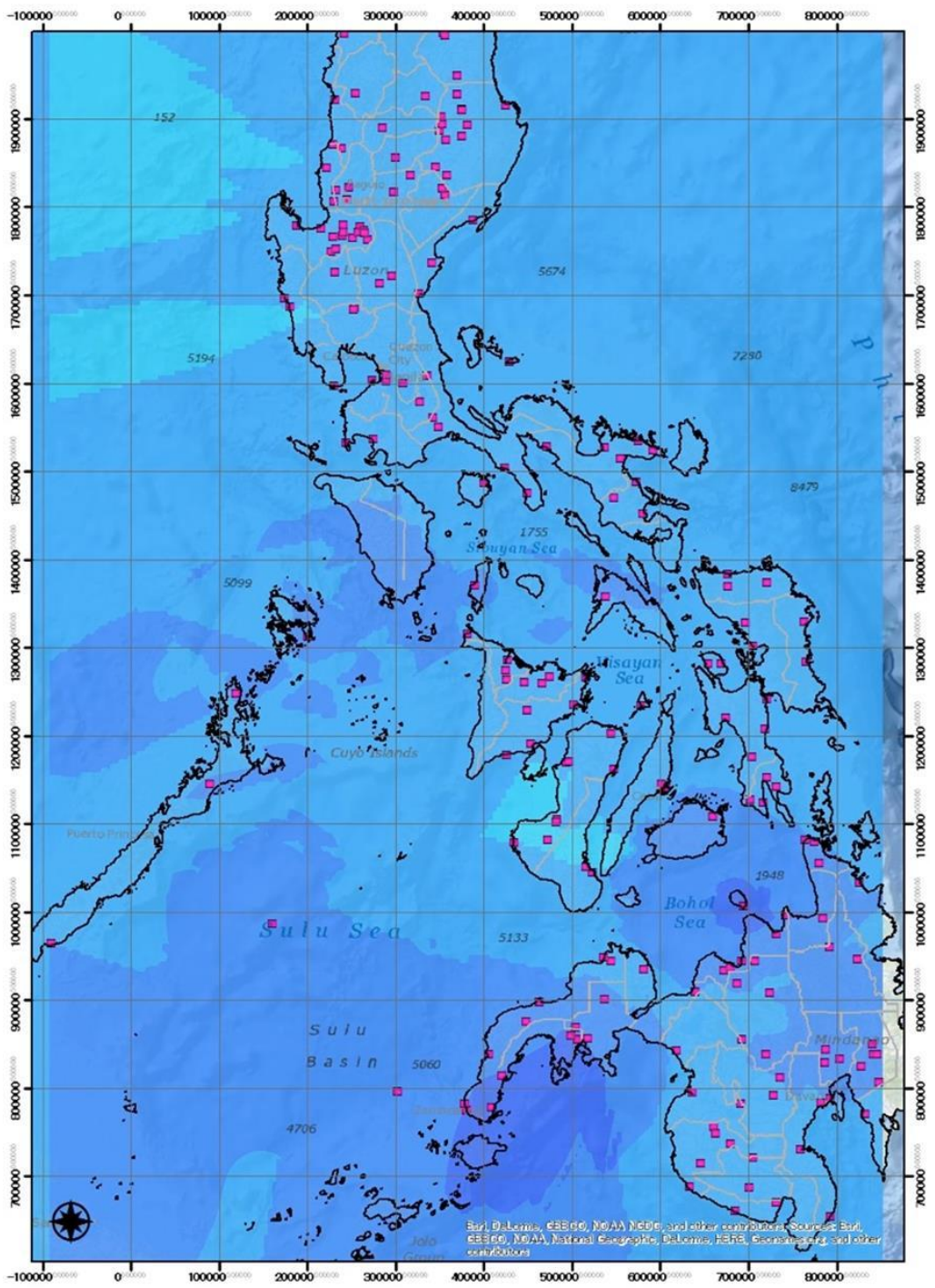
Rainfall 11 PM



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