

ANNEX VI: HYDRO RESOURCE MAP OF LIBERIA: ASSUMPTIONS, ANALYSIS AND OUTPUTS

1 INTRODUCTION

This document is an Annex to the Final Report of the Rural Energy Master Plan for Liberia developed by the Consultant for RREA, and focuses on the preparation of the map of Hydro resource.

This document is formed by four chapters:

- The present chapter is the introduction.
- **Chapter 2** presents the Liberia runoff map and its international watersheds. Methodology and data base are exposed as well as a comparison between hydrometric data and application of Turc method.
- **Chapter 3** presents the hydropower potential map.
- **Chapter 4** exposes the main conclusions from this document.

2 RUNOFF MAP OF LIBERIA AND ITS INTERNATIONAL WATERSHEDS

2.1 GENERAL CONSIDERATIONS

Liberia has very few hydrometric gauging stations in operation all over the country, and respective data series are recent and scarce for a hydrological regime analysis, considering that it is necessary at least 30 consecutive years of data records. For this study, the Consultant only had access to data from 3 gauging stations, with 3 water years of daily data measurements at most.

Due to reduced access to flow data, the river flows considered on this study were obtained by Turc formulation that considers only climate variables, as shown in further subchapters. Results obtained by applying Turc formulation will be compared to hydrometric data measured in the gauging stations to assess the accuracy of the Turc method.

2.2 TURC FORMULATION

The average annual flow was obtained by applying the Turc method that consists on a formulation that determines, for each watershed, the flow deficit considering only climatic variables: average temperature and mean annual precipitation.

Its application is particularly suitable when the existing hydrometric data does not allow to properly describing the hydrological phenomenon, as is the case of Liberia.

The Turc formula determines the value of the average annual runoff in a watershed, when average annual values of precipitation and temperature in the basin are known, and is expressed according to the following formulation:

$$L = 300 + 25 \times T + 0.05 \times T^3 \quad (2.1)$$

$$E = \frac{P}{\sqrt{0.9 + \frac{P^2}{L^2}}} \quad (2.2)$$

$$H = P - E \quad (2.3)$$

where:

H – Flow (mm);

P – Precipitation (mm);

E – Evapotranspiration (mm);

T – Temperature (°C)

L – Turc constant;

In the present study, the implementation of Turc methodology was performed using a Geographic Information System. The procedure was computed in matrix format (raster), and as result an average annual runoff value at each pixel was obtained. The flow value calculated for each pixel corresponds to the annual average runoff in the catchment area defined by that pixel. This methodology was applied in all river basins of Liberia discretized for each pixel, for which precipitation and temperature (annual average) of the watershed were calculated, as evidenced by the expressions (2.1), (2.2) and (2.3).

2.3 AVAILABLE DATA: TEMPERATURE AND RAINFALL

During the execution of this work, temperature and rainfall data measurements were not possible to access. To overcome the lack of information and the need to obtain data in international basins, temperature and rainfall data used in this study were the average monthly temperature and mean annual rainfall data for the African continent, provided by Worldclim.

The data provided by Worldclim¹ were generated through interpolation of average monthly climate data from weather stations on a 30 arc-second resolution grid (often referred to as 1 km² resolution).

The data base used by Worldclim comes from databases compiled primarily by the following organizations:

- *Global Historical Climatology Network (GHCN);*
- *Food and Agriculture Organization (FAO);*
- *World Meteorological Organization (WMO);*
- *International Center for Tropical Agriculture (CIAT), among others.*

¹ WorldClim, [Online]. Available: <http://www.worldclim.org/>.

It should be noted that data from these organizations is based on records for the period between 1950 and 2000.

In **Figure 2.1** and **Figure 2.2**, temperature and rainfall in Liberia and its international watersheds are presented, respectively.

