L-Moment and Frequency Distribution Curve FORTRAN Code QuickStart Guide

by

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1. Introduction

Before beginning the steps detailed in this Quick Start guide, it is assumed that the data to be used has already been quality-controlled. The FORTRAN code available to perform the next steps, including regionalization and L-Moment analysis, is divided into four separate programs. Each program has a different function in the process of creating a drought atlas and comes with unique input and output files. The overall sequence of running these programs and questions to ask with regards to discordancy and heterogeneity are given in Fig. 1 and summarized below.

After the data has been quality-controlled, it is run through cluster analysis using XCLUST.FOR. The results are a proposed set of regions to which all of the sites belong. L-Moments and quantiles are estimated for each region using XFIT.FOR. The resulting L-Moments are then used in XTEST.FOR to test for discordancy and heterogeneity within the region. If either of these tests fail according to a preset criteria, one or more sites are moved to another region. The program XFIT.FOR is run again to get a new set of L-Moments for the revised region. This process is repeated until the region passes the discordancy and heterogeneity tests. Descriptions of each program and the format of their respective input and output files are given in the following sections.

2. XCLUST

After the data is quality-checked, the area over which the data have been measured needs to be divided into homogeneous regions. As a first approximation this can be done by simply combining a good map of mean annual precipitation with seasonality and type of storm data and their source areas. If the area is large and the climate is complex, a statistical clustering algorithm can be helpful. The program XCLUST.FOR was developed for this purpose. Details on what information is required and the final results are given in the following sections.

2.1 Input File

Refer to Fig. 2 as you read this section. The input file is named XCLUST_INPUT.dat and requires several types of information. The number on the second line represents the number of sites in a particular region. The number two lines below provides the number of clusters into which to divide the sites. The list below this line contains at-site information, including site ID, latitude, longitude, area, elevation, number of records, L1, t, t3, t4, and t5. The first four L-Moments represent the mean, L-CV, L-Skew, and L-Kurtosis of the data sample. The value of t5 is required when fitting the five parameters of the Wakeby distribution.

The required information can be copied from a spreadsheet such as Microsoft Excel or Openoffice Calc (CAZALAC promotes open-source software and codes and freedom of information) and pasted into the input file. Because the column spacing is critical for FORTRAN input data a text editor program that allows for filing the input under ASCII format with no hidden characters is essential. A freeware program such as Editpad lite is recommended for this task. (http://www.editpadpro.com/editpadlite.html).

Depending on the site characteristics thought necessary to classify each site into a particular region, not all of the information mentioned above may be needed. For example, if L-Moments are not available, location, drainage area, seasonality and time of occurrence of the maximum and elevation may be sufficient to perform the cluster analysis. The final number of clusters into which all sites is classified is subjective and determined by the user while taking into account the overall characteristics of the larger study area. A note should be made that in regional frequency analysis, little is gained by using regions containing greater than 20 sites. In terms of a minimum number, this depends on the region and the variability of the data. A minimum of five sites would be preferred, but regional homogeneity should not be compromised in order to fulfill this minimum. For more information, refer to pages 180 – 182 of Hosking and Wallis (1997).

A note should be made that if different input variables that those described above are required to perform the cluster analysis, other statistical software (commercial and open-source) can be easily used.

2.2 Output File

Refer to Figs. 3a - d as you read this section. The results of XCLUST.exe are given in the file XCLUST_OUTPUT.dat. Each site in the input file is initially classified as a cluster itself, and one by one clusters are merged until one cluster remains. This process is illustrated in Fig. 3a. Depending on the number of final clusters desired, which is a required input in XCLUST_INPUT.dat, the output file shows in which cluster each site is located and the number of sites in each cluster (Fig. 3b). Similar results are again given in the output file after adjustments were made using the K-means algorithm (Fig. 3c). The final section of XCLUST_OUTPUT.dat (Fig. 3d) provides information on the area of each cluster and the location and elevation of each cluster center. The results of this analysis should then be tested for discordancy and homogeneity using the program XTEST.exe.

3. XFIT

After proposed regions have been tentatively defined using XCLUST.FOR or another method or software, the program XFIT.exe can be used to calculate the L-Moments at each measurement site. The program then determines the regional L-Moments and, using the results, fits a frequency distribution curve for the proposed region. From the regional distribution curve and the at-site mean precipitation amounts, XFIT.exe computes the at-site frequency distribution curves and quantiles. It should be noted that the resulting curves are only tentative until the discordancy and heterogeneity tests performed in XTEST.FOR classify the region as homogeneous. Each of the results will be explained in more detail in the description of the Output File.

