REPORT

Cape Canaveral & Merritt Island, Florida, USA

October 2019

Future Flood Risk:
John F. Kennedy Space Center & Cape Canaveral Air Force Station

CLIMATE CENTRAL

SUMMARY

Climate Central, a science research and communications organization, used its proprietary Portfolio Analysis Tool (PAT) to determine current and future flood risk for the John F. Kennedy Space Center and Cape Canaveral Air Force Station, including all five active launch complexes and one soon-to-be active launch complex located on Cape Canaveral and Merritt Island, Florida. Complexes 13, 37, 40, and 41 are part of the Cape Canaveral Air Force Station, while Complexes 39A and B belong to NASA's Kennedy Space Center. These complexes represent massive investments of time, labor, and capital and are part of our nation's history. Damage to any of these complexes could be not only costly, but result in setbacks for America's space program and commercial space operations. With many of these launch complexes situated only a few feet above sea level, coastal flooding already poses a significant risk to all five active launch sites. As the climate continues to warm and sea levels rise, the risk of flooding to these active launch sites rises dramatically.

Most at risk are Launch Complexes 39A and B, which were originally built for the Apollo/Saturn V rockets and later modified for the Space Shuttle Program. SpaceX obtained a 20-year lease for Complex 39A in 2014, and has launched over a dozen Falcon 9 missions from there. Complex 39B is currently undergoing modifications to allow it to support the launch of NASA's Space Launch System rocket for deep space missions. Complex 39A is estimated to face a 14% annual risk of flooding in 2020 and experience at least one flood event per year on average by 2060. Complex 39B is expected to experience a 6% annual chance of flooding in 2020 and experience annual flooding by 2070.

THIS REPORT DEFINES FLOOD RISK BY ANNUAL CHANCE OF OCCURRENCE, NOT FLOOD DEPTH:

OCCASIONAL
FLOOD RISK

At least 0.01 expected flood event per year. This is approximately a 1% annual chance of flood, which is the level commonly used to establish flood hazard zones. One can statistically expect a 26% chance of a 100-year flood over the course of a 30-year period.

FREQUENT
FLOOD RISK

At least 0.1 expected flood event per year. This is approximately a 10% annual chance of flood.

CHRONIC
FLOOD RISK

At least 1 expected flood event per year, or approximately a 99%+ annual chance of flood.

By 2100, parts of both rocket launch sites are expected to be close to chronic inundation, experiencing almost monthly flooding on average.

Cape Canaveral Air Force Station Space Launch Complexes 40 and 41 are also at substantial risk from future flooding. In 2020, both are estimated to face at least a 1% annual risk of flooding. Complex 40 is leased by SpaceX and is currently used to provide two-way logistics to and from the International Space Station. In 2040, the annual risk for Complex 40 surpasses 10%. Complex 41 is leased by the United Launch Alliance, and is a launch site for weather, telecommunications, and national security satellites, and scientific probes and orbiters. Complex 41 is expected to reach a 13% annual risk in 2070. By 2100, both launch complexes are expected to flood at least once a year on average.

While Space Launch Complexes 13 and 37 face less risk, they are still at significant risk of coastal flooding as sea levels rise. Complex 13 is leased by SpaceX and acts as the landing location for returning launch vehicle booster stages on the East Coast. Complex 37 is operated by the United Launch Alliance. By 2050, both launch complexes are estimated to experience at least a 1% annual risk of flooding and by 2100, that rises to at least a 10% annual risk.

These results do not reflect any potential for construction of coastal defenses (such as levees or sea walls).

This iconic and invaluable part of America's space infrastructure is coming under greater and greater threat from sea level rise and coastal flooding. Without adaptation measures, flooding driven by sea level rise will almost certainly inundate the space launch complexes of America's Space Coast during this century.

HOW TO READ THE NUMBERS IN THIS REPORT:

Climate Central's **Portfolio Analysis Tool (PAT)** utilizes a sea level rise model, local elevation data from the U.S. government, and local tide flood data from the U.S. National Oceanic and Atmospheric Administration (NOAA) to compute the statistical probability of a flood event at a given location, or the Expected Annual Event ("EAE"). If the projected water level at the nearby shoreline is higher than the land elevation of a location, we count this as a flood event at the location. Not all such events will cause flooding at the location, but each event poses a risk. Also, we do not include precipitation in our analysis, but coastal high water impedes runoff and increases the risk of freshwater flooding inland.

