

**DATABASE ON FOREST DISTURBANCES IN EUROPE (DFDE)
– TECHNICAL DESCRIPTION**

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Database on Forest Disturbances in Europe (DFDE) – Technical Description

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CONTENTS

ACKNOWLEDGEMENT.....	5
1. INTRODUCTION.....	6
2. DEFINITIONS	8
3. THE DATABASE.....	10
3.1. OUTLINE OF THE DATABASE.....	10
3.2 CONTENTS OF THE DATABASE.....	12
3.3 TECHNICAL IMPLEMENTATION	13
3.4 QUERYING THE DATABASE	14
3.5 EXAMPLES.....	15
4. DISCUSSION.....	21
5. FUTURE PLANS AND ACTIONS.....	21
REFERENCES	25
Annex 1. Classification of Disturbance Types	27
Annex 2. Number of Records in the Database per Country and per Type of Disturbance.....	28
Annex 3. Total Volume in the Database per Country and per type of Disturbance (1000 m³).....	29
Annex 4. Total Area in the Database per Country and per Type of Disturbance (1000 hectare).....	30
Annex 5. List of Literature References in the DFDE.....	31

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1. INTRODUCTION

Europe's forests were hit hard by storms in 1990 and 1999, which caused respectively 120 and 180 million m³ of damage (Lässig and Schönenberger 2000, UNECE/FAO 2000b). Storms with so much impact on the forest have not been recorded in the past. Historians in France, however, claim that also in earlier times storms have hit the French forest badly (Doll and Riou-Nivert 1991). As a result of the storms, discussion arose why these storms caused so much damage and why there seems to be more frequent wind damage. Several experts draw a connection between changes in climate and an increase of storm intensity and frequency. Others see the increasing damage amount as part of the currently still dominating forest structure of monocultural and evenaged forests (Møller 1957, Lokes and Dandul 2000). In many European countries natural forests have been converted to evenaged monospecies plantations (see e.g. Böhm 1981). They are generally believed to be more vulnerable to windthrow and other damaging agents (Lokes and Dandul 2000). Also both the total forest area and the total standing volume has increased during the last century (Holmsgaard 1982, UN-ECE/FAO 2000c, Päivinen et al. 1999), resulting in a larger resource that can be damaged. Some efforts were made to make an overview of the history of wind damage in Europe's forests (Avram 1983, Holmsgaard 1982), of which the study by Doll and Riou-Nivert (1991) was the most comprehensive. Such studies usually covered only large events, not being complete and usually with a focus on certain regions only.

In the Mediterranean Basin fires are a regular phenomenon with in cases disastrous impacts on the landscape and the economy. Over the last decades, both the number and area of forest fires has increased (Schelhaas and Schuck 2002). Climate change could partly play a role, but human induced activities are of considerable importance. The UN-ECE and the FAO collect and report data on forest fires on a regular basis. The collection started in the early 1980's and resulted in two overviews, published in 1982 and 1984 (FAO 1982, FAO 1984). After a gap of more than a decade data collection was taken up. Since 1996 forest fire overviews are published regularly (UN-ECE/FAO 1996, 1998, 1999, 2000a, 2001).

In the 1980s, concern arose about the forests in Central and Eastern Europe, which seemed to be suffering from high air pollution loads. An international monitoring network was set up (IPC) which annually assesses the crown condition of trees in 38 participating countries in Europe on more than 5000 monitoring plots (UN-ECE-EC 2000). Although the effects of air pollution on the forest turned out to be not as severe as expected, the defoliation levels recorded give concern for some tree species at the local/regional level, like oak, beech and pine (UN-ECE-EC 2000). Air pollution is not the only cause of defoliation, but also other factors can play a considerable role, like climatic conditions (drought), insect damage, and other local or regional events. In order to be

able to separate these effects, data is needed on the occurrence of such events. Some countries, in particular Germany, Austria and Switzerland, have recently published very detailed records on the occurrence and damage levels of insect species (Waldschutzsituation 1999, 2000, 2001). Also other countries have information on the occurrence of insect species, although they may be more scattered throughout scientific literature. However, presently no overview is available on a European scale.

Disturbances have a considerable impact on forestry in European countries. They can be quite different in nature, depending on the geographic location or vegetation zone. Other factors such as climatic changes and human impact may add to the number of disturbance events and their intensity. A large amount of information on the occurrence of disturbances is available at the country level, but it is usually scattered over many sources, making it difficult to put disturbances into a European context. However, such a European perspective is needed, both for providing a basis for comparison between disturbance regimes in different countries and/or periods and for modelling possible impacts of climate change (e.g. Schelhaas et al. 2002b).

A large amount of historic data on disturbances was compiled at Alterra, Wageningen, in 2001 and partly in 2002. The main aim of the current project was to develop an Internet retrievable database to make this valuable collection of data easily accessible to a wider public. Further the database was to allow the possibility for individuals to contribute to the database in order to improve the accuracy and coverage. Especially for the Mediterranean area only a limited amount of information could be identified in the international literature. By providing a feedback possibility this gap could be closed or at least narrowed.

The Database on Forest Disturbances in Europe (DFDE) contributes to several goals of EFI, namely to compile and maintain data on European forests, publish and disseminate knowledge of its work and results. It has been added as a further component to European Forest Institute's 'European Forestry Information and Data Analysis System (EFIDAS)' that is maintained on its website.

