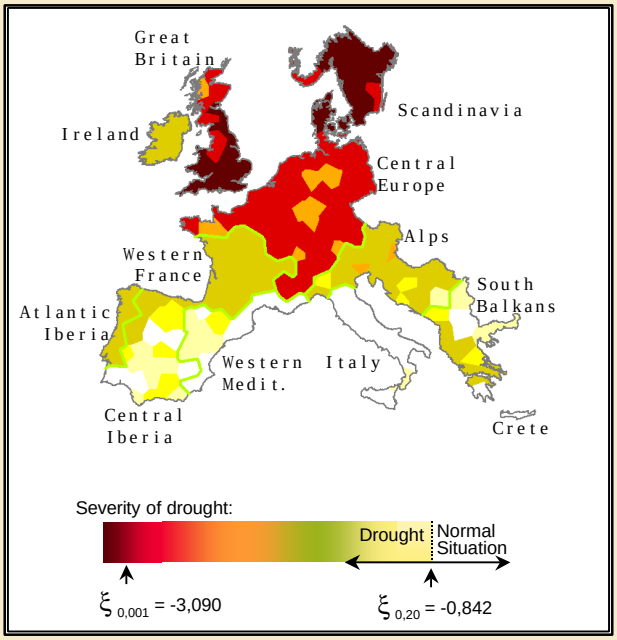
ARIDE

Assessment of the Regional Impact of Droughts in Europe

Technical Report No. 10

Overview of Regional Meteorological Drought Analysis on Western Europe



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Instituto da Água

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Technical Report No. 10

Overview of Regional Meteorological Drought Analysis on Western Europe

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Technical Report to the ARIDE project No.10:

Supplement to Work Package 2 Hydro-meteorological Drought
Activity 2.4 Regional Drought Distribution Model

CONTENTS

ANNEXES

1. Introduction

This Technical Report presents the generalised application of the regional drought distribution model to annual precipitation in Western Europe (activity 2.4 of ARIDE's Workpackage 2-Hydrometeorological Droughts).

Results concerning meteorological drought are organised in this report and conclusions regarding drought affected areas and drought exceptionality are presented for Western Europe.

The study of meteorological drought occurrence in Western Europe assumes basic assumptions for the application of the statistical model. This is the case of the criteria used for drought analysis as the threshold levels regarding variables and areas in drought and data simulation procedures. The analysis of these basic parameters is undertaken and conclusions regarding the use of the threshold levels and features related to regional replicates simulation are drawn.

This follows the work accomplished in two previous Technical Reports: "Analysis of the European annual precipitation series" and "Delimitation of affinity regions in Western Europe for the application of the regional drought model to precipitation data".

2. Previous work regarding annual precipitation

The application of the regional model requires data series availability with the same length, as well as the frequency distribution according to normal distribution. These require a specific study of the data quality, including filling gaps and the normal distribution goodness-of-fit evaluation. This work was undertaken in some of the time series prior to the regional analysis.

The same series length is used for the whole data set in the common period from 1951/52 to 1985/86 (35 years of precipitation) set this way according to data availability in Southeastern areas. For some regions longer series were obtained for different periods. The analysis of the data set and series selection for the drought study is presented in SANTOS & HENRIQUES 1999.

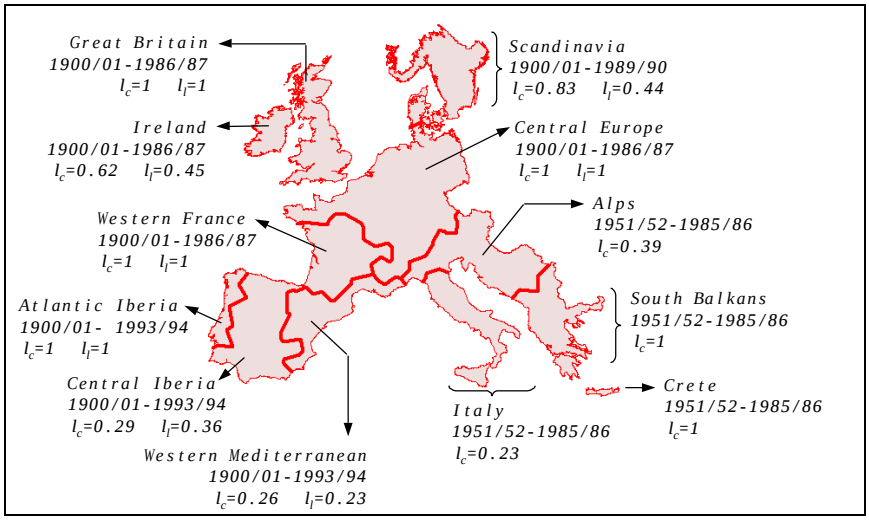

Figure 2.1– European regions for the application of the regional drought distribution model application to the annual precipitation, data available and Box-Cox parameter for the longer (λ_l) and the common period (λ_c).

The European regions to be used for the application of the regional drought model to the annual precipitation are presented in Figure 2.1. Twelve regions are considered. The main features

involved in the definition of regions are dependent on the model used, as explained in SANTOS *et. al.* 1999.

3. Introduction to the regional drought analysis

Regional drought assumption is made concrete through the use of influence areas for each data series, the stepwise selection of the areas under drought based on the areal distribution and the non-consideration of drought when limited areas are affected.

The stepwise selection of the areas in drought is represented in Figure 3.1. In each year the drought nucleus is selected as the area where the observed precipitation is lower than the threshold. From the neighbouring areas a second drought area is selected. This selection considers the precipitation calculated in both areas and selects the second area where calculated precipitation is lower. This calculation continues until the inclusion of all the encircling drought affected areas or when higher precipitation values than the threshold are reached.

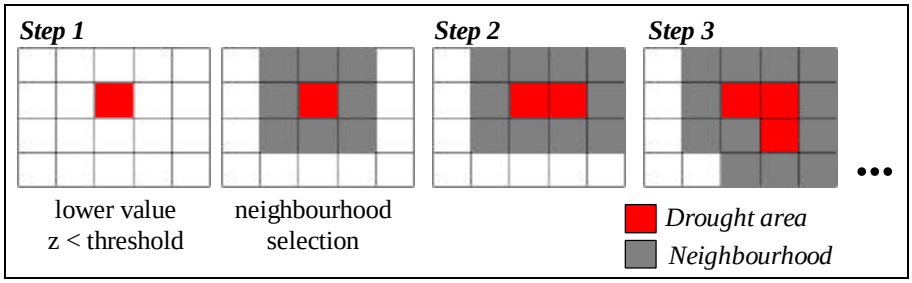

Figure 3.1 – Stepwise selection of drought areas in the regional model.

The drought model application in each European region considers 3 major actions (SANTOS 1996; HENRIQUES & SANTOS 1999):

1. Calculation of drought severity evolution in the area for each drought year and determination of drought return period in sequential years based on the severity of drought for the total area;
2. Calculation of drought severity evolution in the area for simulated longer series of precipitation and determination of severity-area-frequency curves;
3. Comparison between the severity-area-frequency curves and the historical areal evolution of drought severity so as to allow the attribution of recurrence intervals to each observed regional drought.

An example of the several outputs of the drought model is presented in Figure 3.2. The regional drought of 1975 can be compared with the severity-area-frequency curves obtained for several return periods. In this example a return period of the regional drought between 10 and 25 years is obtained. The last drought severity calculation represents drought severity of the whole affected area in the region, which, in the example for 1975, corresponds to the entire area. Drought in sequential years is obtained in 1971 and 1972. For these two years the return period of drought is based on the drought severity calculated for the total area (-Zcalc).

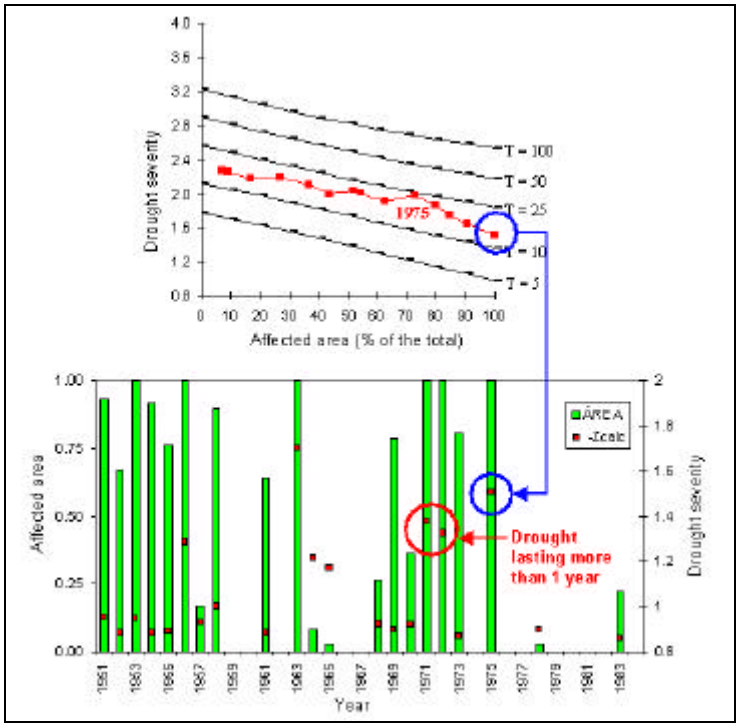

Figure 3.2 – Outputs of the regional drought model.

Data availability restricts the drought model application due to the embedded probability analysis that assumes the use of long data series. The evaluation of a very exceptional drought (e.g. associated to return period of 100 years) can be very illusive when the data set used is shorter than 30 years of data.

In Figure 3.3 the European areas are classified by the size of the precipitation series. Each area is studied using the larger period available. The global analysis allows the comparison of results for the whole area and is only possible for the common period to all the precipitation series (1951/52-1985/86). In order to obtain a measure of the loss accuracy in drought estimates when shorter time series are used, the results from the common (shorter) period analysis can be compared with the ones derived from the longest available data sets.

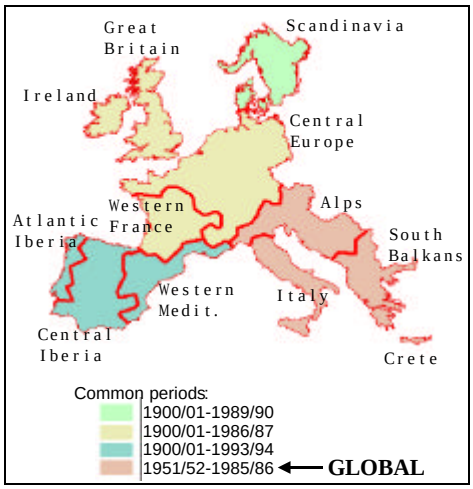

Figure 3.3 – Classification of the European regions by the precipitation data availability.

4. Meteorological drought in the European regions

This application example of the regional drought model considered drought threshold defined as a non-exceedance probability of 0.20 in the regional annual precipitation. The use of other threshold levels is discussed in point 6. Regarding the calculation of the severity-area-curves it was considered:

- a critical area of 90% of the total area of each region.
- the simulation of ten regional replicates with 100 years.
- drought severity representations by means of the absolute value of the standardised transformed precipitation (-z).

The mean area experiencing drought is higher than 75% of the total area studied in each year for 1904/05, 1905/06, 1920/21, 1928/29, 1932/33, 1943/44, 1948/49, 1972/73, 1975/76 and 1988/89 (Figure 4.1). Only two of these events are studied for the whole Western Europe area, since this analysis is restricted by the common period in the European data set (1951/52-1985/86). This is the first aspect that shows the fragility of the conclusions based on shorter periods, pointing out the relevance of the use of a long data set.

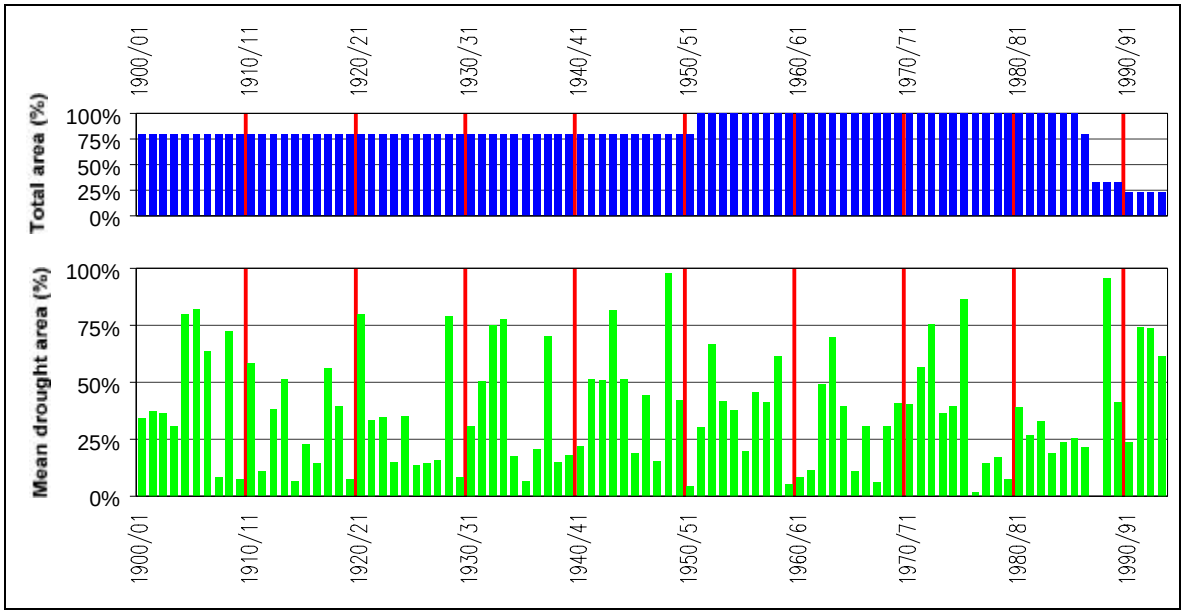

Figure 4.1 – Mean area in drought (% of the total area) and the total area analysed in each year (% of the total).

The return periods associated to drought severity in sequential years and 100% areal coverages are resumed in Table 4.1. More than 75% of the area was affected by drought between 17 and 37% of the years. In general, regions were affected by sequential drought lasting about 2 or 3 years. For Western France and South Balkans longer events can be obtained for a critical area of 75% (4 and 6 years). Most exceptional two-year droughts (in the total area) were isolated for Central Iberia and Ireland. For Central Iberia the drought of 43/44/45 was associated to a return period close to 400 years. The drought of 74/75/76 in Ireland was associated to a return period close to 300 years. Three-year events occurring in 100% of the area were obtained for Central Iberia, for the drought started in 1980/81, and for Western France, for the drought started in 1941/42.

The spatial distribution of drought is presented in ANNEX A. The analysis of drought spread confirms that drought is not a generalised phenomenon in Europe, when it occurs. The regions not affected by drought in the years where drought was generalised (affecting more than 50% of the Western Europe area), are listed following:

- Central Europe, Scandinavia and South Balkans in 1952/53;

- Alps, Atlantic Iberia, Central Iberia, Italy and Western Mediterranean in 1958/59;
- Atlantic Iberia, Central Iberia, Italy and South Balkans in 1963/64;
- Alps, Atlantic Iberia, Italy, Scandinavia, South Balkans and Western Mediterranean in 1971/72;
- Atlantic Iberia and Italy in 1972/73;
- Italy and Western Mediterranean in 1975/76.

Table 4.1 – Characteristics of droughts (series length variable).

REGION	Series length	% drought years (area>75%)	% drought years (area=100%)	Droughts lasting more than 1 year (area > 75% of the total)	Droughts lasting more than 1 year (total area)	Return period of sequential droughts (total area)
Alps	35 years 51/52-85/86	37%	26%	Beginning 1956/57 – 2 years Beginning 1972/73 - 2 years Beginning 1981/82 - 2 years	Beginning 1981/82 - 2 years	11 years
Atlantic Iberia	94 years 00/01-93/94	20%	17%	Beginning 1904/05 – 3 years Beginning 1943/44 – 2 years Beginning 1948/49 - 2 years	Beginning 1943/44 – 2 years Beginning 1948/49 – 2 years	58 years 22 years
Central Europe	87 years 00/01-86/87	31%	20%	Beginning 1902/03 – 2 years Beginning 1905/06 – 2 years Beginning 1927/28 – 2 years Beginning 1931/32 – 3 years Beginning 1941/42 – 3 years Beginning 1962/63 – 2 years Beginning 1970/71 - 3 years	Beginning 1932/33 – 2 years Beginning 1942/43 – 2 years	35 years 21 years
Central Iberia	94 years 00/01-93/94	29%	21%	Beginning 1933/34 – 2 years Beginning 1943/44 – 2 years Beginning 1948/49 – 2 years Beginning 1952/53 – 2 years Beginning 1956/57 – 2 years Beginning 1980/81 – 3 years Beginning 1991/92 - 3 years	Beginning 1943/44 – 2 years Beginning 1948/49 – 2 years Beginning 1952/53 – 2 years Beginning 1956/57 – 2 years Beginning 1980/81 – 3 years	388 years 32 years 90 years 14 years 149 years
Crete	35 years 51/52-85/86	17%	17%	Beginning 1957/58 – 2 years Beginning 1982/83 - 2 years	Beginning 1957/58 – 2 years	51 years
Great Britain	87 years 00/01-86/87	29%	21%	Beginning 1900/01 – 2 years Beginning 1904/05 – 2 years Beginning 1932/33 – 2 years Beginning 1962/63 – 2 years Beginning 1970/71 – 3 years	Beginning 1962/63 – 2 years Beginning 1971/72 – 2 years	33 years 15 years
Ireland	87 years 00/01-86/87	26%	18%	Beginning 1904/05 – 2 years Beginning 1931/32 – 3 years Beginning 1942/43 – 2 years Beginning 1951/52 – 2 years Beginning 1970/71 – 3 years Beginning 1974/75 - 2 years	Beginning 1904/05 – 2 years Beginning 1932/33 – 2 years Beginning 1951/52 – 2 years Beginning 1970/71 – 2 years Beginning 1974/75 – 2 years	57 years 36 years 21 years 37 years 273 years
Italy	35 years 51/52-85/86	31%	23%	Beginning 1969/70 – 2 years Beginning 1980/81 - 3 years	Beginning 1969/70 – 2 years	15 years
Scandinavia	90 years 00/01-89/90	24%	20%	Beginning 1931/32 – 2 years Beginning 1940/41 - 2 years Beginning 1962/63 – 2 years Beginning 1972/73 - 2 years	Beginning 1931/32 – 2 years Beginning 1940/41 – 2 years Beginning 1962/63 – 2 years	11 years 55 years 13 years
South Balkans	35 years 51/52-85/86	37%	17%	Beginning 1973/74 – 4 years	-	-
Western France	87 years 00/01-86/87	30%	20%	Beginning 1902/03 – 4 years Beginning 1932/33 – 2 years Beginning 1941/42 – 6 years Beginning 1971/72 – 2 years	Beginning 1904/05 – 2 years Beginning 1932/33 – 2 years Beginning 1941/42 – 3 years Beginning 1971/72 – 2 years	29 years 18 years 56 years 17 years
Western Mediterranean	94 years 00/01-93/94	33%	16%	Beginning 1904/05 – 3 years Beginning 1922/23 – 3 years Beginning 1948/49 – 2 years Beginning 1963/64 – 2 years Beginning 1980/81 – 3 years Beginning 1988/89 – 2 years Beginning 1992/93 - 2 years	Beginning 1923/24 – 2 years Beginning 1992/93 – 2 years	34 years 16 years

The extreme-value type 1 distribution was used for the calculation of the severity-area-frequency curves. The parameters û and â are variable with the area in drought (A):
$S(A) = û(A) + â(A) \times [-\log(-\log(1- 1/T)]$

The estimation of the extreme-value distribution parameters was obtained using the least squares estimation method.

The parameters of the severity-area-frequency curves obtained are characteristic for each region (Figure 4.2 and **Error! Reference source not found.**). Higher û values were obtained for lower areas and less differences are observed for larger areas (90% and 100%). Calculated û varies between 0.077 and 1.401 while â varies between 0.401 and 0.536.

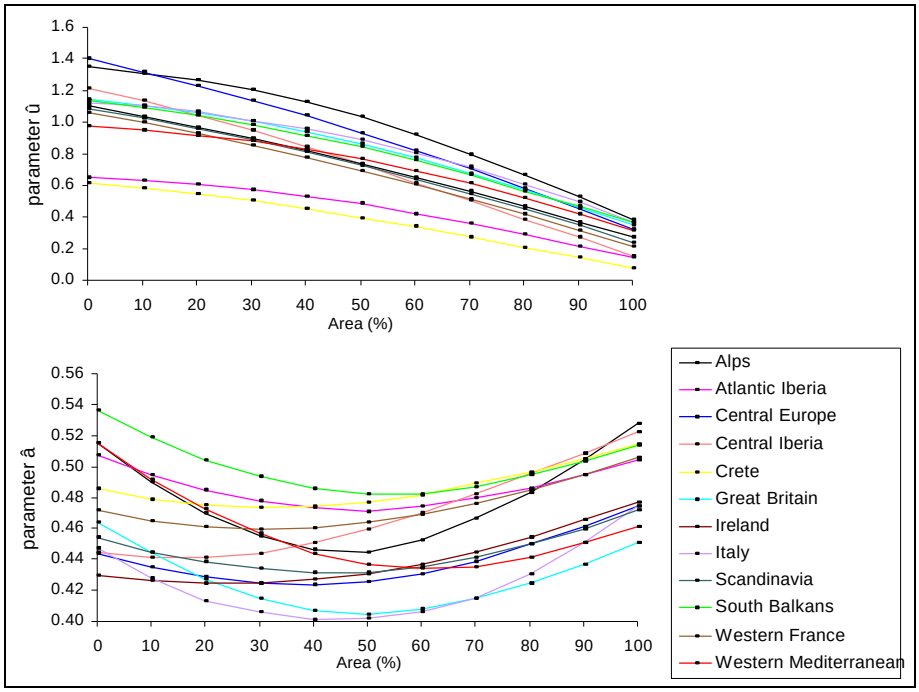

Figure 4.2 – Parameters of severity-area-frequency curves for each region.

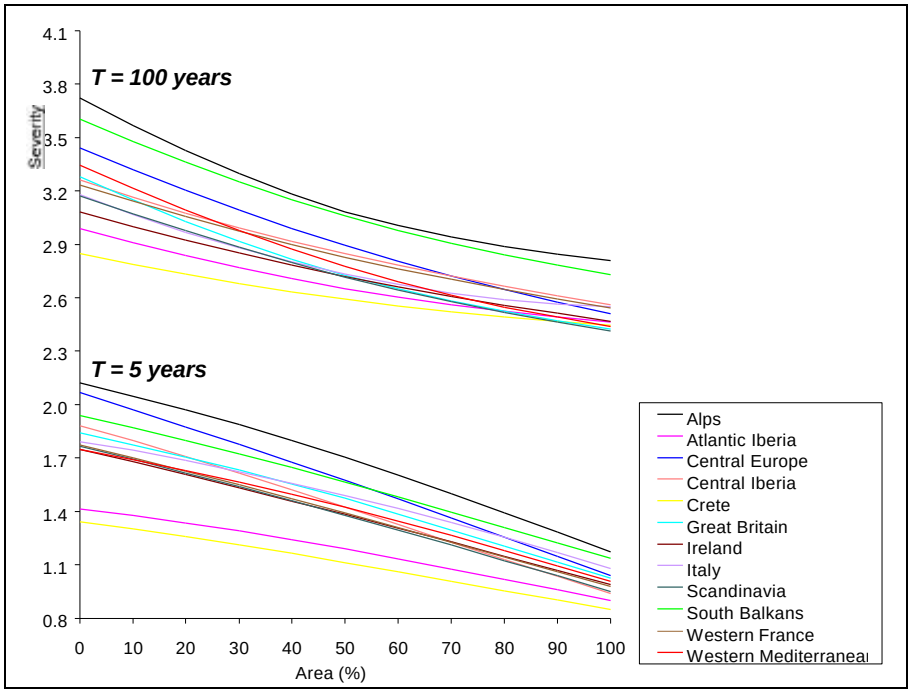

Figure 4.3 – Severity-area-frequency curves obtained for return periods T=5 and T=100 years in each region.

The resulting curves for each region for the return periods 5 and 100 years are presented in Figure 4.3. In some regions a similarity can be observed; nevertheless it is evident that lower severity values are associated to the Atlantic Iberia and Crete zones while higher severity values are related with the Alps, Central Europe and South Balkans regions. This reflects the precipitation variability.

The exceptionality of regional droughts is obtained comparing the severity-area-frequency curves with the historical ones. The example of the hydrological years 1956/57, 1957/58 and 1958/59 is presented in Figure 4.4. For instance the drought verified in 1958/59 is associated to a return period of about 100 years in Ireland, higher than 100 years in Great Britain, close to 25 years in Central Europe, Crete and Scandinavia and lower than 5 years in South Balkans, Western France and Central Iberia. Droughts can be classified in this way and a synthesis of the whole important drought years obtained.

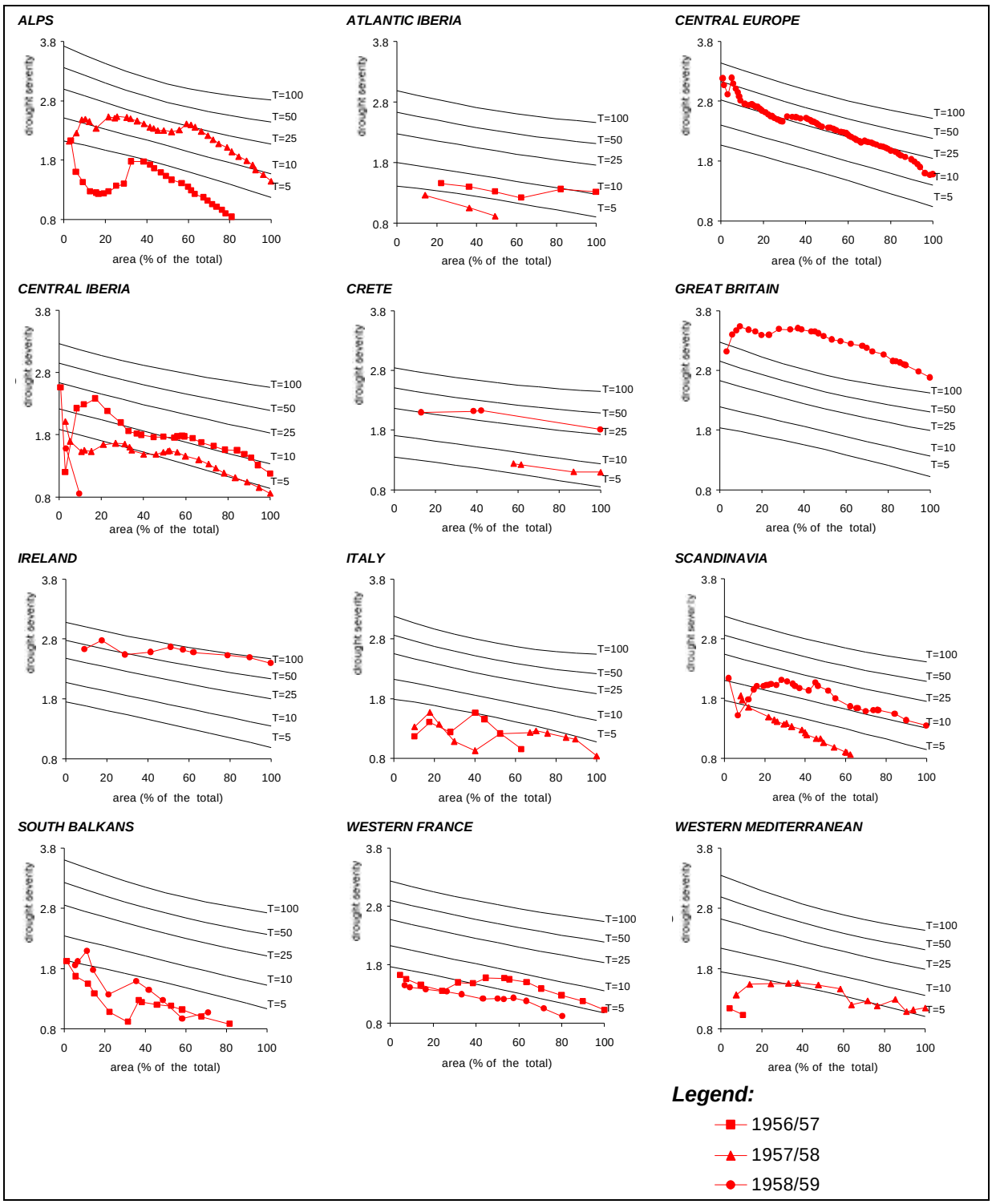

Figure 4.4 – Regional drought return period evaluation. Examples of 1956/57, 1957/58 and 1958/59.

In **Error! Reference source not found.** is presented the regional drought return period evaluation for the two different data sets considered (longer and shorter). For an easy cross comparison of the regional return period obtained, droughts were grouped in four different classes. This classification considers the example given in Figure 4.5. Drought associated to a return period lower than 5 years is a “green” or “A” drought while, for instance, a “red” drought or “D” corresponds to a return period higher than 100 years.

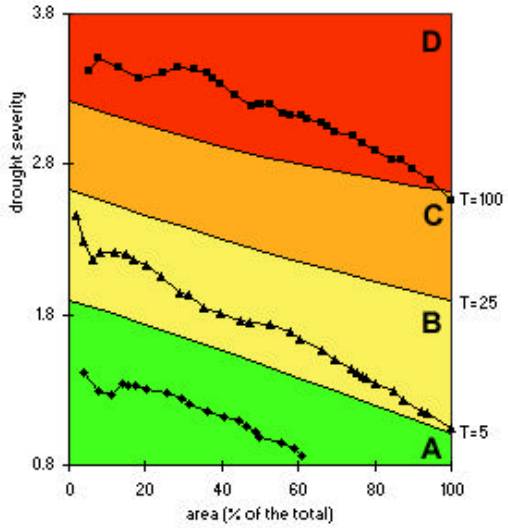

Figure 4.5 -Classification of the regional drought return period (T years).

Considering the threshold 0.20, exceptional droughts, associated to return periods higher than 25 years were detected in years:

- 1904/05 for Great Britain;
- 1910/11 for Ireland;
- 1920/21 for Central Europe, Great Britain, Scandinavia and Western France;
- 1944/45 for Atlantic Iberia, Central Iberia and Western Mediterranean;
- 1946/47 for Central Europe and Scandinavia;
- 1948/49 for Central Europe and Great Britain and Western France;
- 1949/50 for Central Iberia;
- 1951/52 for Alps and South Balkans;
- 1952/53 and 1953/54 for Central Iberia;
- 1958/59 for Central Europe, Crete, Great Britain and Ireland;
- 1969/70 for Crete;
- 1970/71 for the Alps;
- 1974/75 for Ireland;
- 1975/76 for Central Europe, Great Britain, Ireland and Scandinavia;
- 1980/81 for Central Iberia;
- 1984/85 for South Balkans; and
- 1988/89 for Atlantic Iberia.

Return periods close to 100 years were observed for Central Europe in 20/21 and 48/49, Central Iberia in 44/45, Great Britain in 58/59 and 75/76, Scandinavia in 46/47 and 75/76, and Western France in 48/49.

5. Meteorological droughts in Europe in the common period

The same assumptions as the ones considered for the longer period were used for the model runs. For the regions named Italy, Crete, South Balkans and Alps the longer period obtained is the same as the common period analysis results presented in point4 and no comparison can be made.

Global drought affected areas obtained using the common period 1951/52-1985/86 (35 years) and the ones obtained using larger periods (87, 90 or 94 years of data) are compared in Figure 5.1.

Results of the model runned through all western Europe common data sets point out that drought affected more than half of the global area in 1953/54, 1956/57, 1958/59, 1963/64, 1971/72, 1972/73, 1973/74, 1975/76 and 1984/85. The first part of the 70's decade has been of some importance: around 80% of the total western Europe's area was affected by drought in 1972/73 and 1975/76. In these two years some areas in the south were not affected by drought. The areas under drought obtained when the common-shorter period of analysis is used are slightly larger. In some of the years, namely 53/54, 61/62, 68/69 and 85/86 the differences reached 10% or more.

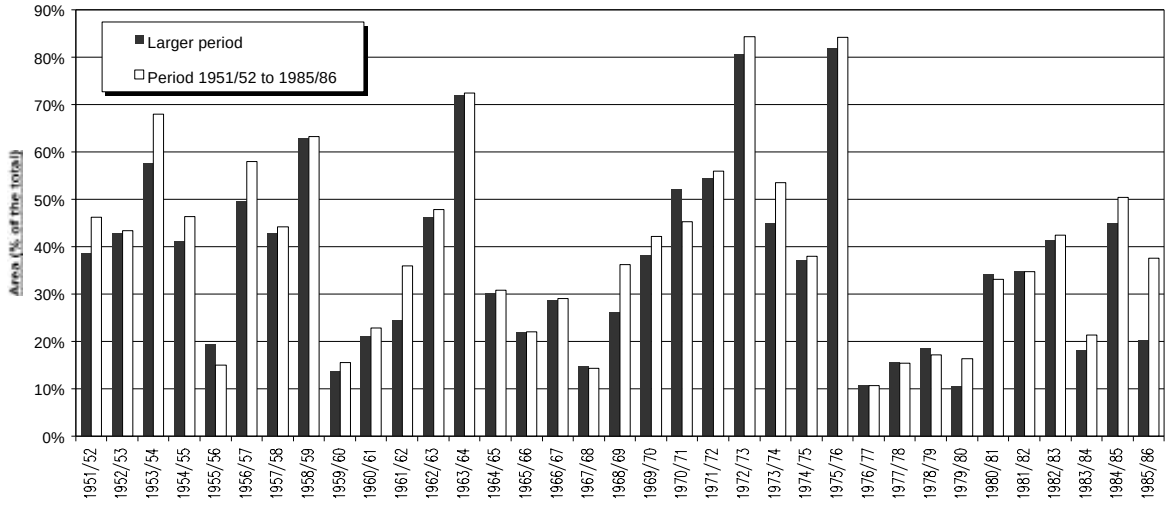

Figure 5.1 – Comparison between the drought affected areas in Europe using the different periods.

Figure 5.2 presents the number of droughts in each region, for critical area 50%, considering the longer period, the smaller period 51/52-85/86 and the longer period results from 51/52 to 85/86. The number of droughts is clearly overestimated in Atlantic Iberia and Western France when the common period is used. For the common period more 4 droughts are obtained in Atlantic Iberia (more 12% of the total) and 3 more droughts in Western France (more 9%) than for the same period when the larger data-set is used. This can be related with the specific period chosen for the common study.

The number of droughts obtained for the longer period is generally lesser than the number of droughts obtained for the period 51/52-85/86. Exceptions are Central Europe with one more drought, Great Britain with four and Ireland with five more. In Atlantic Iberia and Western Mediterranean the number of droughts is much less when the larger period is used (6 and 11% less).

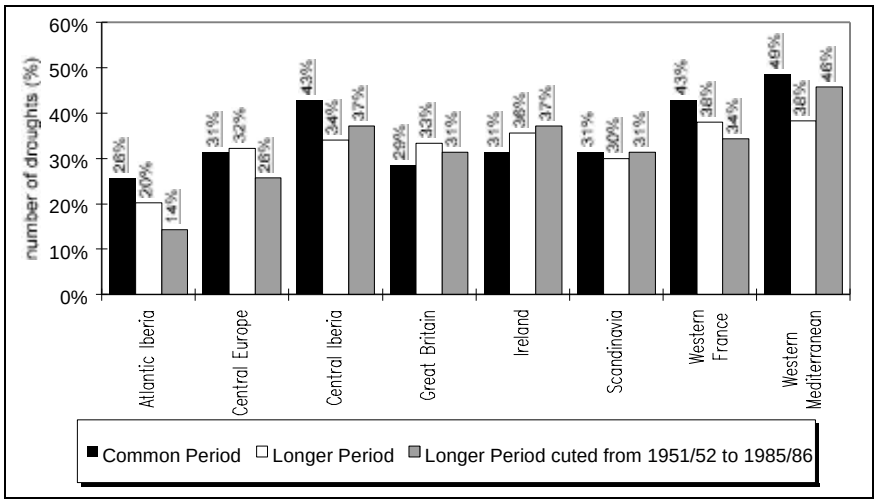

Figure 5.2 – Effect of series length in the number of droughts (%).

In general, the spatial distribution of drought does not vary largely when the size of the sampling period is manipulated, nevertheless some differences can be pointed out. An example for the years 1971/72, 72/73 and 73/74 is presented in Figure 5.3. Differences can be observed for the regions where drought is mildest, for instance Central Iberia, Western Mediterranean and Scandinavia in the example, where lower standardised precipitation (absolute value) are obtained. Severity values are slightly different but the areas in drought are similar in regions affected by drought in the whole extent.

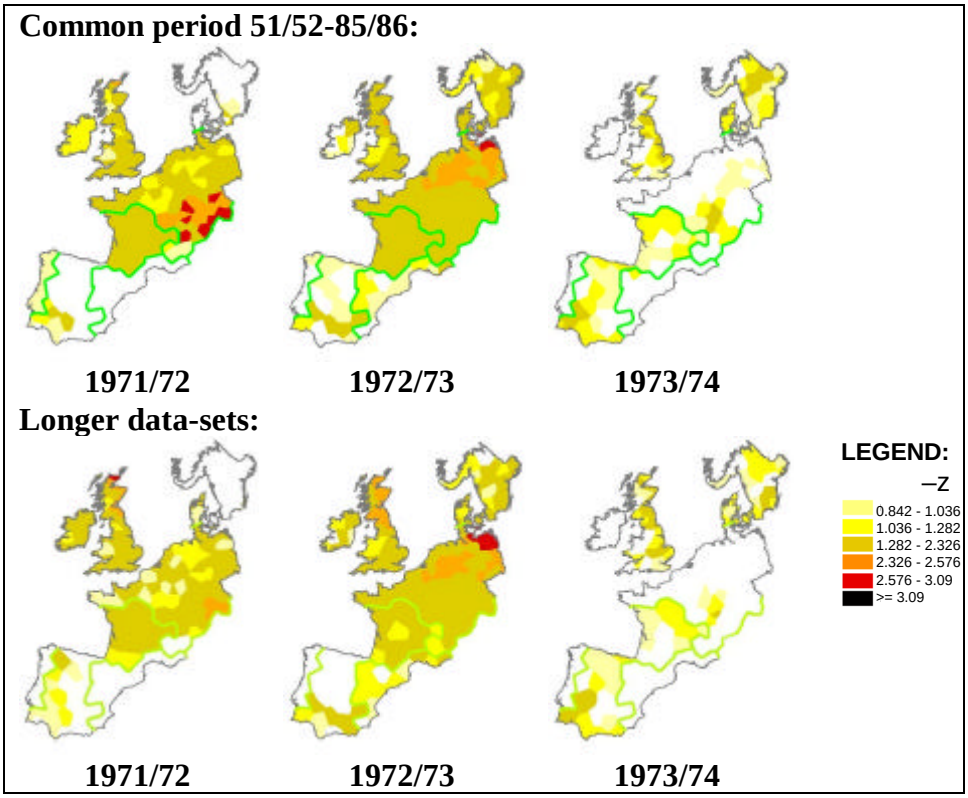

Figure 5.3 – Spatial distribution of droughts using longer and the shorter-common period. Example of the years 1971/72 to 1973/74

The number of drought years and the return periods associated with sequential droughts are resumed in Table 5.1. More than 75% of the area under drought is reached during 17 to 37% of the total years and most of the regions suffered during this time, from sequential droughts lasting 2 or 3 years. For Central Europe a drought event lasting 3 years was obtained in 1970/71-1972/73 with an exceptionality of one year in 74. Nevertheless when the larger sampling period is used this drought can not be considered for sequential years. In fact, some of the conclusions drawn for the shorter-common period are not valid for the larger data set: for instance the two-years drought in Ireland turn out to be much more important (T=273 years) than what was infered from the analysis using the shorter period.

Regional drought return periods are obtained comparing the severity area curves for several return periods with the historical curves. In **Error! Reference source not found.** droughts triggered by threshold 0.20 are classified according to its importance. Classes of return period were defined as higher than 100 years, between 25 and 100 years, between 5 and 25 years and lower or close to a return period of 5 years. Globally, only the year 1959/60 was characterised by neglected drought areas. Return periods higher than 25 years were obtained for:

- Alps and South Balkans in 1951/52;
- Central Iberia in 1952/53 and 1953/54;
- Central Europe, Crete, Great Britain and Ireland in 1958/59;
- Central Europe in 1963/64;
- Crete in 1969/70;

- Alps in 1970/71;
- Central Europe, Great Britain, Ireland and Scandinavia in 1975/76; and
- South Balkans in 1984/85.

An average drought area of about 40% of the total area (~1100x10^3 km^2) is obtained in the common period from 1951/52 to 1985/86.

Table 5.1 – Comparison of drought characteristics using 35 years of record (from 1951/52 to 1985/86) and more than 87 years of record.

REGION	*Series length*	*% drought years (area >75%)*	*drought years (area 100%)*	*Droughts lasting more than 1 year (total area)*	*Return period of sequential droughts (total area)*	*Correspondence in the longer series drought evaluation*
Atlantic Iberia	35 vs. 94 years	20%	20%	Beginning 1952/53 – 2 years	20 years	a)
Central Europe	35 vs. 87 years	29%	17%	Beginning 1970/71 – 3 years	74 years	a)
Central Iberia	35 vs. 94 years	31%	23%	Beginning 1952/53 – 2 years Beginning 1956/57 - 2 years Beginning 1980/81 - 3 years	100 years 16 years 175 years	90 years 14 years 149 years
Great Britain	35 vs. 87 years	23%	20%	Beginning 1962/63 – 2 years Beginning 1971/72 - 2 years	27 years 12 years	33 years 15 years
Ireland	35 vs. 87 years	23%	20%	Beginning 1970/71 - 2 years Beginning 1974/75 - 2 years	19 years 90 years	37 years 273 years
Scandinavia	35 vs. 90 years	20%	17%	Beginning 1962/63 – 2 years	16 years	13 years
Western France	35 vs. 87 years	37%	17%	Beginning 1971/72 – 2 years	37 years	17 years
Western Mediterranean	35 vs. 94 years	37%	17%	b)	b)	b)

a) Drought event can not be considered sequential for the global area in the longer series
b) Sequential droughts were not isolated for the total area

Comparing the drought classification in 51/52-85/86 considering the different periods (shorter and longer) one concludes that the importance of drought classification may differ mainly when lower return periods are concerned (**Error! Reference source not found.**). In general differences are not relevant in what regards the return period of important regional droughts (higher return periods). Exceptions to this behaviour were verified for Ireland in 74/75, Central Europe in 63/64 and 75/76 and Central Iberia in 80/81. For Ireland and Central Europe regional drought's return period is higher for the short period while the opposite is verified for Central Iberia. Nevertheless global conclusions like major duration or severest drought determination can be very influenced by the use of shorter periods, when the results are very dependent of the characteristics of the specific period used.

6. Threshold levels analysis

The widening of the band of thresholds triggering droughts (use of thresholds associated to non-exceedance probability of 0.1 and 0.3), was tested in order to conclude on the suitability of threshold 0.2 in this domain.

In the regional model the threshold represents the value considered for the last model iteration. This is represented in Figure 6.1. When the chosen threshold is represented by smaller non-exceedance probability the smallest severity values are not used in the iterative process. Thus the threshold value to be used has a determinant role in determine drought-affected area's when less severe droughts are at stake. When major events are being analysed, this is not observed since the regional areal coverage is always preserved.

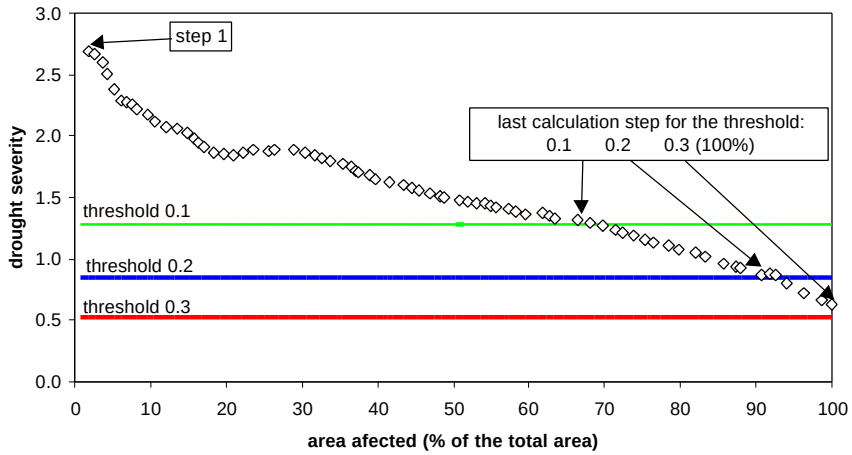

Figure 6.1 – Influence of the threshold level defined on the drought severity evaluation in each period.

The model results are presented for threshold 0.10 in **Error! Reference source not found.** and for threshold 0.30 in **Error! Reference source not found.**.

Drought affected area in Western Europe obtained using the three different thresholds is represented in Figure 6.2. The use of the thresholds leading to higher severity values generates in lower drought affected areas. Differences higher than 20% can be observed for 51/52, 52/53, 53/54, 54/55, 56/57, 69/70, 72/73, 73/74, 78/79 and 85/86. The use of threshold 0.1 selects 4 years where drought affected area reaches more than 50% of the total area, while the threshold 0.2 approach detects 9 years and for threshold 0.3, 21 years are obtained (almost 60% of the time).

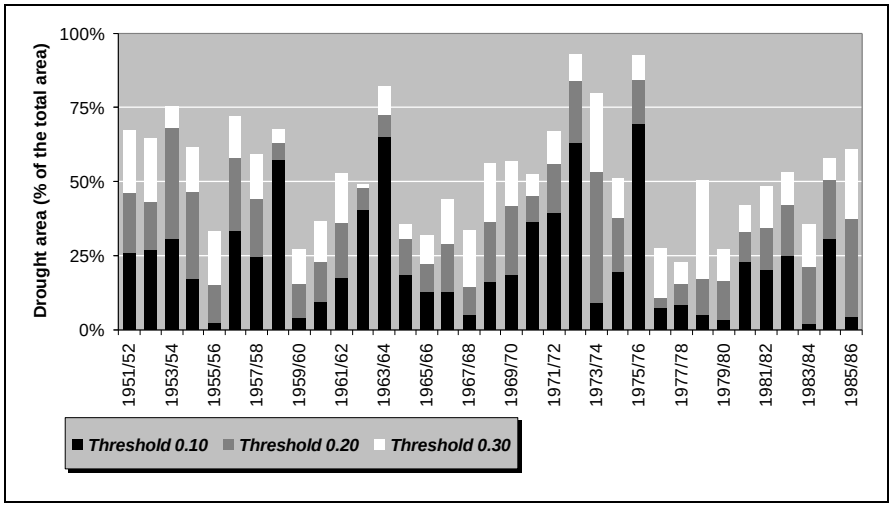

Figure 6.2 – Drought affected area in Western Europe using the thresholds represent by the non-exceedance probability of 0.10, 0.20 and 0.30 (analysis of the common period).

The classification of regional droughts is presented in **Error! Reference source not found.** for both thresholds 0.10 and 0.30. To allow the comparison between these results and those obtained for threshold 0.20, these is also presented. In general, differences in regional drought classification are not significant for most of the droughts with associated return period higher than 25 years. For both periods (longer and shorter common) threshold 0.10 selects less droughts with return period less than 25 years while the use of threshold 0.30 selects more droughts associated with lower return periods. The use of threshold 0.20 is a compromise solution.

In Figure 6.3 the mean duration and number of droughts obtained for the several thresholds are presented by region. The number of sequential droughts is usually higher using the threshold 0.30 in most of the twelve regions. The use of the longer data sets sustains this evidence **Error!**

Reference source not found.). Naturally, the use of the longer data set selects more events for threshold 0.10. The threshold 0.10 leads to the sequential drought absence in the Alps, Atlantic Iberia, Crete, South Balkans and Western Mediterranean regions. Droughts with duration higher than 3 years are verified in Central Europe, South Balkans and Western France.

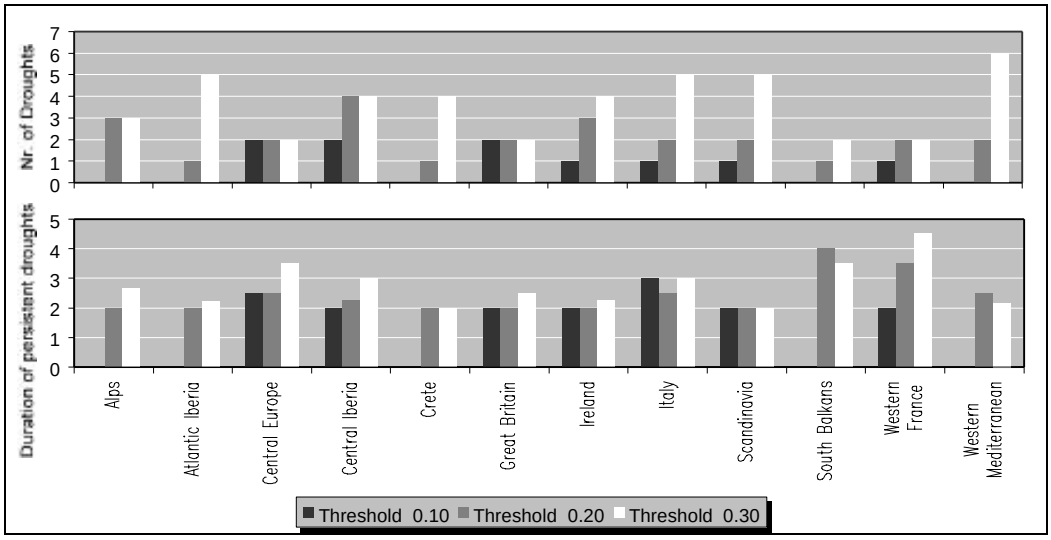

Figure 6.3 - Number and mean duration of droughts lasting more than one year for a critical area of 75% (period 1951/52-85/86)

Table 6.1 - Characteristics of persistent droughts in the common period 1951/52-85/86 for the thresholds defined.