3.1 Input File

Refer to Fig. 4 as you read this section. The input file is named XFIT_INPUT.data and consists of five pieces of information. The number on the second line identifies the type of distribution that is desired according to the list given below:

1. EXP: Exponential
2. GAM: Gamma
3. GEV: Generalized extreme-value
4. GLO: Generalized logistic
5. GNO: Generalized normal (lognormal)
6. GPA: Generalized Pareto
7. GUM: Gumbel
8. PE3: Pearson type III
9. NOR: Normal
10. KAP: Kappa
11. WAK: Wakeby

The fourth line contains a number that identifies the number of sites in the region. Each site will contain three kinds of information beginning with the first site on the second line of the file. This line begins with the Station ID given in parentheses followed by the name of the site. The Station ID, along with the parentheses, and the station name together can be no more than 32 characters long. The third line contains the number of years of data available at that site. The data is then listed below. The simplest way to enter the data is to copy it from a spreadsheet such as Microsoft Excel and paste the numbers into the input file beginning at the line below the line containing the number of years. This completes the information required for the first site.

Similar information for the next site should be entered following the previous site and beginning with the Site ID and name on the line below the last precipitation data value entered. Because the column spacing is critical for FORTRAN input data, a text editor program that allows for filing the input under ASCII format with no hidden characters is essential. A freeware program such as Editpad lite is recommended for this task. (http://www.editpadpro.com/editpadlite.html).

3.2 Output File

Refer to Fig. 5 as you read this section. The results after running XFIT.exe are given in XFIT_OUTPUT.dat. The first set of lines lists information for each site in the region. This information includes the ID, name, number of records, and the L-Moment ratios for each site. The site L-Moment ratios allow the calculation of average regional L-Moment ratios, which are given on the line after that of the final site. The regional L-Moments are then used to estimate the parameters (between 3 and 5) of the regional frequency distribution curve identified in the input file, which allows the calculation of the regional quantiles. The quantiles that were estimated are given in the first line under the heading "QUANTILES". The following line provides the regional values for these quantiles, which are used to construct the regional growth curve. The final set of lines lists the estimated quantile values for all sites. These values are computed by multiplying the mean (L1) for each site by each of the regional quantile values. The final numbers when plotted represent the at-site growth curves.

4. XTEST

The program XTEST.exe computes discordancy, heterogeneity, and goodness-of-fit statistics using the L-Moments already calculated for the various sites as described above with XFIT.FOR. The results will give an idea of whether the region is homogeneous or whether one or more sites should be moved to another region or a new region formed. This process is iterative, with the ultimate goal that all regions are classified as homogeneous, and with no sites within a region obviously discordant. If a site is found discordant or a region heterogeneous, one or more sites may need to be moved to a different region. After site relocation is completed, XFIT.FOR will need to be run again to obtain a new set of L-Moments and quantile estimates. XTEST.FOR should then be rerun using the updated L-Moments to test discordancy and heterogeneity. This procedure should be repeated until no sites are found to be discordant and the region is satisfactorily homogeneous. Critical values of discordancy and heterogeneity are discussed in Section 4.2.

4.1 Input File

Refer to Fig. 6 as you read this section. The at-site data required to run XTEST.exe are provided in the input file XTEST_INPUT.dat. The first line contains the number of sites in the region and the name of the region. The number of sites should be indicated within columns 1-4 and the region name within columns 5-56 as indicated in Fig. 6. The following lines contain the label, number of records, and the L-moments (L1, L-CV, t3, t4, and t5) for each site. These are to be given within columns 1-12, 13-16, and 17-56, respectively. This line format is to be repeated for all additional sites located within the region of interest. Because the column spacing is critical for FORTRAN input data a text editor program that allows for filing the input under ASCII format with no hidden characters is essential. A freeware program such as Editpad lite is recommended for this task. (http://www.editpadpro.com/editpadlite.html).