2. DEFINITIONS

A set of pan-European indicators for sustainable management has been elaborated within the process of the Ministerial Conference on the Protection of Forests in Europe (MCPFE). Under Criterion 2: ‘maintenance of forest ecosystem health and vitality’ indicator 2.2. addresses defoliation while indicators 2.3.a – 2.3.d relate to damages caused by biotic or abiotic agents. Terms and definitions used in the indicator description refer mainly to the Temperate and Boreal Forest Resources Assessment 2000, TBFRA 2000 (UN-ECE/FAO 2000), to glossaries including two papers produced by the European Forest Institute (Pajari and Schuck 1994, Schuck et al. 2002) and expert input. In the following a set of terms will be introduced based on definitions applied in the MCPFE indicators including reference to their application in this report.

Forest

The approach to defining forest differs between countries. This has been described in detail in the report produced by the European Commission (EC 1997). The UN-ECE/FAO (2000) has adopted a commonly accepted forest definition to which reporting countries adjust their national data. The definition reads as follows:

Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity in situ. May consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground; or of open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent. Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 10 percent or tree height of 5 m are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest.

Includes: Forest nurseries and seed orchards that constitute an integral part of the forest; forest roads, cleared tracts, firebreaks and other small open areas within the forest; forest in national parks, nature reserves and other protected areas such as those of special environmental, scientific, historical, cultural or spiritual interest; windbreaks and shelterbelts of trees with an area of more than 0.5 ha and a width of more than 20 m. Rubberwood plantations and cork oak stands are included.

Excludes: Land predominantly used for agricultural practices.

In this report (and in the DFDE Internet database) the figures refer to national definitions of the term ‘forest’ (as presented in: EC, 1997) as the data collection was performed through literature searches at national/regional level.

Damage (Disturbance)

Damage to forest is defined by UN-ECE/FAO (2000) as:

a disturbance to the forest which may be caused by biotic or abiotic agents, resulting in death, or a significant loss of vitality, productivity or value of trees and other components of the forest ecosystem. Both definitions are very addressing the loss both in terms of living biomass and from an economic viewpoint. Further the terms ‘abiotic’ and ‘biotic’ are used as damage cause by non-living agents and damage caused by living organisms respectively (Pajari and Schuck, 1994).

Forest Fire

Forest fire is defined by UN-ECE/FAO (2000) as:

Fire which breaks out and spreads on forest and other wooded land or which breaks out on other land and spreads to forest or other wooded land. Excludes: Prescribed or controlled burning, usually with the purpose of reducing or eliminating the quantity of accumulated fuel on the ground. The term 'primarily damaged by fire' is defined as forest and other wooded land, the vegetation on which, including the trees, has been wholly or largely destroyed by fire.

In this report (and in the DFDE Internet database) the term 'forest fire' refers to national definitions as most of the data have been collected from national publications or through direct contact with national/regional organisations managing forest fire information. Some harmonised forest fire datasets were taken from the FAO and UN-ECE/FAO 'Forest Fire Statistics' publications (e.g. FAO 1984, UN-ECE/FAO 1999).

The authors have adopted the definition of damage/disturbance as given above. Apart from abiotic and biotic causes, also human induced impacts like sanitation fellings due to air pollution are taken into account. Furthermore information about measures to reduce the impact of insect pests were listed as well, like chemical or biological treatments.

3. THE DATABASE

3.1. OUTLINE OF THE DATABASE

The data that were gathered during the literature review differ in many respects. They vary in spatial terms, level of detail, the format in which the damage is reported (volume, area, or share of standing stock damaged) and what data are actually made available, e.g. (i) volume damaged or (ii) the volume that has actually been removed from the forest. The aim was while building the database and its structure, to develop it in a way so that it was flexible to take into account these various aspects. Each report of a disturbance is entered as a record in the database, with the following fields:

1. Start year Year in which the disturbance took place, or the first year of a period over which the disturbance is reported.
2. End year The last year of the period over which the disturbance is reported.
3. Country Country in which the disturbance took place.
4. Region Information on province or region.
5. District Information on a local level, e.g. county, forest administration board or forest district.
6. Damage type Assignment of a disturbance agent to a specific disturbance group. The disturbances are classified into the groups biotic, abiotic, anthropogenic and other/unknown.
7. Cause of damage Cause of the disturbance (e.g. wind, insects, air pollution). For a detailed breakdown of damage types, see Annex 1.
8. Detailed cause of damage For biotic damages, the name of the species is listed that has caused the disturbance. For the group fire, the cause of the fire is specified in more detail. See Annex 1 for a detailed breakdown.
9. Tree species Reference to a particular tree species.
10. Volume The amount of volume damaged.
11. Area The area damaged.
12. Number Field for entering an actual figure/number describing the disturbances. The comment field (see 18) may include an explanation to what the number/figure refers to (e.g. number of damaged trees, number of forest fires).
13. Percentage If the source refers to a percentage, the percentage is listed in this field. In the comment field (18) is explained what this percentage refers to, e.g. percentage of total forest area burned or percentage of growing stock destroyed.

14. Status Additional information regarding the amount of damage. Such information can be for instance the volume referring to the total damage or the volume referring only to the sanitation fellings. For insect damage this can be the total area on which the insect was detected, the area which was defoliated or the area that has been treated with insecticides.
15. Overbark / underbark Indication if volume of damaged wood is reported overbark or underbark.
16. Month Month in which the disturbance took place.
17. Day Day when the disturbance took place.
18. Comments All information of value not fit for one of the other fields.
19. Reference Short literature reference from where the data has been extracted. The database contains a hyperlink to the complete literature reference. All literature references are listed in Annex 5 to this Internal Report.

