Generation of Missing Rain at the Dabola Weather Station in the Republic of Guinea

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Abstract— *The purpose of this research is to determine the missing rainfall data from the Dabola weather station, for the purpose of energy exploitation of the Kalako site on the Tinkisso river. The method of reconstituting the pluviometric data known as of "Generation of long series of contributions from the rains" where method of "Reconstitution of the missing data", was used to calculate the total pluviometric P_x missing from the series of the meteorological station of Dabola. To this end, we used rainfall data over a 42 years period from the three neighboring stations: Mamou, Faranah and Dinguiraye to determine the 82 months of missing data from the Dabola station. Thus, we determined the missing rainfall totals, given in Table II. In addition, it was calculated: the rainfall standards of the three stations $\left(\overline{P_i}\right)$: Mamou station: $\overline{P_1}$ =1749,1 mm, Faranah station: $\overline{P_2}$ =1879,5 mm, Dinguiraye station: $\overline{P_3}$ =1303,9mm, the average interannual precipitation of Dabola P_0^{int} = 296,16 mm and the average rainfall total for the Dabola station $\overline{P_X}$ =1149,5 mm. This method could be used for the study of many sites, whose pluviometric data are not complete, for the purpose of their energy, climatological and environmental recovery. However, the distance separating two neighboring stations must be approximately 150Km.*

Keywords— *Generation, rainfall, precipitation, weather station.*

I. INTRODUCTION

The treatment of the rainfall data missing from a series of observations is a relevant problem for many hydrological, environmental climatological analyzes, etc. [1, 2]. To overcome the problem, a number of technical interpolations have been developed over the decades, aimed at estimating missing observations in climate time series, mainly on a monthly and seasonal basis [3, 4]. The situation becomes particularly complicated when it comes to precipitation, due to its large space and the variability of weather; moreover, in this case the problem is twofold, since the place of time and the amount of precipitation of each event of a day must be reconstructed. The need for complete and continuous chronological data collected over a long period of time from several weather or rain stations for a number of parameters such as very essential for hydrological studies. however, the problem of incomplete or missing observation of precipitation data is a big challenge [5, 6]. The pluviometric data measured directly in the field by the national meteorological services have the advantage of often providing long series of observations essential for the evaluation of the energy potential of a site, works of applied climatology, the detection of changes climatic conditions. However, these data have certain limits: such as the presence of missing values in the series. These shortcomings can be the consequence of various recording problems, such as a mechanical failure in the case of automatic rain gauges, a temporary absence of observers in the case of manual rain gauges or even the temporary and / or permanent stop of the measurement. These gaps are of considerable importance in our regions where the number of rain gauges is very small compared to the densities recommended by the World Meteorological Organization (at least one station for 575 km² in the plain and 250 km² in the mountainous area) [7, 8] . Also, these gaps in time series are a real problem for many other scientific applications which require complete continuous series. We can cite for instance, hydrologists for whom daily precipitation is necessary as input for rain-flow models [9], climatologists who use them in the study of droughts [10, 11, 12]. To get around this major difficulty, statistical tools are used to reconstruct the missing data. Thus, daily rainfall data can be generated or reconstructed using the stochastic generation method [13, 14, 15, 16].

In this research, we used the method of "Generation of long series of inputs from the rains" or method of "Reconstitution of non-existent data" to determine the missing pluviometric quantities from the Dabola meteorological station [17]. These missing data at 82 months over 42 years of observations have been reconstructed.

II. MATERIAL AND METHOD

A. Presentation of the Study Area

The Dabola city is a prefecture. It is located in the central part of the Republic of Guinea, 430 km from Conakry, between 11 ° 30 'and 11 ° 35' West longitude and 10 ° 20 'and 11 ° 00' North latitude. Its area is 6,350 km^2 with a total population of 150,658 inhabitants, i.e. a density of 24 inhabitants / km^2 today.

II.1Material

We used the mathematical formulas of applied statistics in Hydrology, Excel software. Table I, indicates the data of missing rains (82 months) from the meteorological station of Dabola for the period of: 1971-2012 (42 years).

