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Forecasting Low Stream Flow Rate Using Monte—Carlo Simulation of Perigiali Stream, Kavala City, NE Greece †

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Abstract: A small number of scientific research studies with reference to extremely low flow conditions, have been conducted in Greece, so far. Predicting future low stream flow rate values is an essential and of paramount importance task when compiling watershed and drought management plans, designing water reservoirs and general hydraulic works capacity, calculating hydrological and drought low flow values, separating groundwater base flow and storm flow of storm hydrographs etc. The Monte-Carlo simulation method generates multiple attempts to define the anticipated value of a random (hydrological in this specific case) variable. The present study compiles, correspondingly, artificial low stream flow time series of both the same part of the year (2016) as well as a part of the calendar year (2017), based on the stream flow data observed during the same two different interval periods of the years 2016 and 2017, using a 3-inches U.S.G.S. modified portable Parshall flume, a 3-inches conventional portable Parshall flume, a 3-inches portable Montana (short Parshall) flume and a 90° V-notched triangular shaped sharp crested portable weir plate. The recorded data were plotted against the fitted one and the results were demonstrated through interactive tables providing us the ability to effectively evaluate the simulation procedure performance. Finally, we plot the observed against the calculated low stream flow rate data, compiling a log-log scale chart which provides a better visualization of the discrepancy ratio statistical performance metric and calculate statistics featuring the comparison between the recorded and the forecasted low stream flow rate data.

Keywords: artificial time series; discrepancy ratio; Monte-Carlo simulation; low flow data; Parshall flume

1. Introduction

Low flow regimes in rivers and streams are of paramount importance to the ecological conditions of any land surface hydrological feature. Any shift in the flows pattern throughout any hydrological year, stemming, for instance, from either individual activities e.g., groundwater abstraction, precipitation shortage, riparian areas encroachment, stream channelizing due to urbanization etc, or a combination of them, may contribute to stream ecology changes that cannot be undone [1]. Low flow analysis and forecasting is also fundamental when building works along watercourses (e.g., dams, reservoirs, water deviation channels for irrigation purposes etc.) and for watercourse rehabilitation plans regarding which a knowledge of hydrological fluctuation is of fundamental importance in designing sustainable rehabilitation works.

Another type of low flow analysis, specifically probability distribution analysis, was performed in the past analyzing the observed data collected at the same gauging station between 14th of May 2016 and 31th of July 2016 revealing that Pearson type 6 (3P) demonstrated the highest final goodness of fit obtained score based, simultaneously, on all available (Anderson-Darling, Chi-Squared and Kolmogorov-Smirnov) goodness of fit criteria [2]. Furthermore, as far as the same gauging station, similar type of analysis was elaborated considering, this time, the observed data collected at the same gauging station both between 14th of May 2016 and 29th of August 2016 revealing that Wakeby type (5P) probability density function demonstrated the highest final goodness of fit obtained score based on the Kolmogorov-Smirnov goodness of fit criterion and employed to generate an artificial low flow time series for the same time interval [3,4]. Moreover, as far as another gauging station, more specifically the Palaia Kavala Stream gauging station, similar type of analysis was elaborated considering, this time, the 174 observed data collected between 17th of August 2013 and 7th of February 2014 revealing that Kumaraswamy type (4P) probability density function demonstrated the highest final goodness of fit obtained score based on the Kolmogorov-Smirnov goodness of fit criterion and employed to generate an artificial low flow time series for the same time interval [5].

The Monte-Carlo method is a class of computational algorithms that rely on repeated random sampling to compute their results [6]. "Monte Carlo" is synonymous to "stochastic"; In other words, the Monte Carlo method is a numerical method which, like other numerical methods, becomes useful when analytical solutions do not exist (that is, almost always…); While the Monte Carlo method seems to be a natural choice when the problem studied involves randomness, it is also powerful even for purely deterministc problems [7]. The Monte-Carlo simulations were additionally employed to model the high variability of each of the sewage base flows (SBF) components, implementing simultaneously a method of quantifying each of those components using residential end-use modeling [8]. Monte Carlo simulation models have also been used for riverine biological research purposes [9].