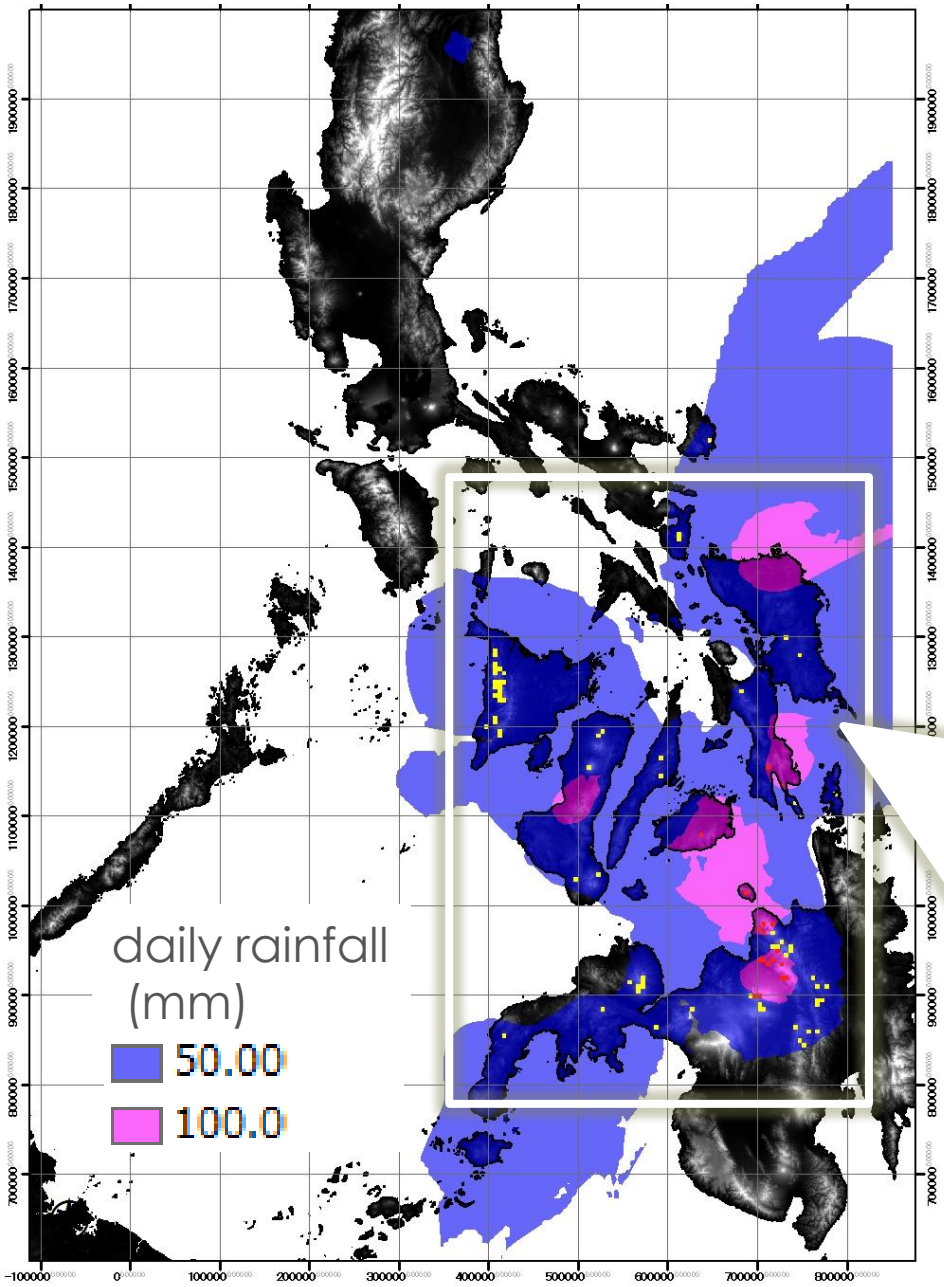
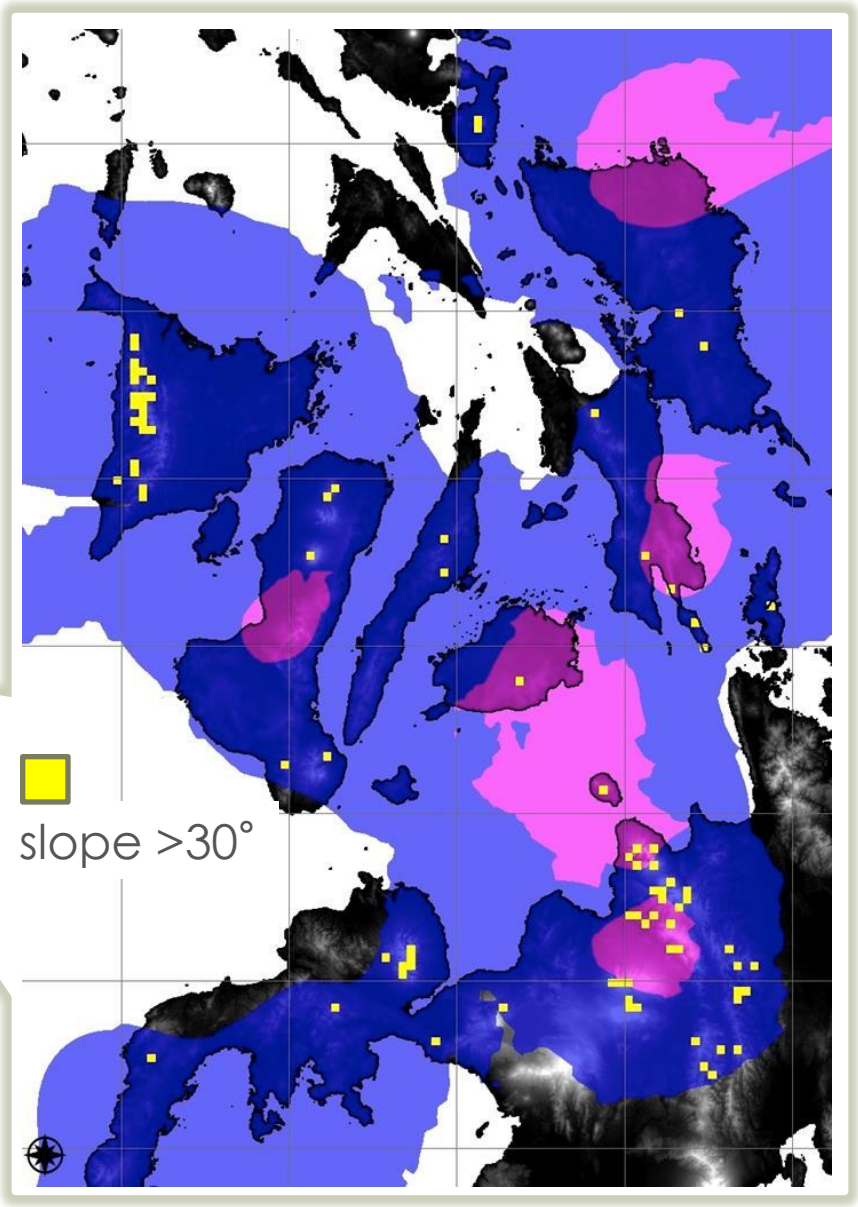
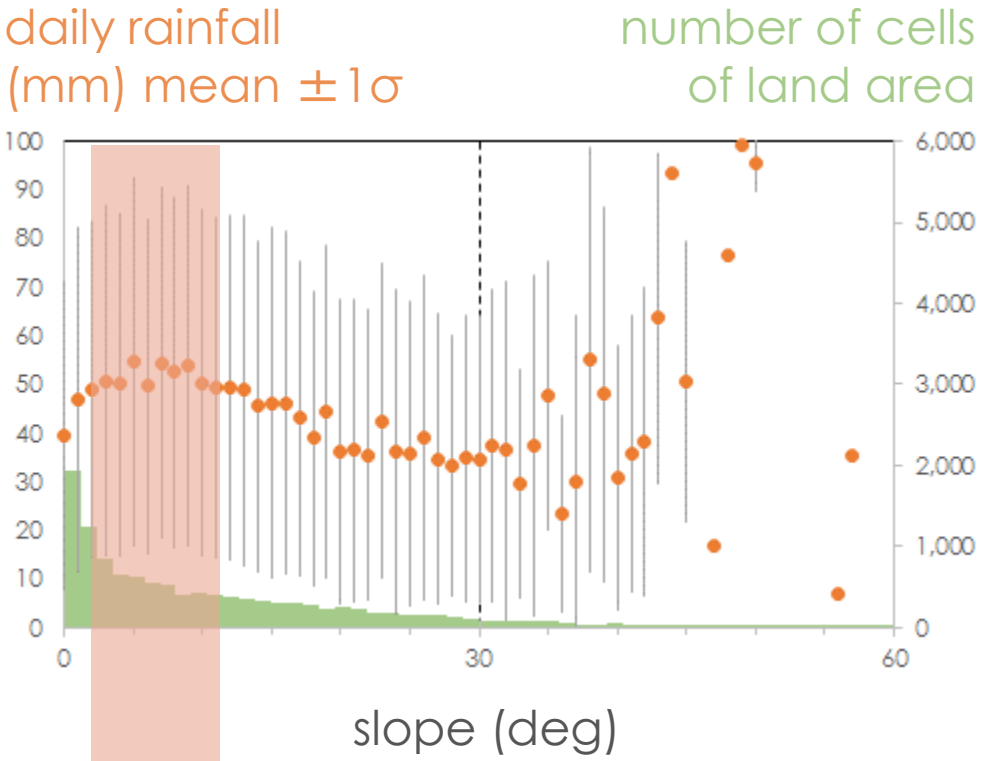
Example of Spatial Analysis (1): Rainfall and Topography in Relation to Possible Landslide and Flood Hazards