TABLE I. Missing rainfall data in mm from Dabola Station in Guinea

Years / Month	Janu	Feb	March	April	May	Jun	Jul	Augt	Sept	Oct	Nov	Dec	Sum. ann
1971	0,0	0,0	0,0	134,0	81,1	261,7	229,7	526,7	274,2	94,3	0	14,5	**1616,2**
1972	0,0	0,0	5,7	45,2	199,3	183,7	259,9	282,6	317,4	79,4	65,1	0	**1438,3**
1973	0,0	0,0	0,0	34,0	249,3	278,4	292,9	434,2	257,3	166,1	8,3	0	**1720,5**
1974	0,0	0,0	6,1	28,8	133,6	253,9	323,7	296,5	218,2	112,1	3,6	0	**1376,5**
1975	0,0	0,0	0,0	43,6	79,6	202,4	297,2	182,8	461,9	158,5	23,6	0	**1449,6**
1976	0,0	0,0	18,4	35,8	49,2	231,3	217,5	251,2	204,4	317,2	55,1	0,0	**1380,1**
1977	0,0	0,0	2,8	18,3	20,8	168,9	27,7	265,2	239,3	132,3	0,0	0	**875,3**
1978	18,7	0,0	10,2	108,2	102,3	174,8	176,5	263,9	243,8	179,3	0,0	0	**1277,7**
1979	0	0,0	5,8	2,3	29,4	211,7	198,3	276,0	174,6		50,8	0	**948,9**
1980	0	3,2	0,0	50,0	114,0	216,3	239,0	228,5	237,0	128,8	80,2	0	**1297,0**
1981	0	70,7	15,3	157,5	212,0	214,5	261,7	165,0	47,0		0,0	0	**1143,7**
1982	0	0,0	6,1	97,6	65,4	171,2	244,2	300,4	180,2				**1065,1**
1983													**0,0**
1984	0	0	0,0	49,1	85,6	54,0	104,3	131,8	336,5	116,0	42,0		**919,3**
1985	0	0	0,7	6,1	58,5	158,9	247,1	270,9	259,0	99,4	2,0	0	**1102,6**
1986	0	0	0	78,8	106,9	65,4	250,7	308,9	266,6	190,0			**1267,3**
1987	0	0	0	1,5	190,8					138,9	0,0	0	**331,2**
1988	0	0	0	0	0								**0,0**
1989	0,0	8,0	0	29,1	147,2	184,8	201,0	244,2	333,6	183,0	8,9	0	**1339,8**
1990													**0,0**
1991													**0,0**
1992													**0,0**
1993	0	34,7	109,6	127,6	124,6	308,2	448,5	300,4	390,4	155,4	0,0	0	**1999,4**
1994	0	11,1	0,0	13,3	197,3	278,2	381,4	280,9	256,8	151,8	44,0	0	**1614,8**
1995	0	0,0	98,1	95,3	122,1	131,1	194,8	509,7	245,4	146,2	0,0	14,6	**1557,3**
1996	8,5	0,0	0,0	55,3	178,4	179,4	302,1	279,7	374,1	144,6	0,0	0,0	**1522,1**
1997	0,0	0,0	2,1	43,9	151,0	208,3	157,8	240,8	414,0	189,8	24,0	0,0	**1431,7**
1998	0	0	9,8	21,9									**31,7**
1999	0	0	0,0	86,0	85,6			299,3	319,5	213,4	34,4	0	**1038,2**
2000	0,4	3,0	10,0	96,0	105,0	110,2	288,6	317,1	388,1	115,1	60,7	0	**1494,2**
2001	0	0	1,5	9,0	105,7	154,3	164,6	567,8	251,1	99,8	87,7	0	**1441,5**
2002	0	0	0	13,2	64,5	217,7	290,5	417,2	303,7	156	0,0	0	**1462,8**
2003	0,5	0	0	46,9	73,7	193,1	289,5	408,1	262,2	95,7	41,0	0	**1410,7**
2004	0	0	0	222,1	68,5	103,8	414,0	202,1	325,5				**1336,0**
2005	0	22,1	15,0	32,4	136,7	207,6	208,8	248,1	305,4	71,9	1,0	0	**1249,0**
2006	0	0	0,3	87,0	130,9	177,6	357,6	290,3	276,5	200,3	0,0	0	**1520,5**
2007	0	0	0	38,3	64,6	85,9	291,6	528,5	377,3	116,3	8,9	0	**1511,4**
2008	0	0	0,3	60,7	178,8	132,0	405,4	405,9	189,7	143,6	0	0	**1516,4**
2009	0	2,4	7,1	10,8	89,2	146,9	219,2	354,7	323,6	142,8	0,5	0	**1297,2**
2010	0	0	5,6	27,6	134,3	127,8	297,2	388,1	227,4	178,1	7,1	0	**1393,2**
2011	0	0	48,9	36,6	186,3	294,4	253,4	407,6	288,7	85,2	0	0	**1601,1**
2012	0	0	0,0	18,9	192,5	144,5	149,6	310,8	231,5	225	27,8	0	**1300,6**

