

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

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.

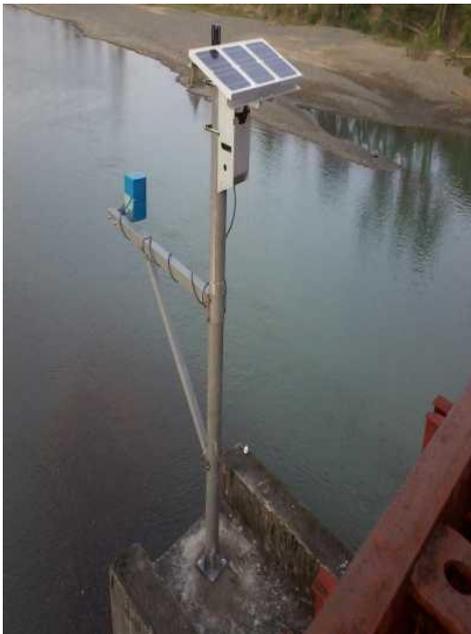
Objectives:

- 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

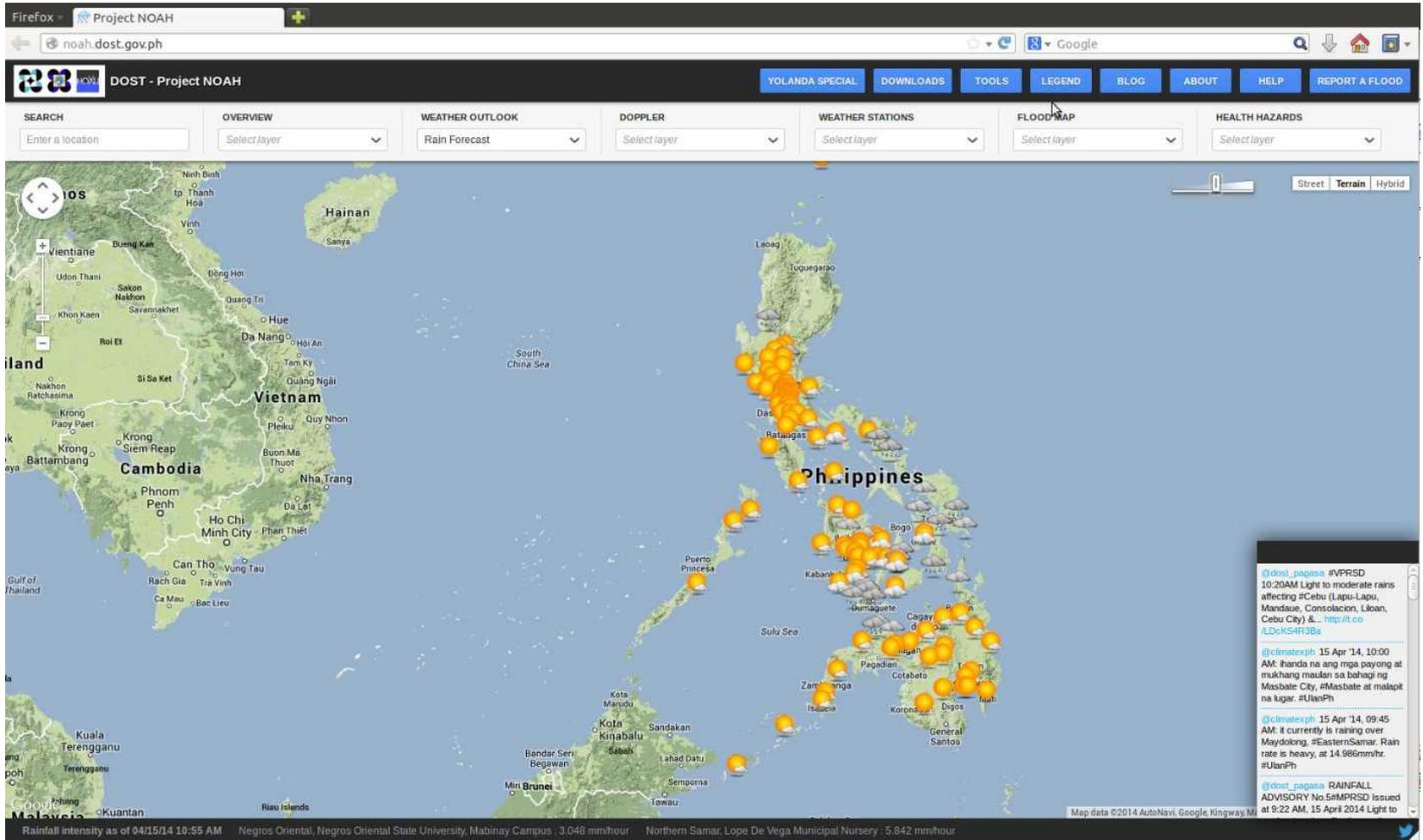
Advantages over Commercially Available Instruments:

- 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

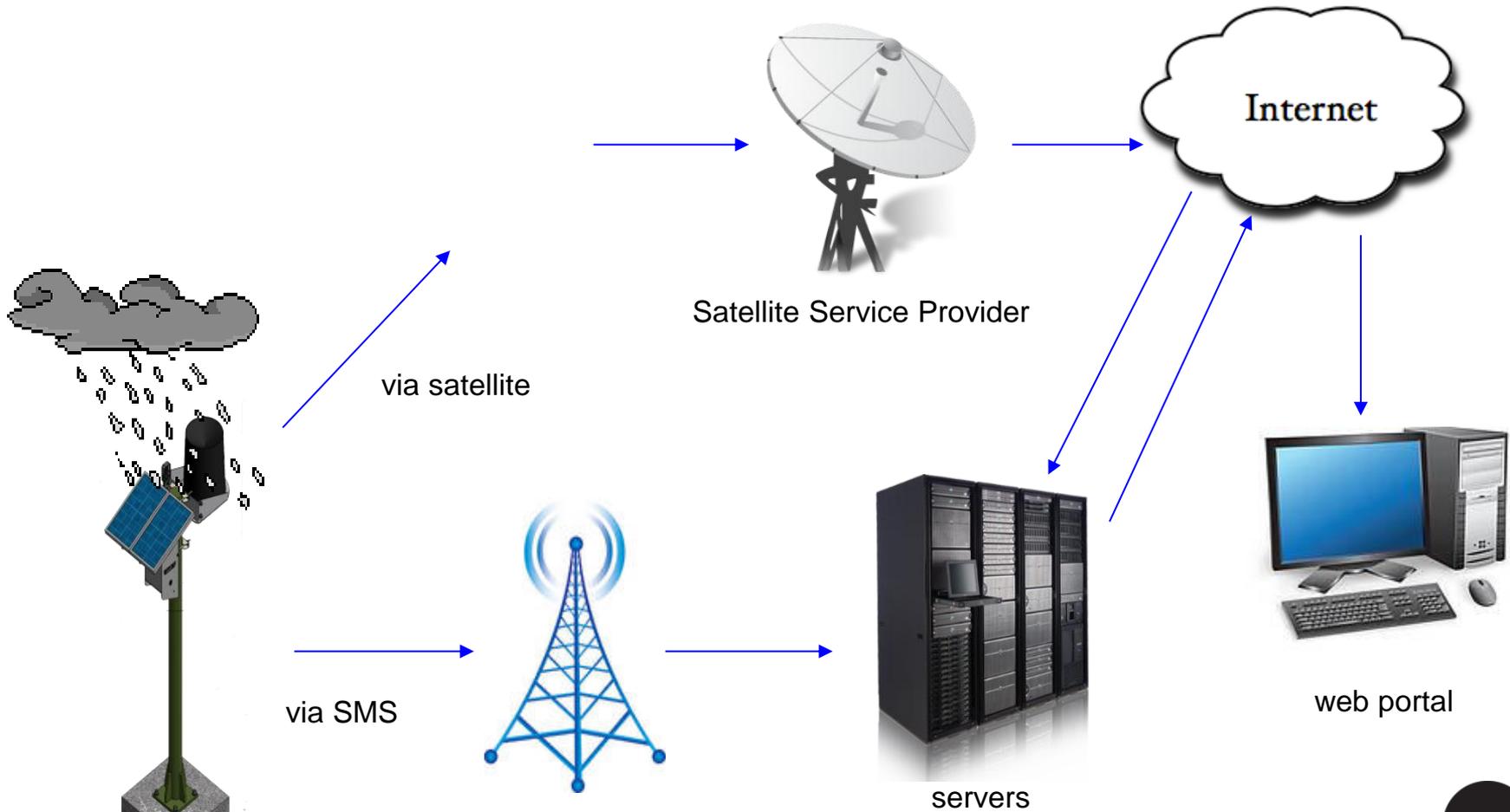
- As of March 2015

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.

概要&ステータス

-  サーバーステータス
-  GeoServerログ
-  連絡先情報
-  GeoServerについて

データ

-  Layer Preview
-  データをインポート
-  ワークスペース
-  ストア
-  レイヤ
-  レイヤグループ
-  スタイル

サービス

-  WCS
-  WFS
-  WMS

設定

-  グローバル
-  JAI
-  カバレッジアクセス

タイルキャッシング

-  タイルレイヤ
-  キャッシング規定値
-  グリッドセット
-  ディスク容量制限

セキュリティ

-  設定

Layer Preview

List of all layers configured in GeoServer and provides previews in various formats for each.

<< < | > >> 結果 1 から 23 (項目 23 以外)

Type	Name	Title	View
	OSM:roads	roads	OpenLayers ↕ Go
	OSM:buildings	buildings	OpenLayers ↕ Go
	OSM:osm_buildings	osm_buildings	OpenLayers ↕ Go
	Yolanda:damage_polygons	damage_polygons	OpenLayers ↕ Go
	Yolanda:yolanda_storm_track_buffer50km	yolanda_storm_track_buffer50km	OpenLayers ↕ Go
	Yolanda:yolanda_storm_track	yolanda_storm_track	OpenLayers ↕ Go
	Hoge:test1	test1	OpenLayers ↕ Go
	Hoge:hillshade	hillshade	OpenLayers ↕ Go
	Hoge:test	test	OpenLayers ↕ Go
	Hoge:buffer	buffer	OpenLayers ↕ Go
	Hoge:test5	test5	OpenLayers ↕ Go
	Hoge:buffer_2	buffer_2	OpenLayers ↕ Go
	pflow:jo_grid1000m_1700	jo_grid1000m_1700	OpenLayers ↕ Go

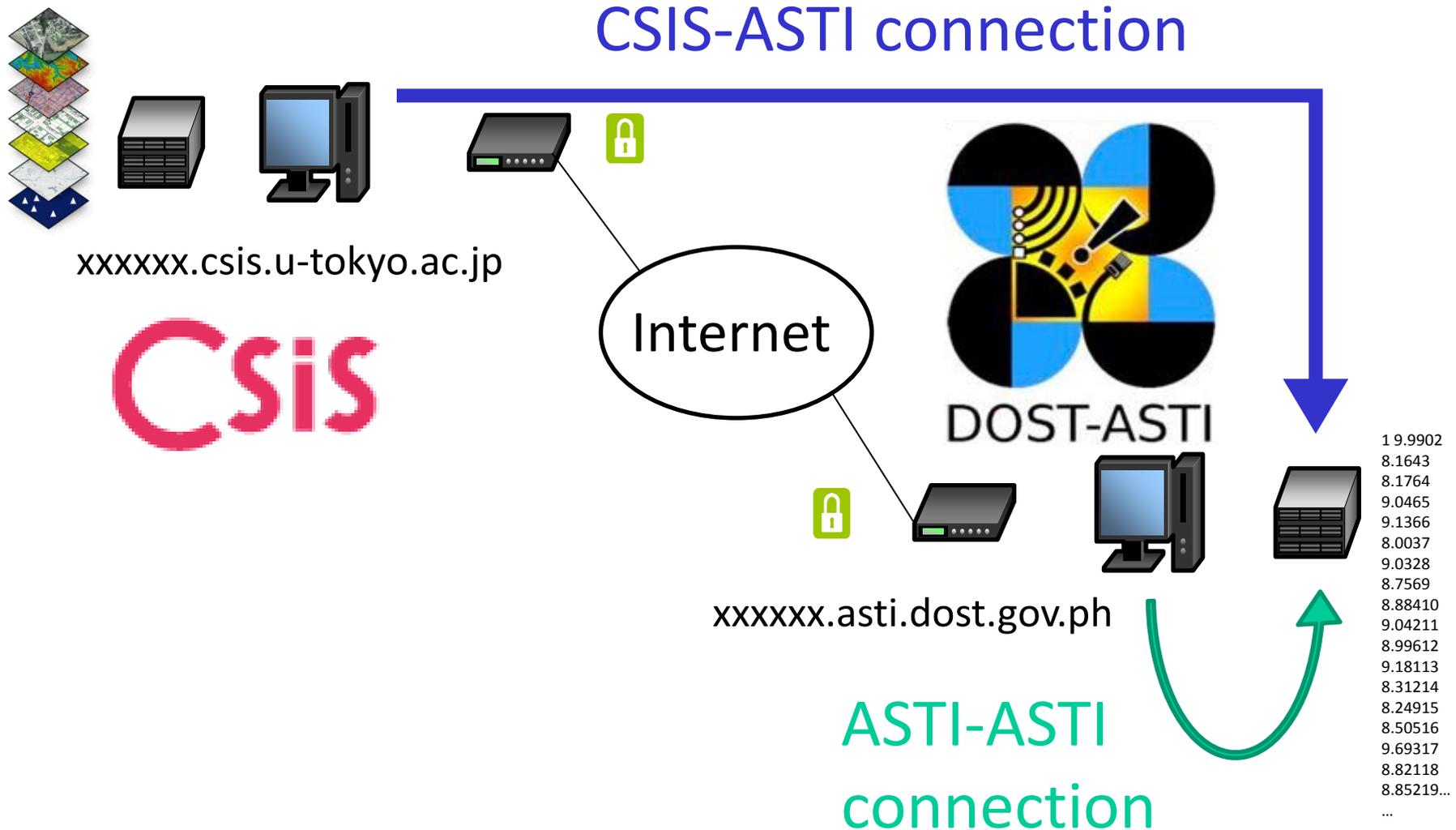
Data Analysis using GeoServer & GIS

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

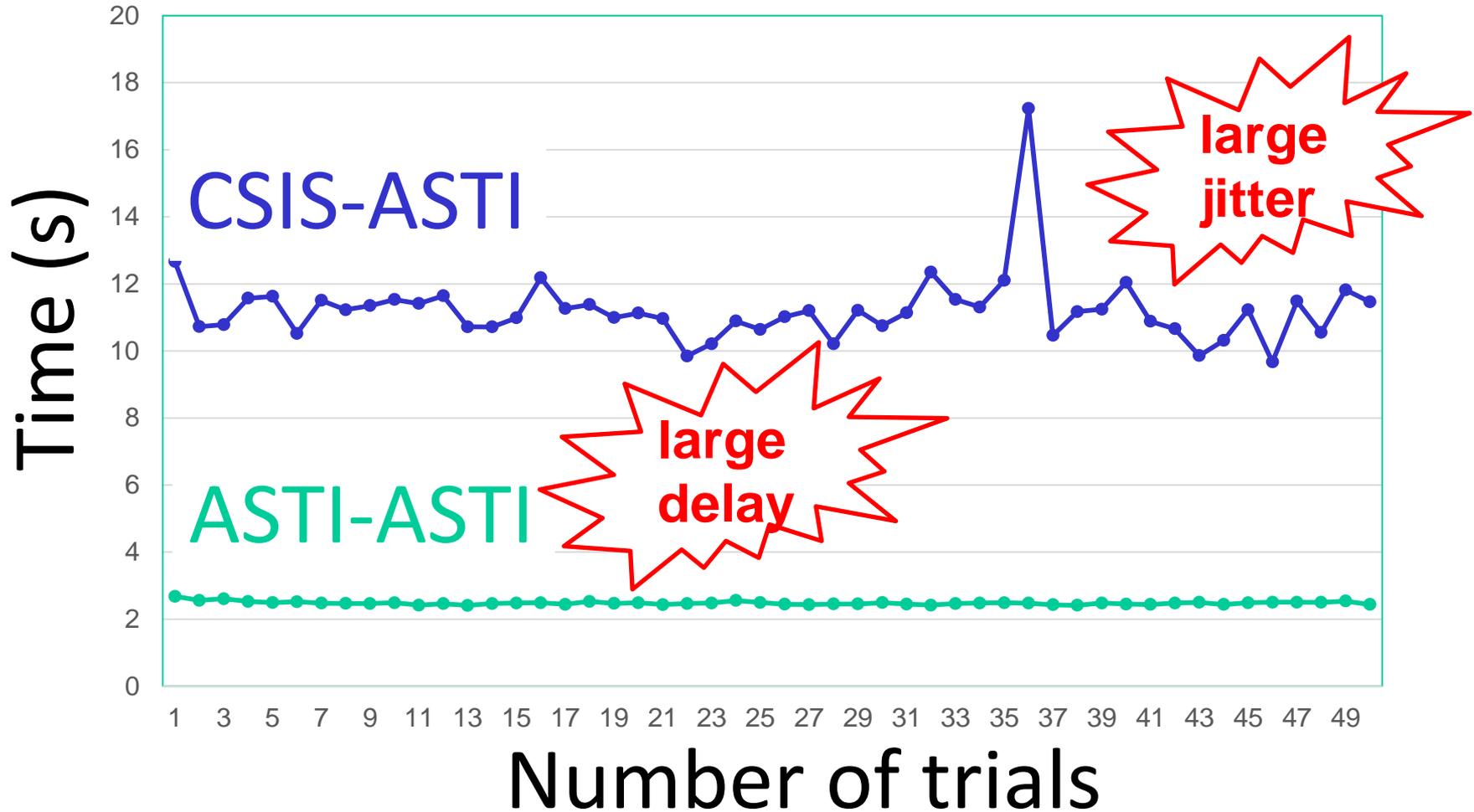
The screenshot displays the QGIS2.8.1-Wien interface with the following components:

- Layer List (Left):** Lists layers including 'csv_sensor141108_150', 'pflow', 'jo_grid1000m_1700', 'jo_grid1000m_1200', 'jo_grid1000m_0800', 'jo_grid1000m_0000', 'yolanda_storm_track', 'Country', and 'srtm_Philippines'.
- Map View (Center):** Shows a map of the Philippines with green squares representing sensor data, a black outline for the boundary, a blue line for typhoon tracks, and a grey shaded area for SRTM elevation.
- OpenGeo Explorer (Right):** Shows a tree view of GeoServer catalogs, including 'Yolandadata', 'GeoServer Workspaces', 'GeoServer Layers', 'GeoServer Groups', 'GeoServer Styles', 'GeoWebCache layers', 'WPS processes', and 'GeoServer Settings'.
- Metadata Panel (Bottom Right):** Displays details for 'Yolandadata', including:
 - About:**
 - Resource name:** GeoServer
 - Build-Timestamp: 25-Nov-2014 02:19
 - Git-Revision: 8648905bbf643e326c9a48d21fe805ccd9763abc
 - Version: 2.6-SNAPSHOT
 - Resource name:** GeoTools
 - Build-Timestamp: 25-Nov-2014 01:59
 - Git-Revision: ea2b82b996401958dac9356d852452a593d3e5f1
 - Version: 12-SNAPSHOT
 - Resource name:** GeoWebCache

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

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
ISABELA-LGU_COMPOUND_-SANTIAGO_CITY-RAIN2-20131108.csv	2014年10月28日 11:56	3 KB	カンマ区切り値
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
EASTERN_SAMAR-GIPORLOS-RAIN2-20131108.csv	2014年6月2日 18:49	1 KB	カンマ区切り値
EASTERN_SAMAR-SULAT_PUBLIC_PLAZA-RAIN2-20131108.csv	2014年5月30日 10:04	4 KB	カンマ区切り値
ZAMBOANGA_CITY-POBLACION_LILOY-BSWM_LUFFT-20131108.csv	2014年5月21日 12:41	11 KB	カンマ区切り値
CATANDUANES-CATANDUANES_STATE_COLLEGES-RAIN2-20131108.csv	2014年5月21日 11:43	3 KB	カンマ区切り値
AGUSAN_DEL_SUR-PROSPERIDAD-BSWM_LUFFT-20131108.csv	2014年5月21日 11:06	11 KB	カンマ区切り値
ZAMBOANGA_DEL_NORTE-POLANCO-BSWM_LUFFT-20131108.csv	2014年5月20日 12:52	10 KB	カンマ区切り値
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
DAVAO_DEL_SUR-SULOP_POBLACION-BSWM_LUFFT-20131108.csv	2014年5月13日 17:17	12 KB	カンマ区切り値
ZAMBOANGA_DEL_SUR-DUMINGAG-BSWM_LUFFT-20131108.csv	2014年5月13日 10:47	11 KB	カンマ区切り値
DAVAO_DEL_SUR-JOSE_ABAD_SANTOS-VAISALA-20131108.csv	2014年5月6日 9:48	6 KB	カンマ区切り値
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
ORIENTAL_MINDORO-MAG_ASAWANG_TURIG_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

	A	B	C	D	E	F	G	H	I	J	K	L
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	12.56	12.56									
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									
19	2013/11/8 1:40	12.53	12.53									
20	2013/11/8 1:50	12.53	12.53									
21	2013/11/8 2:00	12.53	12.53									
22	2013/11/8 2:10	12.53	12.53									
23	2013/11/8 2:20	12.53	12.53									
24	2013/11/8 2:30	12.53	12.53									
25	2013/11/8 2:40	12.53	12.53									
26	2013/11/8 2:50	12.53	12.53									
27	2013/11/8 3:00	12.53	12.53									
28	2013/11/8 3:10	12.53	12.53									
29	2013/11/8 3:20	12.53	12.53									
30	2013/11/8 3:30	12.53	12.53									
31	2013/11/8 3:40	12.53	12.53									
32	2013/11/8 3:50	12.53	12.53									
33	2013/11/8 4:00	12.53	12.53									
34	2013/11/8 4:10	12.53	12.53									
35	2013/11/8 4:20	12.53	12.53									
36	2013/11/8 4:30	12.53	12.53									
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45	2013/11/8 6:00	12.53	12.53									
46	2013/11/8 6:10	12.53	12.53									
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117	2013/11/8 18:00	12.53	12.53									
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127	2013/11/8 19:40	12.53	12.53									
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130	2013/11/8 20:10	12.53	12.53									
131	2013/11/8 20:20	12.53	12.53									
132	2013/11/8 20:30	12.53	12.53									
133	2013/11/8 20:40	12.53	12.53									
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137	2013/11/8 21:20	12.53	12.53									
138	2013/11/8 21:30	12.53	12.53									
139	2013/11/8 21:40	12.53	12.53									
140	2013/11/8 21:50	12.53	12.53									
141	2013/11/8 22:00	12.53	12.53									
142	2013/11/8 22:10	12.53	12.53									

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_Value0															
2	1	La Union	SUDIPEN	16.90878	120.4827	0	BSWM.Lu	0	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	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	0
5	1	Pangasinan	STA. BARBARA	15.96693	120.4667	0	BSWM.Lu	0	0	0	0	0	0	0.6	0	0	0.2	0	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	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	Waterlevel	0	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	Waterlevel	0	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	Waterlevel	0	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	Waterlevel	0	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	Waterlevel	0	0	0	0.254	0.254	0	0	0.254	0	0	0.254	0	0	0	0	0
14	1	Pangasinan	ALORAGAT BRIDGE	16.0873	120.5787	52.531	Waterlevel	0	0	0	0	0	0	0.508	0	0	0.254	0	0	0	0	0	0
15	1	Pangasinan	AMBAYAOAN	16.07525	120.7562	85.4363	Waterlevel	0	0	0	0	0	0	0.508	0.254	0	0	0	0	0	0	0	0
16	1	Pangasinan	BANELA	15.94	120.8404	110.5183	Waterlevel	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	Waterlevel	0	0	0	0	0	0	1.27	0	0	0	0	0	0	0	0	0
18	1	Pangasinan	HECTOR MENDOZA BRIDGE	15.835	120.5004	26.985	Waterlevel	0	0	0	0	0	0	1.016	0	0	0	0	0	0	0	0	0
19	1	Pangasinan	MACALONG BRIDGE	15.97647	120.5709	25.63	Waterlevel	0	0	0	0	0	0	0.508	0	0	0	0	0	0	0	0	0
20	1	Pangasinan	MAGALLANES	16.01342	120.7372	58.8603	Waterlevel	0	0	0	0	0	0	1.016	0	0	0	0	0	0	0	0	0
21	1	Pangasinan	TAGAMUSING BRIDGE	16.01468	120.5791	32.951	Waterlevel	0	0	0	0	0	0	0.762	0	0	0	0	0	0	0	0	0
22	1	Pangasinan	VIRAY BRIDGE	16.03231	120.8001	91.8553	Waterlevel	0	0	0	0	0	0	0.254	0.254	0	0	0	0	0	0	0	0
23	1	Pangasinan	DIPALO BRIDGE	16.00712	120.8067	94.8703	Waterlevel	0	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	0
25	2	Cagayan	DA-RFU IGUIG	0	0	0	BSWM.Lu	0	0	0	0.2	0	0	0.6	0	1	1.2	0.2	1	1	0	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	0
27	2	Isabela	ROXAS	17.06473	121.5893	0	BSWM.Lu	0	0	0	0.2	0	0	1.4	1	1.4	0.2	0	0	5.6	0.2	0.2	0
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	1.4
29	2	Cagayan	LASAM	18.07157	121.6194	0	BSWM.Lu	0	0	0	0	1	0.4	0	0	0	0	0	0	0.8	0	1	1
30	2	Isabela	TUMAUINI	17.28422	121.8253	60	BSWM.Lu	0	0	0	0	3	0	0	2	0.6	0.6	0	5.2	5.8	1.2	3	3
31	2	Nueva Vizcaya	BAGABAG	16.60014	121.2835	0	BSWM.Lu	0	0	0	0	2.6	0	2.6	0	0.4	1.2	1.8	2.2	0.8	2.4	0	0
32	2	Isabela	DIVILACAN	17.32819	122.2962	0	Vaisala	0	0	0	0	0	0	0	0	0	0.05	0	0	0	0	0	0
33	2	Cagayan	STA. ANA MUNICIPAL BOUND	16.457	121.449	0	Vaisala10	0	0	0.11	0.01	0.01	0	1.00	0.00	1.17	0.00	1.00	0	0.01	0.00	0.01	0.01

extraction of
rainfall & air pressure

201 Records / day

Error Removal

Lack of Location

region	province	location	latitude	longitude	elevation	sensor	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_Lufl					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

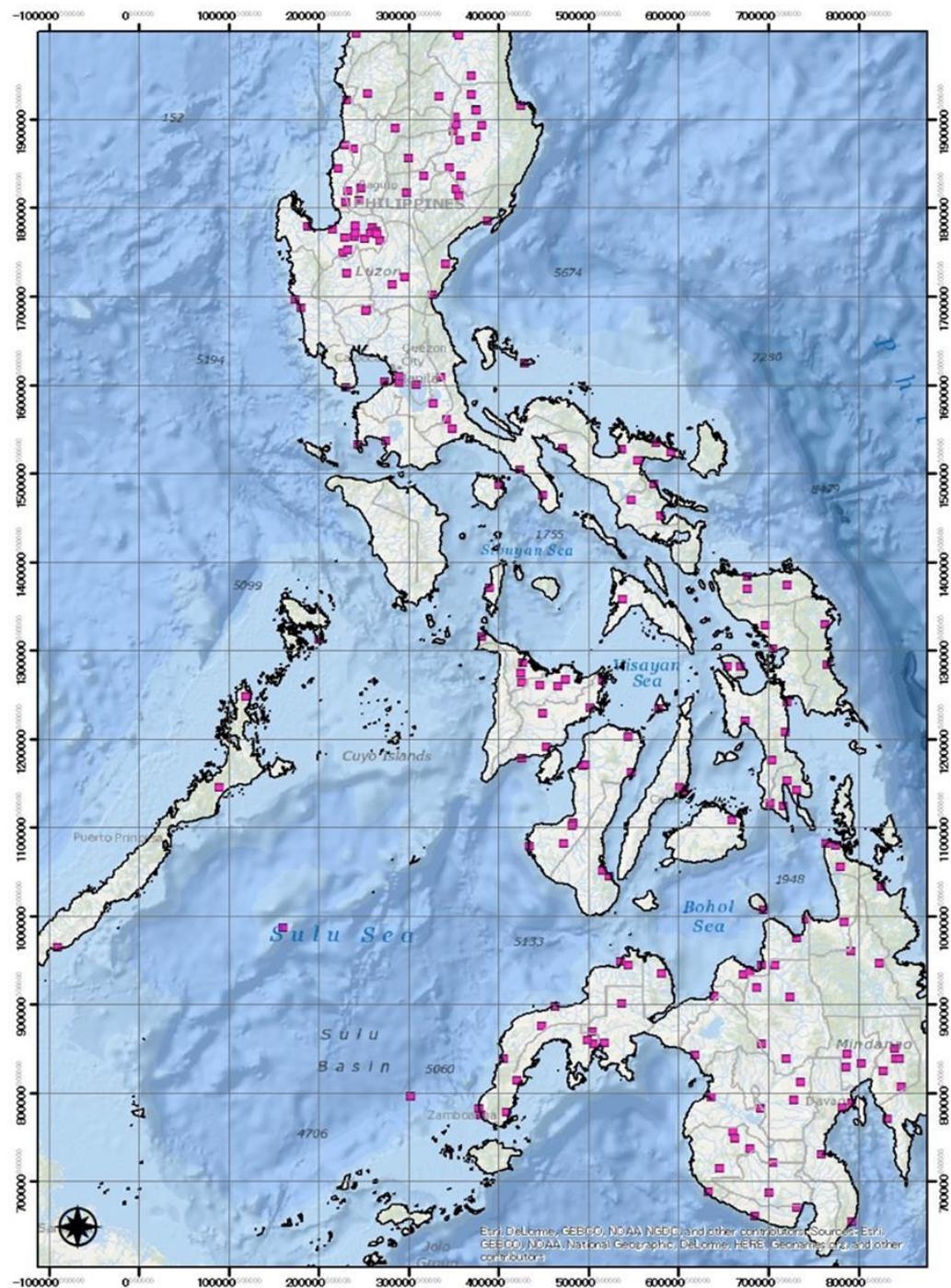
Duplication & Erroneous Values

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

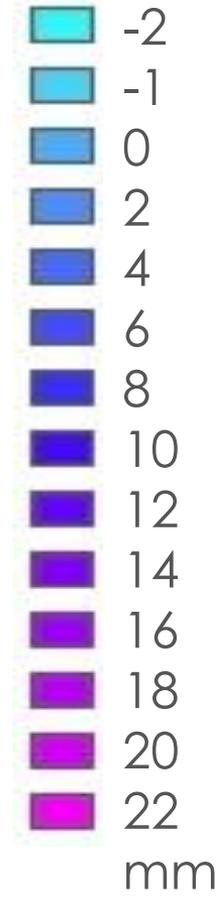
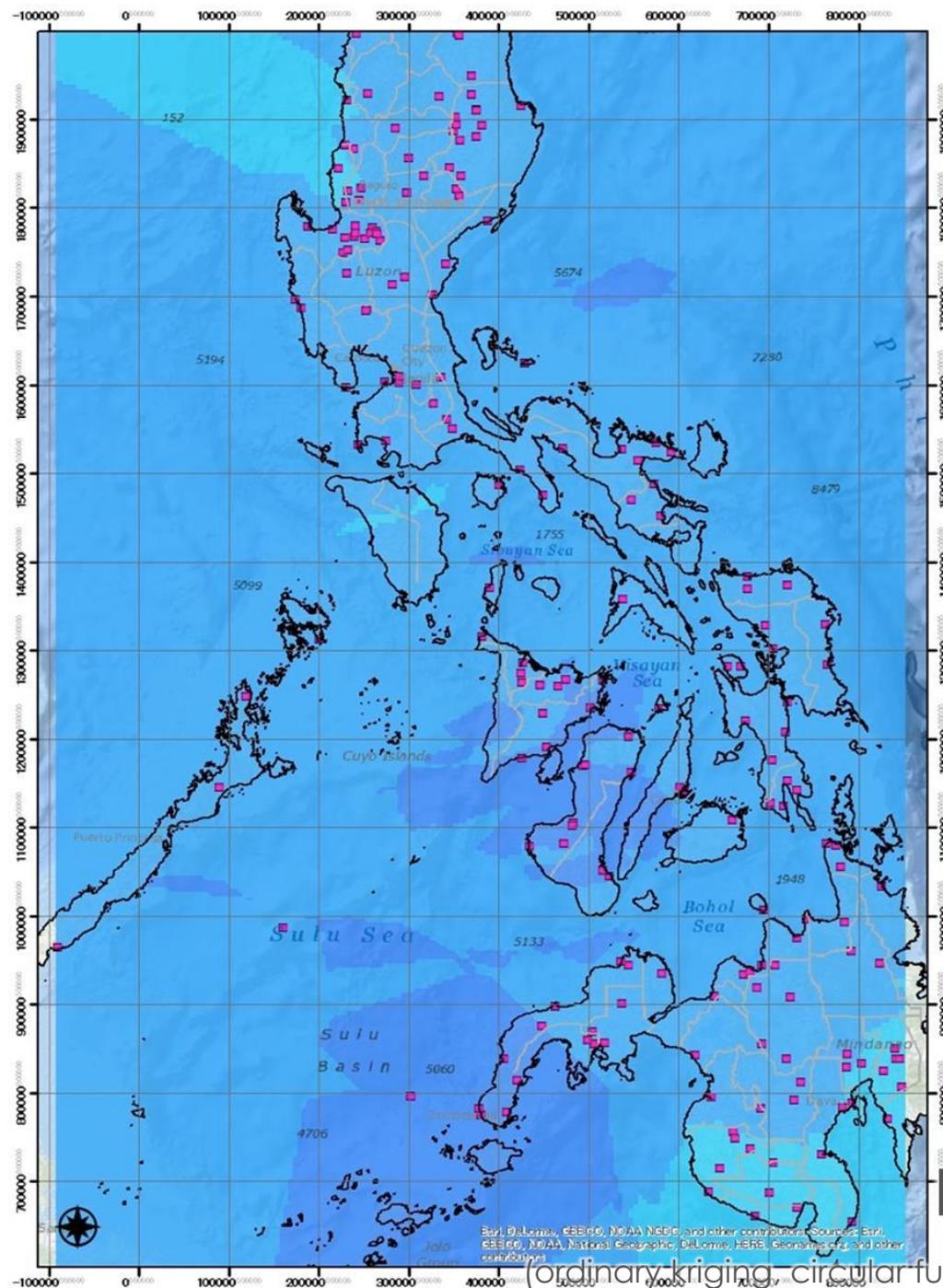
- 13 Agusan del Sur PROSPERIDAD: air pressure in rainfall columns
- 4-A Quezon LUCBAN: duplicate of name