3.2 CONTENTS OF THE DATABASE

In total the DFDE contains around 27 500 records, taken from about 400 consulted literature references from 40 countries (Figure 1). Out of these 400 consulted references, about 270 actually yielded disturbance data. In order to give a complete overview of the results of the literature search, all 400 references are listed in Annex 5. The DFDE covers a total volume of more than 4.4 billion m³ and an area of more than 172 million ha. These numbers, however, cannot be regarded as being the total volume, resp. area that was damaged in the period covered, because there may occur overlaps between different sources. They may give different damage amounts for the same event, and in cases an event can be represented more than once due to splits of the data into different groups or detail levels.

Annex 2 gives an overview of the amount of records in the database, grouped into countries and disturbance group types. Annex 3 and 4 show the total volume, respectively the total area per country and disturbance group type.

The record in the database that goes farthest back in time is an observation of heavy caterpillar feeding damage in the forest of Nürnberg, Germany, in 1449 and 1450. The first storm listed is that of March 15, 1519 in Buisson de Bleu, Normandy, France, in which 60,000 trees were blown down. The amount of records increases with the years (Figure 2) and from about 1840 onwards there was found at minimum one record for each year.

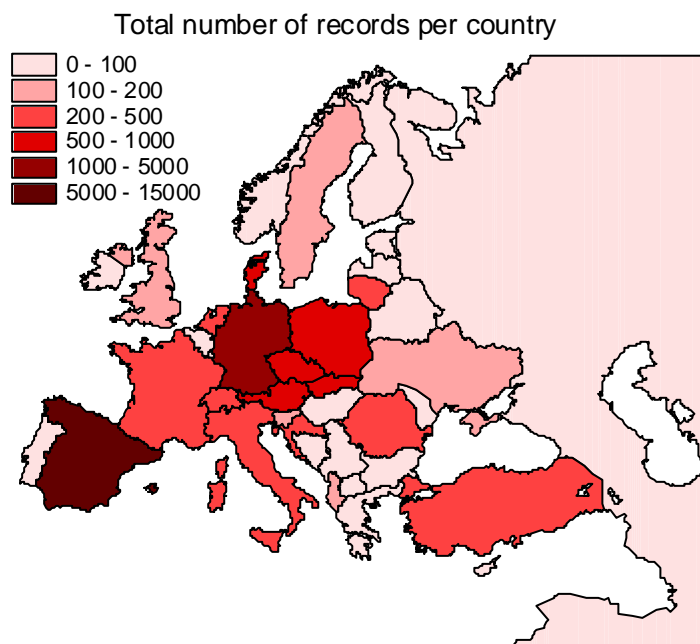


Figure 1. Countries covered by the DFDE and number of records in the database per country.

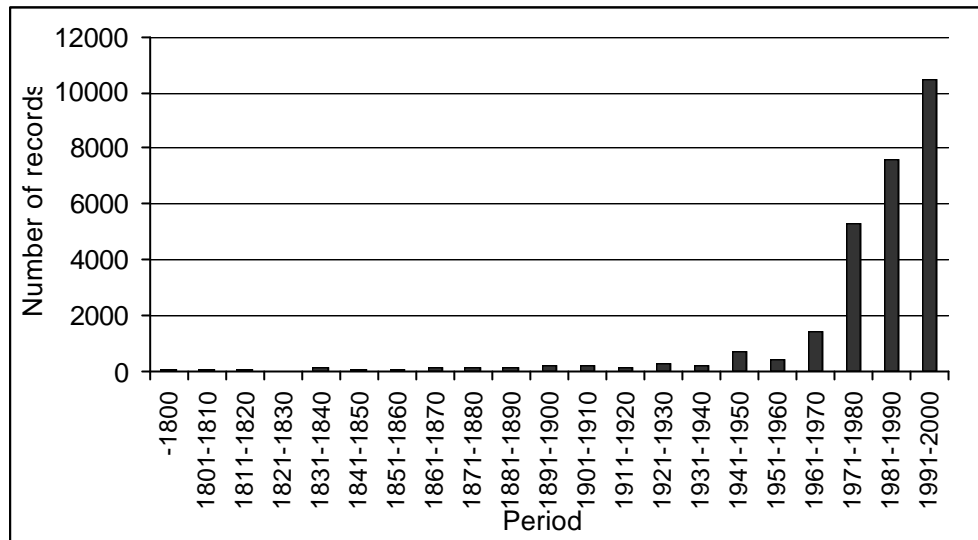


Figure 2. Number of records in the database per 10-year period.

3.3 TECHNICAL IMPLEMENTATION

One of the requirements of the database was that it should be easy to manage and to maintain. This means that the system should not only allow the easy addition of new records, but also the addition of new types of data, like e.g. new insect species or geographical regions. To increase the user friendliness a step by step approach has been applied guiding the user through the query.

The main data table contains the records with the data of each individual disturbance (see Figure 3). Each column of the main data table (e.g. countries) contains only ID numbers, which are linked to look-up tables. In this way it is easy to change the definitions in the look-up tables, for example to correct a misspelled insect name, without having to change all records in the main data table. At the same time this design provides a method to maintain the referential integrity, in other words, a data row cannot be deleted from a look-up table if there is a reference to that data in another table.

