Supplementary Material (SM)

Flood Hazard Mapping and Assessment of Precipitation Monitoring System Using GIS-Based Morphometric Analysis and TRMM Data: A Case Study of the Wadi Qena Watershed, Egypt

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SM 1 The station names with latitude, longitude and altitude. The serial number (No.) of stations are given in Figure 1

No.	Station name	Latitude (N°)	Longitude (E°)	Altitude (m)
1	Alexandria	31.18 N	29.94 E	7 m
2	Mersa Matruh	31.33 N	27.22 E	30 m
3	Cairo	30.04 N	31.24 E	48 m
4	El-Arish	31.08 N	33.82 E	31 m
5	Assiut	27.05 N	31.02 E	226 m
6	Hurghada	27.15 N	33.72 E	14 m
7	Luxor	26.67 N	32.70 E	88 m
8	El Tor	28.23 N	33.62 E	14 m
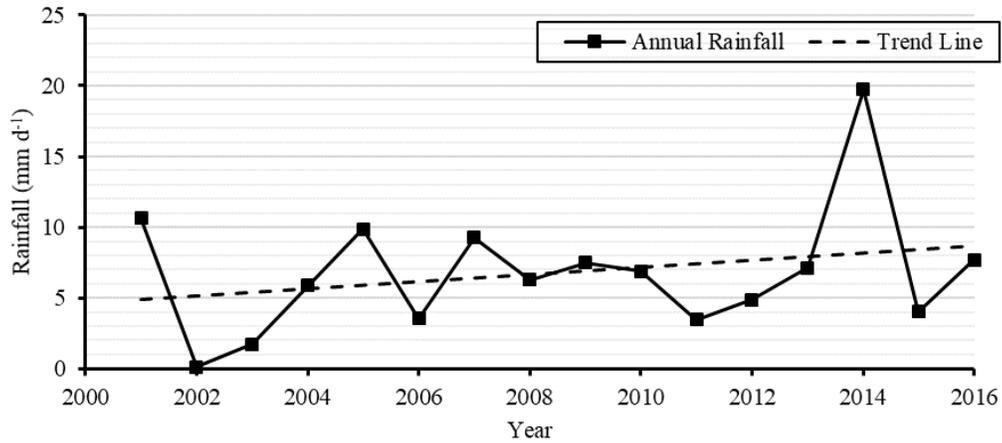
SM 2 The annual time series of rainfall obtained from the corrected TRMM over the study area between 2001 and 2016.
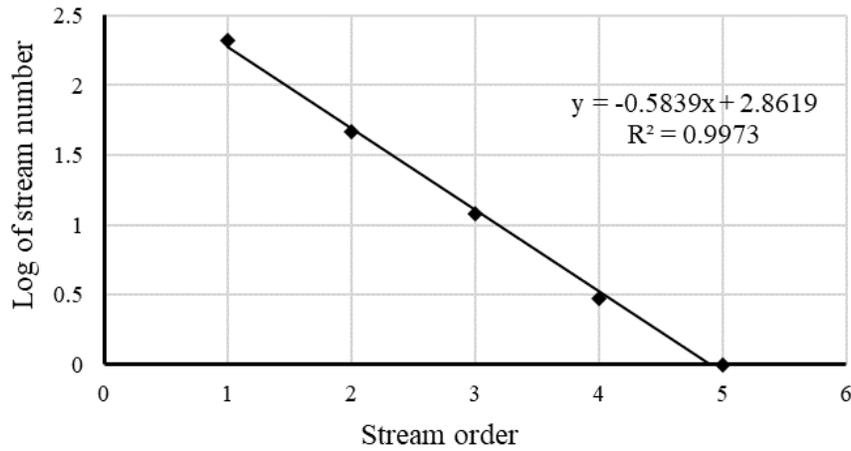
SM 3 Relation between logarithm of stream numbers and stream order.
