Center for Disaster Management and Risk Reduction Technology

CEDIM Forensic Disaster Analysis Group (FDA)

Hurricane Matthew

24 October 2016 – Report No. 1 - Update

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SUMMARY

Official Disaster Name	Date	Landfall UTC	Local	Duration
Hurricane 14L Matthew (HT)	**04-10**	**11 UTC**	**-5**	**12 hours**
Hurricane 14L Matthew	**28-09 – 09-10**	**4 landfalls**		**12 days**

Preferred Hazard Information:

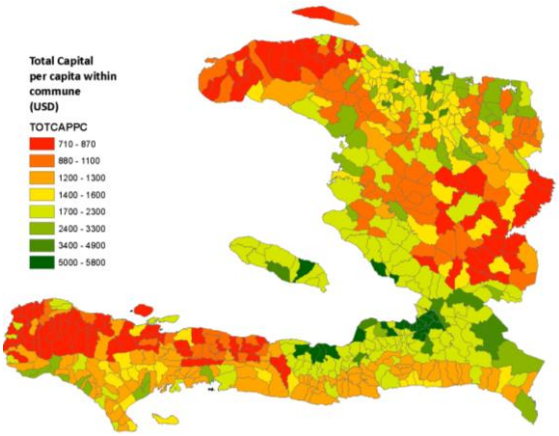
Path	Speed	Definition (Saffir-Simpson Scale)	Width (km)	Gust (Peak)	Landfall	Sustained
N (Haiti)	**16 kt**	**Category 4 (4/10)**		**278 kph**	**11 UTC**	**232 kph**
NNW (Cuba)	**12 kt**	**Category 4 (5/10)**		**259 kph**	**00 UTC**	**213 kph**
NNW (Bahamas)	**27 kt**	**Category 4 (7/10)**		**259 kph**	**00 UTC**	**213 kph**
NE (North Carolina)	**30 kt**	**Category 1 (8/10)**		**148 kph**	**15 UTC**	**120 kph**

Location Information:

Country	ISO	Provinces/Regions	Most Impact	Economic Exposure	HDI (2014)	Urbanity	Pop. affected
Haiti	**HT**	**Grand Anse, Nippes, Sud**	**Western Haiti (Grand Anse, Nippes, Sud)**	**$1.9bn**	**0.483**	**22%**	**Ca. 2 million (greatly)**
USA	**US**	**FL, GE, SC**	**SE Atlantic Coast**	**$5700bn**	**0.908**	**91%**	**Ca. 26 million**
The Bahamas	**BS**	**Island**	**Whole Island**	**$47bn**	**0.790**	**83%**	**Ca 400,000**
Cuba	**CU**	**Guantanamo**	**Eastern Tip**	**$7.2bn**	**0.741**	**64%**	**Ca. 1,000,000**

Vulnerability and Exposure Metrics (Population, Infrastructure, Economic)

A focus is made on Haiti due to the large losses incurred there.
After hurricanes in 2004, 2008 and 2012, unfortunately 2016 provided yet another large loss to an already vulnerable economy reeling from the earthquake in 2010. The total capital per capita ranges from around $700 to $5800 USD depending on the commune. The south-west is dominated by rural communities with only 22% Urban. Coffee and other agriculture are key to these locations.
The building typologies are mostly sheet metal roofed with some thatch and straw towards the western tip. There are a mixture of typologies with wood frames, metal, concrete cinder block, concrete being the construction of choice. Most pure concrete framed buildings fared better than the light wooden framed buildings.
Infrastructure in the region includes the newly built RN7 road, and significant power infrastructure at Les Cayes and across the peninsula. Water is usually supplied on a commune level and is difficult to assess.



(Insured) Loss Estimates:

- Modelled losses in Haiti are around $2.25 billion in total with ca. $500mn ($380mn-$710mn) in residential and non-residential infrastructure in wind and rain losses, with another $250mn ($125mn-$490mn) estimated due to capital flood impacts. It should be noted that this does not include a disaggregation of non-residential and residential.
- The losses globally will be very small in Haiti in the insurance industry due to very low take out. It could be assumed that these will not top $50m. The connectivity of this region is very small however the Haitian Blue coffee provisions may have minor impacts on business interruption.

1 Meteorological Information

1.1 Evolution of Hurricane Matthew

23 September 2016: Matthew arose from a tropical wave west of West Africa. The area of deep convection travelled across the tropical Atlantic Ocean into a westerly direction without showing a low-level closed circulation.

28 September 2016: The thunderstorms organized into a tropical storm at 13.4N 60.7W and was named “Matthew”. The tropical storm crossed the Windward Islands (Lesser Antilles) passing Barbados just to the north and made its way along the Saint Vincent Passage between St. Lucia and St. Vincent into the Caribbean.

29 September 2016: While intensifying into a category 1 hurricane, Matthew moved to the west over the easterly Caribbean.

30 September 2016: The hurricane showed a rapid intensification and deepened from a category 2 into a category 5 hurricane within just 15 hours. 1-minute sustained wind speeds increased from 85 kt to 140 kt (259 kph). The hurricane kept category 5-intensity for only a few hours only and then became upper category 4.

01-02 October 2016: Matthew continued on its westerly track and the storm’s center passed Punta Gallinas (Colombia) at a distance of only 110 km.

02 October 2016: The hurricane changed its track following a northerly direction and headed for SW-Haiti and E-Cuba.

04 October 2016: At 11 UTC Matthew crossed Haiti’s coastline near Les Anglais as a category 4 hurricane with maximum sustained winds of 125 kt (232 kph). Due to its track which followed roughly the Windward Passage between Haiti and Cuba it was only a short interaction with a relatively small landmass. Friction effects didn’t weaken the storm very much and Matthew could keep its strength.

Figure 1: Radar image, 30 Sep, 17:40 UTC; Image source: NOAA/AOML/HRD, via tropicalatlantic.com

05 October 2016: The hurricane arrived at the southern Bahamas after moving across the eastern tip of Cuba as a category 3 storm.

06 October 2016: Matthew raged through the Bahamas and intensified into a category 4 hurricane again from the afternoon and during the following night.

07 October 2016: Matthew followed the coastline of Florida into a north westerly direction. Being a category 3 hurricane, its center was very close to the coast but stayed offshore, and at around 10 UTC the eye was only about 40 km east of Cape Canaveral.

08 October 2016: Matthew began to weaken significantly, the hurricane shifted to the north east and travelled along Georgia’s Atlantic coast before making landfall in South Carolina for a short while as a category 1 storm.

09 October 2016: Matthew followed a track into an easterly direction away from the US-coast and towards the open waters of the Atlantic Ocean; Matthew lost hurricane status at 09 UTC.

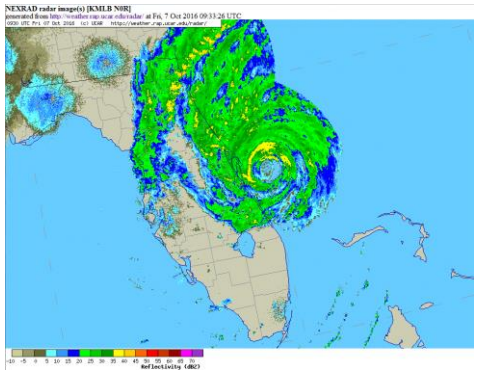


Figure 2: Radar image, 07 Oct 2016, 09:33 UTC; Image source: http://weather.rap.ucar.edu/radar

1.2 Landfalls of Matthew

Hurricane Matthew had multiple (4) landfalls during lifetime, in Haiti, Cuba, the Bahamas and in South Carolina (USA). Figure 3 shows the track of Matthew, and Table 1 gives an overview of the landfalls, their location, their time and their storm category.