Potential Landslide Hazard Areas

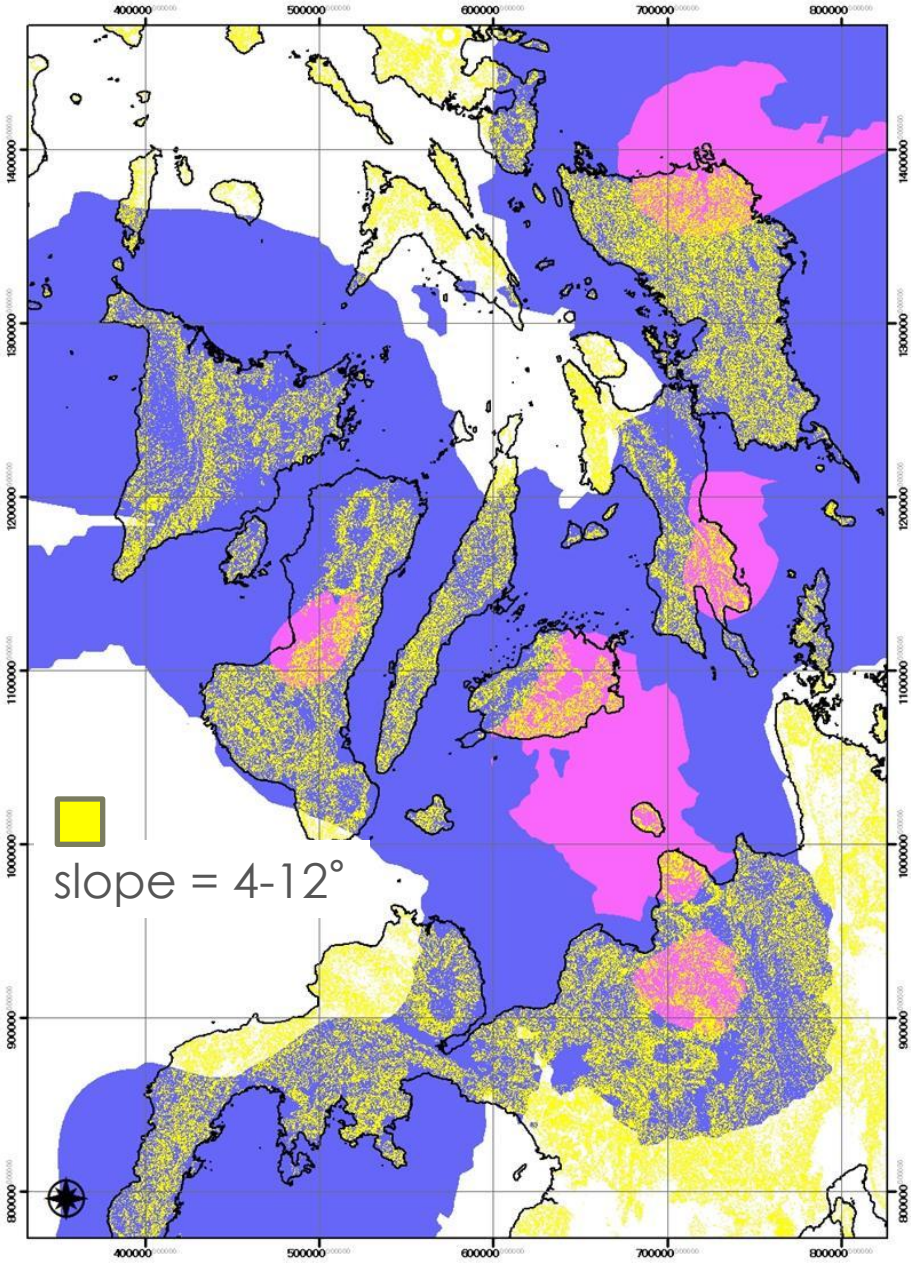




Moderately Sloping Areas Had More Rainfall



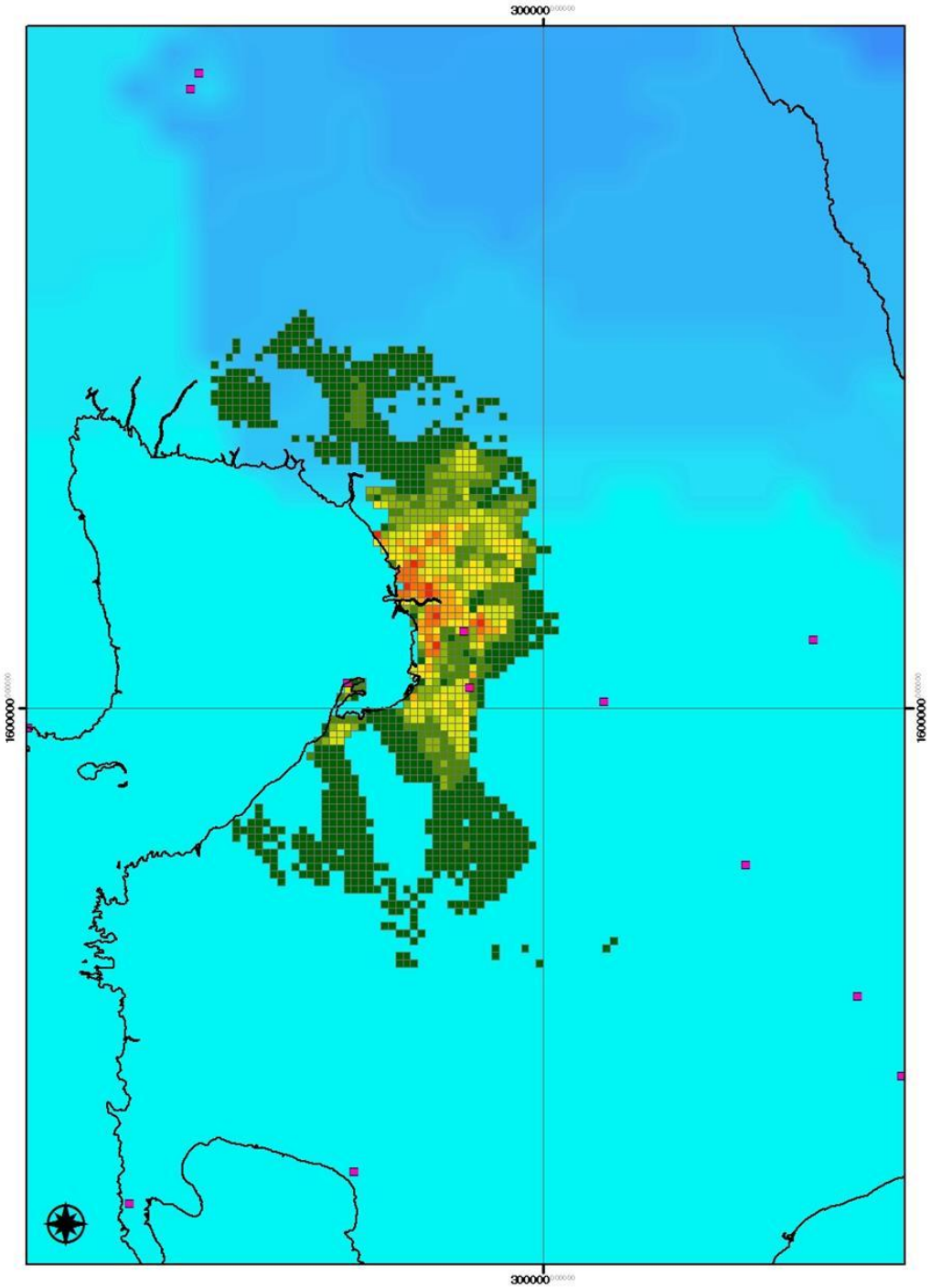
relatively higher rainfalls in slopes 4-12 degs



Example of Spatial Analysis (2): Rainfall and People Flow in Manila (Hourly Population Estimates based on a Questionnaire Survey to 200,000 People)

Pop. & Rainfall

0AM



population (/km^2)

570	3190
3240	7630
7690	12880
12930	19660
14020	28890
28950	42060
42120	64690
64750	106190

(source: person trip data 1996 Manila by CSIS-i)

