Climatic assessment of Watersheds Vulnerability to Flood Risks Along North Western Coast of Egypt

Using Remote Sensing and GIS Techniques

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Abstract

Egypt is characterized by its arid and hyper arid climate; flash floods directly affect human life and ecosystem balance through soil erosion and sediment exchange between different watersheds. The present study provides an integrated approach using remote sensing and Geographic Information Systems, multiple thematic layers, and field investigations to mitigate the flash flood hazard along the west Mediterranean coast area, Egypt, where devastating flash flood hazards and shortage in water supply are critical problems against the development of the region.

Disastrous flash floods are much more frequent in some parts of the Mediterranean region this is due to the local climate, which is prone to short intense bursts of rainfall. The reliefs surrounding the Mediterranean Sea force the convergence of low-level atmospheric flows and the uplift of warm wet air masses that drift from the Mediterranean Sea to the coasts, thereby creating active convection. In addition, population growth is particularly high along the Mediterranean coasts, leading to a rapid increase in urban settlements and populations exposed to flooding.

Total rainfall amounts as well as land use; soil and bedrock types and the initial soil moisture content influence the responses of watersheds to heavy rainfall events and especially their runoff rates: the estimated proportion of the incident rainfall contributing to the observed stream discharges. The runoff rates during flash floods are often limited to 10% to 30%. In some rare cases, when large cumulated rainfall amounts lead to saturation of the watersheds, runoff rates may reach 100%. The observed variability of flood frequencies and discharge magnitudes is therefore the result of complex interplay between the characteristics of the generating rainfall events (spatial extent, duration, maximum intensities) and the factors that control the response of the watersheds, especially rainfall rates.

Keywords: Flood, Rain, Northwest Coast

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1. Introduction:

Egypt is characterized by its arid condition. Intense stream networks distinguish the desert geomorphology, which is subjected to harsh climatic conditions, and extreme water scarcity. However, different stream networks, especially along the seacoasts and the Red Sea Mountains, are subjected to extreme precipitation events in the form of flash floods, where a considerable amount of rainfall occurs, suddenly, for a short duration, and with a relatively long time period. Flood management has mainly two objectives: (1) Benefit of the available floodwater during water scarce period, and (2) Flood attenuation to minimize the damage occurred by flash floods. A methodology for flood predictions, risk assessment, and vulnerability estimation is extremely important. In the last few years, attention has been devoted to the Northwestern coast due to the large urbanization activities in it. The government spares no effort to develop it. Many comprehensive planning studies have been conducted. Many luxurious tourist spots have been built. So, flood management and analysis of this area had become a must.

2. Study Area

The North Western coast is characterized by the presence of some streams networks, which is subjected to harsh climatic conditions, and extreme water scarcity. Temperatures range between an average minimum of 13° C in winter and an average maximum of 30° C in summer. Rainfalls receive along the coast, but even the wettest area, around Alexandria, receives only about 200 millimeters of precipitation per year. Alexandria has relatively high humidity, but sea breezes help keep the moisture down to a comfortable level, moving westward, the amount of precipitation decreases. Some areas will go years without rain and then experience sudden downpours that result in flash floods. Fourteen metrological stations are used in this study, six of them are on the main streams and the rest are in the main surrounding cities (Sallum, Sidi Barrani, Marsa Matruh, Ras EL Hikma, El Dabaa, and Siwa).

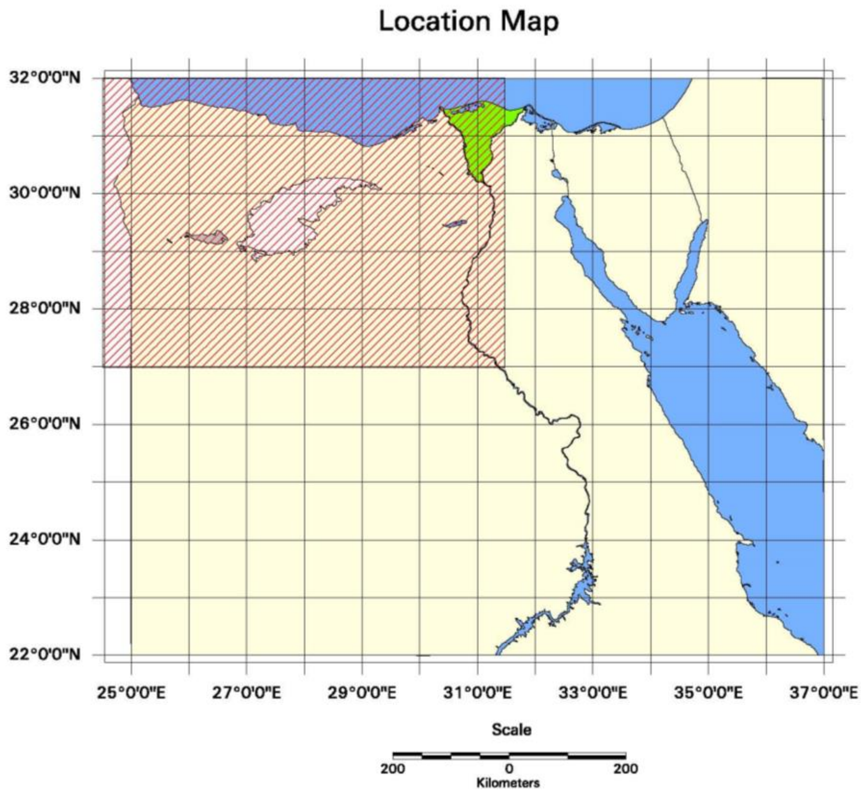

Fig.(1) Location Map of the study area.

From the topographical maps scale 1:50000 and the , the streams and basins were digitized, and used as a guide for the streams and basins calculated from the Digital Elevation Model DEM, with cell size 75 meter. The North Western coast basins are categorized in three main areas due to its geographic locations. Figure (1) shows the location map of the study area.

3. Methodology

The different streams networks and basins in the North Western Coast are studied here to compute its morphological and hydrological parameters as to assess their risk degree and classify their relative vulnerability. The flood risk assessment methodology comprises ranking the studied watershed according to its flood risk based on the previously computed morphological and hydrological parameters using the Watershed Modeling System (WMS 7) software.