Table 1: Time and location of landfalls of hurricane Matthew

Les Anglais, Haiti,
04 Oct 16, 11 UTC, Cat 4
Juaco, Cuba,
05 Oct 16, 00 UTC, Cat 4
Freeport, Bahamas,
07 Oct 16, 00 UTC, Cat 4
McClellanville, South Carolina,
08 Oct 16, 15 UTC, Cat 1

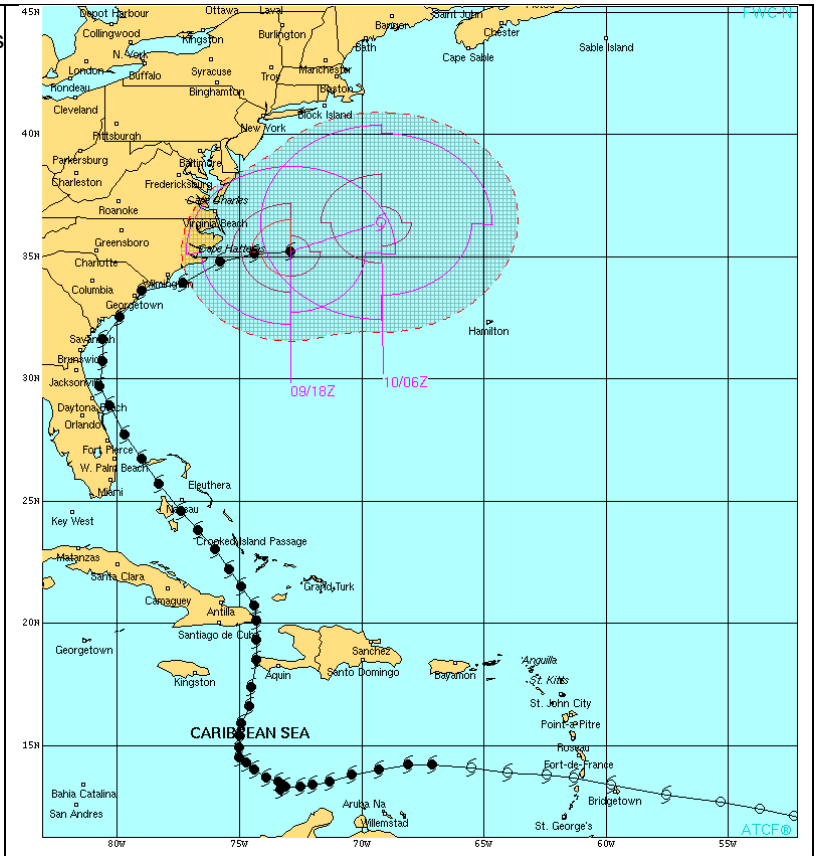


Figure 3: Track of hurricane 14L “Matthew”; Image credit: Fleet Weather Center Norfolk, VA

1.3 Precipitation

Measurements with satellite and satellite based precipitation radar showed values of more than 200 mm all along Matthew’s path through the Caribbean to the Bahamas. When Matthew was in its rapid intensification stage on 30 September 2016, precipitation amounts exceeding 625 mm have been derived. Over land and along the south coast of Haiti and Dominican Republic rain amounts widespread were 400-500 mm. Hourly rain rates were as high as 229 mm in the inner rain bands, cloud tops reached more than 16 km.

Additionally, tremendous rain amounts occurred at the eastern and north eastern flank of the hurricane and far away from the storm’s center. These huge convective complexes probably resulted from a low-troposphere convergence between the strong south westerly flow ahead of the hurricane and the north easterly trade winds. In the Dominican Republic which was not directly hit by Matthew these rainfalls and resulting flooding blamed for several deaths.

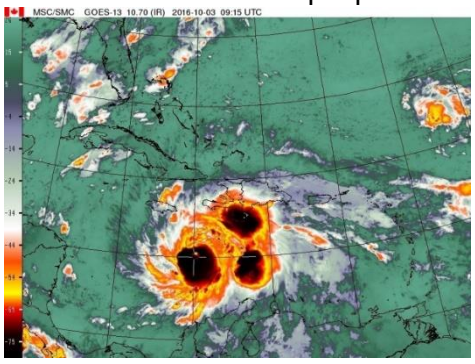


Figure 4: Satellite image, 03 October 2016, 09:15 UTC; Image Credit: Environment Canada, https://weather.gc.ca

In St. Lucia at Hewanorra Intl. Airport rain accumulation was 335 mm within 13 hours. Cartagena in Colombia registered 222 mm within 24 hours on 01 October 2016, at the same day Santa Maria got 142 mm which was well above average for the entire month of October (110 mm).

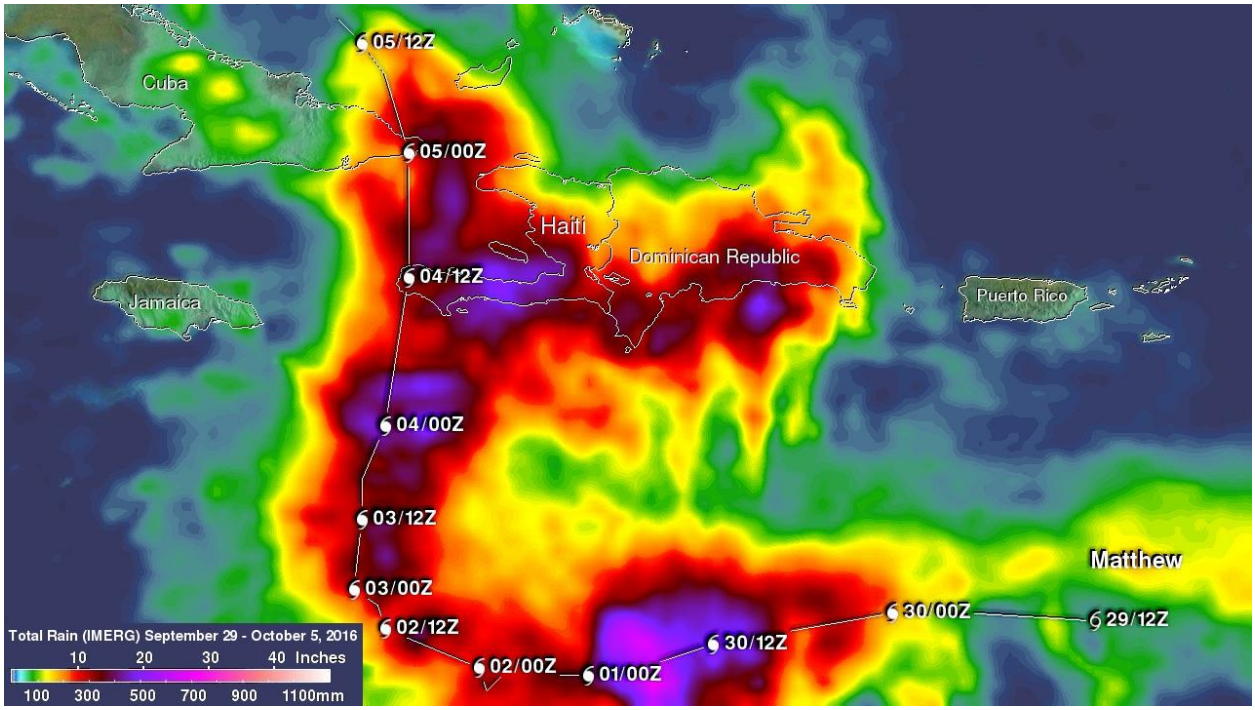


Figure 5: Path of Matthew and satellite and radar derived storm total rain amounts; Image source: Tropical Rainfall Measuring Mission (TRMM)

Matthew also battered the south eastern USA; while approaching Cape Canaveral wind gusts reached 172 kph.