Most fields in the main data table are connected to a series of two interlinked look-up tables. In this way it is possible to make groups of for example countries or insect species, without having to repeat the same data row in the main table. If a certain literature source refers to Germany and The Netherlands, a country group is constructed including the country IDs of both Germany and The Netherlands.

The database runs on a Solid SQL database engine on a Linux operating system. The connection between the database and web, i.e. the dynamic part of the web interface, is programmed in PHP scripting language.

Main table

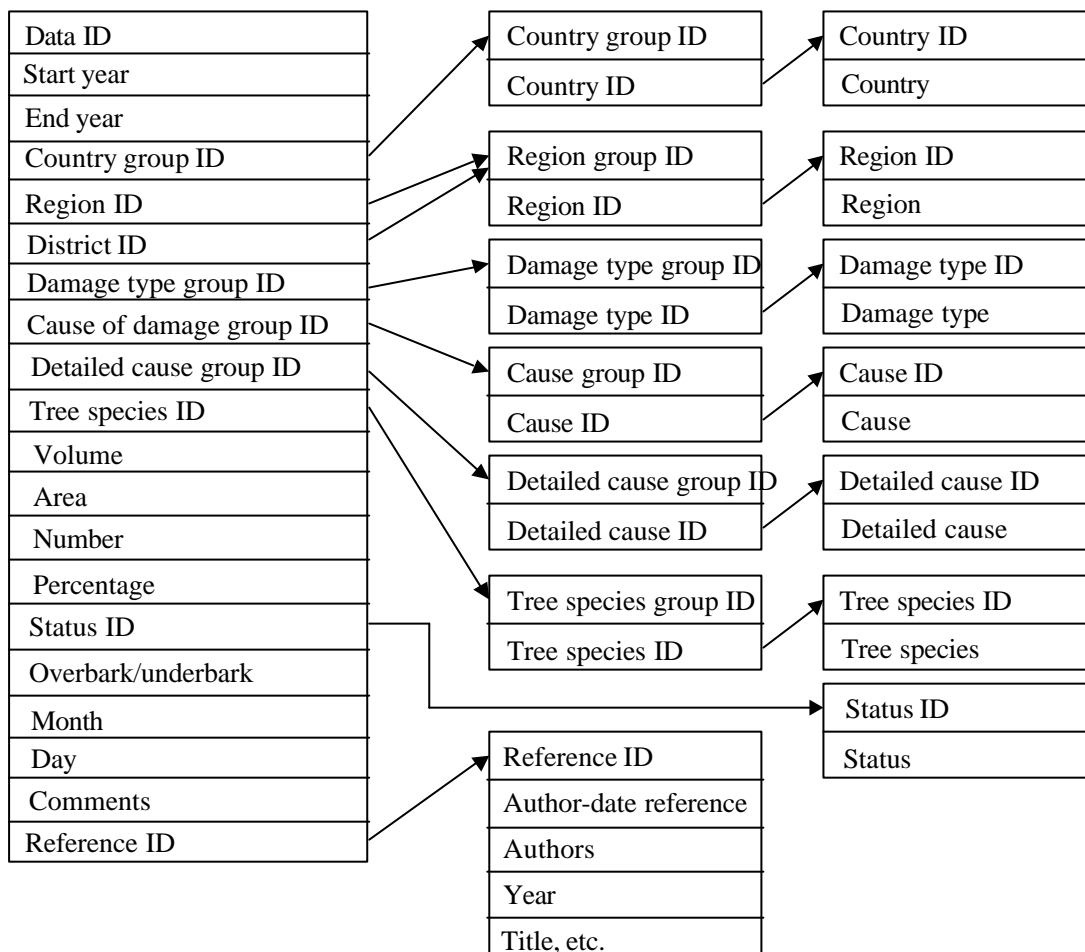


Figure 3. Outline of the tables in the DFDE.

3.4 QUERYING THE DATABASE

For all entries a year or range of years is available, a country or group of countries and the group type of disturbance. Therefore those parameters were chosen as the first search criteria. The first phase of the query consists of three steps. These are respectively: 1) selecting a country 2) selecting a year or period and 3) selecting a disturbance type. In step 2 and 3, only the years and disturbance types are shown that are available from the database, depending on the selection of the country. The result of the query is shown as output on the screen (Figure 4).

Presently the query does not allow to further refine a search. In the near future the DFDE will be developed further to give the user the option for more detailed and comprehensive searches e.g. by region/district level or to more detail regarding the disturbance types.

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Database on Forest Disturbances in Europe (DFDE)

Country: Belgium Period: 1945 - 1990 Damage type: Abiotic

Year / period	Country	Region	District	Damage type	Cause of damage	Detailed cause of damage	Tree species	Volume (m ³)	Area (ha)	Number (see comments)	Percentage (see comments)	Status (e.g. sanitation felling)	Bark (e.g. overbark)	Date	Comments	Refer
1967	Belgium			Abiotic	Wind			3300000				Damaged			Total damage in Europe	Botton 1996
1972	Belgium			Abiotic	Wind			2500000				Damaged			In Europe	Schelhaas 1997
1984	Belgium	Wallony		Abiotic	Wind		Broadleaves	23000				Damaged			In public forests	Cliffange 1996
1984	Belgium	Wallony		Abiotic	Wind		Conifers	301000				Damaged			In public forests	Cliffange 1996
1984	Belgium	Wallony		Abiotic	Wind		Broadleaves	13540				Damaged			In private forests	Cliffange 1996
1984	Belgium	Wallony		Abiotic	Wind		Conifers	690400				Damaged			In private forests	Cliffange 1996
1984	Belgium	Wallony		Abiotic	Wind			1218000				Damaged	November 23-24, 1984			Cliffange 1996

Figure 4. Screenshot of output after a query.