1- The base map used in this work was a mosaic produced from 20 scenes of TM data acquired in 2016 of the path and rows as follows (176/40, 176/41,177/38,177/39, 177/40,177/41, 178/39,178/40, 178/41, 179/38, 179/39,179/40,179/41,180/38,180/39,180/40,180/41,181/38,181/39,181 /40). Fig. (2)
2- Another working sheets were prepared by using SRTM data (Shuttle Radar Topographic Map) acquired in 2016 of ground resolution 30 meter to produce the digital Elevation Model that used to prepare (The Slope Map, The Aspect Map, and the Shade Relief Map)
3- New vector coverage has been created above the Satellite Image to delineate the drainage network and the basins catchments area.
4- The Shade Relief Map used to verify the delineation of the drainage network from the Satellite Image (TM mosaic)
5- The meteorological data of the period 1912-2016 were used for the rate and the maximum events of the rain precipitation for the 37 stations. Table (1,2)
6- And also the rate of evaporation per day has been used table (3)

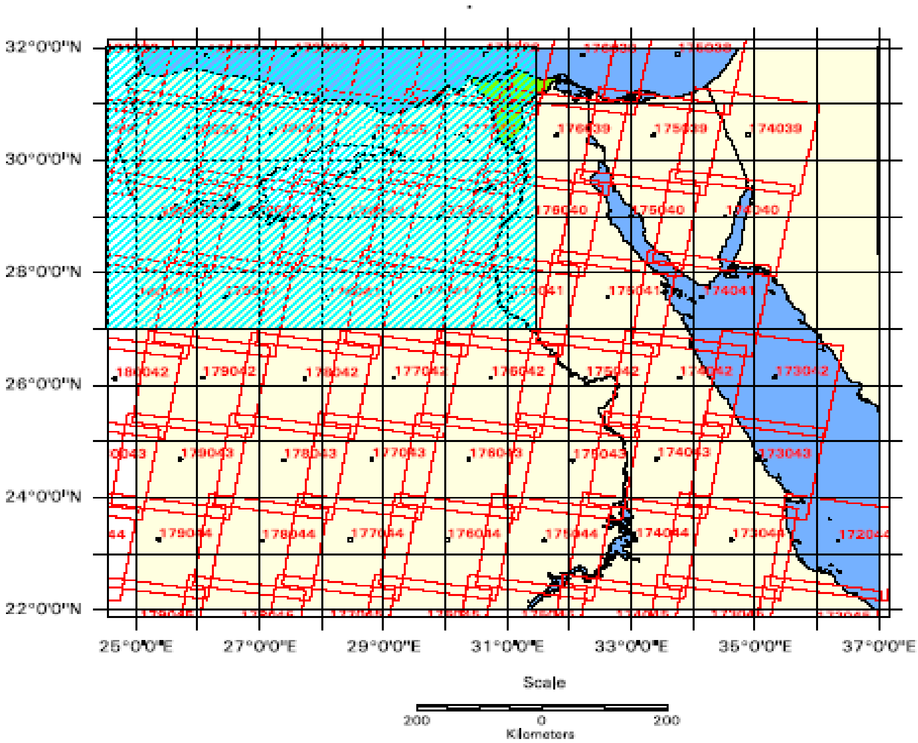

Fig.(2) Location Map of TM Scenes Covering the study area.

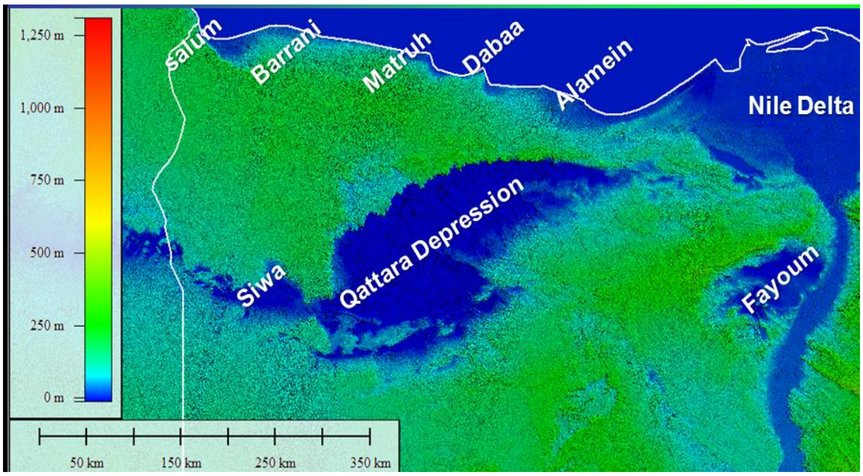

Fig.(3) A Digital Elevation Model Mosaiced from SRTM Data.