II.2Method

The method of reconstituting the pluviometric data used, is that known as of "Generation of long series of contributions from the rains" where method of "Filling of the missing data" [17]. This method makes it possible to calculate the total rainfall Px missing in the station series. To this end, rainfall data from the three stations neighboring the site to be studied are used. The missing rainfall data Px is obtained by the relation (1):

$$P_X = \left(\frac{\overline{P_X}}{\overline{P_1}} x P_1 + \frac{\overline{P_X}}{\overline{P_2}} x P_2 + \frac{\overline{P_X}}{\overline{P_3}} x P_3 \right) \quad (1)$$

Where :

P_X : the total rainfall of the station closest to site X, in mm;

$\overline{P_X}$: the total annual average rainfall of station X, in mm;

$\overline{P_1}$, $\overline{P_2}$, $\overline{P_3}$: average annual rainfall standards for neighboring stations 1, 2, 3, in mm;

P_1, P_2, P_3 : the monthly rainfall totals for stations 1, 2, 3 for the months examined in mm.

Rainfall data from Dabola and neighboring stations: Mamou, Faranah and Dinguiraye, were collected from Meteorological services over a period of 42 years (1971-2012) [18]. For the Dabola station, the monthly rainfall totals of 82 months were missing.

Ii.2.1. Calculation of rain standards for the four stations

The rainfall total for October 1979 for Dabola Station is missing. To reconstruct it, we calculate them $\overline{P_i}$ for the three stations. These rainfall standards are calculated by relation (2) [17]:

$$\overline{P_i} = \frac{\sum P}{n} \quad (2)$$

Where :

$\sum P$: the sum of the average precipitation in mm;

n : the number of years of observation, taken equal to 42 years for this study.

II.2.2. Calculation of the average rain total of the Dabola station

The average rainfall total $\overline{P_X}$ is also calculated in the same way as relation (2).

II.2.3. Calculation of the total rainfall of the Dabola station (Px)

Precipitation P_1, P_2, P_3 respectively of the stations of Mamou, Faranah and Dinguiraye for the month of October 1979 are as follows:

- P_1=147 mm (Mamou Precipitation for October 1979);
- P_2=158,1 mm (Faranah Precipitation for October 1979);
- P_3=111,3 mm (Dinguiraye Precipitation for October 1979).

Ii.2.4. Evaluation of the maximum annual precipitation of the Dabola station

To determine the hydrometric quantities which are: the coefficients of variability, asymmetry, theoretical modulus and flow, the flow, the height of precipitation, of a site, we use the maximum annual precipitation of the station of Dabola. These maximum annual precipitations correspond to the greatest values of the pluviometry in the table of the pluviometric data reconstituted. These values, reported in Table III, are classified in decreasing order of magnitude.

Ii.2.5. Interannual average precipitation

The average interannual precipitation is calculated for the entire observation period (42 years) by relation (3) :

$$P_0^{\text{int}} = \frac{\sum_{i=1}^{n} P_i^{an}}{n} \quad (3)$$

Where :

$\sum_{i=1}^{n} P_i^{an}$: is the sum of average annual precipitation, n = 42 years, the number of years of observations.