4.2 Acceptance of Proposed Homogeneous Sub-Regions

Refer to Fig. 7 as you read this section. The results for XTEST.exe are given in the file XTEST_OUTPUT.dat. The first line shows the region name and the number of sites in the region. The section below this line lists the label, number of records, L-CV, L-Skew, L-Kurt, and the Discordancy (D) value for each site. A threshold of D = 3 is suggested, above which the site is definitely discordant and should be scrutinized for errors and sources of unreliability. For regions containing less then 15 sites, the discordancy criteria may need to be lowered. Suggested values of the criteria are given in Table 3.1 of Hosking and Wallis (1997). This analysis can be performed both before and after homogeneous regions have been tentatively identified. For more information on the discordancy measure, refer to pages 45 – 53 of Hosking and Wallis (1997).

The weighted means of the L-CV, L-Skew, and L-Kurt for the region are then given. The L-Moments are used to fit a Kappa Distribution, from which the estimated parameters are given.

The next section (labeled ***** Heterogeneity Measures *****) provides the results of three heterogeneity analyses of the regional sites. The first analysis computes H(1) using the weighted standard deviation of the at-site sample L-CVs. The other two analyses calculate alternative heterogeneity measures based on L-CV and L-Skew (H(2)) and L-Skew and L-Kurtosis (H(3)). The latter two measures of heterogeneity lack the power to discriminate between homogeneous and heterogeneous regions and are rarely greater than 2. Therefore, it is recommended to use H(1) when testing a regions heterogeneity.

The suggested criteria for classifying a region according to its heterogeneity in Hosking and Wallis (1997) are as follows: if $H < 1$ then the region is "acceptably homogeneous"; if $1 \leq H < 2$ then the region is "possibly heterogeneous"; and if $H \geq 2$ then the region is "definitely heterogeneous". Refer to pages 61 – 72 of Hosking and Wallis (1997) for more information on the heterogeneity measure.

The above heterogeneity criteria measure statistical heterogeneity from known distributions and does not account for additional variability that arises from other sources. Most cooperative precipitation measurement networks include gages operated by various organizations and individuals that provide a varied level of quality control. Therefore, precipitation measurements often contain additional variability due to: gages being moved during the many years of operation; frequent change of operators and level of diligence in timely measurement; missing data arising from inconsistent reporting; lack of attention to measurement precision; and localized site and wind condition changes over time due to building construction or growth of trees in the vicinity of the gage. Recognizing this additional source of variability, it is suggested that for precipitation annual maxima, H(1) values less than 2.00 may be considered acceptably homogeneous and H(1) values greater than 3.00 would be indicative of heterogeneity.

4.3 Frequency Curve/Quantile Estimation

Once the discordancy and heterogeneity criteria have been satisfied, a more thorough analysis of the accuracy of various frequency distribution curves and the associated quantiles is performed. The third section of the results in Fig. 7 provides goodness-of-fit measures for the more common types of frequency distribution curves, which includes the Generalized Logistic, GEV, Generalized Normal, Pearson Type III, and the Generalized Pareto (refer to pages 208 – 209 of Hosking and Wallis (1997)). The statistics provided are the L-Kurt and Z-value for each fitted distribution. Refer to pages 78 – 86 of Hosking and Wallis (1997) for more information on the z-value. It is suggested that distributions be considered acceptable for $Z \leq 1.64$.

Parameter and quantile estimates using the distributions accepted at the 90% level are given in the final two sections (refer to pages 92 – 99 of Hosking and Wallis (1997)). In the example of Fig. 7, these distributions include the GEV, Generalized Normal, Pearson Type III, Generalized Pareto, and Wakeby distributions.

5. Contacts

Direct all questions regarding the programs described above to one of the following people:

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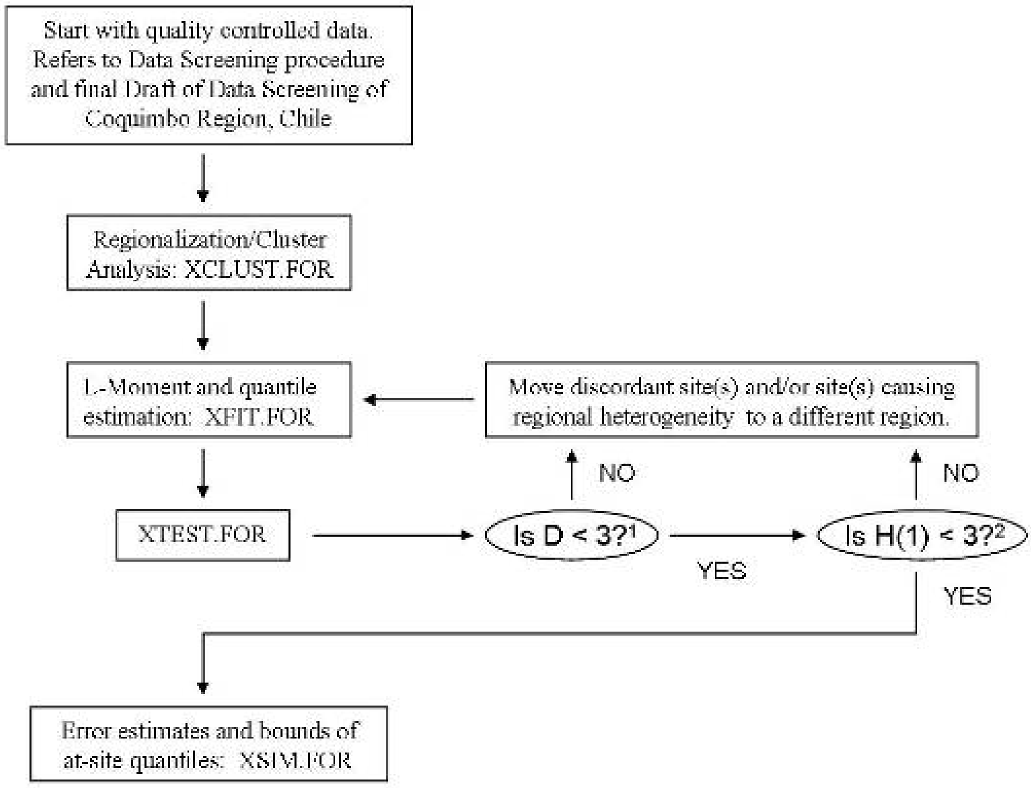
6. **Figures**



[1] If the number of sites < 15 then refer to Table 3.1 of Hosking and Wallis (1997) for appropriate discordancy threshold.

[2] The criteria of H(1) < 3 is appropriate for annual precipitation maxima, but may be different for other variables.

Fig. 1: Flowchart showing the running order for the Fortran programs.

```
*Number of sites
104
*Number of clusters
7
*siteid    lat    long      area    elev   n     l1      t        t3
t4      t5
01578500 39.6900 76.1286   193.0      73  41   7379.95  0.4958  0.4844
0.3348  0.2101
01580000 39.6303 76.4036    94.4     250  65   4273.89  0.2878  0.3443
0.2431  0.0951
01582000 39.6044 76.6211    52.9     305  47   2725.96  0.3040  0.3009
0.2183  0.1027
01583000 39.4944 76.7958     2.0     420  34    186.09  0.3147  0.3548
0.2512  0.0736
01583500 39.5105 76.6769    59.8     262  47   3512.02  0.4872  0.5545
0.4564  0.4115
01584500 39.5050 76.4322    36.1     261  58   3559.83  0.3812  0.2951
0.1519  0.0307
01585100 39.3708 76.4461     7.6      38  30   1779.00  0.3992  0.3746
0.2912  0.1843
01585200 39.3736 76.5930     2.1     285  30    747.23  0.3555  0.2613
0.0717 -0.0712
01585300 39.3411 76.4880     4.4      21  29   1523.79  0.3218  0.2961
0.2835  0.2744
01585400 39.3336 76.4730     1.9      10  29    507.66  0.4746  0.5598
0.4086  0.3284
01585500 39.5930 76.9680     3.2     670  43    392.95  0.5376  0.4915
0.2311  0.1043
01586000 39.5000 76.8833    56.6     425  46   3401.70  0.4283  0.6113
0.5218  0.4068
01587500 39.3514 76.9139    64.4     289  32   4291.56  0.4874  0.5857
0.4366  0.2878
01588000 39.3819 76.9667    11.4     450  43   1185.53  0.5377  0.5678
0.4470  0.3535
01589100 39.2400 76.6925     2.4      45  32    742.44  0.2970  0.4479
0.3373  0.1841
01589300 39.3458 76.7336    32.5     361  33   2458.24  0.4945  0.5777
0.4162  0.3109
01589330 39.3111 76.7172     5.5     310  28   1940.04  0.3861  0.5167
0.3361  0.2000
01589440 39.3917 76.6617    25.2     240  31   1873.29  0.5978  0.7086
0.5486  0.3834
01591000 39.2383 77.0564    34.8     364  47   2827.72  0.5539  0.5942
0.4309  0.2827
01593500 39.1678 76.8519    38.0     260  59   1923.37  0.4134  0.4896
0.3047  0.1862
01613900 39.2144 78.2883    15.0     668  31   1015.77  0.3665  0.1977
0.1804  0.0736
01615000 39.1778 78.0722    57.4     503  48   2901.19  0.3939  0.4013
0.3245  0.1985
```

Fig. 2: Example data from XCLUST_INPUT.dat.