Matthew also brought extremely high amounts of rain to the Southeast of the USA and set numerous new records. In conjunction with hurricane Matthew torrential rain fell from Florida all the way up to Virginia. Norfolk in Virginia got 189 mm on 08 October 2016, now being the new wettest October day on record (previously 158 mm, 17 October 1999). At the same day, a new 24-hour rainfall record was also set at Raleigh-Durham International Airport: 164 mm (old: 151 mm on 01 October 1929). And Fayetteville, NC, received remarkable 356 mm of rain within 24 hours, pulverizing the old calendar-day record of 173 mm on 16 September 1999.

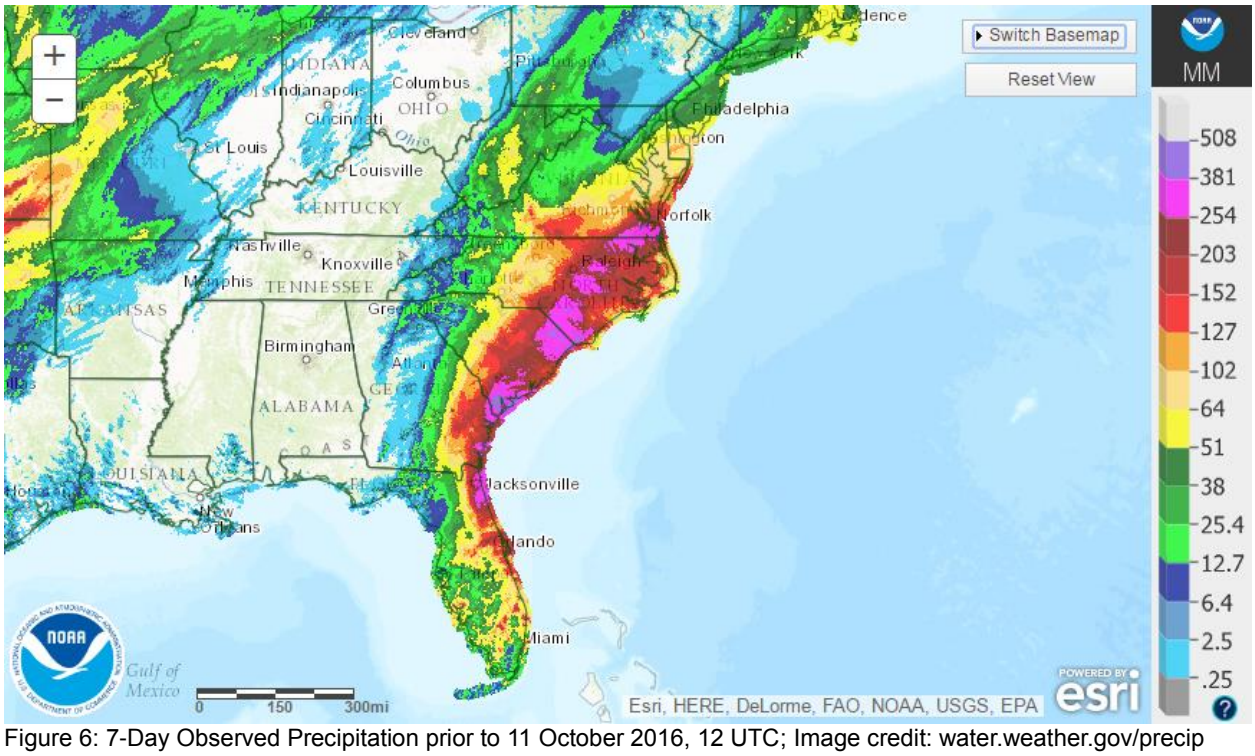


Figure 6: 7-Day Observed Precipitation prior to 11 October 2016, 12 UTC; Image credit: water.weather.gov/precip

Table 2: Storm total rainfall in south eastern USA. 06 Oct., 15 UTC, - 09 Oct., 14 UTC

Delaware	Seaford	80 mm
Delaware	Georgetown	77 mm
Maryland	6 mi s of Berlin	140 mm
Maryland	Public Landing	133 mm
Florida	Sanford/Orlando	200 mm
Florida	Lake Mary	179 mm
Georgia	Savannah	444 mm
Georgia	Abercorn Creek	322 mm
North Carolina	William O. Huske Locke 3	398 mm
North Carolina	Goldsboro	387 mm
South Carolina	Beaufort	357 mm
South Carolina	Reevesville	328 mm
Virginia	10 mi nw of Chesapeake	326 mm
Virginia	Virginia Beach	309 mm

1.4 Record High Water Levels

Matthew not only generated torrential rainfall but also was responsible for a high storm surge. Along the coast from Florida to North Carolina three tide gauges with long-term historical records set new all-time records for their highest water level, see Figure 7. Storm tide is the water level measured relative to the high tide. Several other tide gauges were near-record.

Table 3: New storm tide all-time records (with long-term historical records) due to Matthew; Source: www.wunderground.com

Tide Gauge	Storm Tide (Matthew)	Old storm tide record and date	Recording since
Fort Pulaski, GA	154 cm	104 cm 15 Oct 1947 Hurricane	1935
Wilmington, NC	108 cm	106 cm 15 Oct 1954 Hurricane Hazel	1935
Mayport, FL	100 cm	75 cm 27 Sep 2004 Hurricane Jeanne	1928

Parts of the south eastern states between Florida and Virginia not only saw coastal floods but also many rivers were in flood stage. Many of them had new all-time high water levels. On 09 October 2016 the gauge of the Lumber River at Lumberton, NC, was at 7.41 m which is 1 meter above the old record. The water level of the Lower Little River at Manchester, NC, rose by 6 meters within 12 hours and reached 9.56 m, beating the old record level by 70 cm, see Figure 8. A new all-time record also occurred at the Tar River in the northeast of North Carolina, where water level was 8.45 m, 60 cm above the previous record. Many people (about 1500) were stranded in Lumberton, NC, and had to be rescued by helicopter or boat.

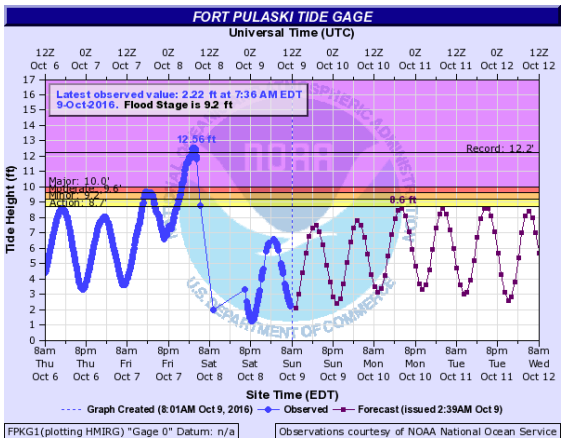


Figure 7: Tide Gauge at Fort Pulaski, GA, 06-12 Oct 2016; Image credit: www.water.weather.gov

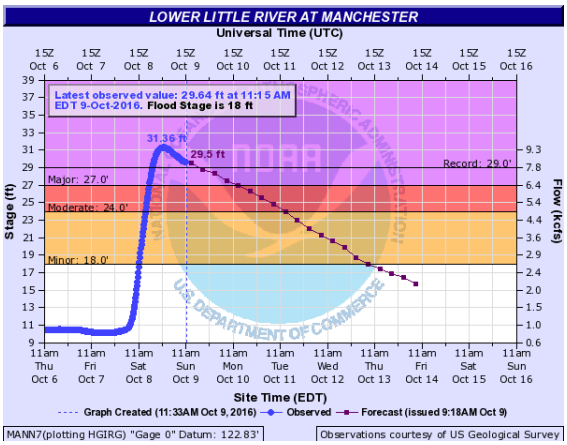


Figure 8: Lower Little River Gauge at Manchester, NC, 06 – 16 Oct 2016; Image credit: www.water.weather.gov

1.5 Some Interesting Facts about Matthew

Referring to CIMSS Satellite Blog, Wunderground and other sources, Matthew set many new record for intensity, longevity and landfall.