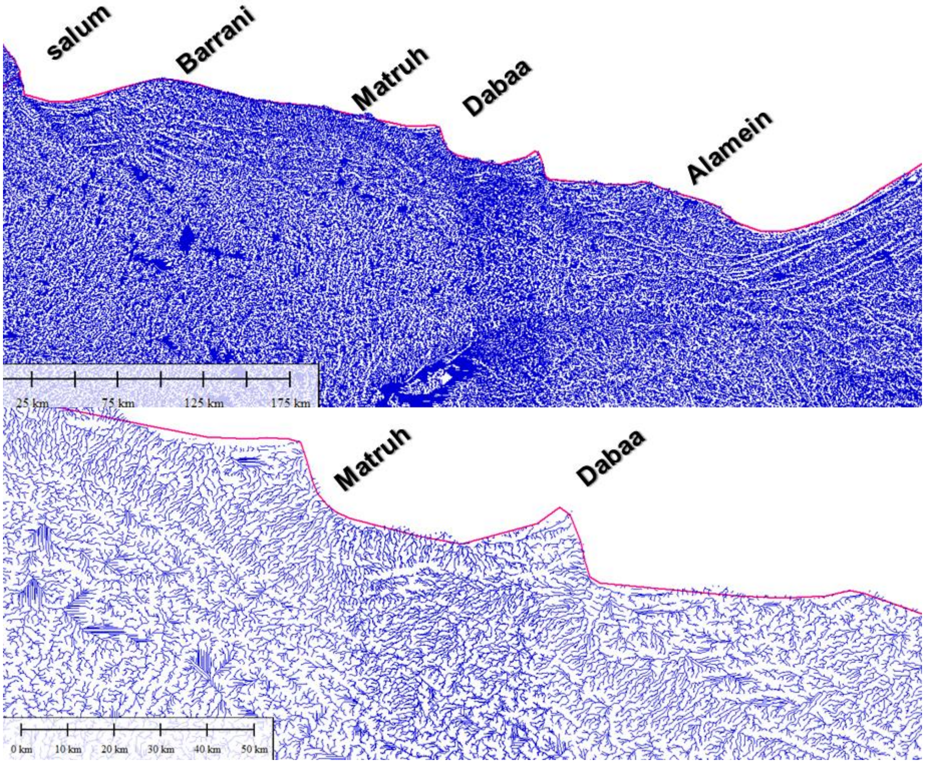

Fig.(4a) Drainage network in the Study Area

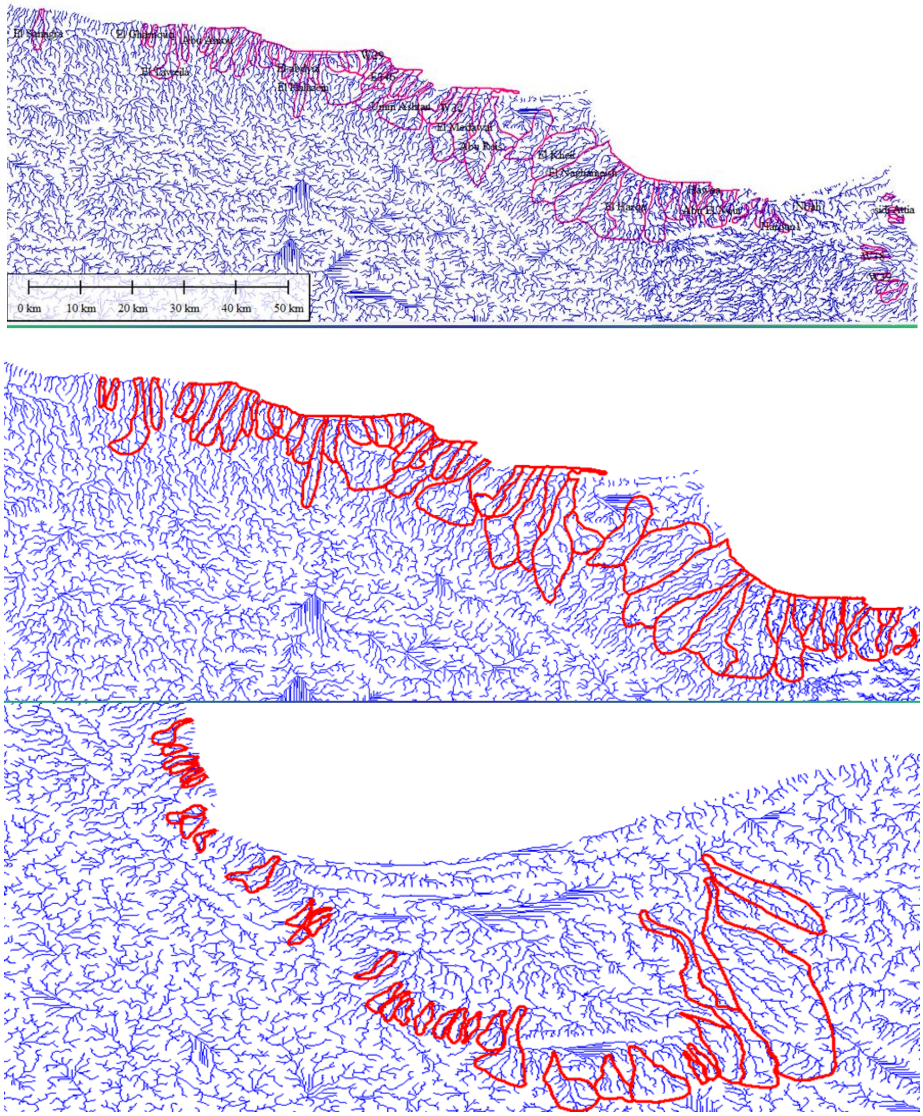

Fig.(4b) Drainage network and basin catchment area

Table (1) shows the Total Rain Fall precipitated over the study area

Total Rain Fall In one Month													
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total /year
Cairo	5.2	3.5	2.4	1.1	0.6	0.1	0	0	0	1	3.4	6.6	23.9
Almaza	4.5	3.9	3.3	1	1.4	0	0	0	0	0.5	3.5	6.7	24.8
Abbasiya	6.8	2.6	2.3	1.3	1.9	0	0	0	0	0.3	3.8	4.1	23.1
Helwan	3.7	3.6	2.1	1	2.6	0	0	0	0	1.1	3.2	6	23.3
Giza	3.5	3.5	2.4	0.9	1.3	0	0	0	0	2.5	3.2	4.9	22.2
Fayoum	1	1.4	1.2	0.6	1	0	0	0	0	0.7	0.9	4	10.8
Katamiya	5.6	3.1	3.9	2	0.2	0	0	0	0	0	1.1	4.4	20.3
Sallum	21	9.6	8.8	3.7	3.5	0.3	0	0	1.5	16	23.9	17.2	105
Sidi Barrani	46	14.6	15.6	6.7	3.4	0.1	0	0	0.8	22	22.2	40	171.4
Matruh	33	15.1	12	2.8	2.6	2	0	0.6	1.1	16	22.5	30.2	137.7
R El Hikma	43	9.8	11.7	5.7	0.9	0.1	0	0	3.4	15	20.8	37	147.1
El Dabaa	34	13.8	11	1.5	1.9	0	0	0	1.1	14	25	38	140.4
Dekheila	59	23.2	11.8	3	1.1	0	0	0	1.4	12	24.7	48.7	184.9
R El Teen	60	15.7	10	5	0.8	0	0	0	0.1	9.2	29.8	49.5	179.2
Alexandria	55	26.6	12.9	4.2	1.5	0	0	0.3	1	9.3	33.1	55.6	199.4
Rosetta	56	28.9	11.7	5.8	2.5	0	0	0.2	0.6	11	26.6	50	190.8
Balteam	47	18.8	18.6	7.3	1.8	0	0	0	1.3	12	22.8	46.6	175.2
Cairo West	4.3	3.5	2.8	1	0.4	0	0	0	0	2.1	5.7	3.8	23.6
El Sirw	15	12.4	6.9	2.8	2.4	0	0	0.5	0.3	3.7	7.4	15.5	66.6
Sakha	17	12.2	6	5	3	0	0	1.8	0	4	7	13.6	69.6
Shubrakhit	69	9.9	11.8	11	0	0	0	0	0	7.4	12.2	23.8	145.1
Tanta	17	4.2	8	5.7	0.4	0.1	0	0	0	4.3	5.4	12	56.9
Sh. El Kom	9.1	5.6	3.9	2.1	2.3	0.1	0	0	0.1	2	5.5	7.4	38.1
Quesna	7.5	1.1	4.5	5.6	0.3	0.1	0	0.6	0	1	8.2	4	32.9
Banha	4.4	3.3	2.9	1.4	1.3	0.1	0	0	0	1.4	3.5	5	23.3
Bahtim	7.3	2.4	3.4	3.5	6.5	0	0	0	0	0.1	5.3	3.2	31.7
Siwa	1.1	2.1	0.3	1.1	1.2	0	0	0	0.1	0.4	1.1	2.1	9.5
Bahariya	0.2	1.1	0.1	0.4	0.2	0.1	0	0	0	0.2	0.4	0.9	3.6
Farafra	0.6	0.2	0.1	0.4	0	0.1	0	0	0	0.5	0.8	0.1	2.8
Dakhla	0.1	0.2	0	0.1	0.1	0	0	0	0	0	0	0	0.5
Kharja	0	0.3	0	0	0.2	0	0	0	0	0	0.1	0.2	0.8
Dmietta	26	17.2	10.7	3.7	1.9	0.1	0	0	0.5	7.1	15.4	24.6	106.7
Port Said	14	11.7	8.8	3.7	2.2	0	0	0	0.2	6.3	8.9	18	73.3
Damanhour	25	14.9	8.1	2.2	2.5	0	0	0.6	0.2	5.1	8.6	22.3	89.6
Ganakleas	20	0.6	4	3.6	0.4	0	0	0	0	5.4	12.5	19.3	56.8
El Tahrir	9.5	4.5	3.5	2	2.6	0	0	0	0.2	1.4	5.9	7.3	36.9
W. Natroun	6.7	3.9	3.5	1.9	1.1	0	0	0	0.3	0.6	13	10.4	41.4
Mansoura	10	7.5	6.8	3.2	4.1	0.6	0	0	0.1	4.1	6.1	10.2	53.1