	Threshold 0.10		***Threshold 0.20***		***Threshold 0.30***	
REGION	*Droughts lasting more than 1 year (total area)*	*Return period of sequential droughts*	*Droughts lasting more than 1 year (total area)*	*Return period of sequential droughts*	*Droughts lasting more than 1 year (total area)*	*Return period of sequential droughts*
Alps	-	-	Beginning 1981/82 - 2 years	11 years	Beginning 1972/73 - 2 years Beginning 1981/82 - 2 years	23 years 11 years
Atlantic Iberia	-	-	Beginning 1952/53 - 2 years	20 years	Beginning 1952/53 - 2 years Beginning 1974/75 - 2 years Beginning 1980/81 - 2 years	20 years 31 years 12 years
Central Europe	-	-	Beginning 1970/71 - 3 years	74 years	Beginning 1962/63 - 2 years Beginning 1970/71 - 3 years	37 years 74 years
Central Iberia	Beginning 1952/53 - 2 years	100 years	Beginning 1952/53 - 2 years Beginning 1956/57 - 2 years Beginning 1980/81 - 3 years	100 years 16 years 175 years	Beginning 1952/53 - 2 years Beginning 1956/57 - 2 years Beginning 1973/74 - 2 years Beginning 1980/81 - 3 years	100 years 16 years 6 years 175 years
Crete	-	-	Beginning 1957/58 - 2 years	51 years	Beginning 1953/54 - 2 years Beginning 1957/58 - 2 years Beginning 1965/66 - 2 years Beginning 1982/83 - 2 years	6 years 51 years 14 years 9 years
Great Britain	-	-	Beginning 1962/63 - 2 years Beginning 1971/72 - 2 years	27 years 12 years	Beginning 1962/63 - 2 years Beginning 1971/72 - 2 years	27 years 12 years
Ireland	Beginning 1974/75 - 2 years	90 years	Beginning 1970/71 - 2 years Beginning 1974/75 - 2 years	19 years 90 years	Beginning 1951/52 - 2 years Beginning 1970/71 - 3 years Beginning 1974/75 - 2 years	12 years 21 years 90 years
Italy	-	-	Beginning 1969/70 - 2 years	15 years	Beginning 1956/59 - 2 years Beginning 1969/70 - 2 years Beginning 1973/74 - 2 years Beginning 1980/81 - 3 years	7 years 15 years 21 years 25 years
Scandinavia	-	-	Beginning 1962/63 - 2 years	16 years	Beginning 1954/55 - 2 years Beginning 1962/63 - 2 years Beginning 1968/69 - 2 years Beginning 1972/73 - 2 years	10 years 16 years 6 years 8 years
South Balkans	-	-	-	-	Beginning 1974/75 - 3 years	30 years
Western France	Beginning 1971/72 - 2 years	37 years	Beginning 1971/72 - 2 years	37 years	Beginning 1953/54 - 4 years Beginning 1971/72 - 3 years	28 years 35 years
Western Mediterranean	-	-	-	-	Beginning 1963/64 - 2 years Beginning 1980/81 - 3 years	8 years 21 years

Characteristics of persistent droughts occurring in the total area of the regions are presented in Table 6.1. For different thresholds the return period of sequential drought does not vary when the number of years under drought is the same. The use of threshold 0.20 selects the most exceptional sequential droughts. In South Balkans and Western Mediterranean regions no sequential droughts are selected when the threshold 0.20 is used, however droughts are not very exceptional there when the threshold 0.30 is used: return periods calculated were not greater than 30 years. In the opposite the use of the threshold 0.10 removes drought occurrences like the one in Central Europe in 70/71-71/72 (T=74 years) and the one in Central Iberia in 80/81-82/83 (T=175 years) being by this mean very restrictive.

The use of different thresholds influences the estimation of the severity-area-frequency curves parameters. For lower non-exceedance values it is expected that the more severe values have more influence in the results.

The parameters of the severity-area-frequency curves for thresholds 0.10 and 0.30 are presented in **Error! Reference source not found.**. For threshold 0.10 calculated û values varies between 0.043 and 1.439 while â varies between 0.354 and 0.522. Results for threshold 0.30 can be resumed in û values between 0.023 and 1.353 and â between 0.430 and 0.570.

The severity-area-frequency curves for T=5 years and T=100 years that result from the different threshold definition are presented in **Error! Reference source not found.**. The curves obtained are not much different from the ones calculated for threshold 0.20. Using the threshold 0.1 the severity values correspondent to high return periods increases while it decreases for lower return periods. The opposite is verified for threshold 0.30. This is a direct result from the selection of lower values for the extremes analysis. Some inversions are observed in areas lower than 30% in the curve T=5 years (for instance for Atlantica Iberia, Central Iberia, Crete, Great Britain and Western Mediterranean regions). These result obtained from the use of the selected values on the first step of the model that are usually higher than the ones calculated for more than one area, turned out to be more sensitive when lower severity values are used, as is the case of threshold 0.30.

7. Return period evaluation

The return period of the regional drought is obtained through the simulation of series for each region with the same statistical characteristics of the historical ones. Characteristics preserved are the mean, the variance, the regional Box-Cox parameter and the spatial correlation. The use of these regional replicates has the advantage of using more drought events in the determination of the severity-area-frequency curves parameters.

The drought model application is usually performed using ten replicates of 100 years of precipitation. This gives, for each region, ten replicates of precipitation and consequently ten replicates of regional drought that are used for the application of the extreme-value distribution. This methodology is very convenient for the isolate regional droughts for the return period evaluation instead of the use of the historical data (SANTOS 1996). Nevertheless, the study of drought in areas where the regional model was never tested should include an evaluation of the return period results for different input.

Features related to the severity-area-curves focused in this point are:
i) the use of shorter series for data simulation;
ii) the size of the simulated series;
iii) the evaluation of the return period using the historical series.

The use of the shorter periods for simulation and the sequential curves parameters calculation is not restrictive for the most of the regions and for the periods defined, 35 years of data between 1951/52 and 1985/86 compared with close to 90 years of data. It seams that the characteristics of the precipitation series in the shorter period are rather steady.

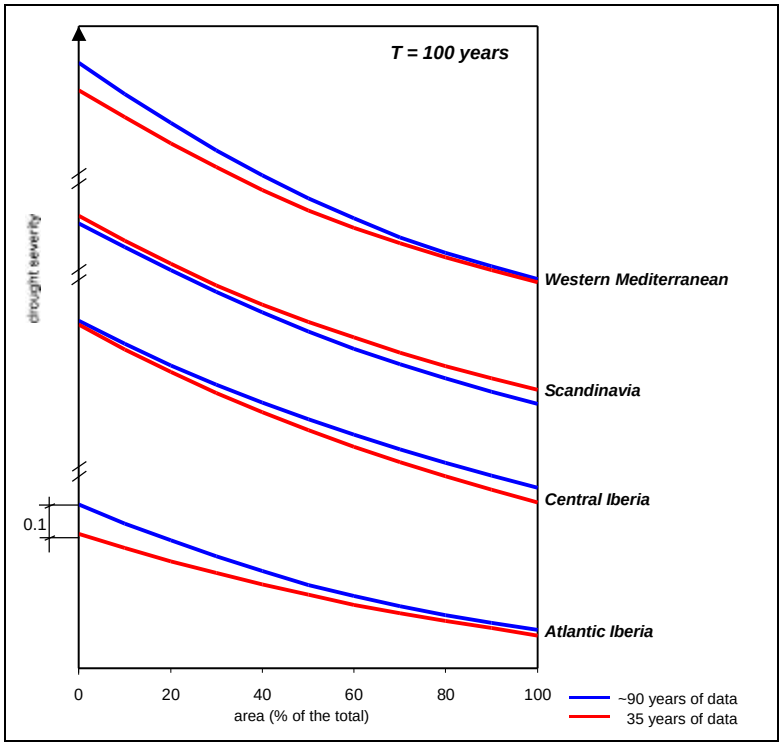

Figure 7.1 -Severity-area-frequency curves for return period 100 years for the regions where higher differences are observed.

The regions where differences are more evident are the Atlantic Iberia and the Western Mediterranean zones (Figure 7.1). This can be due to the climatic variability within years. Higher differences are close to 0.1. Higher severity values obtained for the T=100 years curve correspond to the shorter data set in Scandinavia and to the longer data set in the other regions. This is due to the estimates of the precipitation parameters coming from statistical analysis performed over two different series in both individualised periods.

The analysis of the area-severity-frequency curves for both return periods 5 and 100 years is presented in **Error! Reference source not found.**. Results include the curves for the historical data, for each of the ten replicates of 100 years length, the mean of the severity calculated from the ten replicates and a regional replicate of 1000 years. The results are based on the longer data set existent for each region.

The curves obtained for each of the ten replicates can vary substantially. One can observe that for low return periods (T=5 years) variability is not so high as for T=100 years. However, the curve obtained from the mean of the severities calculated for the ten replicates (getting this way the worst droughts for the whole 10 replicates) represents very well these ten curves.

The mean curves can be very different from the ones obtained using the historical data. This is the case for return period of 100 years in Atlantic Iberia, Central Europe, Crete, Great Britain, Italy, Scandinavia, Western France and Western Mediterranean. For the lower return period (T=5 years) the mean curve gives severity values that are not very far from the historical one.

The use of the mean curve eliminates the high severity variations over the area that can be eventually obtained in the other cases studied (for instance in Italy and Western Mediterranean for T=100 years).

The use of only one replicate with longer size (1000 years) is not adequate for the most of the regions since lower severity droughts are used for the calculation, resulting on a lower severity values for lower return periods (examples of the curves for T=5 years in **Error! Reference source not found.**).

8. Conclusions and recommendations

The model applied can be used in a large scale for the analysis of the drought spread and the evaluation of drought risk, expressed by the exceedance probability of regional events.

Throughout the analysis all the regions experienced at least one small drought, although very exceptional droughts were not identified for all regions. This conclusion, dependent on the size of the data-series used, is more reliable for the regions where longer data sets are available: Atlantic Iberia, Central Europe, Central Iberia, Great Britain, Ireland, Scandinavia, Western France and Western Mediterranean.

Return periods close to 100 years were observed for Central Europe in 20/21 and 48/49, Central Iberia in 44/45, Great Britain in 58/59 and 75/76, Scandinavia in 46/47 and 75/76, and Western France in 48/49.

In general, regions were affected by sequential drought lasting about 2 to 3 years. Most exceptional two-years drought (in the total area) were isolated for Central Iberia and Ireland. For Central Iberia the drought of 43/44-44/45 was associated to a return period close to 400 years. The drought of 74/75-75/76 in Ireland was associated to a return period close to 300 years. The only three-year event studied, that had an areal incidence of 100% of the total area in one of the European's sub-regions, was obtained for Central Iberia for the drought started in 1980/81.

In some cases 35 years can be a limitation for the characterisation of drought since specially dry or humid decades can influence the results. This can be the case of the results obtained for Italy, for instance, where more severe droughts were not obtained. The use of short periods can also overstate accentuate the importance of some drought events less relevant. The percentage of droughts obtained for the longer period (close to 90 years of data) is generally lesser than the number of droughts obtained for the period 51/52-85/86.

The drought conclusions from drought evaluation in sequential years for the shorter (common) data set can also differ from those obtained in the longer data set, like the ones verified in Ireland and Central Europe. In general, the spatial distribution of drought does not vary largely when the size of the data set is different.

Comparing the regional drought classification in 51/52-85/86 using the different periods (shorter and longer) one concludes that the drought incidence differs mainly when lower return periods are at stake. Nevertheless global conclusions like major drought duration and the identification of the severest drought can be very influenced by the use of shorter periods, and the results very dependent on the characteristics of the specific period used.

Relevant recommendations regarding regional drought evaluation are as following:

— The threshold 0.20 can be globally applied to all the regions as the drought trigger for the time-series analysis.
— The critical areas higher than 75% and close to 100% of the total area can be generalised for the analysis of drought in sequential years.
— For the calculation of the severity-area-frequency curves parameters a critical area of 90% retrieves good results.
— The return period of regional drought must be evaluated based on larger data sets obtained by simulations. The best application is achieved if several replicates (ten) of 100 years of data are used.

These results coming from a meteorological drought analysis can be used in cross comparisons with other results obtained from different evaluation contexts, as for instance those drought analysis where hydrological, agricultural or economical criteria are determinants.

The regional drought model described has been used since 1998 as the guiding monitoring and simulation tool to support the Portuguese Reservoir Management Commission's decisions under drought occurrences. In this context all the relevant multiple users' needs for water are carefully

analysed in view of the model outcomes. These applications to drought monitoring in near real time revealed interesting results, which can be extended to other regions.

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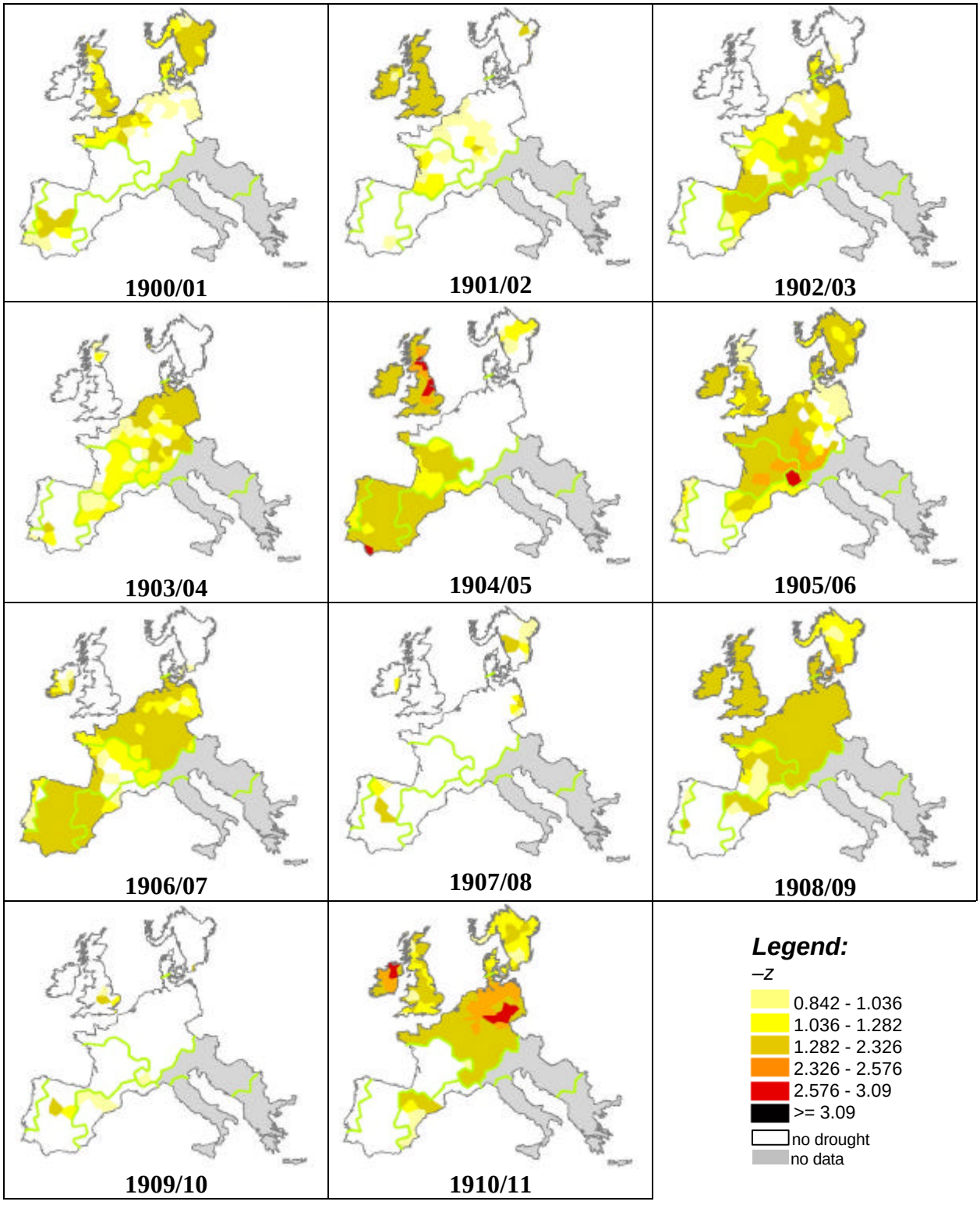
ANNEXES

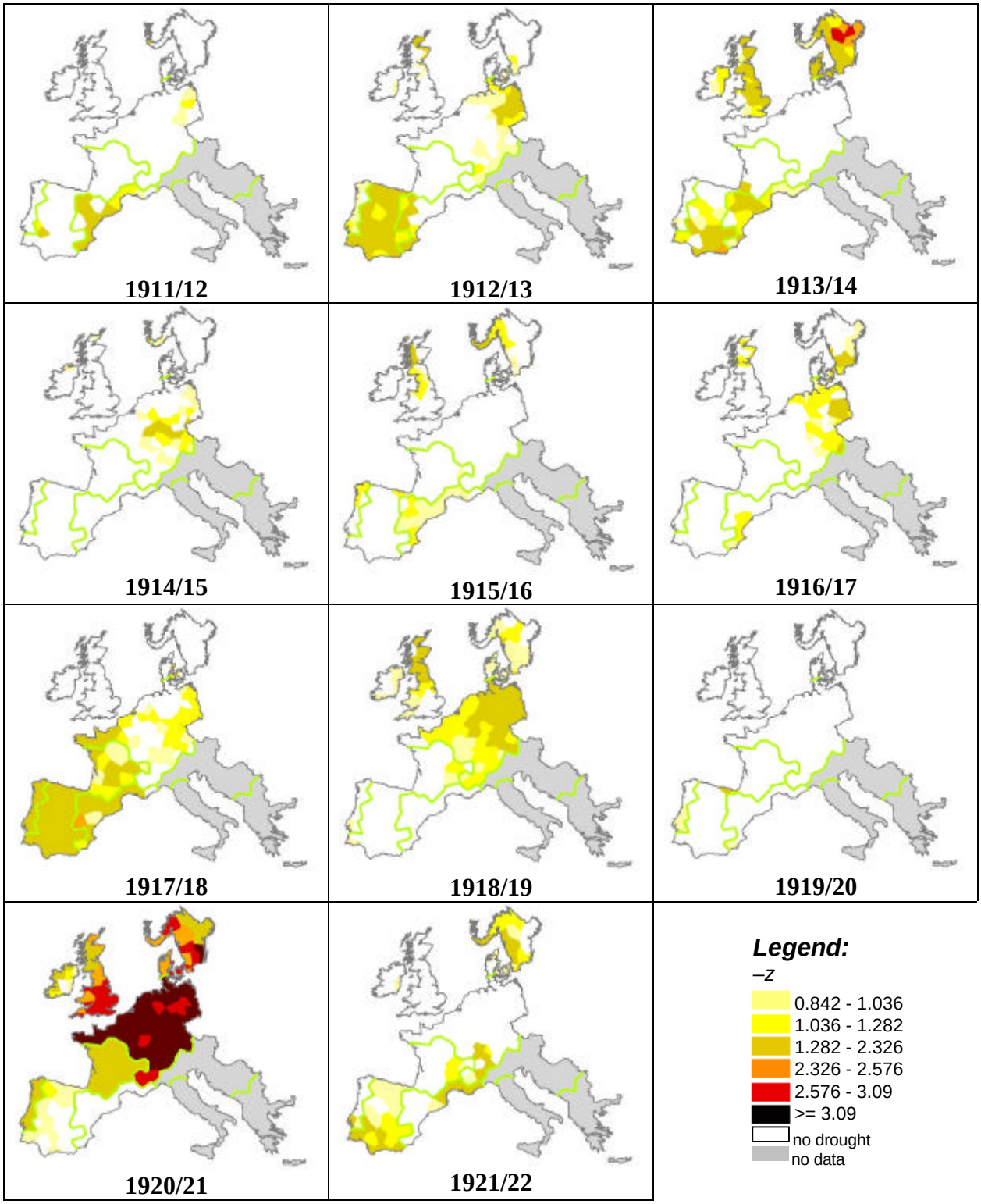
ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS

Analysis of the longer period (1900/01 – 1993/94)



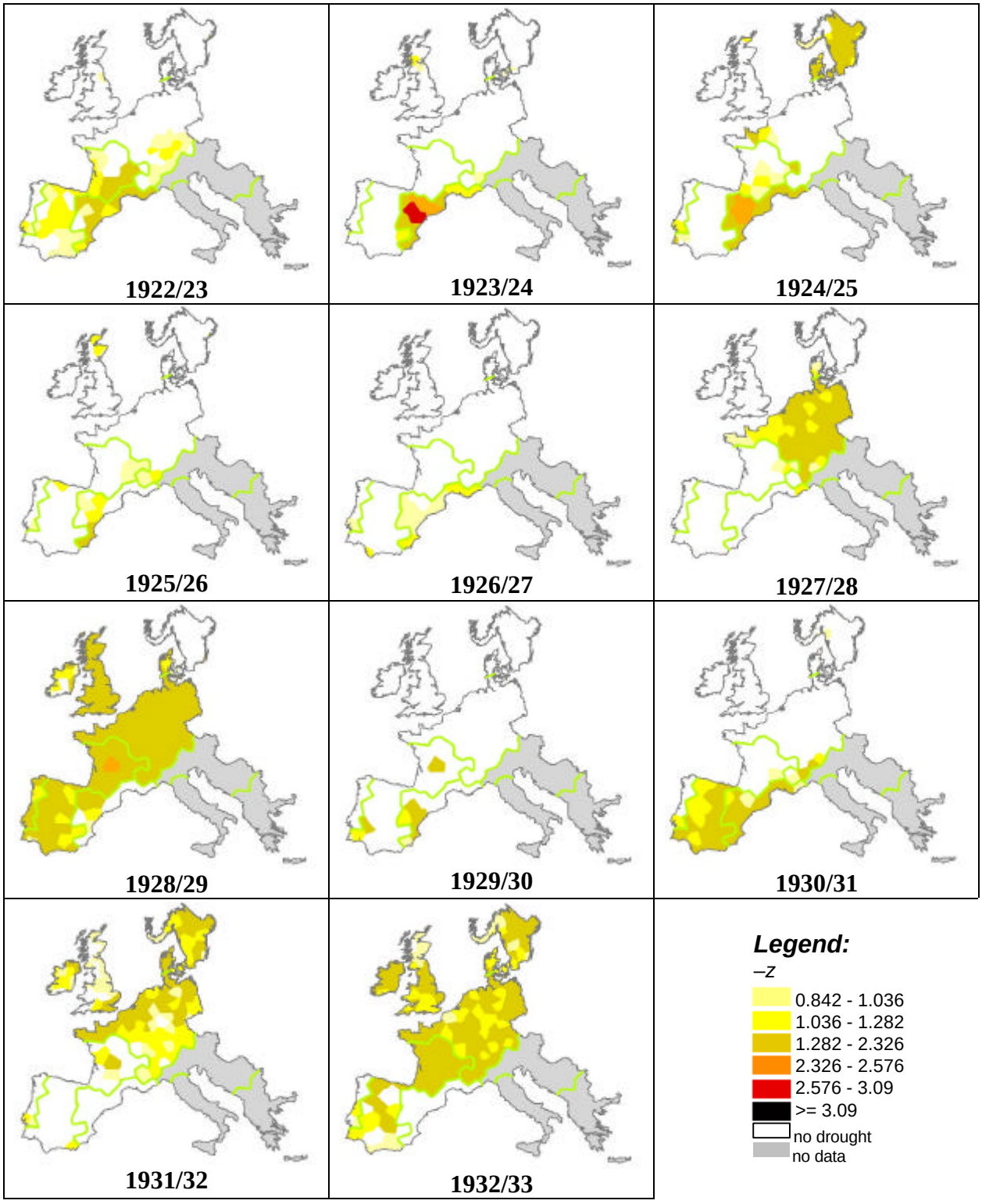
ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS (Cont.)

Analysis of the longer period (1900/01 – 1993/94)



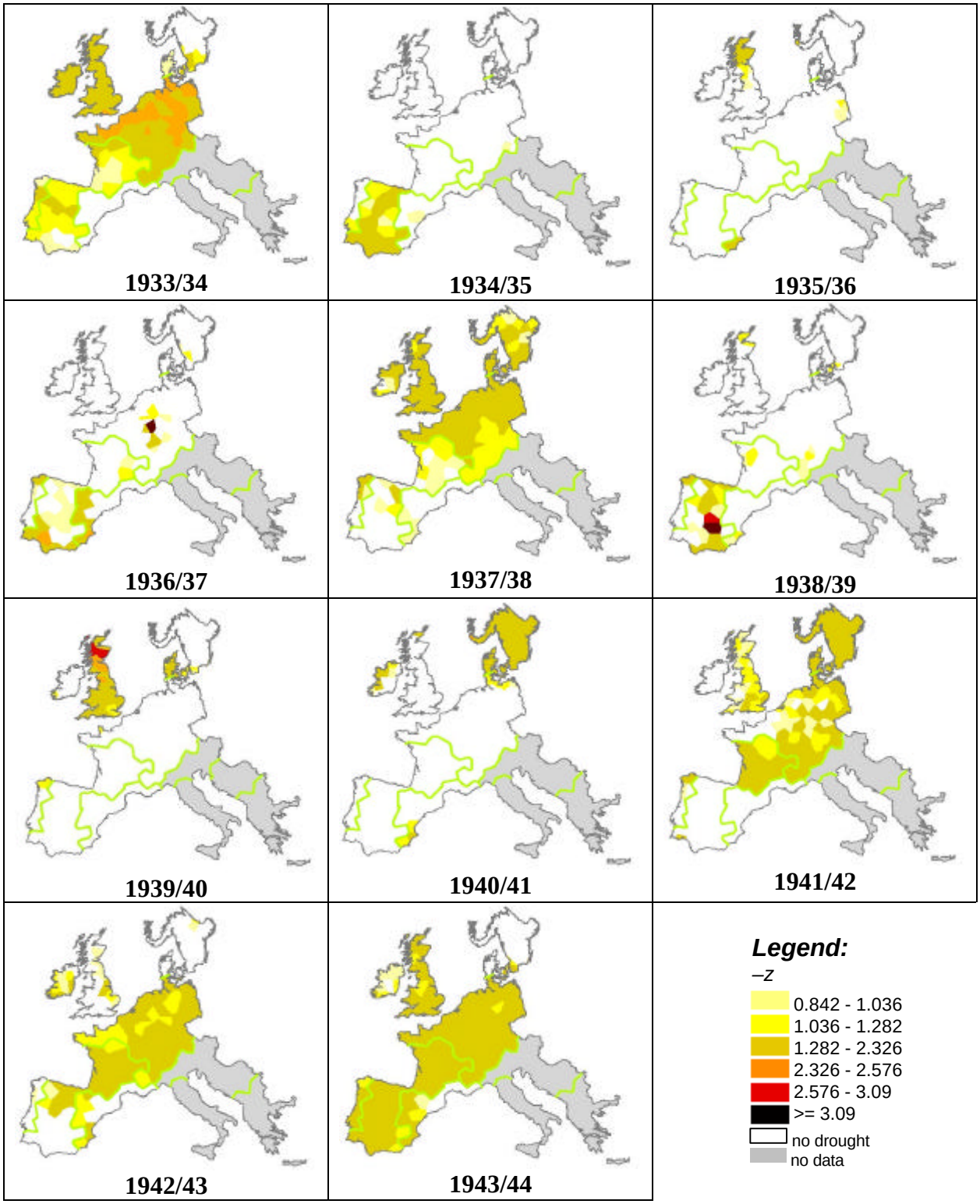
ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS (Cont.)

Analysis of the longer period (1900/01 – 1993/94)



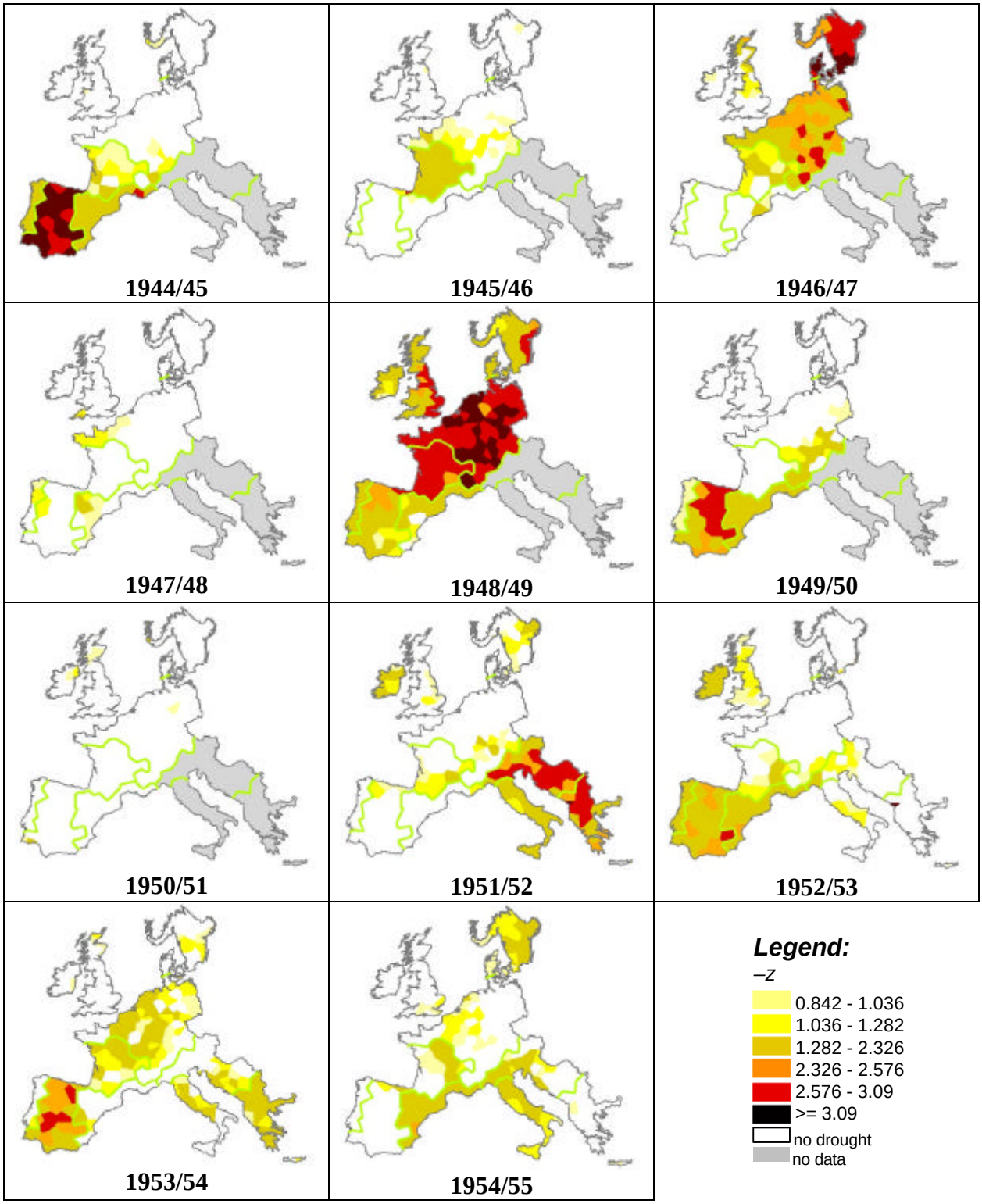
ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS (Cont.)

Analysis of the longer period (1900/01 – 1993/94)



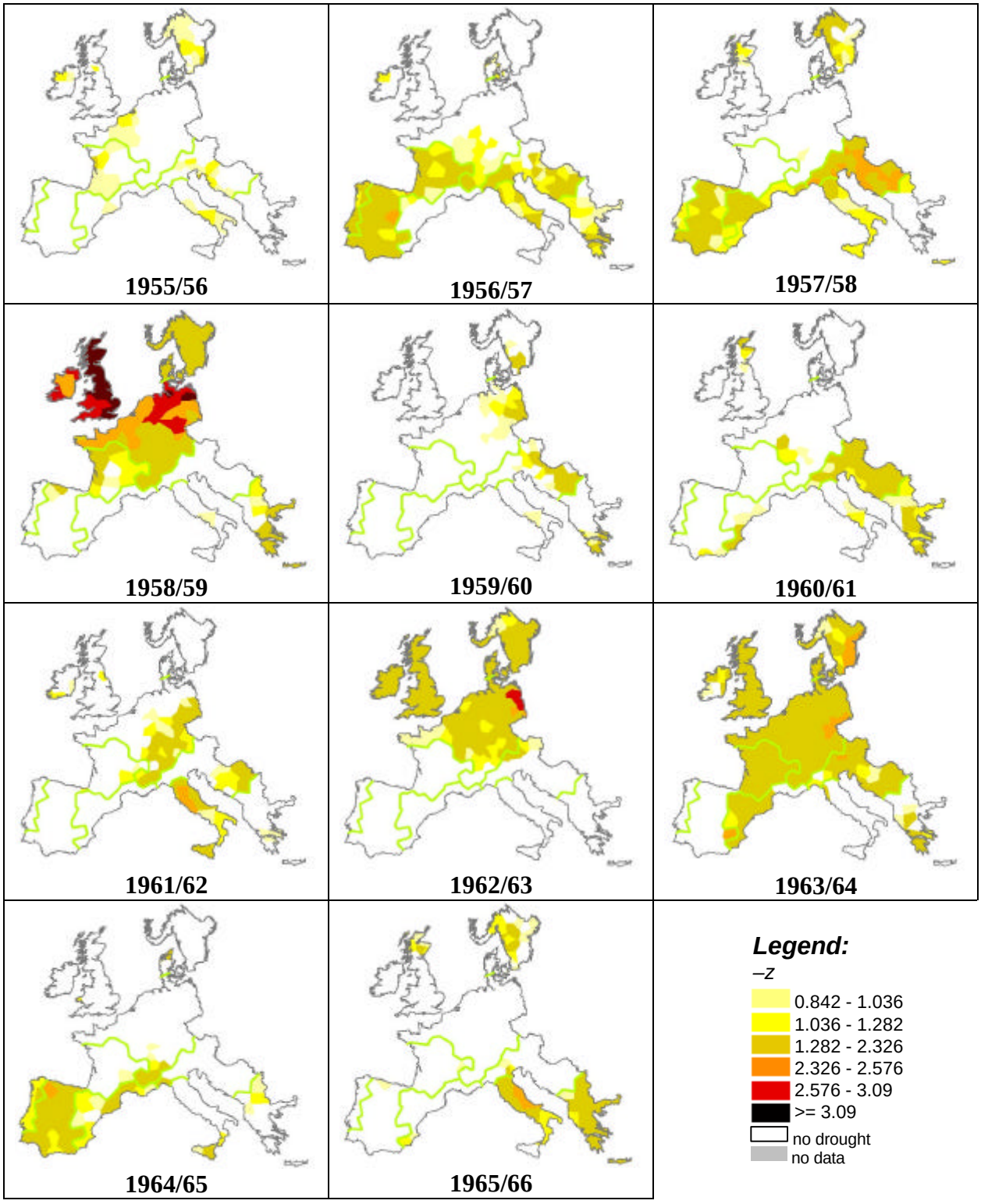
ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS (Cont.)

Analysis of the longer period (1900/01 – 1993/94)



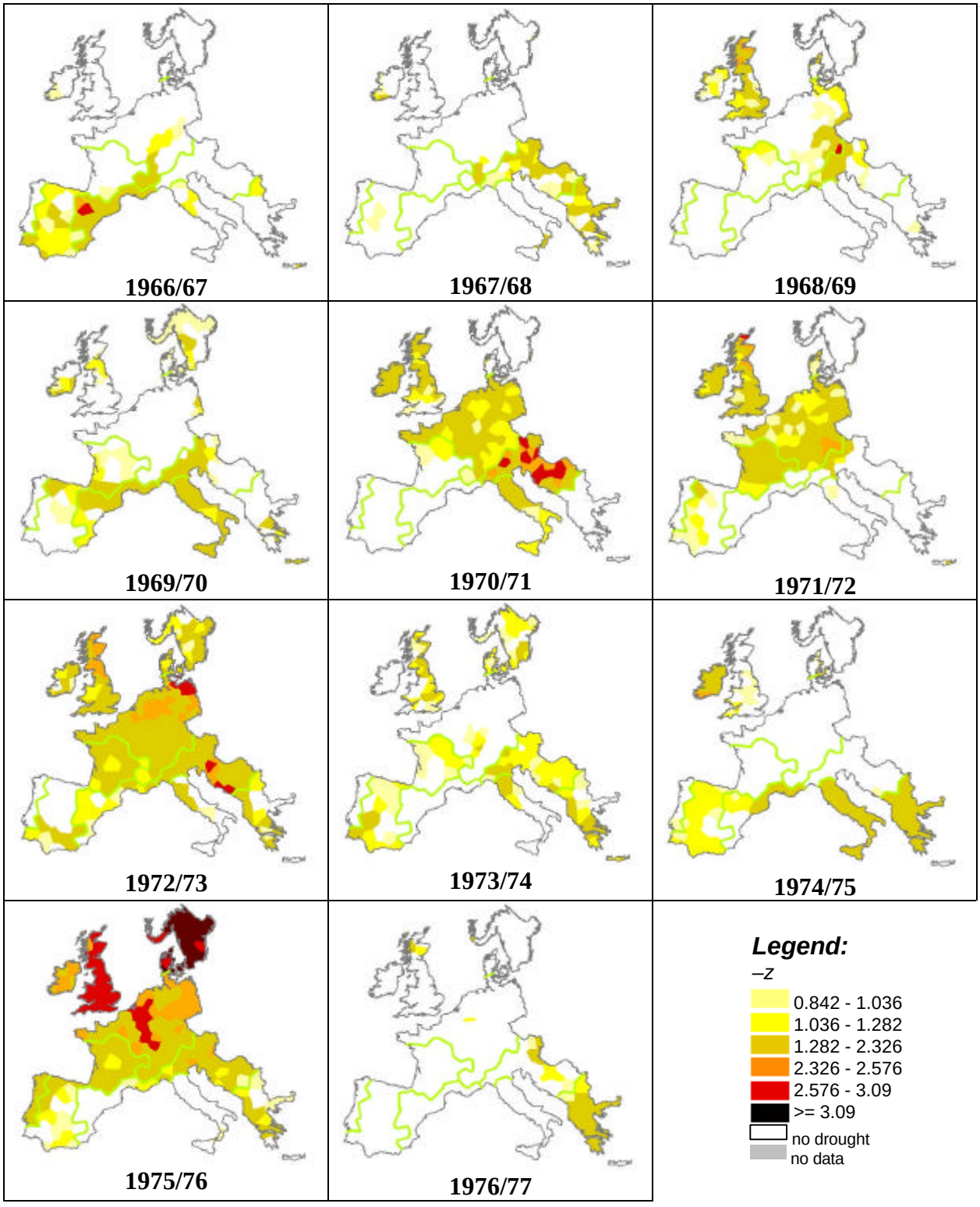
ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS (Cont.)

Analysis of the longer period (1900/01 – 1993/94)



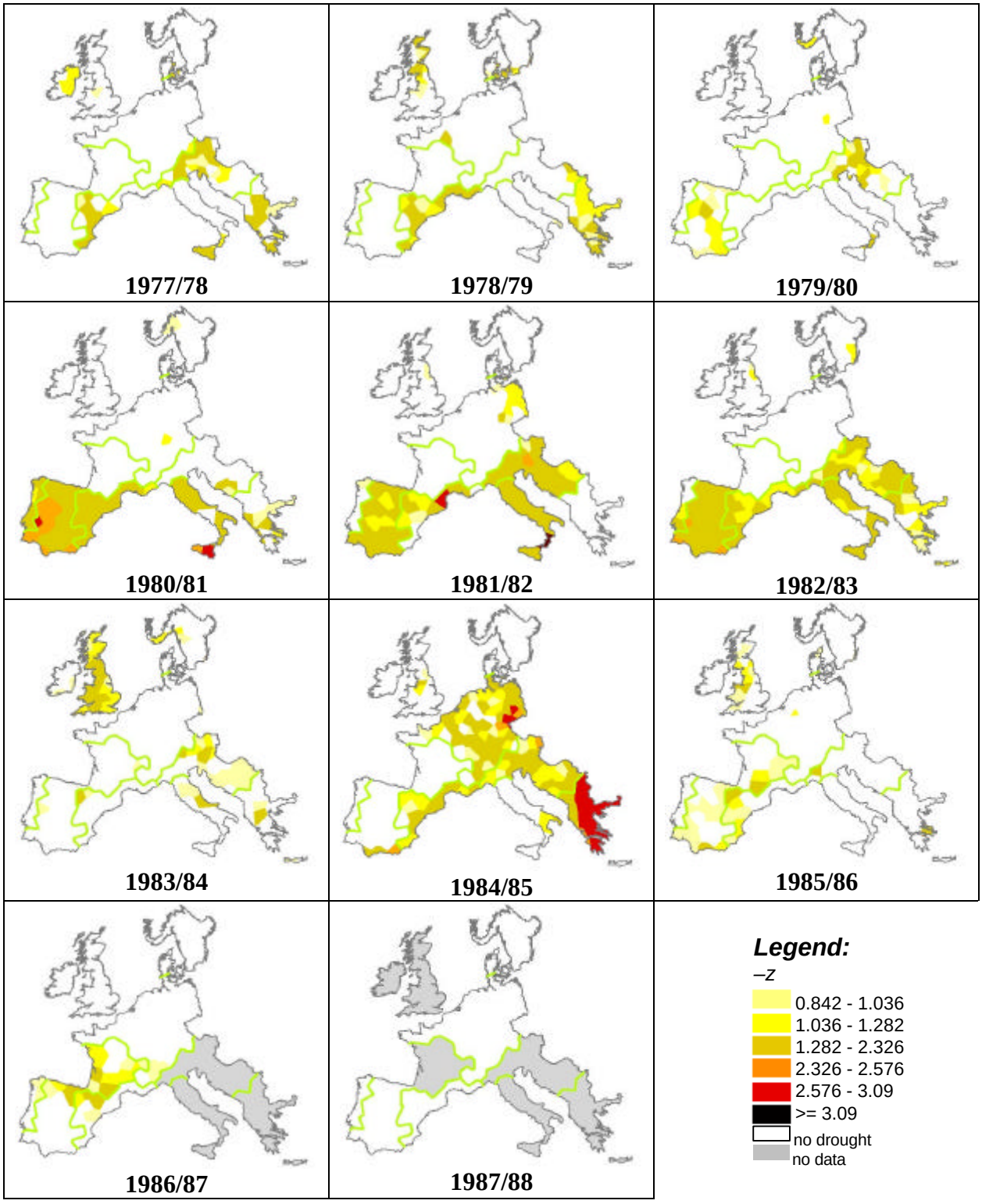
ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS (Cont.)

Analysis of the longer period (1900/01 – 1993/94)



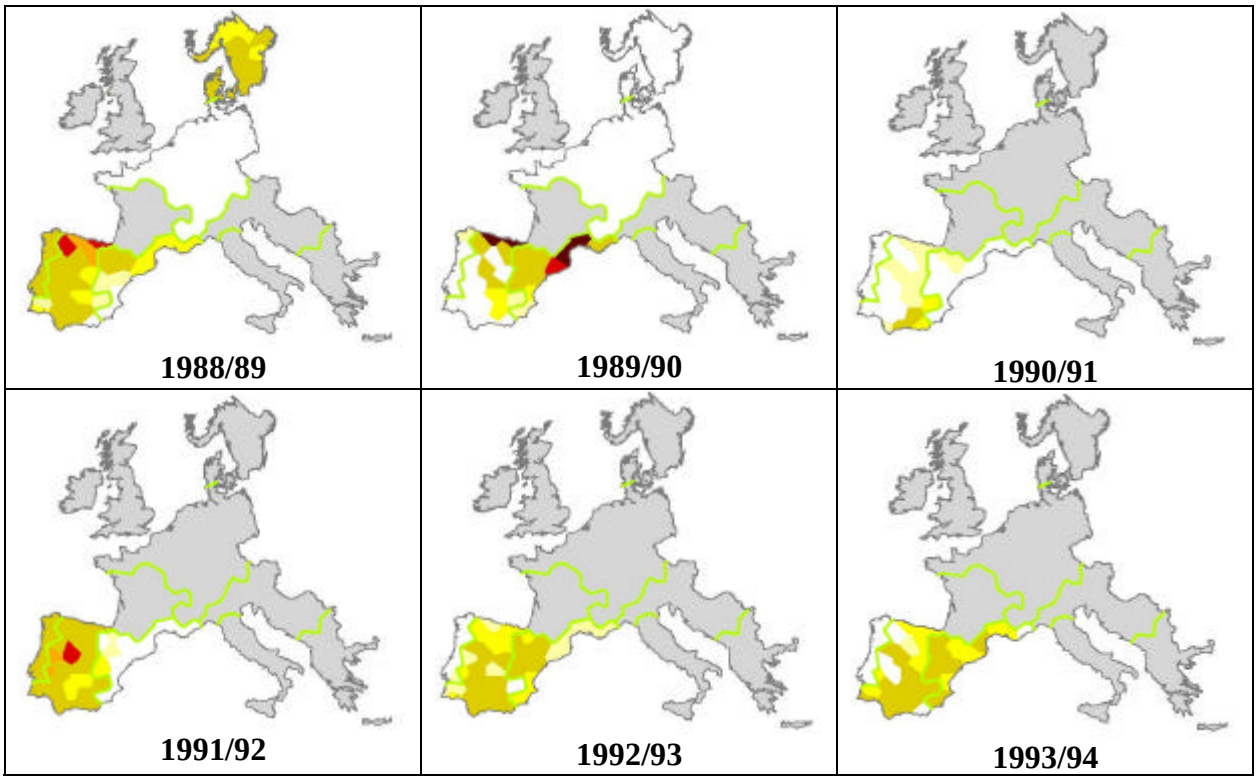
ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS (Cont.)

Analysis of the longer period (1900/01 – 1993/94)



ANNEX A SPACIAL DISTRIBUTION OF DROUGHTS (Cont.)