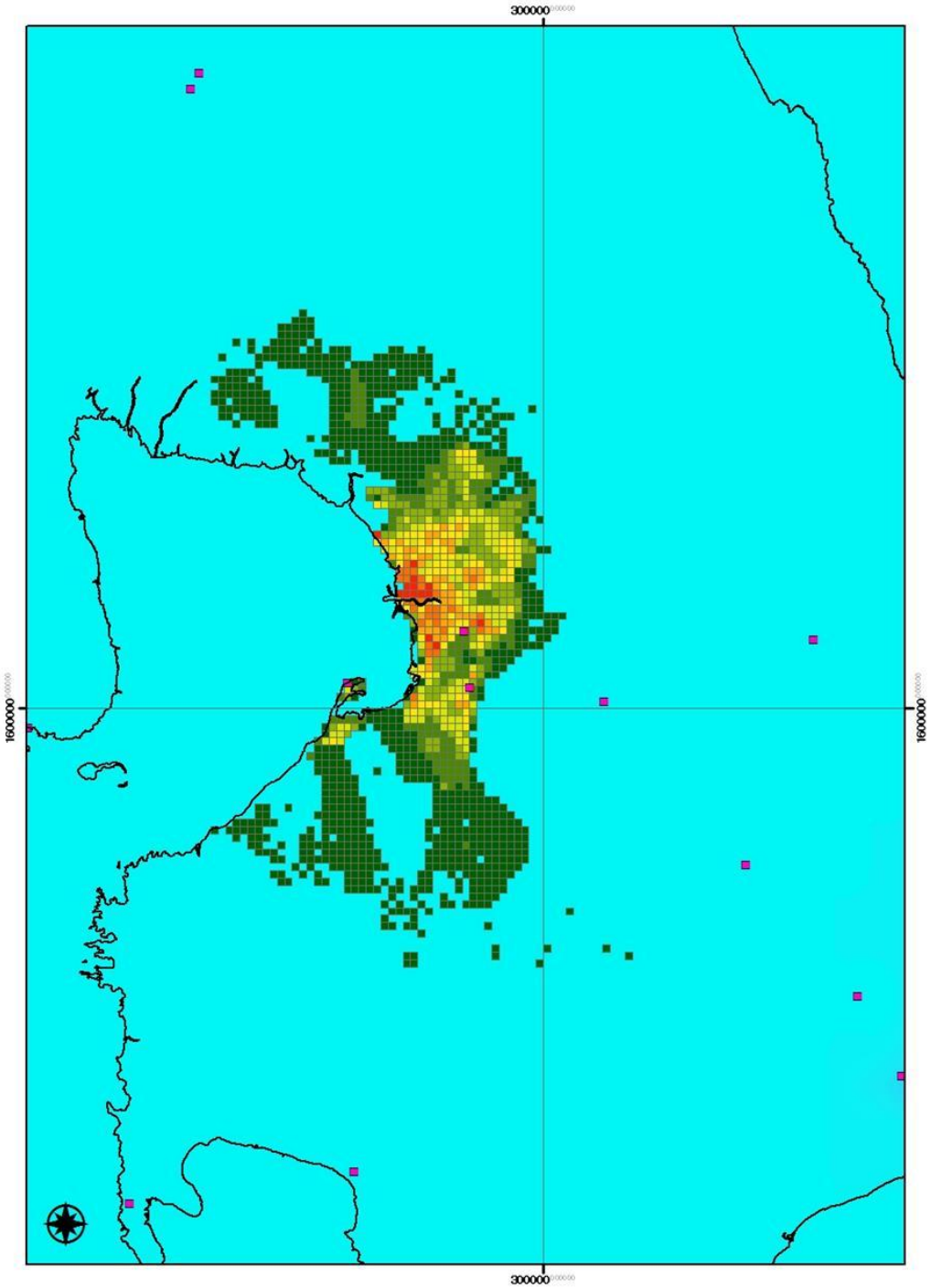
hourly rainfall (mm)

13.9

0

Pop. & Rainfall

8AM



population (/km^2)

570	3190
3240	7630
7690	12880
12930	19660
14020	28890
28950	42060
42120	64690
64750	106190

(source: person trip data 1996 Manila by CSIS-i)