Table (2) shows the Maximum Rain Fall precipitated over the study area

Maximum Rain Fall In one Day													
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Maximum
Cairo	9.6	10.4	10	4.6	6	3.6	0	0	0.1	13.8	18.5	50	50
Almaza	8.7	10.7	10.9	5.4	9.7	0	0	0.1	0.2	4	30	44	44
Abbasiya	12.8	7	5.4	5.4	13	0	0	0	0	4	20.5	13.7	20.5
Helwan	12.2	16.2	11.9	10.4	27.5	0	0	0	0	21.7	23.8	32.7	32.7
Giza	7.8	18.3	15.6	9.3	21.2	0.1	0	0.1	0	53.2	27.4	21.5	53.2
Fayoum	5	6.5	11.8	13	20.8	0	0	0	0	9	16	44	44
Katamiya	8	5.3	9.8	4	1.5	0	0	0	0	0	5	10	10
Sallum	38.4	44.4	30	27	17.1	7.4	0	0	12.4	58.8	120.8	37.2	120.8
Sidi Barrani	70.2	21	37	32.2	19.6	2.7	0	3.5	9.4	53.9	97.6	33.6	97.6
Matruh	35.1	26.2	12.2	8	20.1	47.2	0	15	9	55.5	75.5	53.5	75.5
R El Hikma	52.9	31.2	21.7	19	3.9	1.2	0	0	19.8	45.4	52.5	72.4	72.4
El Dabaa	49	34.7	32	7.6	23.3	0.3	0	0	26.2	36.3	41	30.2	49
Dekheila	43.3	41.4	14.7	12	17.9	0	0	0	21.6	38.2	42.8	63.3	63.3
R El Teen	42.8	17	22.4	10.5	6.7	0.4	0	0	1.4	55.2	55.4	50.4	55.4
Alexandria	47.9	28	21.1	13	8.8	0.3	0	8.8	22.6	39	64.6	54.3	64.6
Rosetta	56	26	20.2	23	13	0.7	0	7	11.6	49	36	47	56
Balteam	44.1	19.6	19	17.4	5.7	0.2	0	0	7.9	50.5	40.9	41.5	50.5
Cairo West	11.2	15.2	15.3	4.4	2.9	0	0	0	0.4	23.3	43.7	7.9	43.7
El Sirw	30	18.8	23.7	10	29.5	0.5	0	13.9	9.5	16	41	28.5	41
Sakha	27.3	33	17	16.8	26.4	0	0	40	2.5	39.8	22	29	40
Shubrakhit	76	9	11	12.4	2.5	0	0	0	0.6	23.4	12	28.4	76
Tanta	25.4	5.5	7.6	9.9	3	0.8	0	0	0	24.9	27.3	12.2	27.3
Sh. El Kom	13.2	16	8.8	8.2	28	1.7	0	0	1.2	19.7	44	13.6	44
Quesna	14.1	2.2	6.2	14.4	1.2	0.7	0	4.4	0	4.1	26	8	26
Banha	17.5	12	9.6	9.5	21.6	3	0	0	0	14	27.3	27.5	27.5
Bahtim	6.9	6.4	8.6	9.9	43.3	0	0	0	0	0.8	23.5	9.7	43.3
Siwa	12	21	1.8	13.6	23	0	0	1.9	2.4	7	25.4	11.7	25.4
Bahariya	2.4	14	2.7	16	5.7	6.4	0	0	1.3	6	14	13	16
Farafra	7.7	3.2	2.7	4.7	0.3	2.6	0	0	0	1.6	15.2	2.2	15.2
Dakhla	5	8	1.1	4.9	3.4	0	0	0	0	1	0	1	8
Kharja	2	5	0	1.5	3.7	0.4	0	0	0	0.8	2	7.5	7.5
Dmietta	37	20.5	20	18.7	15.8	5.8	0	0	18	35	55	30.9	55
Port Said	15	15.3	14.8	22.8	19.5	0	0	0	5.4	39.6	18	47.7	47.7
Damanhour	30.3	25.1	16.9	8.3	34.2	0.2	0	20.4	3.9	39.2	25.8	21.6	39.2
Ganakleas	24.4	3	4.6	5.4	1.8	0	0	0	0	21.5	39	24.8	39
El Tahrir	21.4	14	16.7	4.9	24.9	0	0	0	2.6	7.1	18.3	16	18.3
W. Natroun	18	24	14	27	8	0	0	0	7	10	70	33	70
Mansoura	20.3	20.5	27	24.3	35.3	25	0	0	4	48	45	22	48