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

Base map



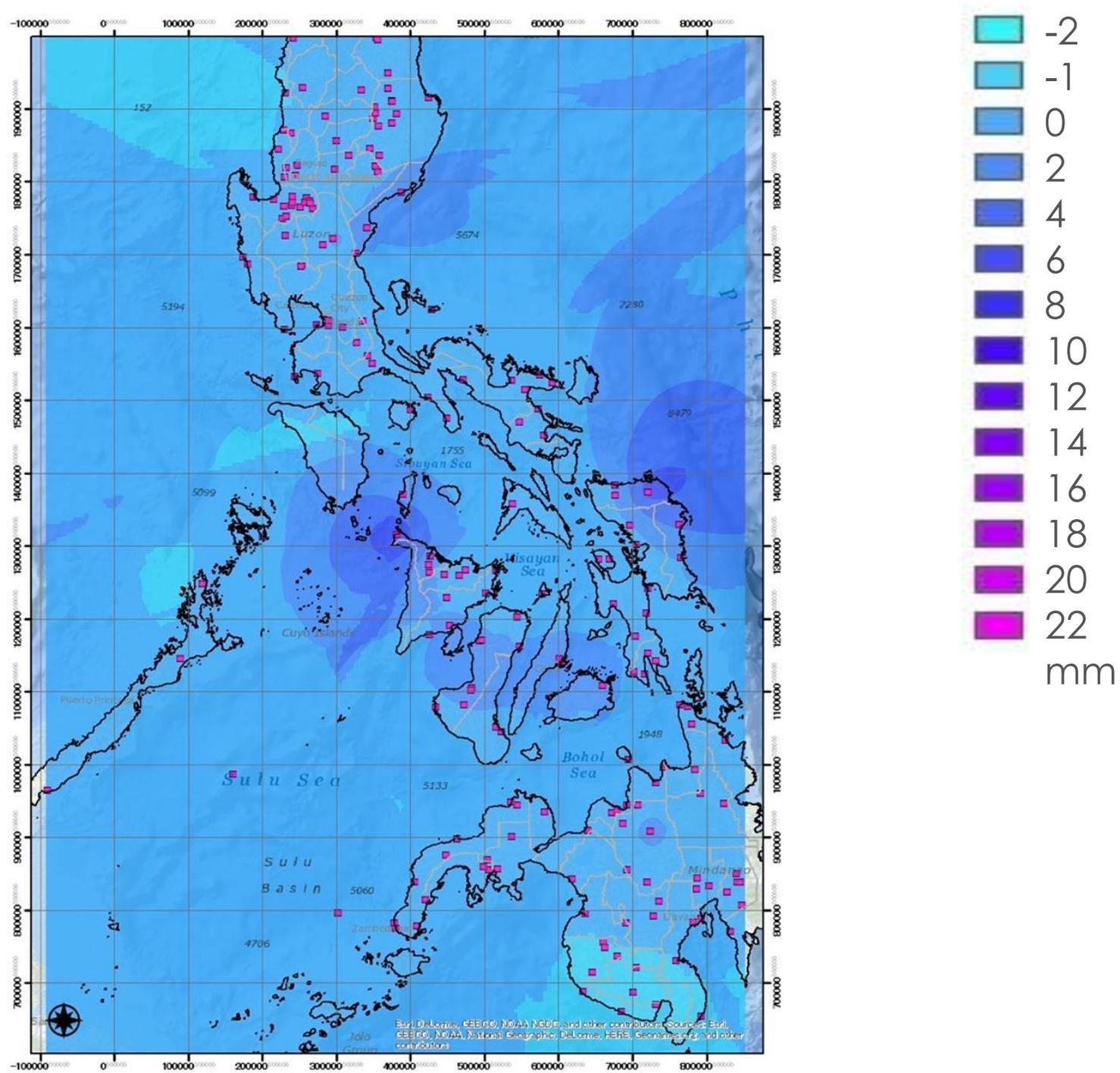
Rainfall 00 AM



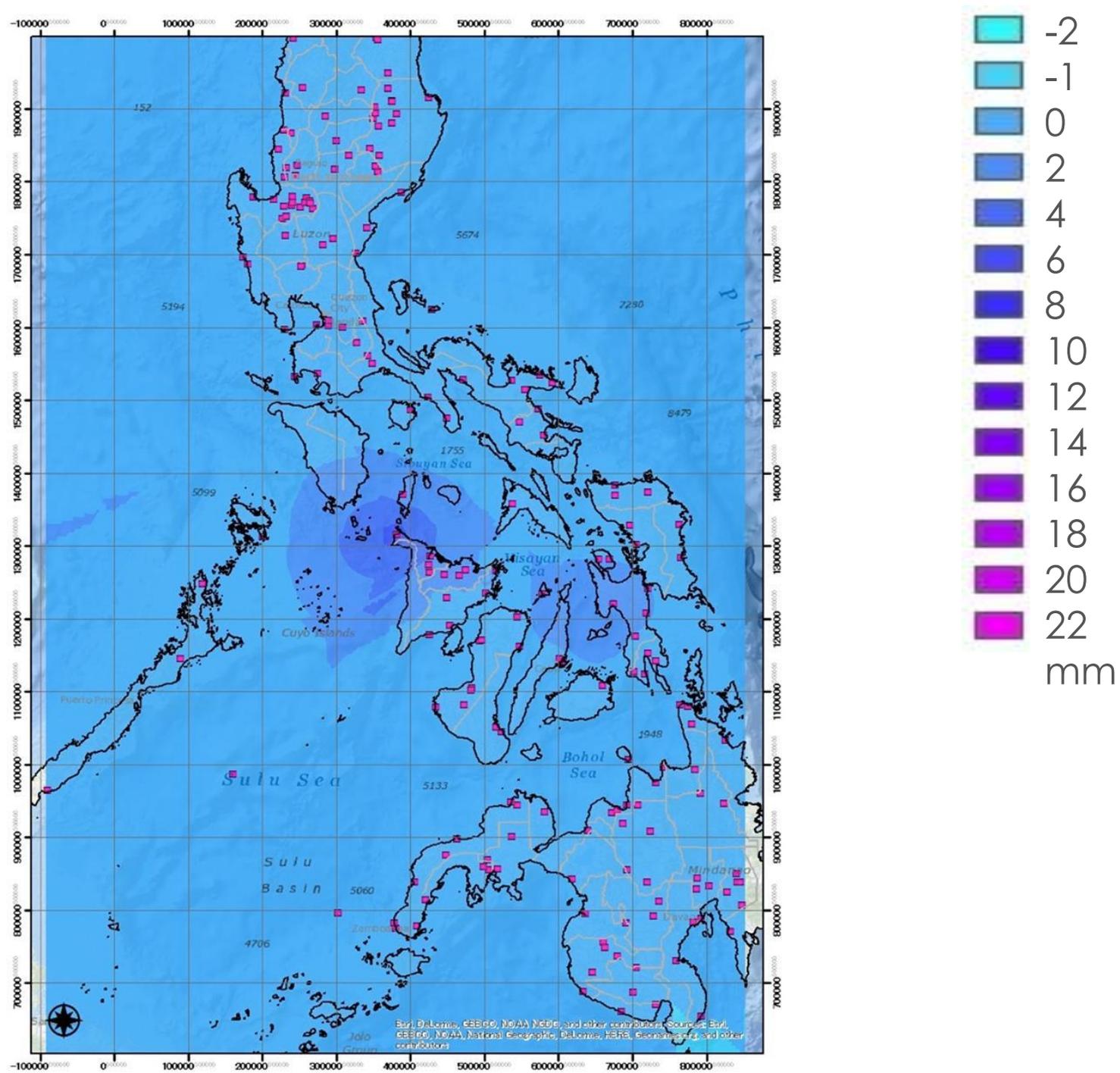
hourly rainfall
kriging interpolation
(ordinary kriging - circular function, 12 neighborhoods)

Barl, D., Lemus, GBB60, NOAA NGDC, and other contributors. Sources: Barl, GBB60, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors.