3.5 EXAMPLES

In order to show possible applications of the DFDE, two examples are presented. The first will show damages due to disturbances in Germany (see also Schelhaas et al. 2002a), the second an analysis of forest fire data for Spain.

3.5.1 Example 1. Disturbance damage in Germany

In the database there are over 4000 records dealing with disturbances in the current territory of Germany. More than half of the references (over 2400) are disturbances of biotic origin, about 1300 have an abiotic cause and the remaining are either a combination, or the cause was not mentioned. The size and scale of the recorded disturbances vary from small local damages to the large scale windthrows of 1990. Although the amount of references to biotic damage is higher, abiotic damage accounts for 90% of the total volume damaged in the period 1800–2000. The largest part (85%) of the abiotic damage is caused by storms. The other 5% are caused by other abiotic factors such as snow and drought. Out of the 10% of the total volume damaged by biotic factors, 7% is caused by bark beetles.

Over the centuries, we see that periods with low and high frequencies of damage alternate (Figure 5). The second half of the 19th century had a relative high frequency of storm damage. Years with

severe damage were 1868 (16 million m³), 1870 (11.5 million m³) and 1894 (9.9 million m³). After the storms in 1902 and 1903 (7.7 and 4.8 million m³ damaged respectively) the first half of the 20th century was relatively calm. The storms of 1967 (25 million m³) and 1972 (24.5 million m³) mark the beginning of a new era with frequent storm damages. In 1984, 13 million m³ were damaged and in 1990 the unprecedented amount of 72.5 million m³ was blown over. For the moment, 1999 is the last one in this series with 30 million m³ of damage.

Severe windthrows are often followed by bark beetle outbreaks, such as the outbreak in 1871–1876, following the storms of 1868 and 1870, and the outbreak after the 1990 storm. The outbreak after the Second World War was caused by some smaller storm damage, combined with damage due to war activities. The damaged timber could not be cleared in time due to a shortage of labour after the war. The bark beetle outbreaks were further favoured by some extremely warm and dry summers, which both weakened the resistance of the trees and favoured the regeneration of the beetles.

When looking at storm damages presented in Figure 5 it can be observed that the damaged amounts per event have been increasing over time. Conclusions should no the less be drawn with caution, since the figure is most likely far from including all storm events. In the recent past more damages were reported. This does not necessarily allow the conclusion that the frequency of events has increased, but it may be due to a higher intensity and accuracy in reporting. More significant events, however, have a larger probability of being reported, so that a general trend of increasing storm damage events can be assumed.

Possible reasons for this development may relate to a varied set of causes including a growing total forest area, higher average growing stocks and higher average stand ages. Climate change is also often mentioned as a possible source for observed changes in storm climate. Different studies have investigated the wind climate in the past, but most came to the conclusion that although there are considerable fluctuations between decades, there seems to be no long-term trend in storm patterns (Dorland et al. 1999, Lässig and Mocalov 2000, Können 1999). As storms show a highly stochastic character, it can be considered rather difficult to detect an actual trend in changes of storm frequency and intensity based on only a short time series.

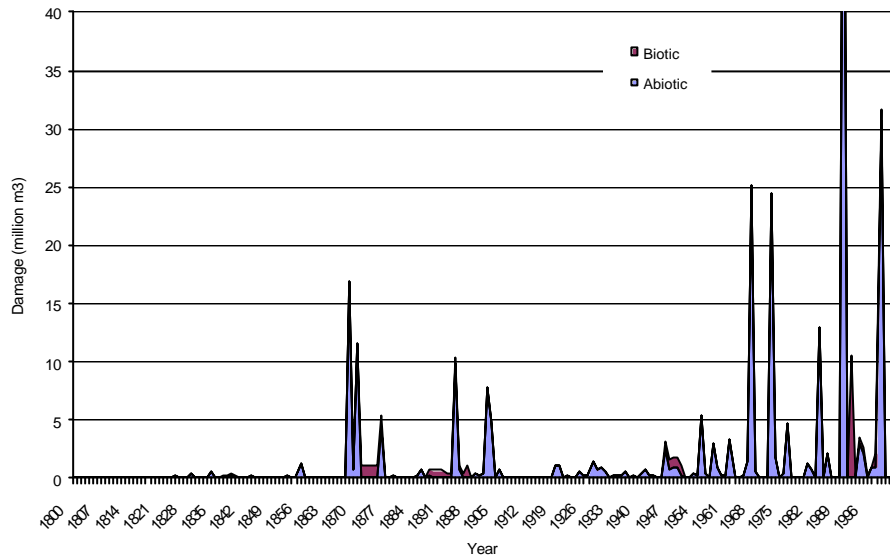


Figure 5. Overview of available information on damage due to biotic and abiotic disturbances in Germany since 1800. The storm in 1990 caused a total damage of 72.5 million m³.