TABLE II. Reconstructed missing rainfall data from the Dabola station

Year / Month	Jn	Feb	Mac	April	May	Jun	Jul	Augst	Sept	Oct	Nov	Dec	Sum. ann
1971	0,0	0,0	0,0	134,0	81,1	261,7	229,7	526,7	274,2	94,3	**40,5**	14,5	1656,7
1972	0,0	0,0	5,7	45,2	199,3	183,7	259,9	282,6	317,4	79,4	65,1	0	1438,3
1973	0,0	0,0	0,0	34,0	249,3	278,4	292,9	434,2	257,3	166,1	8,3	0	1720,5
1974	0,0	0,0	6,1	28,8	133,6	253,9	323,7	296,5	218,2	112,1	3,6	0	1376,5
1975	0,0	0,0	0,0	43,6	79,6	202,4	297,2	182,8	461,9	158,5	23,6	0	1449,6
1976	0,0	0,0	18,4	35,8	49,2	231,3	217,5	251,2	204,4	317,2	55,1	0,0	1380,1
1977	0,0	0,0	2,8	18,3	20,8	168,9	27,7	265,2	239,3	132,3	0,0	0	875,3
1978	18,7	0,0	10,2	108,2	102,3	174,8	176,5	263,9	243,8	179,3	0,0	0	1277,7
1979	0	0,0	5,8	2,3	29,4	211,7	198,3	276,0	174,6	**97,1**	50,8	0	1046,0
1980	0	3,2	0,0	50,0	114,0	216,3	239,0	228,5	237,0	128,8	80,2	0	1297,0
1981	0	70,7	15,3	157,5	212,0	214,5	261,7	165,0	47,0	**96,4**	**6,5**	0	1246,6
1982	0	0,0	6,1	97,6	65,4	171,2	244,2	300,4	180,2	**122,7**	**30,8**	**0,0**	1218,6
1983	**0,0**	**1,7**	**5,7**	**32,1**	**91,0**	**153,8**	**174,3**	**252,2**	**214,6**	**71,9**	**18,1**	**0,5**	1015,9
1984	0	0	0,0	49,1	85,6	54,0	104,3	131,8	336,5	116,0	42,0	**0,0**	919,3
1985	0	0	0,7	6,1	58,5	158,9	247,1	270,9	259,0	99,4	2,0	0	1102,6
1986	0	0	0	78,8	106,9	65,4	250,7	308,9	266,6	190,0	**23,9**	**0**	1291,2
1987	0	0	0	1,5	190,8	**127,3**	**154,3**	**233,4**	**218,2**	138,9	0,0	0	1064,4
1988	0	0	0	0	0	**152,4**	**222**	**200,2**	**145,8**	**52,9**	**35,7**	**0**	809,0
1989	0,0	8,0	0	29,1	147,2	184,8	201,0	244,2	333,6	183,0	8,9	0	1339,8
1990	**0,0**	**0,8**	**0,0**	**54,2**	**66,2**	**107**	**211,5**	**172,8**	**218,8**	**85,3**	**17,5**	**2,98**	937,1
1991	**0,6**	**2,2**	**2,1**	**36,1**	**68,7**	**120,9**	**202,2**	**213,1**	**167,7**	**110,3**	**4,6**	**0,3**	928,8
1992	**0,0**	**4,7**	**0,1**	**28,5**	**88,4**	**112,9**	**183,4**	**247,2**	**164,1**	**124,3**	**11,5**	**0,1**	965,2
1193	0	34,7	109,6	127,6	124,6	308,2	448,5	300,4	390,4	155,4	0,0	0	1999,4
1994	0	11,1	0,0	13,3	197,3	278,2	381,4	280,9	256,8	151,8	44,0	0	1614,8
1995	0	0,0	98,1	95,3	122,1	131,1	194,8	509,7	245,4	146,2	0,0	14,6	1557,3
1996	8,5	0,0	0,0	55,3	178,4	179,4	302,1	279,7	374,1	144,6	0,0	0,0	1522,1
1997	0,0	0,0	2,1	43,9	151,0	208,3	157,8	240,8	414,0	189,8	24,0	0,0	1431,7
1998	0	0	9,8	21,9	**90,5**	**144,5**	**167,1**	**321,8**	**233**	**134,8**	**0**	**0,0**	1123,4
1999	0	0	0,0	86,0	85,6	**169,6**	**191,3**	299,3	319,5	213,4	34,4	0	1399,1
2000	0,4	3,0	10,0	96,0	105,0	110,2	288,6	317,1	388,1	115,1	60,7	0	1494,2
2001	0	0	1,5	9,0	105,7	154,3	164,6	567,8	251,1	99,8	87,7	0	1441,5
2002	0	0	0	13,2	64,5	217,7	290,5	417,2	303,7	156	0,0	0	1462,8
2003	0,5	0	0	46,9	73,7	193,1	289,5	408,1	262,2	95,7	41,0	0	1410,7
2004	0	0	0	222,1	68,5	103,8	414,0	202,1	325,5	**61,5**	**47,9**	**0,0**	1445,4
2005	0	22,1	15,0	32,4	136,7	207,6	208,8	248,1	305,4	71,9	1,0	0	1249,0
2006	0	0	0,3	87,0	130,9	177,6	357,6	290,3	276,5	200,3	0,0	0	1520,5
2007	0	0	0	38,3	64,6	85,9	291,6	528,5	377,3	116,3	8,9	0	1511,4
2008	0	0	0,3	60,7	178,8	132,0	405,4	405,9	189,7	143,6	0	0	1516,4
2009	0	2,4	7,1	10,8	89,2	146,9	219,2	354,7	323,6	142,8	0,5	0	1297,2
2010	0	0	5,6	27,6	134,3	127,8	297,2	388,1	227,4	178,1	7,1	0	1393,2
2011	0	0	48,9	36,6	186,3	294,4	253,4	407,6	288,7	85,2	0	0	1601,1
2012	0	0	0,0	18,9	192,5	144,5	149,6	310,8	231,5	225	27,8	0	1300,6
San	**28,7**	**164,6**	**387,3**	**2213,6**	**4719,5**	**7321,3**	**10192,1**	**12826,6**	**11164,1**	**5683,5**	**913,7**	**32,98**	55648,0