For each point analyzed on the map, the latitude and longitude of the point were determined and the EAE for those coordinates was calculated. For example, in the table on page 7, the EAE count of 1.226 suggests Pin 10 may experience between 1 and 2 floods in year 2100. A cell shaded in **yellow** indicates "occasional risk" of floods. For example, Pin 10 is at occasional risk of annual floods in 2020. A cell shaded in **orange** indicates "frequent risk" of regular floods. A **red-shaded** cell indicates "chronic risk" of frequent floods.

This report presents statistical expectations, not forecasts or predictions, and should be used for scoping and general planning purposes only. Climate Central accepts no responsibility for any damage to property, death or bodily injury, or other loss arising in any way from the use of this report for any purpose.

SITES CONSIDERED

ELEVATION DATA

The table below provides the coordinates of the points with the minimum and maximum elevation within each launch complex, and what that elevation is relative to both the North American Vertical Datum 1988 (NAVD88) and Mean Higher High Water (MHHW; the high tide line) for the five active launch complexes of Cape Canaveral Air Force Station and NASA's Kennedy Space Center.

LAUNCH COMPLEX		LATITUDE	LONGITUDE	ELEVATION RELATIVE TO NAVD88, FEET	ELEVATION RELATIVE TO MHHW (HIGH TIDE LINE), FEET
39A	**Minimum**	28.601319	-80.60488571	2.3	3.0
	Maximum	28.60892186	-80.60488571	41.3	42.0
39B	**Minimum**	28.621637	-80.62144957	2.81	2.04
	Maximum	28.629551	-80.61759414	12.02	11.25
41	**Minimum**	28.58434343	-80.58465586	4.1	4.8
	Maximum	28.58344357	-80.58309957	21.3	20.5
40	**Minimum**	28.5626964	-80.579347	2.6	3.3
	Maximum	28.5626964	-80.577269	21.2	21.9
37	**Minimum**	28.52910143	-80.56639614	2.0	1.2
	Maximum	28.53145029	-80.56404071	23.6	22.8
13	**Minimum**	28.484598	-80.542641	3.1	2.2
	Maximum	28.48523871	-80.544421	11.5	10.6

LAUNCH COMPLEX 39A

Our analysis of Launch Complex 39A estimates that parts of the launch pad will experience frequent flooding by 2020 and chronic flooding by 2060. For a comprehensive assessment of the launch complex, we mapped a grid of points ~400 ft. apart, allowing us to determine which parts of the launch complex are expected to flood and how often (the spacing of the points for each complex was based on its area).

Using this method, we find that a quarter of points sampled are expected to experience at least occasional flooding by 2020, jumping to over a half by 2060, and to almost all sampled points by 2100. The risk of frequent flooding could threaten 12% of sampled points by 2060, and by 2100 over half of sampled points could be threatened by frequent flooding. Finally, chronic flooding is expected at a quarter of the sampled points by 2100.

Launch Complex 39 is currently leased to SpaceX and has been a launch site for Falcon 9 and Falcon Heavy Rockets (NASA, 2019).