2. Study Area

The stream flow rate gauging station established in Kavala city coastal area, is located at the north of the Aegean Sea, across the Thassos Island, and surrounded by the Lekani mountain series branches to the North and East and the Paggaion Mountain ramifications to the West, (established in the proximity of the city urban web center and at the eastern exit of the city as well), located at the specific co-ordinates 40°56′727″ N and 24°25′929″ E, Perigiali city area, and operated continuously, bridging a time interval period from 14 May 2016 to 7 October 2017, as illustrated in Figure 1.

Figure 1. Parshall flumes and V-Notched weir gauging station, Perigiali Stream area, Kavala city, Greece.

It should be noted that since it is located just a few decades of meters upstream the sea shore and simultaneously at the exit of the entire Perigiali area watershed, between the sea shore and the Old National Road connecting the eastern exit of the Kavala city to the Xanthi city, drained by the homonymous Perigiali area stream, the associated stream flow rate measurements provide profaoundly valuable scientific information respecting the entire regime of the water resources of the Perigiali area watershed.

The particular characteristics of the gauging station, namely, outlet of the entire watershed, outlet of the watershed's main stream channel, in close proximity to the seashore, North-Eastern Mediterranean location, partly urbanized watershed makes it of paramount importance since the observed (especially low flow) hydrological regimes could enhance drought, watershed and urban water management plans which could be used for the scientific research study of ungauged catchments with similar to the Perigiali Stream watershed spatial characteristics established within areas dominated by meteorological parameters of the same nature, magnitude and general characteristics.

3. Materials and Methods

We implemented the Monte-Carlo simulation method to simulate low stream flow rate data, acquired at a certain location of the partly channelized semi-urban stream which crosses the eastern exit of Kavala city, Eastern Macedonia & Thrace Prefecture, NE Greece, during part of May, June, July and part of August 2016 until the 29th of August 2016, as well as part of May, June, July, August, September and part of October 2017, until the 10th of October 2017, (see Supplementary).

The distinctively shallow waters, exacerbated by the extremely low water stream flow velocity occurring at the gauging station, make impossible to perform the area-velocity method in order to calculate the stream flow rate (discharge), using a current meter mounted on a wading rod, due to the fact that there isn't adequate depth to submerge the current meter; Moreover, the pronounced low water stream flow velocity is not sufficient enough to trigger the operation of a current meter. Under those noticeable circumstances the only other remaining options, are the use of either a small-sized portable weir (all those its implementation brings difficulties due to the fact that weirs, in general, demand a relatively great head loss which is not available at areas in proximity to watersheds' outlets, where, in most cases, the natural slope of the channel bed is extremely low if not zero) plate or/and a small-sized flume or/and a set of small-sized weir and flumes which, eventually, was our final selected option, more specifically, a "3-inch U.S.G.S. Modified Portable Parshall Flume", "3-inch U.S.G.S. Conventional Portable Parshall Flume" and a "90° V-Notched Triangular-Shaped Sharp-Crested (Sharp-Edged) U.S.G.S. Portable Weir Plate" [10–20], made of sea plywood, covered with a sprayed thin smooth polyester coating, (identical to that usually the industry covers the outside surface of high-speed sea boats, in order to reduce the friction developing between the outside area of those sea boats and the sea water, thus securing that the friction developed between the bottom as well as the walls of the stream flow rate gauging apparatus is minimized/restricted to a minimum, as illustrated in Figure 2.

Meteorological data, namely, total daily rainfall (mm), cumulative [1 January 2006–(14 May 2016–30 August 2016)] and [1 January 2006–(24 May 2017–7 October 2017)] total daily rainfall (mm), mean daily wind velocity (km/h), maximum daily wind velocity (km/h), mean daily temperature (°C), minimum daily temperature (°C), maximum daily temperature (°C), mean daily air humidity (%), minimum daily air humidity (%), maximum daily air humidity (%), mean daily air pressure (hPa), minimum daily air pressure (hPa) and maximum daily air pressure (hPa), has been collected from Dexameni–Kavala city–Eastern Macedonia & Thrace Prefecture–Greece private meteorological station (located at 40°56′25′′ N–E 24°24′01′′ E, Altitude:90 m).