MERGING SEQUENCE FROM WARD'S ALGORITHM

STAGE	NUMBER OF CLUSTERS	MERGED CLUSTERS		SUM OF SQUARES
1	103	27	31	0.01
2	102	83	84	0.03
3	101	3	5	0.07
4	100	40	43	0.13
5	99	49	60	0.22
6	98	92	96	0.31
7	97	29	33	0.40
8	96	46	47	0.49
9	95	16	19	0.59
10	94	21	23	0.69
11	93	16	20	0.82
12	92	39	41	0.95
13	91	12	13	1.08
14	90	4	8	1.22
15	89	21	48	1.37
16	88	65	68	1.53
17	87	53	55	1.71
18	86	75	77	1.90
19	85	10	15	2.09
20	84	14	52	2.29
21	83	3	12	2.49
22	82	6	18	2.70
23	81	61	63	2.91

(a)

ASSIGNMENT OF SITES TO CLUSTERS

1	1	1	2	1	6	2	2	2	2
2	1	1	6	2	6	2	6	6	6
6	5	6	4	5	4	5	7	5	5
5	5	5	3	3	4	3	5	4	5
4	3	5	4	3	5	5	6	1	3
1	6	6	6	6	3	1	1	3	1
2	1	2	1	6	6	1	6	6	1
4	1	1	2	3	6	3	3	6	7
5	3	3	3	3	5	5	5	4	4
5	5	4	7	3	5	6	4	4	5
5	3	5	3						

CLUSTER MEMBERSHIP

CLUSTER 1 HAS 17 MEMBERS:
1 2 3 5 12 13 49 51 57 58
60 62 64 67 70 72 73

CLUSTER 2 HAS 11 MEMBERS:
4 7 8 9 10 11 15 17 61 63
74

CLUSTER 3 HAS 18 MEMBERS:
34 35 37 42 45 50 56 59 75 77
78 82 83 84 85 95 102 104

CLUSTER 4 HAS 12 MEMBERS:
24 26 36 39 41 44 71 89 90 93
98 99

CLUSTER 5 HAS 23 MEMBERS:
22 25 27 29 30 31 32 33 38 40
43 46 47 81 86 87 88 91 92 96
100 101 103

CLUSTER 6 HAS 20 MEMBERS:
6 14 16 18 19 20 21 23 48 52
53 54 55 65 66 68 69 76 79 97

CLUSTER 7 HAS 3 MEMBERS:
28 80 94

(b)

ADJUSTED CLUSTERS FROM K-MEANS ALGORITHM
(SUM OF SQUARES = 215.86)

ASSIGNMENT OF SITES TO CLUSTERS

```
 1  1  1  2  1  1  2  2  2  2
 2  1  1  6  2  1  2  1  1  1
 6  1  6  4  5  4  5  7  5  5
 5  5  5  3  3  4  3  5  4  5
 4  3  5  4  3  5  5  6  1  3
 1  6  6  6  6  3  1  1  3  1
 2  1  2  1  6  6  1  6  6  1
 2  1  1  6  5  6  3  3  6  7
 5  5  3  3  3  5  5  5  4  4
 5  5  4  7  3  5  6  4  4  5
 5  3  5  3
```

CLUSTER MEMBERSHIP

CLUSTER 1 HAS 23 MEMBERS:
1 2 3 5 6 12 13 16 18 19
20 22 49 51 57 58 60 62 64 67
70 72 73

CLUSTER 2 HAS 11 MEMBERS:
4 7 8 9 10 11 15 17 61 63
71

CLUSTER 3 HAS 16 MEMBERS:
34 35 37 42 45 50 56 59 77 78
83 84 85 95 102 104

CLUSTER 4 HAS 11 MEMBERS:
24 26 36 39 41 44 89 90 93 98
99

CLUSTER 5 HAS 24 MEMBERS:
25 27 29 30 31 32 33 38 40 43
46 47 75 81 82 86 87 88 91 92
96 100 101 103

CLUSTER 6 HAS 16 MEMBERS:
14 21 23 48 52 53 54 55 65 66
68 69 74 76 79 97

CLUSTER 7 HAS 3 MEMBERS:
28 80 94

(c)