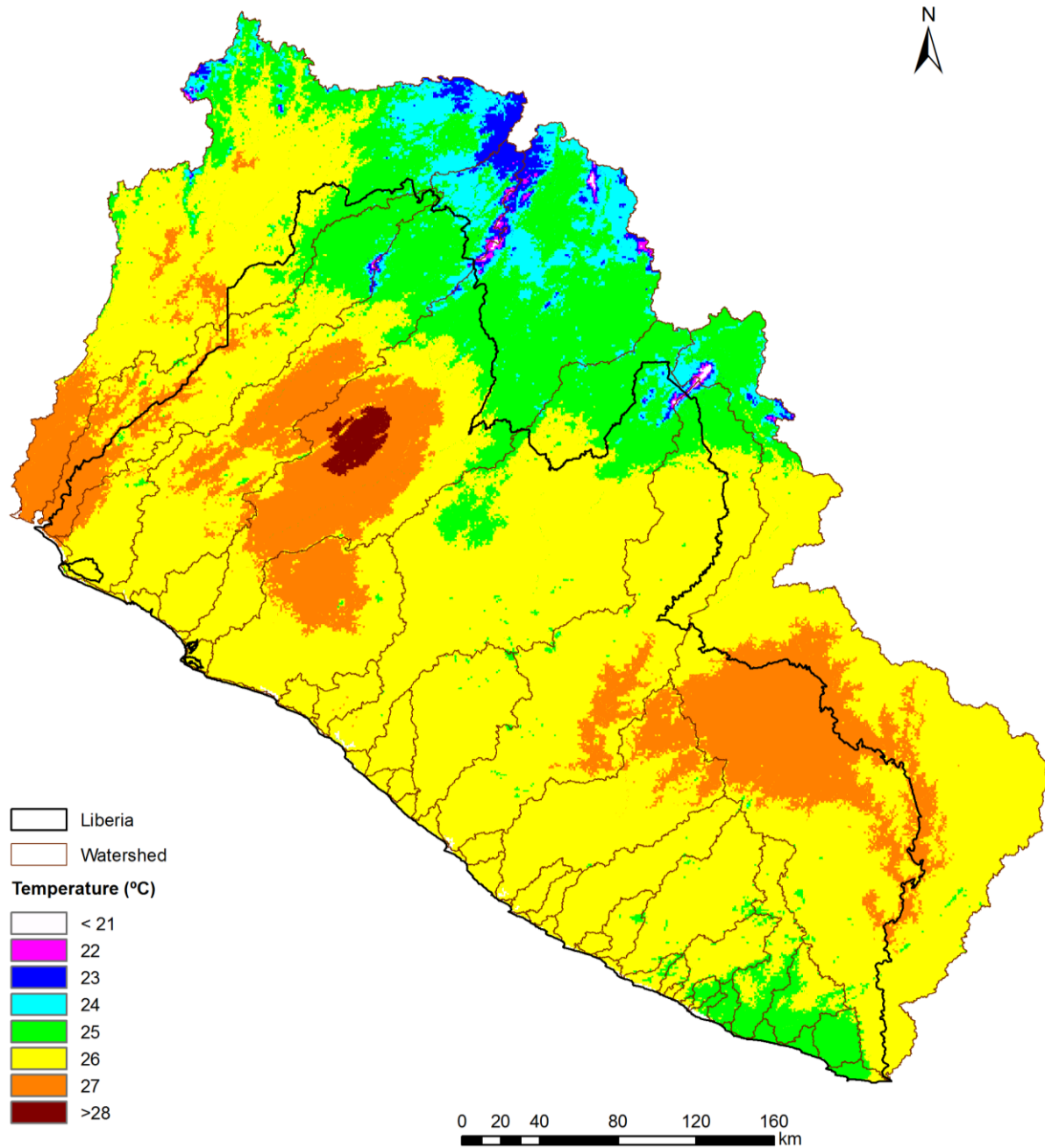


Figure 2.1 – Mean annual temperature².

² WorldClim, [Online]. Available: <http://www.worldclim.org/>.

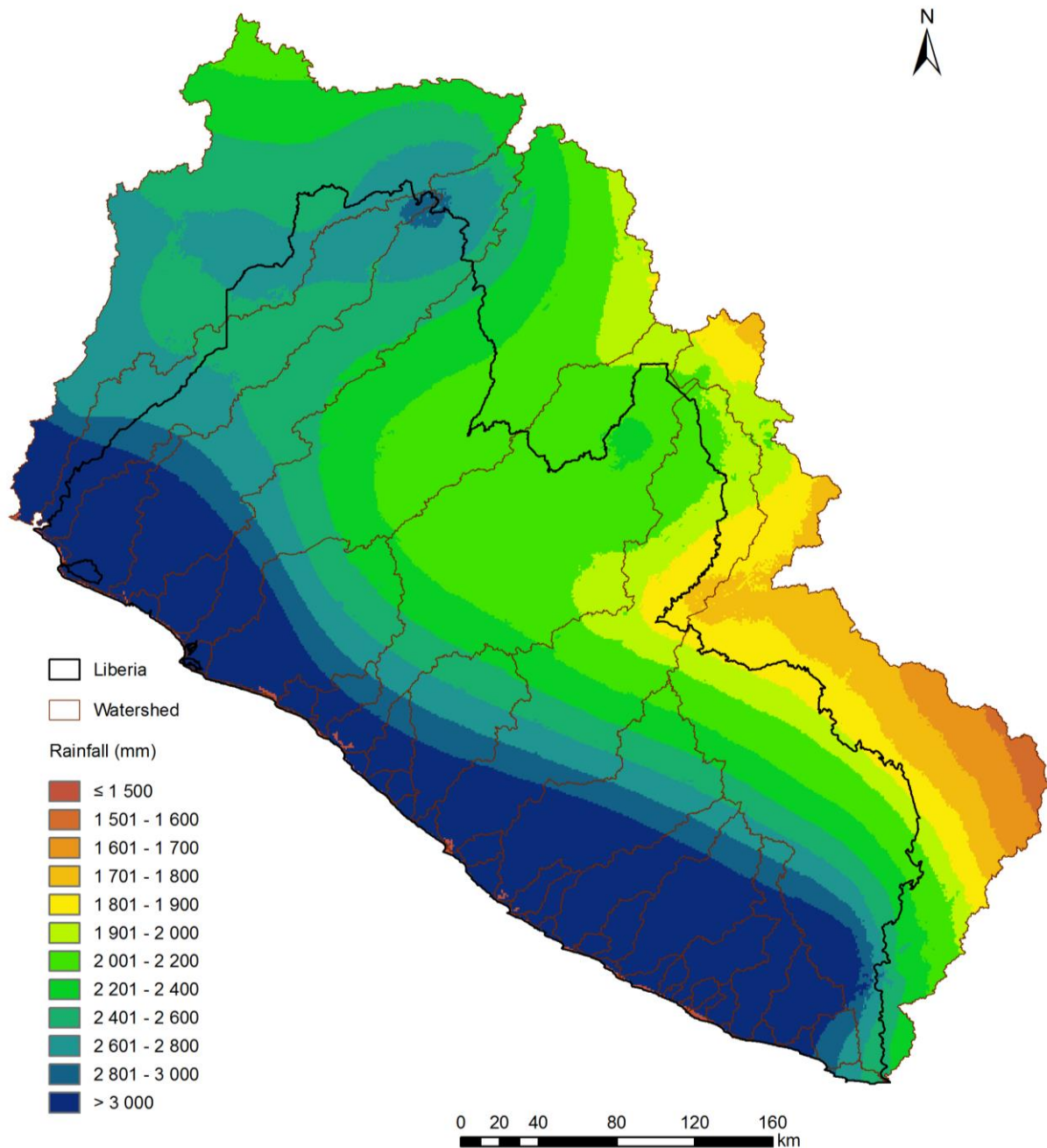


Figure 2.2 – Mean annual rainfall³.