The daily low stream flow rate (provided within Table A1) and the total daily rainfall for the two different time intervals (14 May 2016–30 August 2016 and 24 May 2017–7 October 2017) representing the two different time periods the Perigiali Stream, (Kavala city, Eastern Macedonia and Thrace Prefecture, North-Eeastern Greece) gauging station operated are depicted in contrast within the charts illustrated within the following Figure 3.

Low stream flow rate values were forecasted employing the Monte-Carlo method that is an appropriate type of iteration method both for meteorological as well as for river stream flow rate predictions. The fundamental procedure of the Monte Carlo method generates a certain number of trials in order to specify the anticipated value of a random variable.

Figure 2. Parshall flumes and V-Notched weir gauging station, Perigiali Stream area, Kavala city, Greece, (see Supplementary Materials).

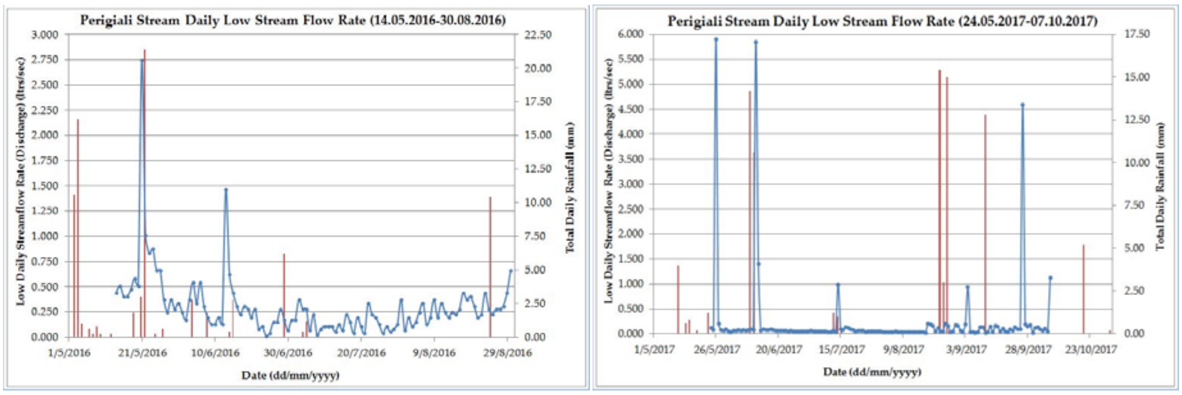

Figure 3. Parshall flumes and V-Notched weir gauging station, Perigiali Stream area, Kavala city, Greece [Daily low stream flow rate (continuous horizontal fluctuating blue line vs. Total daily rainfall (continuous vertical red bars), (14 May 2016–30 August 2016, on the **left**), (24 May 2017–7 October 2017, on the **right**)].

The presence of the 13 independent meteorological variables (predictors) involved implies a multivariate case, hence we constructed a linear equation containing all those variables, seeking a model relating those independent variables (predictors) and the daily low stream flow rate (dependent variable); More specifically, we followed the multiple regression procedure estimating a linear equation of linear form, (where "Y" represents the), as depicted within Equation (1):

$$Y = b_1Xz_1 + b_2Xz_2 + b_3Xz_3 + b_4Xz_4 + b_5Xz_5 + b_6Xz_6 + b_7Xz_7 + b_8Xz_8 + b_9Xz_9 + b_{10}Xz_{10} + b_{11}Xz_{11} + b_{12}Xz_{12} + b_{13}Xz_{13}, \quad (1)$$

It should be noted that, although each of these independent variables can have a unique distribution we assumed, by the beginning, that all of them follow a uniform distribution, an assumption which doesn't violates the results and this conclusion is derived by examining the related statistical criteria (mean, median, skewness, kurtosis etc.), as depicted within the following Table 1.