Matthew was the first Cat 5 Atlantic hurricane since hurricane Felix in 2007.

Matthew was the lowest Cat 5 hurricane on record at 13.3N, roughly 100 km north of Colombia (since hurricane Ivan in 2004)

Matthew showed a rapid intensification; with 44 kt within 24 hours it was third strongest intensification in the Atlantic on record (Wilma 2005, Felix 2007)

Matthew had the sixth lowest Mean Sea Level Pressure (MSLP), 934 hPa, for any Atlantic October since consistent MSLP records began in 1979.

Matthew had peak intensity (Cat 5) with sustained winds of 140 kt (259 kph); at that time MSLP was 941 hPa.

Matthew was the longest-lived Cat 4 or 5 hurricane in the eastern Carribean (<=20°N, 60-90°W)

Matthew had Cat 4 or 5 for 102 hours in October which was a new record for this strength for the month of October

Matthew was a major hurricane (Cat 3, 4 or 5) for 7.25 days, which was the longest-lived major hurricane on record forming after 25 September.

Matthew was the longest lasting major hurricane at any time of the year since Ivan (2004)

Matthew was the fifth longest major hurricane in satellite era (since 1966), tied with Fabian (2003)

Matthew had 4 landfalls (Haiti, Cuba, Bahams, USA)

Matthew was the first Cat 4 hurricane making landfall in Haiti since Cleo (1964)

Matthew was the first Cat 4 hurricane making landfall in Cuba since Ike (2008)

Matthew was the first major (>=Cat 3) hurricane that made landfall in Haiti, Cuba and the Bahamas

Matthew was the second Cat 4 hurricane that made landfall in the Bahamas in October (Joaquin, 2015)

Matthew was the first hurricane making landfall in South Carolina since Gaston (2004)

Matthew was the first hurricane that made landfall north of Georgia in October (Hazel, 1954)

Matthew had also great effect in eastern Nova Scotia and Newfoundland (Canada), where the weather station at Sydney observed a new record for one-day total rainfall which was 225 mm (previously: 129 mm on 17 August 1981)

Matthew contributed to new records in atmospheric moisture along its path in the south eastern US. Record amounts of precipitable water did occur at Jacksonville, FL, (72 mm, previously: 71 mm on 20 July 1983), and Charleston, SC (74 mm, previously: 69 mm on 15 August 2010); readings have been taken by radiosonde soundings.

Because of the track, which was parallel to the US Atlantic coastline most of time, hurricane Matthew affected a very large area starting from southeast Florida and continuing all the way to Virginia. Being extra-tropical Matthew struck parts of eastern Canada, too. In total, 26 Million people were affected by the hurricane in the US.

1.6 Hurricane Return Periods and Tracks

In the US, Matthew made landfall in South Carolina as a Cat 1-hurricane which happens about every 8 years. A major hurricane (Cat 3 or above) would come ashore in South Carolina once in about 22 years. Around the Atlantic Basin most likely (every 5 or 6 years) is a US-landfall by a hurricane in Florida and Northern Carolina.

Somewhat unusual was Matthew's track which would have been more typical in September. In October, hurricanes are most likely to develop in the western Caribbean Sea or in the eastern Gulf of Mexico; the prevailing tracks proceed across Cuba, Florida or close to the Carolinas' coastline.

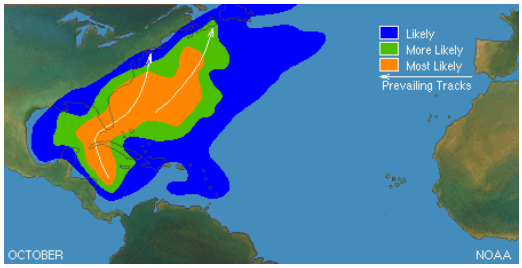


Figure 9: Typical hurricane tracks in October
Image credit: National Hurricane Center

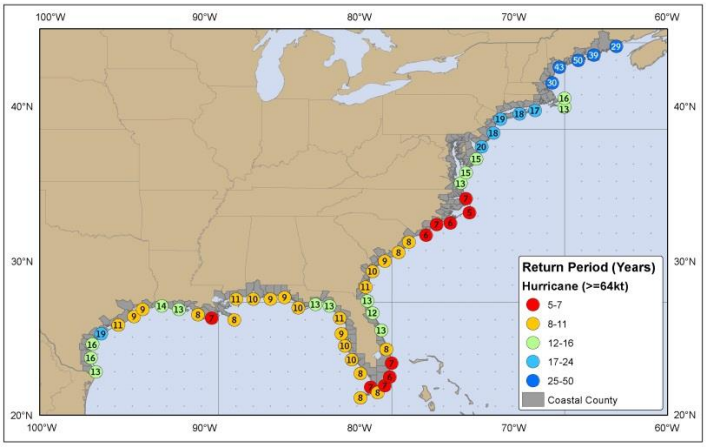


Figure 10: Return periods of hurricanes Cat 1 or above in years
Image credit: National Hurricane Center

Sources:

ideam.gov.co
weather.unisys.com
NRL Tropical Cyclone Page
National Hurricane Center
mapsofworld.com
tropicalatlantic.com
NWS, Weather Prediction Center
weather.rap.ucar.edu
wunderground.com
water.weather.gov
CIMSS Tropical Cyclone Group
Tropical Rainfall Measuring Mission (TRMM)
NASA Earth Observatory
The Weather Network
Environment Canada
Savannahnow.com
nbcnews.com
emdat.be

2 Loss Analysis for Haiti

For the US, Matthew is the most expensive Atlantic hurricane since Sandy in 2012. Goldman Sachs estimate an overall loss of more than $10billion, insured losses $4-6 billion, according to nbcnews.com.

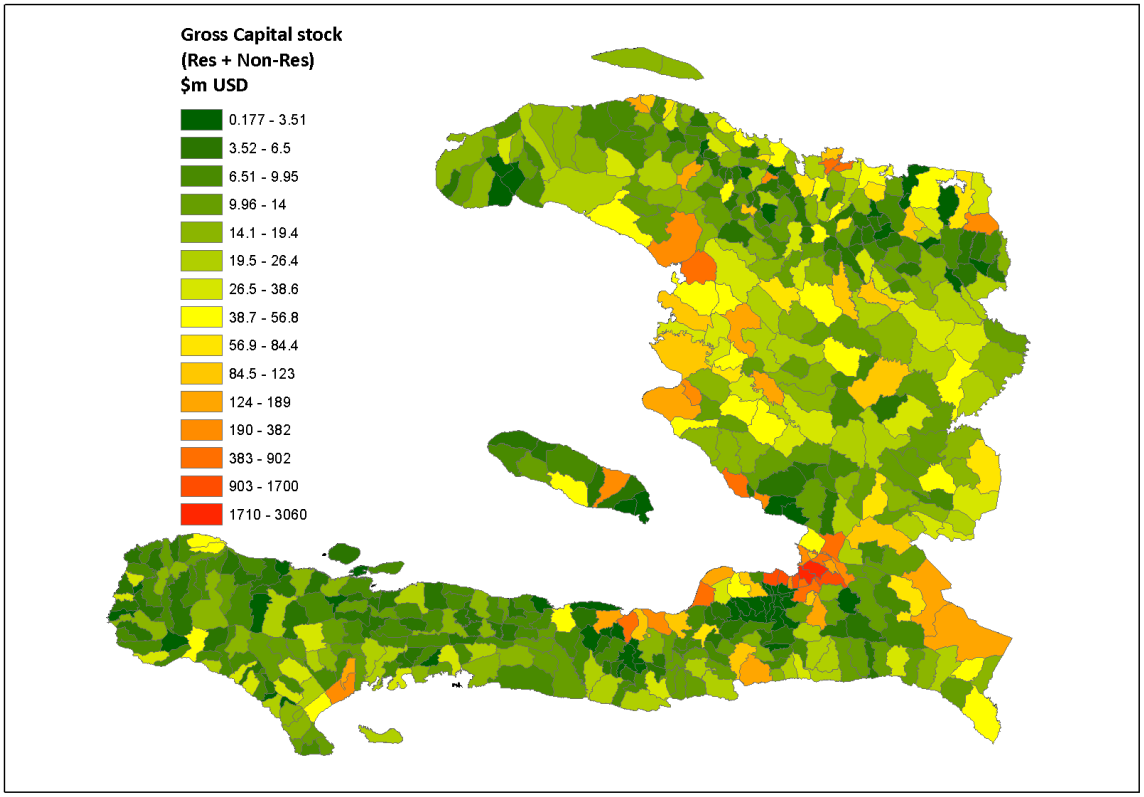
For the Bahamas the costliest natural disasters were Hurricane Frances of 2004 ($1 billion in losses) and Hurricane Jeanne of 2004 ($550 million in damage). Matthew likely was responsible for the largest insured losses from a hurricane ever according to Tribune242 new service. It's expected that Matthew causes a total payout from Bahama insurance companies exceeding that of Jeanne and Frances combined.