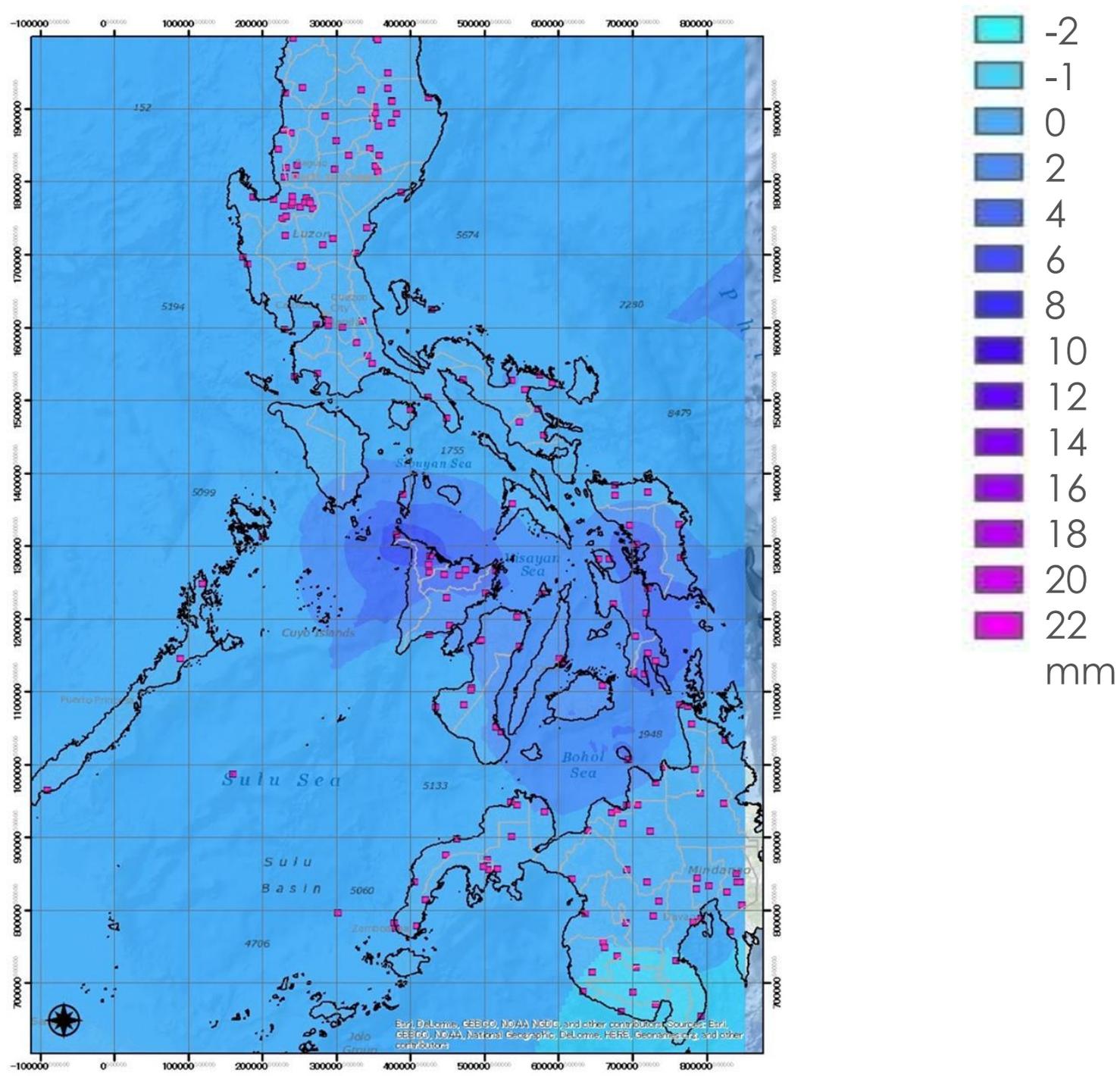
Rainfall 01 AM



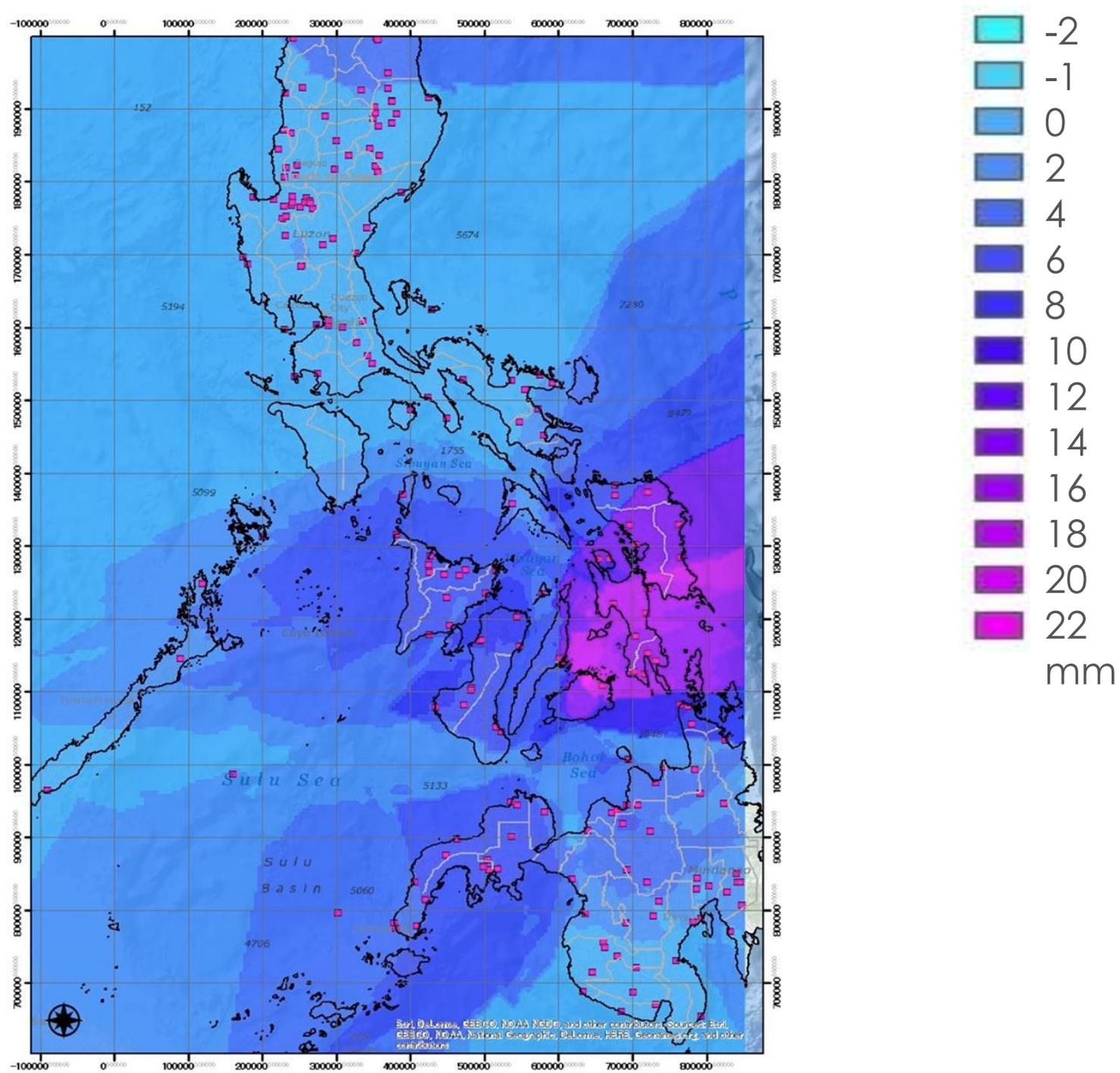
Rainfall 02 AM



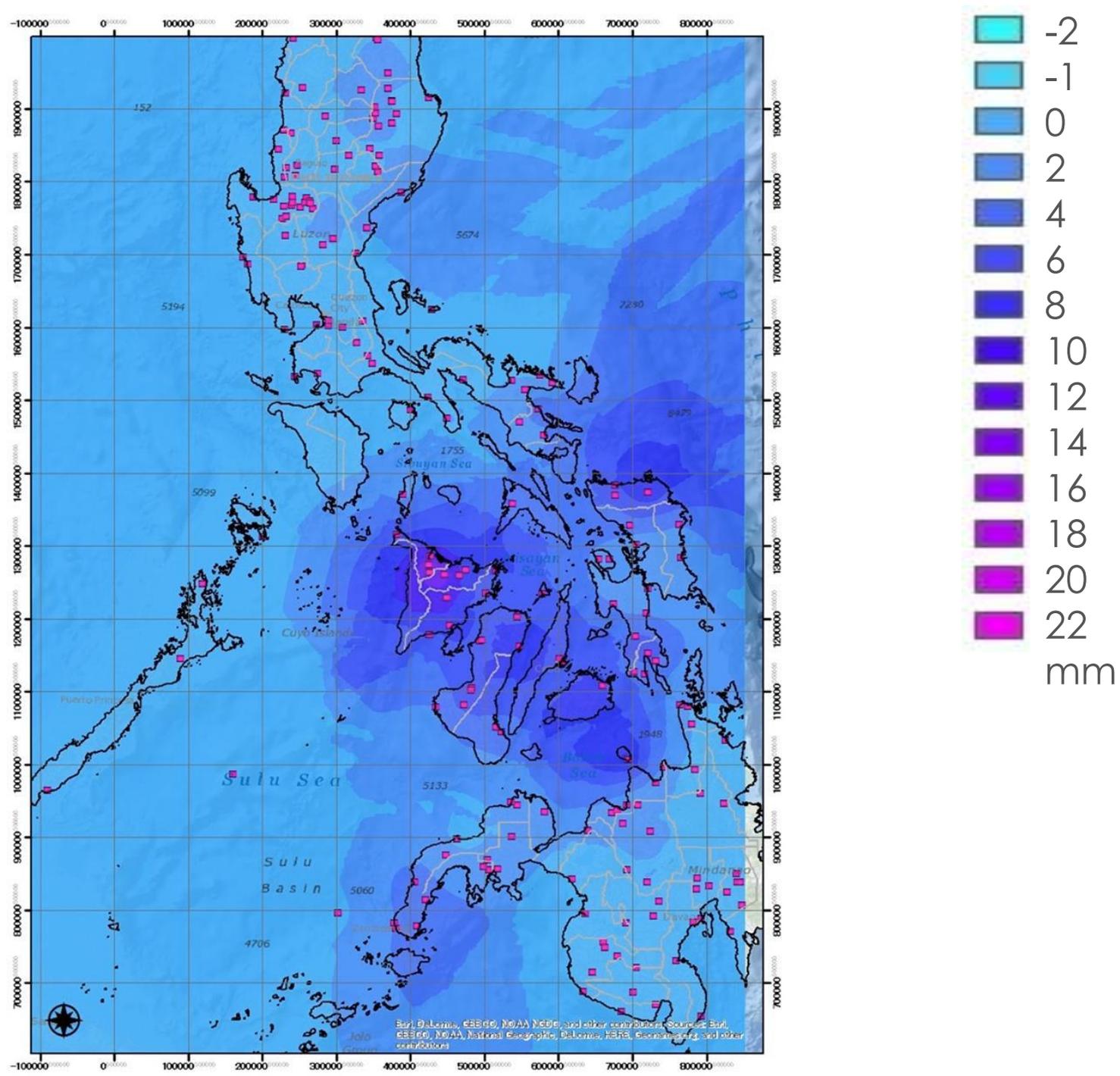
Rainfall 03 AM



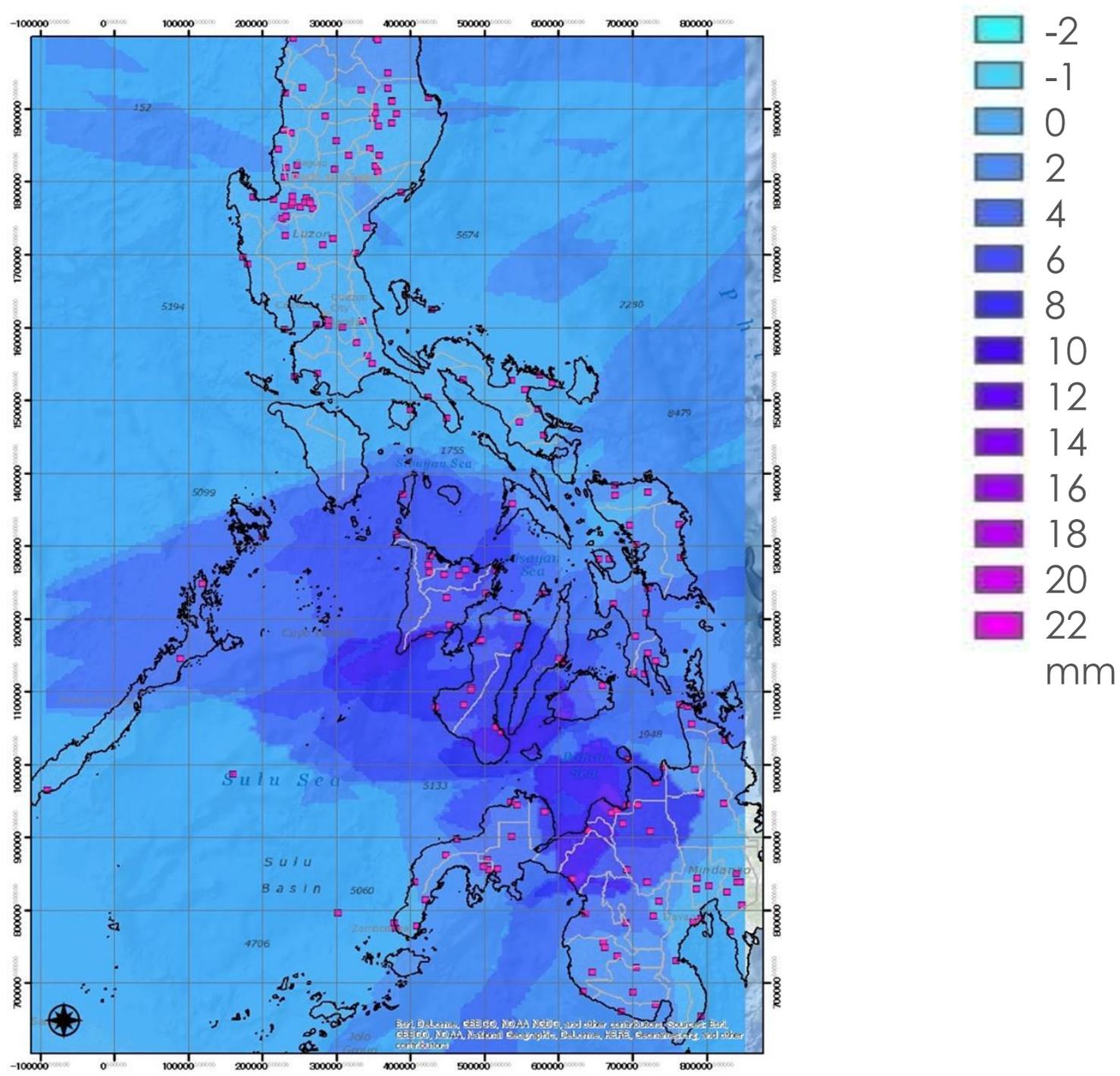
Rainfall 04 AM



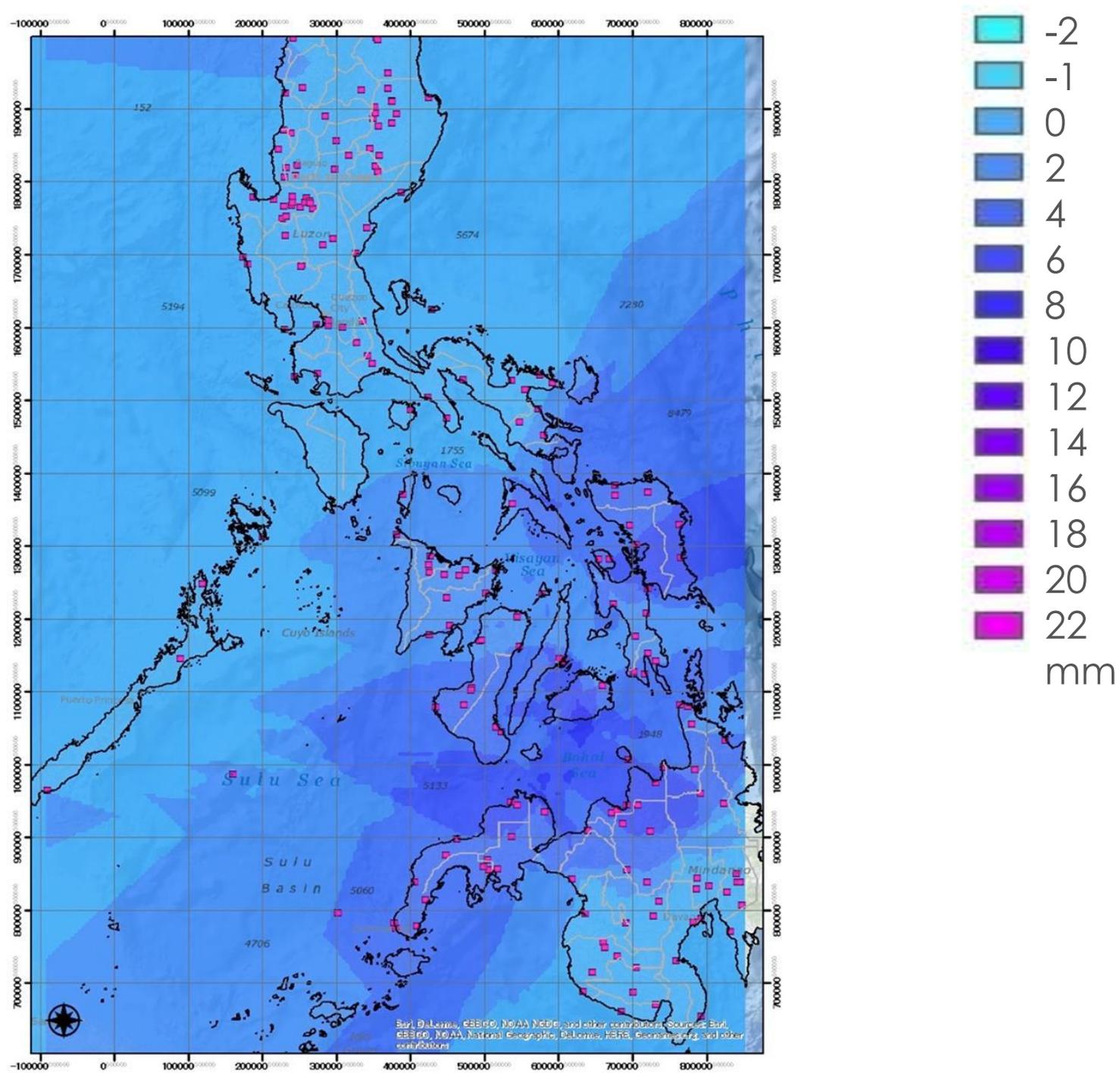
Rainfall 05 AM



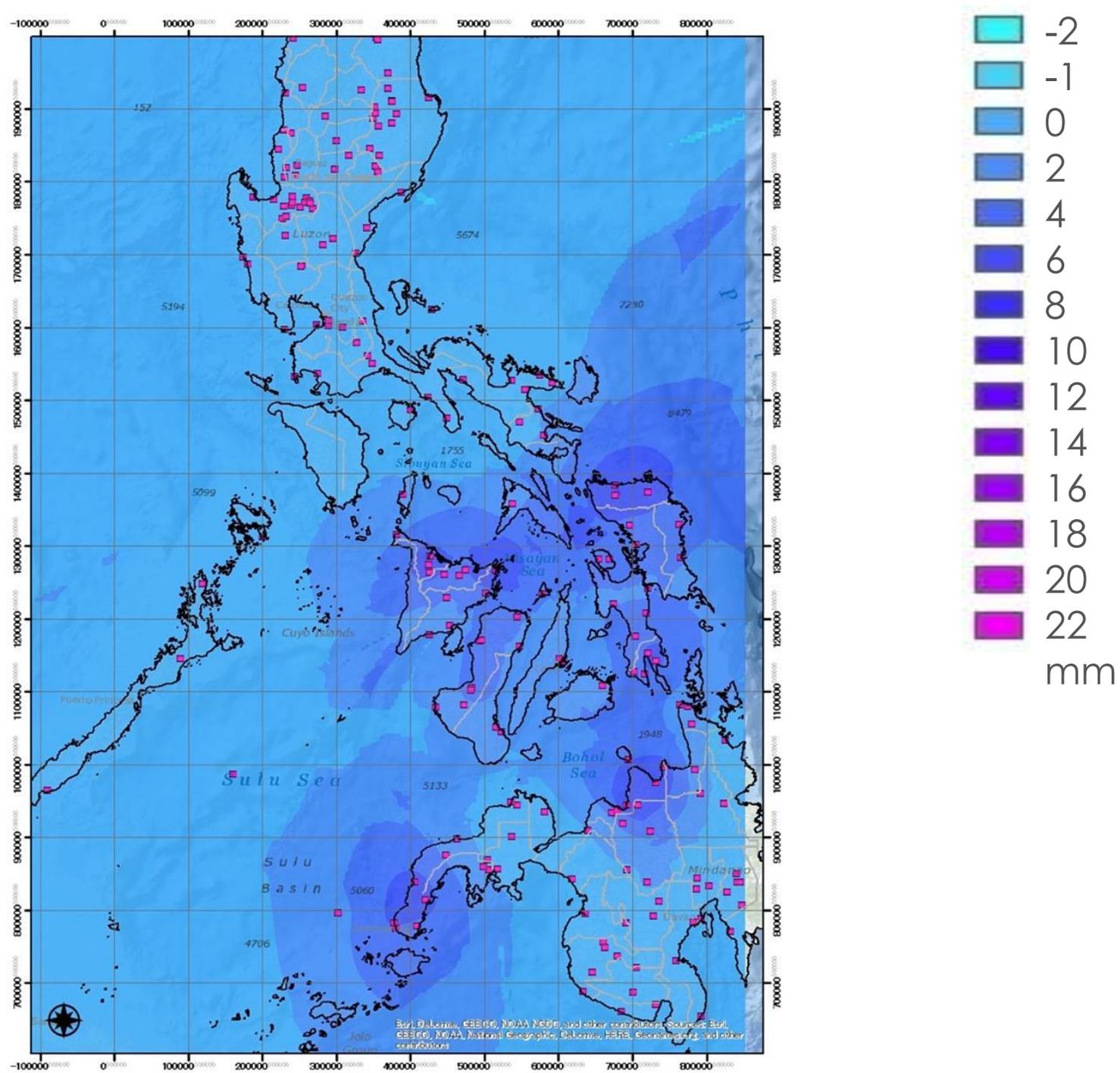
Rainfall 06 AM



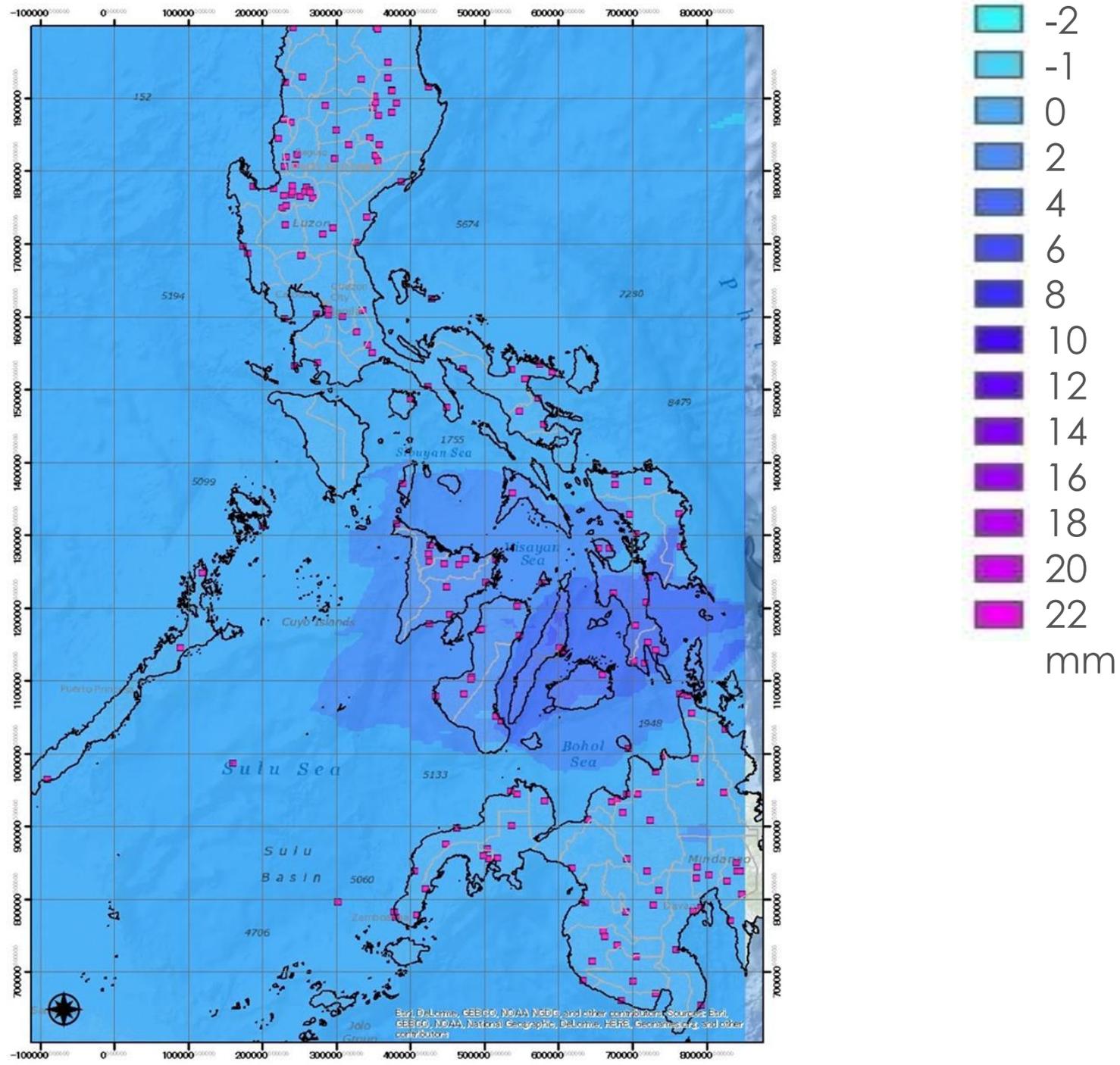
Rainfall 08 AM



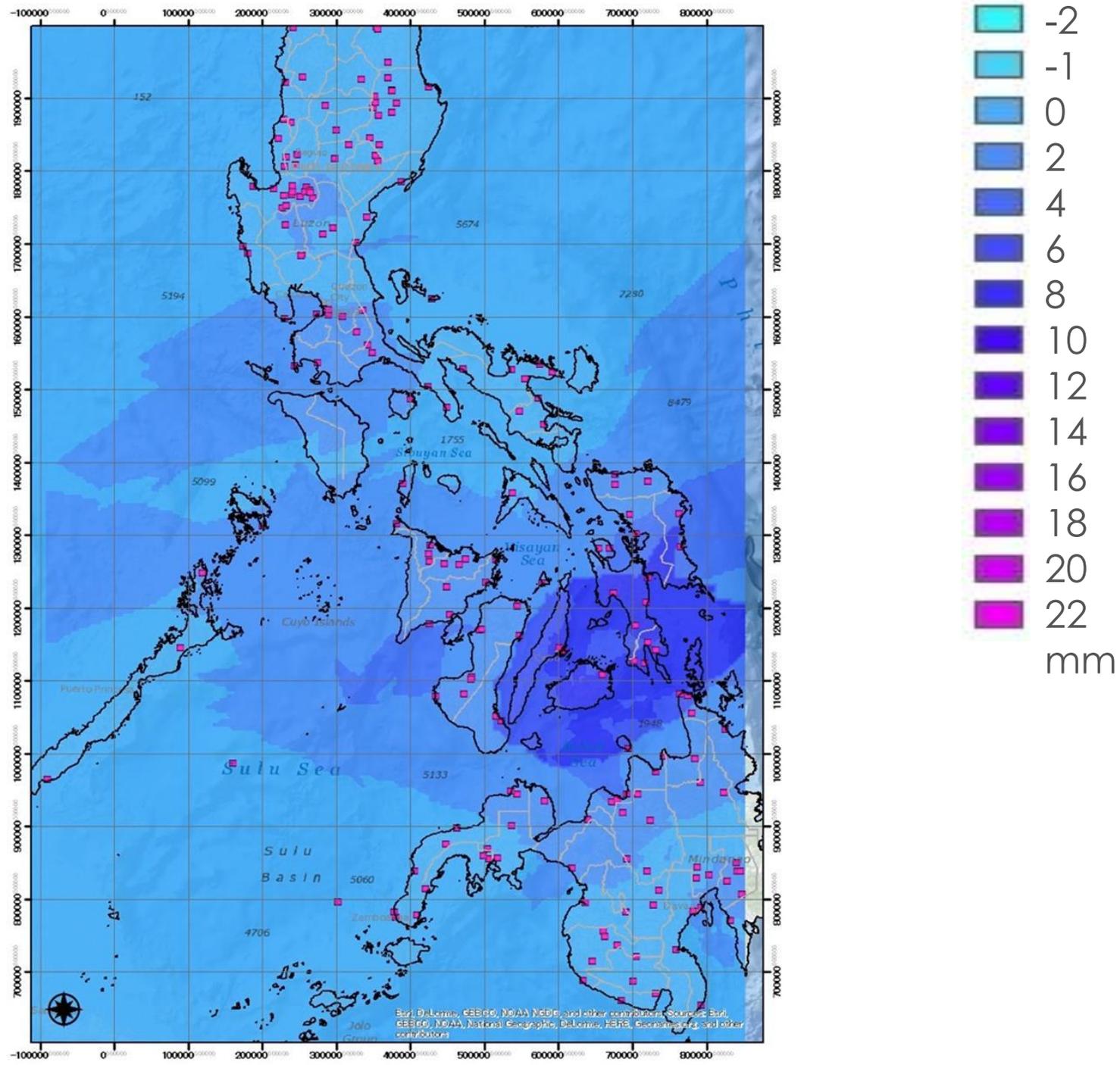
Rainfall 09 AM