Table 1. Statistical criteria of Monte Carlo simulation for Perigiali Stream, Kavala city, Greece.

Number of Iterations	Expected Daily Low Stream Flow Rate (Mean)	Median	Standard Deviation	True (Reviewed) Error of the Estimate	Kurtosis	Skewness
2138	2.596	2.614	1.858	0.121 (4.644%)	−0.383	0.017

Furthermore, we considered that each variable is independent of the others, meaning that each variable's value is not affected by the value of any other independent variable.

The corresponding coefficients b_1, …, b_{13}, involved within Equation (1), were computed employing "MS Excel Solver" ("add-in") tool, in a way that minimizing the squared deviation (squared residuals) between observed and simulated daily low stream flow rate values was considered as a constraint. The positive values resulted from the procedure were collected afterwards in order to continue the procedure and we found the minimum and maximum simulated values, namely, (0.001, 4.784).

Then we implemented the model derived from Equation (1) employing the same computed coefficients values as well as the minimum and maximum values of all the independent variables resulting, correspondingly, to the calculation of the respective minimum and maximum values of the dependent variable "Y" (daily low stream flow rate) values, namely, (1.583, 3.503) which lie between the interval margins defined by the previously referred corresponding values, namely, (0.001, 4.784). The procedure followed implies that any value of these independent variables employed herewith lie within a certain (respective to the nature of each one) interval.

Although several commercial packages running Monte Carlo Simulation are available, however a conventional "MS Excel" spreadsheet was employed to perform the simulation. In the present study, the multiple trials generation is enhanced by establishing a certain basic formula as many times as the number of iterations determined by the specified model.

Following this procedure, the daily low stream flow rate is a random dependent variable with a value which lies within the interval determined by the anticipated minimum and maximum daily low stream flow rate values. As an outcome, this dependent variable will be normally distributed since it represents the outcome of summing a number of certain random independent variables. This result justifies the reason that the specific distribution followed by each independent variable is not considered of a paramount importance.

The general architecture of the Monte Carlo method can be described as following:

- Generating random values for each of the independent (meteorological) variables involved
- Introduce each different series of random values involved to arrive at a total daily low stream flow rate value (dependent variable "Y")
- The anticipated daily low stream flow rate value is then considered the average resulted from these values.

4. Results

Below, a number of parameters that can be computed to conclude respecting the goodness of the derived simulating solution is illustrated and discussed. More specifically, the number of iterations required by the model, the expected daily low stream flow rate (mean, average) and the rest of statistical criteria (median, standard deviation, true error of the estimate, kurtosis and skewness) are depicted within the following Table 1.

The median arithmetic value is very close to the mean corresponding one (with a difference of only 0.69%) implying that the dependent variable "Y" (daily low stream flow rate) follows the normal distribution. The standard deviation was computed taking into consideration the entire range of the 2138 values of the population and is regarded as a fairly low one in value. The kurto-sis statistic metric value which is considered a relative measure of the shape (of the finally achieved distribution) compared with the shape of the normal distribution (which has a kurtosis value of 0) informs us that the finally achieved distribution (of the independent variable "Y") is somewhat flatter than a normal distribution. Furthermore, skewness arithmetic value provides us information with reference to how symmetric is the finally achieved distribution while compared with a normal distribution which has a skewness arithmetic value of 0. In this study, the skewness arithmetic value of 0.017 suggests that the tail of the finally achieved distribution of the dependent variable extends somewhat towards the right.

Furthermore, after having simulated all the observed daily low stream flow rate values, the discrepancy ratio could be computed as an additional statistical performance metric [21].