Analysis of the longer period (1900/01 – 1993/94)



ANNEX B PARAMETERS OF THE SEVERITY-AREA-FREQUENCY CURVES

Extreme-value type 1 distribution: S(A) = û (A) + â (A) x [-log(-log (1- 1/T)]

Model results using the common and the longer period available for each area

Parameter û

area (%) A	Alps	Atlantic Iberia		Central Europe		Central Iberia		Crete	Great Britain		Ireland		Italy	Scandinavia		South Balkans	Western France		Western Mediterranean	
0	1.349	0.653	0.795	1.401	1.270	1.215	1.190	0.615	1.145	1.252	1.104	0.986	1.121	1.084	1.231	1.135	1.065	1.066	0.974	1.034
10	1.313	0.634	0.751	1.319	1.203	1.135	1.125	0.585	1.107	1.179	1.039	0.928	1.101	1.025	1.161	1.091	1.004	1.023	0.951	1.004
20	1.265	0.606	0.701	1.231	1.129	1.046	1.051	0.546	1.064	1.098	0.970	0.864	1.066	0.958	1.081	1.041	0.935	0.973	0.920	0.966
30	1.204	0.572	0.646	1.141	1.044	0.950	0.970	0.502	1.010	1.009	0.896	0.796	1.013	0.887	0.994	0.983	0.860	0.916	0.879	0.915
40	1.130	0.532	0.586	1.042	0.951	0.845	0.880	0.453	0.944	0.911	0.817	0.725	0.955	0.812	0.901	0.918	0.781	0.852	0.830	0.854
50	1.038	0.484	0.520	0.936	0.846	0.734	0.783	0.398	0.865	0.803	0.738	0.648	0.886	0.731	0.803	0.843	0.695	0.779	0.767	0.779
60	0.924	0.422	0.450	0.823	0.733	0.620	0.682	0.339	0.775	0.694	0.651	0.571	0.806	0.643	0.702	0.759	0.604	0.695	0.694	0.689
70	0.799	0.355	0.377	0.706	0.617	0.505	0.573	0.275	0.674	0.581	0.562	0.491	0.718	0.548	0.600	0.667	0.512	0.604	0.613	0.592
80	0.667	0.290	0.304	0.580	0.499	0.387	0.461	0.209	0.569	0.466	0.468	0.409	0.609	0.449	0.497	0.569	0.415	0.509	0.520	0.488
90	0.527	0.218	0.240	0.453	0.383	0.271	0.353	0.145	0.460	0.353	0.369	0.325	0.493	0.348	0.390	0.469	0.318	0.412	0.418	0.378
100	0.382	0.143	0.178	0.327	0.262	0.155	0.243	0.077	0.348	0.237	0.273	0.241	0.366	0.244	0.277	0.365	0.218	0.310	0.315	0.273

Parameter â

area (%) A	Alps	Atlantic Iberia		Central Europe		Central Iberia		Crete	Great Britain		Ireland		Italy	Scandinavia		South Balkans	Western France		Western Mediterranean	
0	0.516	0.508	0.437	0.443	0.480	0.445	0.443	0.485	0.464	0.430	0.430	0.441	0.448	0.454	0.424	0.536	0.472	0.477	0.516	0.463
10	0.490	0.495	0.434	0.435	0.467	0.441	0.435	0.479	0.444	0.426	0.426	0.435	0.428	0.445	0.417	0.519	0.465	0.462	0.492	0.444
20	0.470	0.485	0.433	0.429	0.457	0.441	0.431	0.475	0.427	0.426	0.424	0.433	0.413	0.439	0.415	0.504	0.461	0.450	0.473	0.428
30	0.455	0.478	0.434	0.424	0.451	0.444	0.430	0.474	0.415	0.429	0.425	0.432	0.406	0.434	0.415	0.493	0.460	0.441	0.456	0.417
40	0.446	0.473	0.438	0.423	0.449	0.450	0.433	0.474	0.407	0.436	0.427	0.432	0.401	0.432	0.419	0.485	0.460	0.435	0.444	0.410
50	0.444	0.471	0.443	0.426	0.452	0.459	0.438	0.477	0.405	0.446	0.431	0.435	0.401	0.432	0.424	0.482	0.464	0.434	0.437	0.408
60	0.453	0.474	0.450	0.431	0.458	0.470	0.446	0.482	0.408	0.458	0.437	0.439	0.406	0.435	0.432	0.483	0.469	0.437	0.434	0.412
70	0.466	0.480	0.459	0.438	0.466	0.482	0.456	0.489	0.415	0.471	0.445	0.444	0.415	0.441	0.441	0.487	0.476	0.442	0.435	0.419
80	0.483	0.486	0.468	0.450	0.476	0.495	0.468	0.497	0.425	0.486	0.454	0.451	0.431	0.450	0.451	0.494	0.485	0.450	0.441	0.430
90	0.504	0.494	0.475	0.462	0.486	0.509	0.480	0.505	0.437	0.501	0.466	0.458	0.451	0.460	0.463	0.503	0.495	0.459	0.451	0.442
100	0.528	0.504	0.481	0.474	0.498	0.523	0.493	0.515	0.451	0.517	0.477	0.466	0.475	0.471	0.478	0.514	0.506	0.471	0.461	0.455

Common Period (1951/52-1985/86)

Longer Period

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION

Longer Period

Years	Alps	Atlantic Iberia	Central Europe	Central Iberia	Crete	Great Britain	Ireland	Italy	Scandinavia	South Balkans	Western France	Western Mediterranean
1900/01						A			A			
1901/02						B	B				A	
1902/03			A								A	A
1903/04			A								A	A
1904/05		B		B		C	B				B	B
1905/06		A	A			A	B		B		B	A
1906/07		A	A	B			A				A	A
1907/08												
1908/09			B			B	B		A		A	A
1909/10												
1910/11			B			A	C		A			A
1911/12												A
1912/13		A		B								
1913/14				A		A	A		B			A
1914/15												
1915/16												A
1916/17												
1917/18		B	A	B							A	B
1918/19			A			A	A		A			
1919/20												
1920/21		B	D	A		C	A		C		C	
1921/22				A					A			
1922/23				A							A	B
1923/24												B
1924/25									A			B
1925/26												
1926/27												A
1927/28			A									
1928/29		B	B	B		B	A				B	
1929/30												
1930/31				B								B
1931/32			A			A	A		B			
1932/33			A	A		A	B		A		B	
1933/34		B	B	A		B	B				A	
1934/35				A								
1935/36												
1936/37				A								
1937/38		A	A			B	A		A		A	
1938/39				A								
1939/40						B						
1940/41							A		B			
1941/42			A			A			B		B	
1942/43			B				A				B	

Years	Alps	Atlantic Iberia	Central Europe	Central Iberia	Crete	Great Britain	Ireland	Italy	Scandinavia	South Balkans	Western France	Western Mediterranean
1943/44		B	B	B		B	A				B	A
1944/45		C		D							A	C
1945/46											B	
1946/47			C						D		A	
1947/48		A										
1948/49		B	D	B		C	B		B		D	A
1949/50		A		C								B
1950/51												
1951/52	C						A	B		C		
1952/53		B		C		A	B				A	B
1953/54			A	C				A		B	A	
1954/55					A			A	A		A	B
1955/56									A		A	
1956/57	A	B		B				A		A	B	
1957/58	B			B	B			A	A			A
1958/59			C		C	D	C		B	A	A	
1959/60												
1960/61	A									A		
1961/62								B				
1962/63			A			B	B		B			
1963/64	A		B			B	A		B		B	B
1964/65		B		B								A
1965/66					B			A	A	B		
1966/67				A								B
1967/68	A									A		
1968/69						B	A					
1969/70					C		A	B	A		A	A
1970/71	C		A			A	B	A				
1971/72			A			B	B				B	
1972/73	B		B			B	A		A	A	B	A
1973/74	A			A	B	A			A	A	A	
1974/75				A			C	B		B		A
1975/76	A	B	C	A		D	C		D	A	B	
1976/77										B		
1977/78	A						A			A		A
1978/79										A		A
1979/80	A											
1980/81		B		C				B				B
1981/82	B			B				B				A
1982/83	A			B	B			B		A		A
1983/84	A				A	A						
1984/85	A		A							C		A
1985/86				A								A
1986/87											A	
1987/88												
1988/89		C		B					B			A
1989/90												B
1990/91				A								
1991/92		B		B								
1992/93				A								A
1993/94				A								B

LEGEND:

Longer period:

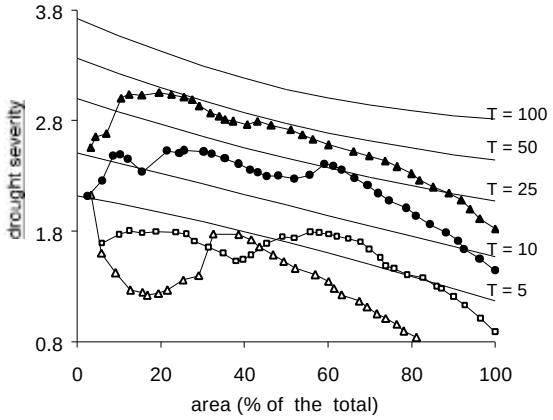
A	T <= 5 years
B	5 < T < 25 years
C	25 < T < 100 years
D	T > 100 years
	Data not available

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION

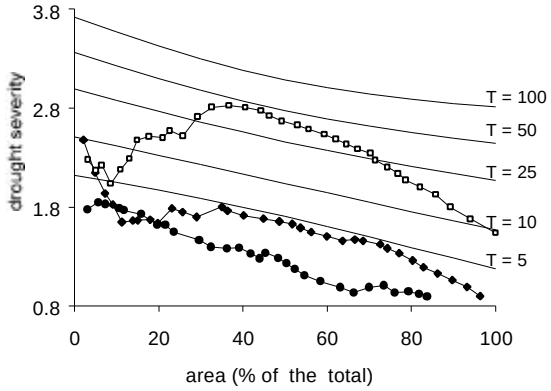
Longer Period

ALPS

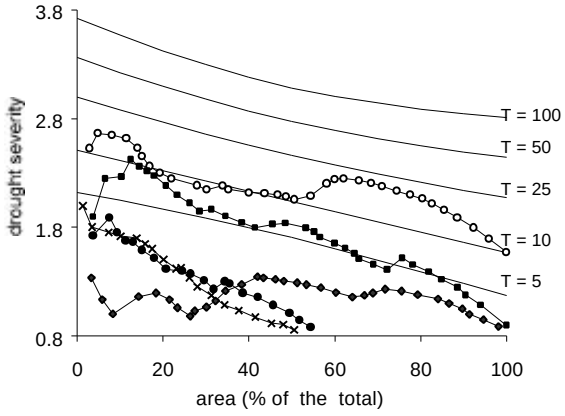
1951/1960



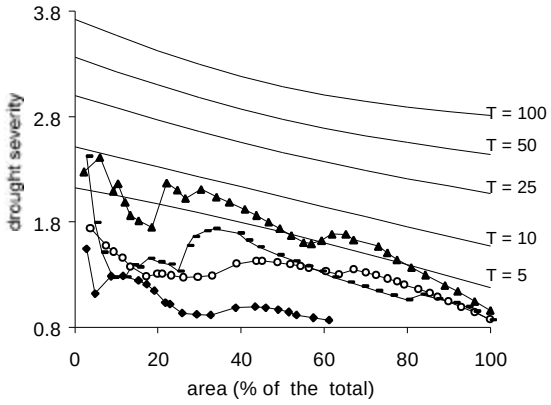
1961/1970



1971/1980



1981/1985



Legend:

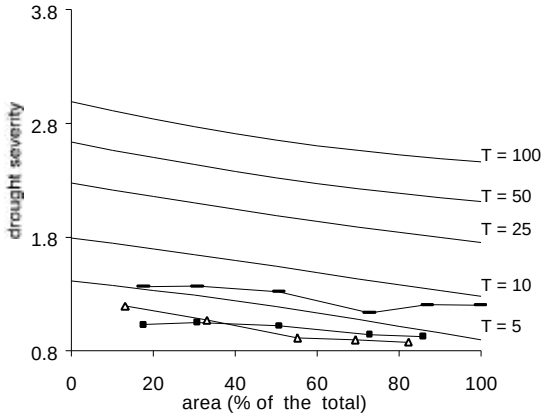
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

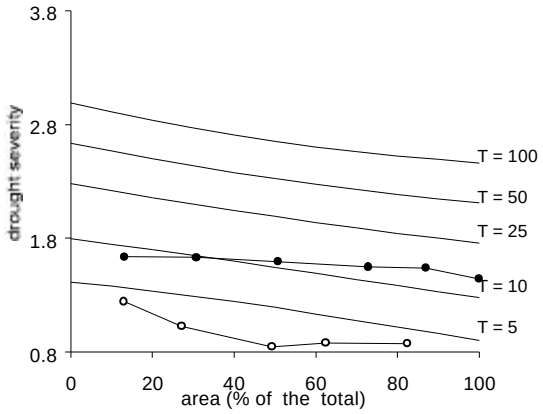
Longer Period

ATLANTIC IBERIA

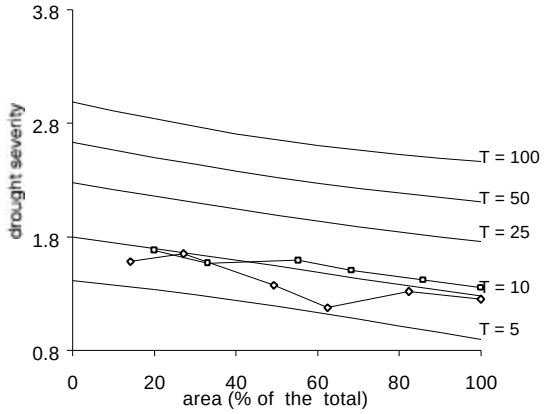
1900/1909



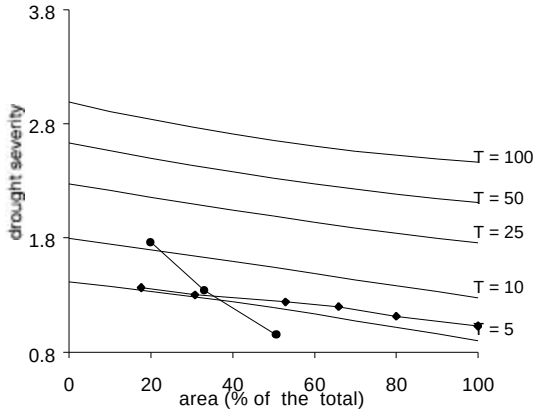
1910/1919



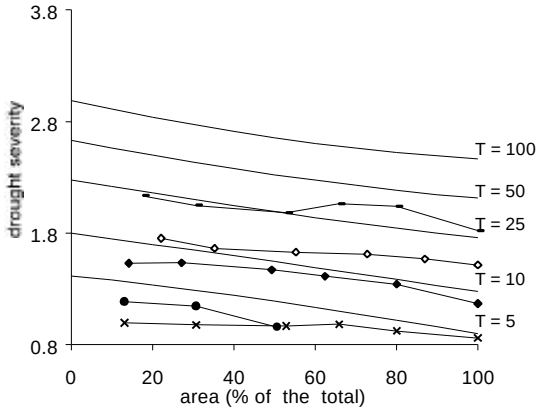
1920/1929



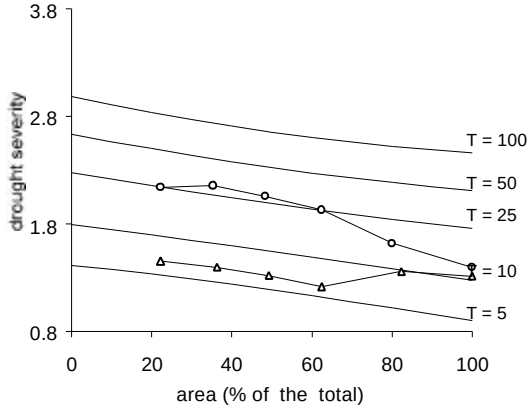
1930/1939



1940/1949



1950/1959



Legend:

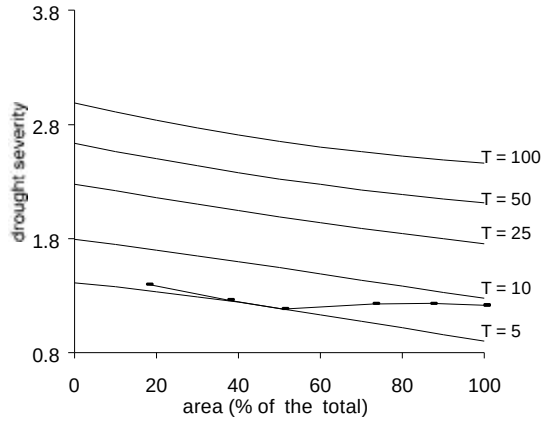
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

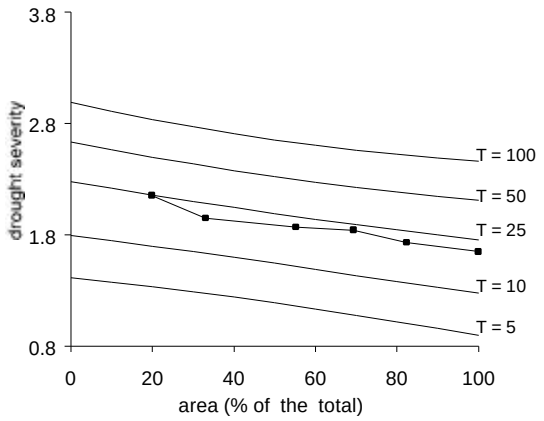
Longer Period

ATLANTIC IBERIA

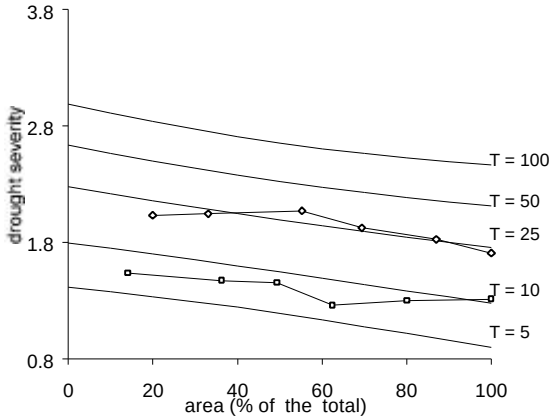
1960/1969



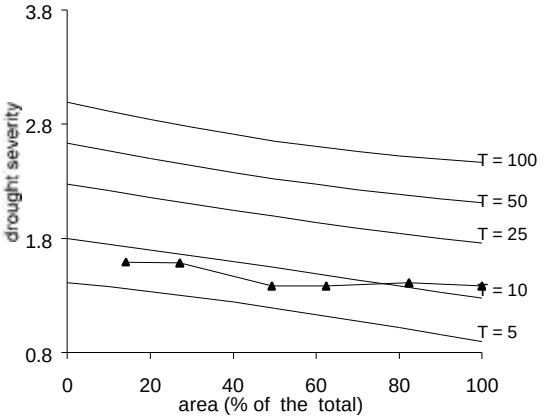
1970/1979



1980/1989



1990/1993



Legend:

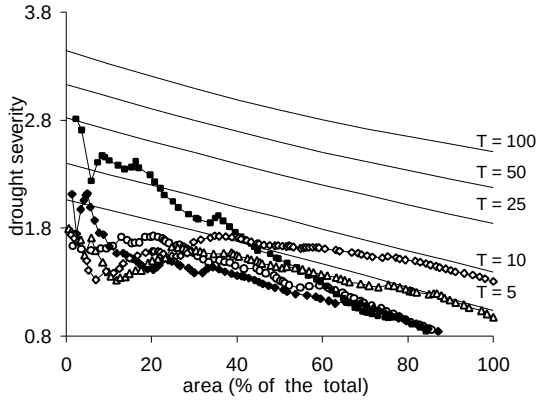
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

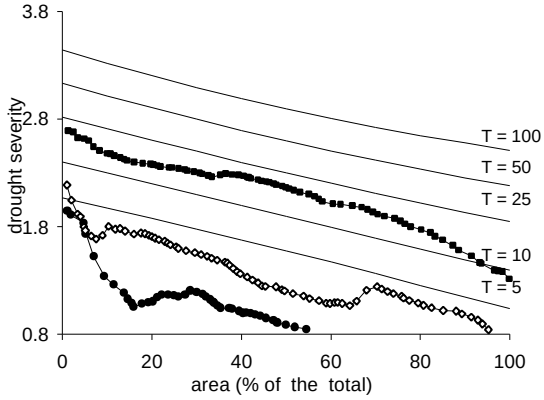
Longer Period

CENTRAL EUROPE

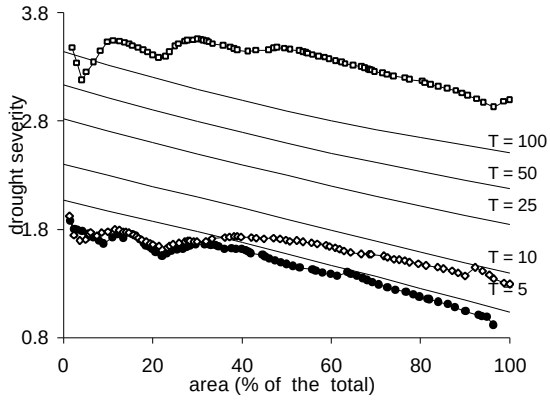
1900/1909



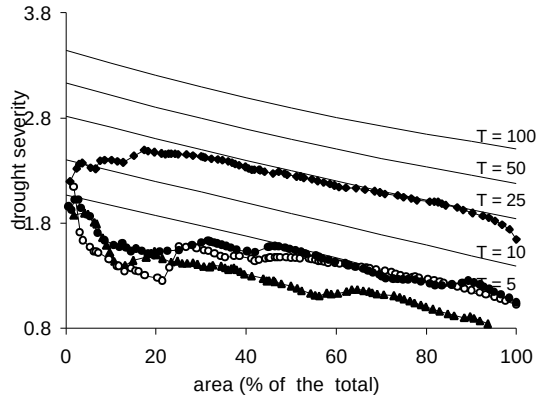
1910/1919



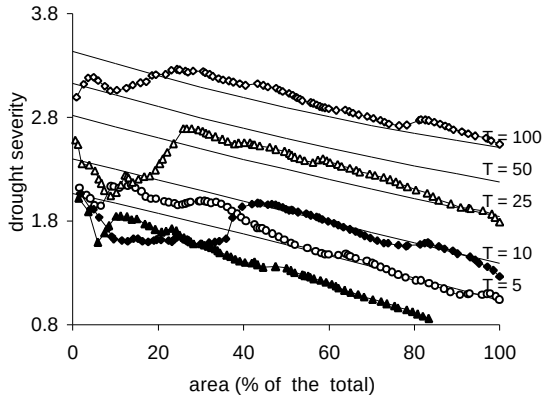
1920/1929



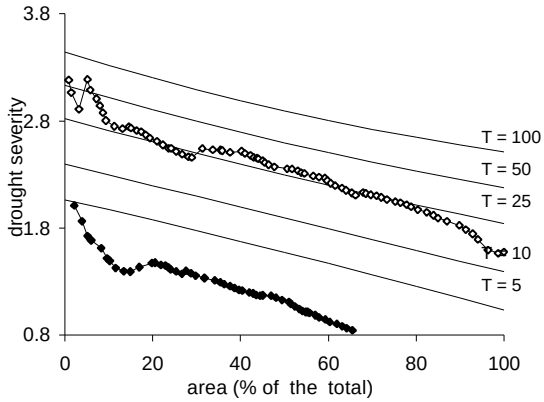
1930/1939



1940/1949



1950/1959



Legend:

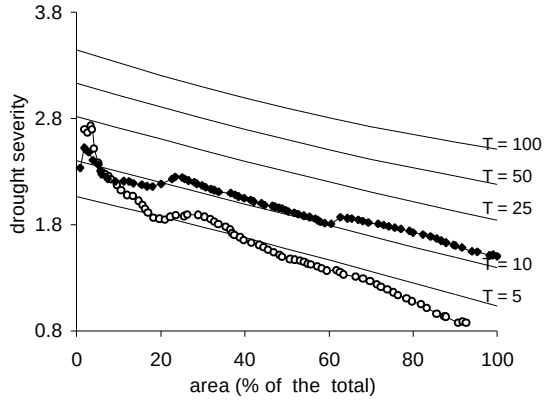
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

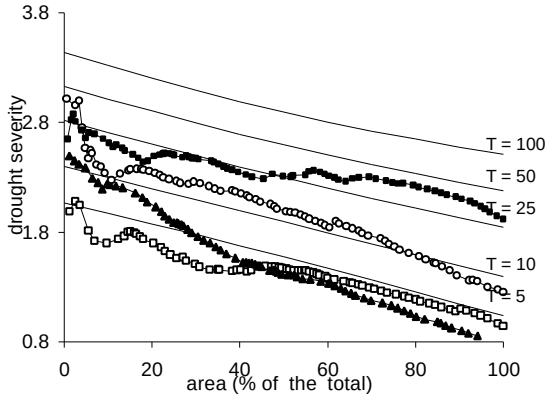
Longer Period

CENTRAL EUROPE

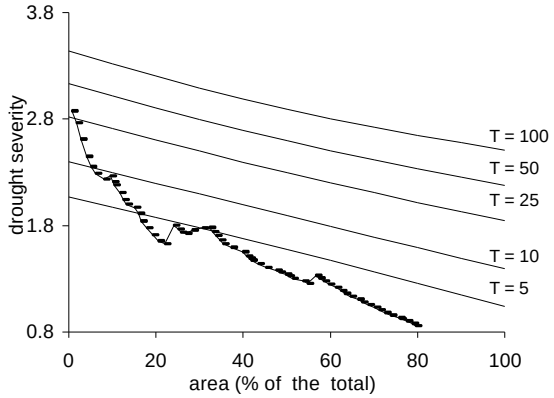
1960/1969



1970/1979



1980/1989



Legend:

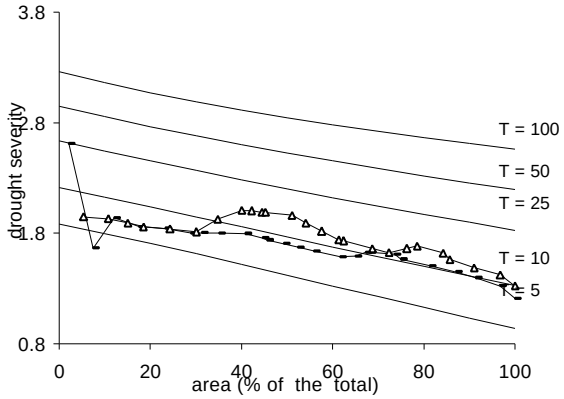
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

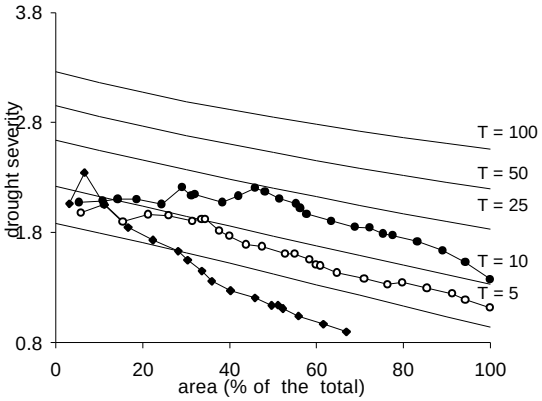
Longer Period

CENTRAL IBERIA

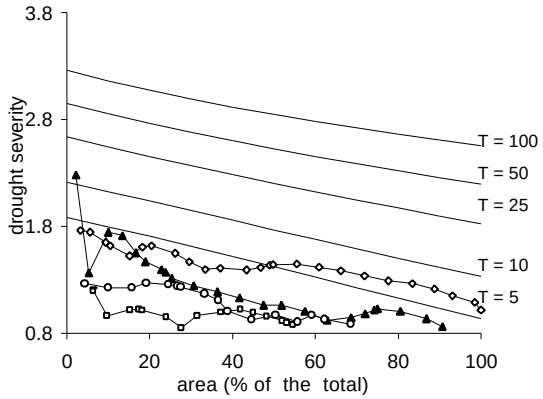
1900/1909



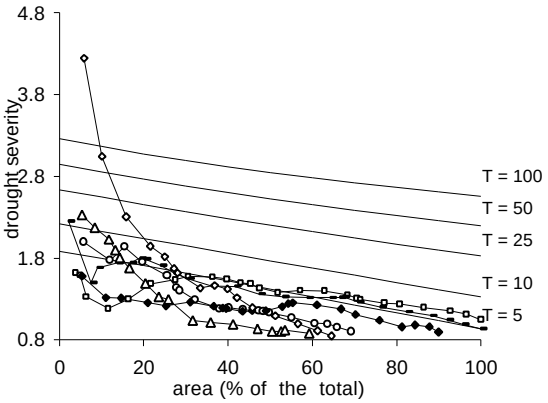
1910/1919



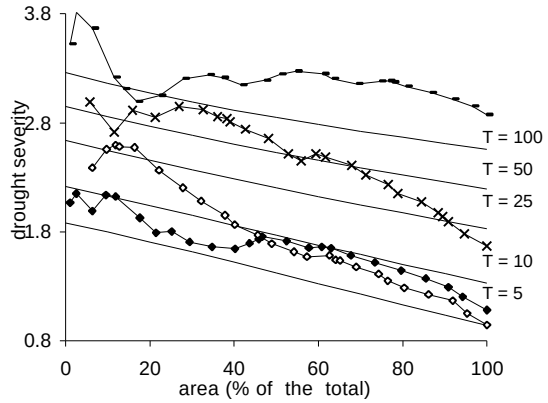
1920/1929



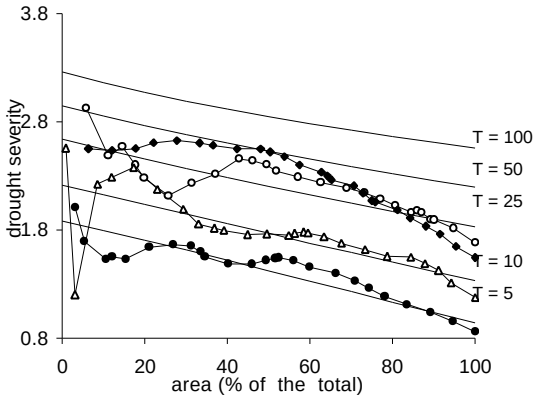
1930/1939



1940/1949



1950/1959



Legend:

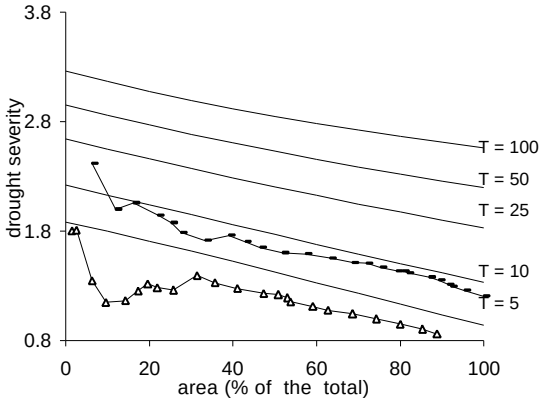
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

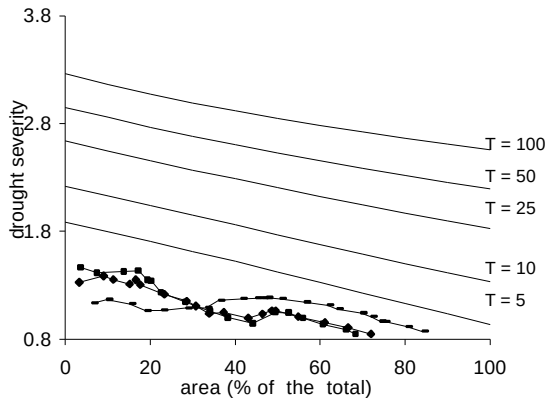
Longer Period

CENTRAL IBERIA

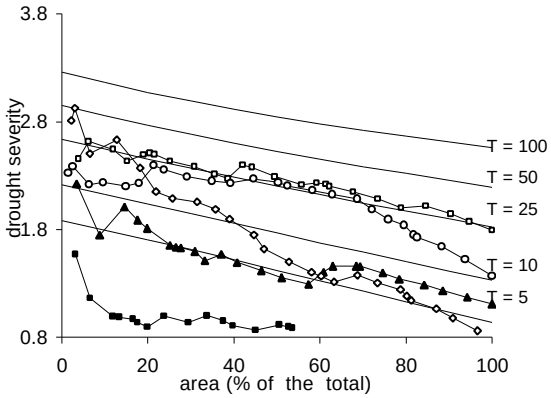
1960/1969



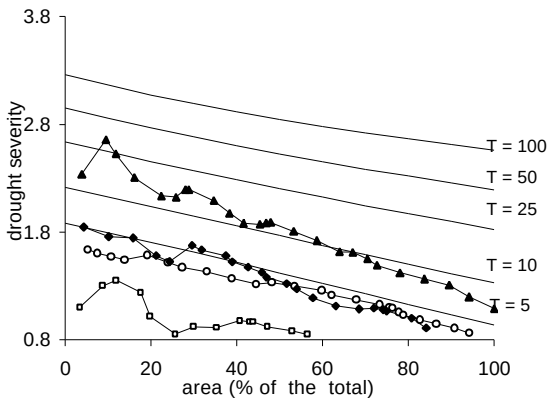
1970/1979



1980/1989



1990/1993



Legend:

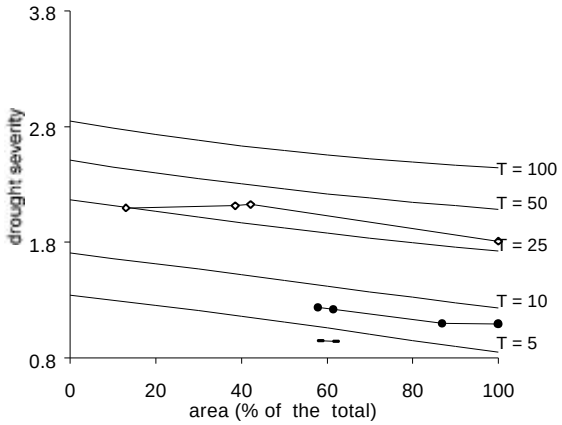
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

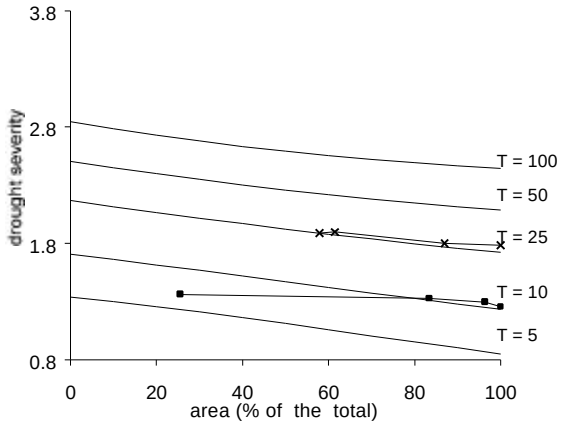
Longer Period

CRETE

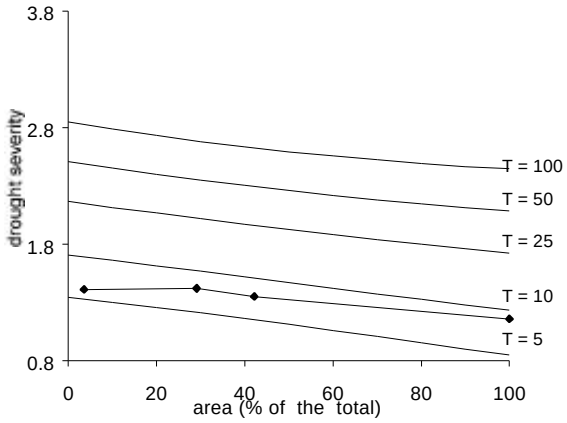
1951/1960



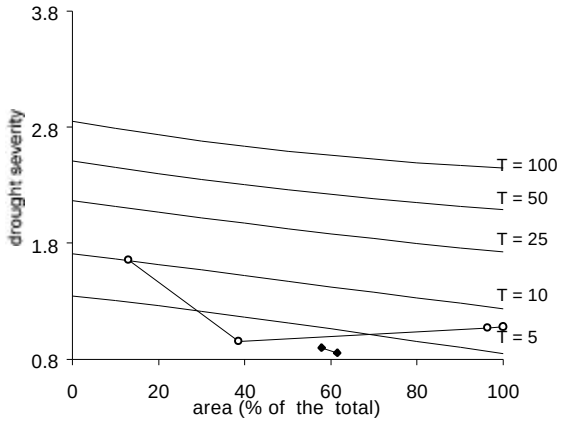
1961/1970



1971/1980



1981/1985



Legend:

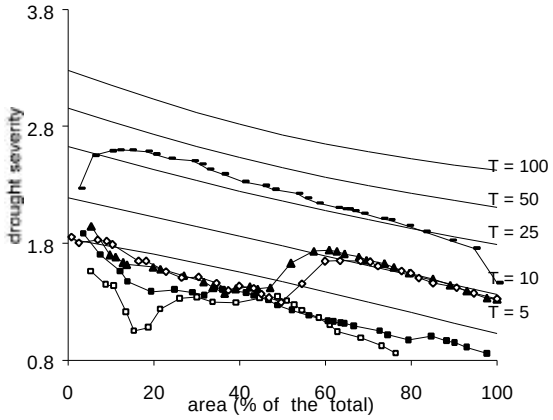
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

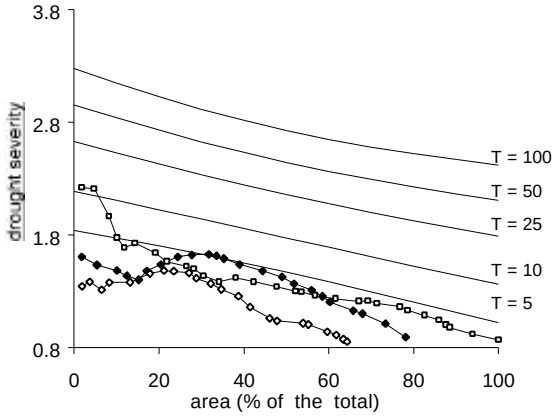
Longer Period

GREAT BRITAIN

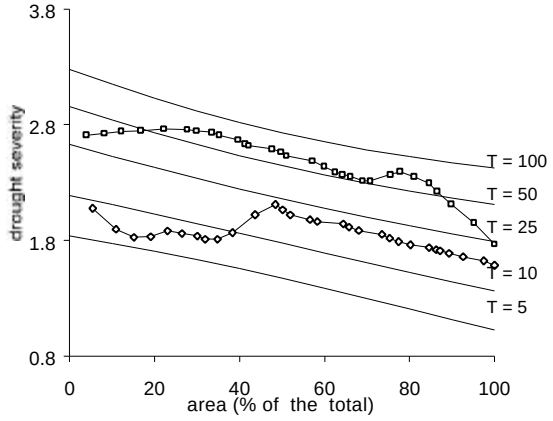
1900/1909



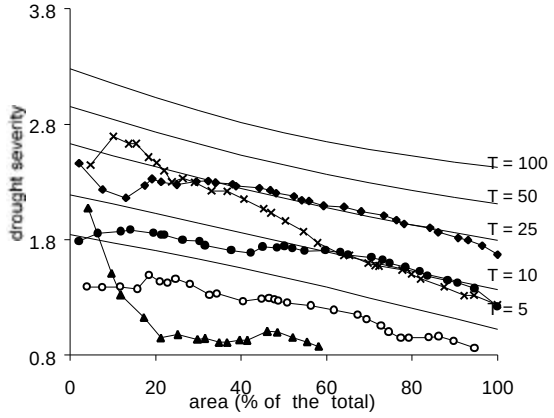
1910/1919



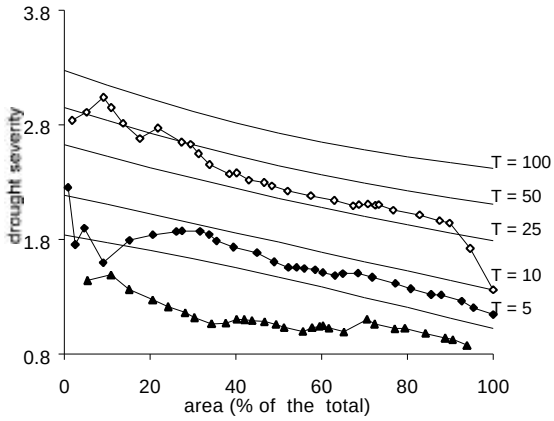
1920/1929



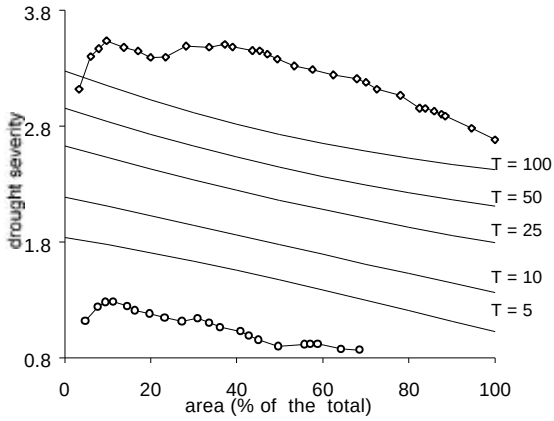
1930/1939



1940/1949



1950/1959



Legend:

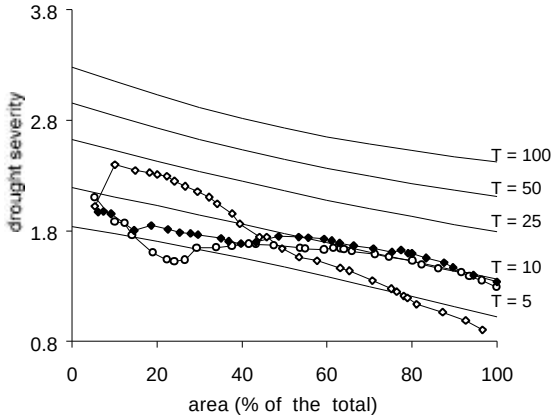
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

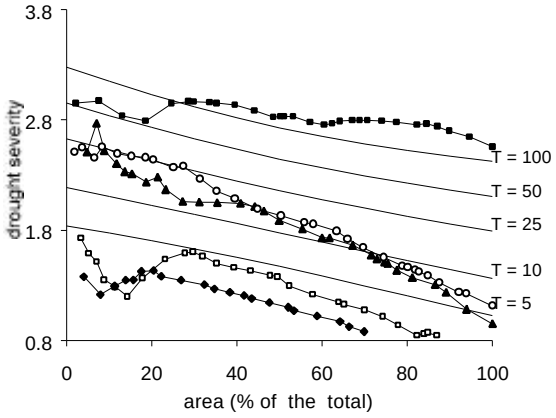
Longer Period

GREAT BRITAIN

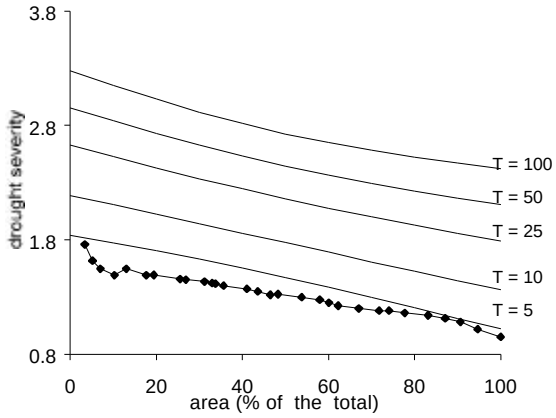
1960/1969



1970/1979



1980/1989



Legend:

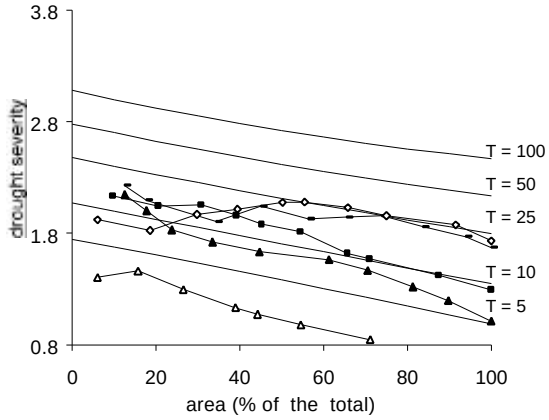
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

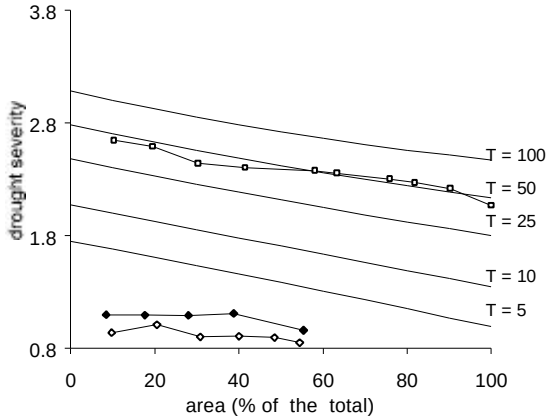
Longer Period

IRELAND

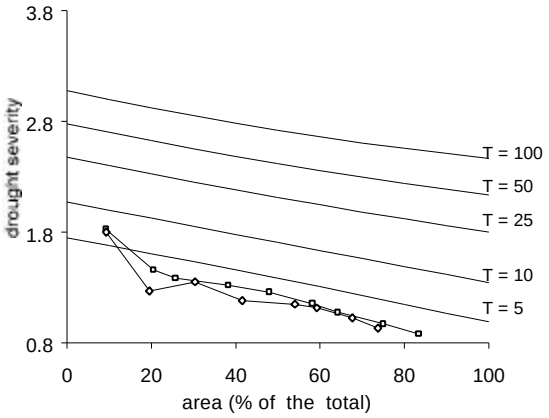
1900/1909



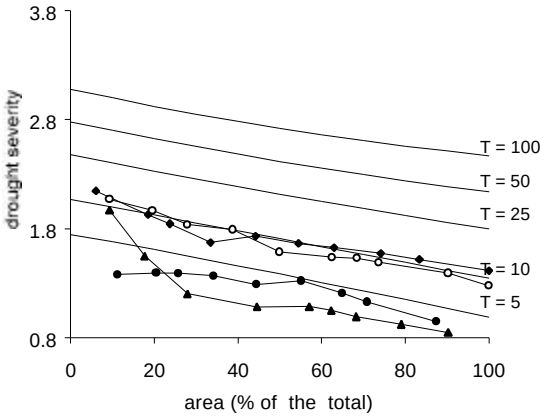
1910/1919



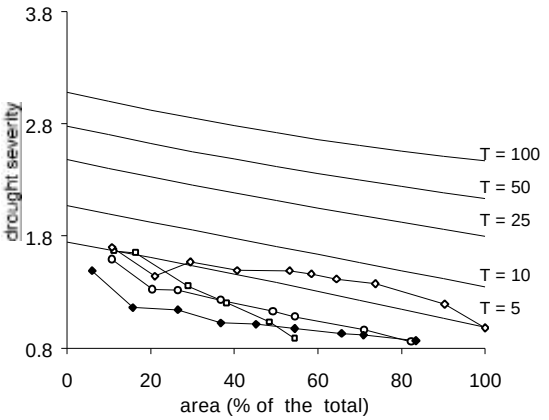
1920/1929



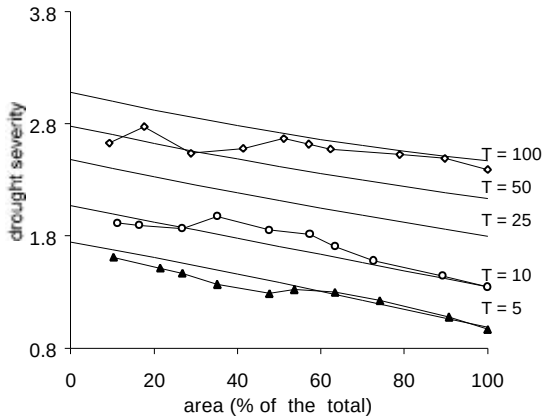
1930/1939



1940/1949



1950/1959



Legend:

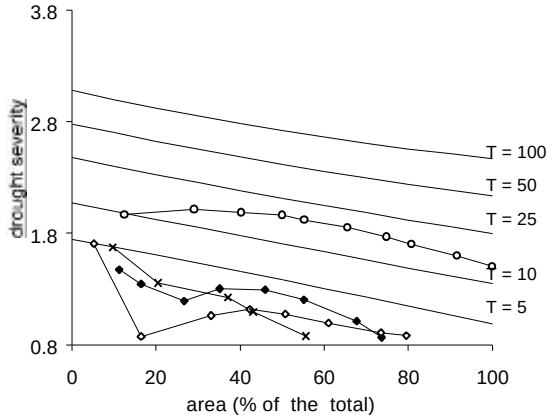
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

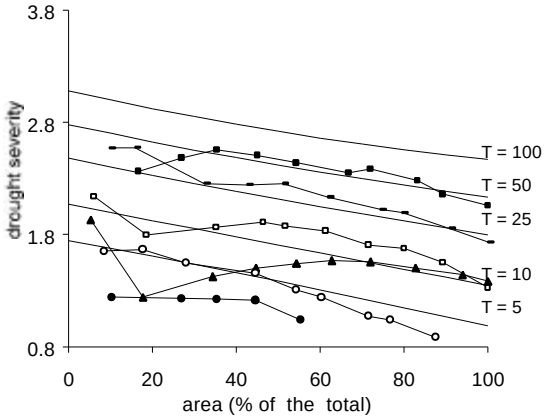
Longer Period

IRELAND

1960/1969



1970/1979



Legend:

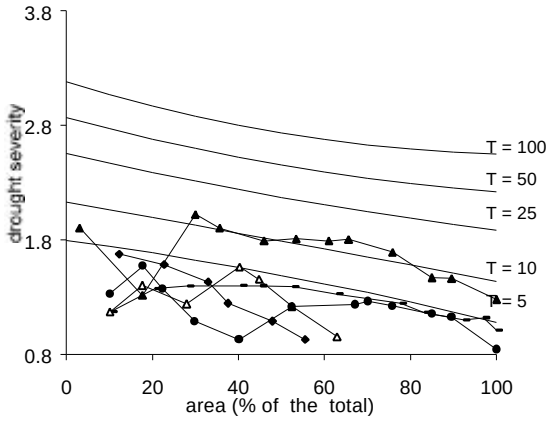
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

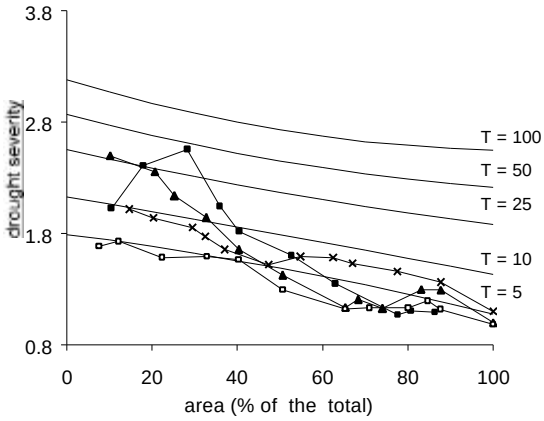
Longer Period

ITALY

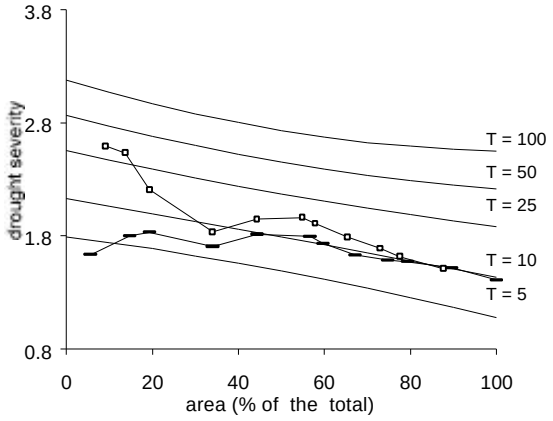
1951/1960



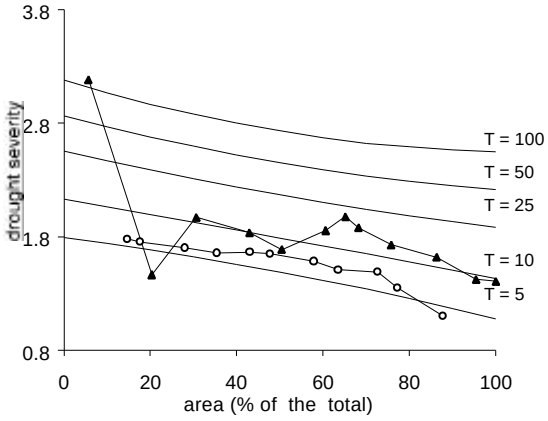
1961/1970



1971/1980



1981/1985



Legend:

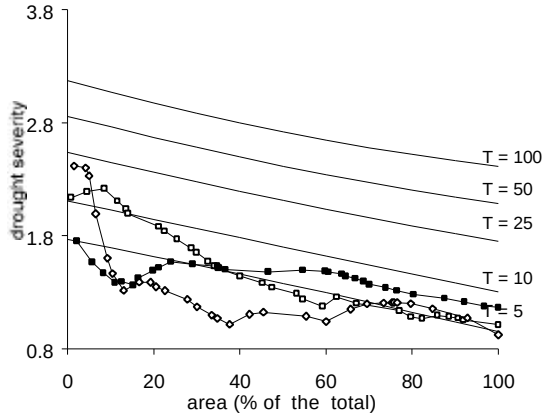
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

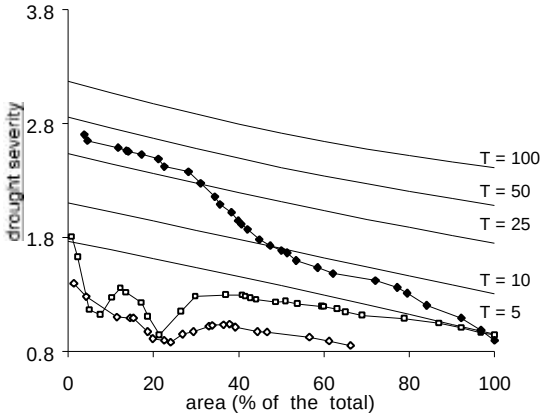
Longer Period

SCANDINAVIA

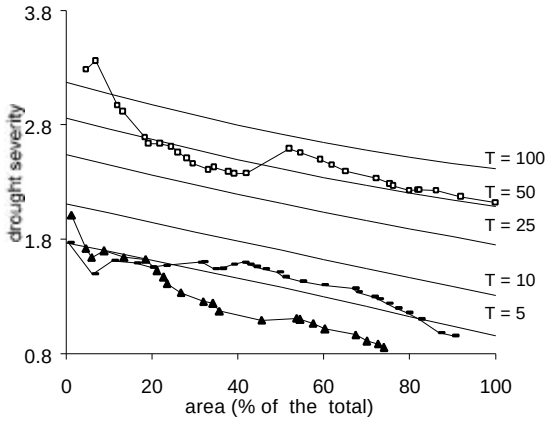
1900/1909



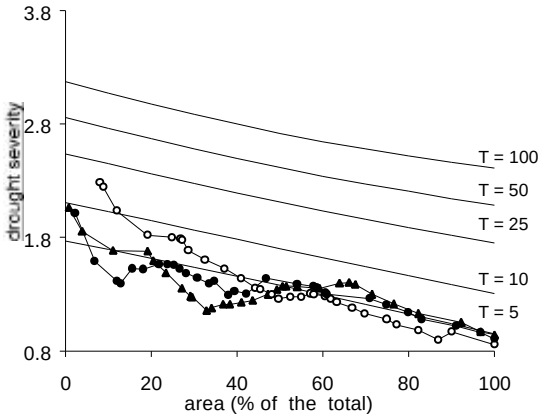
1910/1919



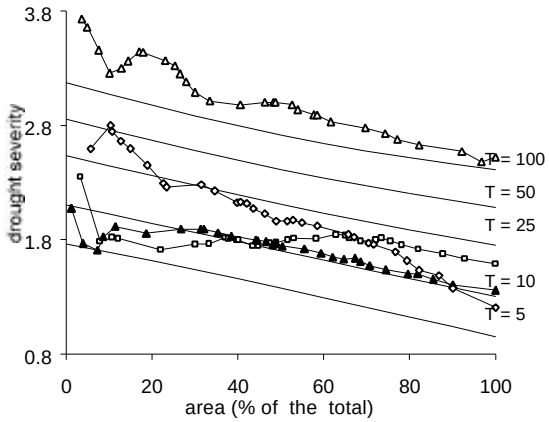
1920/1929



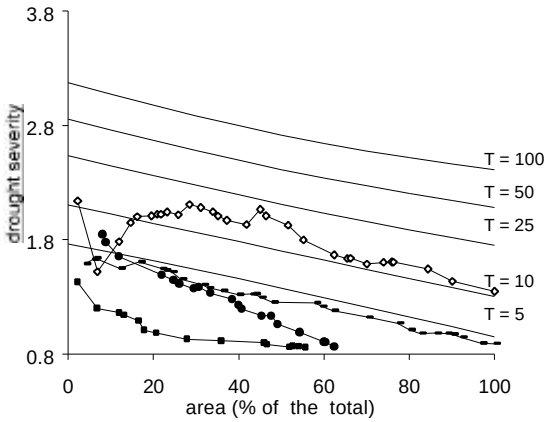
1930/1939



1940/1949



1950/1959



Legend:

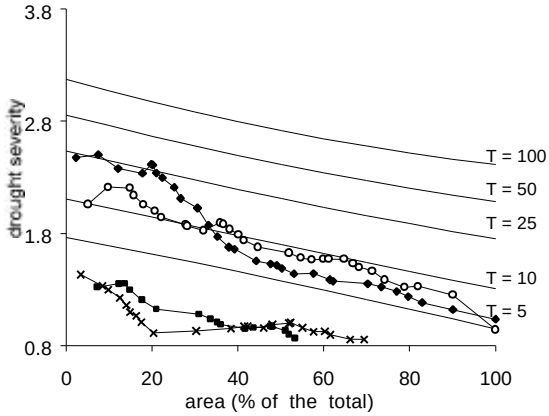
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

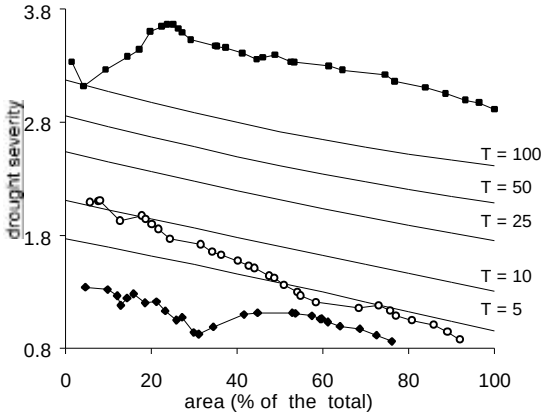
Longer Period

SCANDINAVIA

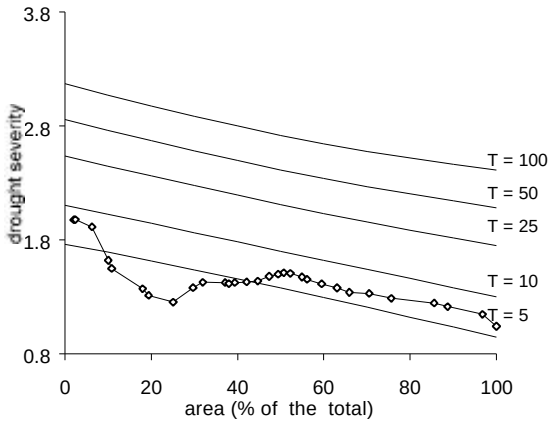
1960/1969



1970/1979



1980/1989



Legend:

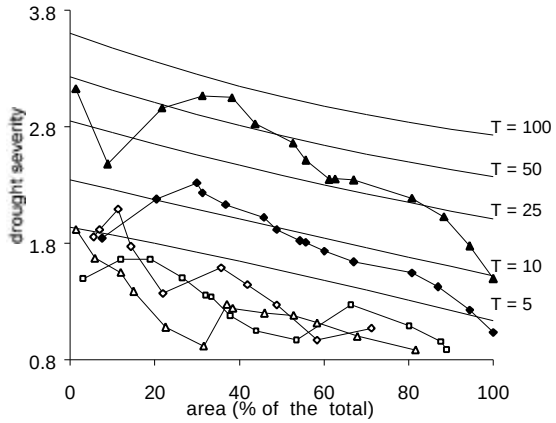
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

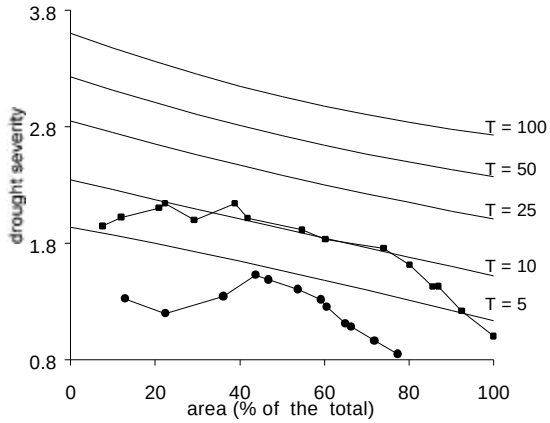
Longer Period

SOUTH BALKANS

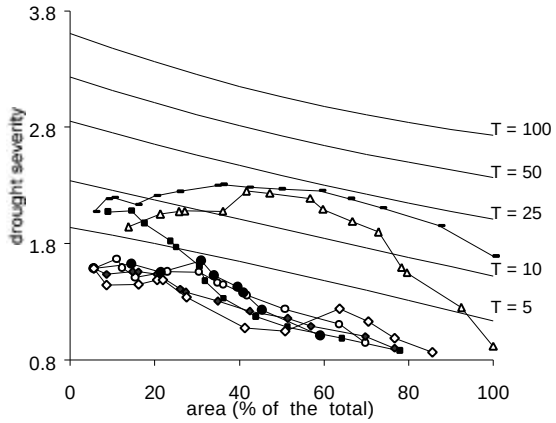
1951/1960



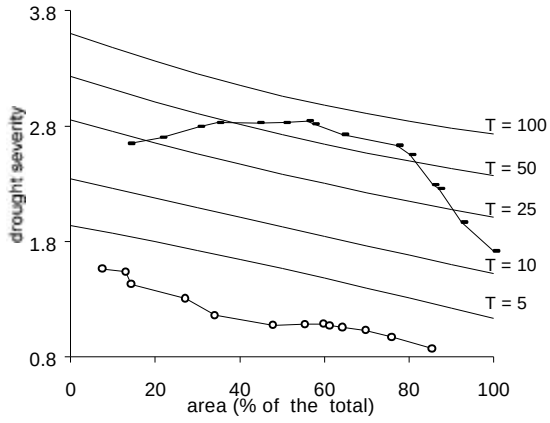
1961/1970



1971/1980



1981/1985



Legend:

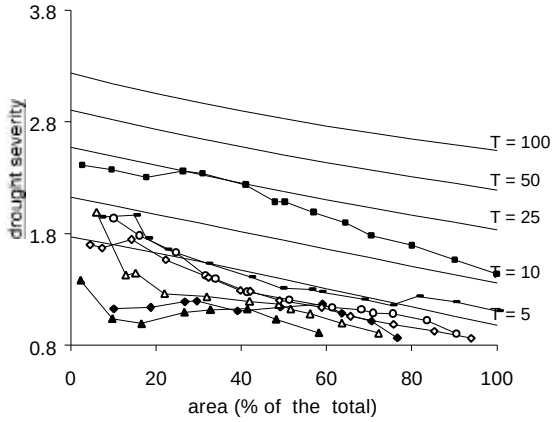
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

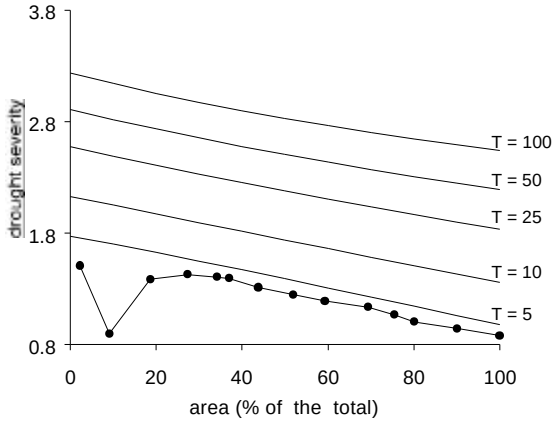
Longer Period

WESTERN FRANCE

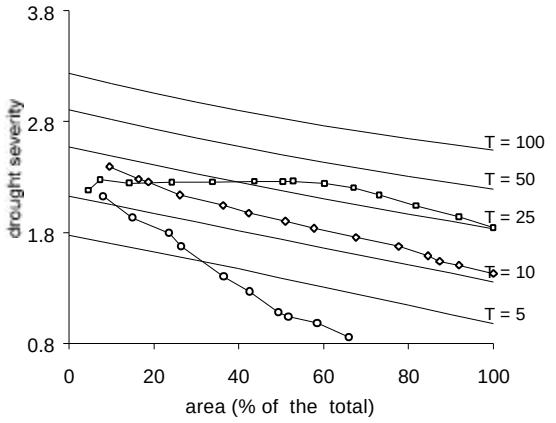
1900/1909



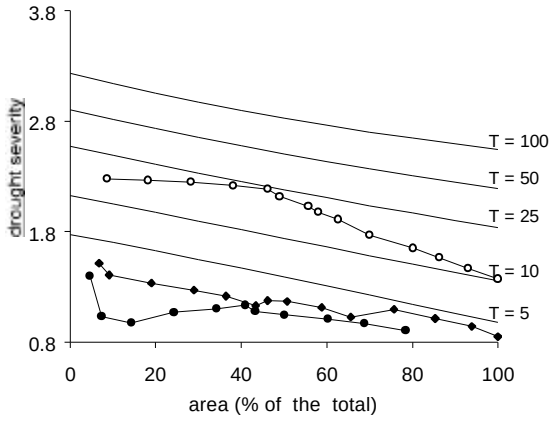
1910/1919



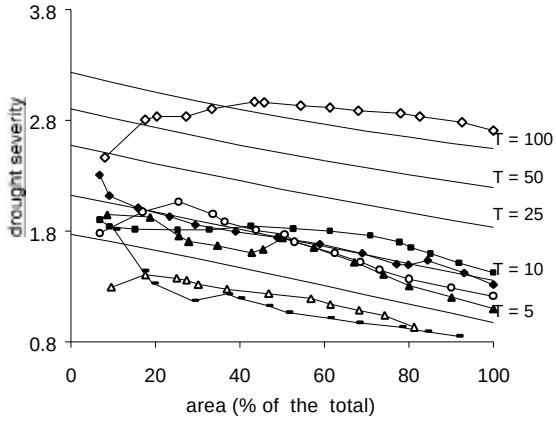
1920/1929



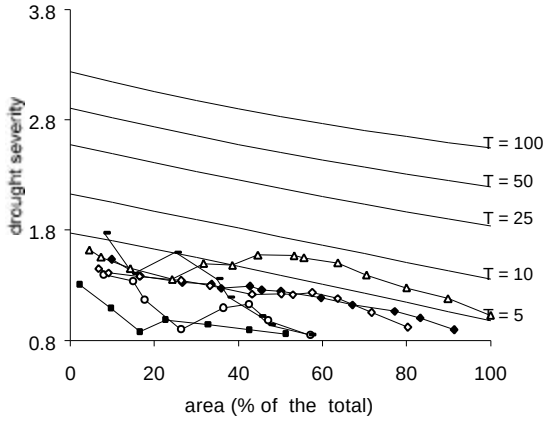
1930/1939



1940/1949



1950/1959



Legend:

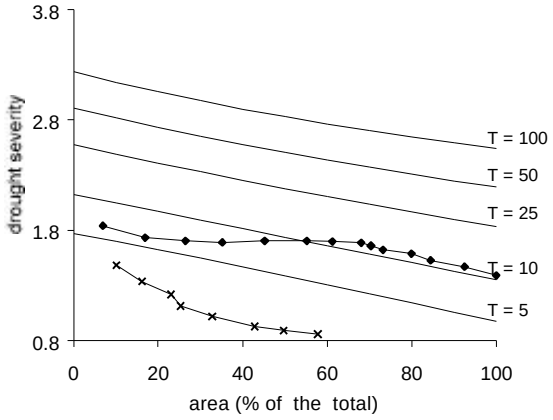
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

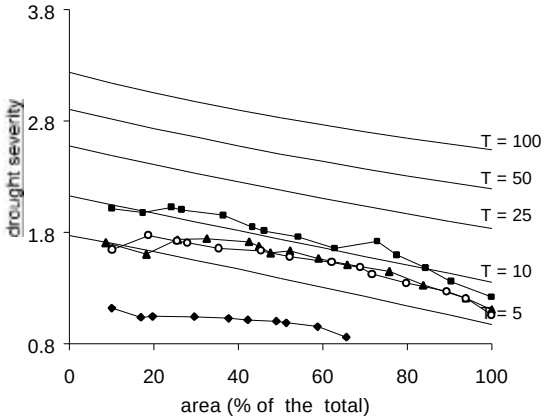
Longer Period

WESTERN FRANCE

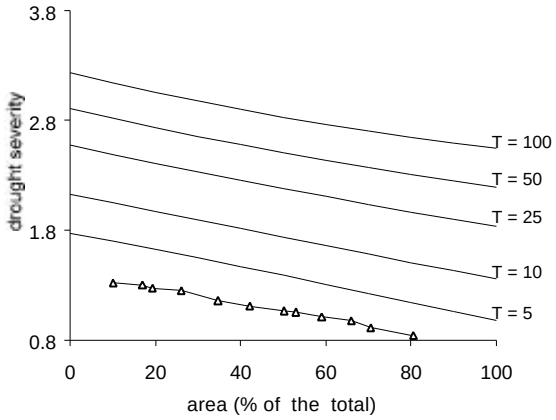
1960/1969



1970/1979



1980/1989



Legend:

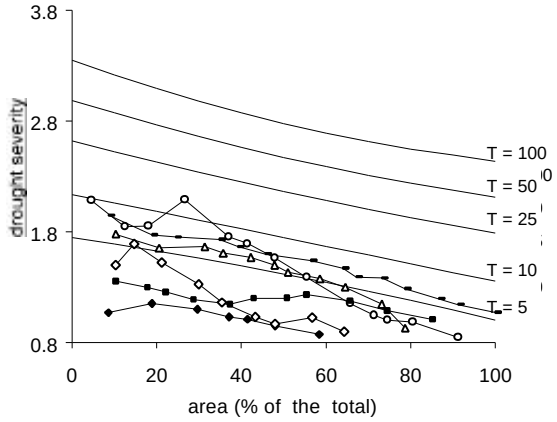
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

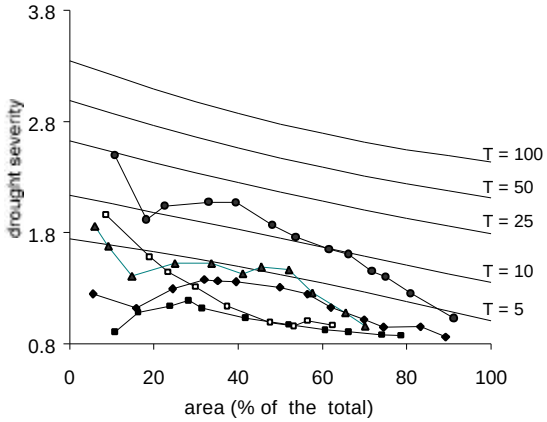
Longer Period

WESTERN MEDITERRANEAN

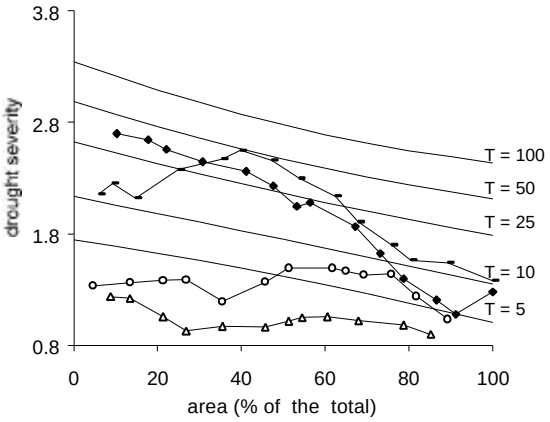
1900/1909



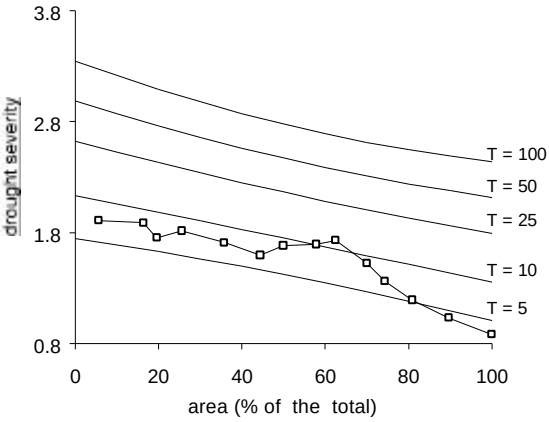
1910/1919



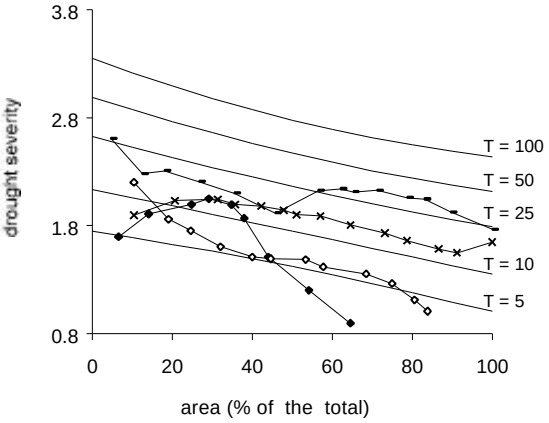
1920/1929



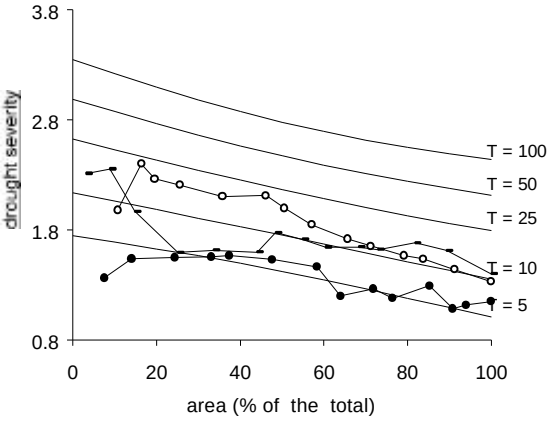
1930/1939



1940/1949



1950/1959



Legend:

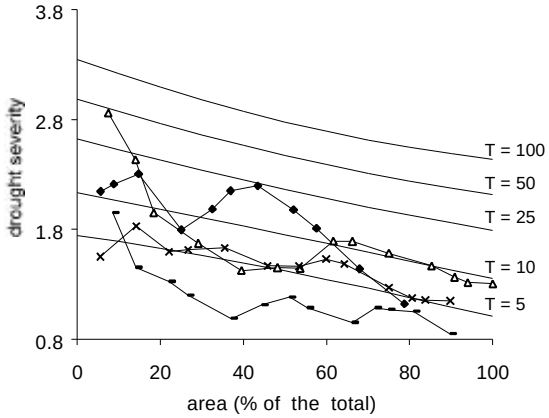
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

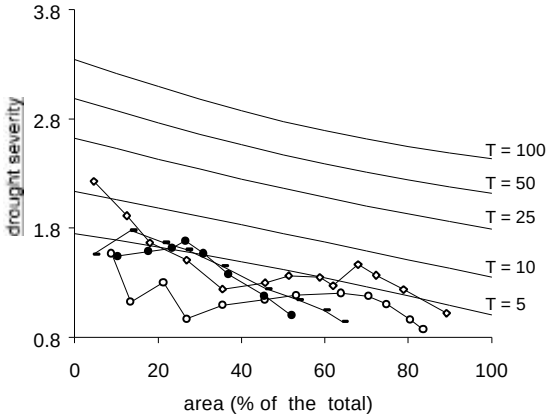
Longer Period

WESTERN MEDITERRANEAN

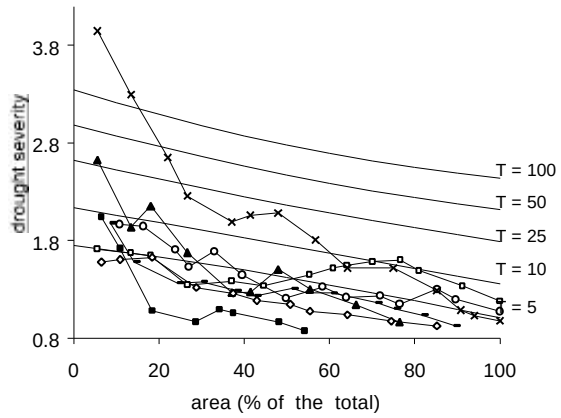
1960/1969



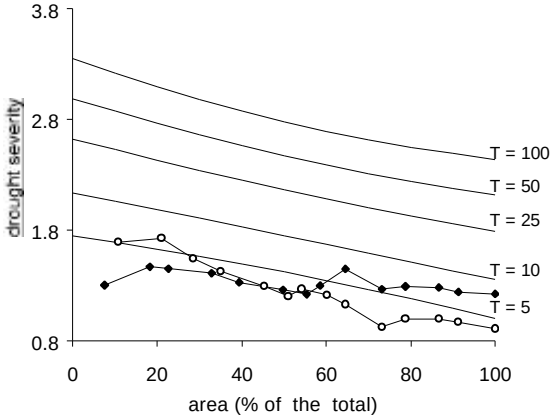
1970/1979



1980/1989



1990/1993



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

Common Period (From 1951/52 to 1985/86)

Years	Atlantic Iberia	Central Europe	Central Iberia	Great Britain	Ireland	Scandinavia	Western France	Western Mediterranean
1951/52					A	A	A	
1952/53	B		C	A	B		A	B
1953/54	A	A	C				A	
1954/55						A	A	B
1955/56							A	
1956/57	B		B				B	A
1957/58	A		A			A		B
1958/59		C		D	C	B	A	
1959/60								
1960/61								
1961/62		A					A	
1962/63		B		B	B	B		
1963/64		C		B	A	B	B	A
1964/65	B		B					A
1965/66						A		
1966/67			A					B
1967/68								
1968/69		A		A				
1969/70						A	A	A
1970/71		B			B			
1971/72	A	B		B	B		B	
1972/73		B	A	B	A	B	B	A
1973/74			A	A		A	A	
1974/75			A		B			A
1975/76	B	D	A	D	C	D	B	
1976/77								
1977/78					A			A
1978/79								A
1979/80			A					
1980/81	B		B					B
1981/82			B					A
1982/83	A		B					A
1983/84				A				
1984/85		B						A
1985/86			A				A	A

LEGEND:

Common period

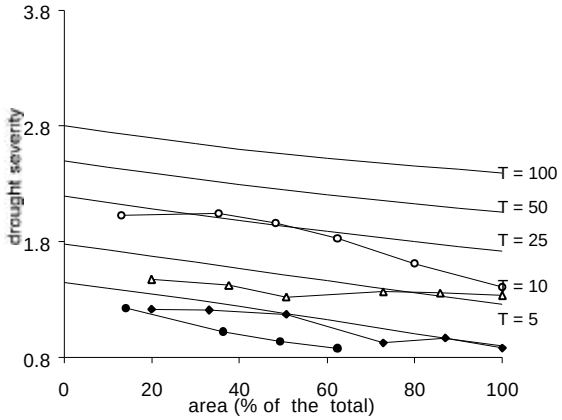
A	T <= 5 years
B	5 < T < 25 years
C	25 < T < 100 years
D	T > 100 years
	Data not available

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

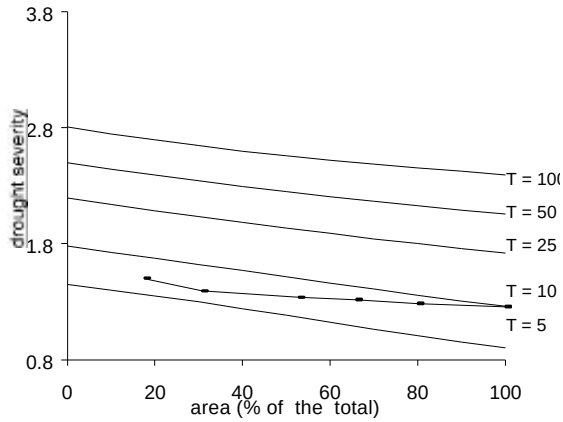
Common Period (From 1951/52 to 1985/86)

ATLANTIC IBERIA

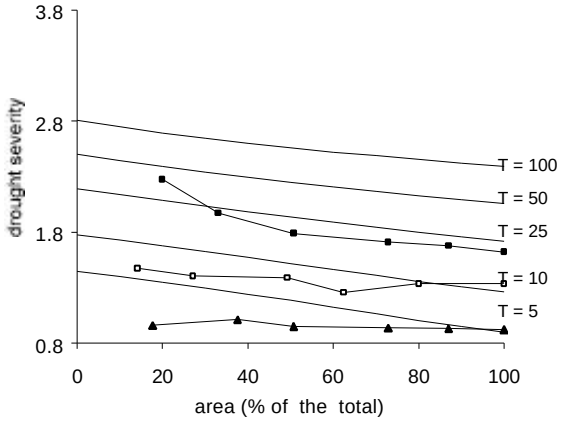
1951/1960



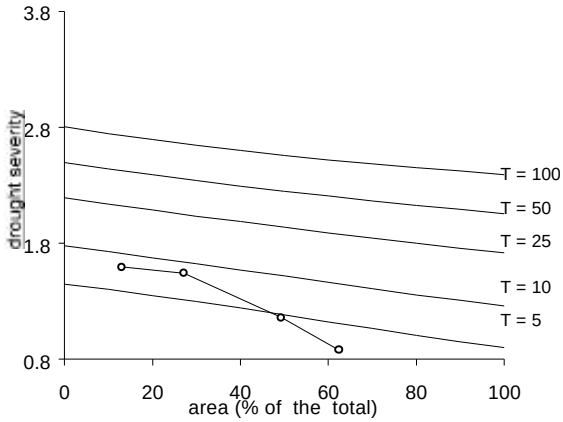
1961/1970



1971/1980



1981/1985



Legend:

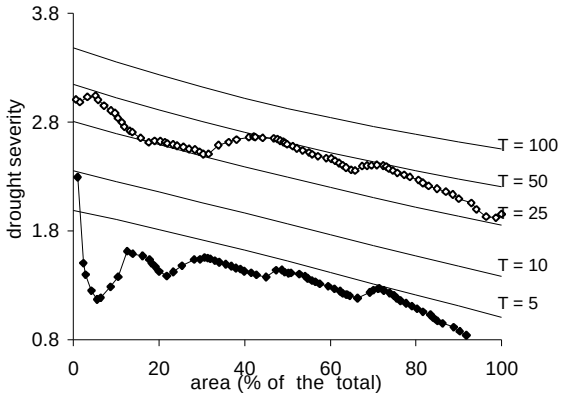
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

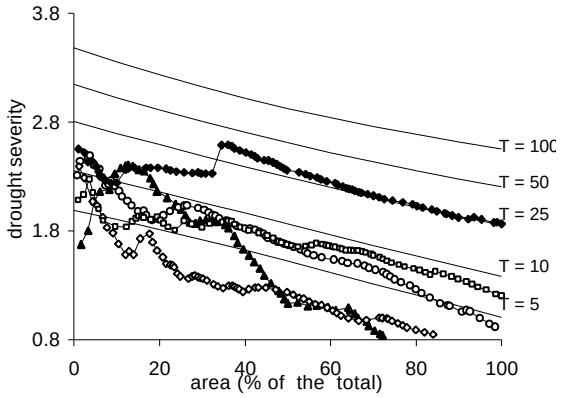
Common Period (From 1951/52 to 1985/86)

CENTRAL EUROPE

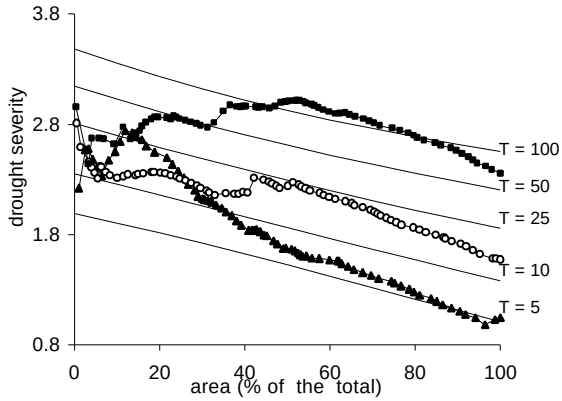
1951/1960



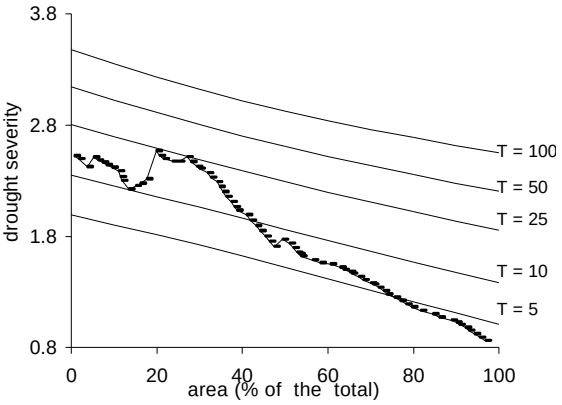
1961/1970



1971/1980



1981/1985



Legend:

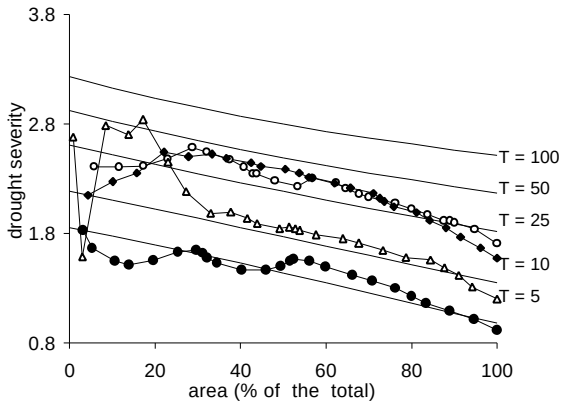
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

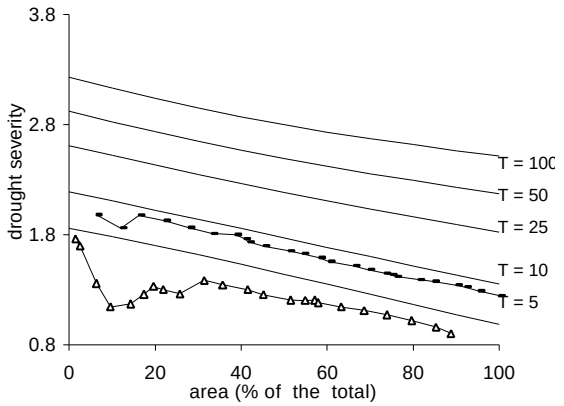
Common Period (From 1951/52 to 1985/86)

CENTRAL IBERIA

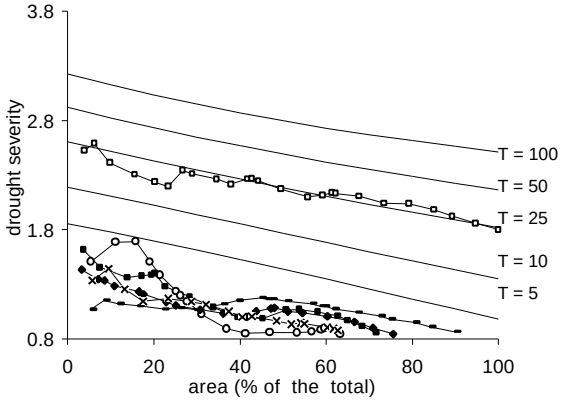
1951/1960



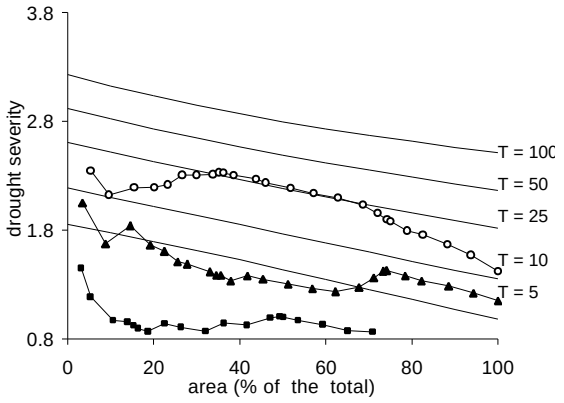
1961/1970



1971/1980



1981/1985



Legend:

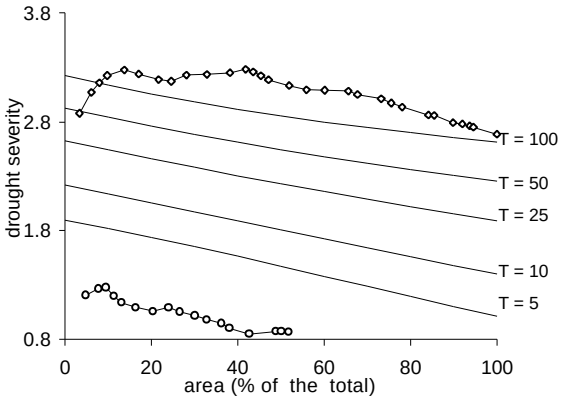
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

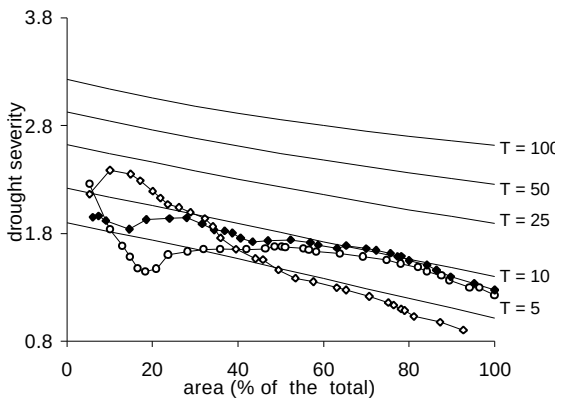
Common Period (From 1951/52 to 1985/86)

GREAT BRITAIN

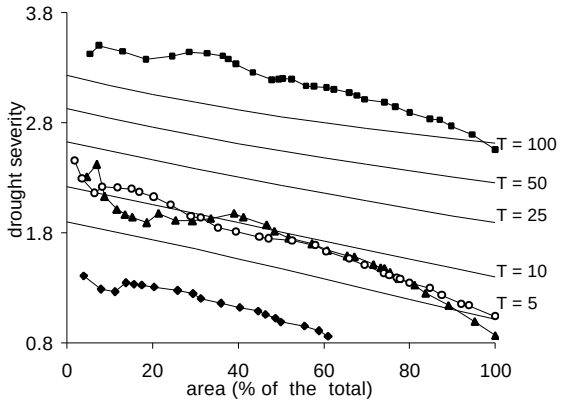
1951/1960



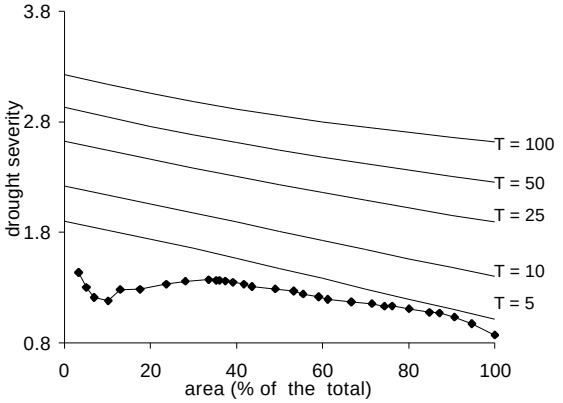
1961/1970



1971/1980



1981/1985



Legend:

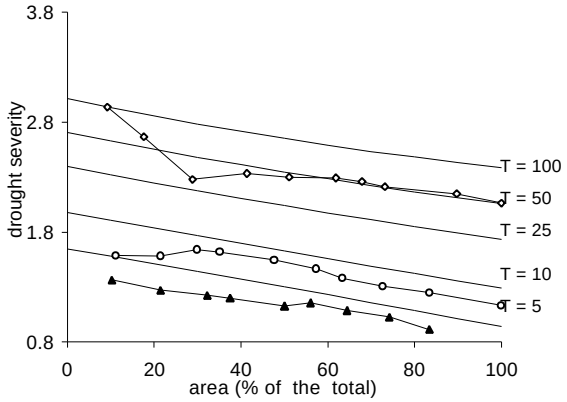
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

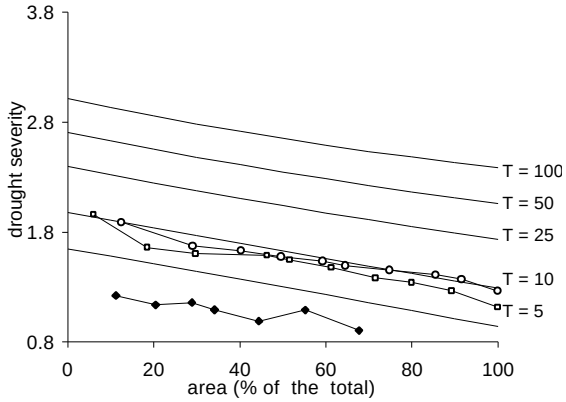
Common Period (From 1951/52 to 1985/86)

IRELAND

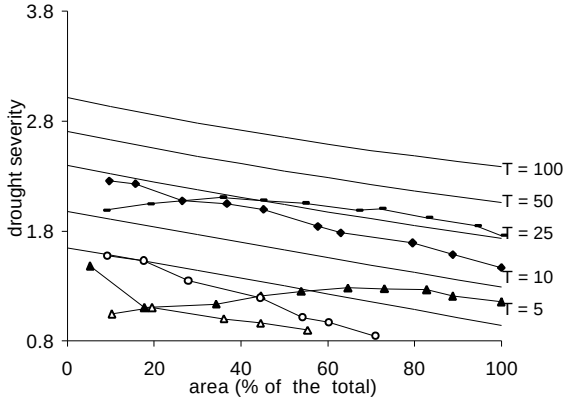
1951/1960



1961/1970



1971/1980



Legend:

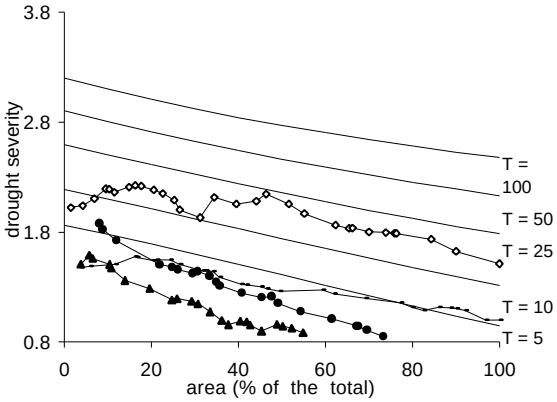
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

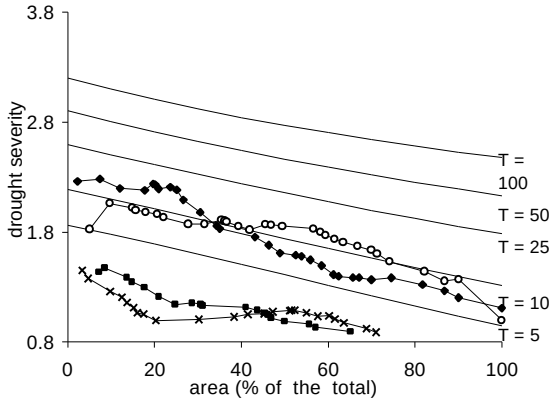
Common Period (From 1951/52 to 1985/86)

SCANDINAVIA

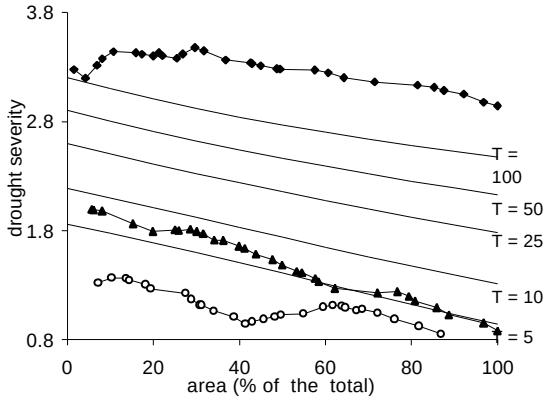
1951/1960



1961/1970



1971/1980



Legend:

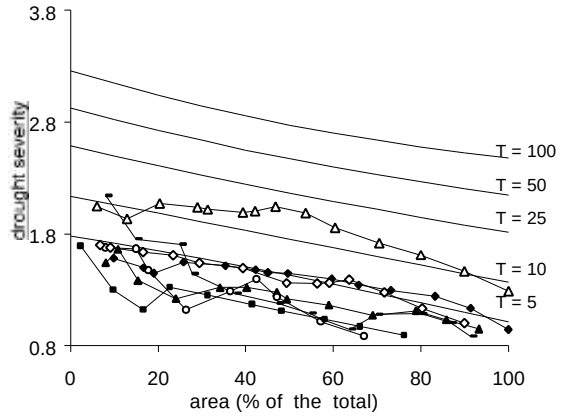
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

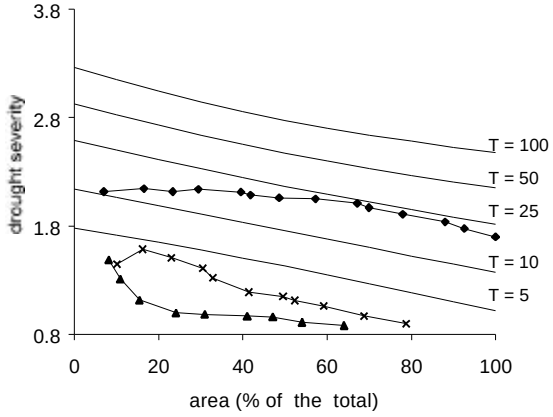
Common Period (From 1951/52 to 1985/86)

WESTERN FRANCE

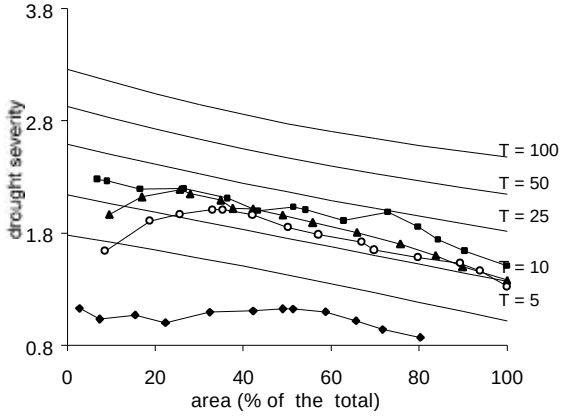
1951/1960



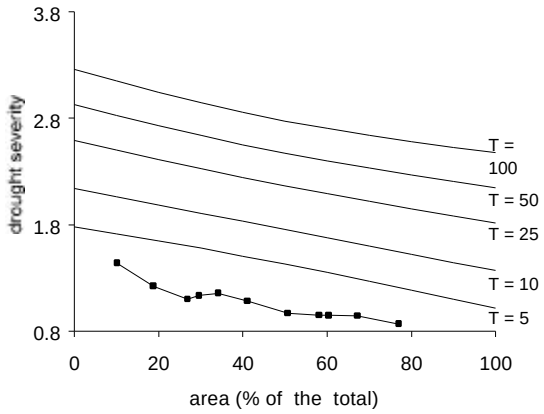
1961/1970



1971/1980



1981/1985



Legend:

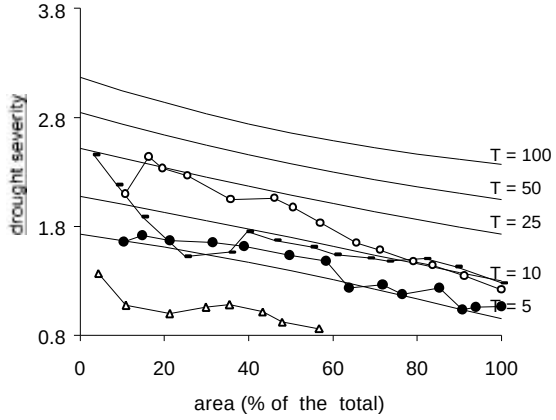
Years: 0 1 2 3 4 5 6 7 8 9

ANNEX C REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

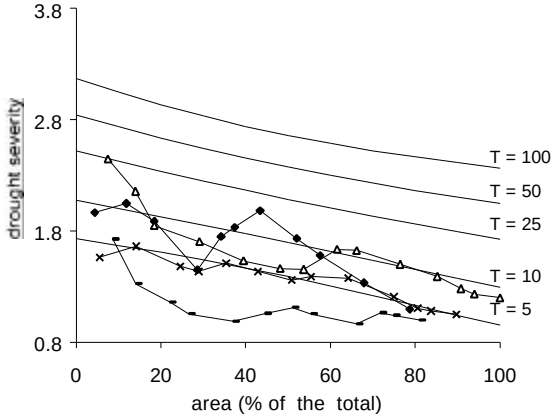
Common Period (From 1951/52 to 1985/86)

WESTERN MEDITERRANEAN

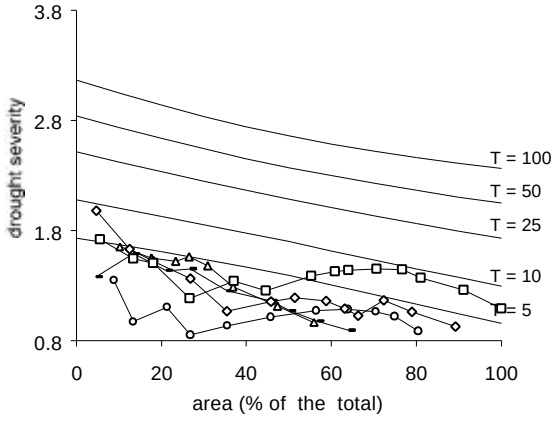
1951/1960



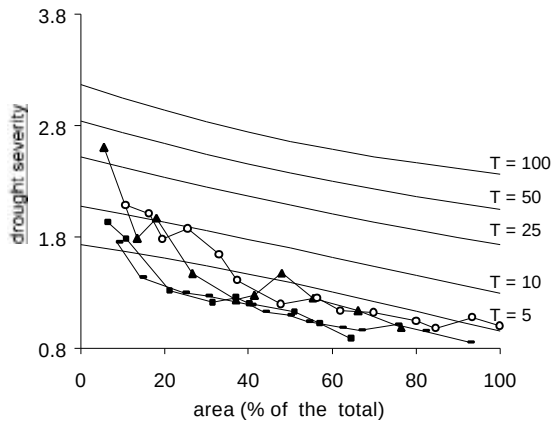
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

ANNEX D RESULTS FOR THRESHOLD 0.10

PART I PARAMETERS OF THE SEVERITY-AREA-FREQUENCY CURVES

Extreme-value type 1 distribution: S(A) = û (A) + â (A) x [-log(-log (1- 1/T)]

Parameter û

area (%) A	Alps		Atlantic Iberia		Central Europe		Central Iberia		Crete	Great Britain		Ireland		Italy	Scandinavia		South Balkans	Western France		Western Mediterranean	
0	1.247	0.538	1.163	1.439	1.593	1.147	1.272	0.452	1.106	1.085	1.160	0.961	1.222	1.390	1.375	1.204	1.103	1.139	1.004	1.004
10	1.256	0.526	1.115	1.382	1.524	1.092	1.231	0.462	1.087	1.039	1.101	0.904	1.224	1.316	1.290	1.163	1.056	1.152	1.012	1.012
20	1.252	0.511	1.065	1.313	1.440	1.027	1.171	0.457	1.068	0.989	1.035	0.843	1.214	1.241	1.200	1.109	1.000	1.156	1.011	1.011
30	1.240	0.494	1.011	1.236	1.332	0.948	1.109	0.443	1.040	0.929	0.957	0.780	1.178	1.167	1.100	1.052	0.936	1.135	1.012	1.012
40	1.214	0.473	0.950	1.149	1.209	0.855	1.034	0.428	1.006	0.865	0.864	0.722	1.120	1.086	0.987	0.992	0.869	1.090	1.004	1.004
50	1.168	0.452	0.877	1.058	1.067	0.753	0.948	0.402	0.953	0.796	0.771	0.667	1.057	0.997	0.860	0.921	0.798	1.024	0.976	0.976
60	1.082	0.416	0.802	0.961	0.916	0.639	0.857	0.354	0.879	0.725	0.671	0.615	0.980	0.890	0.738	0.852	0.725	0.930	0.937	0.937
70	0.980	0.378	0.727	0.851	0.776	0.533	0.756	0.288	0.792	0.660	0.572	0.560	0.902	0.768	0.622	0.779	0.650	0.837	0.881	0.881
80	0.859	0.337	0.653	0.735	0.652	0.424	0.650	0.210	0.691	0.593	0.471	0.493	0.778	0.639	0.502	0.707	0.577	0.748	0.774	0.774
90	0.721	0.289	0.580	0.617	0.533	0.320	0.543	0.126	0.584	0.519	0.367	0.425	0.646	0.511	0.385	0.630	0.502	0.650	0.658	0.658
100	0.587	0.241	0.505	0.496	0.414	0.220	0.432	0.043	0.469	0.443	0.277	0.352	0.496	0.387	0.262	0.550	0.427	0.543	0.549	0.549

Parameter â

area (%) A	Alps		Atlantic Iberia		Central Europe		Central Iberia		Crete	Great Britain		Ireland		Italy	Scandinavia		South Balkans	Western France		Western Mediterranean	
0	0.515	0.518	0.339	0.426	0.381	0.454	0.409	0.512	0.452	0.456	0.404	0.434	0.398	0.372	0.380	0.497	0.450	0.449	0.490	0.490
10	0.484	0.508	0.339	0.412	0.371	0.446	0.397	0.498	0.433	0.449	0.401	0.432	0.379	0.367	0.380	0.484	0.443	0.421	0.463	0.463
20	0.458	0.499	0.340	0.403	0.366	0.442	0.392	0.488	0.415	0.445	0.400	0.431	0.363	0.364	0.382	0.475	0.438	0.397	0.439	0.439
30	0.435	0.491	0.343	0.396	0.369	0.442	0.388	0.481	0.399	0.444	0.403	0.431	0.355	0.361	0.388	0.467	0.435	0.379	0.415	0.415
40	0.416	0.484	0.347	0.392	0.377	0.446	0.387	0.475	0.386	0.443	0.411	0.430	0.354	0.360	0.397	0.461	0.434	0.370	0.394	0.394
50	0.405	0.477	0.355	0.391	0.390	0.454	0.391	0.472	0.379	0.445	0.419	0.428	0.355	0.362	0.410	0.458	0.435	0.366	0.380	0.380
60	0.407	0.475	0.364	0.392	0.407	0.465	0.396	0.475	0.378	0.448	0.429	0.427	0.360	0.370	0.423	0.456	0.436	0.372	0.369	0.369
70	0.415	0.473	0.373	0.398	0.421	0.474	0.405	0.483	0.383	0.450	0.440	0.426	0.367	0.383	0.435	0.456	0.439	0.379	0.364	0.364
80	0.430	0.473	0.382	0.407	0.433	0.486	0.416	0.495	0.392	0.453	0.452	0.429	0.386	0.400	0.449	0.456	0.441	0.385	0.373	0.373
90	0.450	0.476	0.392	0.417	0.443	0.496	0.428	0.508	0.403	0.458	0.465	0.432	0.409	0.417	0.463	0.458	0.445	0.394	0.387	0.387
100	0.471	0.479	0.401	0.428	0.454	0.505	0.442	0.522	0.417	0.464	0.475	0.437	0.438	0.434	0.479	0.462	0.449	0.407	0.399	0.399

Common Period (1951/52-1985/86)

Longer Period

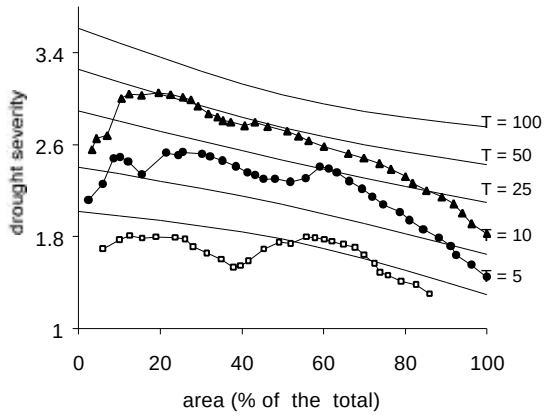
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION

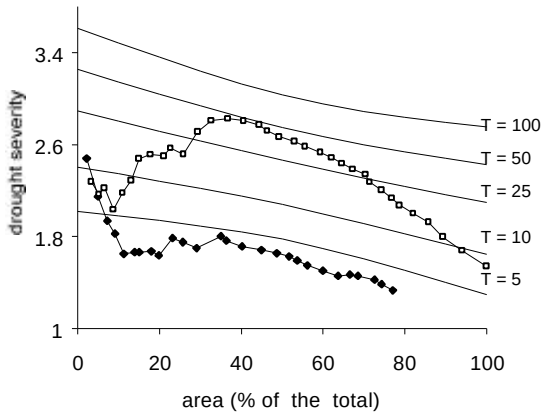
Longer Period

ALPS

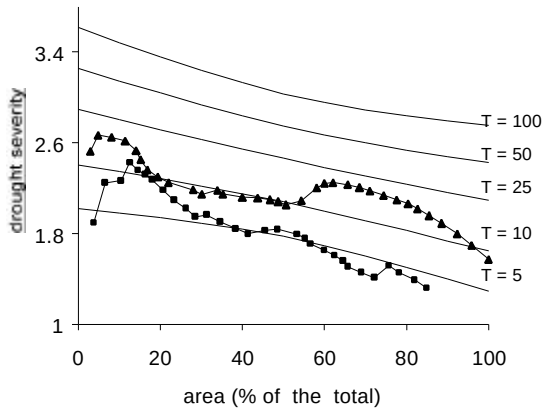
1951/1960



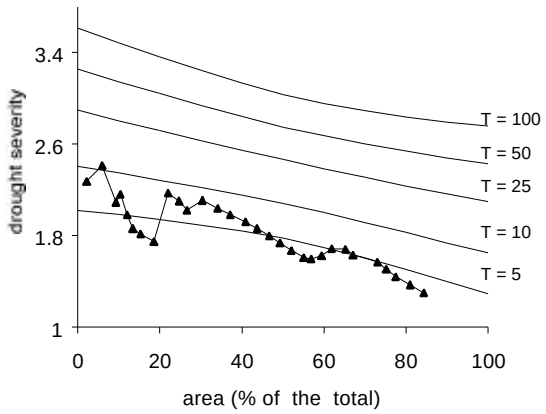
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