Table (3) shows the Monthly Rate of Evaporation the study area

Evaporation Per Day													
Station	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual rate**
Cairo	7.5	9.1	11.6	14.4	16.4	17	13.9	12.8	12.3	11.2	8.2	7.4	11.82
Almaza	5.6	7	8.7	10.4	12.5	12.8	10.8	9.6	8.9	8.3	6.3	5.4	8.86
Abbasiya	4.7	5.8	7.6	9.5	11	11	9.1	8.1	8	7.3	4.9	4.6	7.63
Helwan	6	7.6	10.2	13	15.6	16.2	14	13.4	12.3	10.9	7.5	6.2	11.08
Giza	3.6	4.6	6.1	7.9	10.1	10.5	9.1	7.6	6.7	5.8	4.1	3.4	6.63
Fayoum	3.2	4.4	6	8.4	9	10	11	9.6	8.2	6.7	4.4	3.2	7.01
Katamiya	6.4	9.1	12.2	15.8	17.4	18.1	16.4	14.4	13.7	11.5	7.8	6.4	12.43
Sallum	7.1	6.7	8.2	8.7	8.2	9.7	9.1	9.1	8.2	8.5	7.1	7.3	8.16
Sidi Barrani	5.9	7	7.5	7.5	6.3	6.9	6.4	6.5	7.1	6.9	6.4	6.3	6.73
Matruh	6.9	7.3	8.2	8.2	7.9	8.4	8.4	8.6	8.8	7.8	6.6	6.8	7.83
R El Hikma	6.5	6.9	6.5	6.5	5.3	6.1	6.1	6.8	6.9	6.8	6.2	6.7	6.44
El Dabaa	5.2	6	6.8	7.2	6.8	7.6	7.9	7.5	7.6	6.9	5.8	5.3	6.72
Dekheila	5.5	6.2	7.2	7.3	6.8	7	7.4	7.7	8.1	7.2	6.6	6.1	6.93
R El Teen	5.2	5.3	5.8	5.7	5	5.1	5.1	5.5	6.2	6	5.6	5.6	5.51
Alexandria	4.1	4.6	5.6	5.6	5.8	5.8	5.6	5.6	5.9	5.8	4.4	3.8	5.22
Rosetta	3.3	3.7	4.1	4.4	4.6	4.8	4.8	4.8	4.8	4.6	3.8	3.3	4.25
Balteam	3.3	3.9	4.8	5.2	5.2	5.6	5.4	5.2	5	4.5	3.9	3.5	4.63
Cairo West	6.9	8	10.5	12.9	14.1	15.1	13	12.2	11.3	9.5	6.8	6.6	10.58
El Sirw	2.8	3.2	4.1	4.9	5.5	5.8	5.3	5	4.5	4	3.1	2.5	4.23
Sakha	2.2	2.7	3.5	4.9	6.3	6.6	5.8	5	4.6	3.8	2.9	2.2	4.21
Shubrakhit	3.7	4.4	5.5	7	8.1	8.3	8.2	6.4	6.2	5.3	4.1	3.6	5.90
Tanta	3.2	4.5	6.2	8.2	10.3	11.1	8.2	7.2	7.2	6.8	4.6	3.7	6.77
Sh. El Kom	2.7	3.4	4.3	5.8	7.1	7.5	6.2	5.3	5	4.5	3.2	2.7	4.81
Quesna	3.5	5.4	6.6	9.2	11.7	12.2	9.3	8.1	8.4	7.5	4.9	3.9	7.60
Banha	3	3.8	4.9	6.4	7.9	8.4	7.5	5.3	5.1	4.5	3.4	2.9	5.20
Bahtim	3.9	5.5	6.7	8.6	11.3	12.8	8.7	6.6	7.9	7.3	4.8	4.2	7.40
Siwa	5.5	7.1	9.7	12.5	14.4	15.8	15.6	14.3	11.7	9	6.4	5.4	10.62
Bahariya	5.3	6.7	8.8	11.1	13.3	14	13.1	12.2	10.3	8.2	6.1	5.1	9.52
Farafra	7	9.4	13.2	16.4	20	22.9	20.7	19.7	17.1	13.7	9	6.5	14.63
Dakhla	7.7	9.8	13.7	18	22.2	24.8	23.2	22.3	20.2	16.1	10.6	7.7	16.36
Kharja	7.8	9.8	13.5	18.3	22.4	24.7	22.8	21.5	20	16.1	11.1	7.9	16.33
Dmietta	2.8	3.3	4.1	4.6	5.1	5.4	4.9	4.6	4.4	4.2	3.5	2.8	4.14
Port Said	4.5	5.5	6.2	6.2	6.5	7.1	7.1	7	7.2	7	6	4.6	6.24
Damanhour	2.5	3.2	4.2	5.5	6.7	6.8	5.8	5.3	4.9	4.2	3.1	2.6	4.57
Ganakleas	3.9	5.6	7	8.5	8.9	8.9	8.1	7.6	6.9	6.2	4.4	4.4	6.70
El Tahrir	4.2	5.4	6.9	8.7	9.9	10.3	8.6	7.8	7.3	6.1	4.2	4.3	6.98
W. Natroun	5.3	6.8	8.7	10.9	12.7	14	13.2	12.1	10.5	8.6	6.3	5.2	9.53
Mansoura	2	2.6	3.4	4.2	5.3	5.5	4.7	4.1	3.8	3.6	2.6	2.1	3.66