5. Discussion and Conclusions

The Monte Carlo simulation method was employed and implemented to model the observed daily low stream low rate values of Perigiali Stream, Kavala city, Eastern Macedonia and Thrace Prefecture, North-Eastern Greece. Firstly, a multiple regression linear model was designed by investigating the relationships existing between the independent meteorological variables and the dependent one "Y" (daily low stream flow rate values) and the corresponding coefficients (b_1, b_2…, b_{12}, b_{13}) of the independent variables were computed and produced the minimum and maximum marginal interval limits of the simulated daily low stream flow rate values range. Then, the "MS Excel Solver" ("add-in") tool was employed, in a way to minimize, as a constraint, the squared deviation (squared residuals) between observed and simulated daily low stream flow rate values. A conventional "MS Excel" spreadsheet was employed to establish and run the determined simulation, generating multiple trials by establishing a basic formula 2138 iterations times as required by the established model. Then, by assuming that each variable follows a uniform distribution we employed the "MS Excel" "RAND ()" function generating random numbers lying within the interval (0, 1) and multiplied these by the values of the entire range of all the independent meteorological variables. This range of values is actually determined by the difference between the corresponding maximum and minimum values. Then, we determined the number of iterations required by the model and computed the anticipated value of the daily low stream flow rate and also predicted the estimation error, which is proportional to the number of iterations. The computed statistical performance metrics indicates that by assuming from the beginning that the dependent variable (daily low stream flow rate values) "Y" follows a normal distribution did not compromise the results.

The expected daily low stream flow rate value (2.596 L/s) is considered rather fairly high, when compared with the most of the observed ones, suggesting that the observed low stream flow rate values might should be clustered in different arithmetic classes in accordance with their magnitude and manipulated independently by implementing the Monte Carlo procedure to each different class yielding simulated values of different magnitudes correspondingly to each class.

6. Further Research

Additionally, other architectural types of models, such as Artificial Neural Networks (ANN) schemes should be designed in order to further investigate the relationships between the independent meteorological variables and the dependent variable (daily low stream flow rate value) "Y", simulating daily low stream flow rate values of the maximum possible highest accuracy, enhancing watershed and drought management plans, water reservoirs designing, water deviation works for agricultural purposes, urban water management etc. [21].

Thus, the future extension of Perigiali Stream gauging station hydrological observations is considered, together with the collection of Dexameni private meteorogical station meteorological parameters, of paramount importance in order to further improve the various types of models which have been derived so far, (such as stochastic generation of artificial daily low stream flow rate data, design of artificial neural networks etc.), particularly, as far as the present study, the Monte Carlo simulation model.

Finally, the installation of additional gauging stations throughout the upstream area of the Perigiali watershed, by monitoring the stream flow rate regimes of the watershed's headwaters and low order streams, would contribute significantly to the broader understanding of the Perigiali catchment response, introducing additional parameters to the hydrological investigation thus further the derived hydrological models development.

Supplementary Materials: The following are available online at https://www.youtube.com/watch?v=Wu8KBj3qqXg, Video S1: Watershed Stream Flow Measurement—Stream Perigiali—2016.06.18—Kavala City—Greece, https://www.youtube.com/watch?v=-HbPZLNGplY&feature=youtu.be, Video S2: Watershed Stream Flow Measurement—Stream Perigiali—2017.07.27(a)—Kavala City—Greece (08:16:49 a.m.).

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The dates of all measurements as well as both the site measured as well as the calculated stream flow rates of Perigiali Stream are presented in Table A1.

Table A1. Stream flow rate measurements of Perigiali Stream.

No.	Date	Stream Flow Rate (m^3/s) Site-Measured
1	14-5-2016	0.4370
2	15-5-2016	0.5080
3	16-5-2016	0.4030
4	17-5-2016	0.4030
5	18-5-2016	0.4720
6	19-5-2016	0.5830
7	20-5-2016	0.5080
8	21-5-2016	2.7460
9	22-5-2016	1.0110
10	23-5-2016	0.8300
11	24-5-2016	0.8740
12	25-5-2016	0.6620
13	26-5-2016	0.6620
14	27-5-2016	0.3700
15	28-5-2016	0.2488
16	29-5-2016	0.3701
17	30-5-2016	0.2775
18	31-5-2016	0.3381
19	1-6-2016	0.2488
20	2-6-2016	0.1700
21	3-6-2016	0.3701
22	4-6-2016	0.5451
23	5-6-2016	0.3381
24	6-6-2016	0.5450
25	7-6-2016	0.3072
26	8-6-2016	0.1950
27	9-6-2016	0.1238
28	10-6-2016	0.1238
29	11-6-2016	0.1950
30	12-6-2016	0.1238
31	13-6-2016	1.4650
32	14-6-2016	0.6220
33	15-6-2016	0.4371
34	16-6-2016	0.3072
35	17-6-2016	0.2213