One of the reasons for developing the DFDE is to provide a basis for modelling in the field of forest disturbances. In an existing large scale forest scenario model, EFISCEN, a module was developed to allow simulating the effect of disturbances on the development of forests and vice versa (Schelhaas et al. 2002b). The impact of a certain disturbance event in the model depends on the actual state of the forest, so a storm will cause more damage to old and/or coniferous forest than to young and/or broadleaved forest. By changing the forest management practice, the impact of disturbances can be reduced or enhanced. In a recent study, this new module was applied to Germany (Dolstra 2003, Schelhaas et al. 2002a). The simulations show that under the current felling level the build up of growing stock will continue. In 2050 the simulated average growing stock will reach nearly 450 m³ ha⁻¹ (Figure 6). As a result of this increase in growing stock and average age, also the expected annual damage will increase. Since disturbances are stochastic events, it cannot be predicted when they will take place and how severe they will be, but it is not unlikely that such high damages as in 1990 and 1999 will happen again.

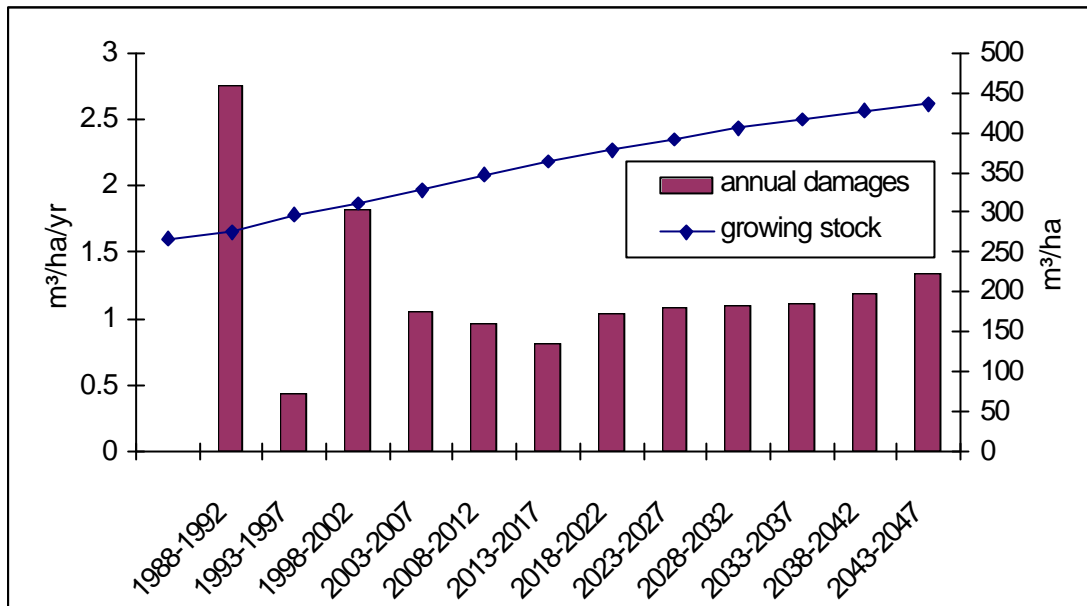


Figure 6. Development of growing stock and average annual damages per 5-year period until 2050 as simulated by the EFISCEN model.

3.5.2 Example 2. Forest fires in Spain

A complete overview of the number and area of fires in Spain is available since 1961 until the present. Both the area burned on forest land and the area burned on forest and other wooded land has increased considerably since the 1960's (Figure 7). Especially during the 1980's and early 1990's a number of severe fire damages were reported. The years following 1994 show only moderate damages, although the average burned area is still rather high. More obvious than the increase in fire area is the increase in number of fires (Figure 8). In the 1960's the average annual number of fires was about 2000, nowadays the number is tenfold. Only few of the forest fires (less than 5%) are reported to have a natural cause (Figure 9). Most fires are initiated by individuals, of which arson and negligence are the main reasons. Negligence has a rather stable share of about 15% in the causes of fires, while the share of arson seems to have risen to over 60%. The share of unknown causes has been decreasing over the studied time period. Possible reasons for this development can be found in constantly improving forest fire reporting systems including a more comprehensive investigation of the causes. The same accounts for the increase of the number of fires. Forest fires are reported more accurately including also small forest fires.

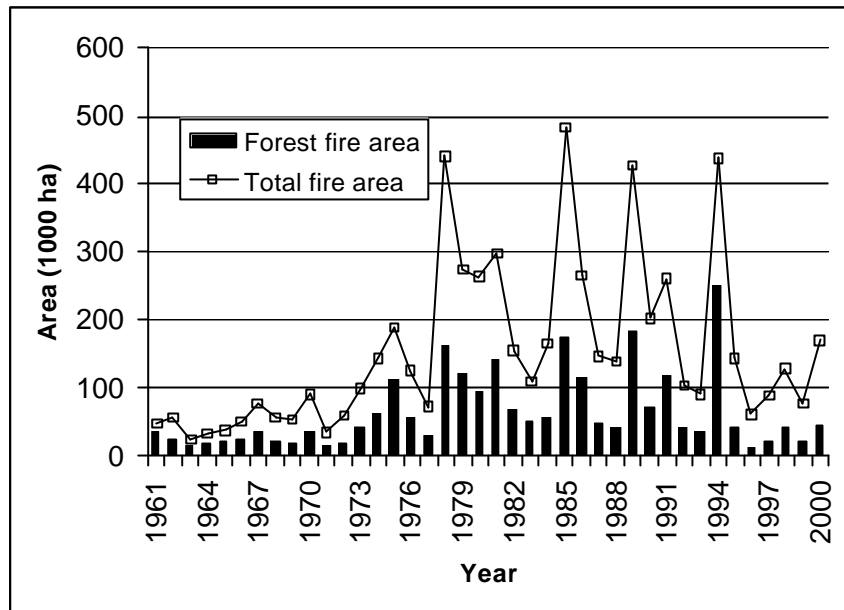


Figure 7. Area of fires on forest land and total area of fires in Spain, 1961–2000 (Vélez Munoz 1995, Segundo 1998, UNECE/FAO 2001)