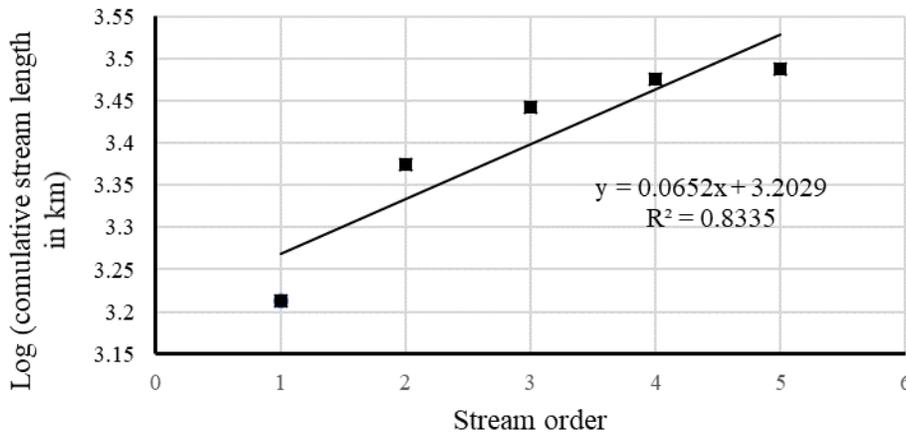
SM 4 Relation between logarithm of cumulative stream length and stream order.

SM 5 Flood Hazard assessment using the ranking method based on the morphometric parameters

| ID	Hazard degree for each parameter										Sum	Hazard degree
	A	Re	Rt	Ish	Rr	Rn	Sm	Cc	F	D		
1	3.236	3.656	4.706	3.221	1.112	1.150	1.717	3.776	1.810	1.063	25.447	3.030
2	1.564	4.052	5.000	3.699	1.118	1.080	1.299	4.423	2.886	1.009	26.131	3.192
3	3.269	3.303	4.033	2.827	1.096	1.049	1.701	3.849	1.552	1.031	23.710	2.620
4	1.159	2.271	3.512	1.848	1.083	2.701	1.230	3.292	4.192	3.303	24.593	2.829
5	1.182	2.643	1.583	2.171	1.037	2.539	1.484	3.709	1.711	2.250	20.308	1.816
6	1.443	2.458	2.166	2.006	1.051	1.983	1.917	2.672	2.065	1.633	19.393	1.600
7	1.573	2.974	2.920	2.487	1.069	1.718	1.688	3.843	1.994	1.531	21.799	2.169
8	1.135	3.550	1.934	3.099	1.046	2.143	1.316	4.208	2.022	2.463	22.915	2.432
9	1.560	2.886	1.971	2.400	1.047	2.554	2.335	3.711	1.450	1.525	21.438	2.083
10	1.092	2.135	1.742	1.739	1.041	1.477	1.247	3.251	2.461	2.886	19.072	1.524
11	1.103	3.431	2.022	2.966	1.048	2.464	1.346	4.090	2.325	2.728	23.524	2.576
12	1.829	4.612	4.199	4.441	1.099	1.622	1.722	4.391	2.126	1.465	27.506	3.517
13	1.064	2.657	2.191	2.183	1.052	3.458	1.715	3.958	2.887	3.251	24.415	2.787
14	1.239	2.336	1.374	1.902	1.033	2.244	1.511	3.440	1.454	2.061	18.594	1.411
15	1.067	3.015	2.507	2.527	1.059	3.384	1.829	4.537	2.830	3.137	25.892	3.135
16	1.159	2.679	1.671	2.204	1.040	2.473	1.748	3.773	1.849	2.293	20.888	1.953
17	1.026	1.833	2.054	1.511	1.049	4.024	1.813	2.963	3.816	3.947	24.035	2.697
18	1.036	2.607	2.540	2.138	1.060	3.892	1.994	4.150	3.534	3.828	26.780	3.345
19	1.172	2.341	1.509	1.907	1.036	2.434	1.511	3.384	1.769	2.359	19.420	1.607
20	1.069	2.046	1.619	1.670	1.038	2.312	1.323	2.463	2.802	3.283	19.625	1.655
21	1.011	3.521	3.133	3.066	1.074	4.714	2.176	4.514	4.445	4.511	32.166	4.618
22	1.096	1.951	1.662	1.597	1.039	2.842	1.388	3.056	2.407	2.757	19.796	1.695
23	1.060	1.000	1.352	1.000	1.032	2.805	1.225	1.000	2.963	3.507	16.943	1.021