Pin	EAE_2020	EAE_2030	EAE_2040	EAE_2050	EAE_2060	EAE_2070	EAE_2080	EAE_2090	EAE_2100
16	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
6	0	0	0.001	0.001	0.001	0.001	0.001	0.002	0.005
11	0.001	0.001	0.001	0.001	0.002	0.002	0.003	0.008	0.019
24	0.001	0.001	0.001	0.002	0.002	0.002	0.004	0.013	0.024
32	0.001	0.001	0.002	0.002	0.002	0.003	0.005	0.014	0.026
17	0.002	0.002	0.002	0.002	0.003	0.003	0.007	0.018	0.033
20	0.002	0.002	0.002	0.003	0.003	0.004	0.01	0.023	0.045
12	0.002	0.003	0.003	0.004	0.004	0.006	0.015	0.031	0.062
14	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
15	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
21	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
22	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
29	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
35	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
36	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
39	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
23	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.041	0.094
34	0.003	0.004	0.004	0.005	0.007	0.011	0.025	0.049	0.116
13	0.004	0.005	0.006	0.007	0.009	0.015	0.034	0.073	0.175
26	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
31	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
37	0.005	0.005	0.006	0.008	0.01	0.018	0.039	0.086	0.206
30	0.005	0.006	0.007	0.008	0.011	0.021	0.044	0.1	0.242
5	0.006	0.007	0.008	0.01	0.014	0.028	0.056	0.138	0.338
40	0.006	0.007	0.008	0.011	0.014	0.028	0.057	0.141	0.345
33	0.006	0.008	0.009	0.011	0.016	0.032	0.063	0.158	0.388
18	0.007	0.009	0.01	0.013	0.019	0.038	0.077	0.197	0.483
19	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
8	0.009	0.01	0.012	0.016	0.024	0.048	0.103	0.271	0.66
27	0.01	0.012	0.014	0.019	0.028	0.058	0.129	0.345	0.834
10	0.012	0.014	0.018	0.024	0.039	0.079	0.191	0.518	1.226
4	0.012	0.015	0.019	0.025	0.04	0.082	0.201	0.547	1.291
7	0.013	0.016	0.02	0.027	0.044	0.091	0.226	0.616	1.444
28	0.013	0.016	0.021	0.028	0.046	0.094	0.235	0.643	1.503
9	0.016	0.02	0.026	0.035	0.062	0.13	0.347	0.939	2.071
38	0.023	0.029	0.038	0.056	0.107	0.246	0.683	1.787	3.425
1	0.025	0.031	0.041	0.06	0.116	0.272	0.755	1.962	3.683
2	0.026	0.033	0.044	0.065	0.126	0.301	0.839	2.127	3.885
3	0.03	0.038	0.052	0.079	0.159	0.398	1.117	2.674	4.555
41	0.136	0.203	0.347	0.762	2.079	4.68	7.514	9.437	10.265

LAUNCH COMPLEX 39B

Image credit: BatchGeo

Our analysis of Launch Complex 39B estimates that parts of the launch pad will experience frequent flooding by 2040 and chronic flooding by 2070. For a comprehensive assessment of the launch complex, we mapped a grid of points ~400 ft. apart, allowing us to determine which parts of the launch complex are expected to flood and how often (the spacing of the points for each complex was based on its area).

Using this method, we find that a quarter of points sampled are expected to experience at least occasional flooding by 2020, jumping to over a half by 2050, and to almost all sampled points by 2100. The risk of frequent flooding could threaten a tenth of sampled points by 2060, and by 2100 over three -quarters of sampled points could be threatened by frequent flooding. Finally, chronic flooding is expected at a quarter of the sampled points by 2100.

Launch Complex 39 is currently undergoing construction to prepare it to support the launch of NASA's Space Launch System (SLS) rocket for missions to the Moon and Mars (NASA, 2018).

Pin	EAE_2020	EAE_2030	EAE_2040	EAE_2050	EAE_2060	EAE_2070	EAE_2080	EAE_2090	EAE_2100
6	0	0	0.001	0.001	0.001	0.001	0.001	0.002	0.005
11	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.011
24	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.005	0.013
32	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.006	0.016
38	0.001	0.001	0.001	0.002	0.002	0.002	0.004	0.012	0.023
25	0.001	0.001	0.002	0.002	0.002	0.002	0.005	0.014	0.025
31	0.002	0.002	0.002	0.002	0.003	0.003	0.007	0.018	0.032
42	0.002	0.002	0.003	0.003	0.004	0.005	0.012	0.027	0.053
16	0.002	0.002	0.003	0.003	0.004	0.005	0.013	0.028	0.055
15	0.003	0.003	0.004	0.004	0.005	0.008	0.019	0.037	0.08
47	0.004	0.005	0.006	0.007	0.009	0.016	0.035	0.076	0.181
13	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
14	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
22	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
29	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
30	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
33	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
34	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
36	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
37	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
39	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
17	0.005	0.006	0.007	0.008	0.011	0.019	0.041	0.093	0.224
21	0.007	0.008	0.009	0.012	0.016	0.033	0.065	0.163	0.4
20	0.007	0.008	0.01	0.012	0.017	0.034	0.068	0.174	0.426
23	0.007	0.009	0.01	0.013	0.019	0.038	0.079	0.202	0.495
44	0.007	0.009	0.01	0.013	0.019	0.038	0.079	0.203	0.495
28	0.008	0.009	0.011	0.014	0.02	0.04	0.082	0.213	0.52
7	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
8	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
9	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
10	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
19	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
26	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
27	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
18	0.009	0.011	0.014	0.018	0.027	0.055	0.123	0.329	0.796
5	0.011	0.013	0.016	0.021	0.034	0.069	0.16	0.431	1.035
41	0.012	0.015	0.019	0.025	0.04	0.082	0.2	0.543	1.282
3	0.014	0.017	0.021	0.029	0.048	0.098	0.248	0.677	1.579
40	0.014	0.017	0.022	0.03	0.051	0.105	0.269	0.734	1.687
12	0.015	0.018	0.022	0.031	0.052	0.107	0.277	0.754	1.724
43	0.016	0.019	0.025	0.034	0.06	0.125	0.331	0.899	1.995
4	0.021	0.026	0.034	0.049	0.092	0.207	0.57	1.506	3.001
1	0.026	0.033	0.044	0.066	0.129	0.312	0.87	2.187	3.959
46	0.027	0.034	0.045	0.068	0.133	0.323	0.901	2.248	4.033
45	0.029	0.037	0.05	0.076	0.152	0.38	1.065	2.572	4.43
2	0.031	0.04	0.054	0.083	0.167	0.424	1.189	2.816	4.728
35	0.064	0.087	0.13	0.238	0.579	1.625	3.772	6.313	8.037