Table (4): Morphometric analysis of the basins in the study area

Basin No.	Area	Perimeter	Max. Elevation	Min. Elevation	Elevation Mean	Elevation Range	Max. Length	Max. Width	Shape F.
2	591665280	111457.62	347	101	197.81	247	30024.77	29310.551	1.0243673
3	388389888	93392.211	308	16	158.71	293	32934.141	14568.81	2.2605925
4	85003008	41471.465	274	136	214.20	139	15975.46	6093.71	2.6216311
5	85526128	40051.121	281	152	226.81	130	13543.14	8175.1401	1.6566
6	245057408	72542.031	348	160	249.55	189	28337.869	12655.41	2.2391901
7	193475616	82970.242	242	17	138.17	226	36692.32	7827.71	4.6874909
8	664292288	120529.29	343	191	269.44	153	35358.969	36725.43	0.9627925
9	191692832	67143.68	273	-17	83.03	291	25481.631	13404.36	1.9009956
10	287145408	74396.359	349	-21	139.56	371	20090.01	23368.119	0.8597187
11	84029384	46869.32	157	10	74.59	148	11028.51	12214	0.90294
12	128425248	58076.348	345	-57	106.63	403	21758.6	8132.8101	2.6754098
13	59956876	46943.52	176	12	62.89	165	16576.23	6566.1299	2.5245054
14	90406912	50661.473	338	256	291.55	83	20477.59	5851.9399	3.4992824
15	207053040	61394.785	343	-50	139.29	394	21667.51	16793.881	1.2902026
16	88323584	46150.301	334	256	286.59	79	19312.1	6405.7798	3.0147929
17	116527776	48479.129	343	253	288.96	91	15969.05	12997.62	1.2286134
18	126655984	69472.984	338	236	295.52	103	25274.449	5423.8198	4.6598983
19	68315752	35911.246	287	232	260.96	56	13984.6	7024.5698	1.9908123
20	61005864	37144.598	346	276	313.29	71	10861.94	10366.39	1.0478036
21	11808629	15097.719	69	24	48.39	46	5353.5098	3027.99	1.7680078
22	112636232	42917.68	29	-53	0.99	83	16498.311	9191.0898	1.7950331
23	10707473	14425.063	48	21	35.21	28	5748.9399	3305.95	1.7389677
24	14243159	17712.482	48	20	33.58	29	7573.54	2142.52	3.5348749
25	203998144	90076.719	24	-45	2.08	70	26398.59	9071.0703	2.9101956
26	57367688	50083.156	343	147	288.26	197	14021.97	11675.72	1.2009512
27	174768752	68581.859	70	-9	19.96	80	24205.311	9605.6602	2.5199008
28	75386248	36150.336	316	258	277.93	59	13663.38	8967.46	1.5236622
29	260831248	93438.266	221	10	113.71	212	35245.148	12519.82	2.8151481
30	480459072	124765.63	264	132	197.06	133	48646.941	16011.05	3.0383356
31	68062424	42351.273	233	26	102.74	208	16521.311	7333.9399	2.2527196
32	36949364	32816.578	239	27	95.44	213	13642.65	3330.4399	4.0963507
33	72975904	44914.953	228	27	97.85	202	17231.98	8565.7695	2.0117259
34	166711344	61638.785	225	146	173.18	80	17204.84	18940.551	0.9083601
35	30719642	30113.232	215	30	88.22	186	12341.41	5284.3799	2.3354509
36	30963148	35001.734	183	32	75.98	152	15107.82	2888.4299	5.2304611
37	172597504	57305.844	215	134	169.21	82	23012.061	10915.53	2.1081944
38	19506160	22078.443	90	31	57.38	60	9704.3701	2759.72	3.516433
39	14092833	20916.998	85	30	58.41	56	9017.7998	1913.34	4.7131195
40	20751548	21381.125	210	156	177.32	55	9149.6699	3539.95	2.5846891
41	165780016	52711.879	210	133	165.69	78	20422.82	11914.96	1.7140486
42	11041964	14838.437	84	40	63.11	45	15257.04	3469.1201	4.3979568
43	12042367	17616.594	86	41	64.74	46	7349.6699	2557.5601	2.8737037
44	7814902	17174.146	75	36	57.64	40	7862.8999	1147.74	6.8507676
45	444453760	93891.711	186	101	140.17	86	29891.131	24765.33	1.2069749

46	214560272	67275.914	189	50	119.32	140	25942.74	13427.75	1.9320244
47	84708272	44986.867	166	50	110.20	117	17068.189	9827.79	1.7367271
48	33925188	31421.848	164	85	123.46	80	10486.06	3448.45	3.0408037
49	170777856	60235.039	164	111	135.82	54	20070.77	8860.7197	2.2651398
50	277413760	83653.305	319	190	255.19	130	34588.578	11981.37	2.8868632
51	261181856	63841.195	193	100	153.67	94	24567.061	14129.41	1.738718
52	388271136	115266.73	332	167	253.60	166	40931.52	12251.58	3.3409176
53	613757888	130462.94	269	148	199.30	122	35346.531	18189	1.9432917
54	434353120	92249.305	312	175	249.02	138	33728.648	20681.631	1.6308506

Follows Table (4)

Basin No.	Tot.Dr. No.	Order 1	Order 2	Order 3	Order 4	Order 5	Order 6	Frequency	Bi Furkation Ratio
2	243	184	41	10	5	2	1	0.4107052	2.6500
3	196	143	41	11	1	0	0	0.5046476	6.0717
4	46	30	9	4	2	1	0	0.5399935	2.0833
5	62	41	14	4	2	1	0	0.7264808	2.5000
6	147	103	34	7	2	1	0	0.5998594	3.4524
7	89	68	16	4	1	0	0	0.4600063	4.0833
8	528	375	113	28	9	2	1	0.7948309	3.4117
9	39	27	9	2	1	0	0	0.2034505	3.1667
10	46	31	12	2	1	0	0	0.1601976	3.5278
11	50	42	13	4	1	0	0	0.59503	3.4936
12	17	12	4	1	0	0	0	0.1323727	3.5000
13	20	15	4	1	0	0	0	0.3335731	3.2404
14	53	39	10	5	3	1	0	0.5862384	2.2222
15	40	28	9	2	1	0	0	0.1931872	3.2037
16	43	30	9	3	1	0	0	0.4868462	3.1111
17	120	88	23	6	2	1	0	1.0297974	2.9444
18	128	98	25	4	1	0	0	1.0106115	4.7233
19	40	3	0	0	0	0	0	0.5855165	3.0000
20	131	93	27	7	3	1	0	2.1473346	3.0635
21	24	17	4	2	1	0	0	2.0324121	2.7500
22	34	21	9	3	1	0	0	0.3018567	2.7778
23	34	26	5	2	1	0	0	3.1753523	3.2333
24	16	12	3	1	0	0	0	1.1233463	3.8750
25	41	32	8	1	0	0	0	0.2009822	3.8500
26	43	30	9	3	1	0	0	0.7495509	3.1111
27	45	35	9	1	0	0	0	0.2574831	3.1250
28	20	12	5	2	1	0	0	0.2653004	2.3000
29	17	13	3	1	0	0	0	0.0651762	3.6667
30	30	23	6	1	0	0	0	0.0624403	4.9167
31	22	16	5	1	0	0	0	0.3232327	4.1000
32	4	3	1	0	0	0	0	0.1082563	3.0000
33	17	12	4	1	0	0	0	0.2329536	3.5000
34	57	3	0	0	0	0	0	0.3512831	3.4167
35	11	7	3	1	0	0	0	0.3580771	2.6667

36	8	5	2	1	0	0	0	0.2583717	2.2500
37	57	42	11	3	1	0	0	0.3302481	3.4949
38	17	12	4	1	0	0	0	0.8923087	3.5000
39	4	3	1	0	0	0	0	0.2838322	3.0000
40	11	7	3	1	0	0	0	0.5300809	2.6667
41	52	3	0	0	0	0	0	0.3136687	3.2885
42	10	6	3	1	0	0	0	0.905636	2.5000
43	13	9	3	1	0	0	0	1.079522	3.0000
44	9	6	2	1	0	0	0	1.1516459	2.5000
45	133	100	25	7	1	0	0	0.2992437	4.8571
46	29	20	6	2	1	0	0	0.1350136	2.7778
47	42	28	7	4	2	1	0	0.497186	1.9167
48	18	11	4	2	1	0	0	0.5305792	2.2500
49	35	26	6	2	1	0	0	0.2049446	3.1111
50	48	33	11	3	1	0	0	0.1730267	3.2222
51	10	7	2	1	0	0	0	0.0382875	2.7500
52	37	29	7	1	0	0	0	0.0952942	5.5714
53	18	10	5	2	1	0	0	0.0293275	2.1667
54	121	85	25	8	2	1	0	0.2785752	3.0417