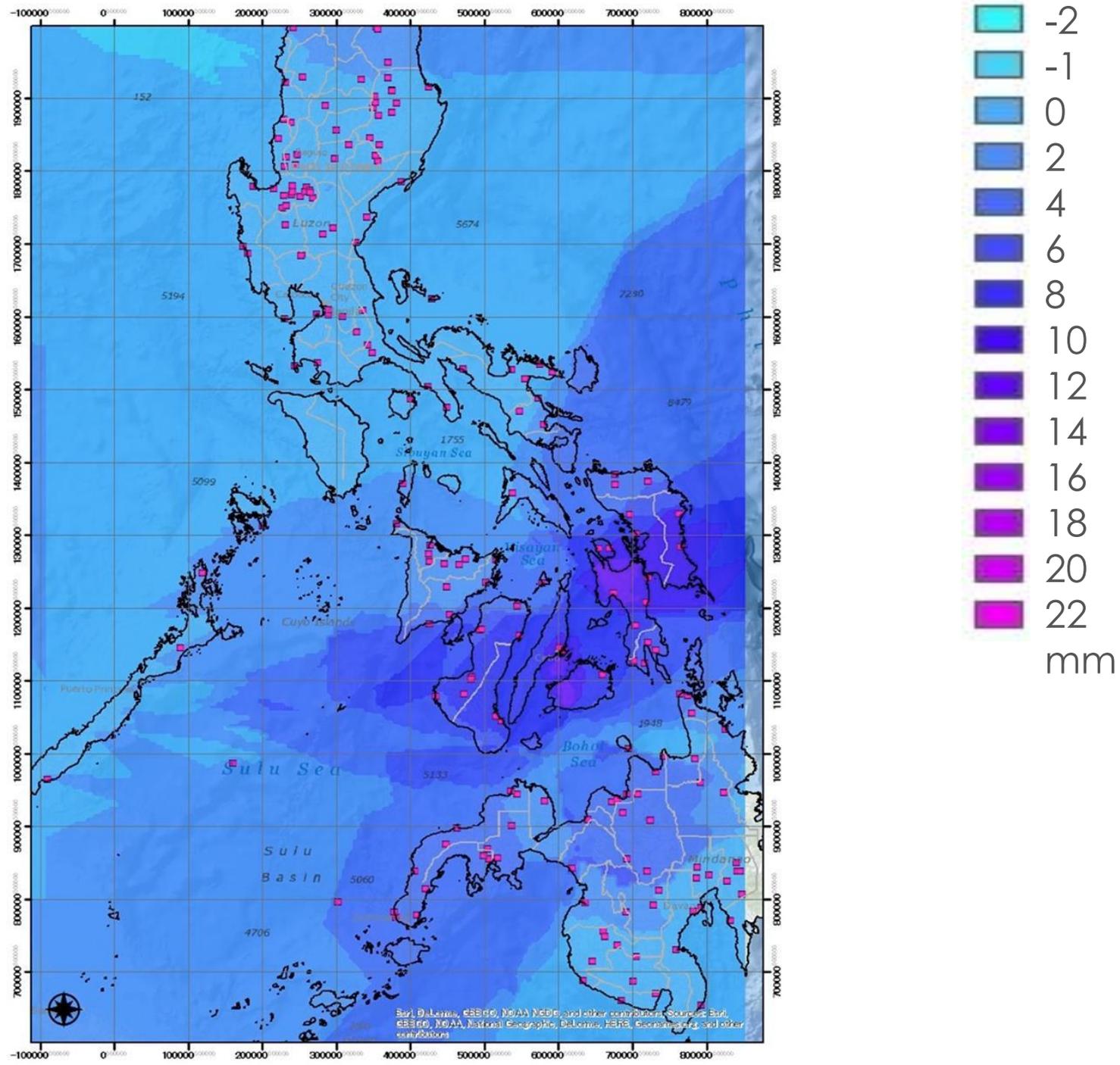
Rainfall 10 AM



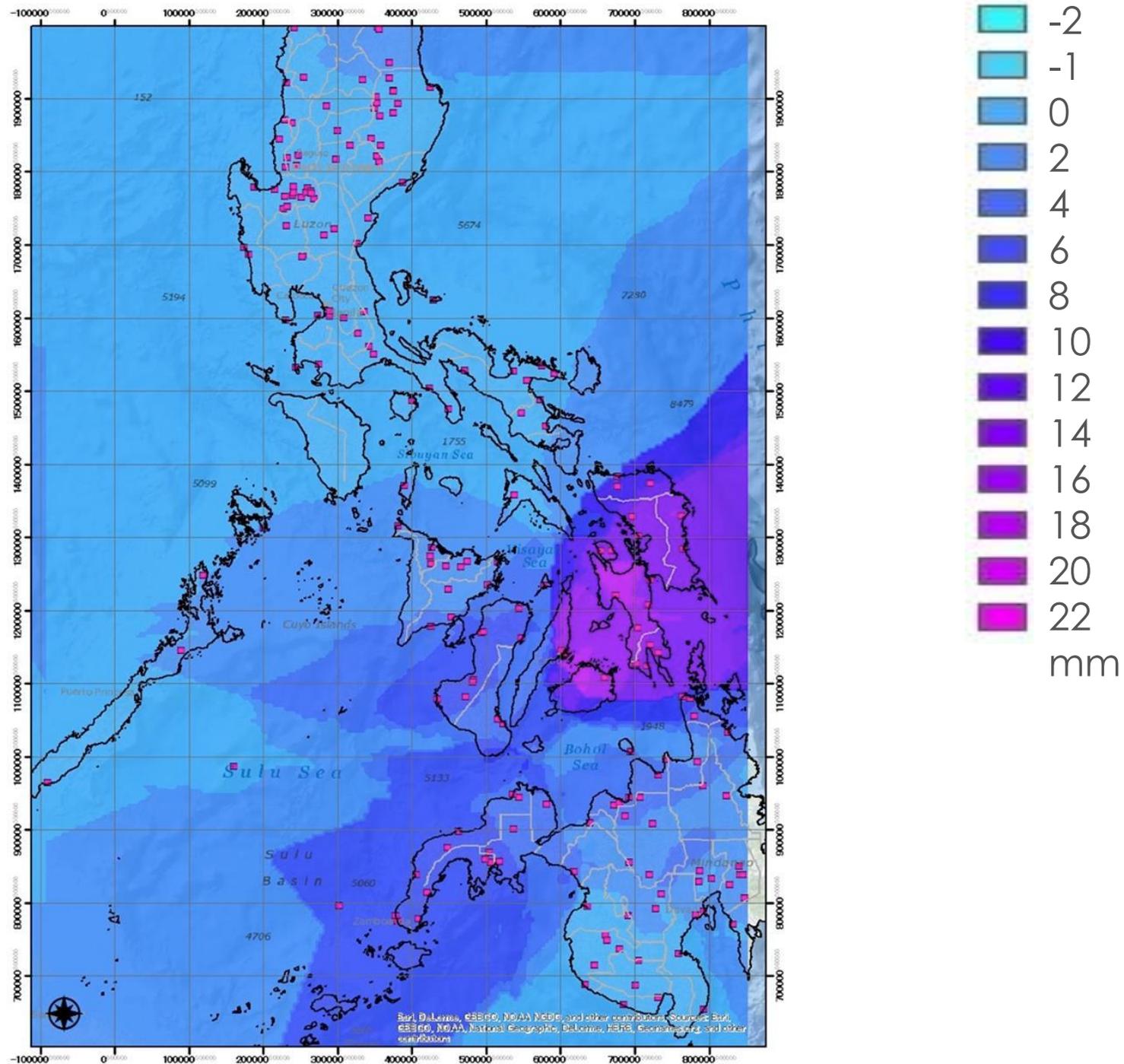
Rainfall 11 AM



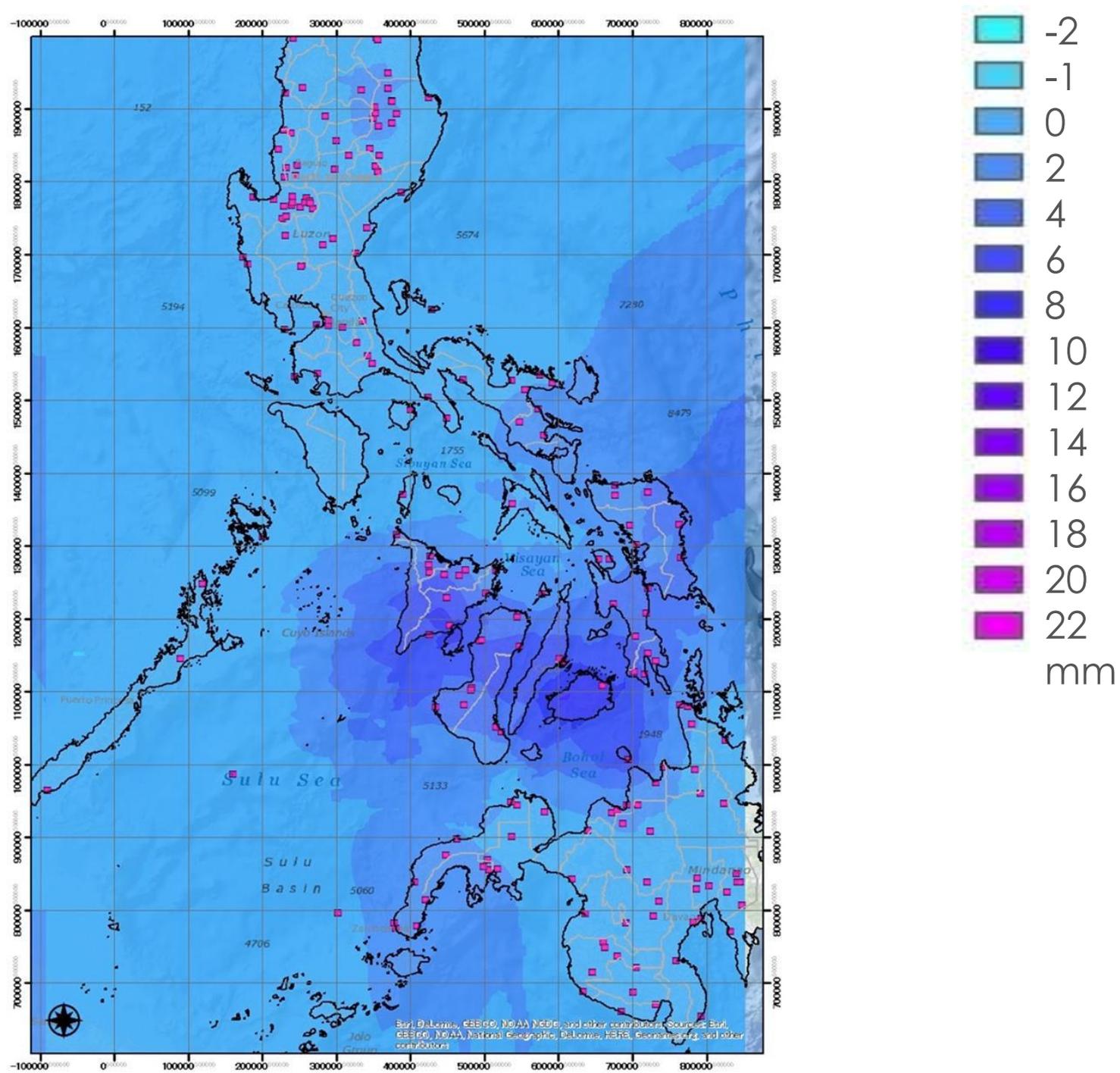
Rainfall 01 PM



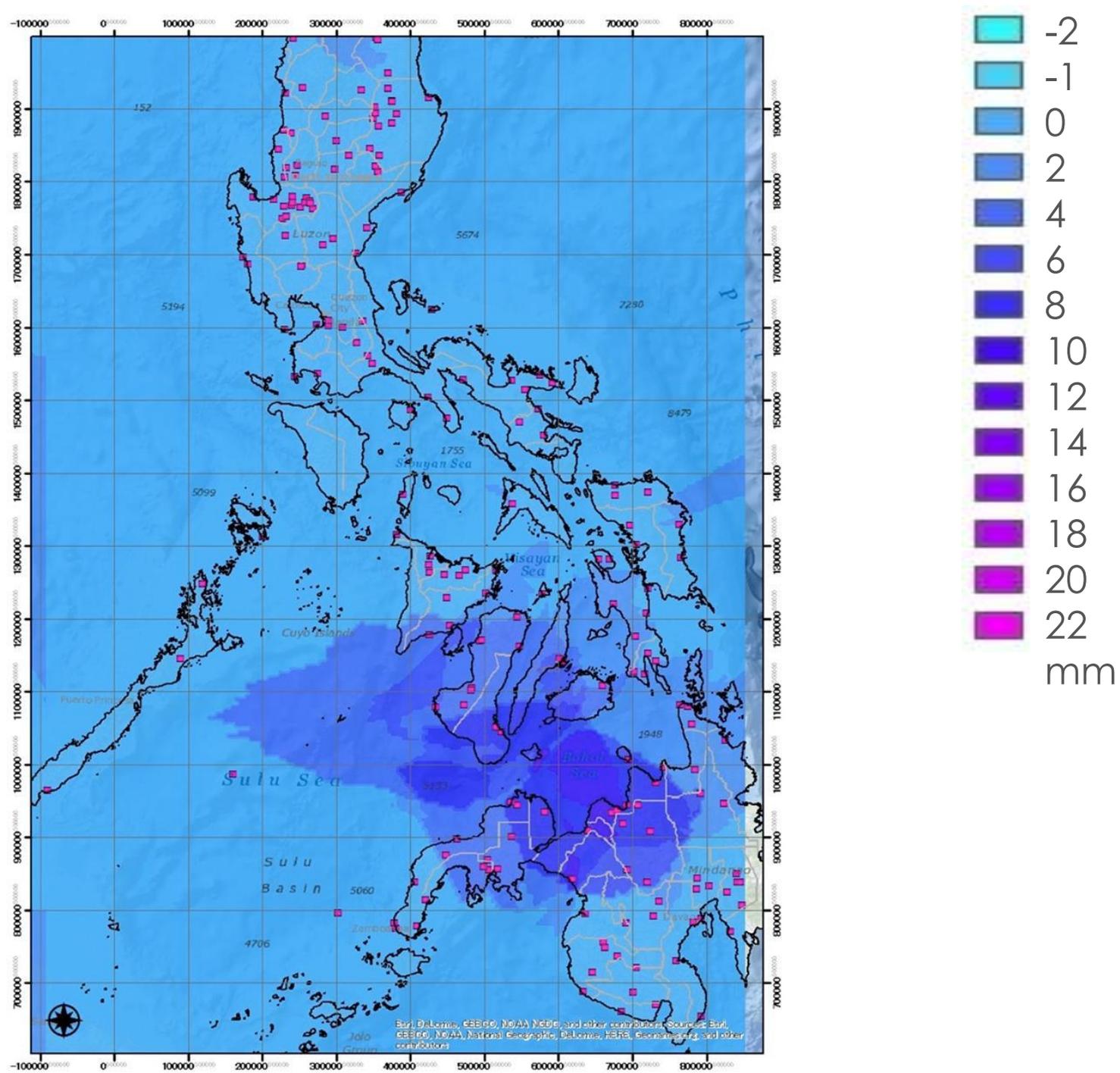
Rainfall 02 PM



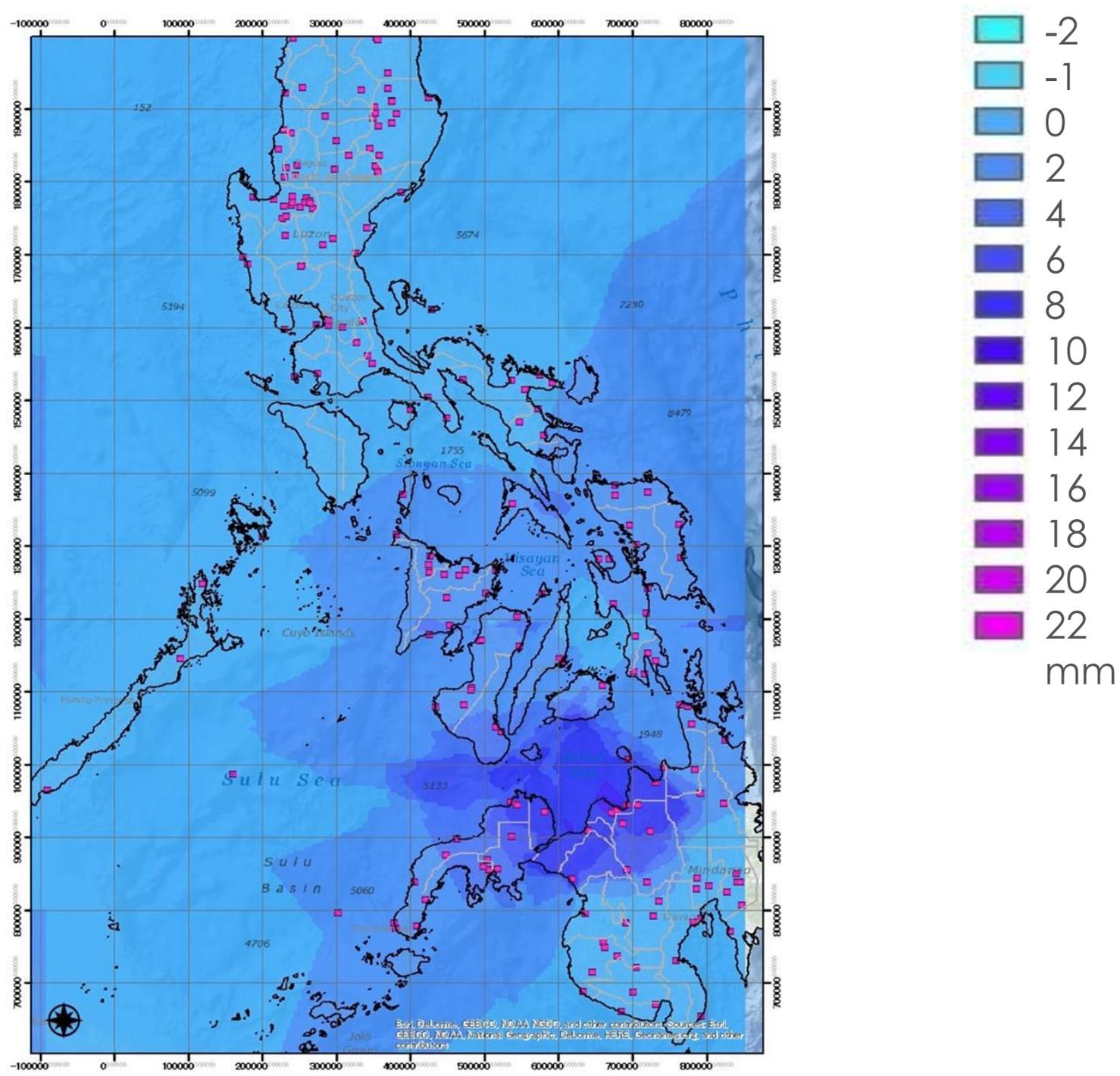
Rainfall 03 PM



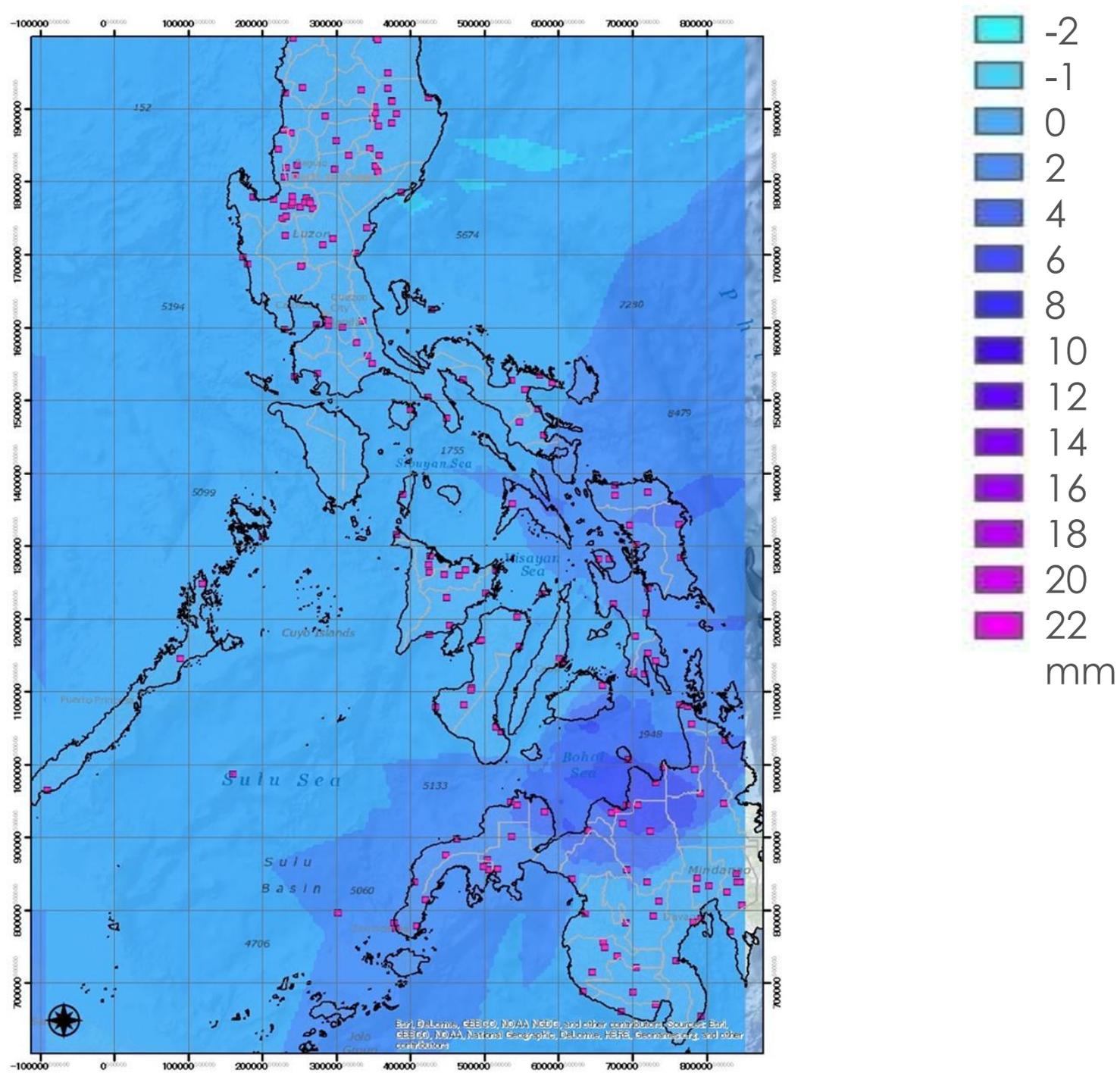
Rainfall 04 PM



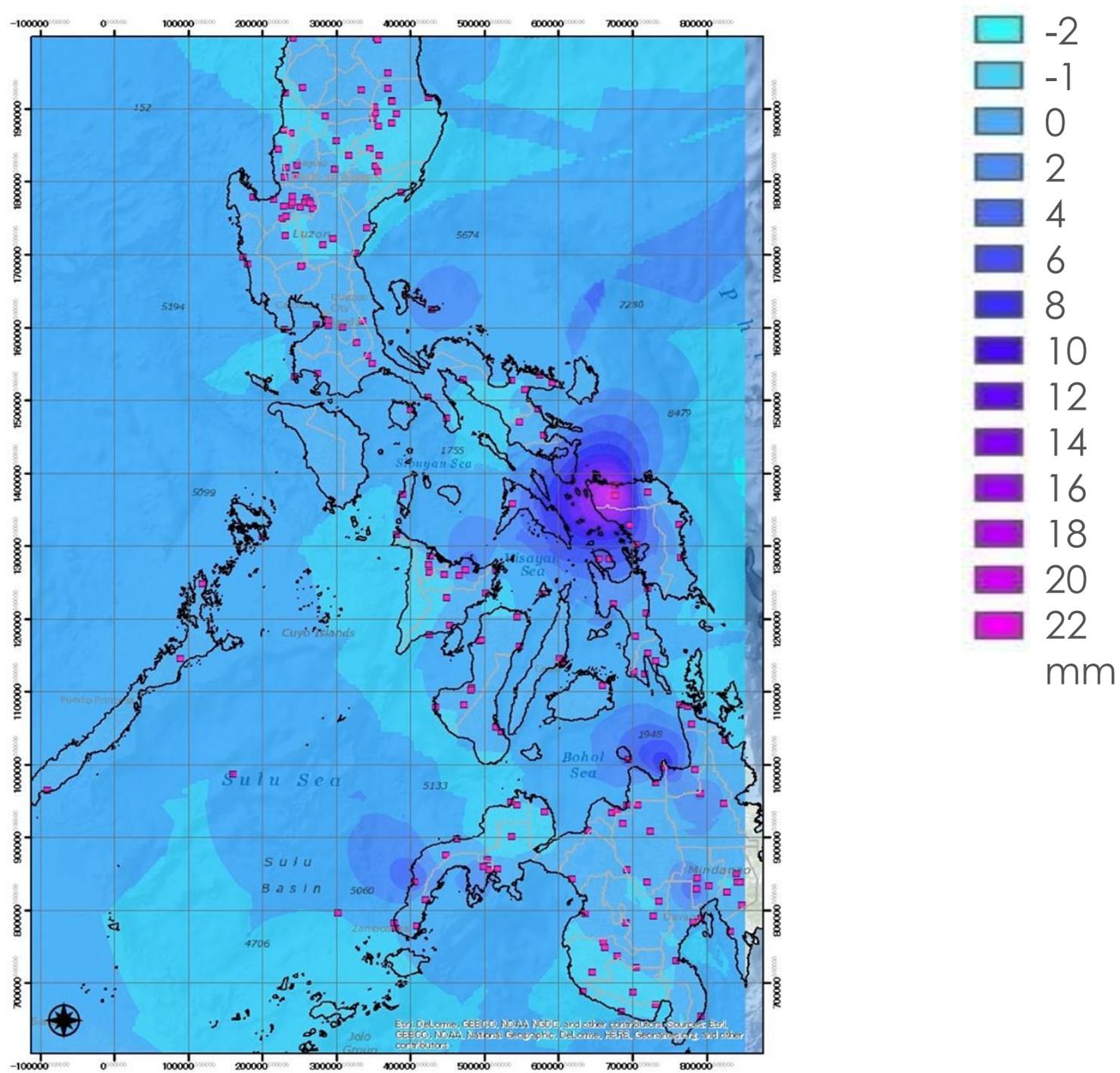
Rainfall 05 PM



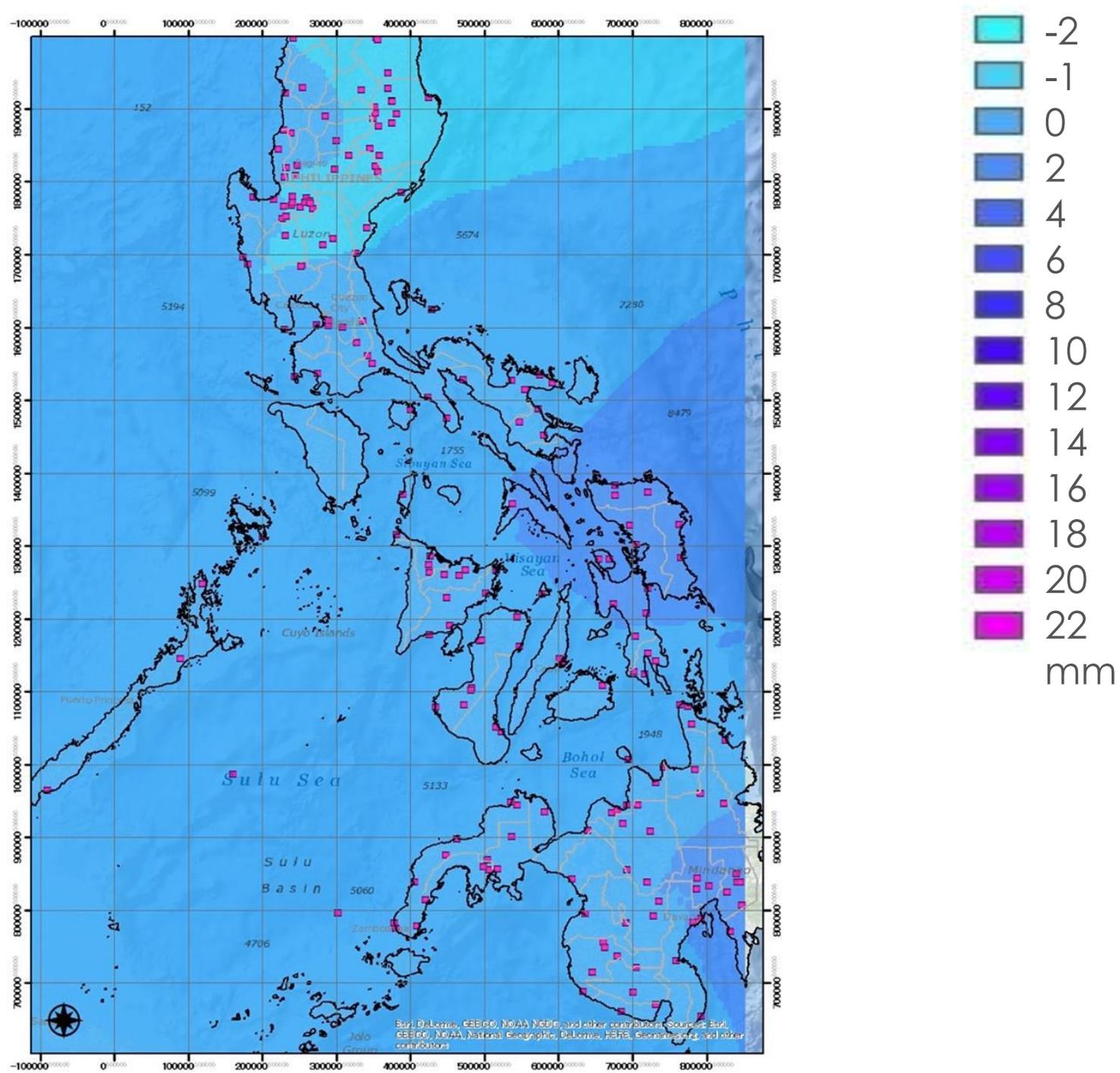
Rainfall 06 PM



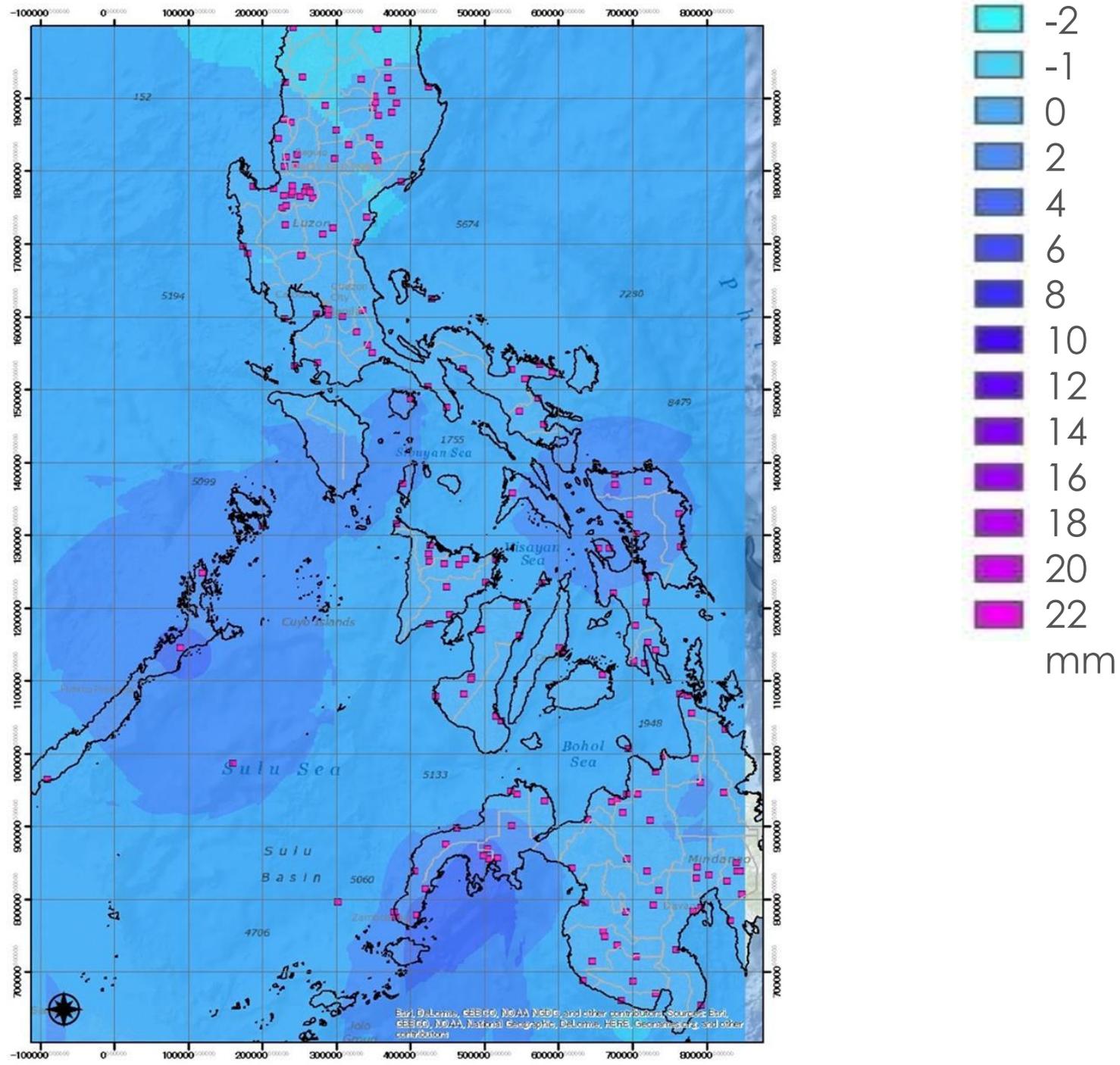