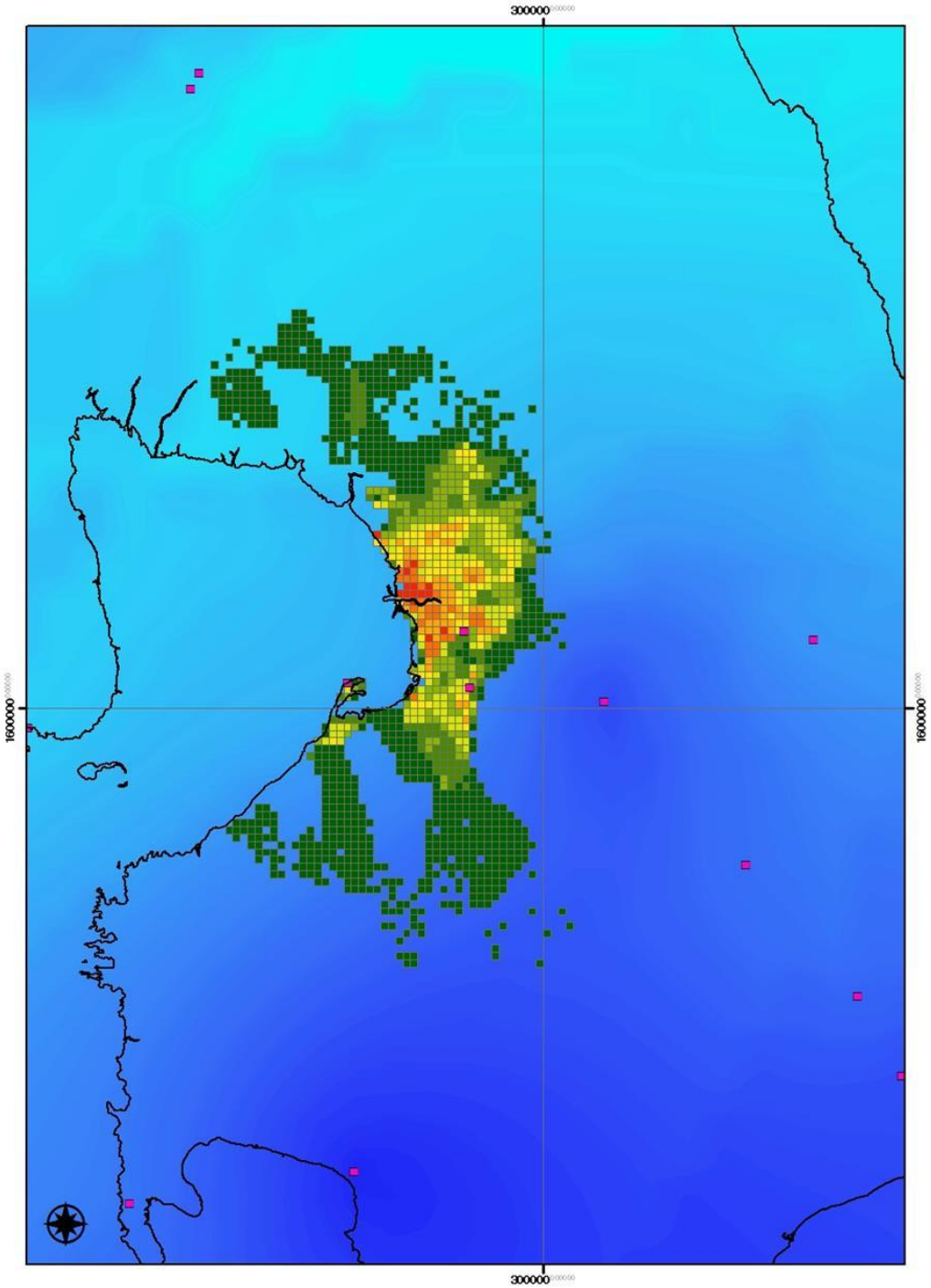
hourly rainfall (mm)

13.9

0

Pop. & Rainfall

Noon



population (/km^2)

570	3190
3240	7630
7690	12880
12930	19660
14020	28890
28950	42060
42120	64690
64750	106190

(source: person trip data 1996 Manila by CSIS-i)

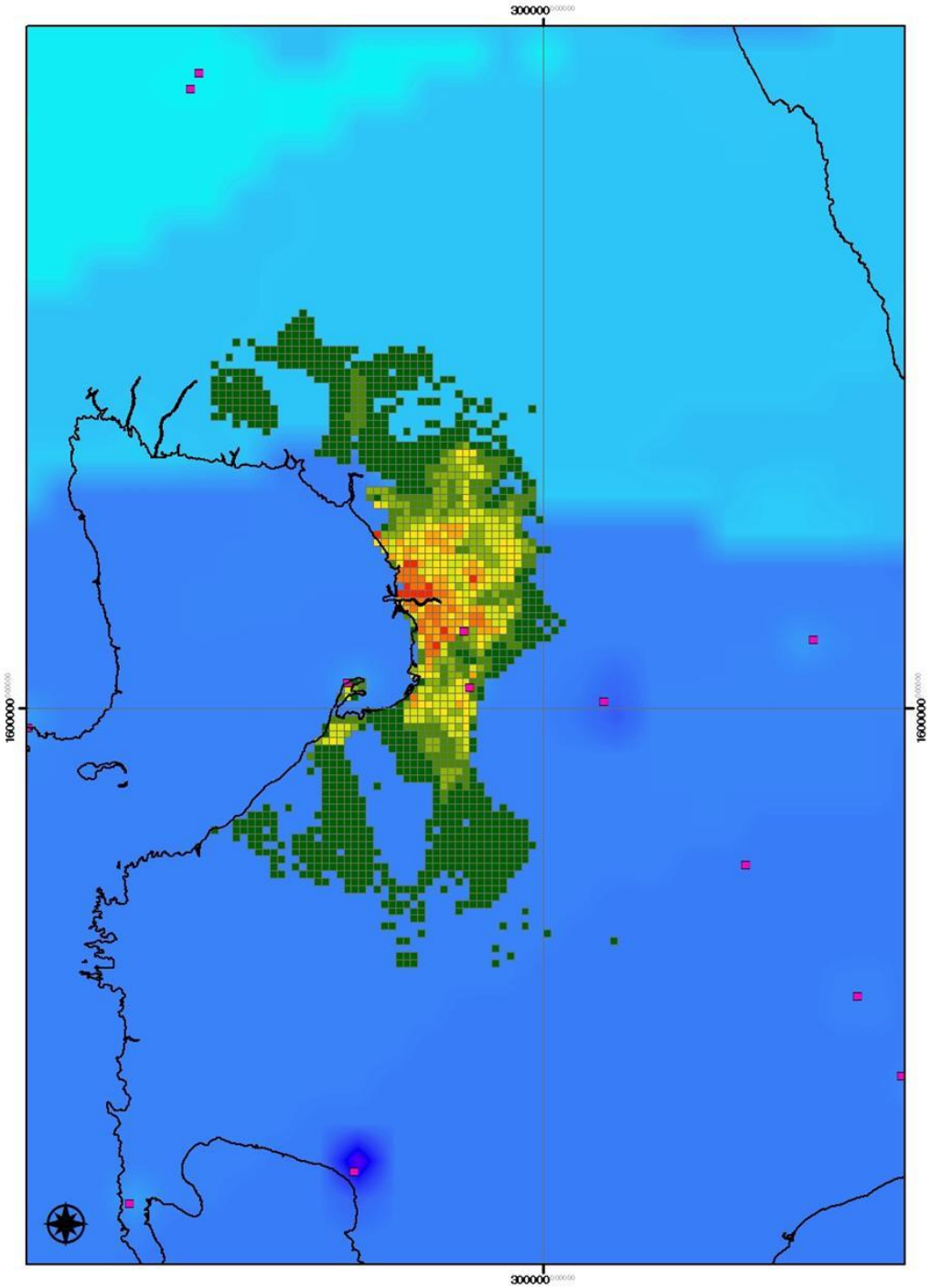
hourly rainfall (mm)