Follows Table (4)

Basin No.	To Dr. L.	Density	Slope	Risk of slop	Risk of K.	Risk of D.	Risk of Q	Risk of Shape	Total Risk
2	448295.25	0.7576839	0.0082	2	1	2	2	1	1.6
3	310963.81	0.8006486	0.0089	2	3	2	2	2	2.2
4	79870.586	0.9376	0.0087	2	1	2	2	2	1.8
5	60280.633	0.7063342	0.0096	2	1	2	3	1	1.8
6	172797.77	0.7051318	0.0067	2	2	2	2	2	2
7	182128.3	0.9413502	0.0062	2	3	2	2	3	2.4000001
8	686399.19	1.0332788	0.0043	2	2	3	3	1	2.2
9	129384.16	0.6749556	0.0114	3	2	2	1	1	1.8
10	196066.86	0.6828138	0.0185	3	3	2	1	1	2
11	75869.258	0.9028896	0.0134	3	2	2	2	1	2
12	67999.844	0.5294897	0.0185	3	3	1	1	2	2
13	37938.305	0.6327599	0.0100	2	2	2	2	2	2
14	69986.047	0.7741228	0.0041	2	1	2	2	2	1.8
15	150006.63	0.724484	0.0182	3	2	2	1	1	1.8
16	73893.063	0.8366176	0.0041	2	2	2	2	2	2
17	137514.22	1.1800982	0.0057	2	1	3	3	1	2
18	135743.34	1.0717484	0.0041	2	3	3	3	3	2.8
19	48963.641	0.7167255	0.0040	2	2	2	2	1	1.8
20	96257.313	1.5778371	0.0065	2	2	3	3	1	2.2
21	21221.881	1.7971503	0.0086	2	1	3	3	1	2
22	66093.602	0.5867881	0.0050	2	1	1	2	1	1.4
23	21859.078	2.0414786	0.0049	2	2	3	3	1	2.2
24	18430.09	1.2939608	0.0038	1	3	3	3	2	2.4000001
25	117277.31	0.574894	0.0027	1	3	1	1	2	1.6

26	56117.969	0.9782156	0.0140	3	2	2	3	1	2.2
27	91029.781	0.5208585	0.0033	1	2	1	1	2	1.4
28	40701.906	0.5399116	0.0043	2	1	1	1	1	1.2
29	80720.164	0.3094727	0.0060	2	3	1	1	2	1.8
30	168845.83	0.351426	0.0027	1	3	1	1	2	1.6
31	41250.02	0.6060616	0.0126	3	3	2	2	2	2.4000001
32	18306.049	0.4954361	0.0156	3	2	1	1	3	2
33	52207.215	0.7154035	0.0117	3	3	2	1	2	2.2
34	116450.52	0.7176684	0.0046	2	2	2	2	1	1.8
35	29647.816	0.9651094	0.0151	3	1	2	2	2	2
36	25078.275	0.8099394	0.0101	3	1	2	1	3	2
37	95934.406	0.5558273	0.0036	1	2	1	2	2	1.6
38	20759.24	1.0896264	0.0062	2	3	3	3	2	2.5999999
39	16505.646	1.1712085	0.0062	2	2	3	1	3	2.2
40	16218.163	0.7815399	0.0060	2	1	2	2	2	1.8
41	92848.609	0.5600712	0.0038	1	2	1	2	1	1.4
42	20752.982	1.8794647	0.0029	1	1	3	3	3	2.2
43	22851.789	1.897616	0.0063	2	2	3	3	2	2.4000001
44	12505.466	1.6002077	0.0051	2	1	3	3	3	2.4000001
45	251380.22	0.5655937	0.0029	1	3	1	1	1	1.4
46	72297.258	0.3365902	0.0054	2	1	1	1	1	1.2
47	69989.508	0.8285191	0.0069	2	1	2	2	1	1.6
48	29309.379	0.8639416	0.0076	2	1	2	2	2	1.8
49	93165.906	0.5455385	0.0027	1	2	1	1	2	1.4
50	130770.88	0.4713929	0.0038	1	2	1	1	2	1.4
51	60462.113	0.2314943	0.0038	1	1	1	1	1	1
52	174813.72	0.4502362	0.0041	2	3	1	1	2	1.8
53	138739.2	0.2260488	0.0035	1	1	1	1	1	1
54	291797.69	0.6717983	0.0041	2	2	2	1	1	1.6

Where is the basins assigned by its number, Area is the basin area in sq. Kilometer, perimeter is the outline perimeter of each basin, max. Elevation is the maximum elevation level of basin catchment area, Min. Elevation is the minimum elevation in the same basin catchment area, Elevation Mean is the mean of elevation of the same basin catchment area, and Elevation Range is the range of elevation in each basin catchment area, max. Length is the maximum length of the drainage segment that takes place from the up stream to the end of the wadi, Max. Width is the maximum width of basin catchment area; Slope Factor is the main slope over the basin area, Tot. Dr. No. is the summation of all the drainage segment length in each basin, order 1, 2, 3, 4, 5, 6 is the number of each order in each basin ordered according to Horton classification, Frequency is the ratio between the number of drainage segments in individual basin area, bifurcation ratio is the summation of the ratios between each two successive orders divided over the number of ratios, Tot. Dr. L is the summation of the drainage segment lengths in each basin, while the Density is the result of dividing the total drainage lengths in a basin over its area; the slope is the result of dividing the elevation difference over the maximum length of each basin.

4. Calculation Method:

The method of calculating the risk can be summarized in the following steps:

1. The slopes of basins were sorted in ascending order and the highest in slope is the highest in risk as it mean that the increasing of the slope will increase the velocity of water current.
2. The Bifurcation ratio is sorted in ascending order and the highest of bifurcation ratio is highest in risk.
3. The Density is sorted in ascending order and the highest of Density is highest in risk.
4. The Frequency ratio is sorted in ascending order and the highest of Frequency ratio is highest in risk.

5. The Shape factor is sorted in ascending order and the nearest number to the value of integer 1 is highest in risk, while the further fraction is lowest in risk. Where the shape factor is the result of dividing the maximum length of each basin over the maximum width of the same basin.

6. the total Risk is the mean of all the previous risks

At the end of that method we have to insist on the fact that the impact risk will not be calculated or happen if one of the following factors verified

1. Enough amount of water precipitation i.e. high rate of rain falls in short time span.
2. Presence of any strategic building or projects dissected by the wadis pass.
3. Presence of external and mature drainage network.