TABLE III. Maximum annual precipitation for Dabola station

Classified years	$P_i^{\max}$ Classified	$K_i = \frac{P_i^{an}}{P_0^{\text{int}}}$	$(K_i - 1)$	$(K_i - 1)^2$	$P = \frac{m}{n+1} x100$
2001	567,8	1,92	0,92	0,8413	2,326
2007	528,5	1,78	0,78	0,6155	4,651
1995	509,7	1,72	0,72	0,5199	6,977
1975	461,9	1,56	0,56	0,3132	9,302
2002	417,2	1,41	0,41	0,1670	11,628
2003	408,1	1,38	0,38	0,1429	13,953
2011	407,6	1,38	0,38	0,1416	16,279
2008	405,9	1,37	0,37	0,1373	18,605
2009	405,9	1,37	0,37	0,1373	20,930
2010	388,1	1,31	0,31	0,0964	23,256
1984	336,5	1,14	0,14	0,0186	25,581
1989	333,6	1,13	0,13	0,0160	27,907
1998	321,8	1,09	0,09	0,0075	30,233
1972	317,4	1,07	0,07	0,0051	32,558
2000	317,1	1,07	0,07	0,0050	34,884
2012	310,8	1,05	0,05	0,0024	37,209
1993	300,4	1,01	0,01	0,0002	39,535
1999	299,3	1,01	0,01	0,0001	41,860
2006	290,3	0,98	-0,02	0,0004	44,186
1994	280,9	0,95	-0,05	0,0027	46,512
1996	279,7	0,94	-0,06	0,0031	48,837
1971	274,2	0,93	-0,07	0,0055	51,163
1986	266,6	0,90	-0,10	0,0100	53,488
1985	259	0,87	-0,13	0,0157	55,814
1973	257,3	0,84	-0,16	0,0263	58,140
2005	248,1	0,84	-0,16	0,0263	60,465
1992	247,2	0,83	-0,17	0,0273	62,791
1978	243,8	0,82	-0,18	0,0313	65,116
1997	240,8	0,81	-0,19	0,0349	67,442
1977	239,3	0,81	-0,19	0,0369	69,767
1980	237	0,80	-0,20	0,0399	72,093
1990	218,8	0,74	-0,26	0,0682	74,419
1974	218,2	0,74	-0,26	0,0693	76,744
1987	218,2	0,74	-0,26	0,0693	79,070
1983	214,6	0,72	-0,28	0,0758	81,395
1991	213,1	0,72	-0,28	0,0787	83,721
1976	204,4	0,69	-0,31	0,0960	86,047
2004	202,1	0,68	-0,32	0,1009	88,372
1982	180,2	0,61	-0,39	0,1533	90,698
1979	174,6	0,59	-0,41	0,1685	93,023
1988	145,8	0,49	-0,51	0,2578	95,349
1981	47	0,16	-0,84	0,7078	97,674
Sn	**12438,8**			**5,2730**	