Rainfall 08 PM



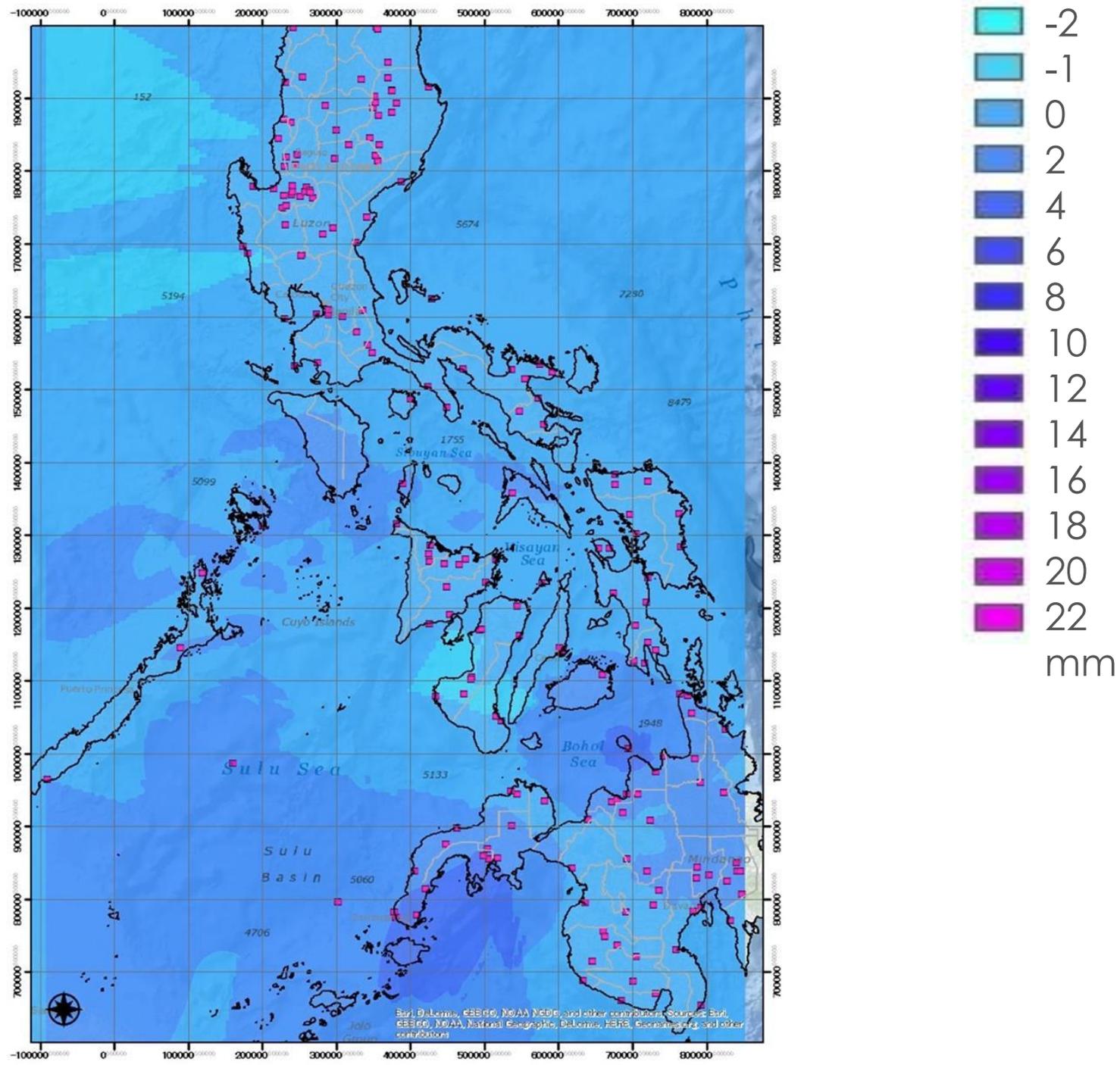
Rainfall 09 PM



Rainfall 10 PM

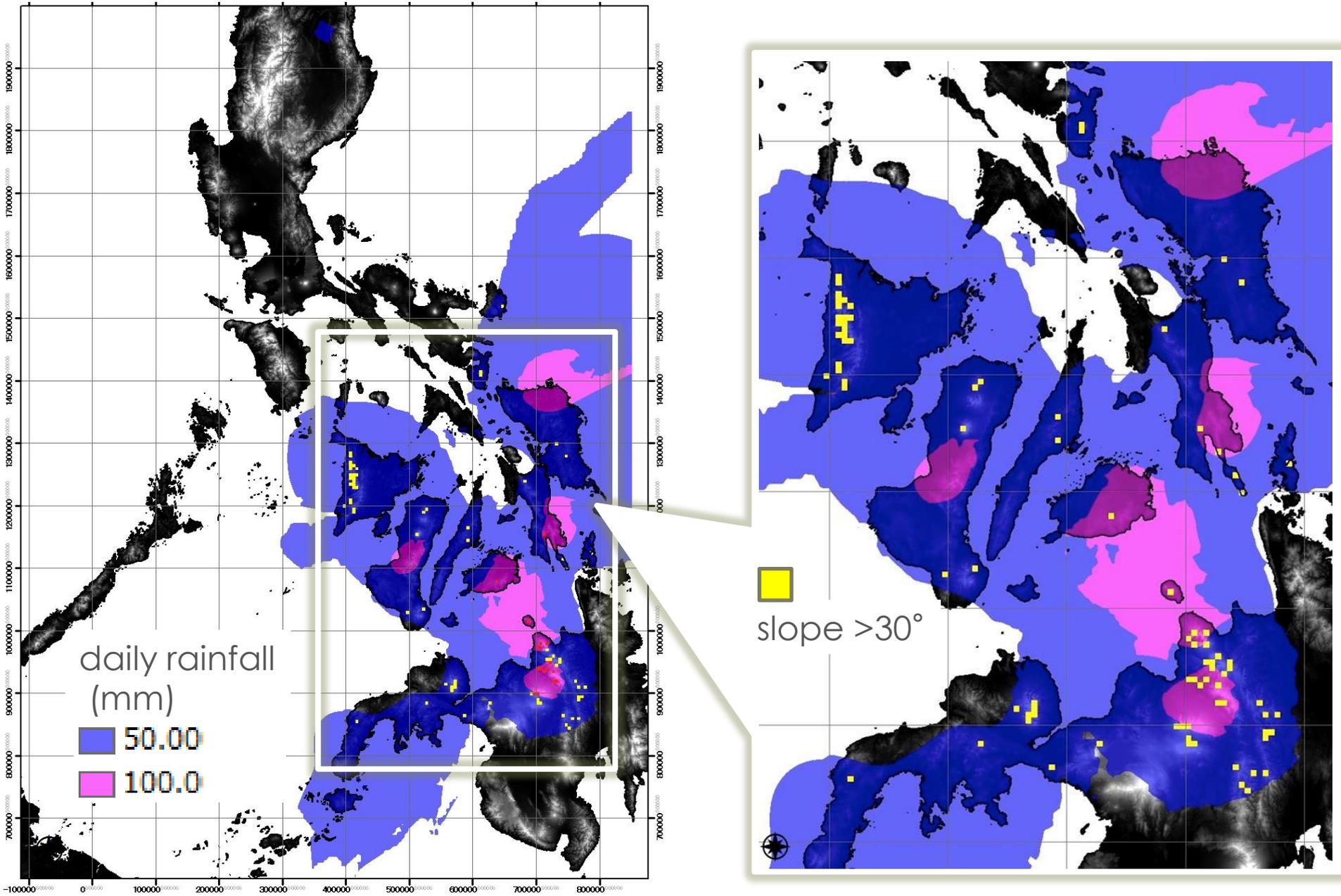


Rainfall 11 PM



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

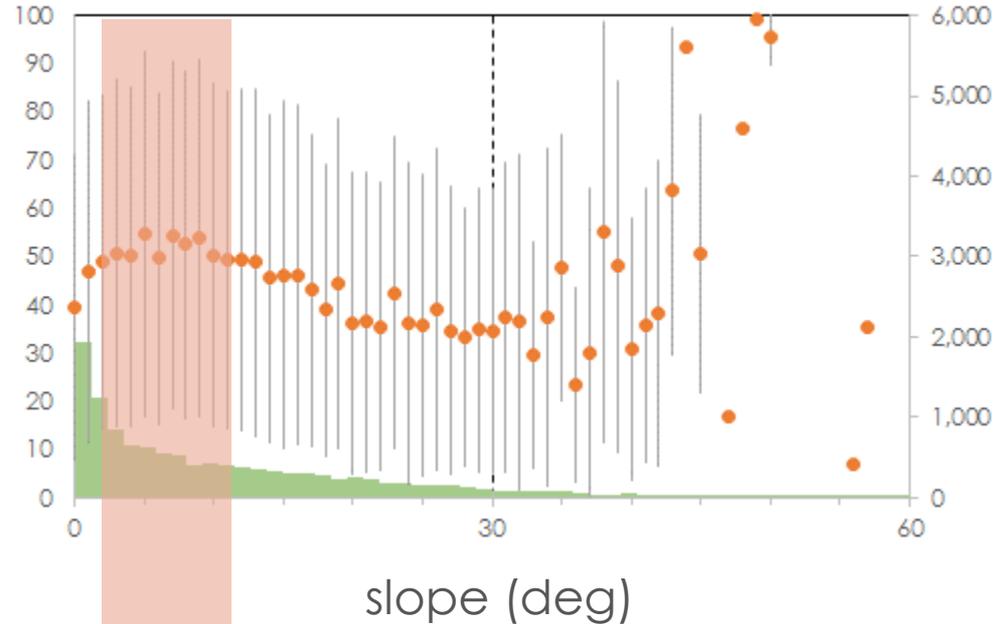
Potential Landslide Hazard Areas



Moderately Sloping Areas Had More Rainfall

daily rainfall
(mm) mean $\pm 1\sigma$

number of cells
of land area

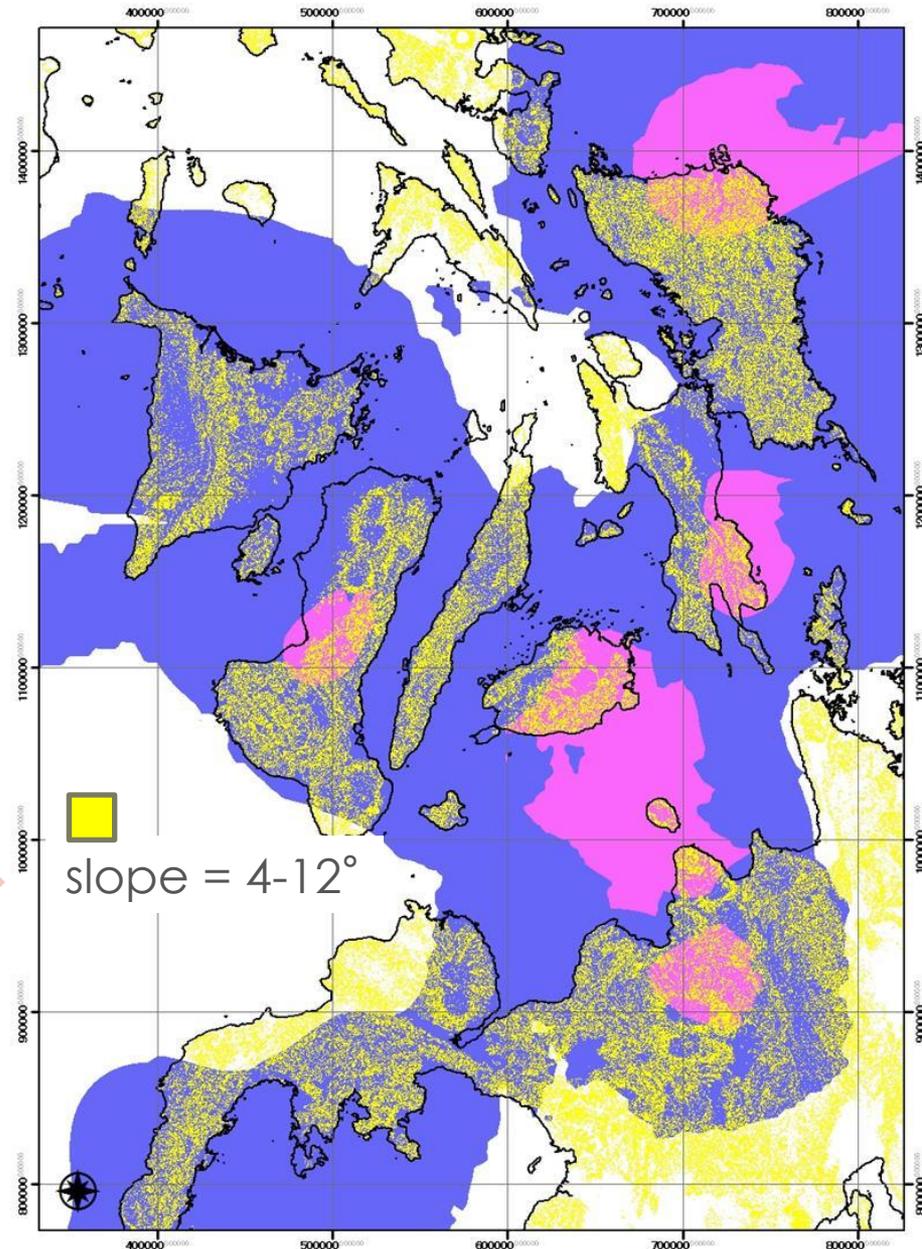


relatively higher rainfalls in slopes 4-12 degs