2.4 RESULTS

As mentioned before, the implementation of Turc methodology was performed using a Geographic Information System. The procedure was computed in matrix format (raster) with a 30 x 30 m of resolution. The flow value calculated for each pixel corresponds to the annual average runoff in the catchment area defined by that pixel. This methodology was applied in all river basins of Liberia

³ WorldClim, [Online]. Available: <http://www.worldclim.org/>.

discretized for each pixel, for which precipitation and temperature (annual average) of the watershed were calculated. In **Figure 2.3** runoff map is presented.

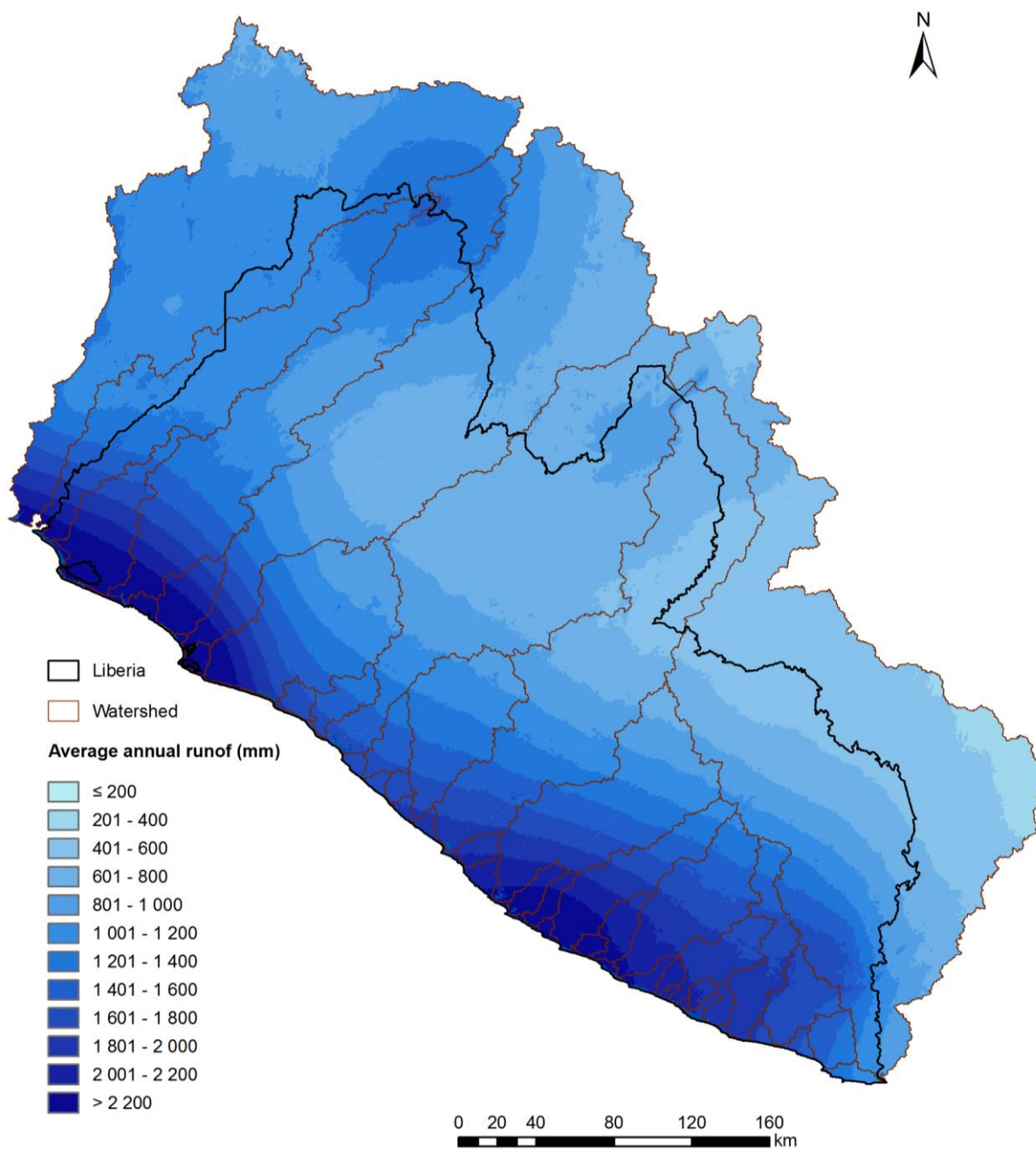


Figure 2.3 – Runoff map: Turc methodology.

2.5 COMPARISON BETWEEN HYDROMETRIC DATA MEASURED AND TURC METHODOLOGY

The formulation proposed by Turc, having a general nature and using only the climatological variables, generates average annual flow values that may have some deviation from the flow values obtained for the same basin, using hydrometric data.

During this study the Consultant only had access to data from 3 gauging stations, with 3 water years of daily data measurements at most. This information is not sufficient to perform a hydrological regime analysis in Liberia, but it can be used to assess accuracy of the results obtained by using Turc method. The three gauging stations are located in Saint Paul and Saint John rivers, which are the two main rivers in Liberia.

In **Table 2.1**, information about gauging stations is present and in **Figure 2.4** the location of gauging stations is displayed. Hydrometric data are presented in **APPENDIX VI-I: Hydrometric data**.

Table 2.1 – Hydrometric data available.