The losses in Haiti are the most extensive across the region with estimates in the order of $2.25 billion being likely. Of this, it is unclear as yet what percentage is due to flooding vs. wind related losses however an attempt has been made to remove overlap.

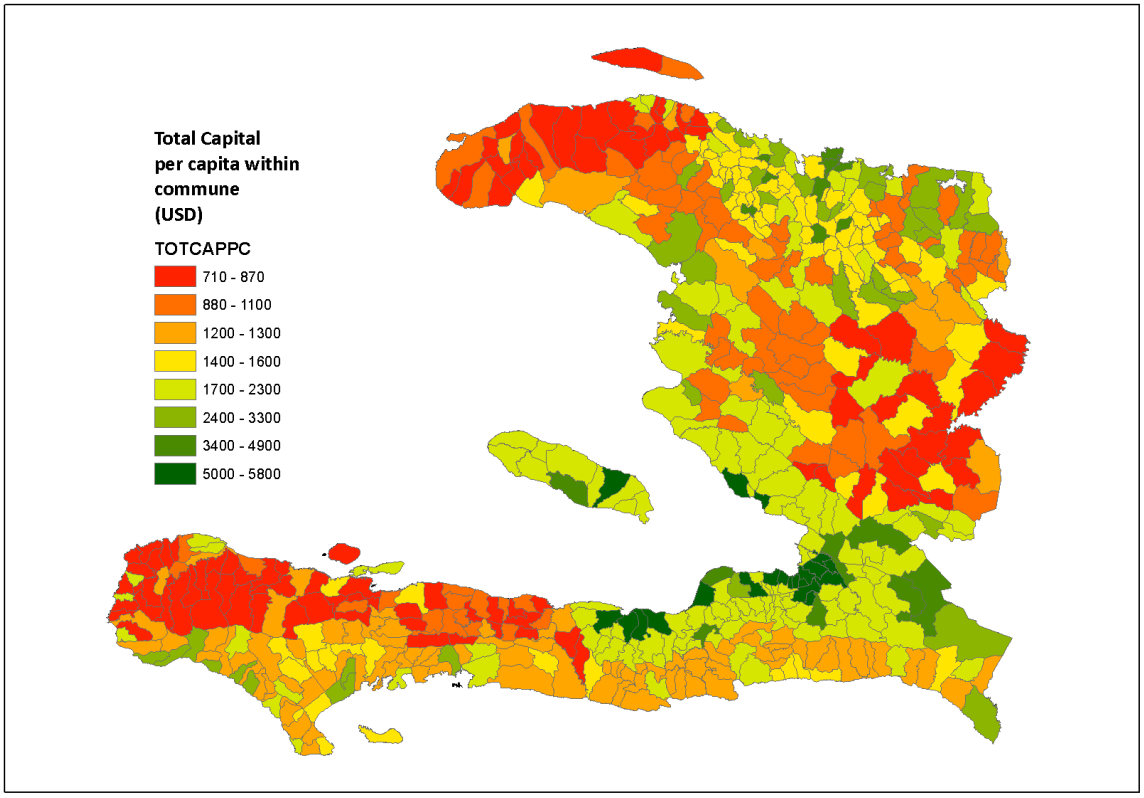
Only capital losses have been modelled, and other losses have been assessed based on a factor basis from previous hurricanes to hit the area, with the building component pegged at 33%. $756 million in losses to capital is estimated from the rapid assessment of loss.

Similarly for flooding, flash flood and riverine flooding are modelled using the NATHAT (2010) data combined with other data.

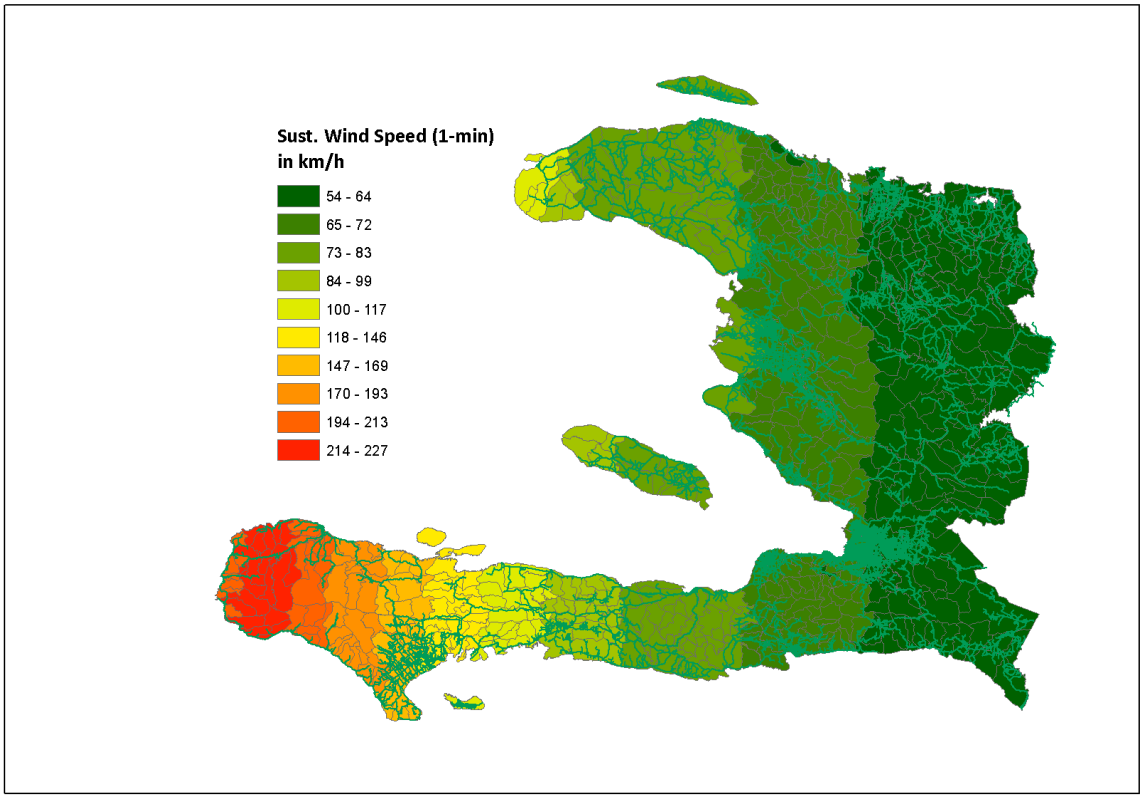
Total capital in Haiti has been estimated via the methodology within Daniell (2014) to be around $31.7 billion currently for non-residential and residential components. Using historical damage ratios and empirical based functions for capital losses, the estimation is made.