36	18-6-2016	0.3072
37	19-6-2016	0.2775
38	20-6-2016	0.1950
39	21-6-2016	0.2775
40	22-6-2016	0.0832
41	23-6-2016	0.1028
42	24-6-2016	0.0115
43	25-6-2016	0.0344
44	26-6-2016	0.1462
45	27-6-2016	0.1462
46	28-6-2016	0.2775
47	29-6-2016	0.1700
48	30-6-2016	0.0652
49	1-7-2016	0.1700
50	2-7-2016	0.1700
51	3-7-2016	0.3701
52	4-7-2016	0.2775
53	5-7-2016	0.2775
54	6-7-2016	0.0652
55	7-7-2016	0.2213
56	8-7-2016	0.0218
57	9-7-2016	0.0832
58	10-7-2016	0.1028
59	11-7-2016	0.1028
60	12-7-2016	0.1028
61	13-7-2016	0.0489
62	14-7-2016	0.1238
63	15-7-2016	0.0652
64	16-7-2016	0.2213
65	17-7-2016	0.1462
66	18-7-2016	0.0344
67	19-7-2016	0.1950
68	20-7-2016	0.1028
69	21-7-2016	0.0344
70	22-7-2016	0.3381
71	23-7-2016	0.2213
72	24-7-2016	0.1950
73	25-7-2016	0.1238
74	26-7-2016	0.0340
75	27-7-2016	0.1028
76	28-7-2016	0.0489
77	29-7-2016	0.0832
78	30-7-2016	0.1238
79	31-7-2016	0.3701
80	1-8-2016	0.0652
81	2-8-2016	0.1950
82	3-8-2016	0.1028
83	4-8-2016	0.1462
84	5-8-2016	0.2488
85	6-8-2016	0.3381
86	7-8-2016	0.1238
87	8-8-2016	0.1950

88	9-8-2016	0.3701
89	10-8-2016	0.1950
90	11-8-2016	0.3381
91	12-8-2016	0.2488
92	13-8-2016	0.1950
93	14-8-2016	0.2488
94	15-8-2016	0.2219
95	16-8-2016	0.2775
96	17-8-2016	0.4371
97	18-8-2016	0.3701
98	19-8-2016	0.4031
99	20-8-2016	0.3072
100	21-8-2016	0.1950
101	22-8-2016	0.2213
102	23-8-2016	0.4371
103	24-8-2016	0.2775
104	25-8-2016	0.2213
105	26-8-2016	0.2775
106	27-8-2016	0.2775
107	28-8-2016	0.3072
108	29-8-2016	0.4371
109	30-8-2016	0.6616
110	24-5-2017	0.1210
111	25-5-2017	0.0820
112	26-5-2017	5.9150
113	27-5-2017	0.2130
114	28-5-2017	0.0820
115	29-5-2017	0.0650
116	30-5-2017	0.1010
117	31-5-2017	0.0490
118	1-6-2017	0.0340
119	2-6-2017	0.0650
120	3-6-2017	0.0650
121	4-6-2017	0.0820
122	5-6-2017	0.0650
123	6-6-2017	0.0820
124	7-6-2017	0.0650
125	8-6-2017	0.0820
126	9-6-2017	0.1010
127	10-6-2017	0.0820
128	11-6-2017	5.8560
129	12-6-2017	1.4010
130	13-6-2017	0.0650
131	14-6-2017	0.1010
132	15-6-2017	0.0820
133	16-6-2017	0.0820
134	17-6-2017	0.1010
135	18-6-2017	0.0820
136	19-6-2017	0.0650
137	20-6-2017	0.0650
138	21-6-2017	0.0650
139	22-6-2017	0.0650