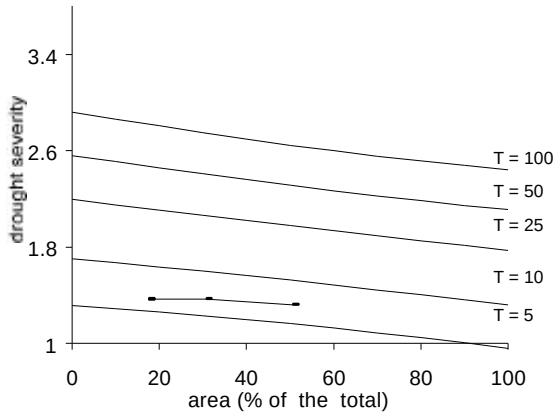
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

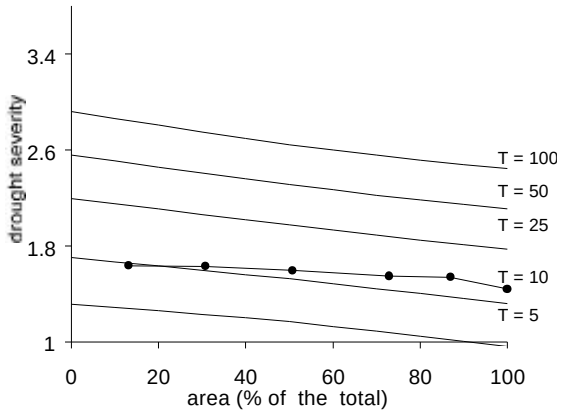
Longer Period

ATLANTIC IBERIA

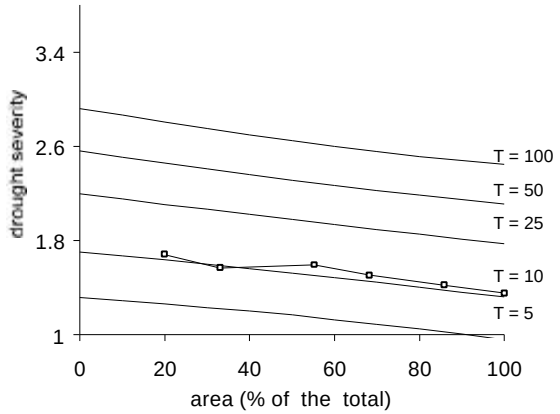
1900/1909



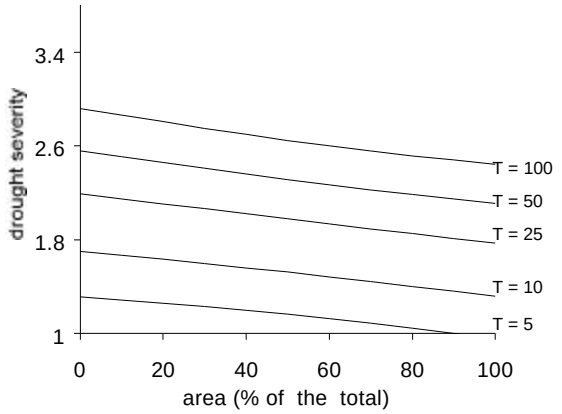
1910/1919



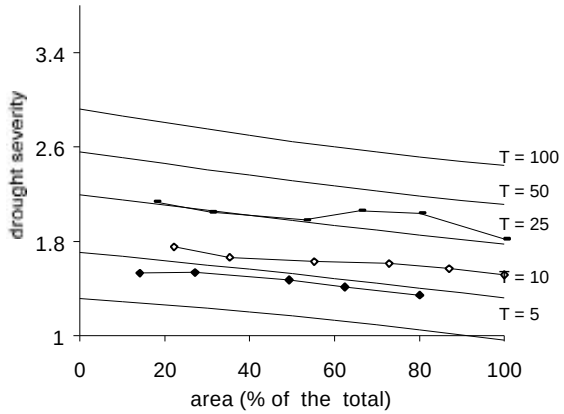
1920/1929



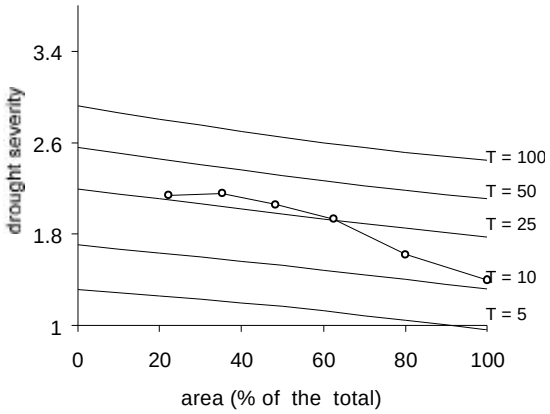
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

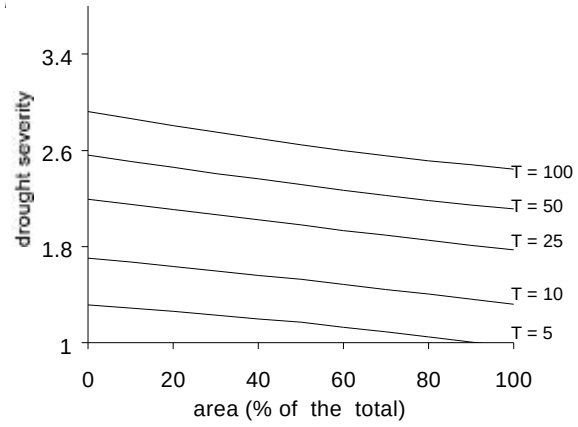
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

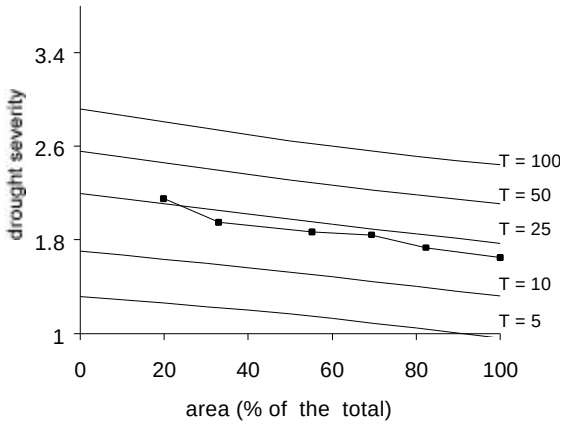
Longer Period

ATLANTIC IBERIA

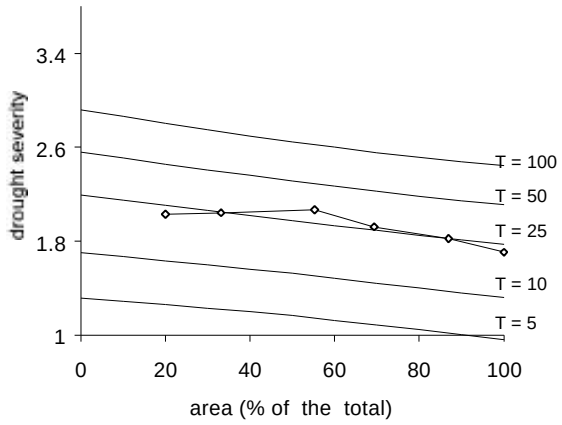
1960/1969



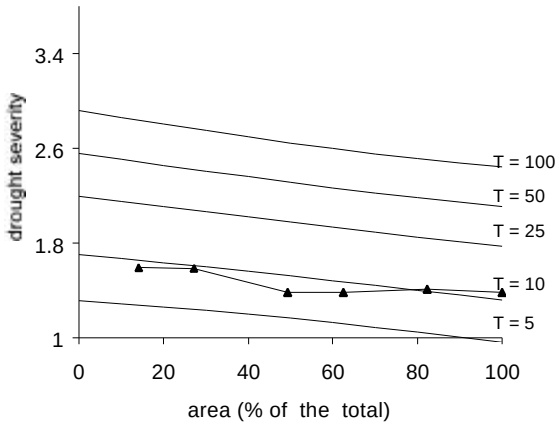
1970/1979



1980/1989



1990/1993



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

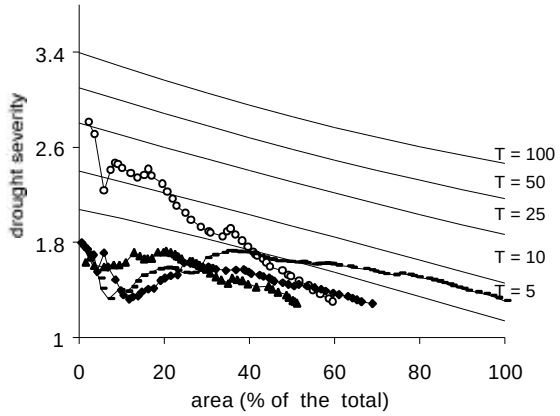
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

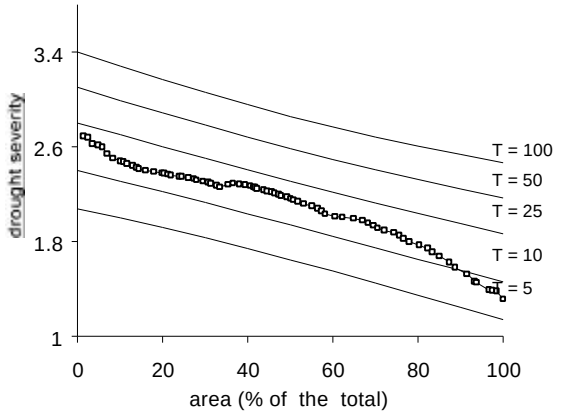
Longer Period

CENTRAL EUROPE

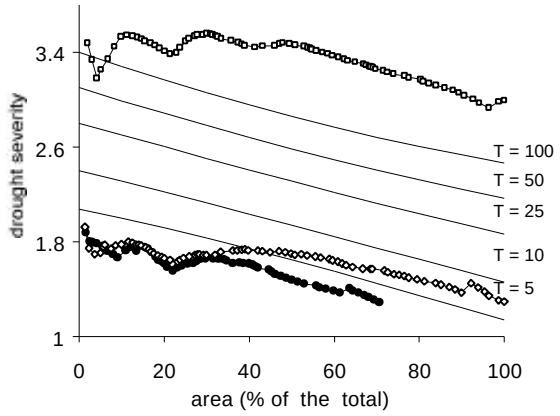
1900/1909



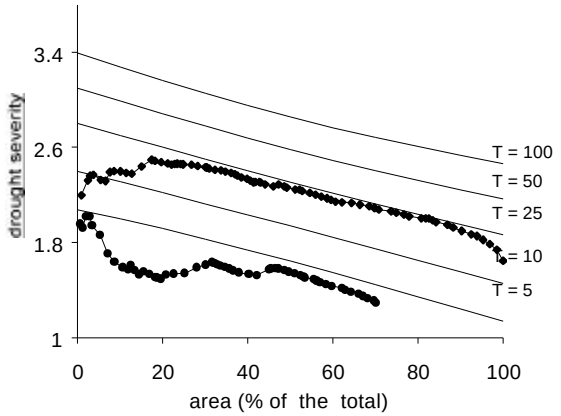
1910/1919



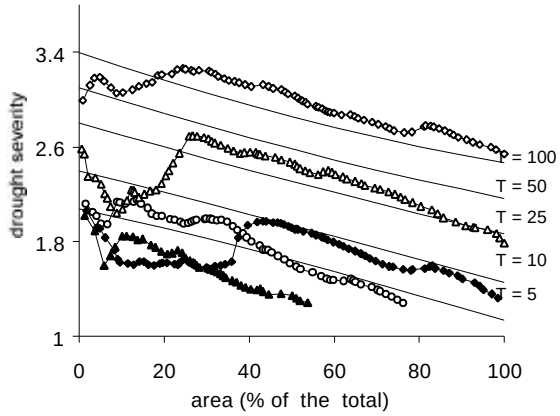
1920/1929



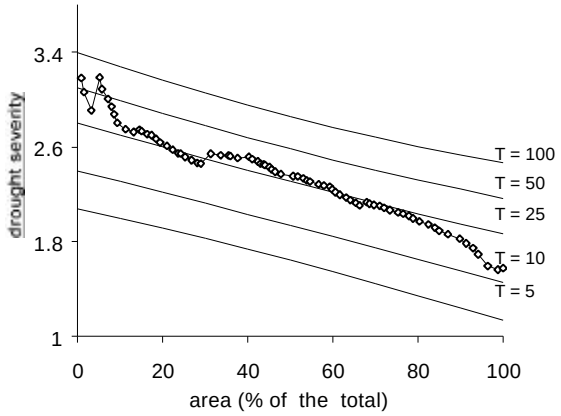
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

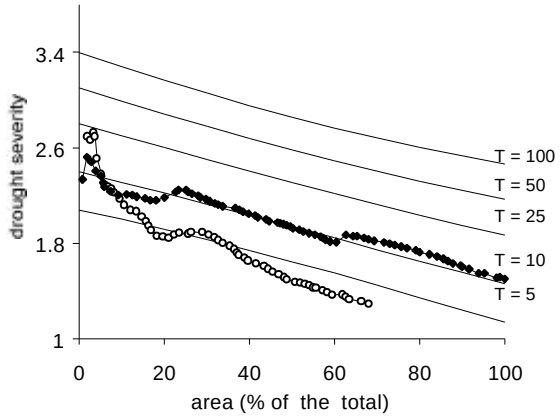
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

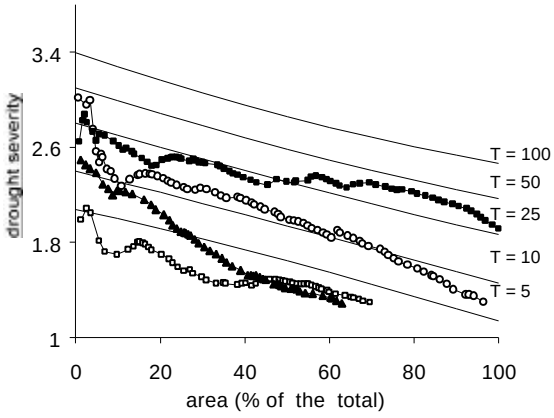
Longer Period

CENTRAL EUROPE

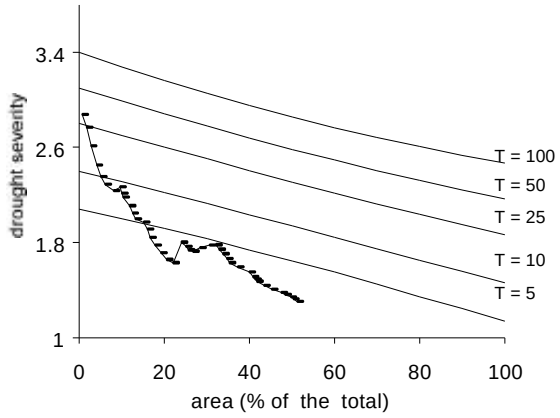
1960/1969



1970/1979



1980/1989



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

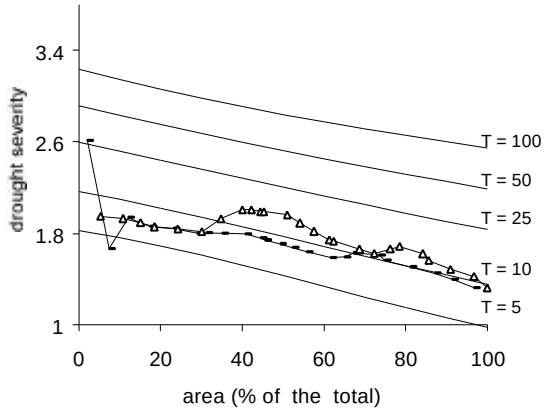
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

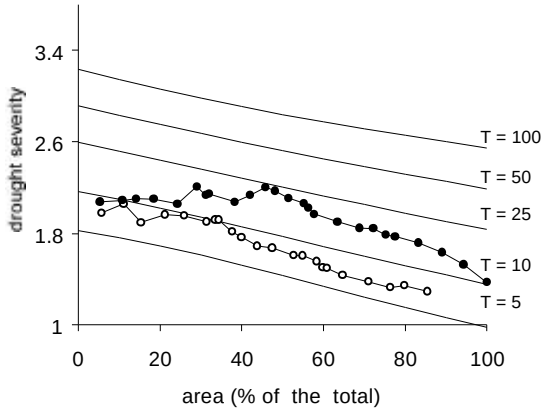
Longer Period

CENTRAL IBERIA

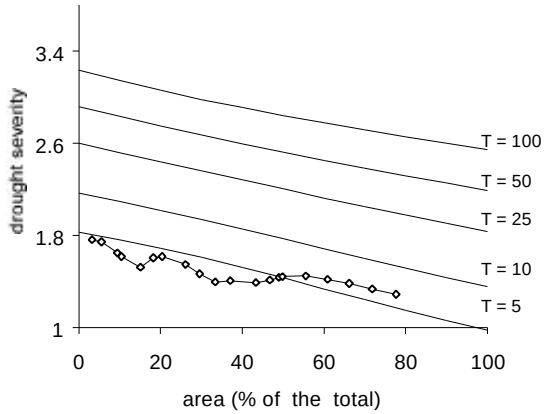
1900/1909



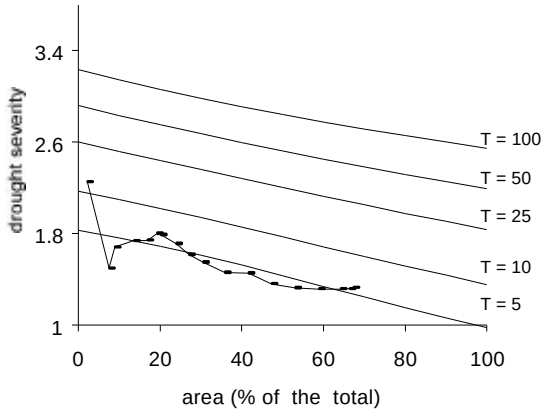
1910/1919



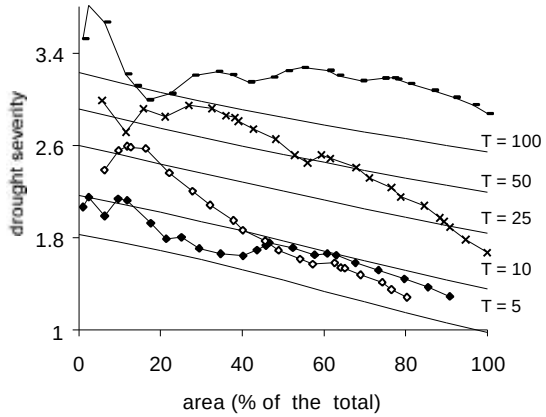
1920/1929



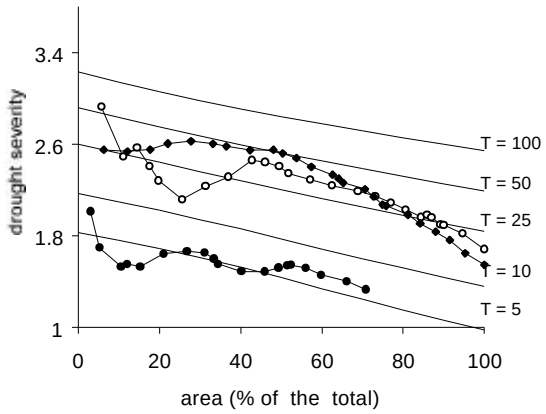
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

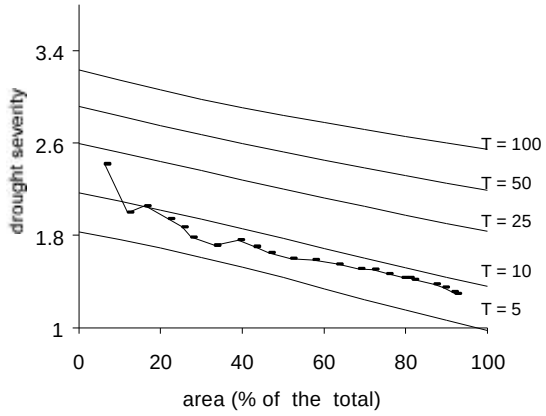
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

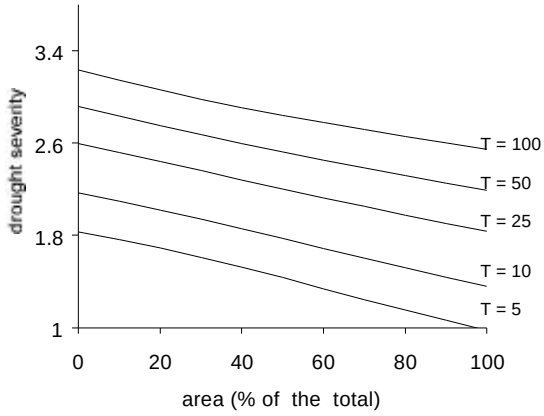
Longer Period

CENTRAL IBERIA

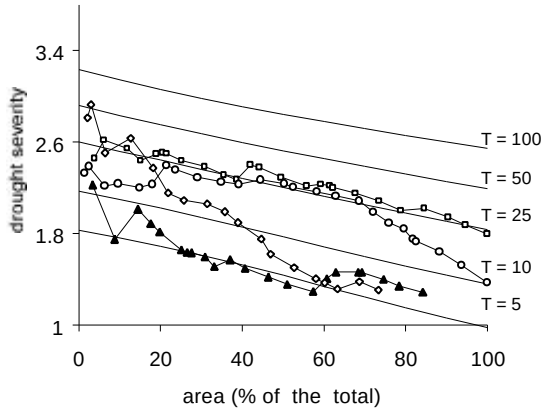
1960/1969



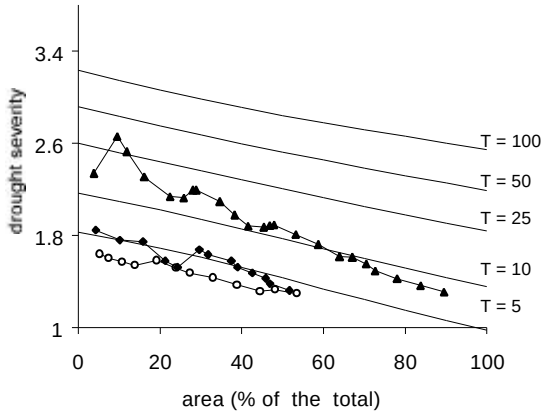
1970/1979



1980/1989



1990/1993



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

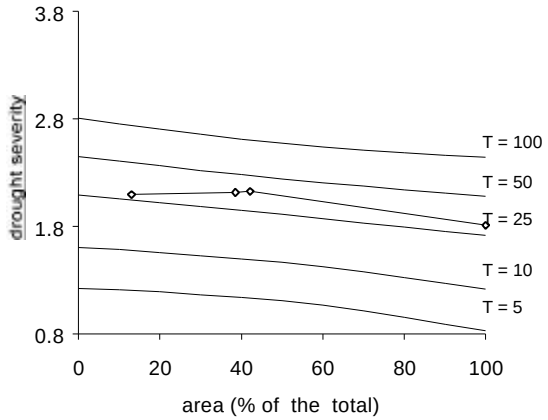
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

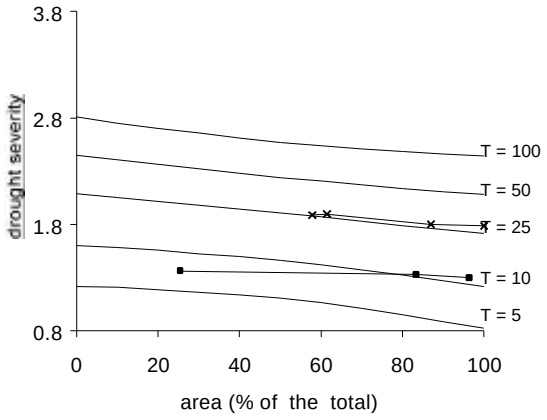
Longer Period

CRETE

1951/1960



1961/1970



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

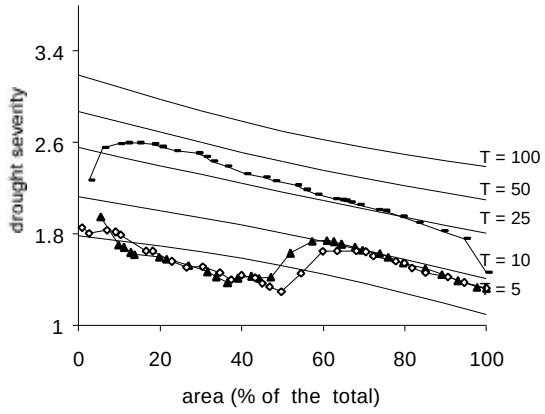
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

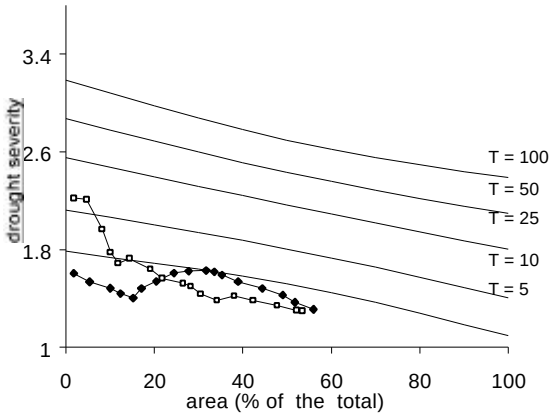
Longer Period

GREAT BRITAIN

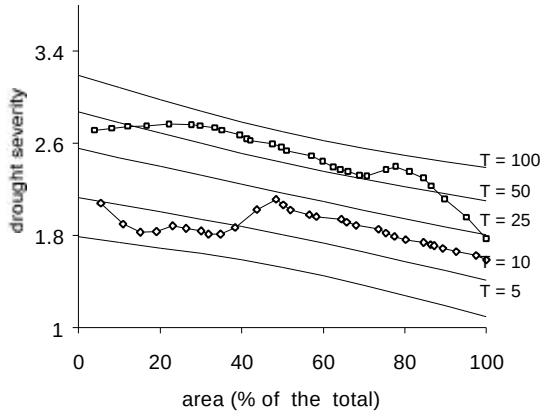
1900/1909



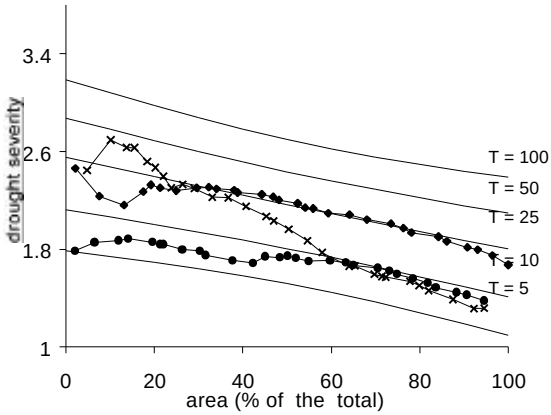
1910/1919



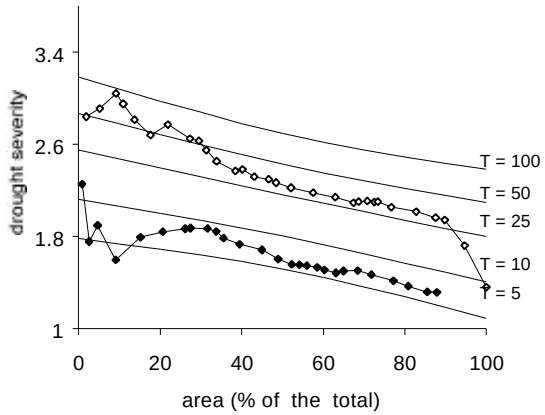
1920/1929



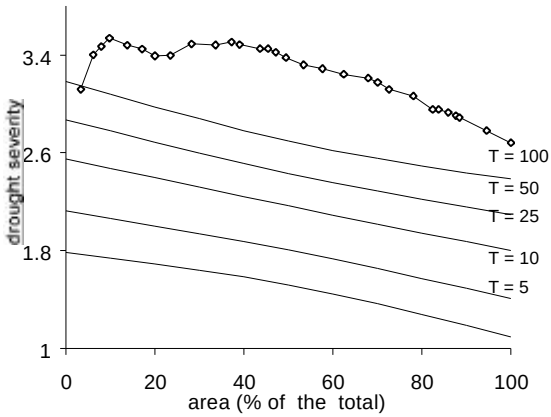
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

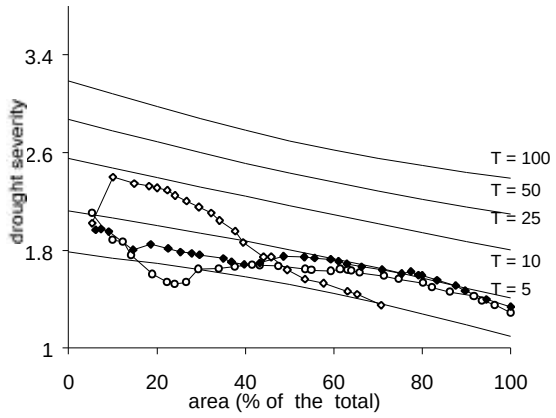
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

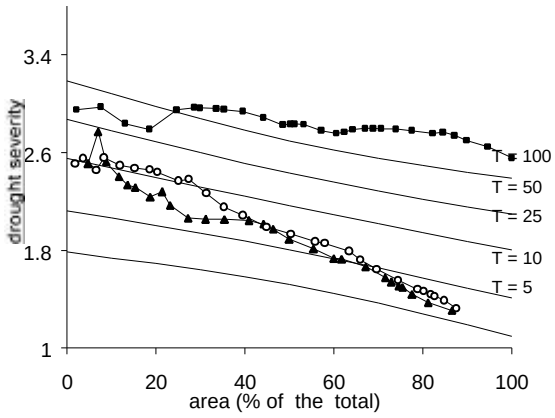
Longer Period

GREAT BRITAIN

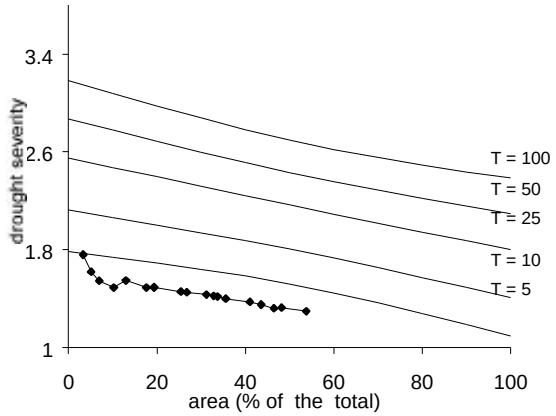
1960/1969



1970/1979



1980/1989



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

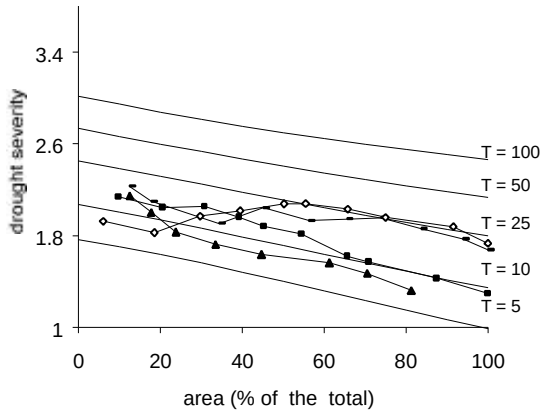
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

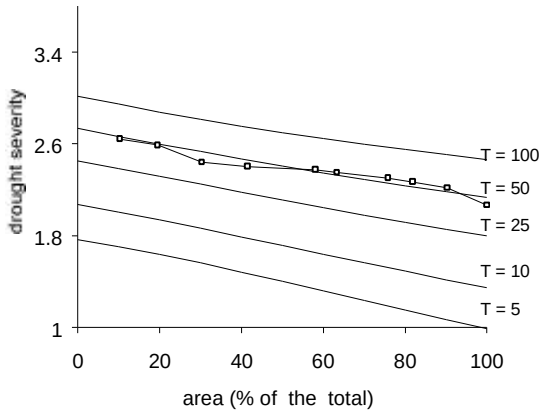
Longer Period

IRELAND

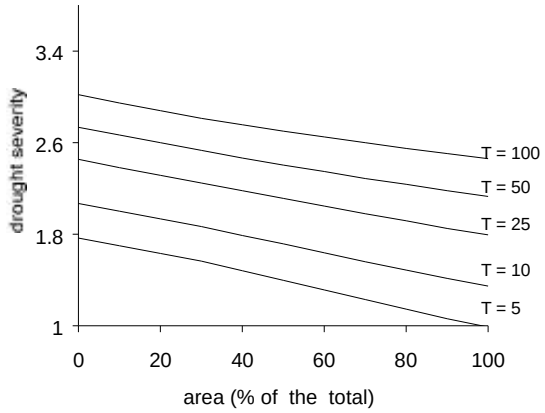
1900/1909



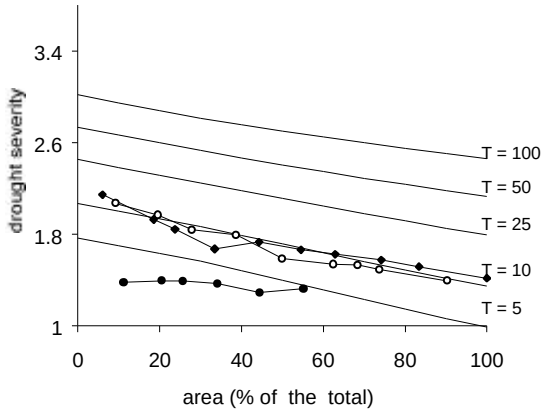
1910/1919



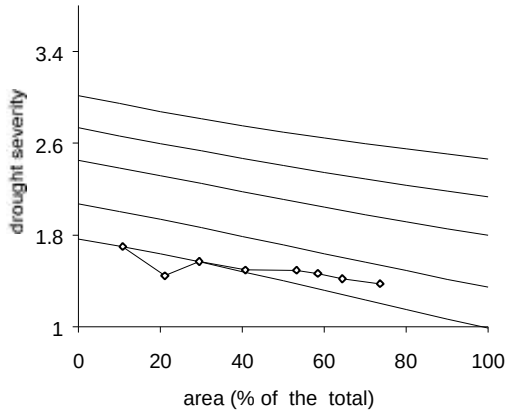
1920/1929



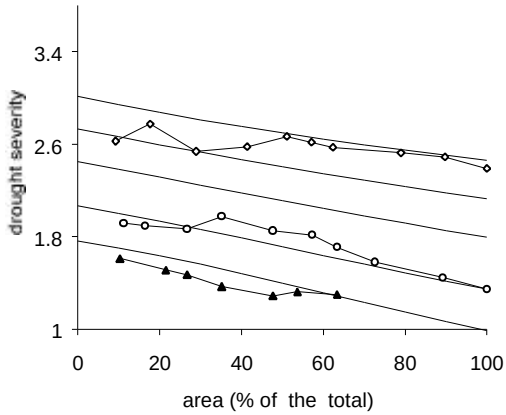
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

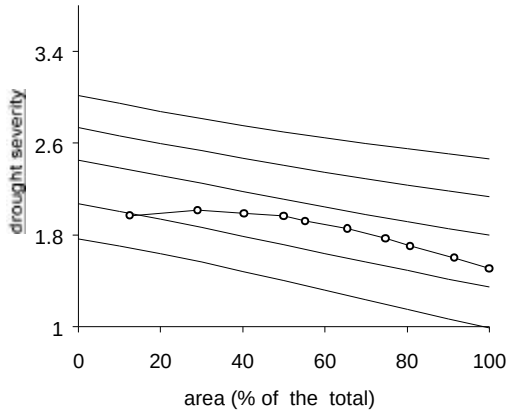
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

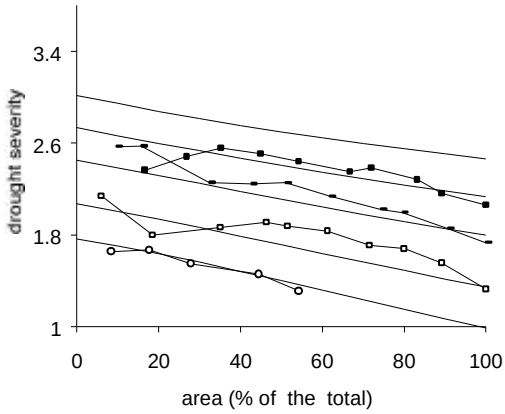
Longer Period

IRELAND

1960/1969

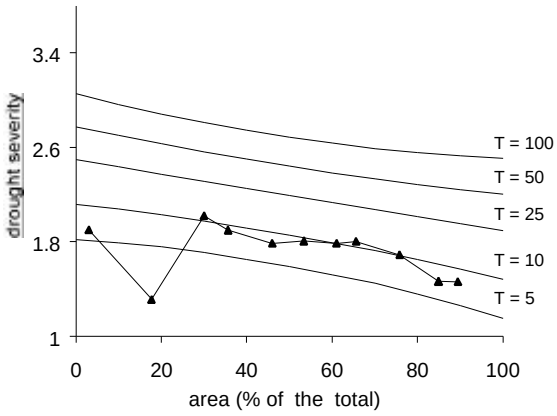


1970/1979

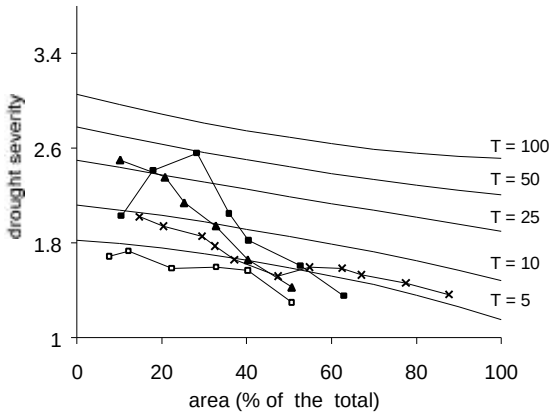


ITALY

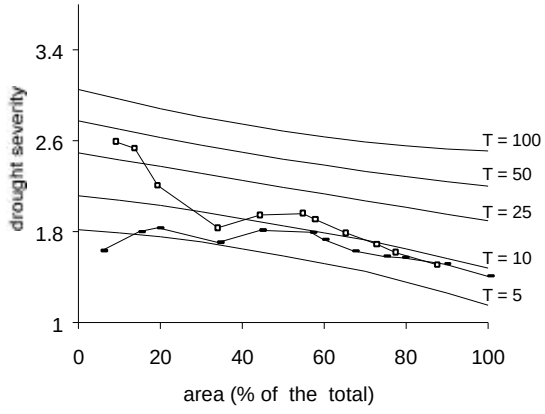
1951/1960



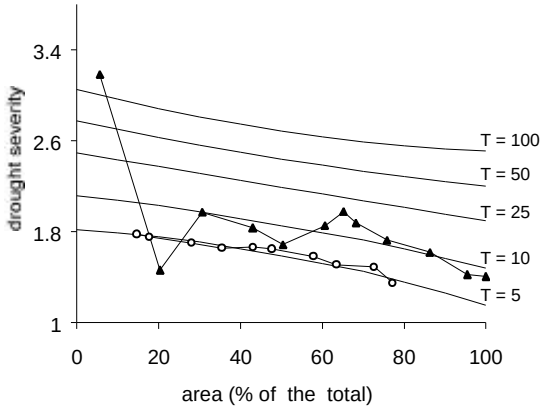
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

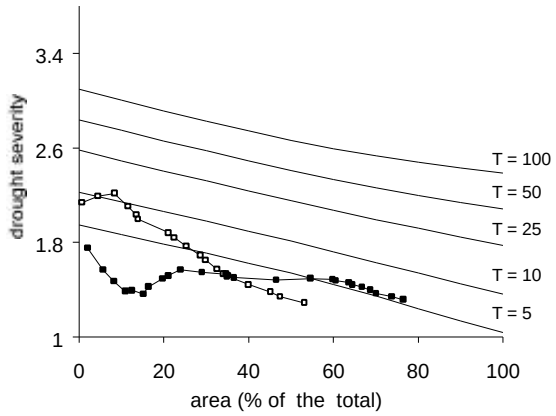
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

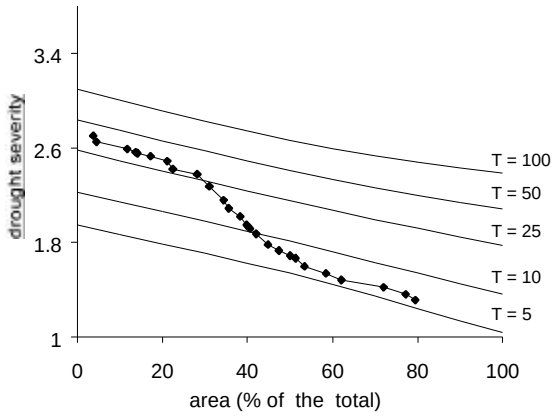
Longer Period

SCANDINAVIA

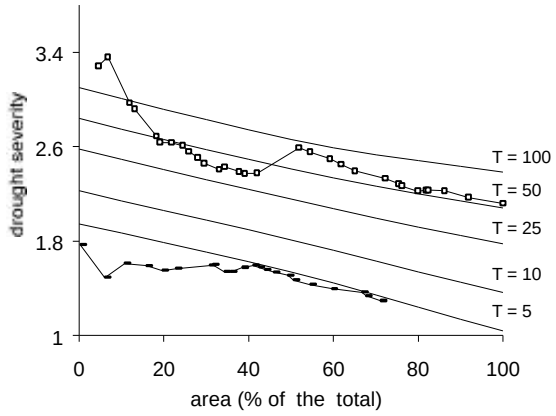
1900/1909



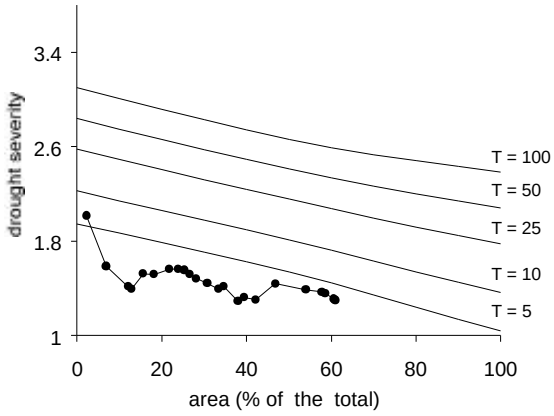
1910/1919



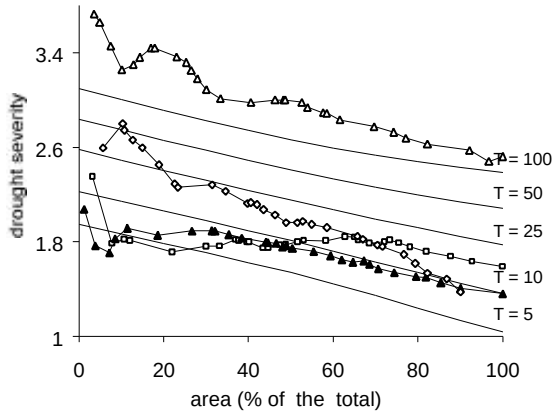
1920/1929



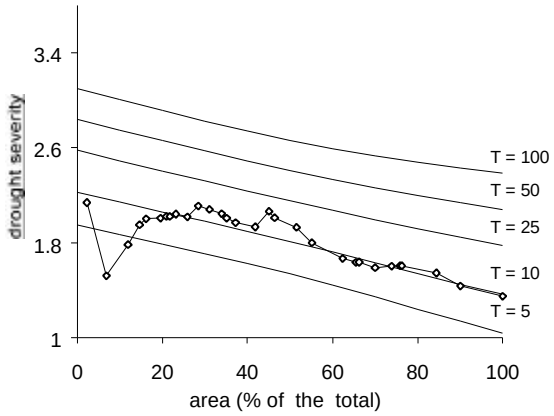
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

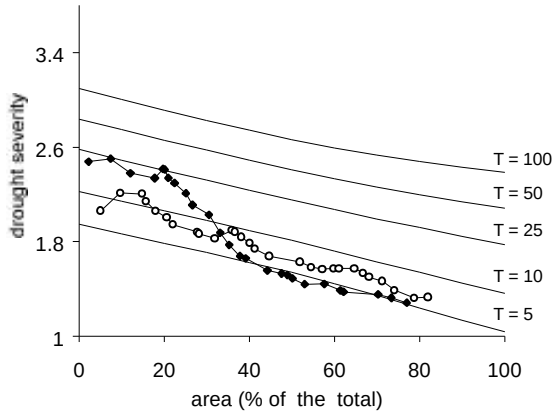
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

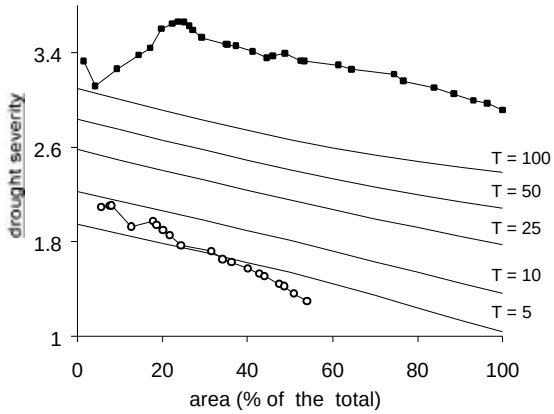
Longer Period

SCANDINAVIA

1960/1969



1970/1979



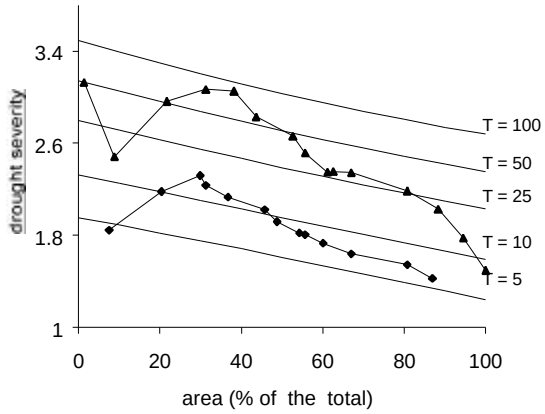
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

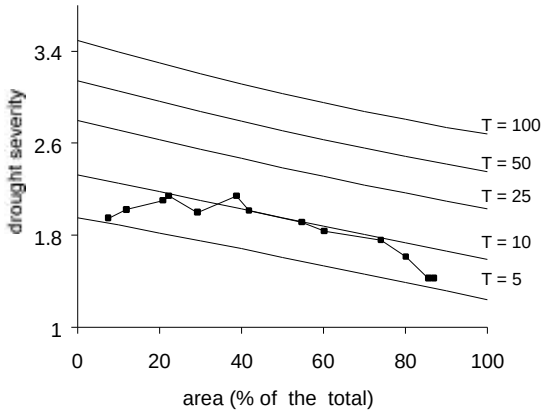
Longer Period

SOUTH BALKANS

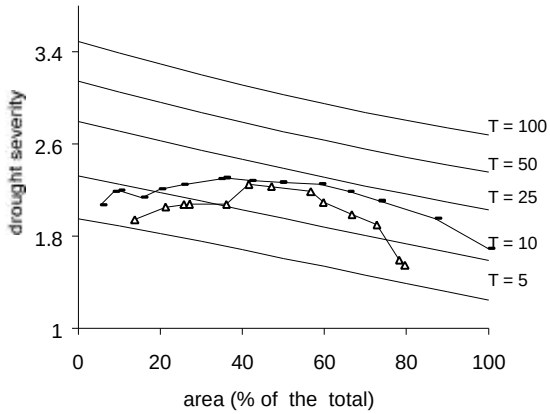
1951/1960



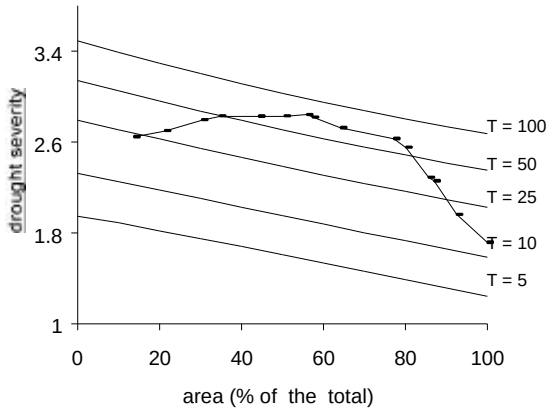
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

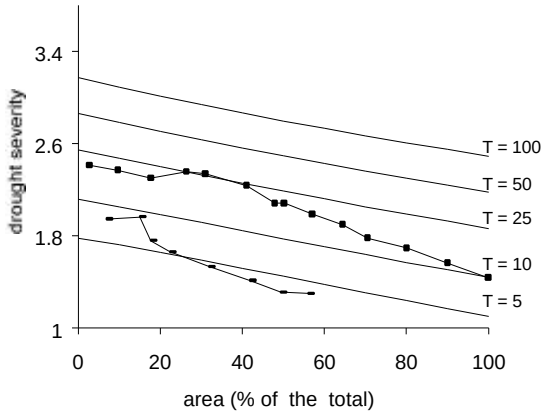
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

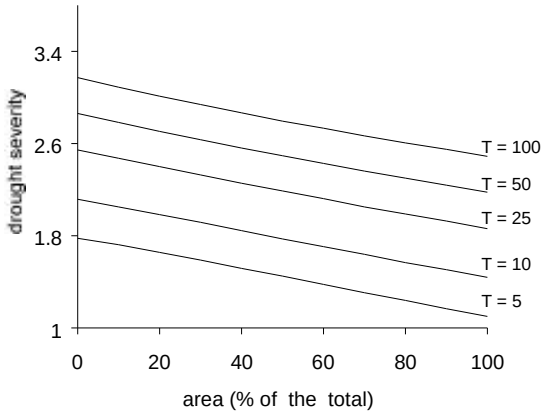
Longer Period

WESTERN FRANCE

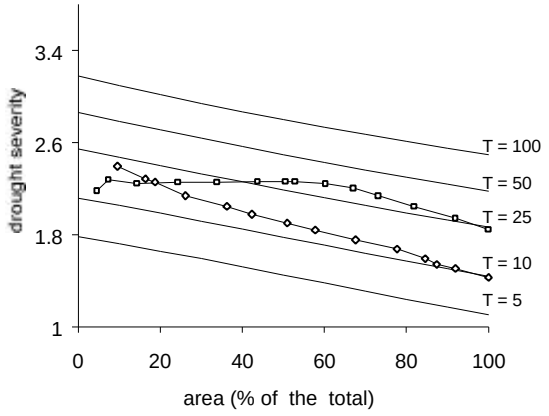
1900/1909



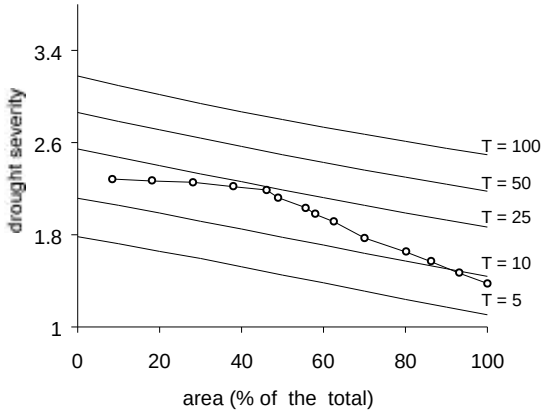
1910/1919



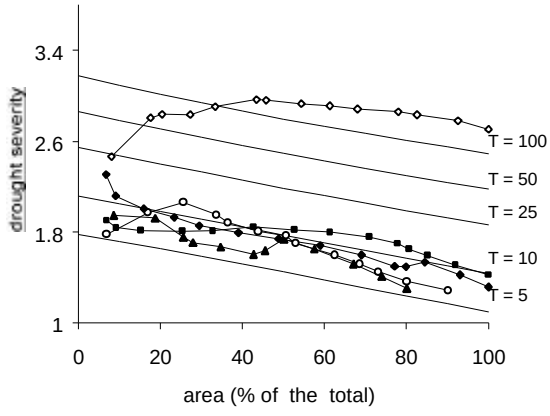
1920/1929



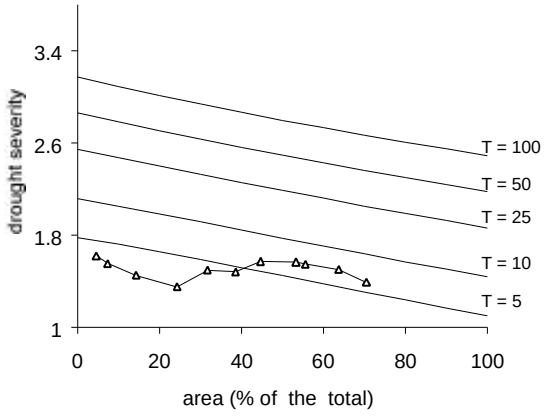
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