LAUNCH COMPLEX 41

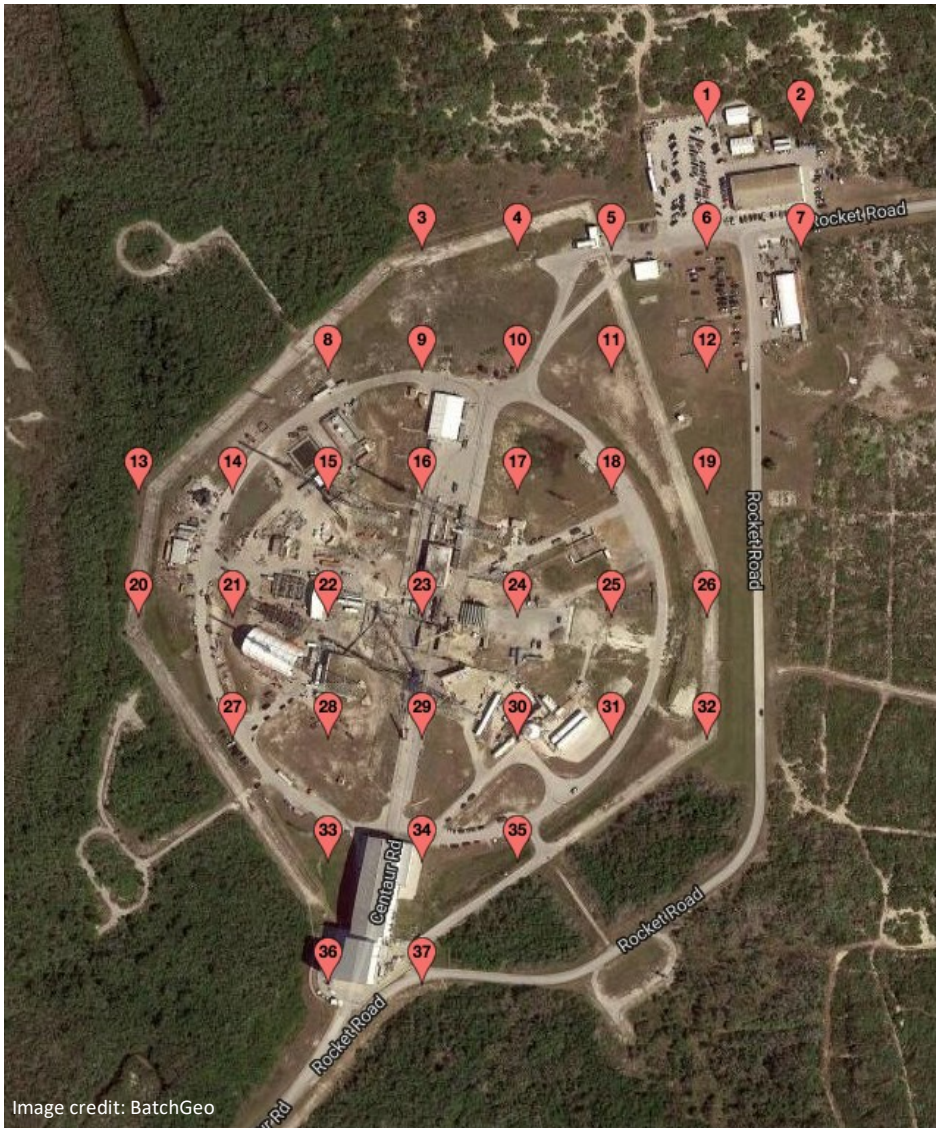
Our analysis of Launch Complex 41 estimates that parts of the launch pad will experience occasional flooding by 2020 and frequent flooding by 2070. For a comprehensive assessment of the launch complex, we mapped a grid of points ~200 ft. apart, allowing us to determine which parts of the launch complex are expected to flood and how often.