Gauging Station	Station ID	River	Catchment area (km ²)	Location		Time series		Nr Water years
				Lon	Lat	Start	End	
St. Paul River at Haindi	04SP001	Saint Paul	18 276	10.362	6.902	01-05-2012	31-10-2015	3
St John at Frank Diggs	06SJ001	Saint John	10 862	9.526	6.466	01-03-2013	31-10-2015	2
St John at Mt. Finlay	06SJ002	Saint John	15 723	9.870	6.084	08-04-2013	31-10-2015	2

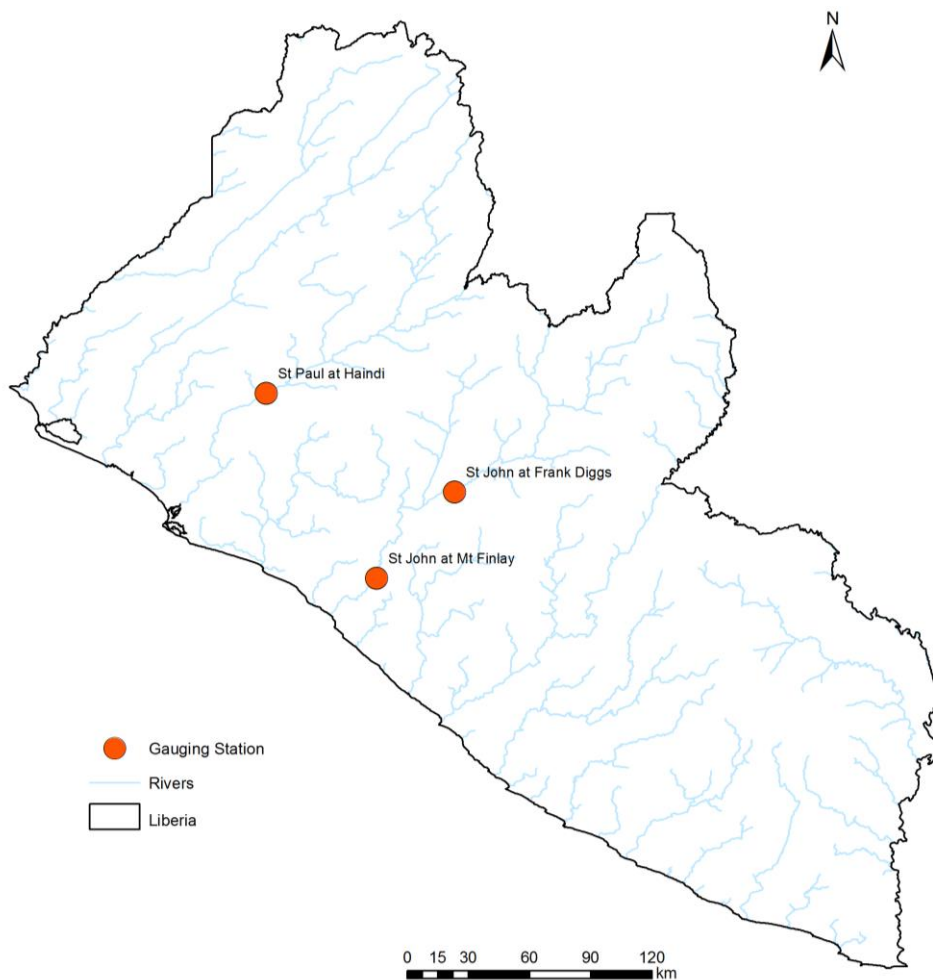


Figure 2.4 – Gauging stations location.

To assess accuracy of the results obtained by using Turc method, data measured in gauging station was compared with mean annual flow obtained by Turc methodology. In **Table 2.2**, results of this comparison are presented.

Table 2.2 – Mean annual runoff obtained by data measurement and Turc method.

Gauging Station	Station ID	LHS		SRTM and Turc method		ERROR	
		Watershed (km ²)	Q _{mod} (m ³ /s)	Watershed (km ²)	Q _{mod} Turc (m ³ /s)	Watershed	Q
St. Paul River at Haindi	04SP001	18 276	484.1	18 333	486.3	-0.3%	-0.5%
St John at Frank Diggs	06SJ001	10 862	252.1	10 946	254.1	-0.8%	-0.8%
St John at Mt. Finlay	06SJ002	15 723	395.2	15 269	369.2	2.9%	6.6%

As it can be seen in **Table 2.2** the results obtained by the Consultant's analysis and the ones made available by LHS are very similar, so it can be assumed that Turc method is suitable to use in this study.

3 HYDROPOWER POTENTIAL MAP

3.1 INTRODUCTION

The evaluation of hydropower potential integrates hydrological results and terrain features as well as technical and economic criteria in order to obtain regions reflecting the higher or lower potential of the analyzed locations.

For the development of these analysis, the Consultant has spatial analysis tools as well an extensive experience in developing custom made models appropriated to each geography.

The primary elements needed to evaluate hydro potential are head (elevation gradient) and flow (surface runoff), therefore its modelling is essential.

The head was evaluated based on SRTM with resolution 30 x 30 m by NASA⁴. Surface runoff was calculated based on Turc formulation due to Liberian insufficient hydrometric data.

3.2 HYDROPOWER POTENTIAL MAPPING

In theory, hydropower potential map is the mapping of possible capacities that can be installed on each point of the analysis, considering the estimated average daily flow rate and the usable head at each point.

Based on the runoff map of Liberia obtained by Turc formulation, with a resolution of 30m x 30m, it was possible to determine the modular flow at each point of the territory. For the calculation of the potential map, a design flow equal to modular flow was assumed.

⁴ SRTM-30", "Shuttle Radar Topography Mission," [Online]. Available: http://topex.ucsd.edu/cgi-bin/get_srtm30.cgi.

Gross head was calculated based on the difference of altitudes given by the digital terrain model of the SRTM, between the point of analysis and the point of lowest elevation present in a 1km radius of the point of analysis. A net head of 95% of the gross head was considered.

From these assumptions it was possible the determination of the hydroelectric potential map by:

$$P = \eta \gamma Q H \quad (3.1)$$

where:

P – capacity (W)

η – turbine-generator efficiency (86%)

γ – specific weight of water (kN/m³)

Q – design flow (m³/s)

H – net head (m)

To complement the map of hydropower potential, average annual isoenergetic lines were also calculated, that express the producible energy per area unit per year. The expression used was as follows:

$$W = 0.002 E h \quad (3.2)$$

where:

W – average annual energy (kWh/m²)

E – flow (m)

h – altitude above mean sea level (m)

Hydropower potential map is presented in **Figure 3.1**. As it can be seen in **Figure 3.1**, Liberia has many rivers with potential to install hydropower plants. The main hydro potential rivers are Lofa, Saint Paul, Saint John and Cestos.