13.9

0

Pop. & Rainfall

5PM



population (/km^2)

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3240	7630
7690	12880
12930	19660
14020	28890
28950	42060
42120	64690
64750	106190

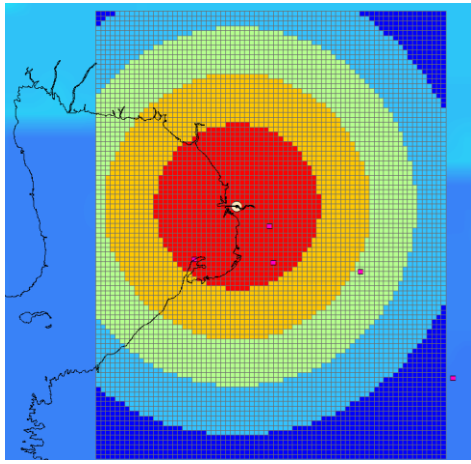
(source: person trip data 1996 Manila by CSIS-i)

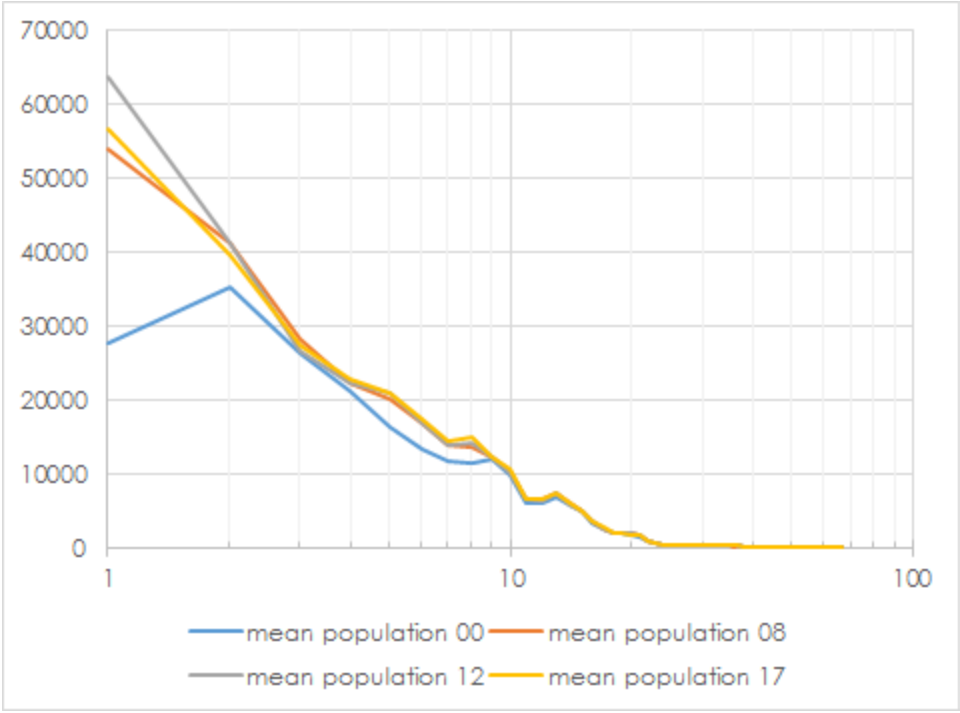
hourly rainfall (mm)