Using this method, we find that 10% of the sampled points are expected to experience at least occasional flooding by 2040, jumping to nearly a third by 2080, and to almost all points by 2100. The risk of frequent flooding could threaten one sampled location within the complex by 2070 and a sixth of points by 2100. Finally, chronic flooding is expected at one point by 2100.

Launch Complex 39 is the launch site for the Atlas V rockets (Air Force Space and Missile Museum).

Pin	EAE_2020	EAE_2030	EAE_2040	EAE_2050	EAE_2060	EAE_2070	EAE_2080	EAE_2090	EAE_2100
19	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0.002
4	0	0	0	0.001	0.001	0.001	0.001	0.002	0.005
9	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.008
3	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.011
14	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.011
5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.012
1	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.005	0.014
2	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.007	0.017
31	0.001	0.001	0.001	0.001	0.002	0.002	0.003	0.008	0.018
10	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.019
15	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.019
16	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.019
20	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.019
21	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.019
26	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.019
27	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.019
13	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.01	0.02
22	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.011	0.022
28	0.001	0.001	0.001	0.002	0.002	0.002	0.004	0.013	0.023
18	0.002	0.002	0.002	0.003	0.003	0.004	0.009	0.022	0.042
24	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
6	0.002	0.003	0.003	0.003	0.004	0.006	0.014	0.03	0.059
12	0.003	0.003	0.003	0.004	0.005	0.008	0.018	0.035	0.077
8	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
7	0.004	0.004	0.005	0.006	0.007	0.012	0.028	0.057	0.135
17	0.004	0.004	0.005	0.006	0.008	0.014	0.03	0.063	0.151
23	0.007	0.008	0.01	0.012	0.018	0.036	0.071	0.182	0.446
29	0.008	0.01	0.012	0.016	0.023	0.046	0.098	0.257	0.628
11	0.016	0.02	0.025	0.035	0.061	0.127	0.336	0.91	2.016

LAUNCH COMPLEX 40



Our analysis of Launch Complex 40 estimates that parts of the launch pad will experience occasional flooding by 2020 and frequent flooding by 2040. For a comprehensive assessment of the launch complex, we mapped a grid of points ~200 ft. apart, allowing us to determine which parts of the launch complex are expected to flood and how often.

Using this method, we find that over a quarter of sampled points are expected to experience at least occasional flooding by 2060, jumping to over half by 2080 and to almost all sampled points by 2100. The risk of frequent flooding could threaten two points by 2040 and a quarter of sampled points by 2100. Finally, chronic flooding is expected at two points by 2100.

Launch Complex 40 is currently leased to SpaceX and has been the launch site for several Falcon 9 rockets (Air Force Space and Missile Museum; SpaceX).