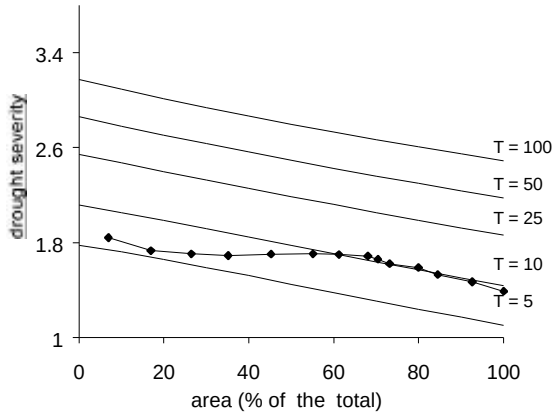
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

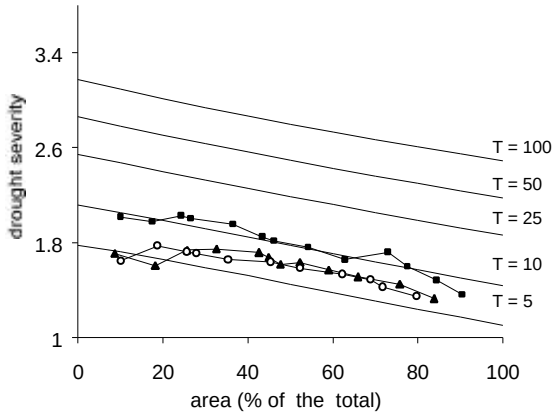
Longer Period

WESTERN FRANCE

1960/1969



1970/1979



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

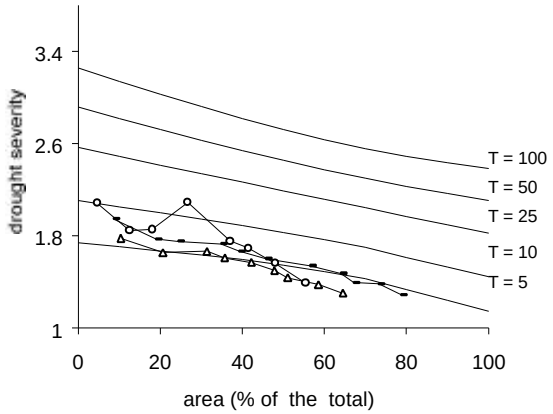
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

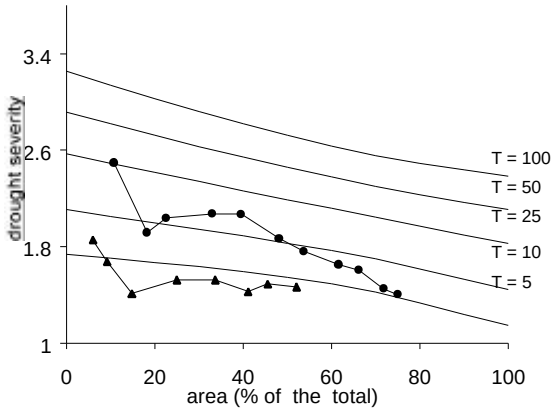
Longer Period

WESTERN MEDITERRANEAN

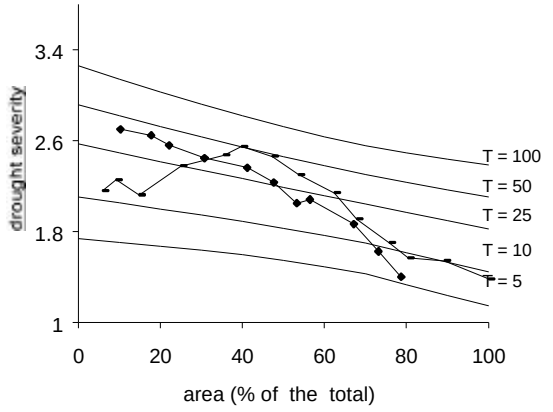
1900/1909



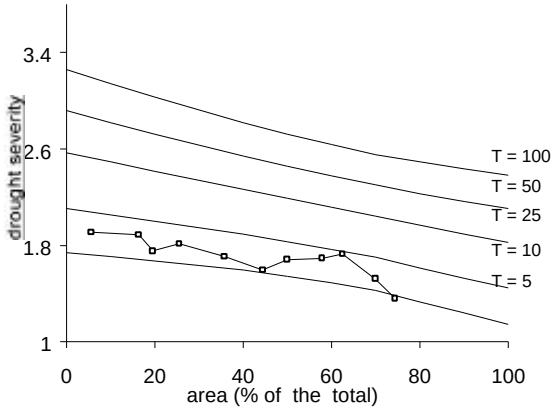
1910/1919



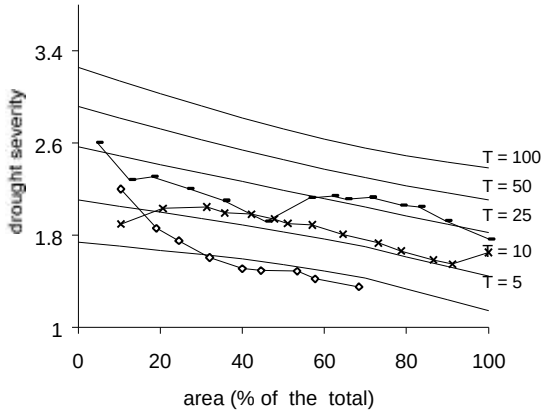
1920/1929



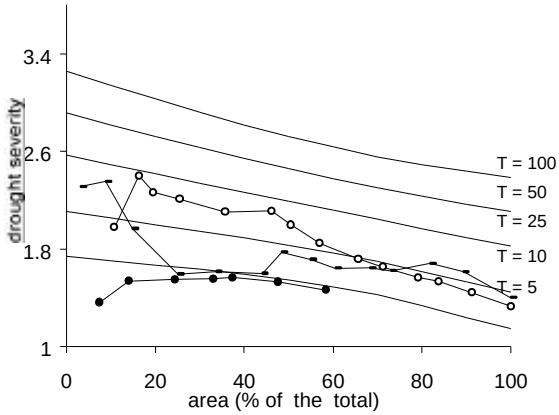
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

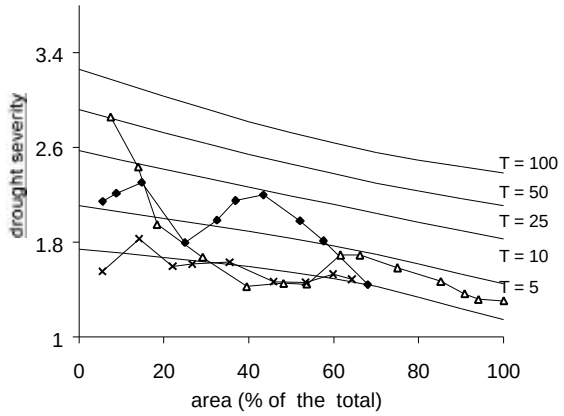
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

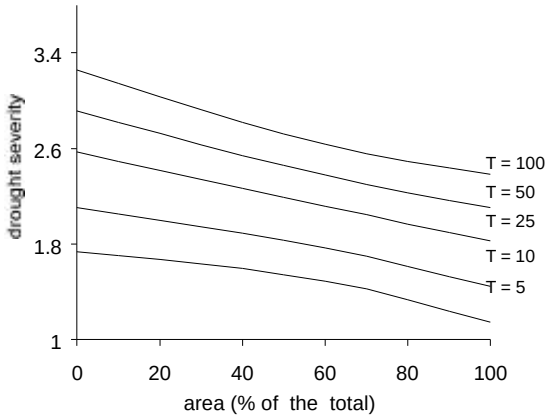
Longer Period

WESTERN MEDITERRANEAN

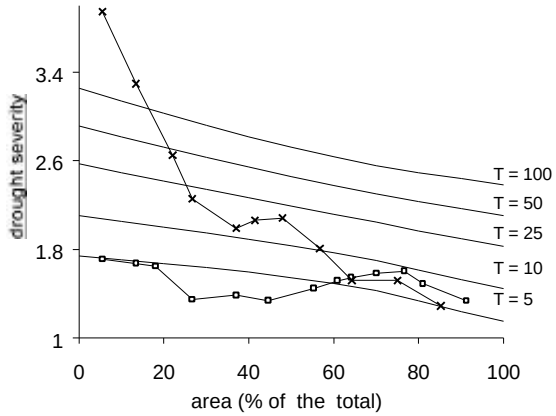
1960/1969



1970/1979



1980/1989



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

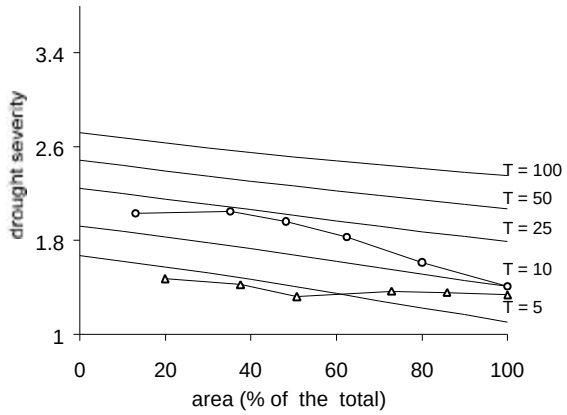
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

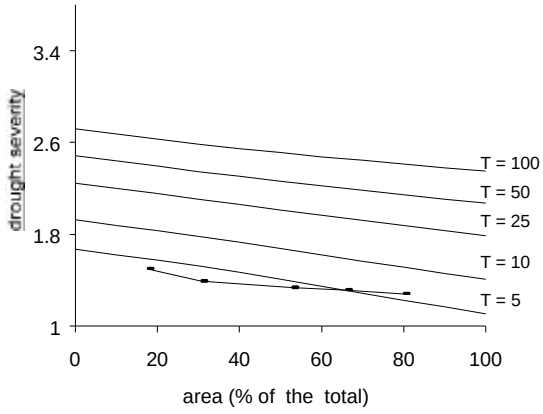
Common Period (From 1951/52 to 1985/86)

ATLANTIC IBERIA

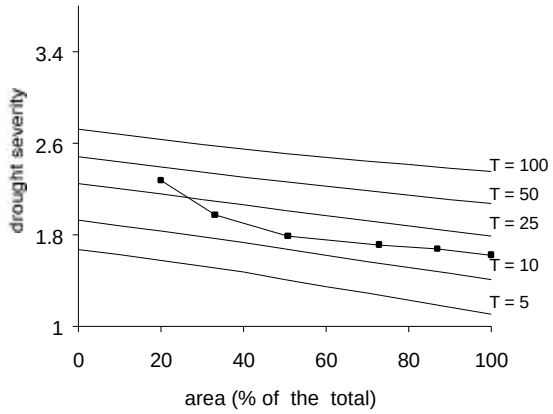
1951/1960



1961/1970



1971/1980



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

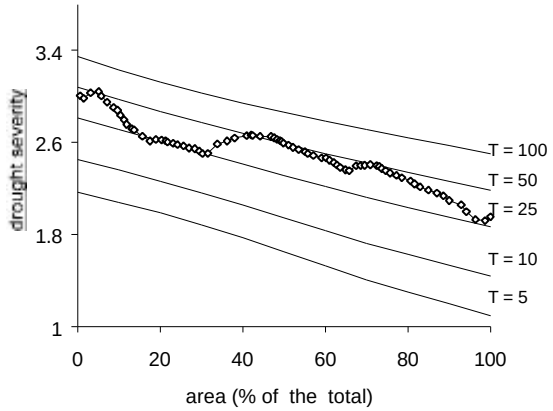
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

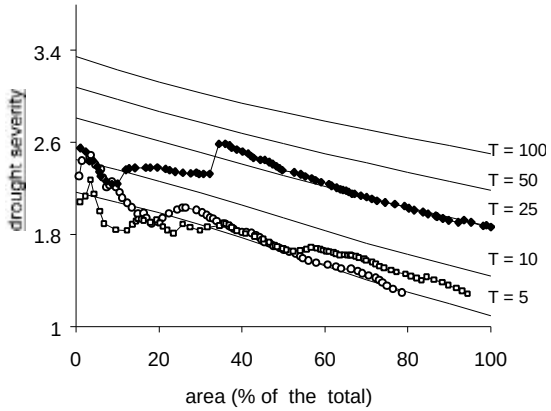
Common Period (From 1951/52 to 1985/86)

CENTRAL EUROPE

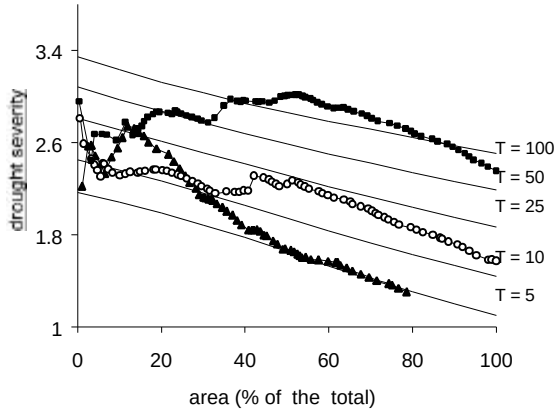
1951/1960



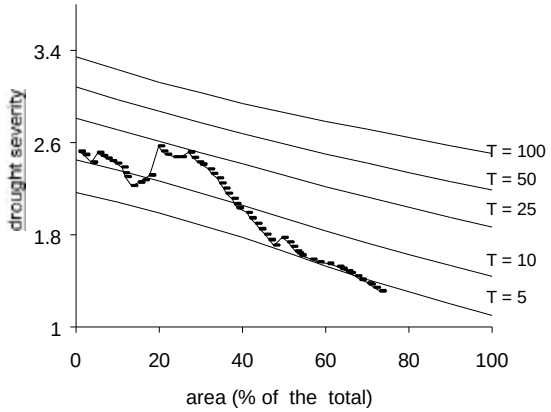
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

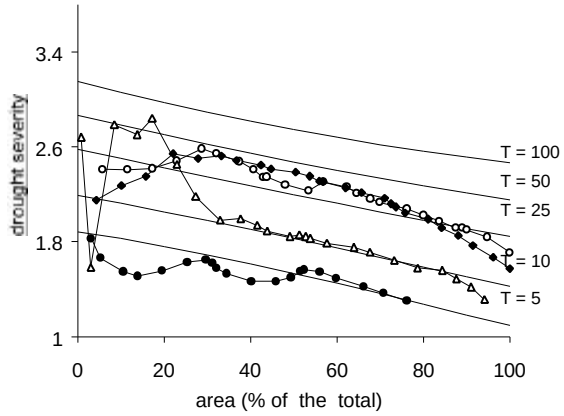
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

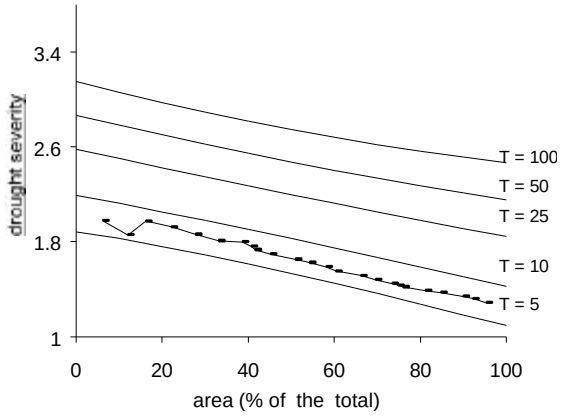
Common Period (From 1951/52 to 1985/86)

CENTRAL IBERIA

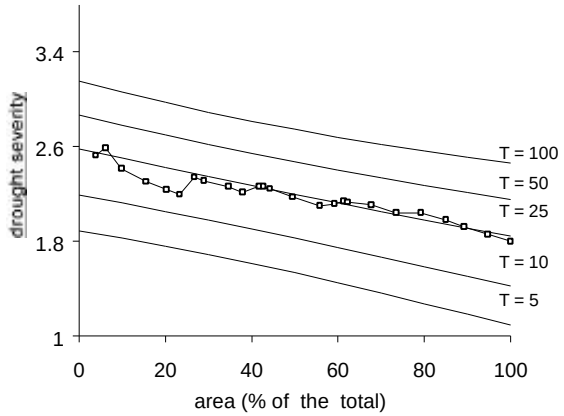
1951/1960



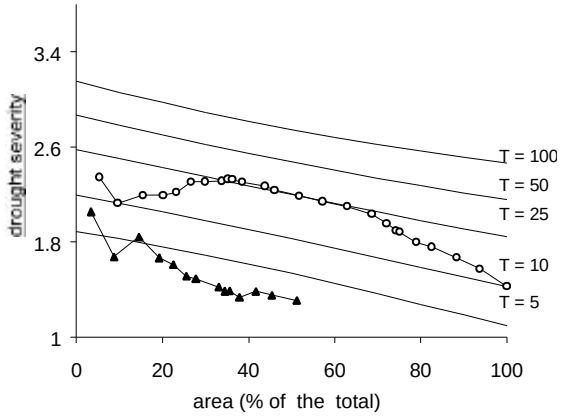
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

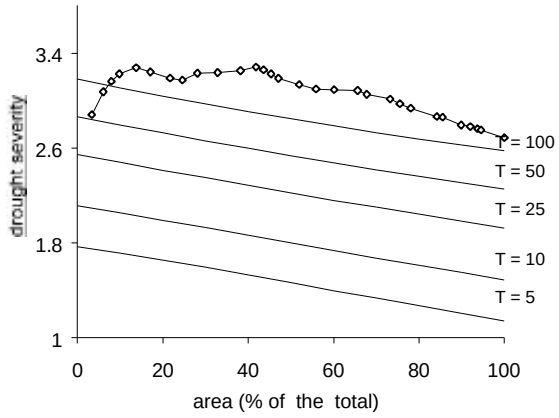
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

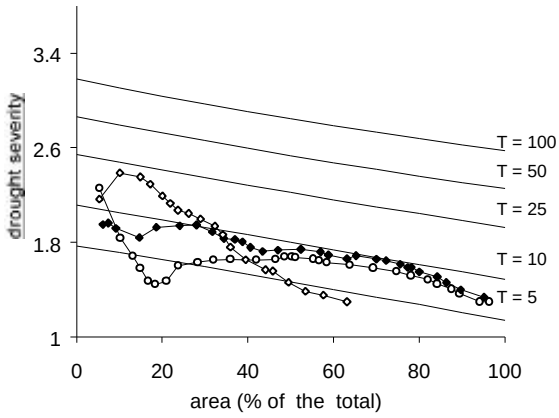
Common Period (From 1951/52 to 1985/86)

GREAT BRITAIN

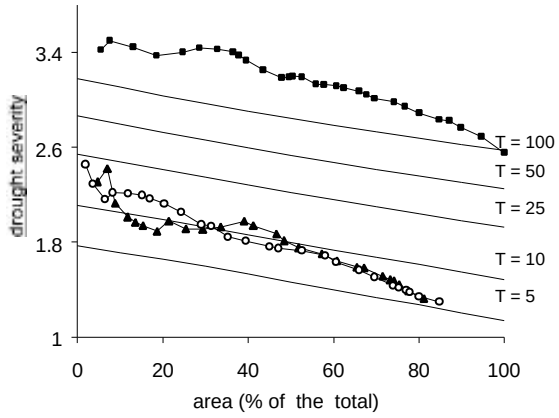
1951/1960



1961/1970



1971/1980



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

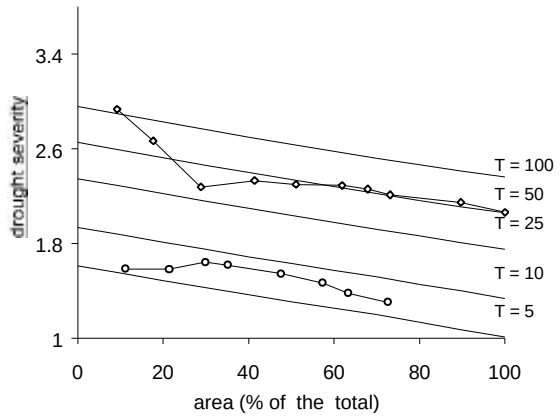
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

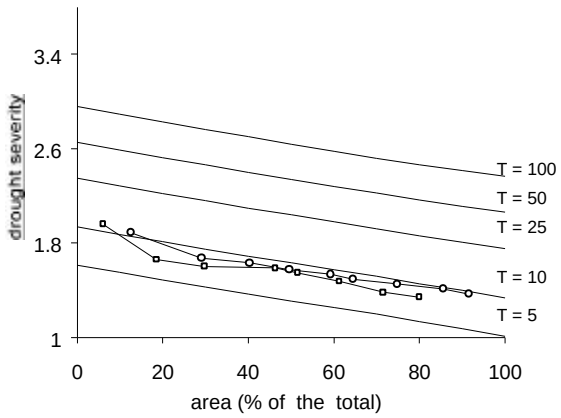
Common Period (From 1951/52 to 1985/86)

IRELAND

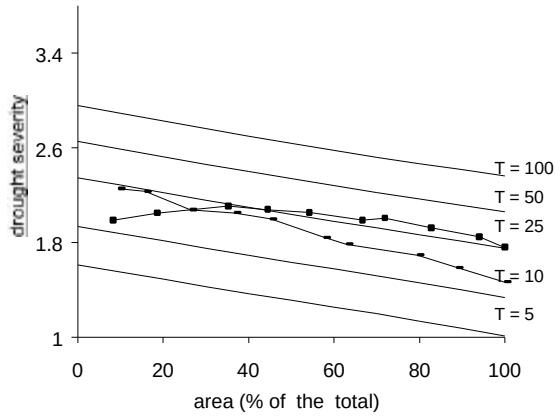
1951/1960



1961/1970



1971/1980



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

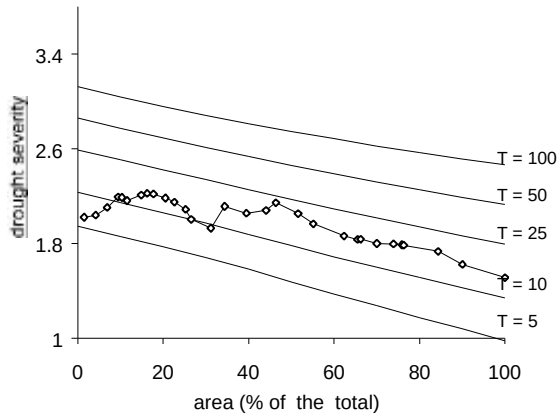
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

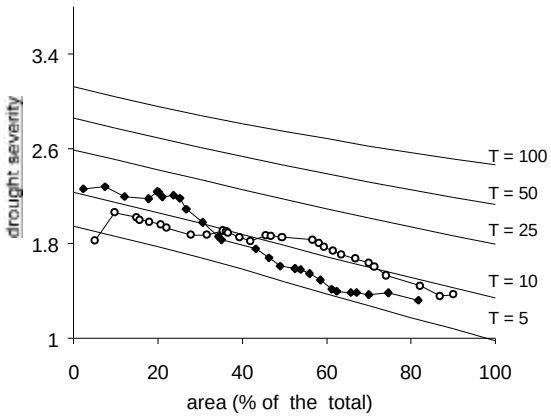
Common Period (From 1951/52 to 1985/86)

SCANDINAVIA

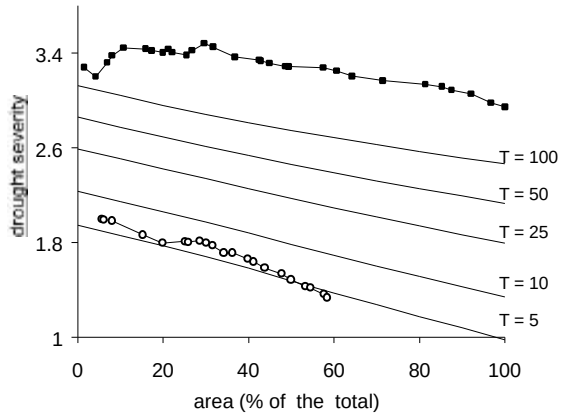
1951/1960



1961/1970



1971/1980



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

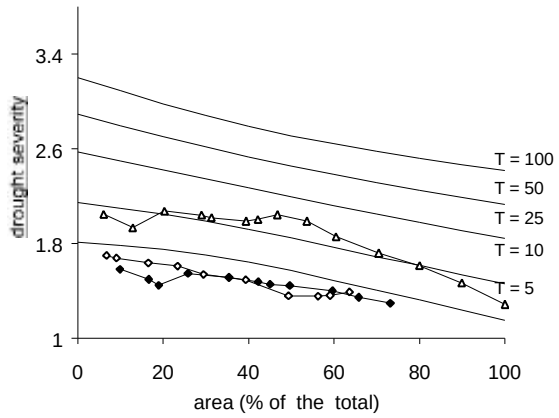
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

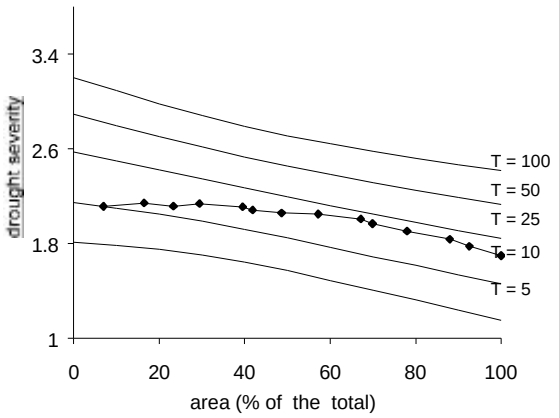
Common Period (From 1951/52 to 1985/86)

WESTERN FRANCE

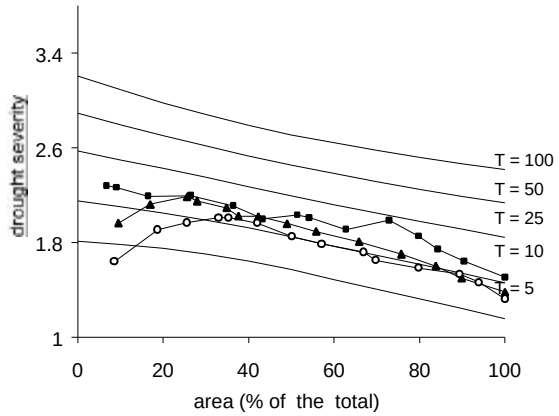
1951/1960



1961/1970



1971/1980



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

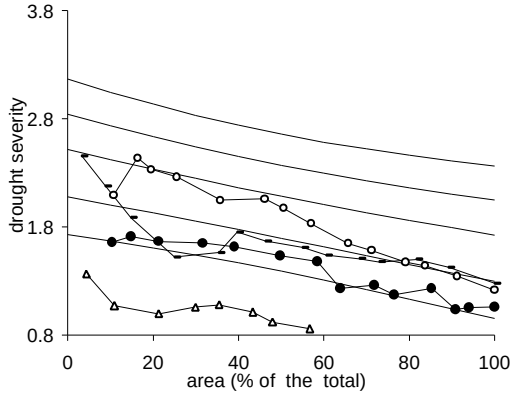
ANNEX D RESULTS FOR THRESHOLD 0.10

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (cont.)

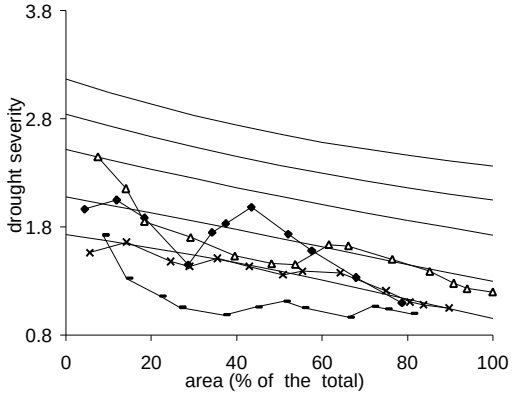
Common Period (From 1951/52 to 1985/86)

WESTERN MEDITERRANEAN

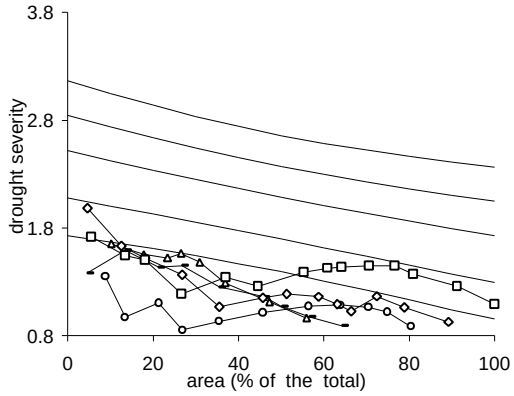
1951/1960



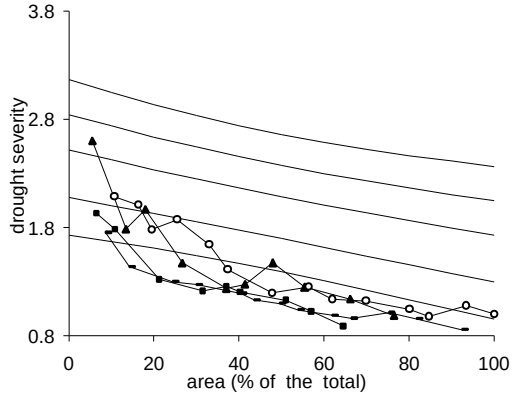
1961/1970



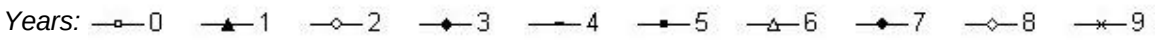
1971/1980



1981/1985



Legend:



ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

Common Period (From 1951/52 to 1985/86)
Extreme-value type 1 distribution: S(A) = û (A) + â (A) x [-log(-log (1- 1/T)]

Model results using the common and the longer period available for each area

Parameter û

area (%) A	Alps		Atlantic Iberia		Central Europe		Central Iberia		Crete	Great Britain		Ireland		Italy	Scandinavia		South Balkans	Western France		Western Mediterranean	
0	1.353	0.631	0.709	1.296	1.181	1.252	1.060	0.528	1.161	1.110	1.018	0.936	1.050	0.998	1.177	1.193	0.993	0.941	1.042	0.969
10	1.290	0.600	0.659	1.205	1.086	1.157	0.991	0.498	1.099	1.029	0.946	0.872	1.017	0.925	1.090	1.136	0.921	0.890	0.992	0.918
20	1.216	0.562	0.606	1.108	0.986	1.056	0.915	0.461	1.032	0.943	0.870	0.804	0.976	0.847	0.998	1.072	0.843	0.833	0.934	0.859
30	1.131	0.517	0.550	1.006	0.881	0.948	0.832	0.418	0.959	0.851	0.792	0.732	0.920	0.766	0.902	0.999	0.759	0.769	0.866	0.792
40	1.036	0.465	0.490	0.899	0.772	0.835	0.742	0.370	0.879	0.753	0.708	0.655	0.850	0.684	0.802	0.917	0.671	0.697	0.789	0.716
50	0.929	0.409	0.424	0.785	0.658	0.720	0.646	0.317	0.788	0.649	0.620	0.575	0.767	0.598	0.699	0.827	0.578	0.618	0.704	0.633
60	0.808	0.345	0.356	0.669	0.541	0.601	0.546	0.261	0.689	0.545	0.529	0.491	0.674	0.507	0.591	0.729	0.483	0.531	0.609	0.540
70	0.677	0.273	0.285	0.548	0.420	0.481	0.440	0.203	0.584	0.437	0.437	0.405	0.572	0.414	0.477	0.624	0.384	0.439	0.511	0.440
80	0.540	0.199	0.214	0.426	0.297	0.362	0.329	0.144	0.473	0.327	0.344	0.316	0.458	0.320	0.362	0.513	0.284	0.344	0.404	0.336
90	0.399	0.121	0.146	0.301	0.172	0.242	0.220	0.084	0.360	0.215	0.252	0.225	0.339	0.225	0.250	0.401	0.183	0.246	0.296	0.230
100	0.253	0.040	0.080	0.176	0.045	0.123	0.110	0.023	0.242	0.101	0.159	0.135	0.211	0.126	0.142	0.284	0.083	0.142	0.187	0.123

Parameter â

area (%) A	Alps		Atlantic Iberia		Central Europe		Central Iberia		Crete	Great Britain		Ireland		Italy	Scandinavia		South Balkans	Western France		Western Mediterranean	
0	0.539	0.524	0.466	0.482	0.514	0.440	0.495	0.519	0.468	0.482	0.460	0.461	0.486	0.486	0.451	0.535	0.497	0.526	0.511	0.496
10	0.516	0.512	0.463	0.475	0.510	0.439	0.485	0.511	0.454	0.479	0.457	0.457	0.466	0.480	0.447	0.518	0.492	0.511	0.492	0.480
20	0.500	0.503	0.463	0.471	0.508	0.441	0.480	0.505	0.443	0.479	0.457	0.454	0.449	0.476	0.446	0.504	0.491	0.499	0.477	0.468
30	0.488	0.498	0.464	0.468	0.509	0.447	0.477	0.501	0.435	0.481	0.458	0.454	0.440	0.473	0.447	0.495	0.492	0.491	0.467	0.460
40	0.483	0.495	0.466	0.470	0.512	0.455	0.478	0.501	0.430	0.487	0.461	0.455	0.437	0.472	0.450	0.490	0.495	0.487	0.460	0.455
50	0.484	0.494	0.472	0.474	0.518	0.465	0.482	0.502	0.431	0.495	0.467	0.459	0.440	0.473	0.456	0.489	0.500	0.486	0.459	0.455
60	0.493	0.498	0.478	0.480	0.526	0.477	0.489	0.505	0.436	0.505	0.474	0.464	0.448	0.477	0.464	0.493	0.507	0.489	0.462	0.459
70	0.507	0.504	0.486	0.489	0.536	0.490	0.498	0.510	0.445	0.517	0.482	0.471	0.461	0.483	0.475	0.501	0.516	0.495	0.467	0.466
80	0.525	0.513	0.494	0.500	0.547	0.503	0.510	0.516	0.456	0.529	0.492	0.479	0.480	0.491	0.488	0.511	0.525	0.502	0.476	0.476
90	0.546	0.523	0.502	0.512	0.560	0.518	0.522	0.523	0.470	0.544	0.501	0.489	0.501	0.499	0.501	0.524	0.536	0.512	0.488	0.488
100	0.570	0.535	0.510	0.525	0.574	0.533	0.535	0.531	0.487	0.560	0.512	0.499	0.528	0.509	0.513	0.539	0.547	0.524	0.501	0.501

Common Period (1951/52-1985/86)
Longer Period

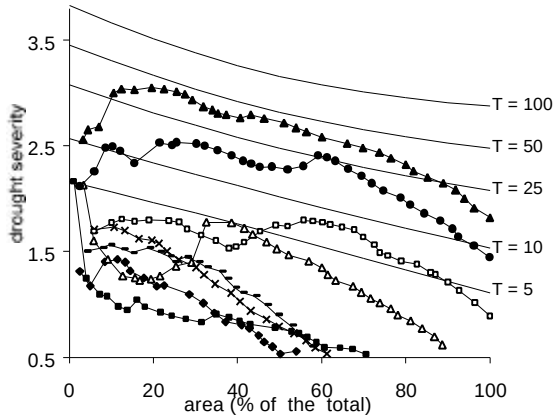
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION

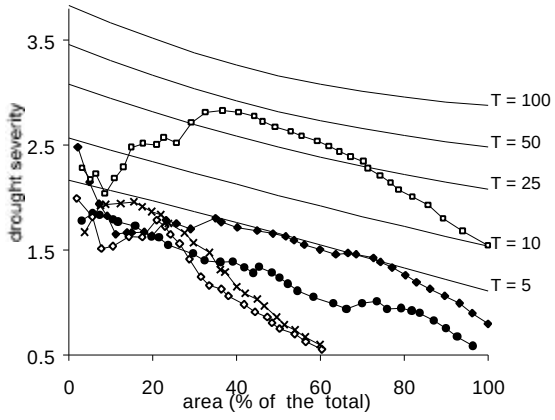
Longer Period

ALPS

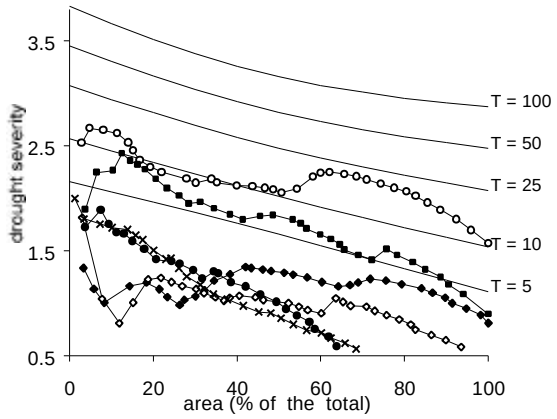
1951/1960



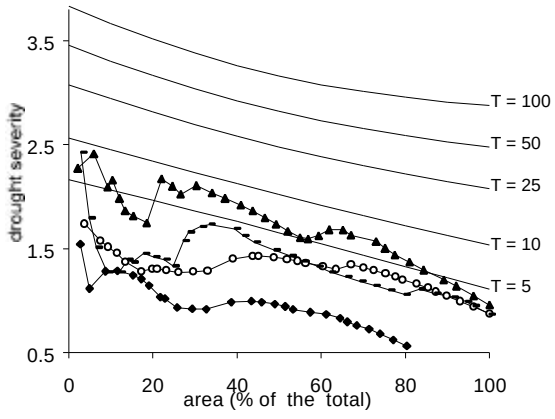
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

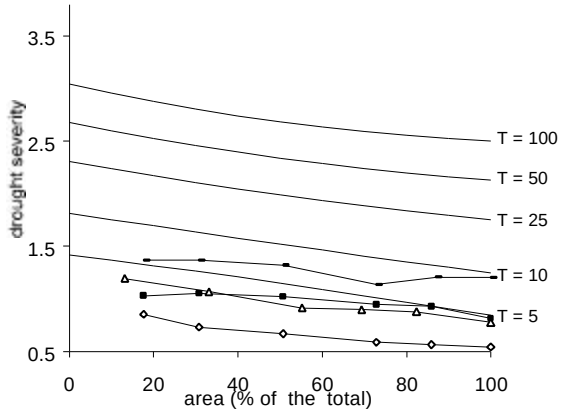
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

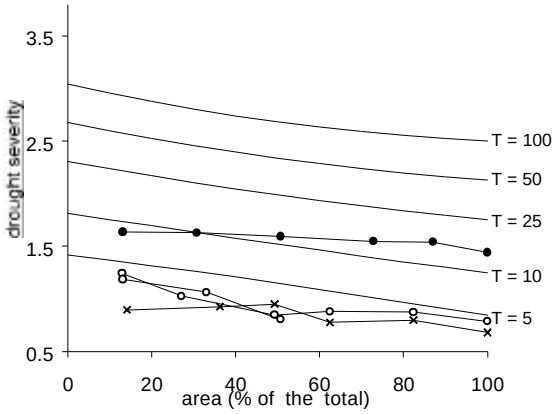
Longer Period

ATLANTIC IBERIA

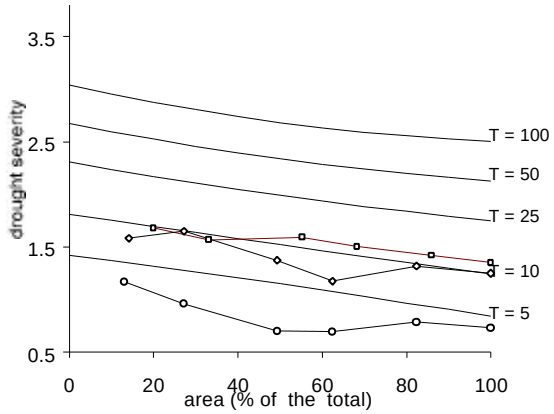
1900/1909



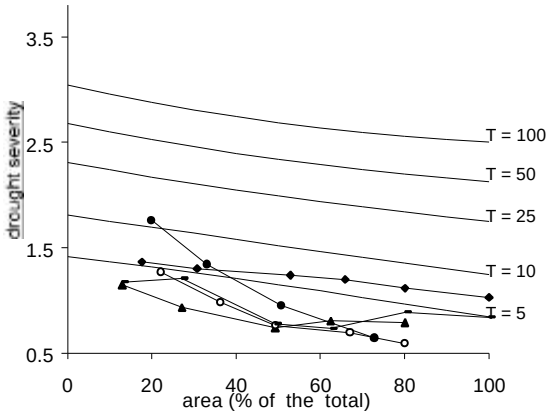
1910/1919



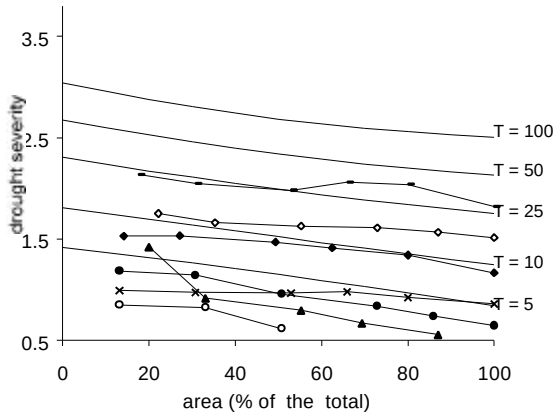
1920/1929



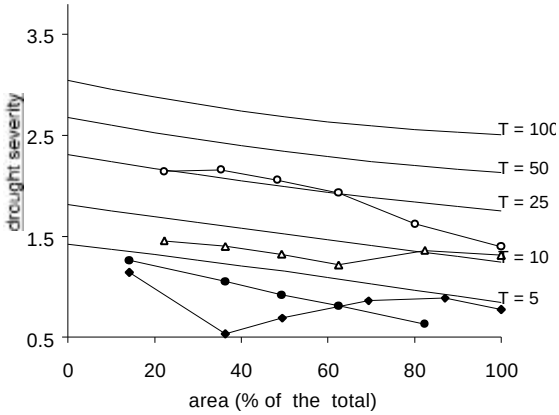
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

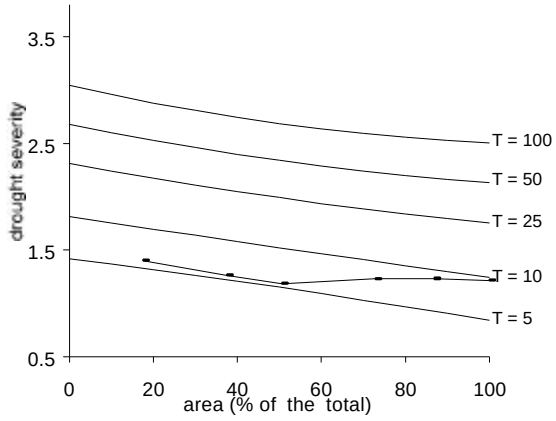
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

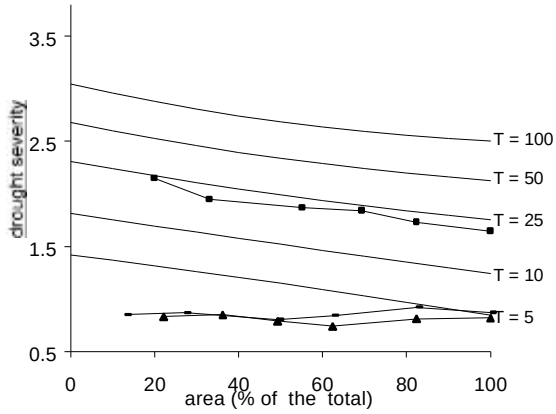
Longer Period

ATLANTIC IBERIA

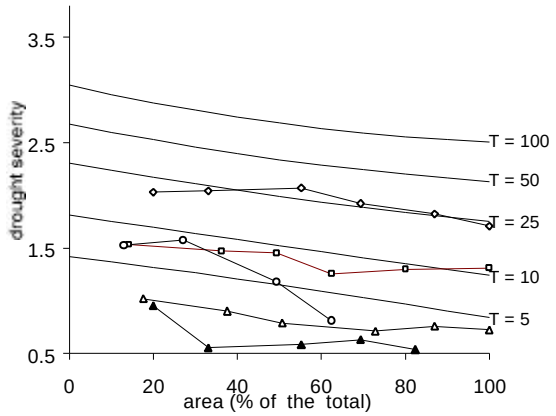
1960/1969



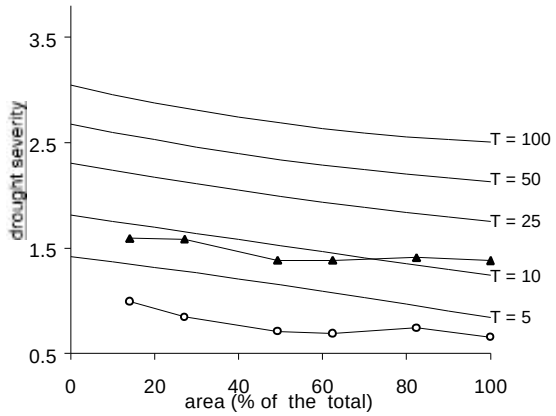
1970/1979



1980/1989



1990/1993



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

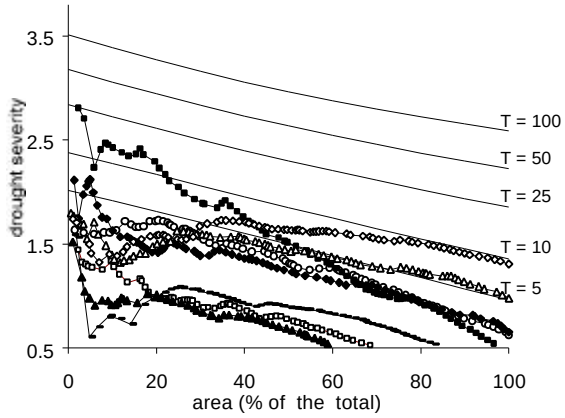
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

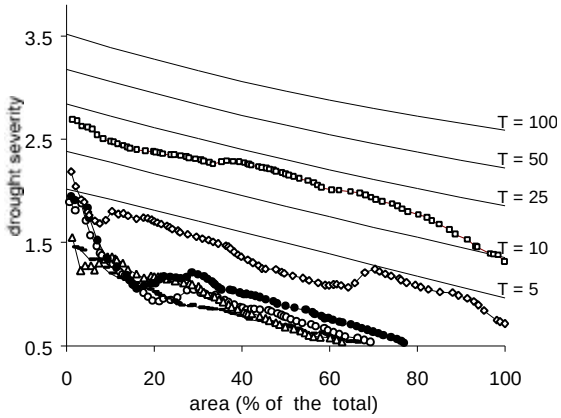
Longer Period

CENTRAL EUROPE

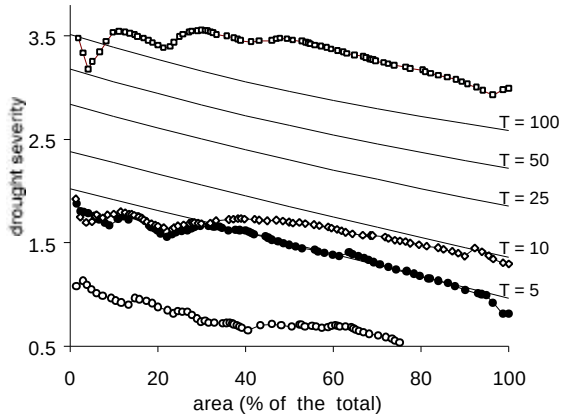
1900/1909



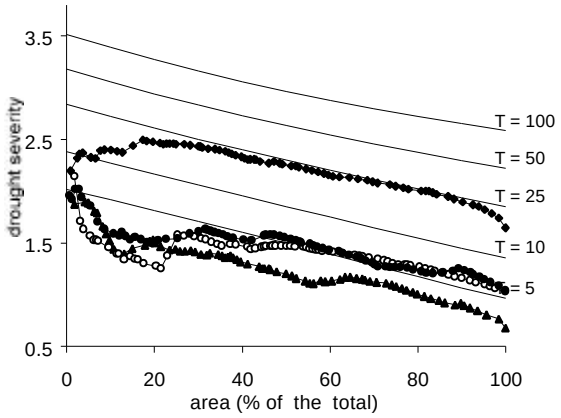
1910/1919



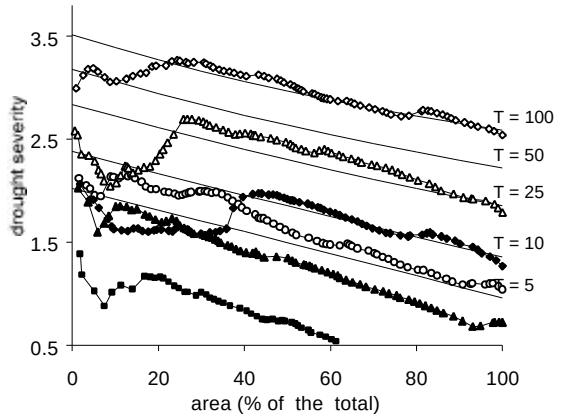
1920/1929



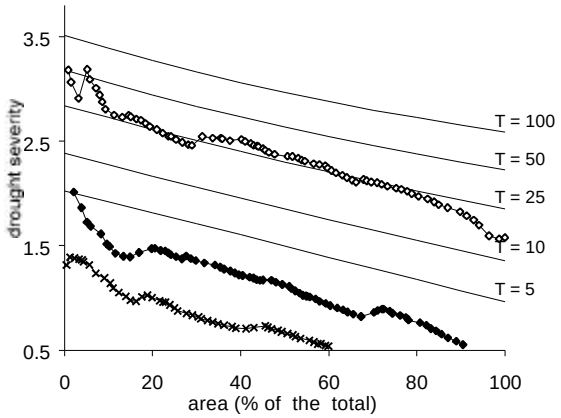
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

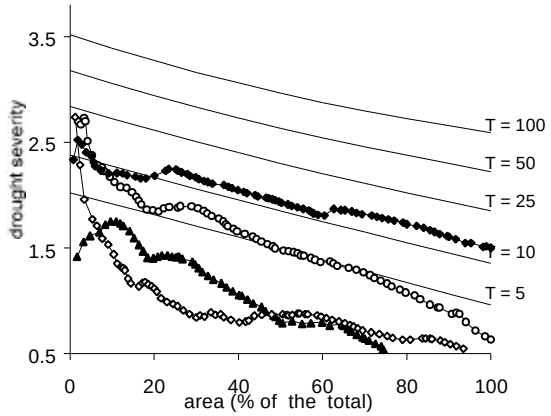
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