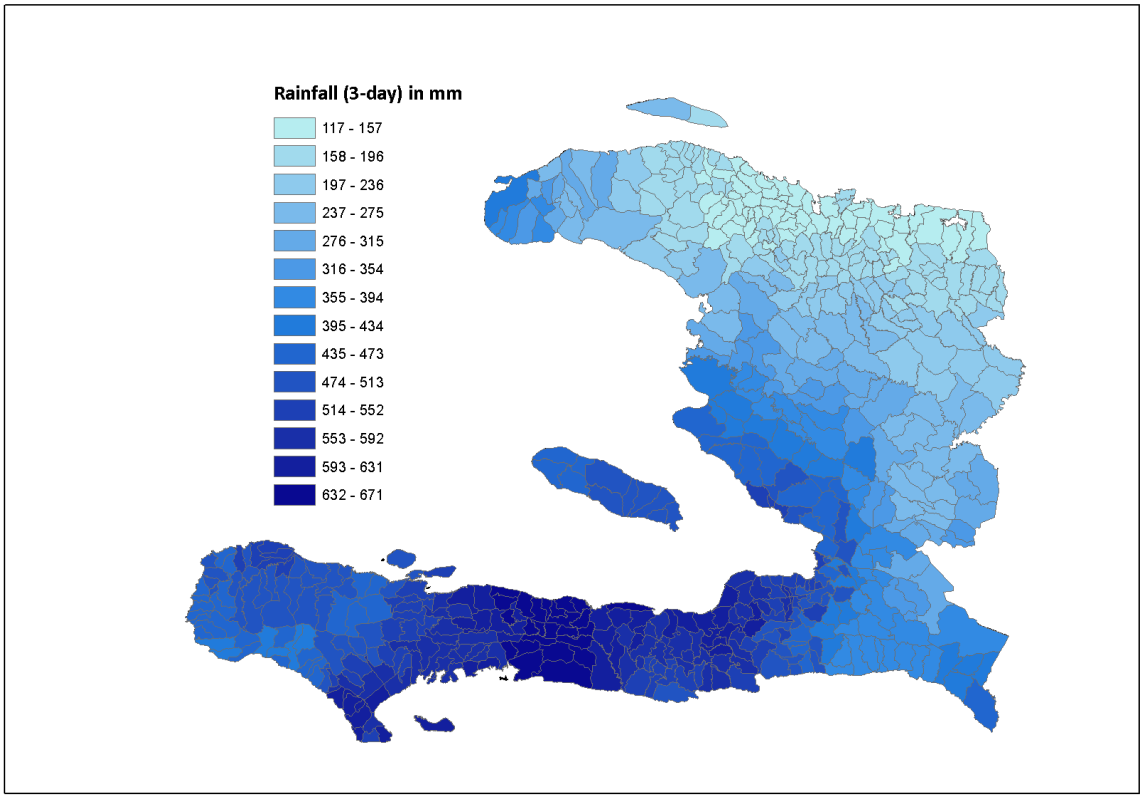
It can be seen that total capital per capita per commune differs markedly across Haiti, and that the western tip is one of the poorest locations within Haiti.



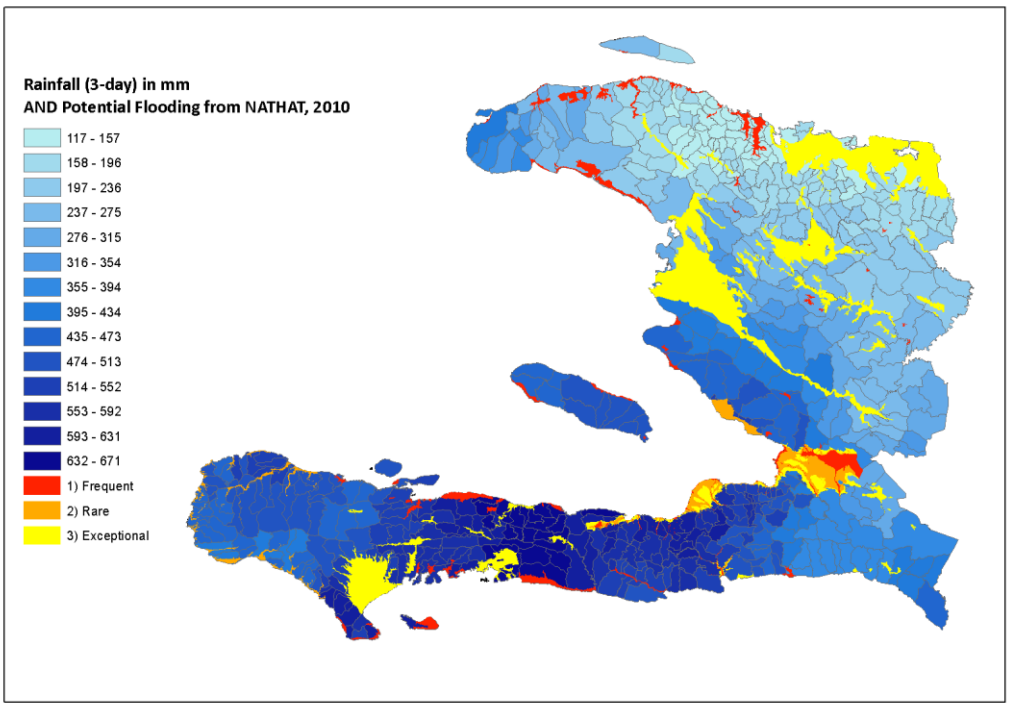
The sustained wind speeds are shown here overlaying the road density network, in order to show the relative density of infrastructure potentially affected at high wind speeds. Of course, road networks are more prone to flooding, but are a good proxy for electricity and water systems where available.



The 3-day rainfall was in the order of 300mm across the island, however it can be seen that communes along the south had higher rainfalls, especially in the mountainous areas.