Pin	EAE_2020	EAE_2030	EAE_2040	EAE_2050	EAE_2060	EAE_2070	EAE_2080	EAE_2090	EAE_2100
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0
5	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.008
6	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.01
19	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.01
1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.011
7	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.011
12	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.011
2	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.019
34	0.001	0.001	0.001	0.002	0.002	0.002	0.004	0.013	0.024
15	0.001	0.001	0.002	0.002	0.002	0.003	0.005	0.015	0.027
36	0.002	0.002	0.002	0.003	0.003	0.004	0.009	0.022	0.041
22	0.002	0.002	0.002	0.003	0.003	0.004	0.01	0.023	0.044
21	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
28	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
33	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
8	0.002	0.002	0.003	0.003	0.004	0.005	0.01	0.024	0.047
26	0.002	0.002	0.003	0.003	0.004	0.005	0.012	0.026	0.051
14	0.002	0.003	0.003	0.003	0.004	0.006	0.014	0.029	0.058
27	0.003	0.003	0.003	0.004	0.005	0.007	0.017	0.033	0.069
11	0.003	0.003	0.003	0.004	0.005	0.007	0.017	0.033	0.07
32	0.003	0.003	0.004	0.004	0.005	0.008	0.019	0.036	0.079
30	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.041	0.094
37	0.003	0.003	0.004	0.005	0.006	0.009	0.022	0.042	0.097
17	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
18	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
24	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
25	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
31	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
35	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
4	0.006	0.007	0.008	0.01	0.014	0.028	0.057	0.138	0.339
3	0.008	0.009	0.011	0.014	0.02	0.041	0.084	0.217	0.53
20	0.066	0.091	0.137	0.252	0.619	1.738	3.981	6.547	8.229
13	0.068	0.094	0.141	0.261	0.644	1.809	4.113	6.694	8.35

LAUNCH COMPLEX 37

Our analysis of Launch Complex 37 estimates that parts of the launch pad will experience occasional flooding by 2040 and frequent flooding by 2090. For a comprehensive assessment of the launch complex, we mapped a grid of points ~400 ft. apart, allowing us to determine which parts of the launch complex are expected to flood and how often.

Using this method, we find that over half of the sampled points are expected to experience at least occasional flooding by 2060, jumping to almost three-quarters by 2080. The risk of frequent flooding could threaten over half of sampled points by 2100.

Launch Complex 37 has been the launch site for several Delta IV rockets (Air Force Space and Missile Museum).

Pin	EAE_2020	EAE_2030	EAE_2040	EAE_2050	EAE_2060	EAE_2070	EAE_2080	EAE_2090	EAE_2100
6	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0.001	0.002
3	0	0	0	0	0	0.001	0.001	0.001	0.003
14	0	0	0	0	0	0.001	0.001	0.001	0.003
15	0	0	0	0	0	0	0.001	0.001	0.003
21	0	0	0	0	0	0.001	0.001	0.001	0.003
7	0	0	0	0.001	0.001	0.001	0.001	0.002	0.004
16	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.005	0.015
17	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
10	0.002	0.003	0.003	0.004	0.004	0.006	0.015	0.031	0.064
19	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
20	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
26	0.003	0.003	0.004	0.005	0.006	0.009	0.021	0.04	0.091
1	0.004	0.004	0.005	0.006	0.008	0.013	0.028	0.058	0.138
29	0.004	0.005	0.006	0.007	0.009	0.016	0.036	0.077	0.184
4	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
5	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
8	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
18	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
24	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
28	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
31	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
32	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
33	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
30	0.005	0.006	0.007	0.008	0.011	0.02	0.043	0.097	0.234
23	0.005	0.006	0.007	0.008	0.011	0.02	0.043	0.098	0.235
9	0.006	0.007	0.008	0.01	0.013	0.025	0.052	0.124	0.304
12	0.006	0.007	0.008	0.01	0.014	0.027	0.055	0.133	0.324
25	0.006	0.007	0.009	0.011	0.015	0.029	0.058	0.143	0.349
2	0.007	0.008	0.009	0.012	0.016	0.033	0.066	0.168	0.411
11	0.008	0.009	0.011	0.014	0.02	0.04	0.083	0.215	0.527

LAUNCH COMPLEX 13

Image credit: BatchGeo

Our analysis of Launch Complex 13 estimates that parts of the launch pad will experience occasional flooding by 2050 and frequent flooding by 2090. For a comprehensive assessment of the launch complex, we mapped a grid of points ~200 ft. apart, allowing us to determine which parts of the launch complex are expected to flood and how often.

Using this method, we find that about half of the sampled points are expected to experience at least occasional flooding by 2060, jumping to about three-quarters by 2080, and all sample points by 2100. The risk of frequent flooding could threaten over half of sample points by 2100.

Launch Complex 13 is currently leased to SpaceX and is a landing site for Falcon 9 rockets (Air Force Space and Missile Museum; ULA).