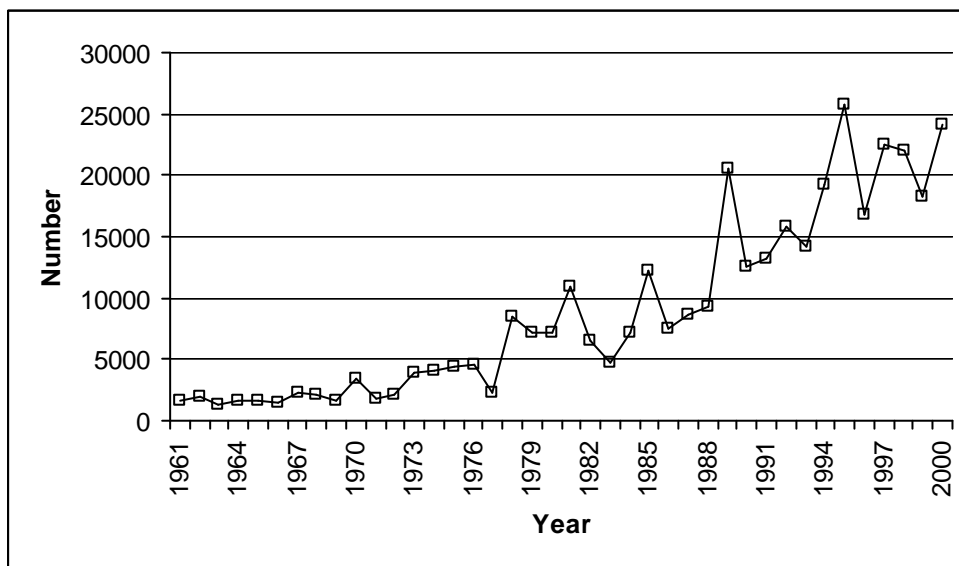


Figure 8. Total number of fires in Spain, 1961–2000 (Vélez Munoz 1995, Segundo 1998, UNECE/FAO 2001)

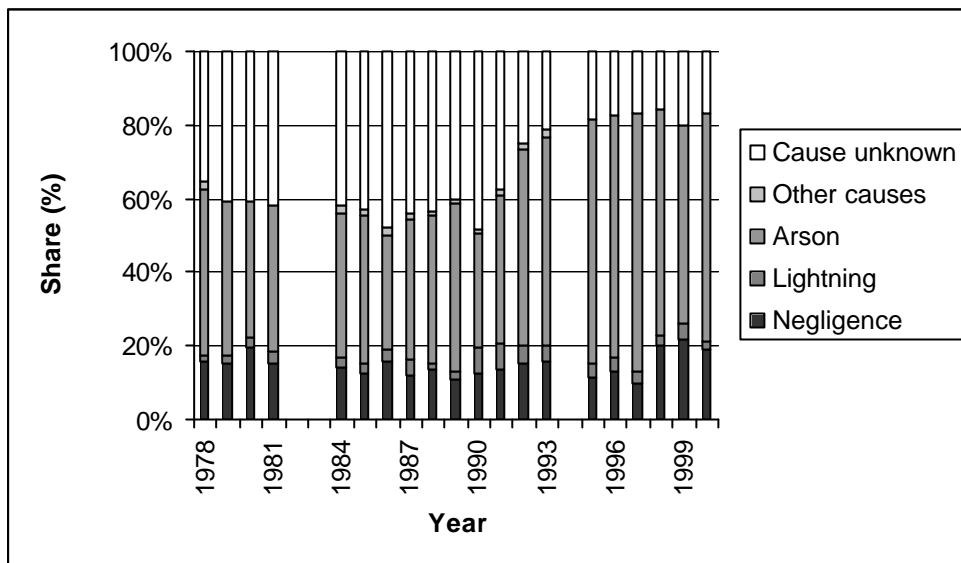


Figure 9. Share of different causes of the total number of fires for the years 1978–2000, excluding 1982, 1983 and 1994 (no data) (FAO 1982, 1984, UNECE/FAO 1998, 2001)

4. DISCUSSION

Countries differ greatly in amount of data and level of detail. For most Mediterranean countries only forest fire statistics could be identified from literature, mostly on a rather aggregated level. In cases, forest fire data was found to be very detailed, as in the case of Spain (Annex 2). Germany has shown to have the most detailed records, both over time and disturbance types. It must be kept in mind that the DFDE incorporates only the information that was found in an extensive literature review and by no means includes all disturbance events. Therefore, the information can not be regarded as being complete, not even for the most recent years. Combining different information sources can compensate partly for this lack.

The DFDE contains all information that was identified, regardless of the source or the expected accuracy. This may result in the fact that the same event is reported by different sources, and the figures of the damage can vary considerably. The reason for such differences is not necessarily obvious in all cases and it is up to the user to make a best choice of a source for a particular disturbance event. The availability of the full reference of the data source can assist the user in this decision. The DFDE was established to give an overview of the availability of disturbance events existing in literature, both scientific and popular.