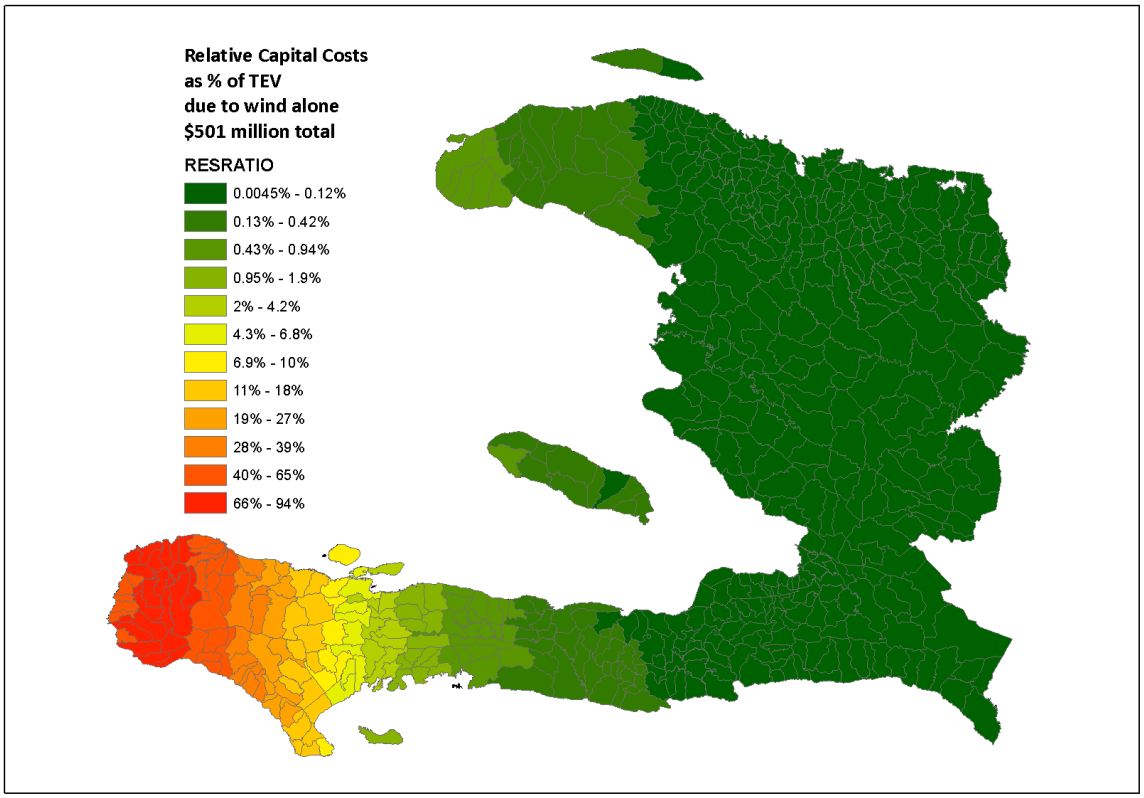


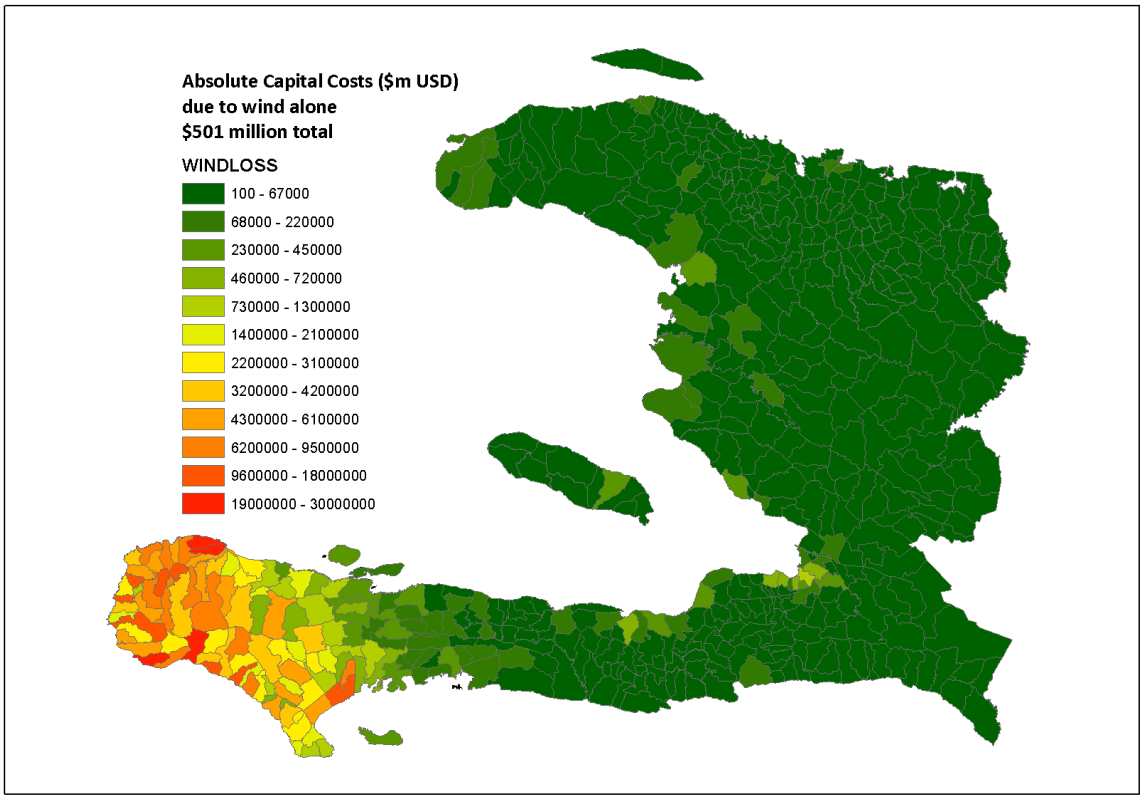
The 3-day rainfall was combined with previous flood modelling done in Haiti, in order to see the potential impacts. This however is only riverine flooding and significant flash flooding also occurred.

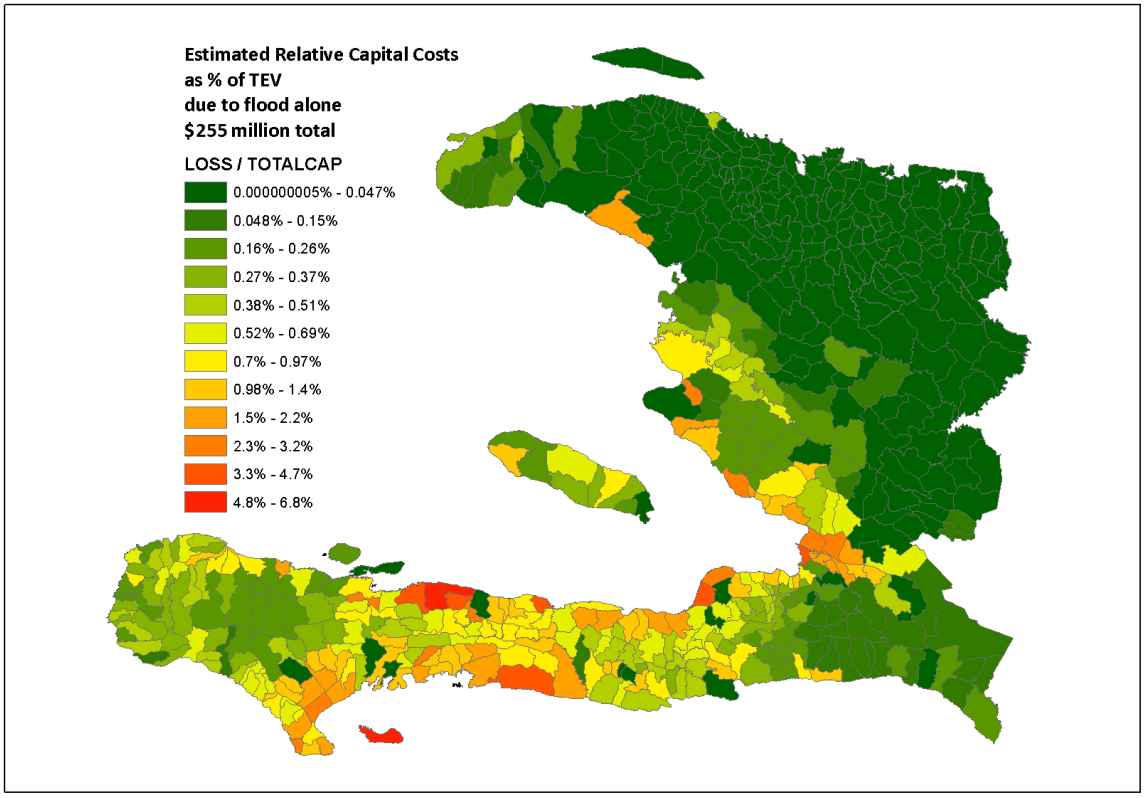


The mean damage ratio to capital per commune was calculated therefore not only for wind but also for flood in order to calculate the potential impact across Haiti. This matches up well with

some of the ground trothing in particular locations where we have information.







In total the losses amount to $501m, mostly in Grand Anse, Nippes and Sud for the wind damage. However, for flood, where around $255m in capital costs are expected, losses are seen further afar in Ouest, Sud, Nippes, Arbonite and even Sud-Est.