Hydropower Potential Map

RURAL ENERGY MASTER PLAN FOR LIBERIA

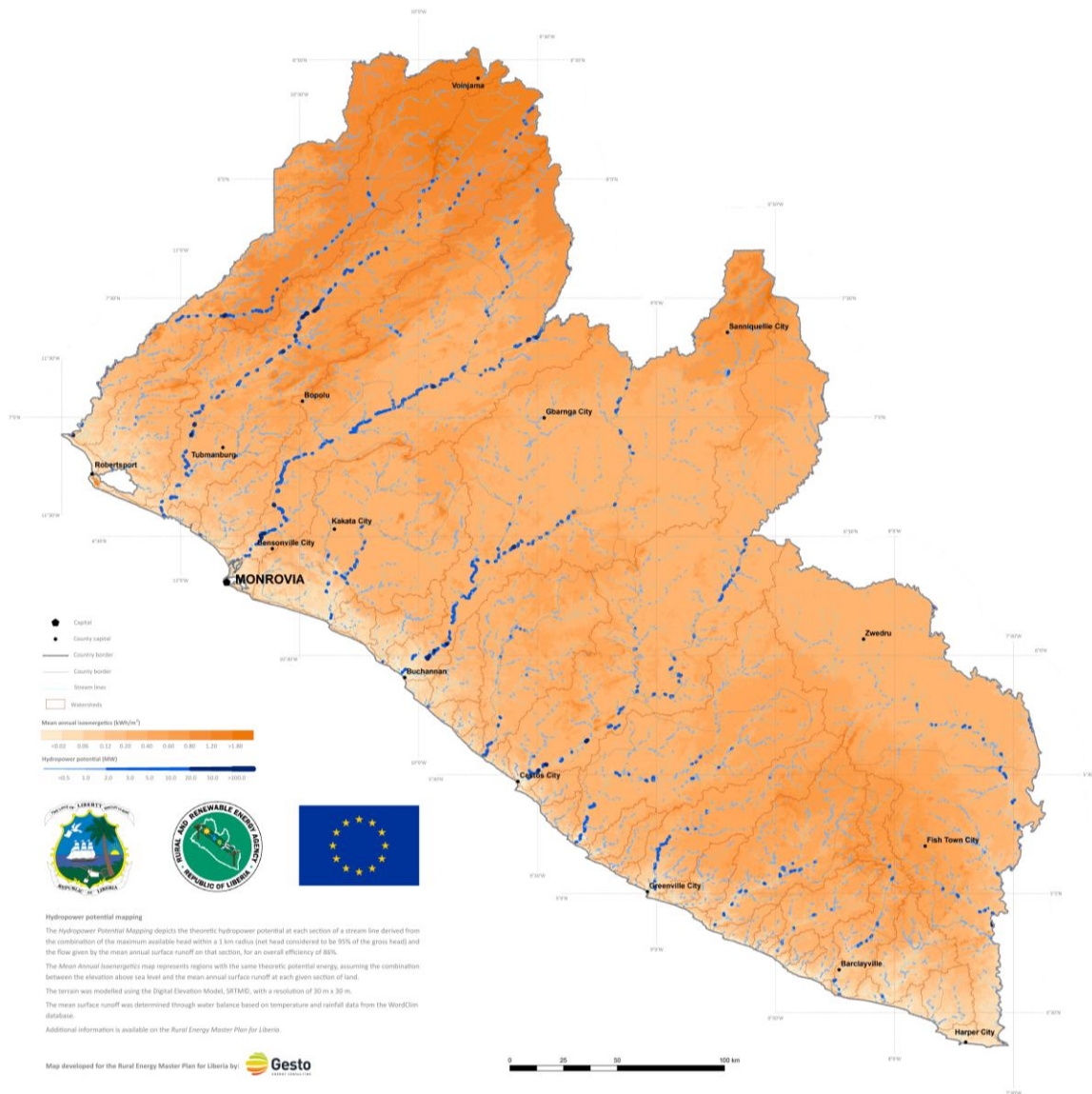


Figure 3.1 – Hydropower potential map.

4 CONCLUSIONS

The results obtained by applying Turc methodology compared to the hydrometric records show a reasonable agreement. The Turc method, given its simplicity, is not meant to be an error-free model, whereby the results obtained by this method are considered valid. The Consultant believes that the mapping obtained by this method is, at the date of this study, a useful tool in a first assessment of water resources in river basins of Liberia.

Hydropower potential map of Liberia was determined and it will allow identifying any site nationwide with generation capacity between any power ranges, being an auxiliary tool to promote rural electrification through hydropower.

APPENDIX VI-I: HYDROMETRIC DATA

Gauging Station: St. Paul River at Haindi: Daily flow (m³/s)