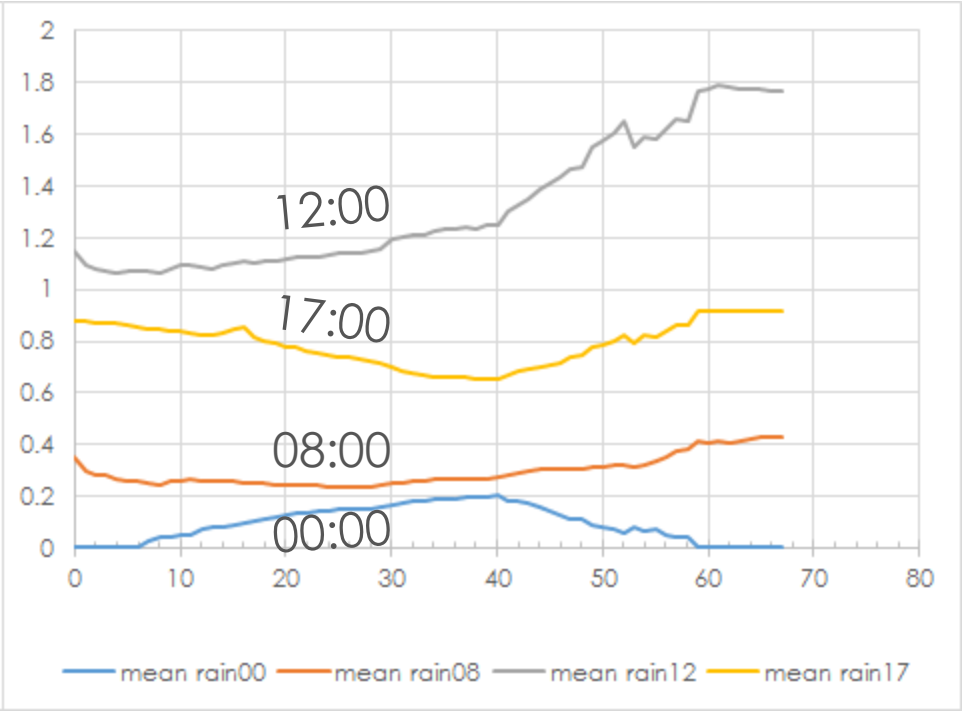
13.9

0

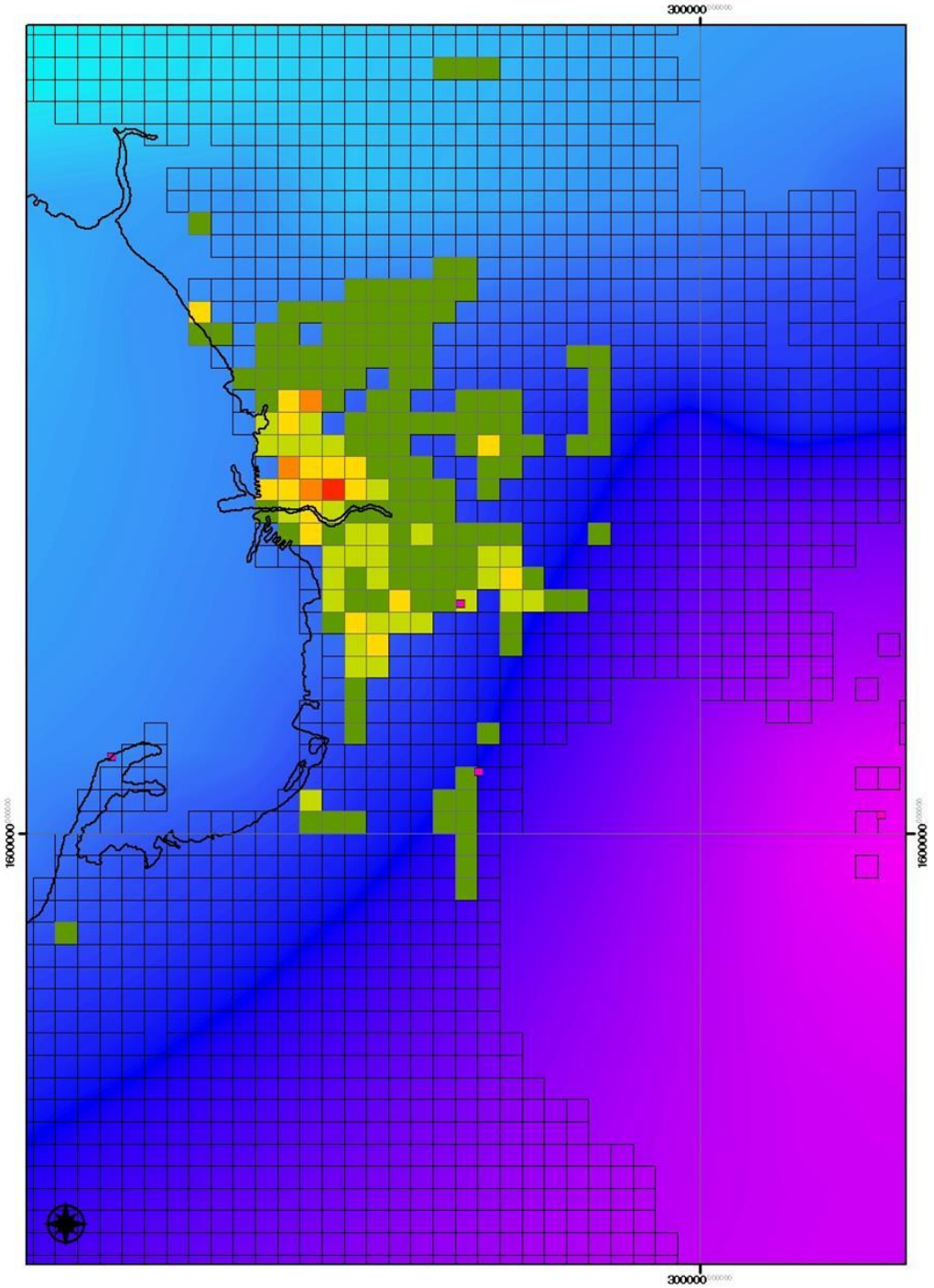
Population & Yolanda-day Rainfall vs. Distance to Manila Center







Severe Situation at Noon



population (/km^2)
only >20k/km^2

- 20001 - 40000
- 40001 - 60000
- 60001 - 80000
- 80001 - 100000
- 100001 - 120000

hourly rainfall (mm)

2.0

0.7

Concluding Remarks

- Combination of the DOST-ASTI meteorological sensor network system and the CSIS GeoServer/GIS system looks promising for future hazard mitigation in the Philippines because it enables various GIS applications
- Network-related problems have to be solved for developing a usable real-time system