24	2.217	2.341	2.522	1.907	1.060	1.793	2.045	2.841	1.576	1.299	19.601	1.649
25	1.087	1.672	1.519	1.399	1.036	3.018	1.715	2.381	2.528	2.884	19.239	1.564
26	1.047	3.980	2.856	3.609	1.068	3.646	1.995	4.750	3.242	3.455	29.647	4.023
27	1.513	1.588	1.851	1.344	1.044	2.324	1.650	2.057	1.856	1.633	16.860	1.002
28	1.059	1.653	1.709	1.386	1.040	3.264	1.529	2.600	2.988	3.268	20.497	1.861
29	1.068	1.578	1.616	1.337	1.038	2.584	1.331	2.435	2.817	3.296	19.099	1.531
30	1.166	2.203	1.407	1.793	1.033	2.191	1.626	2.946	1.805	2.365	18.537	1.398
31	1.000	3.532	3.349	3.079	1.079	5.000	2.205	4.541	5.000	5.000	33.784	5.000
32	1.159	2.763	1.717	2.282	1.041	2.242	1.398	3.902	1.845	2.243	20.591	1.883
33	1.194	2.493	2.590	2.036	1.061	1.802	1.250	3.142	3.004	2.179	20.753	1.921
34	1.347	4.143	3.583	3.814	1.085	1.438	1.160	4.537	2.467	1.736	25.309	2.998
35	1.240	3.148	1.528	2.662	1.036	2.001	1.948	3.958	1.451	1.958	20.930	1.963
36	3.037	3.945	3.811	3.566	1.090	1.460	3.669	3.652	1.603	1.000	26.833	3.358
37	3.017	2.377	2.493	1.937	1.059	2.060	2.674	2.526	1.350	1.170	20.663	1.900
38	1.196	3.097	2.102	2.610	1.050	1.563	1.877	3.437	2.313	1.883	21.128	2.010
39	1.442	2.030	1.000	1.657	1.024	1.802	2.782	2.804	1.000	1.654	17.194	1.081

SM 5 Flood Hazard assessment using the ranking method based on the morphometric parameters (*continued*)

| ID	Hazard degree for each parameter										Sum	Hazard degree
	A	**Re**	**Rt**	**Ish**	**Rr**	**Rn**	**Sm**	**Cc**	**F**	**D**		
40	1.185	2.472	1.593	2.018	1.038	1.703	1.091	3.762	1.696	2.255	18.813	1.463
41	1.011	1.841	2.422	1.517	1.057	4.769	2.675	3.431	4.438	4.563	27.725	3.569
42	2.281	3.375	3.648	2.905	1.086	1.714	5.000	3.833	1.788	1.067	26.697	3.326
43	1.034	3.424	2.396	2.958	1.057	1.098	1.045	3.878	3.574	2.072	22.536	2.343
44	1.079	2.410	2.042	1.965	1.048	3.202	2.554	3.844	2.645	3.053	23.842	2.651
45	1.001	2.561	2.951	2.097	1.070	4.906	2.349	4.082	4.931	4.976	30.924	4.324
46	1.043	3.971	2.409	3.598	1.057	1.299	1.000	4.056	3.328	3.605	25.367	3.011
47	1.569	2.838	3.005	2.353	1.071	1.557	1.877	3.953	2.006	1.236	21.464	2.089