Pin	EAE_2020	EAE_2030	EAE_2040	EAE_2050	EAE_2060	EAE_2070	EAE_2080	EAE_2090	EAE_2100
9	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.005	0.014
19	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.005	0.014
2	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.007	0.017
13	0.001	0.001	0.001	0.001	0.002	0.002	0.004	0.009	0.02
12	0.001	0.001	0.001	0.002	0.002	0.002	0.005	0.014	0.025
10	0.002	0.002	0.002	0.003	0.003	0.004	0.008	0.021	0.04
3	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
4	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
5	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
6	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
20	0.002	0.002	0.002	0.003	0.003	0.005	0.01	0.024	0.046
11	0.002	0.003	0.003	0.004	0.004	0.006	0.015	0.031	0.064
18	0.004	0.004	0.005	0.006	0.007	0.012	0.028	0.057	0.134
7	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
8	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
14	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
15	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
16	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
21	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
22	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
24	0.005	0.005	0.006	0.008	0.01	0.017	0.038	0.084	0.199
17	0.005	0.006	0.007	0.009	0.012	0.022	0.047	0.109	0.265
23	0.006	0.007	0.008	0.01	0.014	0.026	0.054	0.13	0.319
1	0.006	0.007	0.009	0.011	0.016	0.031	0.062	0.156	0.381

METHODOLOGY

Accelerating sea level rise has increased routine flood events in communities around the country. Quantified flood risk allows individuals, businesses, and communities located along coastlines to plan for sea level rise and increased flooding risk from climate change.

Climate Central's proprietary **Portfolio Analysis Tool (PAT)** estimates future coastal flood risks to residential properties, commercial sites, ports, and infrastructure, computing the statistically expected number of flood events each decadal year, 2020, 2030, ... through 2100.

Our analysis combines sea level rise science with local flood history data to estimate the number of statistically-expected future coastal flood events at specific locations. Flood risk information from FEMA does not currently include future expected sea level rise.

The Portfolio Analysis Tool defines a flood event as the occurrence of flood water height exceeding the elevation of the ground at a specific location (defined by latitude and longitude coordinates). Flood water height is statistically derived from local flood history combined with projected sea level rise. Ground elevation is determined from a NOAA database of LiDAR elevation data. Elevation of structures above the ground are not known or evaluated.

Local flood history comes from the nearest NOAA tide station with at least 30 years' history of hourly water level data. Tide stations that have not experienced a hurricane in their recorded history may not adequately represent the risk of a future hurricane.

Projected sea level rise is derived from a sea level rise model. Inputs to the model include an assumption that carbon emissions continue unchecked in the so-called business-as-usual scenario.

Our Portfolio Analysis Tool estimates the expected annual number of flood events (EAE) each year and reports the results in decadal increments starting in 2020 through 2100. Our analysis is based on the statistically expected number of future flood events during the course of a year.

Image credit: NASA

ABOUT CLIMATE CENTRAL

Climate Central is an independent organization of leading scientists and journalists researching and reporting the facts about our changing climate and its impact on the public. Climate Central surveys and conducts scientific research on climate change and informs the public of key findings. Our scientists publish and our journalists report on climate science, energy, sea level rise, wildfires, drought, and related topics. Climate Central is not an advocacy organization. We do not lobby, and we do not support any specific legislation, policy or bill. Climate Central is a qualified 501(c)3 tax-exempt organization.

Climate Central's Program on Sea Level Rise strives to provide accurate, clear, and granular information about sea level rise and coastal flood hazards both locally and globally, today and tomorrow. Anchored in rigorous primary research, our work distinguishes itself by its user-friendly maps and tools, extensive datasets, and high-quality visual presentation. The program dedicates its efforts to helping citizens, communities, businesses, organizations, and governments at every level to understand the consequences of different carbon pathways and to navigate the shifting waters of our warming world.

You can search or navigate our interactive tools to see maps of areas below different amounts of sea level rise and flooding, down to neighborhood scale, matched with area timelines of risk. Our tool also provides statistics of population, homes, and land affected by city, county, and state, plus links to fact-sheets, data downloads, action plans, embeddable widgets, and more.

If you are interested in a customized report using Climate Central's proprietary Portfolio Analysis Tool (PAT), contact us at portfolio@climatecentral.org.