Year	Month	Days																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2012	May	92	95	95	86	102	100	91	89	97	92	106	154	161	154	198	206	228	241	220	214	210	206	212	222	239	224	202	222	252	241	222
2012	June	276	424	426	416	437	427	399	404	361	326	296	290	535	481	397	344	531	544	441	377	319	323	363	388	399	409	399	370	456	418	
2012	July	620	691	833	747	729	803	783	708	604	639	665	676	590	508	434	412	905	880	721	537	468	459	564	821	800	669	588	529	580	915	1277
2012	August	1404	1718	1538	1373	1222	1265	1366	1362	1354	1320	1193	1104	1046	1077	1006	916	880	858	827	802	786	817	883	1002	1084	1054	1474	1303	1195	1130	1308
2012	September	1273	1101	937	806	719	684	664	785	967	1172	1028	960	1053	1324	1361	1440	1623	1729	1795	1642	1502	1446	1432	1457	1411	1340	1294	1376	1444	1474	
2012	October	1327	1108	1048	979	938	916	978	990	936	919	949	872	802	762	736	699	672	714	763	849	827	830	912	952	912	870	897	988	1146	1177	1032
2012	November	862	756	696	640	592	565	538	506	462	485	511	476	443	434	414	394	421	457	500	616	618	587	585	622	579	523	431	410	439	427	
2012	December	402	382	414	404	392	369	340	317	282	269	250	241	233	228	237	226	228	216	207	199	203	199	189	184	180	179	178	156	184	154	139
2013	January	138	137	134	125	121	117	113	109	106	106	103	101	98	95	94	93	92	90	88	87	87	85	82	81	83	82	81	79	78	77	76
2013	February	74	73	71	67	66	63	62	61	59	57	55	53	52	50	48	46	44	43	42	42	44	47	53	61	60	58	53	54			
2013	March	55	57	58	57	59	69	85	93	106	111	100	87	82	76	86	101	98	94	90	82	74	71	64	59	57	56	60	65	79	85	97
2013	April	101	94	90	110	178	220	192	142	142	130	110	96	86	77	89	117	140	149	126	117	119	133	162	149	136	106	93	91	96	94	
2013	May	101	97	94	102	113	101	95	115	126	154	140	117	106	97	91	83	84	100	101	100	122	146	157	157	137	118	112	119	110	99	89
2013	June	130	329	382	374	344	366	369	334	293	288	224	206	228	226	210	154	166	178	142	134	125	113	108	104	97	95	91	97	157	154	
2013	July	226	257	261	268	293	305	248	265	268	277	241	214	222	344	329	356	435	430	397	427	354	265	204	161	159	286	339	319	302	341	341
2013	August	314	317	331	348	397	460	508	559	682	946	969	880	766	653	571	608	692	712	804	763	705	729	653	596	562	770	1153	1252	1311	1447	1690
2013	September	1781	1662	1425	1223	1194	1282	1320	1429	1811	2202	2046	1743	1587	1303	1202	1141	1093	999	872	787	840	898	972	1011	1145	1210	1223	1182	1223	1389	
2013	October	1307	1210	1097	1038	1014	1026	1057	1011	961	931	991	1057	1038	1018	961	995	1198	1049	916	876	851	819	777	722	659	634	618	599	565	571	559
2013	November	562	618	663	646	621	574	491	449	432	421	419	443	482	485	471	449	494	529	491	465	494	596	541	520	443	389	364	364	361	336	
2013	December	317	281	295	302	307	298	284	265	243	226	216	210	202	194	198	210	210	212	208	202	194	190	180	156	148	143	140	136	133	129	125
2014	January	122	125	149	159	156	151	148	134	123	117	112	108	104	102	101	99	97	102	107	103	101	99	101	113	110	107	106	115	119	115	109
2014	February	99	89	80	73	72	67	63	59	57	55	54	61	63	59	58	56	57	67	88	130	154	146	113	96	82	72	64	58			
2014	March	53	49	45	43	40	38	36	34	33	31	30	29	28	26	26	27	29	27	28	30	38	42	44	47	51	48	43	43	51	80	80
2014	April	77	70	73	78	73	82	81	78	79	82	101	95	87	78	70	66	64	64	65	61	55	50	46	43	44	43	41	45	55	56	

RURAL ENERGY STRATEGY AND MASTER PLAN FOR LIBERIA

TECHNICAL REPORT

		Days																														
Year	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2014	May	54	51	53	59	60	67	69	68	115	182	195	214	241	243	316	315	317	361	357	323	296	313	328	299	256	238	216	183	157	162	212
2014	June	269	338	314	260	258	318	334	380	398	353	332	440	431	592	629	530	458	449	607	720	656	531	429	412	404	355	305	285	288	339	
2014	July	329	392	502	337	316	599	606	581	745	759	613	498	396	372	378	344	378	509	530	484	416	361	337	364	390	373	378	497	727	897	983
2014	August	930	880	804	763	721	787	855	809	1251	1475	1318	1131	1077	1384	1361	1206	1310	1604	1732	1613	1539	1493	1685	1681	1526	1328	1211	1271	1181	1083	1027
2014	September	993	988	1034	1152	1073	991	1361	1527	1315	1186	1150	1080	1107	1311	1213	1095	1029	1132	1218	1194	1159	1259	1314	1252	1204	1313	1282	1308	1487	1446	
2014	October	1456	1450	1380	1351	1295	1225	1248	1239	1197	1108	1002	972	1079	1185	1071	1034	930	1008	909	829	825	854	797	723	640	598	565	546	531	525	528
2014	November	544	541	544	539	543	548	565	566	535	484	449	429	413	400	389	382	401	405	438	462	454	457	428	383	427	710	589	480	401	364	
2014	December	350	342	339	398	410	398	383	361	331	297	277	265	249	236	225	217	210	206	200	194	188	181	168	164	161	158	154	147	142	136	132
2015	January	128	126	123	120	117	114	111	108	106	104	102	101	98	96	94	91	89	88	86	85	84	85	90	105	135	127	116	105	95	86	80
2015	February	74	71	68	69	69	69	66	65	64	68	90	107	103	99	96	113	117	110	102	90	79	72	74	74	66	66	74	73			
2015	March	64	56	50	46	43	40	38	37	39	42	41	42	40	39	40	42	49	54	58	72	96	88	101	118	135	119	97	83	77	76	67
2015	April	60	54	48	44	40	38	45	72	92	100	106	94	93	90	86	77	74	69	63	61	58	57	57	56	66	69	68	66	66	66	
2015	May	65	66	84	90	85	82	78	67	60	57	59	58	58	79	132	151	122	144	169	168	140	123	136	205	196	164	161	198	260	268	227
2015	June	177	146	146	208	369	590	584	450	386	406	363	301	241	246	332	450	495	414	313	243	197	215	208	248	240	215	195	203	243	308	
2015	July	345	330	288	271	270	276	286	362	452	467	444	417	442	638	524	497	536	597	575	717	689	718	726	814	766	712	842	887	848	806	744
2015	August	658	577	505	533	609	599	576	603	791	921	966	985	864	788	707	656	666	779	904	939	994	1261	1718	1983	2028	1938	1822	1685	1749	1912	1895
2015	September	1593	1260	1106	1169	1142	1174	1585	1677	1554	1576	1523	1478	1415	1334	1172	1128	1640	1864	1852	1538	1204	1103	1526	1560	1583	1359	1173	1129	1206	1202	
2015	October	1157	1121	1141	1177	1145	1093	1133	1198	1157	1053	1014	999	1014	1022	1109	1202	1121	1057	916	808	780	766	752	735	705	646	628	634	674	843	872