A factor of 3 indicates the usual increase accounting for infrastructure, agriculture, commerce and other losses seen across the board, from hurricanes of this nature. More analysis will follow in the future to assess the other sectors.

Current estimates from the government

Using the current loss statistics from the government, 546 are dead and 128 missing, however many more are estimated to have been killed. Ca. 1600 is the last count when applying similar damage ratios and fatality ratios across unknown towns.

	Dead	Missing	Injured	In Shelters
Artibonite	5	2	23	
Centre				
Grand'Anse	261	53	197	99400
Nippes	36	1	102	7866
Nord				
Nord-Est				
Nord-Ouest	1		2	
Ouest	51	1	87	3877
Sud	186	71	22	64366
Sud-Est	6		6	
TOTAL	**546**	**128**	**439**	**175509**

As of 13th October 2016, Civil Protection, official estimates in Haiti

In total, however there are more damages expected across the region. These are the current numbers estimated as of 13th October 2016.

	Uncon-firmed deaths	Displaced People	Losses	Comments
Cuba	0	37809	In the order of $100m +	95% of houses without roofs in Maisi (Guantanamo)
Haiti	1600 (estimate)	1400000* (175000)	In the order of $2bn	Catastrophic in Grand'Anse, Nippes, Sud
United States	46		In the order of $15bn+	Florida, North Carolina (widespread flood-ing), South Carolina, Georgia, Virginia
Dominican Republic	4	7000		
Bahamas		3500	In the order of $1bn+ ($200m in-sured)	
Colombia	1			
St. Vincent and Grena-dines	1			

http://www.one.cu/publicaciones/provincias_masinf/guantanamo.htm gives more information as to the socioeconomic status of the Cuban eastern tip.

3 On-sight Report from Beaumont, Haiti

At the time of Hurricane Matthew, there was a group of KIT students in Haiti, specifically Beaumont near the Western tip of the island, working the on construction of a school and orphanship. All of them are volunteers for the student association Engineers Without Borders (EWB) – Karlsruhe Institute of Technology e.V.

A group of 11 stayed in Beaumont at the time when Hurricane Matthew had landfall. They wanted to proceed construction of their project and didn't expect the severe impact this hurricane had. They prepared themselves as good as possible, reinforced windows with additional timber and gathered food supplies the days before. The storm hit during the night, but due to the recent and strong (and also earthquake proof) construction of the new school building (a small assembly hall), they survived the landfall unharmed. In the morning after, they saw the magnitude of impact. Almost all trees in the areas have been unrooted or lost all leaves. Most buildings their roof, walls were knocked down. Most people in the area lost their home. The telecommunication network wasn't working, thus a currier was sent to Port-au-Prince to report on the situation. None of the group got harmed, but the region has been devastated. At least 100 fatalities have been counted in the area of Beaumont. Most buildings are destroyed. The assembly hall is currently used as a base hospital. Due to the current situation and the elections ahead, the security of the group was no longer granted, thus it has been decided to leave Haiti and to return to Germany. This happened some days after landfall, until then the group supported locals in their first reconstruction efforts. They return home knowing that their project building a school and home for youngest generation in Beaumont is of higher demand than ever.

Further information (German): http://ewb-karlsruhe.de/beaumont/

Fotos: Engineers Without Borders

4 Evacuation

Hurricane Matthew affected several Caribbean States and some parts of the United States.

4.1 Haiti

Haiti was certainly the most affected country by hurricane Matthew. In the department of Grande Anse 14,500 people[1] have been displaced and in the hard hit South more than 20,000 people[2]. On October 8th the number of evacuees was 61,537 who took shelter in 191 temporary shelters[3].

4.2 Dominican Republic, Cuba, Jamaica and the Bahamas

On October 7th in the Dominican Republic 10,950 people were displaced in family houses. 903 were in 17 official shelters[4].

On October 3rd 700 people evacuated in Guantanamo province in Cuba and hundreds in the Jamaican capital Kingston[5].

601 people were in shelters in the Bahamas[6] on October 9th.

4.3 United States of America

In the United States the following states were directly affected by hurricane Matthew: Florida, Georgia, North Carolina and South Carolina.

Florida

For Florida there exists a lot of information regarding the evacuation of counties. Overall more than 1.5 million residents were in evacuation zones on October 5th. In Palm Beach County voluntary evacuations already started, mandatory evacuations should have started the same day. In Boward County voluntary evacuations for mobile homes and low lying areas started. Mandatory evacuations should have started on October 6th for barrier islands and low lying areas of St. Johns County. On October 5th voluntary evacuations have begun for Jacksonville Beach, Atlantic Beach and Neptune Beach. For the same day in Brevard County mandatory evacuations were announced for barrier islands beginning at 3 pm. In St. Lucie County voluntary evacuations started on October 5th. Mandatory evacuations were announced for October 6th.

Also in Flagler County voluntary evacuations begun on October 5th. In Indian River voluntary evacuations started for barrier islands on October 5th, mandatory evacuations for barrier islands, mobile and manufactured homes and low lying areas were said to start the following day. In Martin County mandatory evacuations were in effect for Sewall's Point, Hutchinson Island, Jupiter Island and mobile homes. In Miami-Dade County, Florida's county with the

[1] http://reliefweb.int/disaster/tc-2016-000106-hti

[2] http://reliefweb.int/disaster/tc-2016-000106-hti

[3] http://reliefweb.int/report/haiti/haiti-hurricane-matthew-situation-report-no-4-8-october-2016

[4] http://reliefweb.int/report/haiti/haiti-hurricane-matthew-situation-update-07-october-2016

[5] http://reliefweb.int/sites/reliefweb.int/files/resources/ECDM_20161003_TC_MATTHEW.pdf

[6] http://reliefweb.int/sites/reliefweb.int/files/resources/PAHOWDC_SituationReport10_Hurricane%20Matthew__09Oct2016.pdf

highest population, voluntary evacuations for mobile homes were in effect. In Nassau County mandatory evacuations were announced for October 6th for beaches and coastal areas. Voluntary evacuations of barrier islands started on October 5th, mandatory evacuations should follow the next morning[7].

Georgia

In Georgia residents east of Interstate 95 were under mandatory evacuation. These coastal areas belong to the following counties: Bryan, Chatham, Liberty, McIntosh, Glynn and Camden. Also west of Interstate 95 residents were encouraged to evacuate voluntarily if they lived on barrier islands or low lying, coastal areas[8].

North Carolina

On October 8th more than 1,000 people lived in 60 shelters in the center and eastern parts of the state[9].

South Carolina

On October 5th residents of Charleston and Beaufort County began to evacuate. Horry and Georgetown should have evacuated on October 6th[10]. On October 9th the evacuation orders have been lifted for all residents in Charleston, Dorchester, Berkeley and Colleton counties. The evacuation orders for Beaufort, Georgetown, Horry and Jasper remained as before[11].

In several parts of the affected areas in the U.S. such as South Carolina lane reversals were implemented to speed up evacuation processes. Moreover, in some parts tolls on roadways were suspended for the evacuation like e.g. in Florida.

Further detailed meteorlogical information in German:

http://www.wettergefahren-fruehwarnung.de/Ereignis/20161004_e.html

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[7] http://www.flgov.com/2016/10/05/gov-scott-issues-updates-on-hurricane-matthew-preparedness-efforts-as-storm-approaches-florida-3/

[8] http://dps.georgia.gov/press-releases/2016-10-06/hurricane-matthew-travel-advisory-0

[9] http://www.ncdps.gov/press-release/governor-mccrory-warns-severe-flooding-and-power-outages-hurricane-matthew-becomes

[10] http://www.thestate.com/news/politics-government/article106079937.html

[11] http://scemd.org/component/content/article/11-home-page/news/252-matthew-news-release-14