II.2.6. Precipitation module (K_i) coefficients for the whole period

These coefficients determine the variability of precipitation in the area per year. They are calculated by the relation (4):

$$K_i = \frac{P_i^{an}}{P_0^{\text{int}}} \quad (4)$$

Or: P_i^{an} is the average precipitation for each year.

II.2.7. The width of the arithmetic average values (K_i - 1)

The values of the spacing, as well as those of the standard deviation squared and the probability of overshoot P_r , are calculated and given in table III, where m is the serial number.

III. Results And Discussion

The results obtained after the application of the reconstitution method and the determination of certain parameters essential to this study are given below:

III.1. Rain Standards for the Four Stations

The calculations of the rainfall standards of the three stations close to that of Dabola give us :

- *Mamou Station*: $\overline{P_1}$ =1749,1 mm;
- *Faranah Station* : $\overline{P_2}$ =1879,5 mm ;
- *Dinguiraye Station* : $\overline{P_3}$ =1303,9 mm.

III.2. Total Average Rainfall from Dabola Station **(** $\overline{P_X}$ **)**

The calculation of the average rainfall total for the Dabola station gives: $\overline{P_X}$ *= 1149,5 mm.*

III.3. Total Rainfall for Dabola Station (P_x)

The application of the relation (1) in October for the calculation of the missing pluviometry of the weather station of Dabola gives: $P_{x(oct-1979)}$=97,1mm.

So, in the same way, the 82 month missing values of the pluviometry of the weather station of Dabola were calculated. The results obtained are shown in Table II (figures in bold).

III.4. Maximum Annual Precipitation of the Dabola Station $\left(P_n^{\max}\right)$

These maximum annual precipitations correspond to the largest values of the pluviometry in table II, of the pluviometric data reconstituted. These values, shown in Table III, are classified in decreasing order of magnitude.

III.5. Interannual Average Precipitation

The average interannual precipitation calculated from formula (3) is: P_0^{int} = 296,16mm.

III.6. Precipitation Module (K_i) Coefficients for the Whole Period

These values are calculated from formula (4). They are listed in Table III above. These are coefficients that determine the variability of precipitation in an area per year.

III.7. Spread of Arithmetic Average Values (K_i - 1)

The values of the spacing, as well as those of the standard deviation squared and the probability of overshoot P_r , are calculated and given in the above table III.

IV. CONCLUSION

Using rainfall data collected from the four meteorological stations (Dabola, Mamou, Faranah and Dinguiraye), over a period of 42 years, the missing pluviometric data (82 months) were reconstructed for the meteorological station of Dabola using the method of filling in missing data.

In addition, the other rainfall parameters, were determined from data supplemented by Dabola, among others: the rainfall standards of the three stations ($\overline{P_i}$): Mamou station: $\overline{P_1}$ =1749,1 mm, Faranah station: $\overline{P_2}$ =1879,5 mm, Dinguiraye station: $\overline{P_3}$ =1303,9mm, the average interannual precipitation of Dabola P_0^{int} = 296,16mm and the average total rainfall of the station of Dabola ($\overline{P_X}$ =1149,5 mm).

In the near future, we are considering in perspective, a study on filling in the missing rainfall data for certain sites with significant energy potential.

This method could be used for the study of many other sites, whose pluviometric and hydrological data are not complete, for the purpose of their energy, climatological and environmental recovery. In view of this research, we plan to use this reconstitution method for other sites in Guinea while taking into account the error calculations and then, to evaluate the energy parameters of the Kalako site in Dabola for the establishment of a small hydroelectric power plant.

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