48	1.218	3.865	3.308	3.469	1.078	1.586	1.164	4.396	2.784	2.033	24.902	2.902
49	1.025	4.761	3.173	4.652	1.075	2.094	1.926	4.804	3.861	2.200	29.572	4.005
50	1.355	2.593	2.836	2.126	1.067	1.818	1.672	3.622	2.426	1.465	20.980	1.975
51	3.683	3.282	2.530	2.804	1.060	1.541	3.309	3.684	1.027	1.016	23.936	2.673
52	5.000	2.498	3.590	2.041	1.085	1.238	2.368	2.900	1.334	1.124	23.178	2.494
53	1.336	3.964	3.091	3.590	1.073	1.435	1.914	4.715	2.077	1.376	24.571	2.823
54	1.111	2.645	1.691	2.172	1.040	2.048	2.560	3.337	2.246	1.941	20.791	1.930
55	1.002	4.141	3.639	3.812	1.086	3.474	2.228	4.856	4.908	3.297	32.443	4.683
56	1.122	3.426	1.931	2.961	1.046	1.940	1.981	4.081	2.136	1.871	22.496	2.333
57	1.769	3.618	4.312	3.177	1.102	1.312	2.264	4.368	2.257	1.263	25.442	3.029
58	3.103	3.210	3.105	2.728	1.074	1.150	1.748	3.745	1.308	1.024	22.195	2.262
59	1.390	4.804	1.686	4.713	1.040	1.344	1.994	5.000	1.079	1.272	24.322	2.765
60	1.076	1.606	1.610	1.356	1.038	2.603	1.873	2.568	2.678	2.182	18.590	1.411
61	1.095	2.388	1.803	1.946	1.043	2.161	1.513	3.464	2.425	2.037	19.875	1.714
62	2.597	2.895	2.451	2.409	1.058	1.189	2.149	2.290	1.505	1.015	19.559	1.639
63	1.213	3.747	3.511	3.327	1.083	1.363	1.669	4.581	2.832	1.278	24.604	2.831
64	1.155	3.163	3.409	2.679	1.081	1.880	2.163	4.070	3.463	1.824	24.886	2.898
65	1.377	3.342	1.845	2.869	1.044	1.591	1.981	3.901	1.509	1.504	20.962	1.971
66	1.182	5.000	1.984	5.000	1.047	1.000	1.596	4.650	1.712	1.178	24.349	2.771
67	1.180	2.130	1.495	1.734	1.035	1.268	1.119	3.413	1.719	1.758	16.853	1.000
68	2.783	3.279	3.542	2.801	1.084	1.146	2.638	3.990	1.483	1.091	23.838	2.650
69	3.228	4.176	3.840	3.857	1.091	1.302	2.336	3.596	1.574	1.071	26.071	3.178
70	1.505	2.506	2.591	2.048	1.061	1.575	1.837	3.838	1.877	1.348	20.188	1.788

Note: A: Area; Re: elongation ratio; Rt: texture ratio; Ish: basin shape index; Rr: relief ratio; Rn: ruggedness number; Sm: mean basin slope; Cc: compactness coefficient; F: Stream Frequency; D: drainage density.
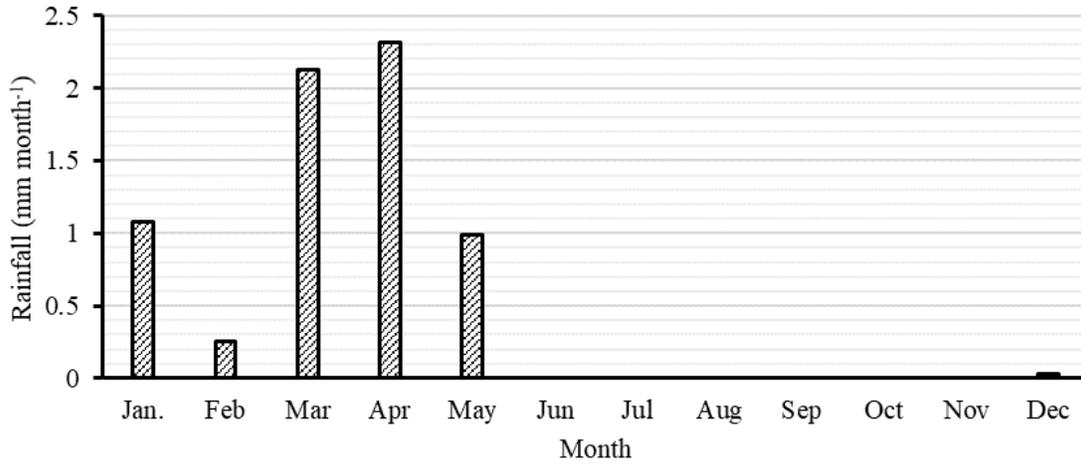
SM 6 Average monthly rainfall over the study area from 2001 to 2016.