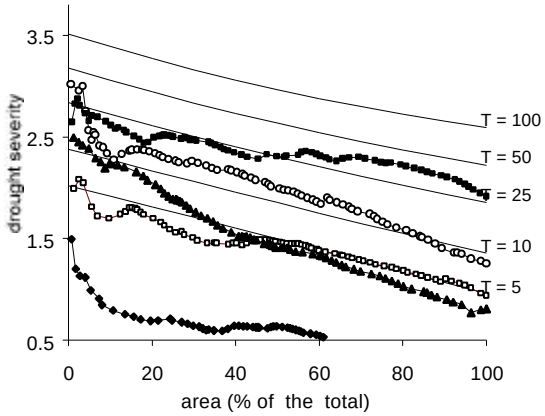
Longer Period

CENTRAL EUROPE

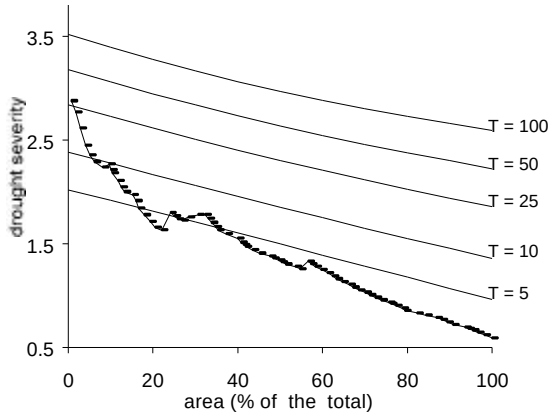
1960/1969



1970/1979



1980/1989



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

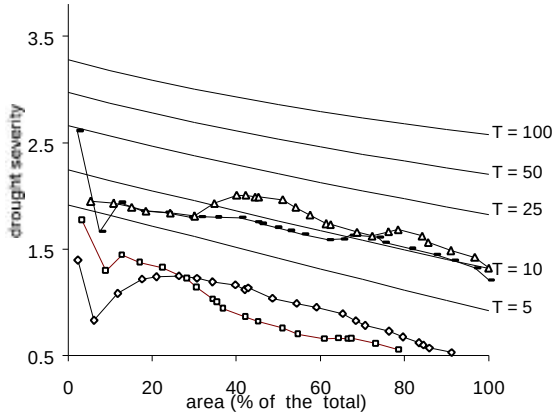
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

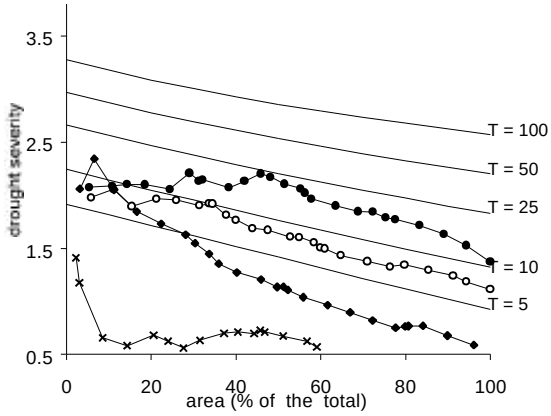
Longer Period

CENTRAL IBERIA

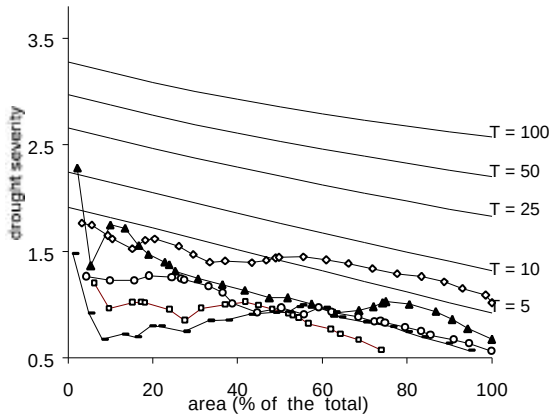
1900/1909



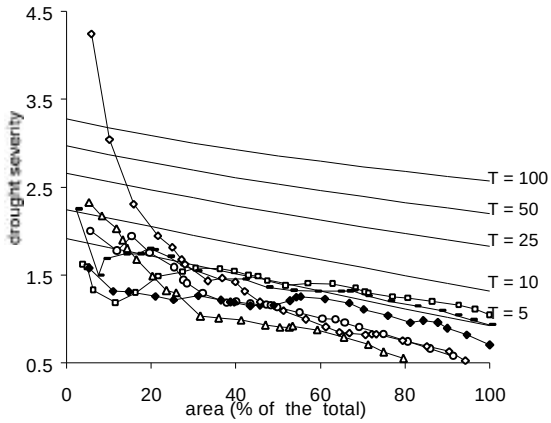
1910/1919



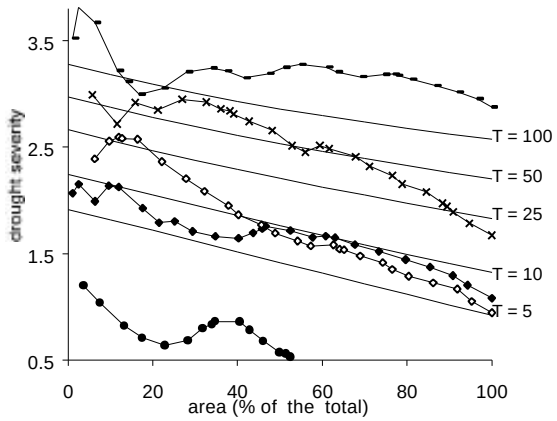
1920/1929



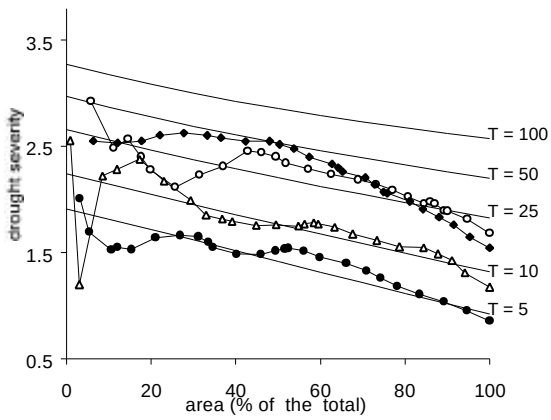
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

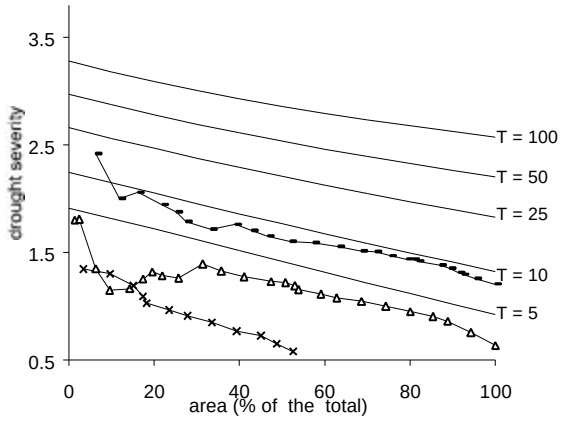
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

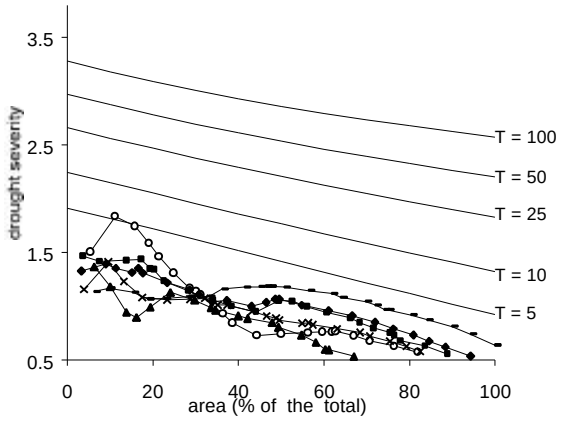
Longer Period

CENTRAL IBERIA

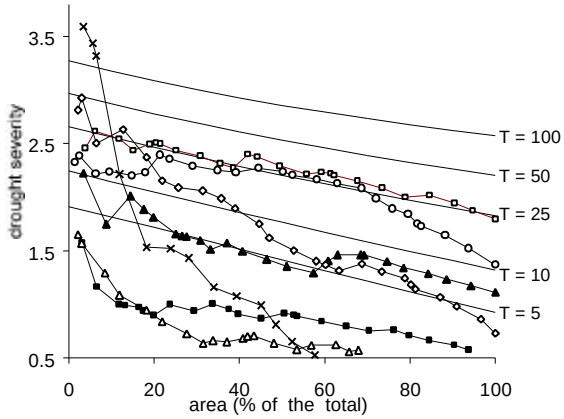
1960/1969



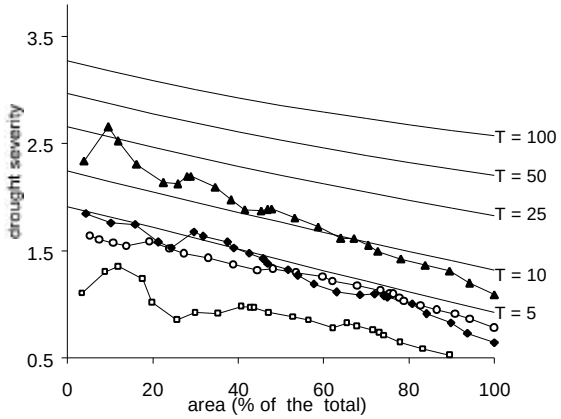
1970/1979



1980/1989



1990/1993



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

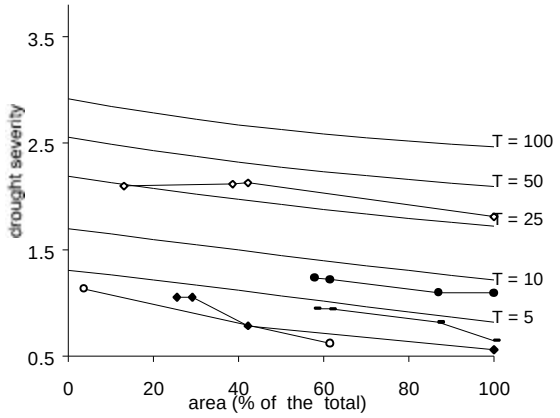
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

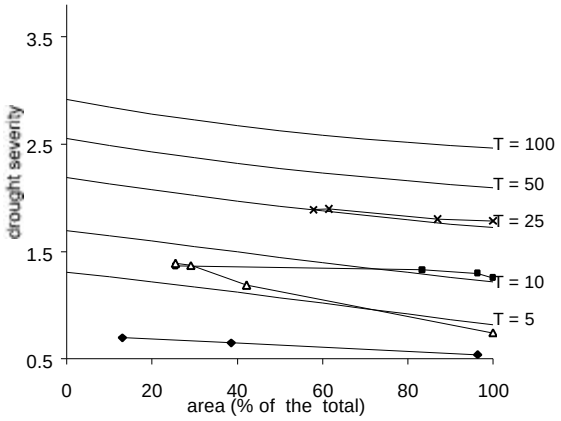
Longer Period

CRETE

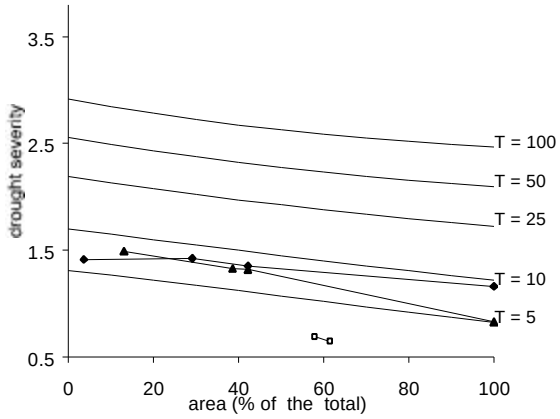
1951/1960



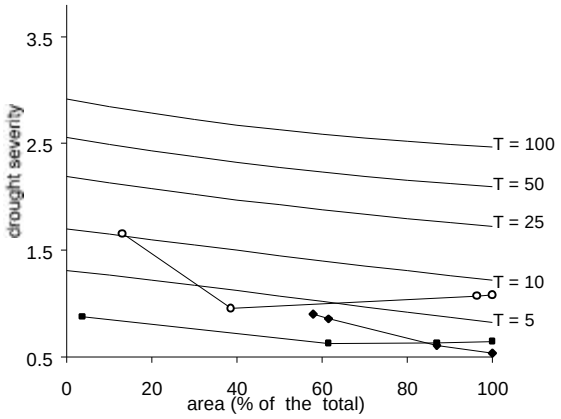
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

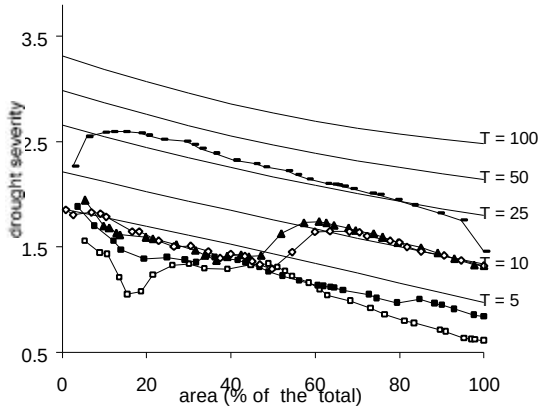
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

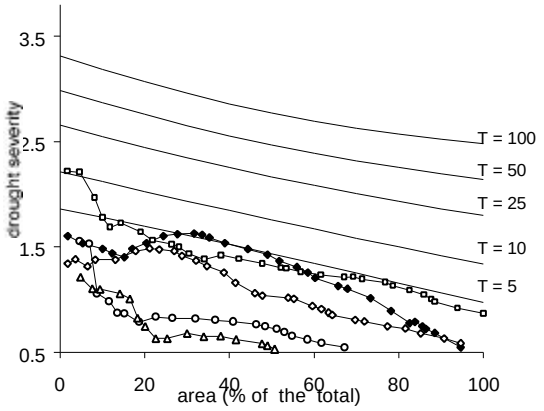
Longer Period

GREAT BRITAIN

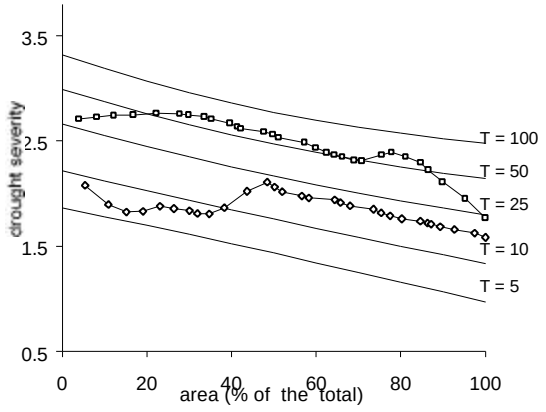
1900/1909



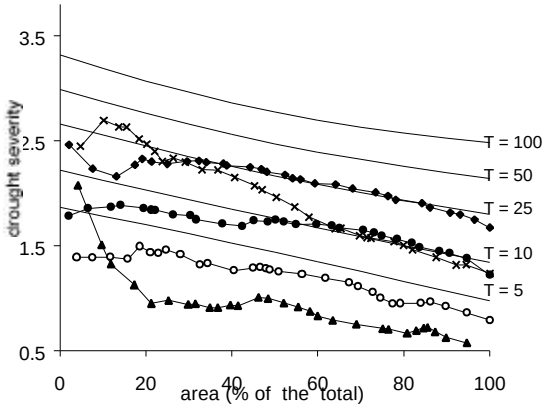
1910/1919



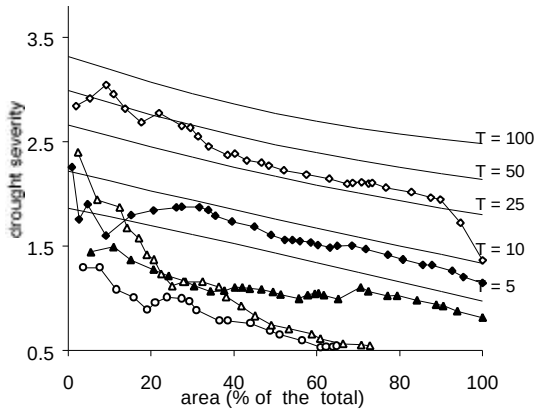
1920/1929



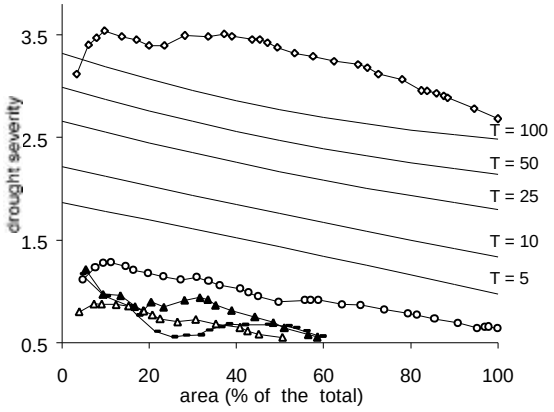
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

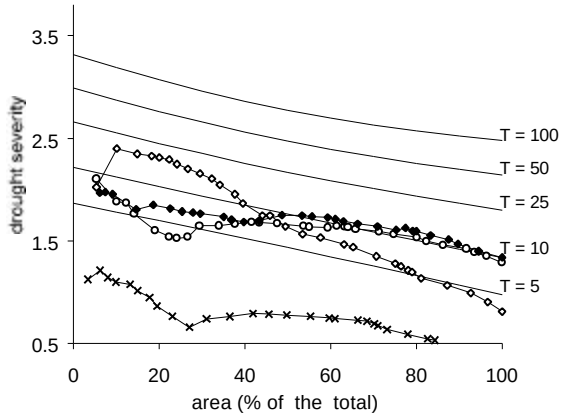
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

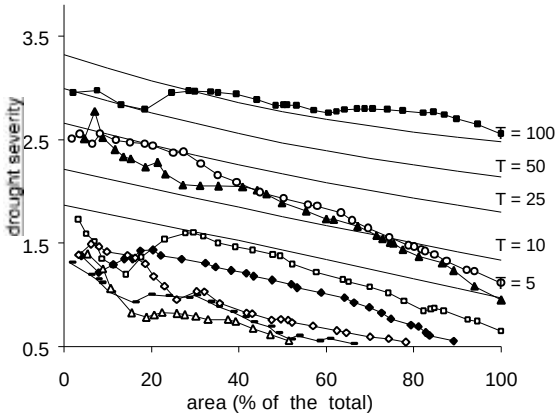
Longer Period

GREAT BRITAIN

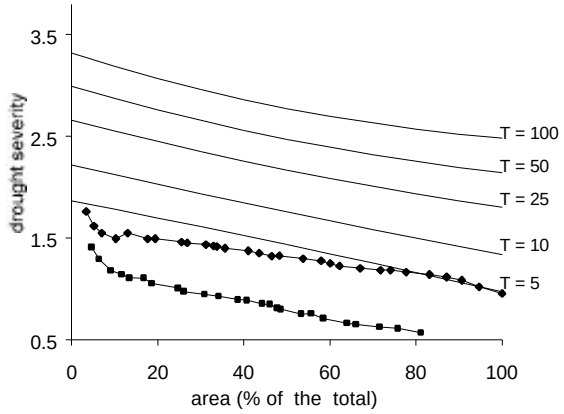
1960/1969



1970/1979



1980/1989



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

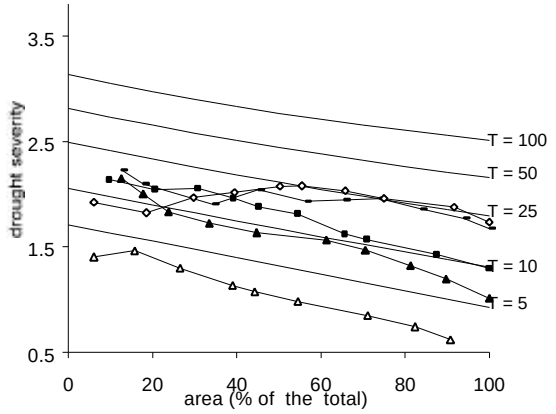
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

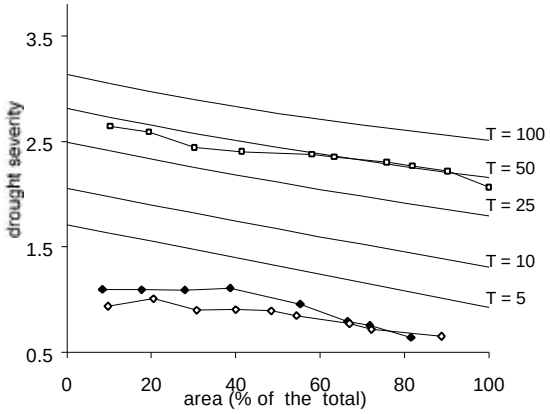
Longer Period

IRELAND

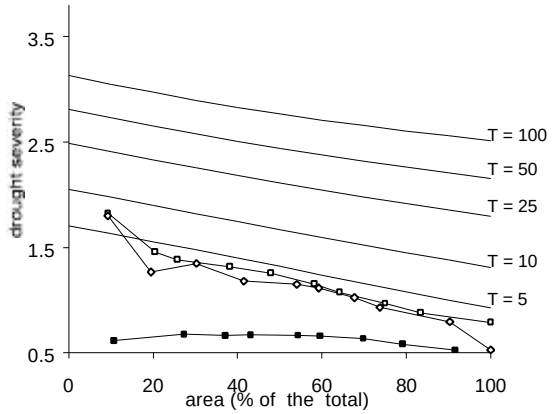
1900/1909



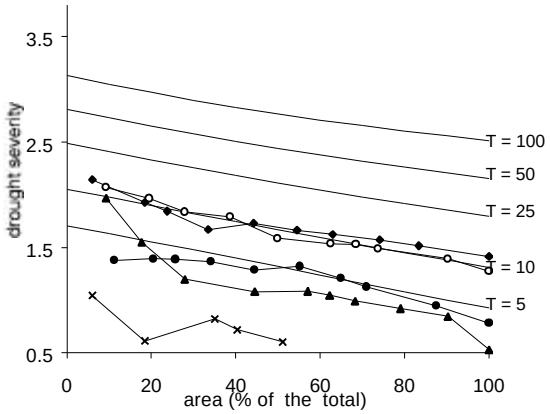
1910/1919



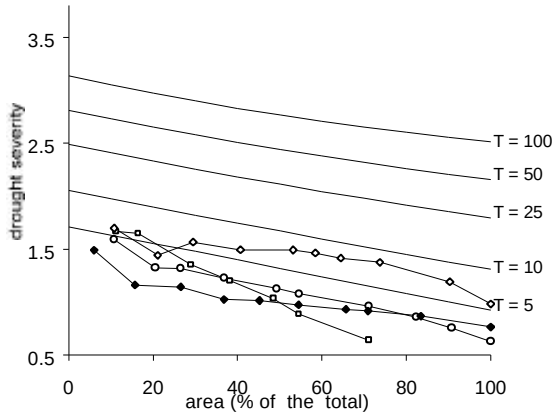
1920/1929



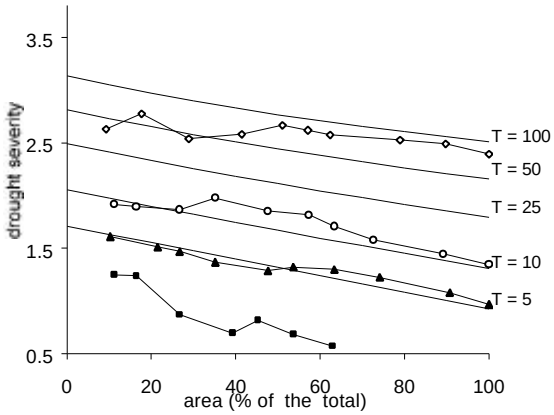
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

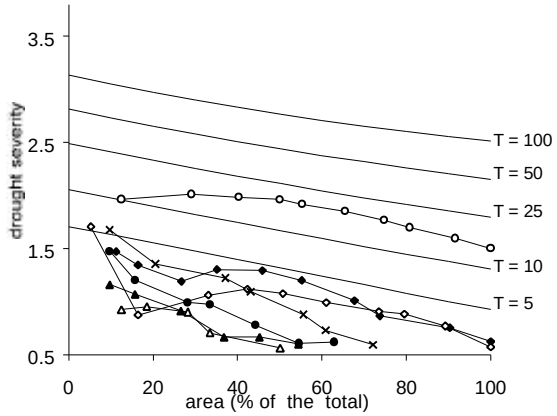
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

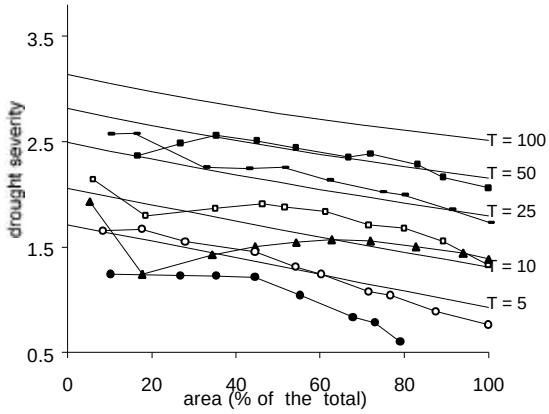
Longer Period

IRELAND

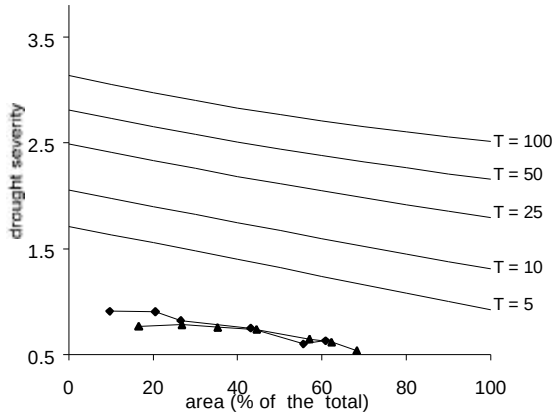
1960/1969



1970/1979



1980/1989



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

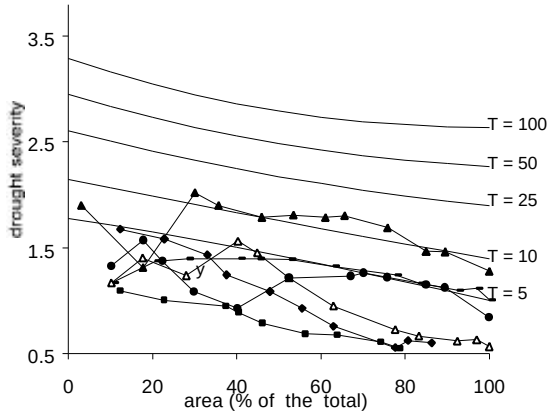
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

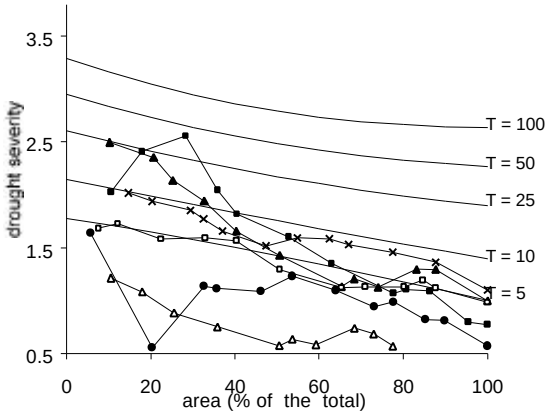
Longer Period

ITALY

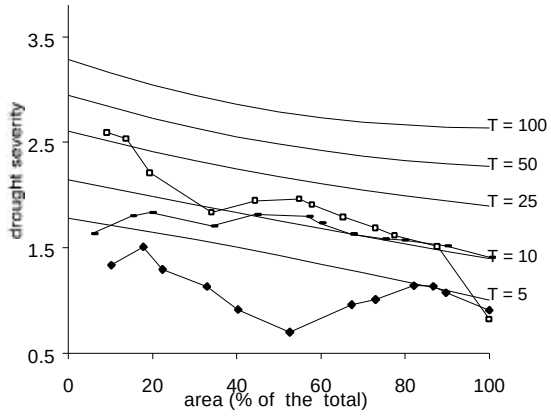
1951/1960



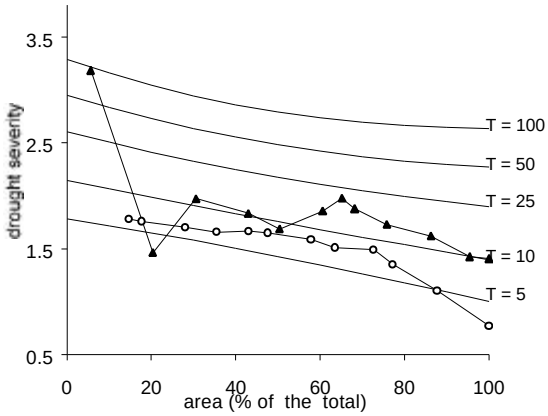
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

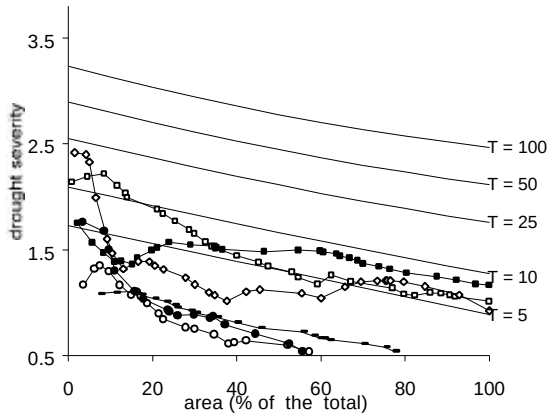
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

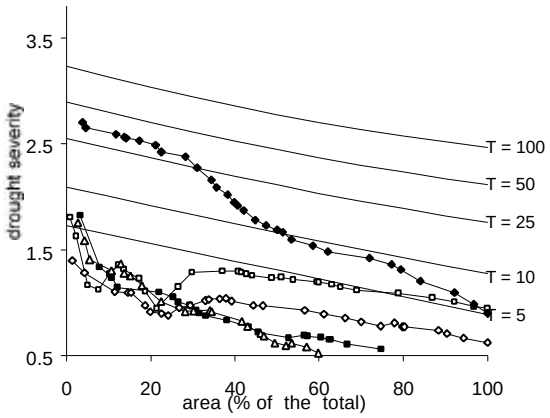
Longer Period

SCANDINAVIA

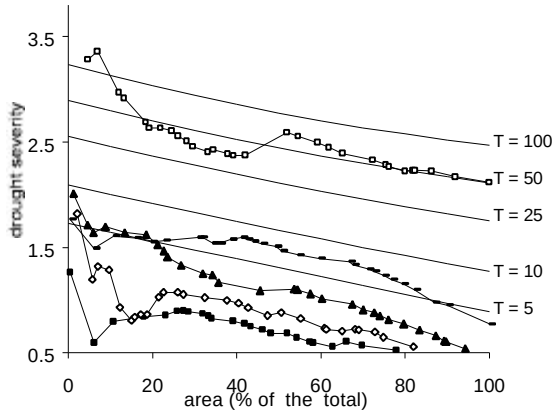
1900/1909



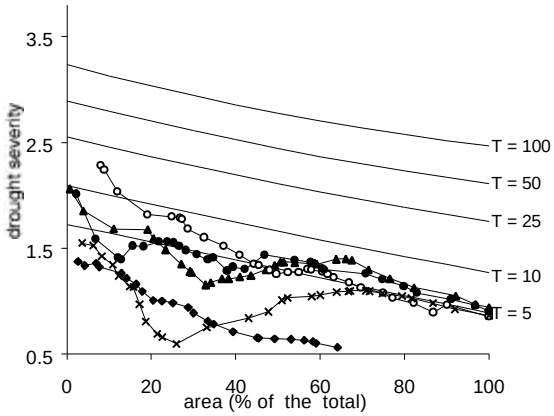
1910/1919



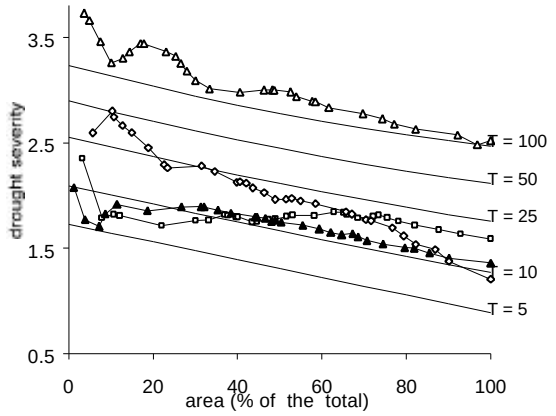
1920/1929



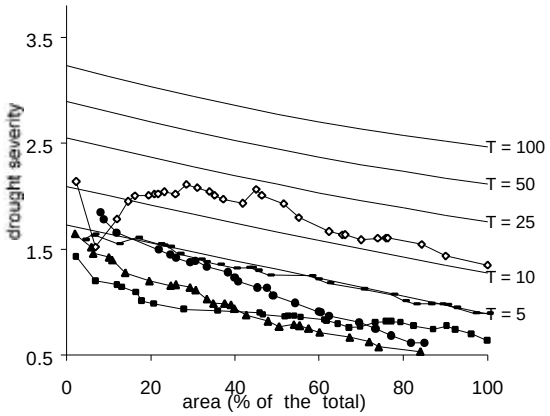
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

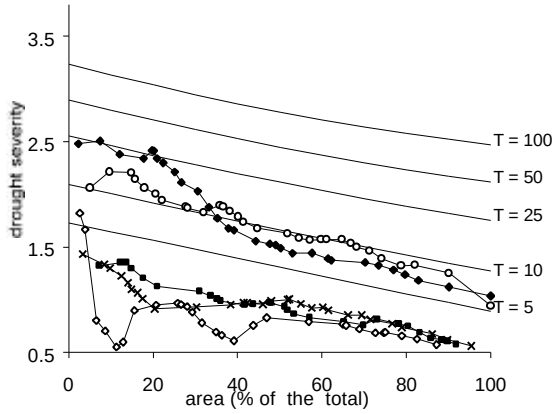
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

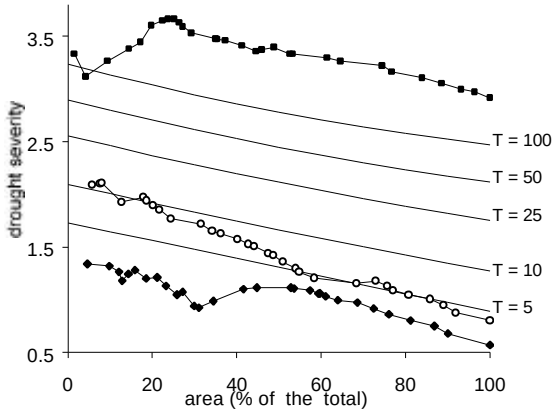
Longer Period

SCANDINAVIA

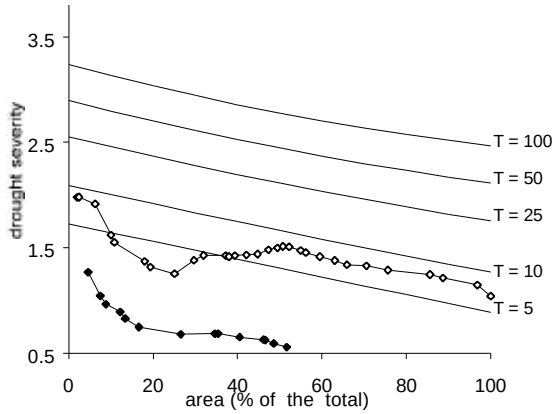
1960/1969



1970/1979



1980/1989



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

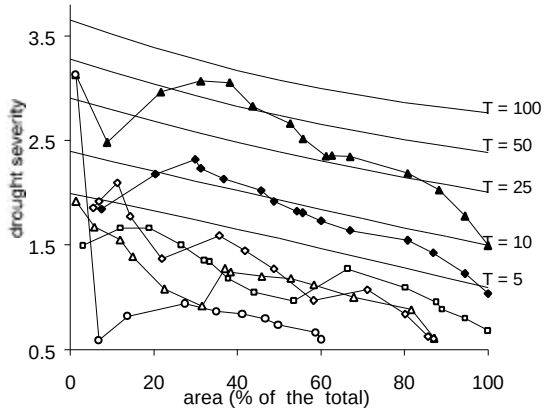
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

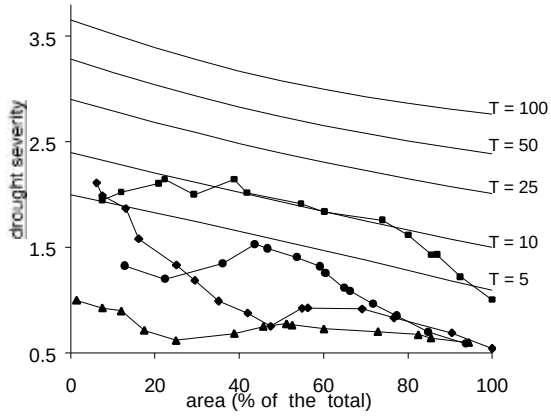
Longer Period

SOUTH BALKANS

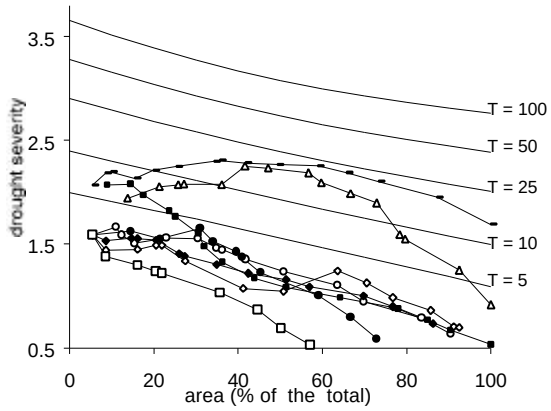
1951/1960



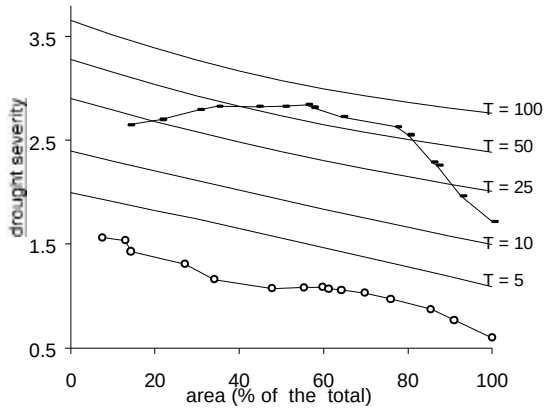
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

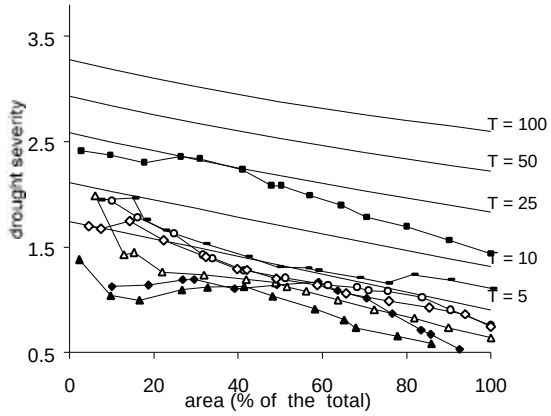
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

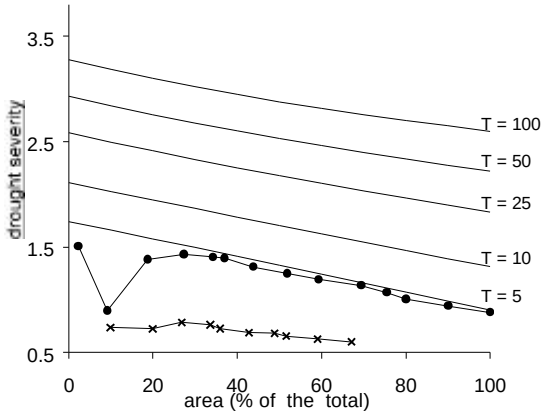
Longer Period

WESTERN FRANCE

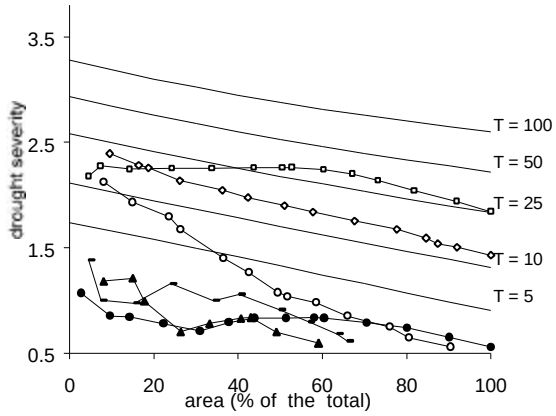
1900/1909



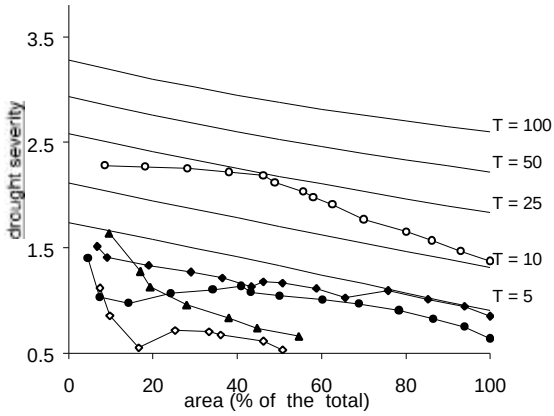
1910/1919



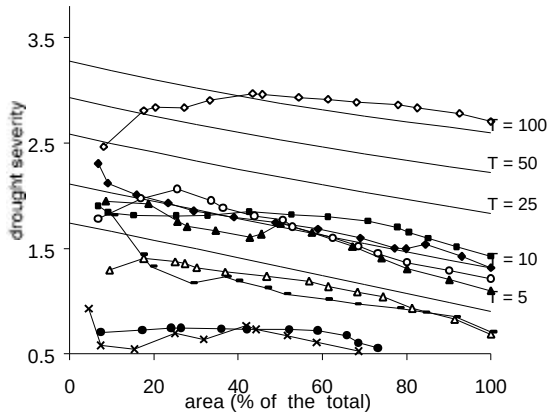
1920/1929



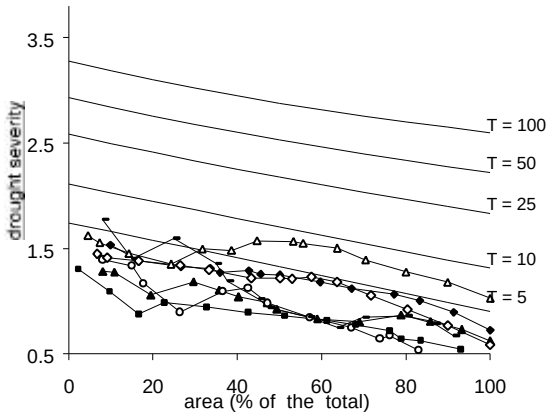
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

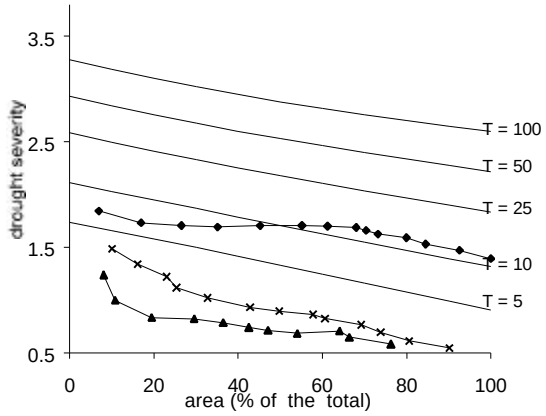
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

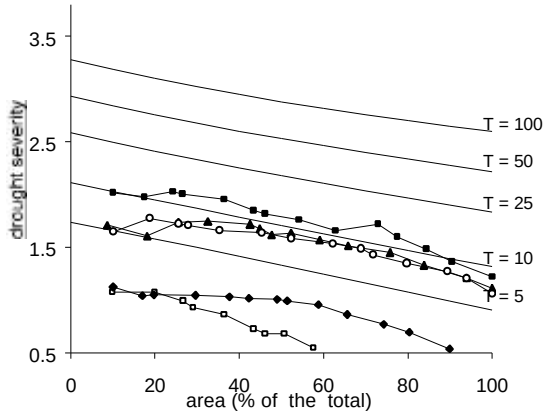
Longer Period

WESTERN FRANCE

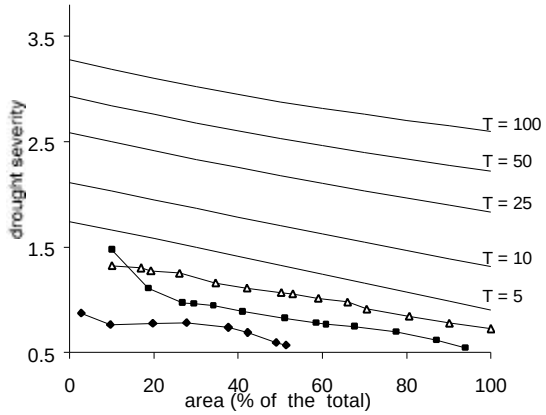
1960/1969



1970/1979



1980/1989



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

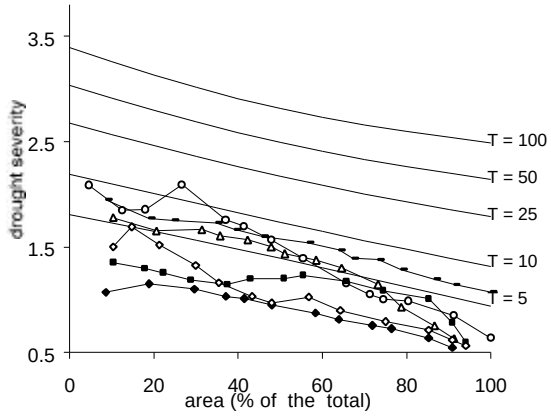
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

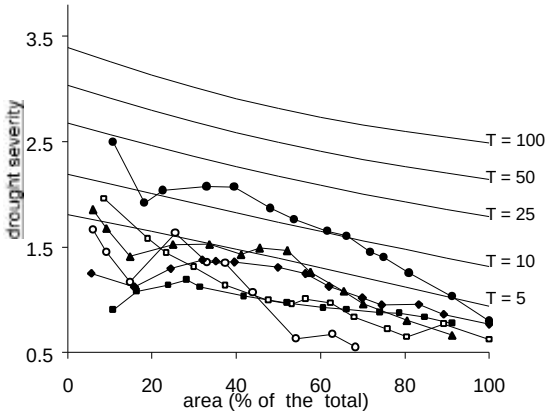
Longer Period

WESTERN MEDITERRANEAN

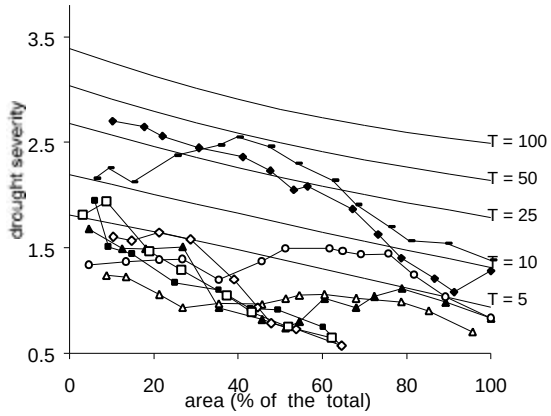
1900/1909



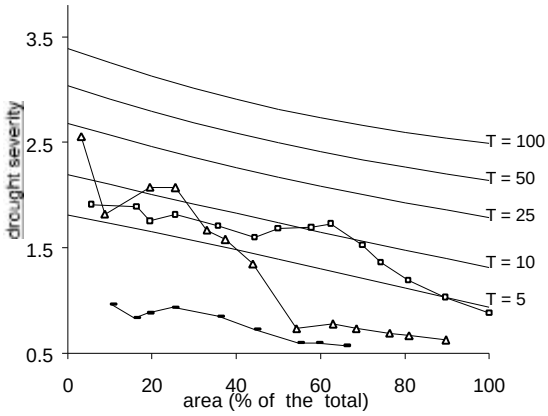
1910/1919



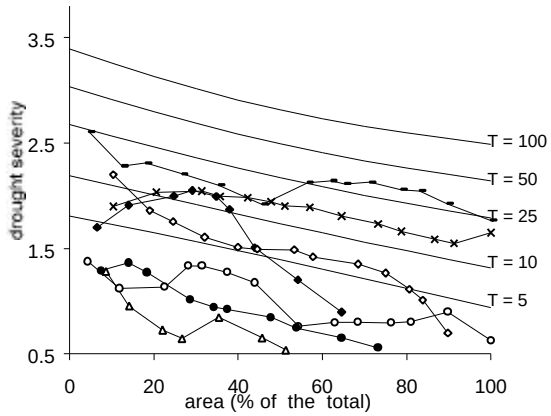
1920/1929



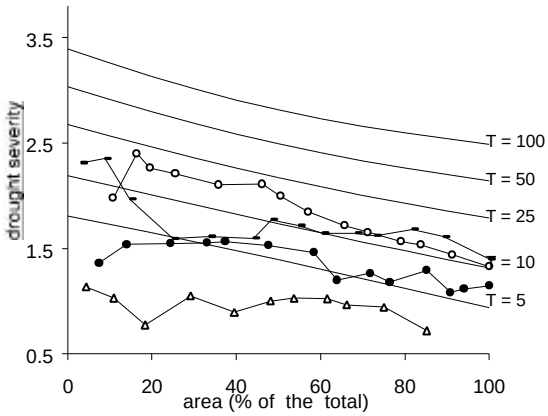
1930/1939



1940/1949



1950/1959



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

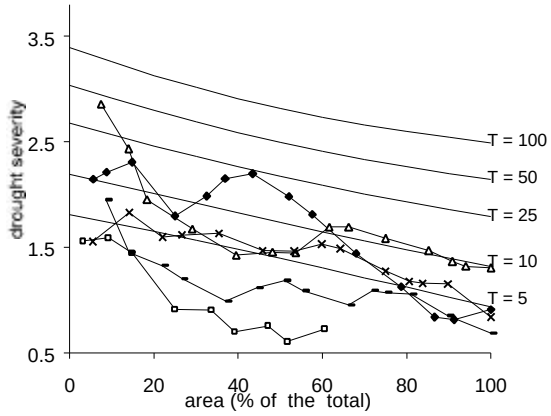
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont)