CLUSTER CENTERS

	AREA	ELEV	LAT	LONG
1	63.88	232.68	39.23	77.08
2	3.29	204.62	39.26	76.84
3	863.68	322.08	38.49	78.00
4	7.09	967.65	38.22	78.75
5	139.48	636.47	38.15	78.59
6	13.71	392.02	38.99	77.59
7	0.54	702.88	38.23	78.55

(d)

Fig. 3: Example results from XCLUST_OUTPUT.dat.

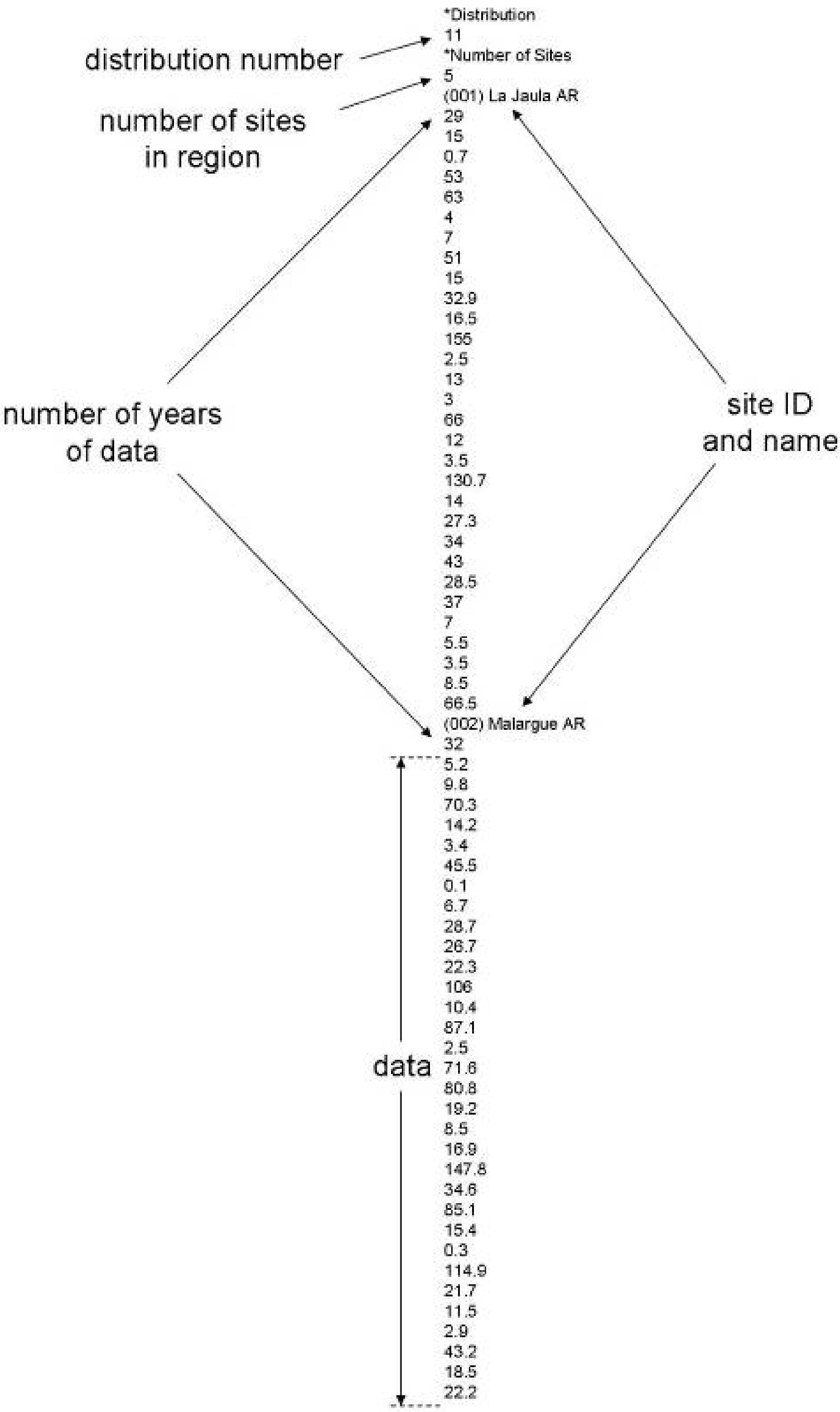


Fig. 4: Example data from XFIT_INPUT.dat.

```
 REGIONAL ANALYSIS, UNBIASED L-MOMENTS

 SITE  1 (001) La Jaula AR              N= 29   L-MOMENT RATIOS    31.68   0.5749
0.4269   0.2123   0.1486
 SITE  2 (002) Malargue AR              N= 32   L-MOMENT RATIOS    36.06   0.5596
0.3762   0.1376   0.0153
 SITE  3 (003) Arroyo Hondo AR          N= 20   L-MOMENT RATIOS    31.66   0.4733
0.4060   0.2347   0.0234
 SITE  4 (004) Valle del Uco AR         N= 28   L-MOMENT RATIOS    46.48   0.4628
0.2670   0.2126   0.2601
 SITE  5 (005) Juncalitoo AR            N= 21   L-MOMENT RATIOS    36.77   0.5841
0.3651   0.0952   0.0659


 REGIONAL AVERAGE L-MOMENT RATIOS   1.0000   0.5328   0.3668   0.1785   0.1072

 REGIONAL WAKEBY PARAMETERS     -0.0016     -0.3696      1.8832      1.1259      0.0034



  SITE                        QUANTILES
 NUMBER    0.1000    0.2000    0.5000    0.8000    0.9000    0.9500    0.9800    0.9900
0.9990    0.9999
 ---------------------------------------------------------------------------------------
------------------
 REGION      0.08      0.18      0.64      1.63      2.41      3.19      4.24      5.03
7.67     10.34

    1        2.59      5.78     20.17     51.59     76.26    101.15    134.19    159.28
243.03    327.45
    2        2.95      6.58     22.96     58.74     86.82    115.15    152.78    181.33
276.69    372.80
    3        2.59      5.78     20.16     51.56     76.22    101.09    134.13    159.20
242.91    327.29
    4        3.80      8.48     29.59     75.69    111.89    148.40    196.89    233.69
356.58    480.44
    5        3.01      6.71     23.41     59.88     88.51    117.40    155.76    184.87
282.09    380.08
```

Fig. 5: Example results from XFIT_OUTPUT.dat.