daily rainfall
(mm)

50.00

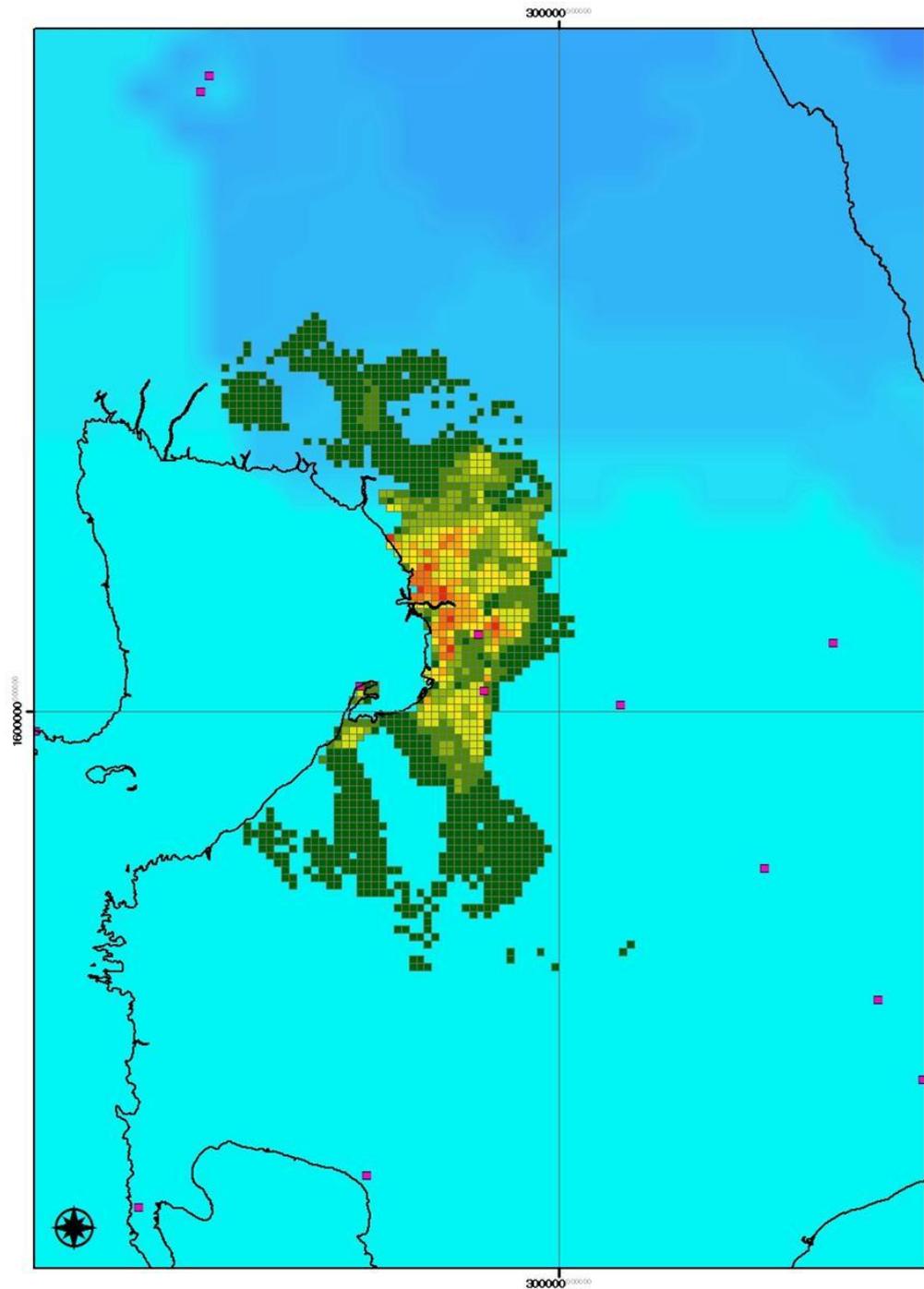
100.0



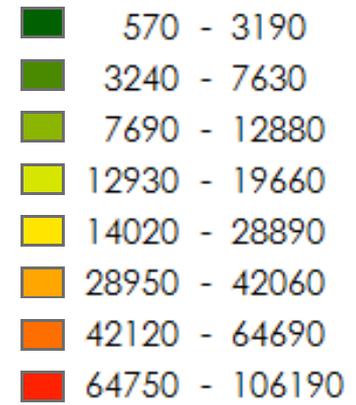
**Example of Spatial Analysis (2):
Rainfall and People Flow in
Manila (Hourly Population
Estimates based on a
Questionnaire Survey to 200,000
People)**

Pop. & Rainfall

0AM

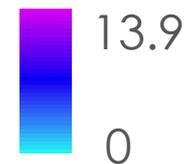


population (/km²)



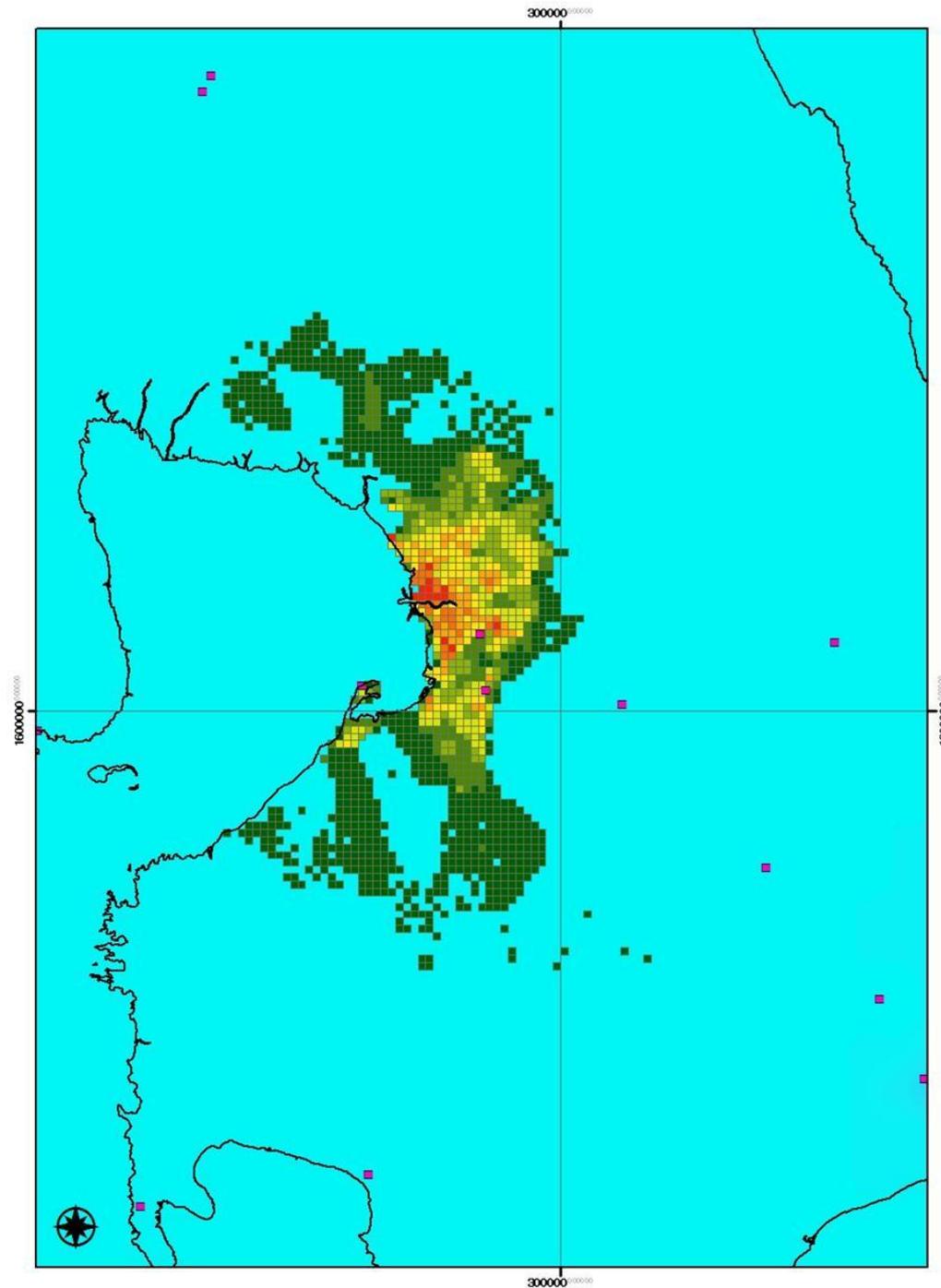
(source: person trip data
1996 Manila by CSIS-i)

hourly rainfall (mm)