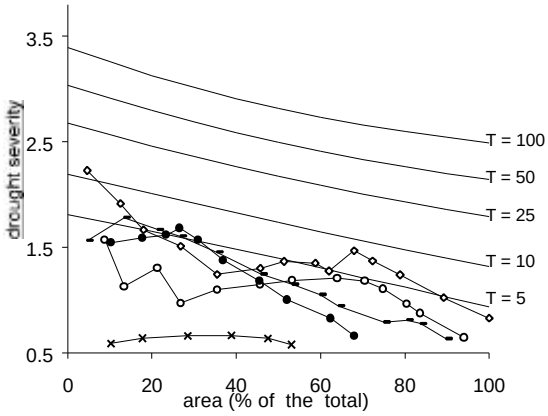
Longer Period

WESTERN MEDITERRANEAN

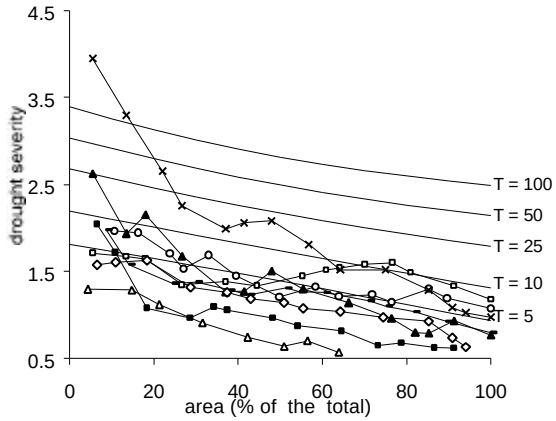
1960/1969



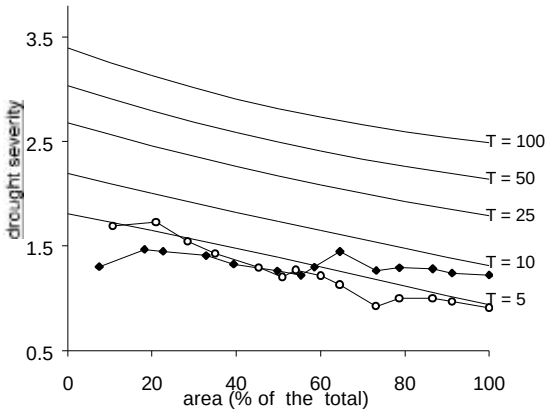
1970/1979



1980/1989



1990/1993



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

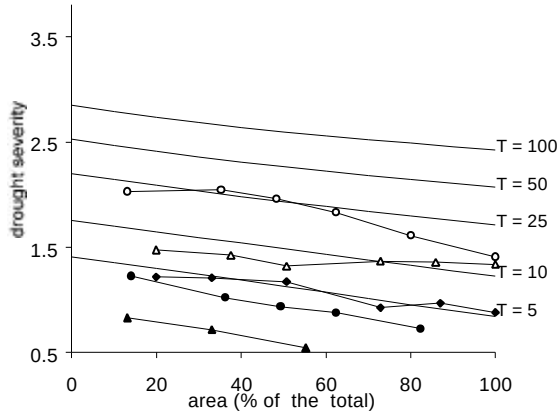
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

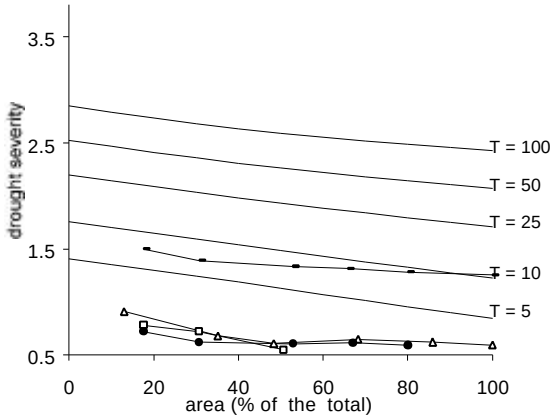
Common Period (From 1951/52 to 1985/86)

ATLANTIC IBERIA

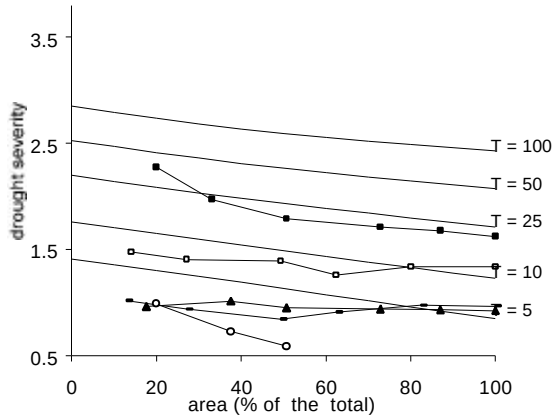
1951/1960



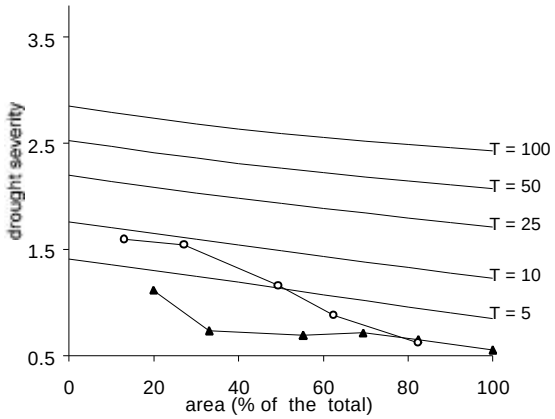
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

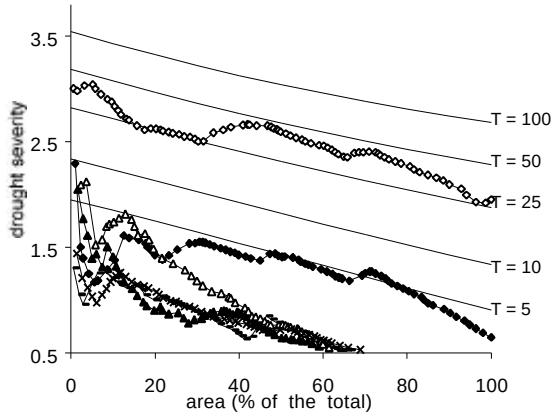
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

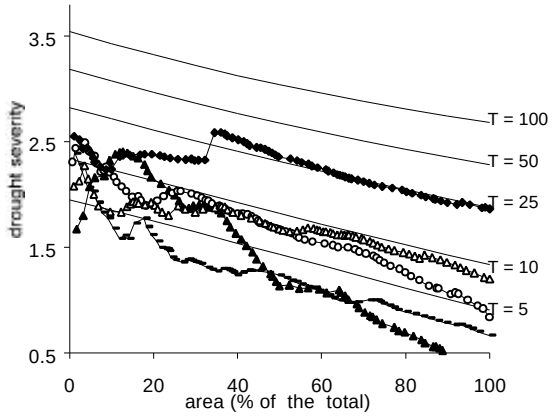
Common Period (From 1951/52 to 1985/86)

CENTRAL EUROPE

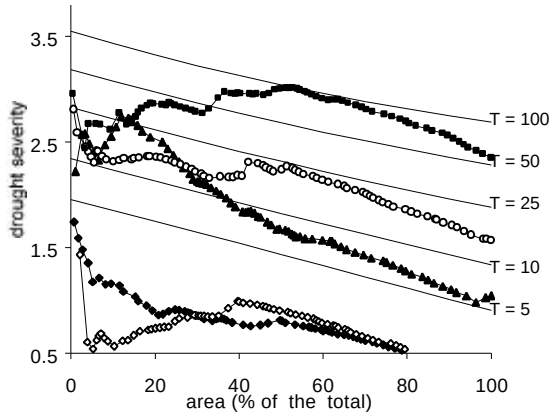
1951/1960



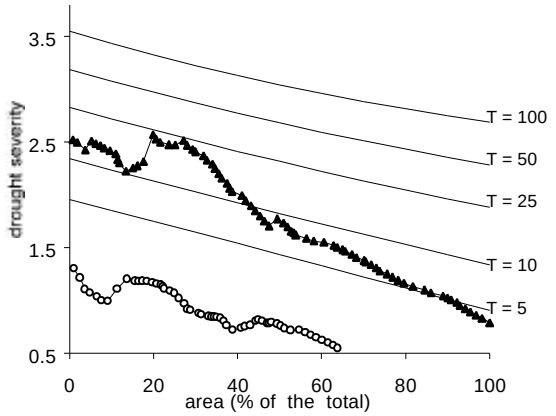
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

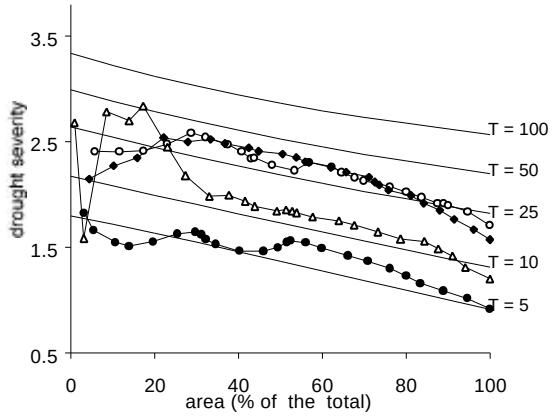
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

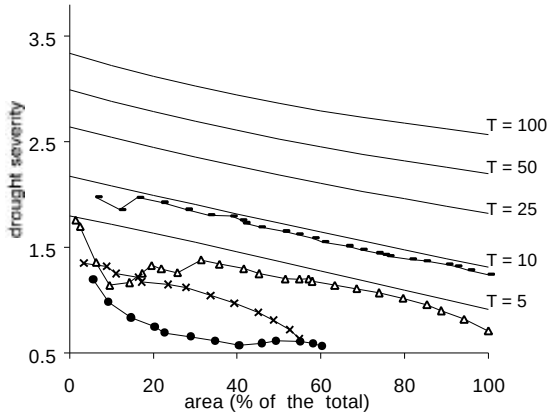
Common Period (From 1951/52 to 1985/86)

CENTRAL IBERIA

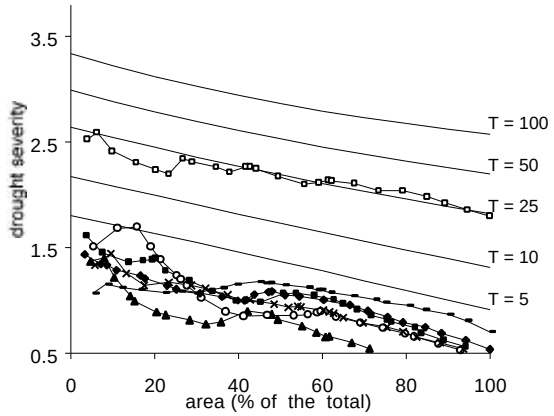
1951/1960



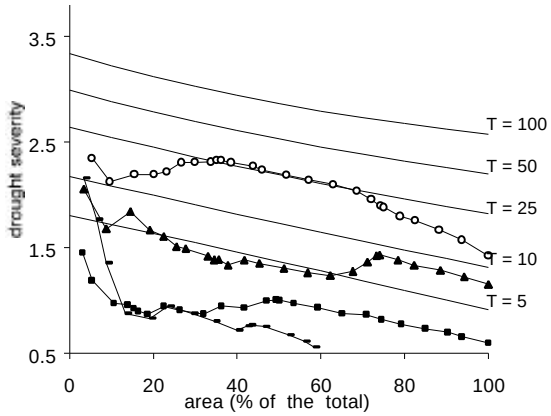
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

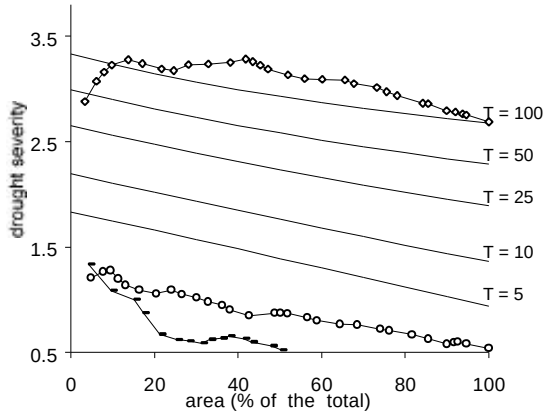
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

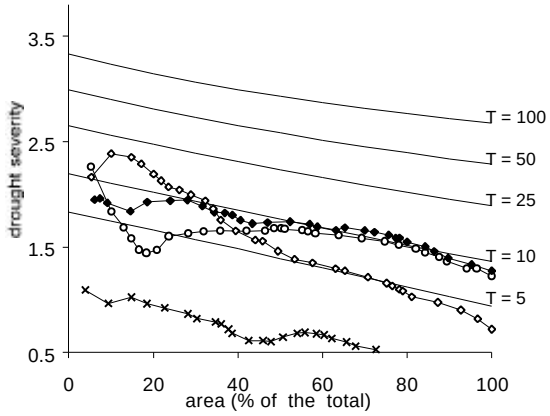
Common Period (From 1951/52 to 1985/86)

GREAT BRITAIN

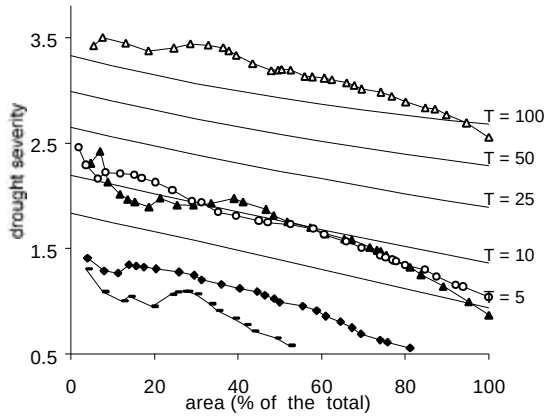
1951/1960



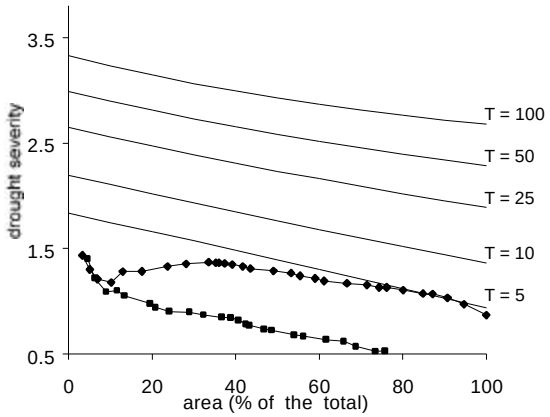
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

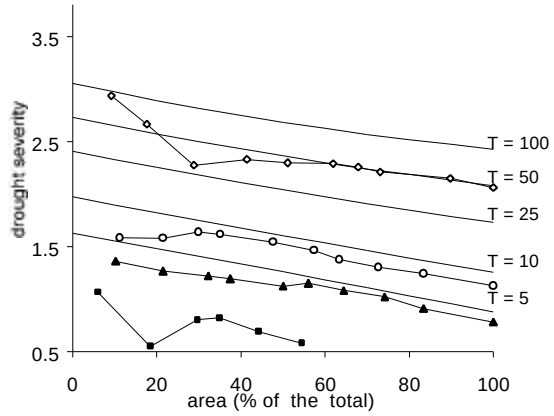
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

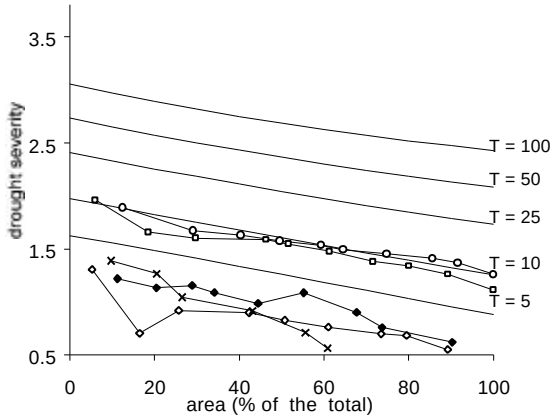
Common Period (From 1951/52 to 1985/86)

IRELAND

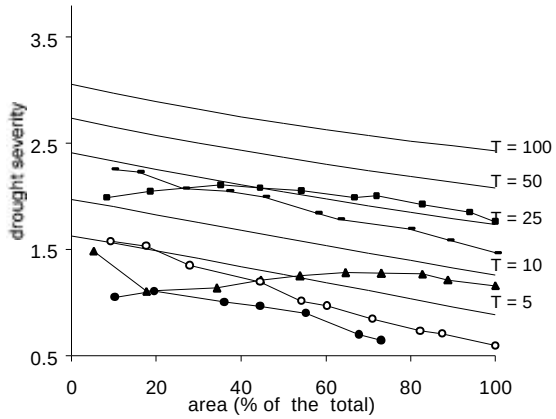
1951/1960



1961/1970



1971/1980



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

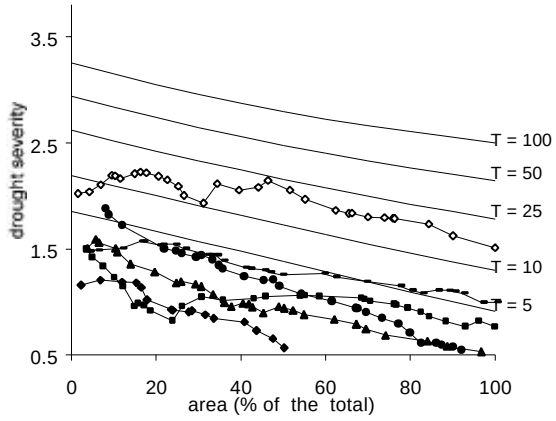
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

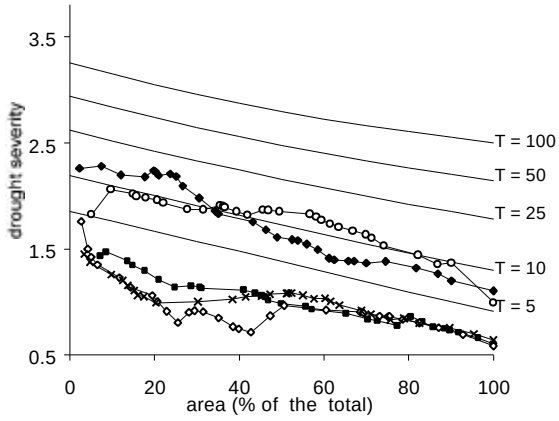
Common Period (From 1951/52 to 1985/86)

SCANDINAVIA

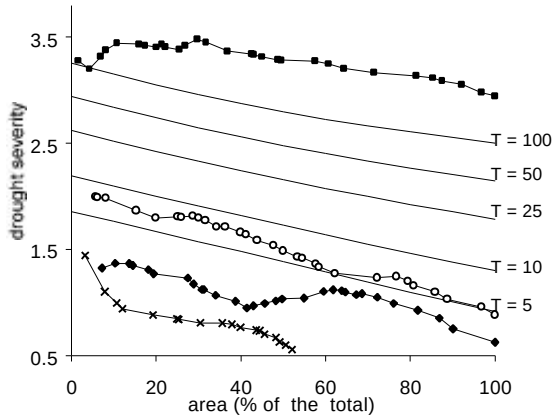
1951/1960

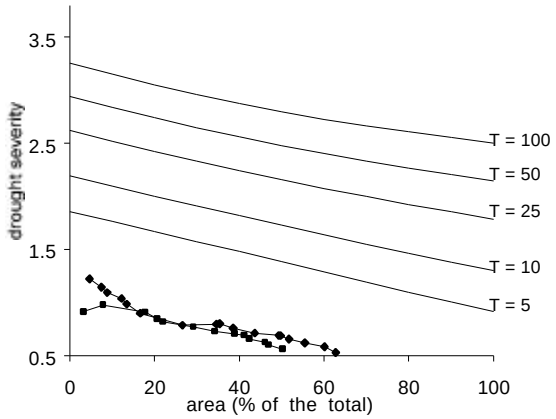


1961/1970



1971/1980





Legend:

Years: 0 1 2 3 4 5 6 7 8 9

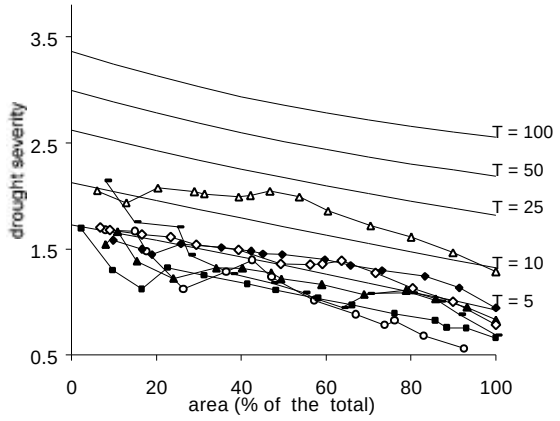
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

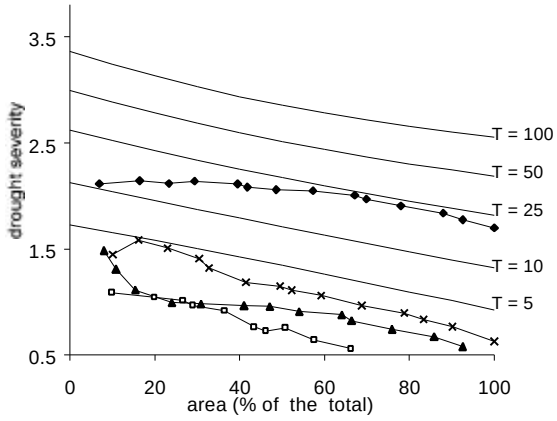
Common Period (From 1951/52 to 1985/86)

WESTERN FRANCE

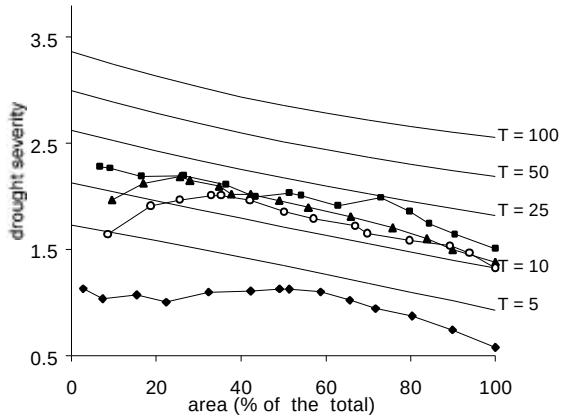
1951/1960



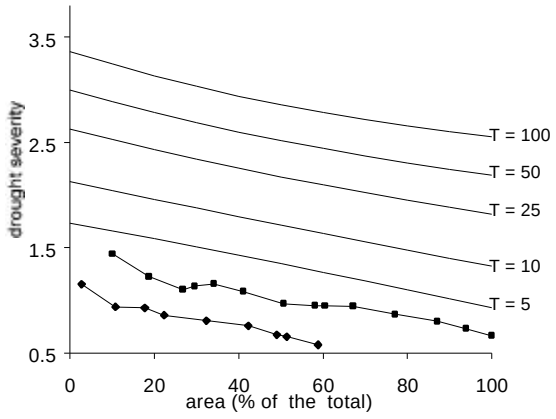
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

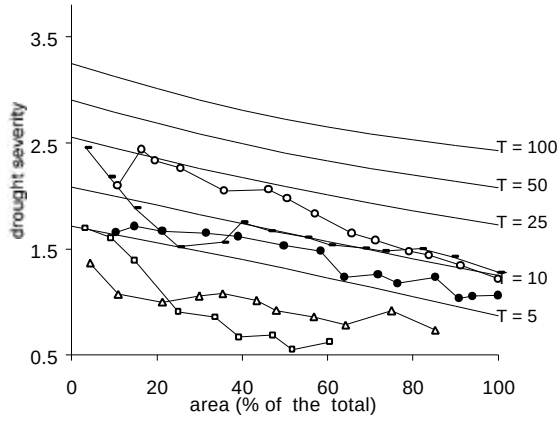
ANNEX E RESULTS FOR THRESHOLD 0.30

PART II REGIONAL DROUGHT RETURN PERIOD EVALUATION (Cont.)

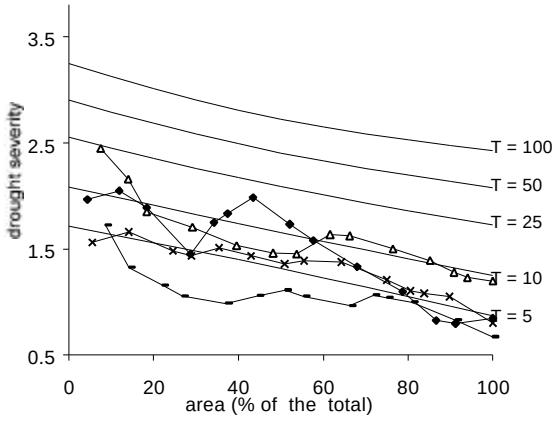
Common Period (From 1951/52 to 1985/86)

WESTERN MEDITERRANEAN

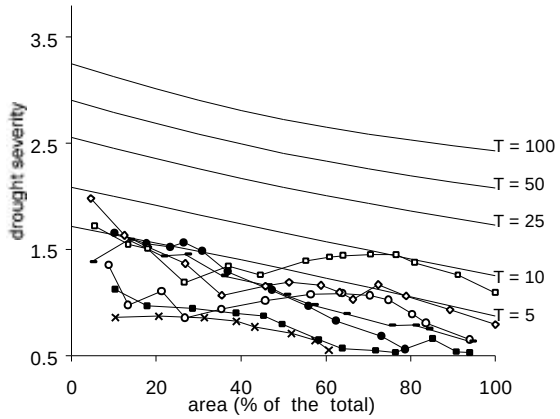
1951/1960



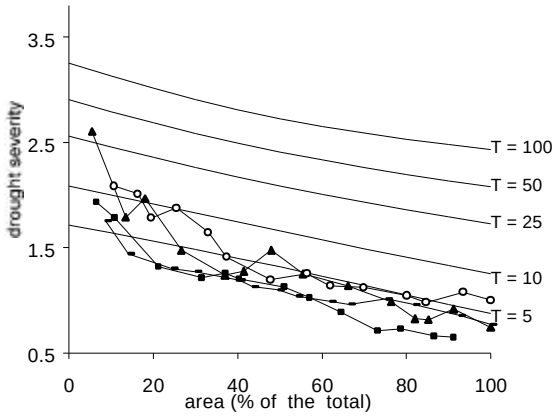
1961/1970



1971/1980



1981/1985



Legend:

Years: 0 1 2 3 4 5 6 7 8 9

ANNEX F METEOROLOGICAL DROUGHTS EXCEPTIONALITY

For common and longer periods using the thresholds 0.10, 0.20 and 0.30

ANNEX G ANALYSIS OF DIFFERENT THRESHOLDS

i) Number of droughts lasting more than one year for the large data set (critical area 75%)

REGION	***Nr of years***	***Threshold 0.10***	***Threshold 0.20***	***Threshold 0.30***
Atlantic Iberia	94	1 (duration 2 years) 1 event, mean duration 2 years	2 (duration 2 years) 1 (duration 3 years) 3 events, mean duration 2.3 years	7 (duration 2 years) 2 (duration 3 years) 1 (duration 4 years) 10 events, mean duration 2.4 years
Central Europe	87	1 (duration 2 years) 1 event, mean duration 2 years	4 (duration 2 years) 3 (duration 3 years) 7 events, mean duration 2.4 years	3 (duration 2 years) 3 (duration 3 years) 1 (duration 5 years) 7 events, mean duration 2.9 years
Central Iberia	94	3 (duration 2 years) 1 (duration 3 years) 4 events, mean duration 2.3 years	5 (duration 2 years) 2 (duration 3 years) 7 events, mean duration 2.3 years	7 (duration 2 years) 1 (duration 3 years) 1 (duration 4 years) 1 (duration 5 years) 10 events, mean duration 2.6 years
Great Britain	87	2 (duration 2 years) 2 events, mean duration 2 years	4 (duration 2 years) 1 (duration 3 years) 5 events, mean duration 2.2 years	3 (duration 2 years) 1 (duration 3 years) 1 (duration 6 years) 5 events, mean duration 3 years
Ireland	87	3 (duration 2 years) 3 events, mean duration 2 years	4 (duration 2 years) 2 (duration 3 years) 6 events, mean duration 2.8 years	4 (duration 2 years) 3 (duration 3 years) 7 events, mean duration 2.4 years
Scandinavia	90	2 (duration 2 years) 2 events, mean duration 2 years	4 (duration 2 years) 4 events, mean duration 2 years	9 (duration 2 years) 1 (duration 3 years) 10 events, mean duration 2.1 years
Western France	87	1 (duration 2 years) 1 (duration 3 years) 2 events, mean duration 2.5 years	2 (duration 2 years) 1 (duration 4 years) 1 (duration 6 years) 4 events, mean duration 3.5 years	3 (duration 2 years) 1 (duration 3 years) 3 (duration 6 years) 7 events, mean duration 3.9 years
Western Mediterranean	94	1 (duration 2 years) 1 event, mean duration 2 years	4 (duration 2 years) 3 (duration 3 years) 7 vents, mean duration 2.4 years	6 (duration 2 years) 1 (duration 3 years) 4 (duration 4 years) 11 events, mean duration 2.8 years

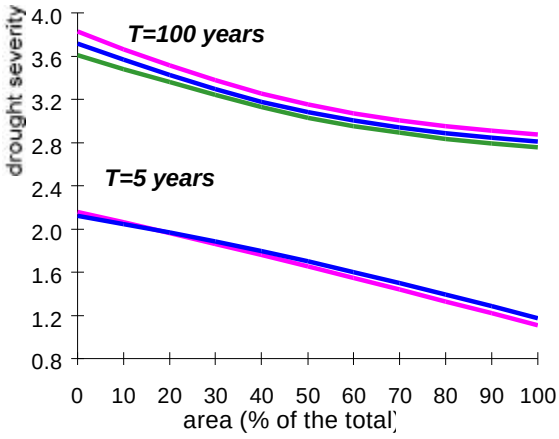
ANNEX G ANALYSIS OF DIFFERENT THRESHOLDS (cont.)

ii) Persistence of drought events for the large data set (critical area 100%)

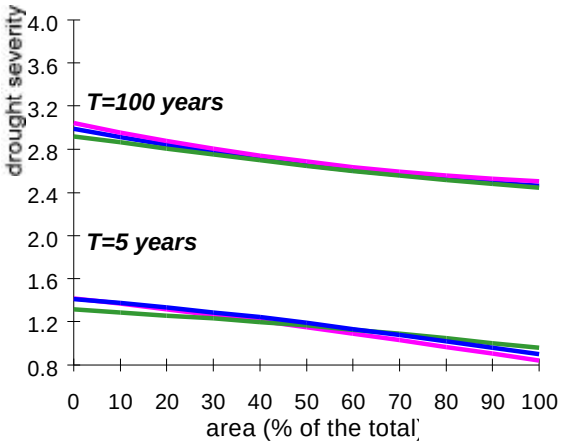
	Prob.0.10		***Prob.0.20***		***Prob.0.30***	
REGION	*Droughts lasting more than 1 year (area 100%)*	*Return period of sequential droughts*	*Droughts lasting more than 1 year (area 100%)*	*Return period of sequential droughts*	*Droughts lasting more than 1 year (area 100%)*	*Return period of sequential droughts*
Atlantic Iberia	-	-	Beginning 1943/44 - 2 years Beginning 1948/49 - 2 years	58 years 22 years	Beginning 1904/05 - 3 years Beginning 1919/20 - 2 years Beginning 1933/34 - 2 years Beginning 1943/44 - 2 years Beginning 1947/48 - 3 years Beginning 1952/53 - 2 years Beginning 1974/75 - 2 years Beginning 1991/92 - 2 years	20 years 14 years 12 years 58 years 26 years 17 years 28 years 14 years
Central Europe	-	-	Beginning 1932/33 - 2 years Beginning 1942/43 - 2 years	35 years 21 years	Beginning 1902/03 - 2 years Beginning 1927/28 - 2 years Beginning 1931/32 - 3 years Beginning 1941/42 - 3 years Beginning 1962/63 - 2 years Beginning 1970/71 - 3 years	6 years 16 years 39 years 26 years 16 years 25 years
Central Iberia	Beginning 1952/53 - 2 years	90 years	Beginning 1943/44 - 2 years Beginning 1948/49 - 2 years Beginning 1952/53 - 2 years Beginning 1956/57 - 2 years Beginning 1980/81 - 3 years	388 years 32 years 90 years 14 years 149 years	Beginning 1921/22 - 2 years Beginning 1933/34 - 2 years Beginning 1943/44 - 2 years Beginning 1948/49 - 2 years Beginning 1952/53 - 2 years Beginning 1956/57 - 2 years Beginning 1980/81 - 3 years Beginning 1991/92 - 3 years	6 years 9 years 388 years 32 years 90 years 14 years 149 years 15 years
Great Britain	Beginning 1962/63 - 2 years	33 years	Beginning 1962/63 - 2 years Beginning 1971/72 - 2 years	33 years 15 years	Beginning 1900/01 - 2 years Beginning 1904/05 - 2 years Beginning 1932/33 - 2 years Beginning 1961/62 - 2 years Beginning 1970/71 - 3 years	13 years 20 years 25 years 33 years 18 years
Ireland	Beginning 1904/05 - 2 years Beginning 1974/75 - 2 years	57 years 273 years	Beginning 1904/05 - 2 years Beginning 1932/33 - 2 years Beginning 1951/52 - 2 years Beginning 1970/71 - 2 years Beginning 1974/75 - 2 years	57 years 36 years 21 years 37 years 273 years	Beginning 1904/05 - 2 years Beginning 1931/32 - 3 years Beginning 1942/43 - 2 years Beginning 1951/52 - 2 years Beginning 1962/63 - 2 years Beginning 1970/71 - 3 years Beginning 1974/75 - 2 years	57 years 33 years 7 years 21 years 16 years 46 years 273 years
Scandinavia	Beginning 1940/41 - 2 years	55 years	Beginning 1931/32 - 2 years Beginning 1940/41 - 2 years Beginning 1962/63 - 2 years	11 years 55 years 13 years	Beginning 1931/32 - 2 years Beginning 1939/40 - 3 years Beginning 1954/55 - 2 years Beginning 1962/63 - 2 years Beginning 1972/73 - 2 years	11 years 73 years 8 years 13 years 7 years
Western France	-	-	Beginning 1904/05 - 2 years Beginning 1932/33 - 2 years Beginning 1941/42 - 3 years Beginning 1971/72 - 2 years	29 years 18 years 56 years 17 years	Beginning 1904/05 - 3 years Beginning 1927/28 - 2 years Beginning 1932/33 - 2 years Beginning 1941/42 - 6 years Beginning 1971/72 - 2 years	31 years 13 years 18 years 238 years 17 years
Western Mediterranean	-	-	Beginning 1923/24 - 2 years Beginning 1992/93 - 2 years	34 years 16 years	Beginning 1921/22 - 4 years Beginning 1963/62 - 2 years Beginning 1980/81 - 3 years Beginning 1992/93 - 2 years	66 years 9 years 26 years 16 years

ANNEX H AREA-SEVERITY-FREQUENCY CURVES FOR DIFFERENT THRESHOLDS (PART I)

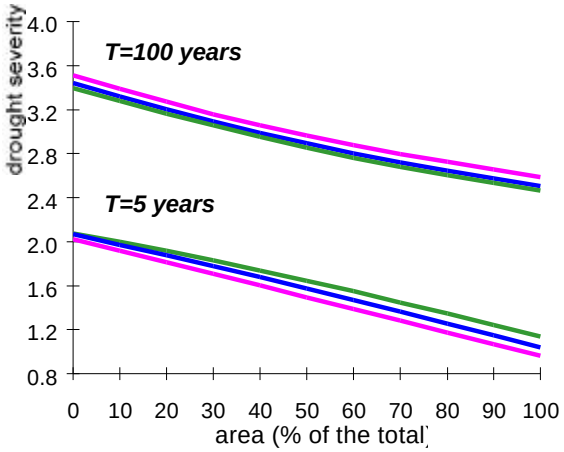
Alps



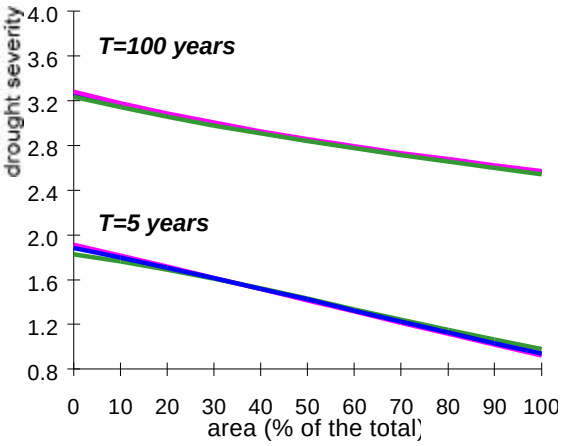
Atlantic Iberia



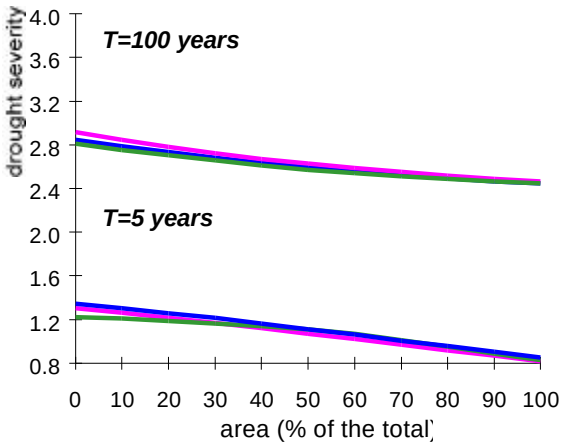
Central Europe



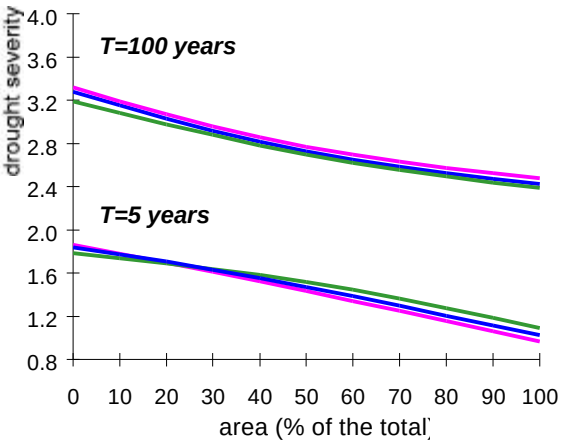
Central Iberia



Crete



Great Britain

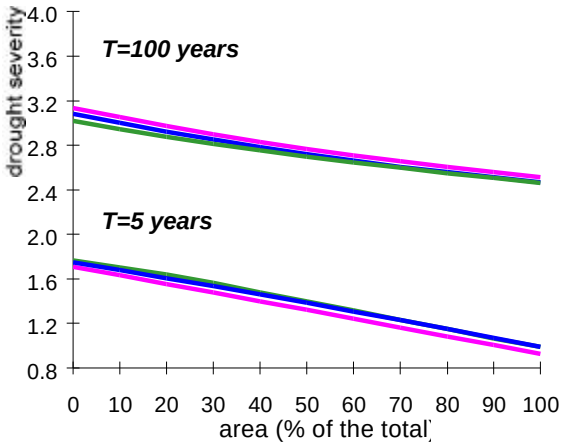


Legend:

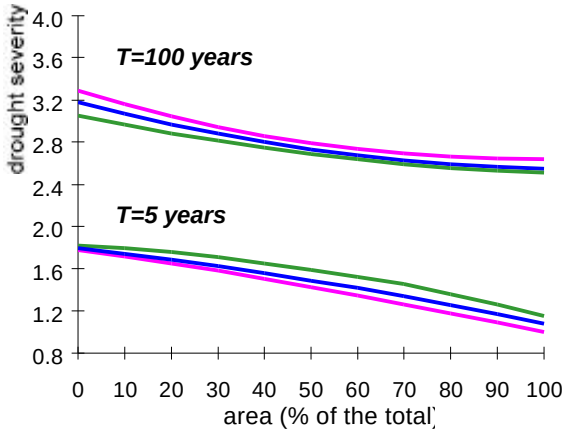
Threshold 0.10
Threshold 0.20
Threshold 0.30

ANNEX H AREA-SEVERITY-FREQUENCY CURVES FOR (PART II) DIFFERENT THRESHOLDS

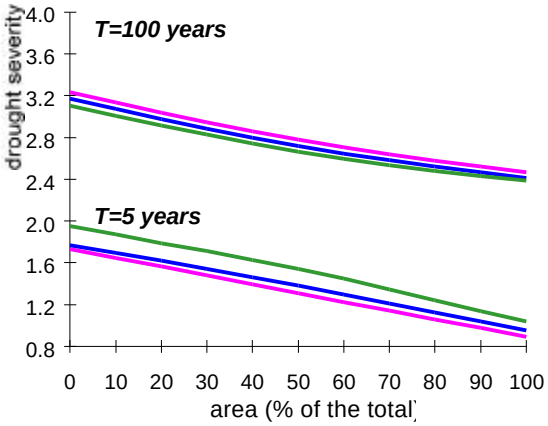
Ireland



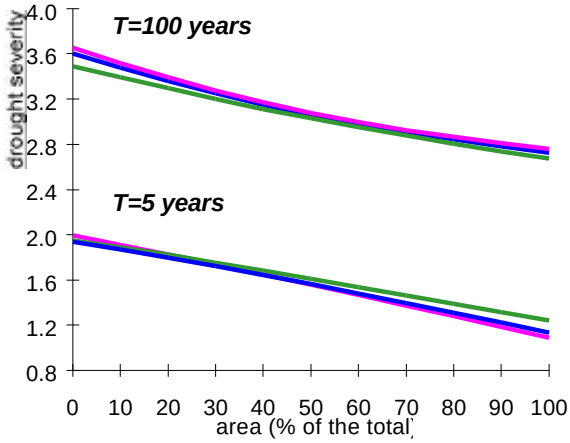
Italy



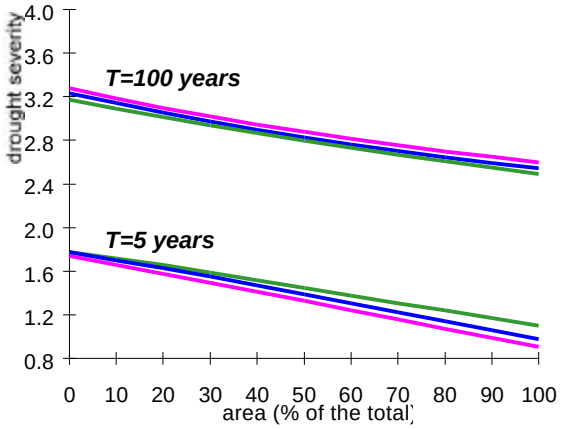
Scandinavia



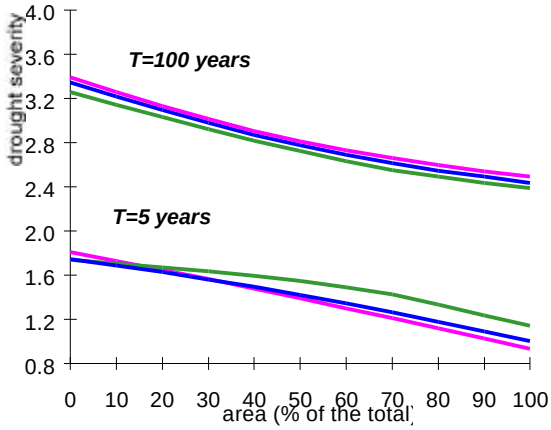
South Balkans



Western France



Western Mediterranean

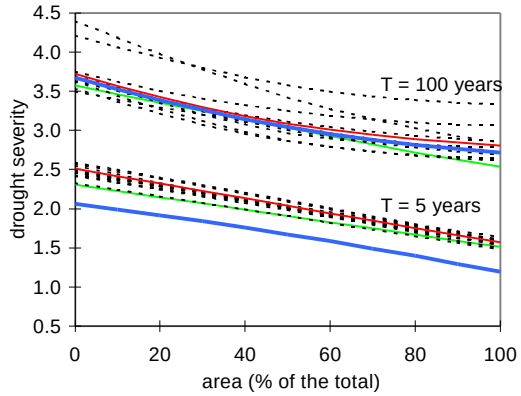


Legend:

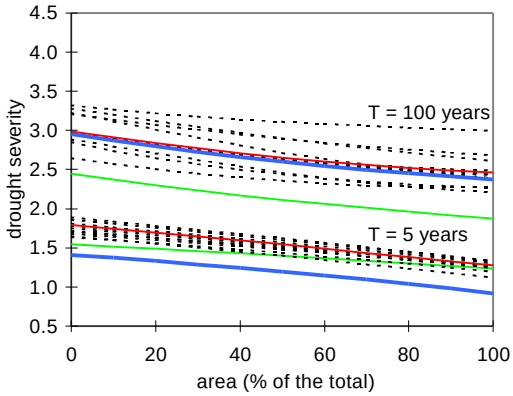
Threshold 0.10
Threshold 0.20
Threshold 0.30

ANNEX I AREA-SEVERITY-FREQUENCY CURVES ANALYSIS (PART I)

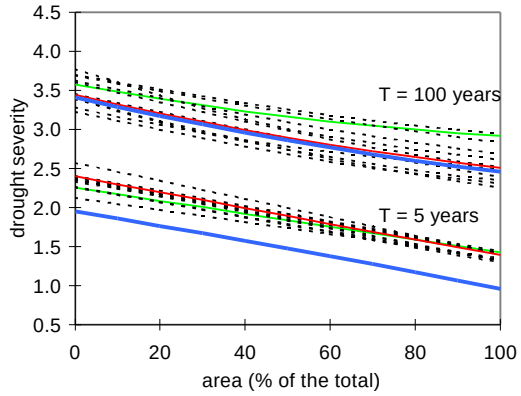
Alps



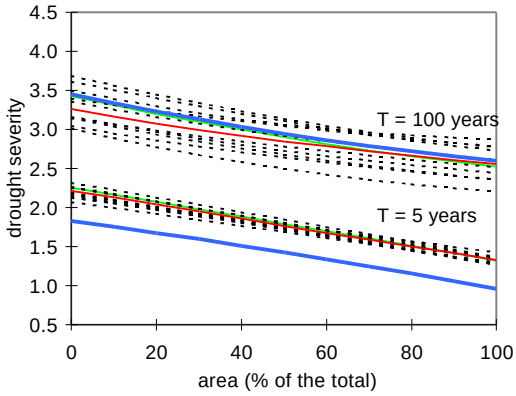
Atlantic Iberia



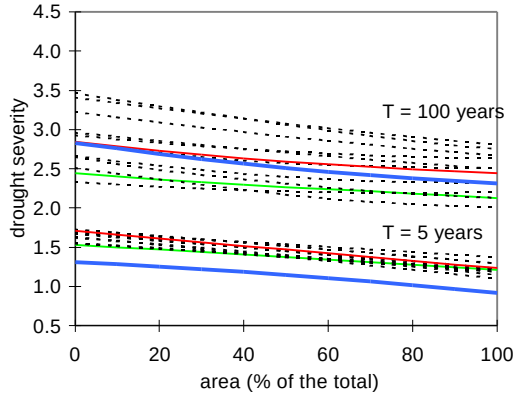
Central Europe



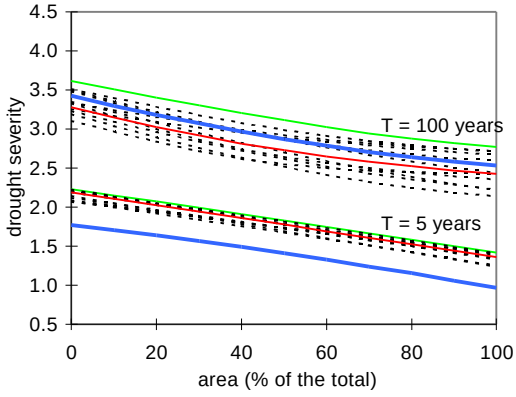
Central Iberia



Crete



Great Britain

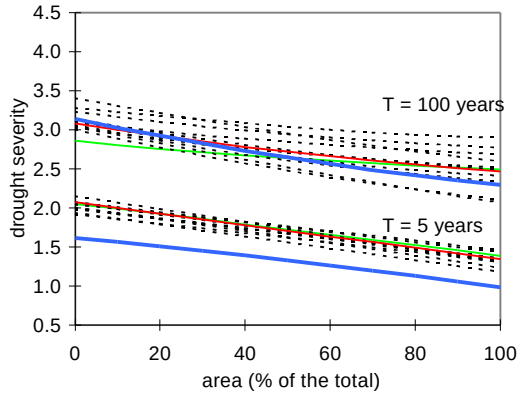


Legend:

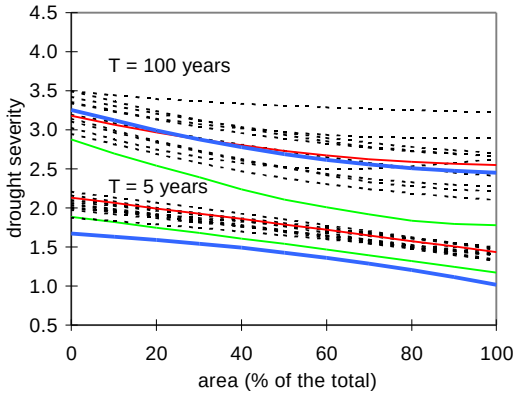
- *Historical*
- *Regional replicate 100 years*
- *Mean of the 10 regional replicates x 100 years*
- *Regional replicate 1000 years*

ANNEX I AREA-SEVERITY-FREQUENCY CURVES ANALYSIS (PART II)

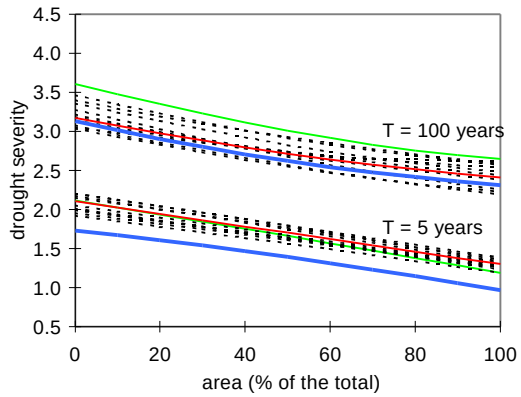
Ireland



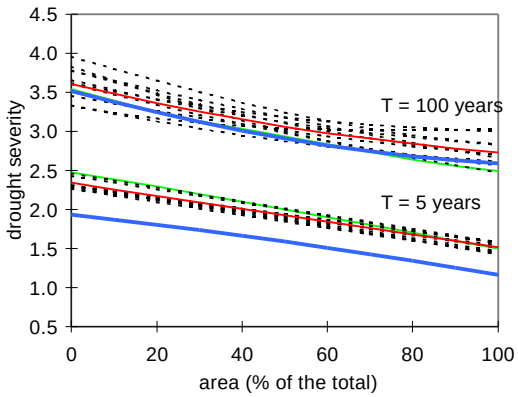
Italy



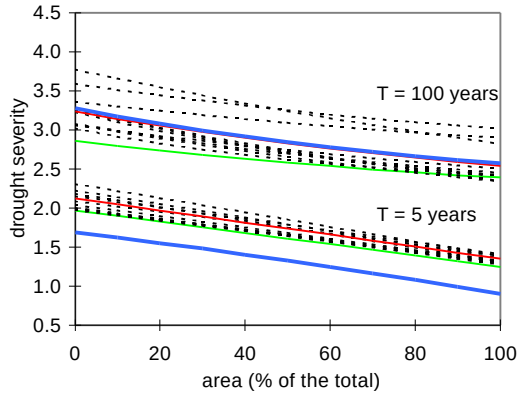
Scandinavia



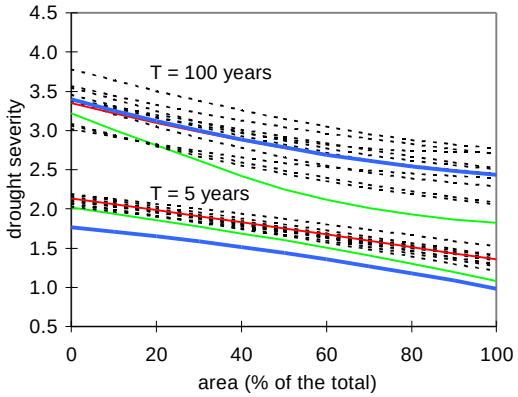
South Balkans



Western France



Western Mediterranean



Legend:

- *Historical*
- *Regional replicate 100 years*
- *Mean of the 10 regional replicates x 100 years*
- *Regional replicate 1000 years*