Gauging Station: St. John River at Frank Diggs: Daily flow (m³/s)

Year	Month	Days																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2013	March	35	35	33	31	31	34	38	36	39	80	82	64	52	44	40	51	91	106	90	83	72	64	55	49	43	39	38	36	36	35	35
2013	April	52	56	56	51	56	94	117	125	108	77	61	60	53	46	58	59	57	53	52	45	50	50	57	55	46	43	43	37	33	29	
2013	May	30	31	30	43	39	56	60	63	81	95	63	103	90	78	79	72	62	61	79	108	105	87	79	76	82	96	108	125	156	163	175
2013	June	224	243	275	299	282	295	319	309	268	209	186	168	158	164	151	128	108	89	79	78	78	75	73	67	60	54	60	64	75	86	
2013	July	153	202	217	233	214	179	164	156	188	241	268	263	220	193	212	285	321	328	303	289	258	175	119	111	129	116	128	161	151	144	126
2013	August	119	116	103	97	98	98	95	102	126	170	205	196	181	156	124	108	107	112	125	121	116	113	113	117	118	140	279	397	544	747	781
2013	September	779	803	766	700	634	666	631	579	687	744	693	659	617	652	691	735	760	794	749	706	666	686	695	680	725	779	766	781	803	814	
2013	October	771	691	624	570	598	654	684	679	657	675	670	622	596	580	572	575	610	603	556	509	454	422	417	395	360	334	331	342	337	305	309
2013	November	328	337	349	363	381	357	328	296	255	251	255	254	249	247	240	230	237	268	275	328	395	480	481	468	423	387	334	263	251	247	
2013	December	234	210	197	191	208	209	210	181	164	157	157	132	126	122	121	122	126	128	131	116	109	108	99	97	91	87	82	80	77	78	77
2014	January	79	86	101	121	125	117	105	91	84	77	69	68	67	69	67	68	50	64	61	60	59	60	62	65	62	55	55	62	72	70	48
2014	February	57	53	48	43	37	35	32	29	31	33	43	67	61	46	43	38	37	40	46	60	95	86	60	54	45	42	36	30			
2014	March	25	21	21	21	20	20	19	18	17	18	19	19	19	18	18	17	17	18	23	20	19	19	20	20	22	23	21	20	21	23	26
2014	April	30	38	41	39	43	49	43	37	33	35	34	40	54	55	48	43	47	53	51	45	40	42	43	42	40	38	39	38	36	45	
2014	May	55	70	71	79	81	67	65	83	97	121	134	166	174	142	135	154	170	189	197	222	220	200	182	164	150	127	110	106	120	136	150
2014	June	164	197	220	212	192	181	163	166	182	214	247	285	318	358	369	343	263	228	205	255	300	306	309	269	249	240	218	191	164	173	
2014	July	217	357	458	533	584	582	611	641	624	499	444	381	319	268	221	199	209	245	283	292	234	197	177	169	196	229	280	328	360	401	439
2014	August	498	556	606	589	577	572	561	508	476	592	687	773	873	858	775	735	706	682	684	654	661	702	727	720	675	645	587	543	509	499	504
2014	September	504	489	468	442	423	438	503	516	483	498	514	489	480	486	473	470	503	524	524	511	572	603	638	648	611	601	551	531	601	675	
2014	October	689	746	695	689	627	601	594	568	582	555	526	494	511	529	536	551	594	610	577	563	533	521	509	485	458	401	348	334	314	295	279
2014	November	276	263	256	248	243	280	300	327	336	300	273	258	232	213	206	205	209	217	220	225	230	225	216	206	217	249	293	321	311	261	
2014	December	261	263	321	358	381	318	290	268	233	208	189	175	162	151	140	134	127	120	115	111	107	103	99	98	94	94	90	86	81	79	78
2015	January	72	69	68	67	61	59	59	57	55	48	45	45	44	43	43	42	40	40	39	40	40	40	46	55	60	76	76	67	60	51	48
2015	February	40	38	36	34	36	41	51	53	49	45	45	48	50	50	48	45	42	38	37	38	43	40	40	43	45	40	40	40			
2015	March	40	39	39	39	36	33	33	30	36	33	30	28	24	27	26	21	25	31	35	40	48	46	47	51	70	64	54	46	43	37	34
2015	April	33	32	30	33	36	44	55	63	74	89	99	105	106	91	88	73	65	51	40	35	34	35	36	40	36	30	28	27	25	29	

RURAL ENERGY STRATEGY AND MASTER PLAN FOR LIBERIA

TECHNICAL REPORT

Year	Month	Days																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2015	May	36	43	43	35	44	48	41	40	36	33	29	23	28	36	37	45	47	48	73	101	121	151	179	217	236	200	146	119	94	82	67
2015	June	61	94	129	175	201	239	261	279	251	270	292	273	249	233	233	293	342	289	234	192	177	168	168	206	270	245	193	167	142	177	
2015	July	213	247	228	193	172	163	153	167	175	164	162	167	183	196	232	229	206	189	210	221	292	363	430	473	536	620	584	551	470	367	305
2015	August	259	214	234	262	273	273	280	300	340	372	373	417	422	412	389	375	378	408	447	496	560	680	841	898	964	1013	1041	1039	995	929	861
2015	September	801	662	638	618	615	603	596	615	634	655	698	760	852	915	869	906	948	948	881	852	824	809	782	749	707	657	606	572	584	606	
2015	October	631	627	579	601	652	627	625	661	625	606	587	579	585	589	631	657	617	591	565	521	485	458	433	406	386	358	340	321	316	352	392