140	23-6-2017	0.0650
141	24-6-2017	0.0490
142	25-6-2017	0.0650
143	26-6-2017	0.0490
144	27-6-2017	0.0490
145	28-6-2017	0.0490
146	29-6-2017	0.0490
147	30-6-2017	0.0490
148	1-7-2017	0.0490
149	2-7-2017	0.0490
150	3-7-2017	0.0645
151	4-7-2017	0.0486
152	5-7-2017	0.0486
153	6-7-2017	0.0486
154	7-7-2017	0.0486
155	8-7-2017	0.0486
156	9-7-2017	0.0486
157	10-7-2017	0.0344
158	11-7-2017	0.0344
159	12-7-2017	0.0645
160	13-7-2017	0.0344
161	14-7-2017	0.9872
162	15-7-2017	0.1007
163	16-7-2017	0.0819
164	17-7-2017	0.1421
165	18-7-2017	0.1208
166	19-7-2017	0.1007
167	20-7-2017	0.0819
168	21-7-2017	0.0486
169	22-7-2017	0.0645
170	23-7-2017	0.0645
171	24-7-2017	0.0645
172	25-7-2017	0.0344
173	26-7-2017	0.0486
174	27-7-2017	0.0486
175	28-7-2017	0.0486
176	29-7-2017	0.0486
177	30-7-2017	0.0486
178	31-7-2017	0.0486
179	1-8-2017	0.0344
180	2-8-2017	0.0344
181	3-8-2017	0.0344
182	4-8-2017	0.0344
183	5-8-2017	0.0344
184	6-8-2017	0.0486
185	7-8-2017	0.0344
186	8-8-2017	0.0344
187	9-8-2017	0.0344
188	10-8-2017	0.0344
189	11-8-2017	0.0344
190	12-8-2017	0.0344
191	13-8-2017	0.0344

192	14-8-2017	0.0344
193	15-8-2017	0.0344
194	16-8-2017	0.0344
195	17-8-2017	0.0344
196	18-8-2017	0.0221
197	19-8-2017	0.2060
198	20-8-2017	0.1890
199	21-8-2017	0.1670
200	22-8-2017	0.0486
201	23-8-2017	0.1210
202	24-8-2017	0.0486
203	25-8-2017	0.0486
204	26-8-2017	0.2070
205	27-8-2017	0.1690
206	28-8-2017	0.0344
207	29-8-2017	0.0486
208	30-8-2017	0.1770
209	31-8-2017	0.1710
210	1-9-2017	0.0730
211	2-9-2017	0.0470
212	3-9-2017	0.1930
213	4-9-2017	0.9439
214	5-9-2017	0.0344
215	6-9-2017	0.0360
216	7-9-2017	0.0320
217	8-9-2017	0.0430
218	9-9-2017	0.1390
219	10-9-2017	0.1370
220	11-9-2017	0.0220
221	12-9-2017	0.0344
222	13-9-2017	0.1450
223	14-9-2017	0.0344
224	15-9-2017	0.1610
225	16-9-2017	0.1490
226	17-9-2017	0.0486
227	18-9-2017	0.1080
228	19-9-2017	0.0486
229	20-9-2017	0.0344
230	21-9-2017	0.0990
231	22-9-2017	0.0714
232	23-9-2017	0.1380
233	24-9-2017	0.0996
234	25-9-2017	0.0934
235	26-9-2017	4.6003
236	27-9-2017	0.1870
237	28-9-2017	0.1510
238	29-9-2017	0.1790
239	30-9-2017	0.0330
240	1-10-2017	0.1280
241	2-10-2017	0.1420
242	3-10-2017	0.0910
243	4-10-2017	0.0650

244	5-10-2017	0.1050
245	6-10-2017	0.0590
246	7-10-2017	1.1245

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