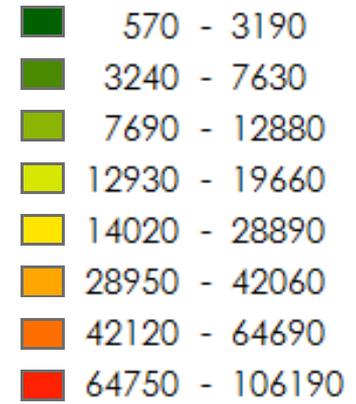


Pop. & Rainfall

8AM

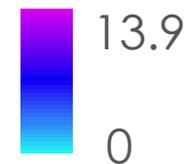


population (/km²)



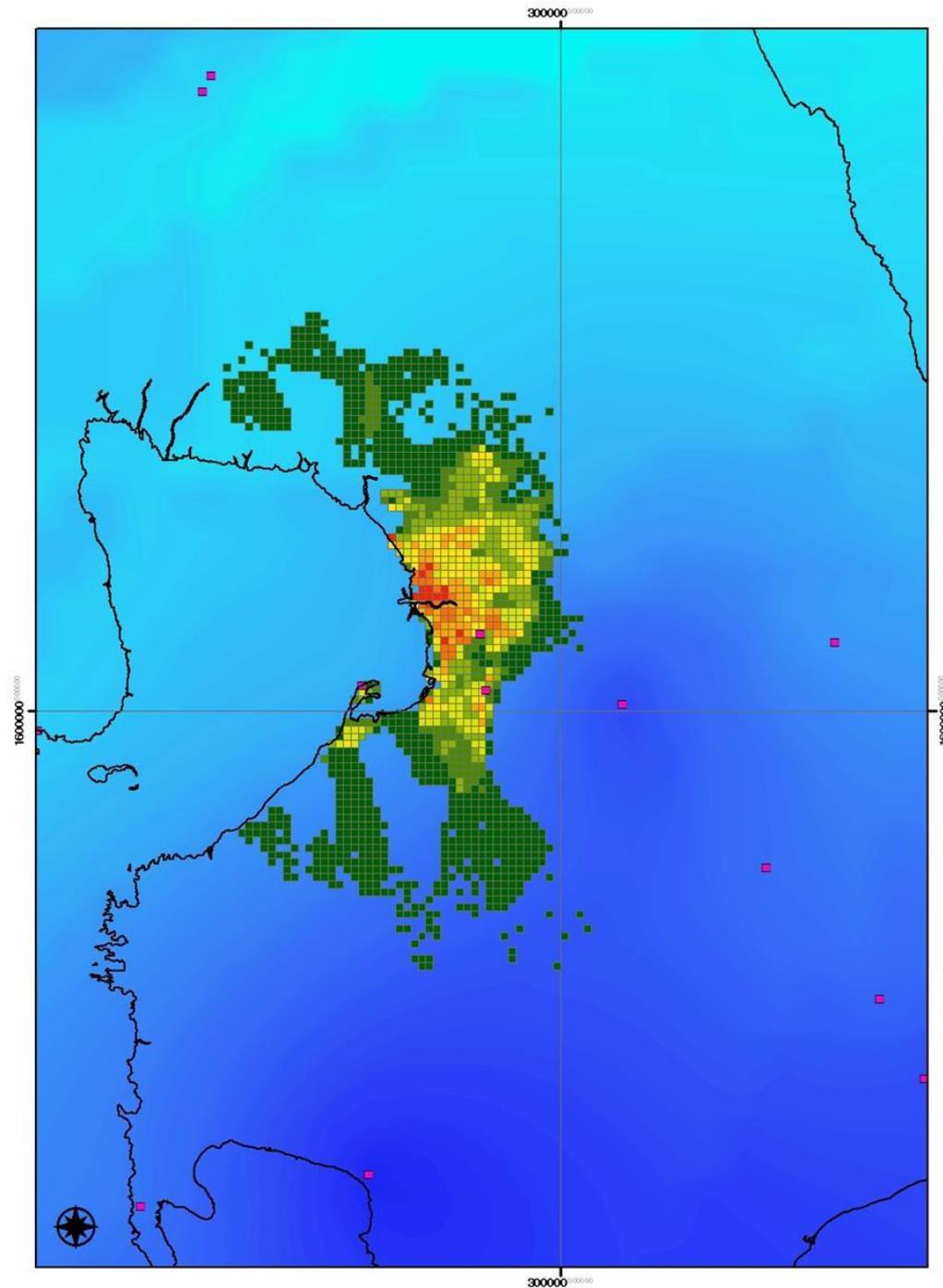
(source: person trip data
1996 Manila by CSIS-i)

hourly rainfall (mm)

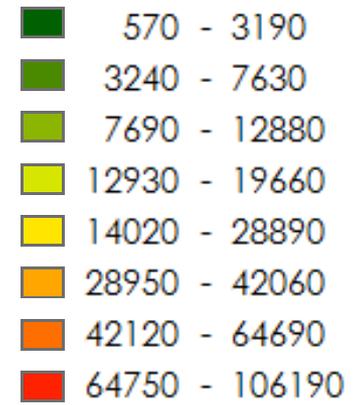


Pop. & Rainfall

Noon

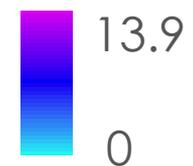


population (/km²)



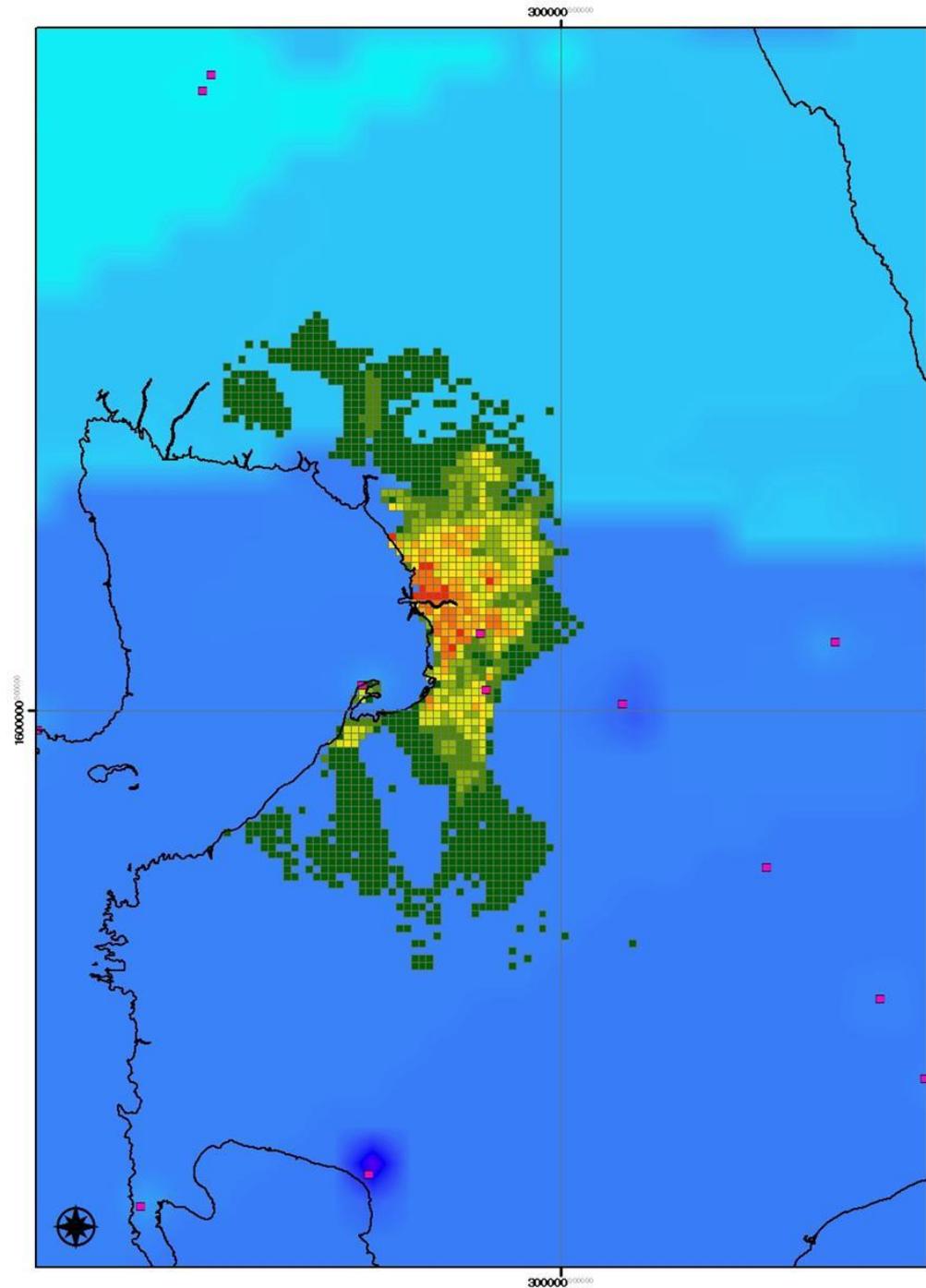
(source: person trip data
1996 Manila by CSIS-i)

hourly rainfall (mm)

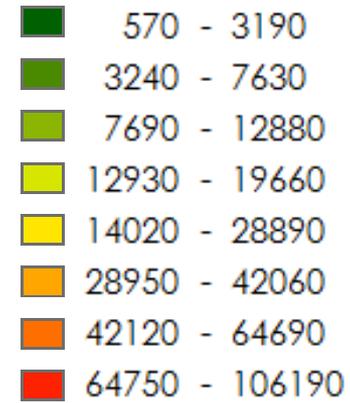


Pop. & Rainfall

5PM

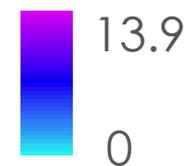


population (/km²)

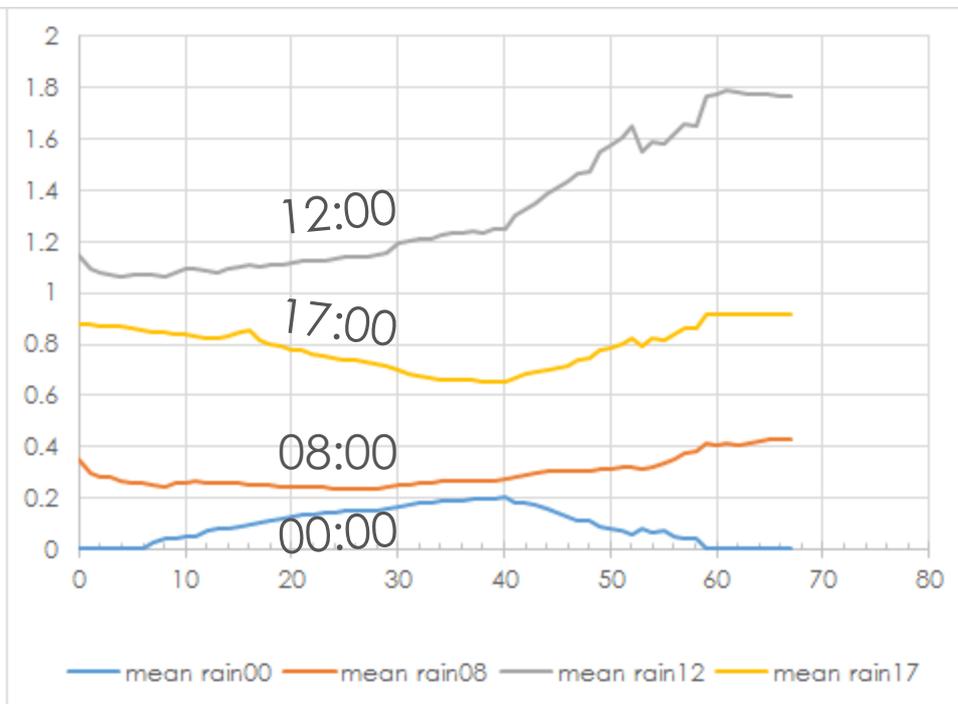
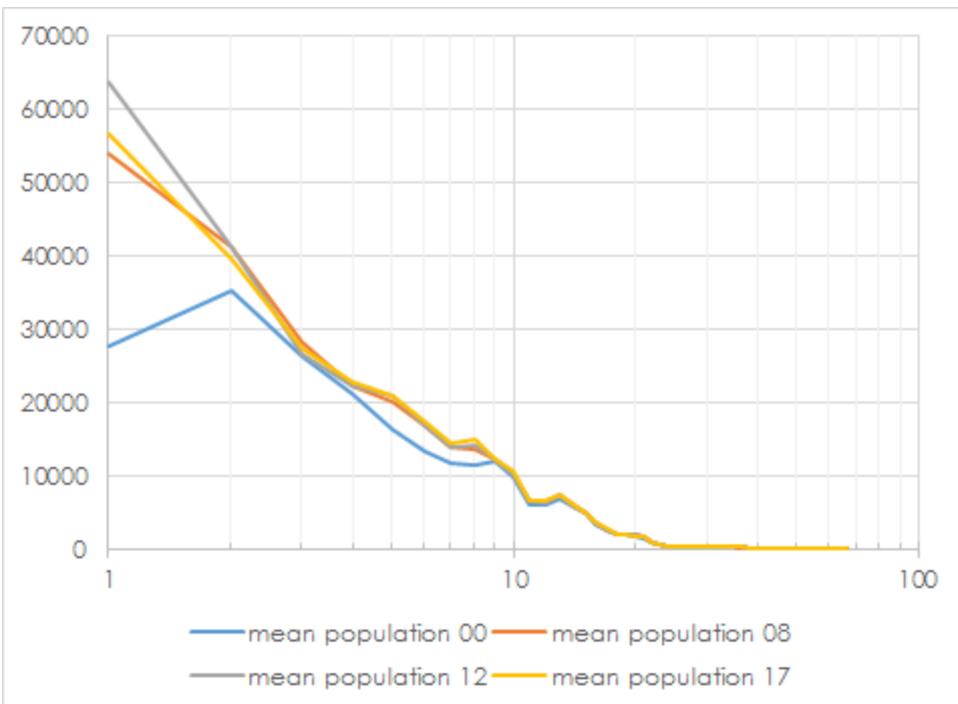
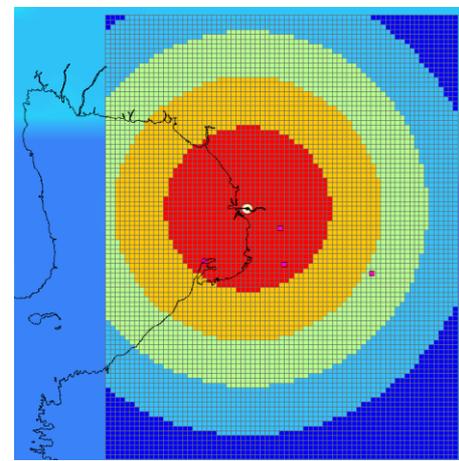


(source: person trip data
1996 Manila by CSIS-i)

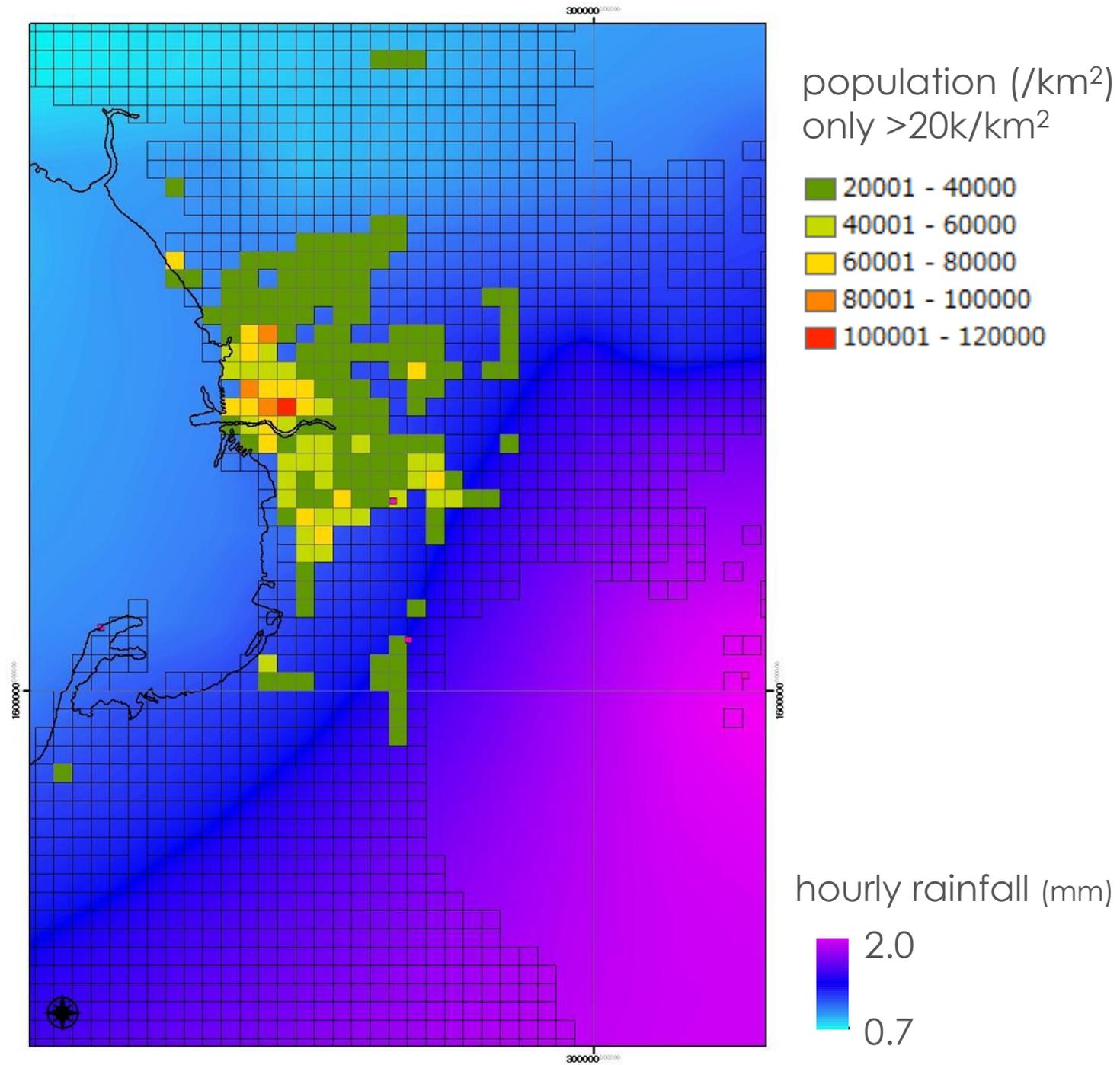
hourly rainfall (mm)



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



Severe Situation at Noon



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