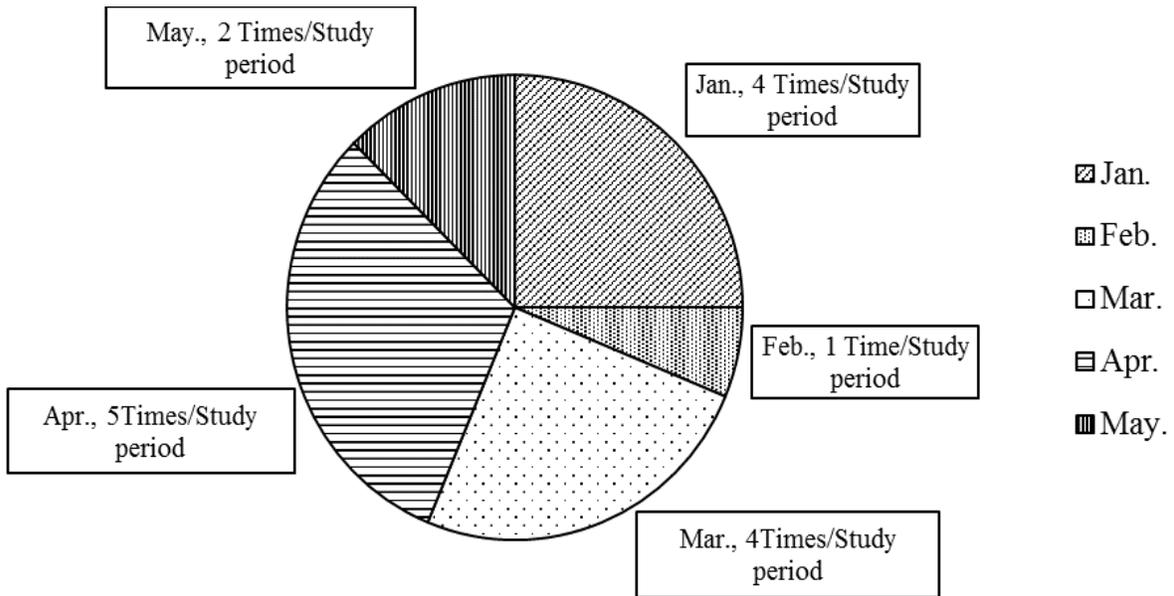
SM 7 Frequency of the rainiest months per year over the study area from 2001 to 2016.
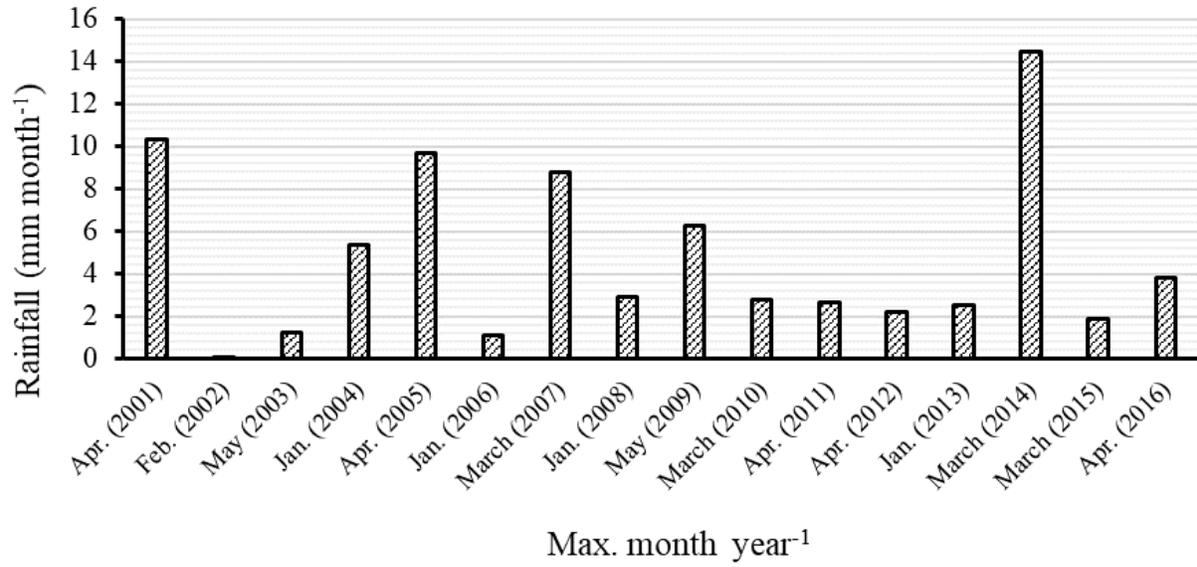
SM 8 Maximum monthly rainfall per year over the study area obtained from the corrected TRMM.