5. Interpretation and comment

The factors that control the risk were verified only in 7 sheets of the study area, from north to south are (Matruh, Sidi Barrani, As Sallum, Al Fayyum, Ghard Ar Rammak, Almenya and Al Wahat Al Bahariya. As the rate of rainfall precipitation increase in the north and decrease in the south.

In the same time, the rate of evaporation recorded high values in the south stations and low values in the northern stations so we will notice that the northern areas of flooding risks concentrated mainly along the northern part of the study area.

The last point has to be mentioned that some areas has delineated with the flood risk to be considered in future during planning and development.

The using of GIS techniques allows us to read and comment all the resulting maps

As we overlay the following layers

1- Roads layer

2- Urban layer

3- Shore line layer

4- Risk grade layer

5- Gazetteer of Egypt.

It will show the following facts

1- At Matruh sheets the degree of risks ranging from low to moderate risk degree at the same time there are many numbers of underground wells that can be charged by the amount of surface run off water by making some engineering works such as rock fill dams based on the layer of DEM. The underground water wells there such as (Az Zumlah, El Wahl , El Tayif, Abâr El Tauif, Bîr el Sioda, Bîr El •arâ¬na, Bi'r Sanøsy, Bîr Rahil, Bîr Omar Mahammad, , Bi'r Mayyår, Bîr el Mansûri, Åbår Ma±mød Abø Bakr, Abâr Kraiyim Himeida, Bîr Kharrît, Bîr el Khâssa, Åbår Hårøn, Åbår 'åmid, Bîr Ghineiwa Rihaiyim, Bi'r Faraj Hayøb, Bîr Ellet Abu Huweim, Bîr Eilet Similli, Bîr Eilet Firkash, Bi'r Dughaym, Bîr Dgheim, Bîr ¯Ali ¯Omâr, Bîr Ali el Qâdi , Bîr ¯Ali ¯Atîya, Bîr Abu Smeit and Åbår Abø Bakr Jødah . all of the previous wells surrounding Ras El Hekma area while other south Matruh city such as (Abâr Husein el Âsi, Bîr Zaqâwa, Abâr Zaolûk Bey, Bîr Yâdim el Garrâri, Abâr el Wisheika, Bîr Umm el Rakham, Bîr Sigîfa, Abâr el Shôlahi Bîr Shâmekh, Bi'r as Sajifah, Abâr Sa¯d Abu Shinâf, Bi'r Qaryat Då'od, Bîr el Hashîma, Bîr Gâryet Dâwûd, Bîr Eilet Similli, Bîr Eilet Ilwâni.) and the risk shows high grade at Haggag El Midar Area.

2- In sidi Barrani Sheet the Risk Degree also ranges between Low to moderate and there are many wells also can be recharged using the runoff water such as(Bir Qitani, Bir Nasib, bir Nasri, and Bir Lakhan)

3- In As Sallum Sheet the risk recorded low grade along the road connecting between Barrani and Sallum while it records moderate risk degree upon Sallum city from the south west direction.

4- Along Cairo Al Wahat Al Baharyia road the risk is low to moderate except the area near the Conical Hill and Bluff Hill it recorded high grade of risk.

5- Around Al Fayyum area the risk low to moderate.

6- South al Fayyum and in Asyut and Al Minya sheets recorded high grade of risk along the cultivated land parallel to the Nile River near to Sidi Al Ashi and Arab Yaqoub, Sidi Ahmed, Sidi abu Al Nour, and Kôm el Hâsil villages.

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تقييم مناخي لقابلية تأثر احواض التصريف بمخاطر السيول على طول الساحل الشمالي الغربي لمصر، باستخدام تقنيات الاستشعار عن بعد ونظم المعلومات الجغرافية

ملخص

تتميز مصر بمناخها الجاف وشديد الجفاف. وتؤثر الفيضانات المفاجئة بشكل مباشر على حياة الإنسان وتوازن النظام البيئي من خلال تآكل التربة وتبادل الرواسب بين مستجمعات المياه المختلفة. تقدم الدراسة الحالية نهجا متكاملا باستخدام الاستشعار عن بعد ونظم المعلومات الجغرافية، والطبقات المعلوماتية الجغرافية المتعددة، والتحقق الميداني للتخفيف من مخاطر الفيضانات على طول منطقة ساحل غرب البحر الأبيض المتوسط ، مصر، حيث تشكل مخاطر الفيضانات المدمرة ونقص إمدادات المياه مشاكل خطيرة ضد تنمية المنطقة.

تكون الفيضانات الخاطفة الكارثية أكثر تواترًا في بعض أجزاء منطقة البحر الأبيض المتوسط. ويرجع ذلك إلى المناخ المحلي، الذي يكون عرضة لهطول أمطار قصيرة ومكثفة. تجبر الطبيعة الجغرافية لمنطقة الدراسة على التقارب بين التدفقات الجوية منخفضة المستوى ورفع الكتل الهوائية الرطبة الدافئة التي تنجرف من البحر الأبيض المتوسط إلى السواحل، وبالتالي تخلق الحمل الحراري النشط. بالإضافة إلى ذلك، فإن النمو السكاني مرتفع بشكل خاص على طول سواحل البحر الأبيض المتوسط ، مما يؤدي إلى زيادة سريعة في المستوطنات الحضرية والسكان المعرضين للفيضانات.

تؤثر كميات الأمطار الإجمالية وكذلك استخدام الأراضي وأنواع التربة والصخور ومحتوى رطوبة التربة الأولي على استجابات مستجمعات المياه لأحداث هطول الأمطار الغزيرة وخاصة معدلات الجريان: النسبة المقدرة لهطول الأمطار العارضة المساهمة في تصريفات التيار المرصود. غالبًا ما تقتصر معدلات الجريان السطحي أثناء الفيضانات المفاجئة على ١٠ ٪ إلى ٣٠ ٪. في بعض الحالات النادرة، عندما تؤدي كميات الأمطار المتراكمة الكبيرة إلى تشبع مستجمعات المياه، فقد تصل معدلات الجريان السطحي إلى ١٠٠٪. وبالتالي، فإن التباين الملحوظ في ترددات الفيضانات وأحجام التصريف هو نتيجة التفاعل المعقد بين خصائص أحداث هطول الأمطار المتولدة (المدى المكاني، والمدة، والشدة القصوى) والعوامل التي تتحكم في استجابة مستجمعات المياه، وخاصة معدلات هطول الأمطار. المعلومات الجغرافية في قراءة جميع الخرائط الناتجة والتعليق عليها.

كلمات الدالة: السيول، الأمطار، الساحل الشمالي الغربي