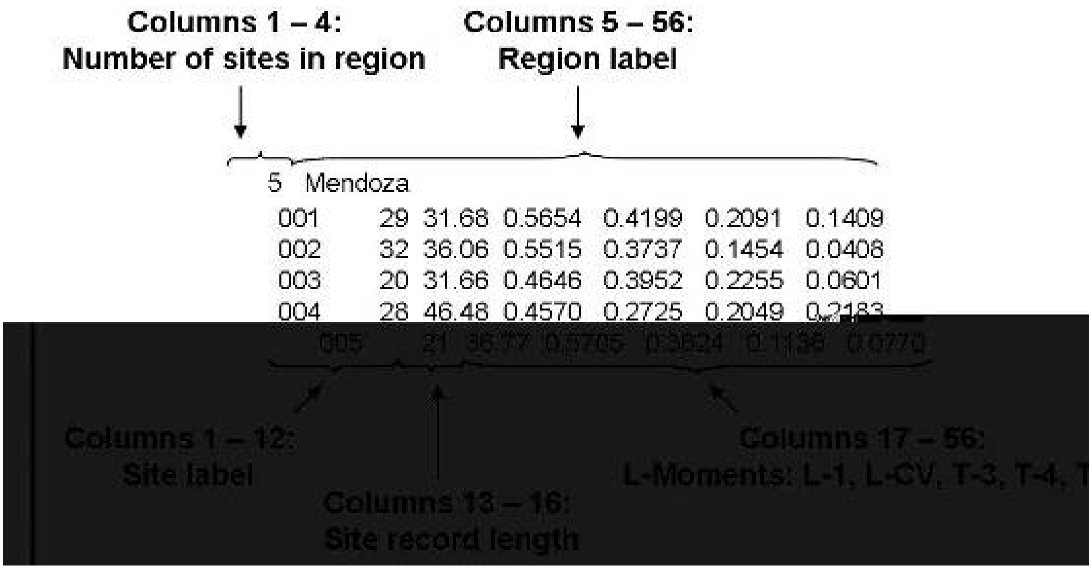


Fig. 6: Example data from XTEST_INPUT.dat.

```
    Mendoza                              5 SITES

 SITE   N     NAME      L-CV   L-SKEW  L-KURT   D(I)
   1   29    001        0.5654  0.4199  0.2090   1.31
   2   32    002        0.5515  0.3737  0.1450   0.24
   3   20    003        0.4646  0.3952  0.2250   1.31
   4   28    004        0.4570  0.2725  0.2040   1.33
   5   21    005        0.5705  0.3624  0.1130   0.81

   WEIGHTED MEANS       0.5239  0.3637  0.1791

 PARAMETERS OF REGIONAL KAPPA DISTRIBUTION  -
0.1551  1.0729 -0.0161  1.1731


 ***** HETEROGENEITY MEASURES *****
 (NUMBER OF SIMULATIONS  =   500)

 OBSERVED     S.D. OF GROUP L-CV         =  0.0493
 SIM. MEAN OF S.D. OF GROUP L-CV         =  0.0491
 SIM. S.D. OF S.D. OF GROUP L-CV        =  0.0184
 STANDARDIZED TEST VALUE H(1)            =  0.01

 OBSERVED AVE.  OF L-CV / L-SKEW DISTANCE =  0.0650
 SIM. MEAN OF AVE. L-CV / L-SKEW DISTANCE =  0.0868
 SIM. S.D. OF AVE. L-CV / L-SKEW DISTANCE =  0.0283
 STANDARDIZED TEST VALUE H(2)            = -0.77

 OBSERVED AVE.  OF L-SKEW/L-KURT DISTANCE =  0.0626
 SIM. MEAN OF AVE. L-SKEW/L-KURT DISTANCE =  0.1076
 SIM. S.D. OF AVE. L-SKEW/L-KURT DISTANCE =  0.0336
 STANDARDIZED TEST VALUE H(3)            = -1.35


 ***** GOODNESS-OF-FIT MEASURES *****
 (NUMBER OF SIMULATIONS  =   500)

 GEN. LOGISTIC       L-KURTOSIS= 0.277   Z VALUE=  2.06
 GEN. EXTREME VALUE   L-KURTOSIS= 0.256   Z VALUE=
1.61 *
 GEN. NORMAL         L-KURTOSIS= 0.227   Z VALUE=  0.97 *
 PEARSON TYPE III    L-KURTOSIS= 0.178   Z VALUE= -0.12 *
 GEN. PARETO         L-KURTOSIS= 0.191   Z VALUE=  0.18 *


 PARAMETER ESTIMATES FOR DISTRIBUTIONS ACCEPTED
AT THE 90% LEVEL

 GEN. EXTREME VALUE   0.484  0.540 -0.281
 GEN. NORMAL          0.676  0.725 -0.769
 PEARSON TYPE III     1.000  1.071  2.184
 GEN. PARETO         -0.013  0.945 -0.067
 WAKEBY              0.000  0.000  0.000  0.000  0.000

 QUANTILE ESTIMATES
                0.010  0.020  0.050  0.100  0.200  0.500  0.900
0.950  0.990  0.999
 GEN. EXTREME VALUE  -0.187 -0.128 -0.026  0.082  0.243
0.692  2.177  2.987  5.557 11.934
 GEN. NORMAL        -0.110 -0.073 -0.001  0.085  0.226  0.676
2.259  3.073  5.375  9.886
 PEARSON TYPE III     0.024  0.030  0.051  0.092  0.192  0.649
2.377  3.147  4.959  7.563
 GEN. PARETO         -0.003  0.006  0.036  0.087  0.200  0.658
2.340  3.122  5.084  8.284
 *** ERROR *** ROUTINE QUAWAK : PARAMETERS INVALID
 *** ERROR *** ROUTINE QUAWAK : PARAMETERS INVALID
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 *** ERROR *** ROUTINE QUAWAK : PARAMETERS INVALID
 WAKEBY              0.000  0.000  0.000  0.000  0.000  0.000
0.000  0.000  0.000  0.000


 ALL DATA PROCESSED
```

Fig. 7: Example results from XTEST_OUTPUT.dat.