Gauging Station: St. John River at Mt. Finlay: Daily flow (m³/s)

Year	Month	Days																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2013	April								153	159	63	83	82	72	63	79	80	78	72	71	61	68	68	78	76	63	59	59	51	46	41	
2013	May	42	44	43	59	54	77	82	86	109	127	140	196	188	163	142	94	84	83	107	145	141	118	107	103	111	129	145	239	297	297	272
2013	June	275	305	369	397	392	376	492	501	434	356	288	249	240	249	242	212	177	147	107	105	105	101	99	92	82	73	81	87	101	116	
2013	July	322	329	312	334	344	283	244	264	339	365	387	406	335	297	290	343	387	397	448	384	300	235	194	169	154	147	160	197	215	203	183
2013	August	165	160	150	138	130	161	153	167	212	260	308	326	295	246	201	172	176	172	180	188	174	162	158	162	181	204	300	559	1097	1200	1101
2013	September	1046	1112	1037	937	835	962	1119	1063	1048	1242	1090	1052	1035	991	1009	1090	1097	1094	1063	974	955	1070	1046	1135	1193	1295	1242	1202	1172	1200	
2013	October	1130	979	863	783	841	1057	1039	1081	1041	966	970	901	955	855	796	765	790	835	796	699	642	626	600	567	549	500	486	549	523	484	483
2013	November	522	522	554	544	579	530	483	441	409	372	371	376	362	365	362	394	471	708	500	498	624	722	732	677	645	560	554	384	373	365	
2013	December	364	335	306	308	339	365	338	299	268	239	221	207	198	190	187	184	187	197	195	191	179	168	157	147	140	134	111	108	104	105	104
2014	January	107	116	133	153	172	170	156	141	113	104	94	93	92	94	90	93	68	87	83	81	80	81	84	88	84	76	75	84	98	95	65
2014	February	84	76	69	63	58	54	51	48	46	50	49	52	64	77	70	64	58	70	84	81	93	117	113	93	75	64	58	52			
2014	March	46	41	38	35	32	30	29	29	28	27	25	25	25	25	23	25	24	24	22	23	27	29	27	26	27	31	34	33	32	30	28
2014	April	30	33	35	47	54	67	60	55	51	52	54	59	60	69	75	66	59	59	63	63	59	56	57	56	54	52	52	56	54	54	
2014	May	73	75	90	103	127	115	104	116	125	165	195	276	263	254	248	269	312	368	402	375	334	330	310	280	254	255	222	180	160	159	260
2014	June	383	439	412	367	301	308	320	315	307	294	315	431	487	606	616	564	491	426	415	451	554	543	497	416	434	414	372	322	285	282	
2014	July	300	408	642	871	960	825	821	839	752	661	607	589	471	380	331	290	297	643	635	602	527	414	355	320	326	355	357	600	700	636	704
2014	August	381	409	419	401	523	652	700	741	934	1283	1271	1211	1101	1006	968	943	996	1030	962	906	951	1028	1019	974	887	783	800	835	771	704	710
2014	September	735	730	688	649	611	612	849	829	790	728	732	758	777	819	760	767	819	897	814	817	800	879	987	996	924	906	863	804	945	1054	
2014	October	1242	1414	1334	1223	1070	947	914	914	910	837	762	728	739	893	910	887	839	849	833	767	814	800	802	796	682	611	587	547	498	477	477
2014	November	451	435	414	404	412	431	441	501	497	460	432	397	368	348	321	313	320	326	336	355	331	321	334	335	426	477	533	543	487	426	
2014	December	369	398	357	303	307	312	332	390	375	343	280	264	246	239	226	206	195	187	181	176	167	161	156	147	143	141	134	128	124	118	113
2015	January	110	104	101	96	94	88	86	82	79	78	76	74	73	71	70	66	64	63	62	60	59	62	64	72	83	112	113	106	91	81	72
2015	February	64	61	63	60	56	55	58	58	58	59	57	60	111	104	95	86	95	99	83	75	74	73	74	75	69	68	59	52			
2015	March	49	45	45	41	37	33	32	33	34	35	32	34	34	32	32	30	30	35	57	71	73	80	82	82	103	92	86	79	71	70	69
2015	April	68	62	54	47	41	39	40	43	66	90	103	118	164	157	136	102	82	69	53	52	52	50	54	66	69	68	62	57	60	53	
2015	May	50	53	57	54	52	58	60	54	50	46	44	41	37	35	31	32	62	86	112	123	122	113	142	246	355	372	283	245	282	397	381

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2015	June	341	292	255	231	252	371	456	451	402	503	475	428	368	322	457	638	754	654	528	398	312	260	330	565	607	503	388	315	254	312	
2015	July	406	383	330	310	296	299	278	273	262	285	299	269	289	332	362	387	349	315	302	401	543	647	663	741	837	974	955	792	708	604	508
2015	August	456	368	325	329	384	411	408	498	607	713	750	695	677	607	617	607	600	617	631	638	686	910	1431	1429	1421	1351	1256	1195	1153	1106	1070
2015	September	985	891	817	790	764	806	908	893	855	1032	998	979	1088	1331	1297	1218	1421	1620	1609	1472	1195	1103	1070	1070	1028	991	943	843	833	1006	
2015	October	1009	1039	947	941	918	926	875	1106	1057	994	885	962	962	943	1004	1041	991	869	996	819	802	747	732	700	640	635	567	512	484	483	556