5. FUTURE PLANS AND ACTIONS

The structure of the DFDE is such that it is easy to add data at a later stage. This was done in view of new data becoming available each year and that there are still numerous data to be found in literature. Users of the DFDE have the possibility to comment on the contents of the database and they can indicate new sources in literature that are not included, by filling out and sending a contact form available on the DFDE website. Using this approach we target to receive new data sources that could not be identified in the literature review. Sources could be e.g. local archives or grey literature that is not easily accessible. The Regional Project Centres of EFI could play an important role in collecting more information and data on forest disturbances.

The current interface of the database gives only the opportunity to search by year, country and disturbance type. We aim to expand these search options, which will enable the user to make more elaborate queries by narrowing down to a specific geographical region or occurrences of a particular insect species.

The DFDE will be useful in other projects, carried out at EFI, Alterra or elsewhere. It can either be used to produce historical overviews, provide data for parameterisation or act as a first stop

regarding literature references to publications and papers on disturbances. One example of the use of the database for parameterisation purposes is in modelling applications. The DFDE has been used in the context of the European Forest Information Scenario Model (EFISCEN). EFISCEN is large scale scenario model that is used to provide projections of future development of European forest resources under various scenario assumptions (e.g. Nabuurs 2001). This model is presently being extended with a module that addresses the effects of natural disturbances. Case studies have been carried out for Switzerland (Schelhaas et al. 2002b) and Germany (Dolstra 2003, see example 2). It is planned to include a separate section in the DFDE containing the national results of the ICP forest monitoring program on defoliation levels, which are made available in their Annual Reports.

Possibilities of visualising the DFDE data are under investigation as e.g. to create graphs and/or maps of query results. Extracts from the DFDE have been utilised in the European Forest Information System project (EFIS). The project was awarded by the EURO-Landscape project of the Institute for Environment and Sustainability, Joint Research Centre of the European Commission on behalf of DG AGRI in support to the EFICS Regulation (EEC No. 1615/89) to a consortium of organisations under contract number: 17186-2000-12 F1ED ISP FI. The European Forest Institute acted as the co-ordinator of the EFIS development. The EFIS prototype allows compilation, processing, analysis, presentation and dissemination of available forestry information of various heterogeneous data sources on international, national and regional levels. Figure 10 shows forest fire data visualised with the help of the Internet based EFIS.

Further metadata information has been provided to the International Union of Forest Research Organizations (IUFRO) Special Programme on building a Global Forest Information Service, GFIS. The metadata has been added to the service and can be searched through GFIS at <http://www.iufro-gfis.net/> (Figure 11).

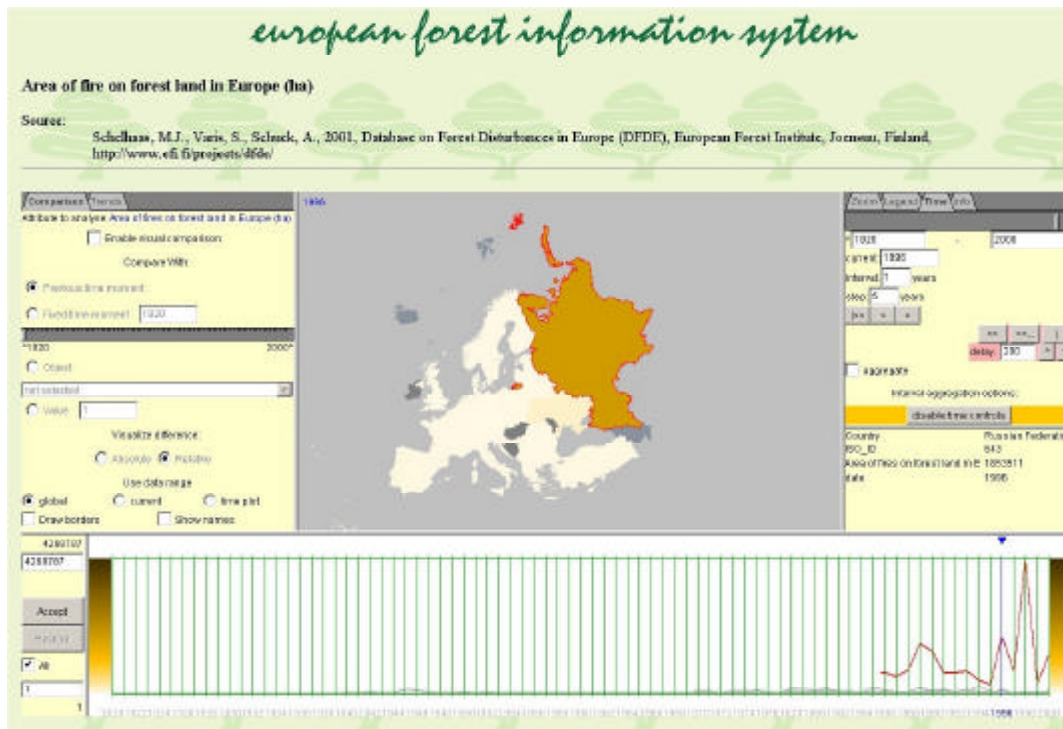


Figure 10. Area of forest fires on forest land in Europe (ha) visualised using the EFIS Toolkit.

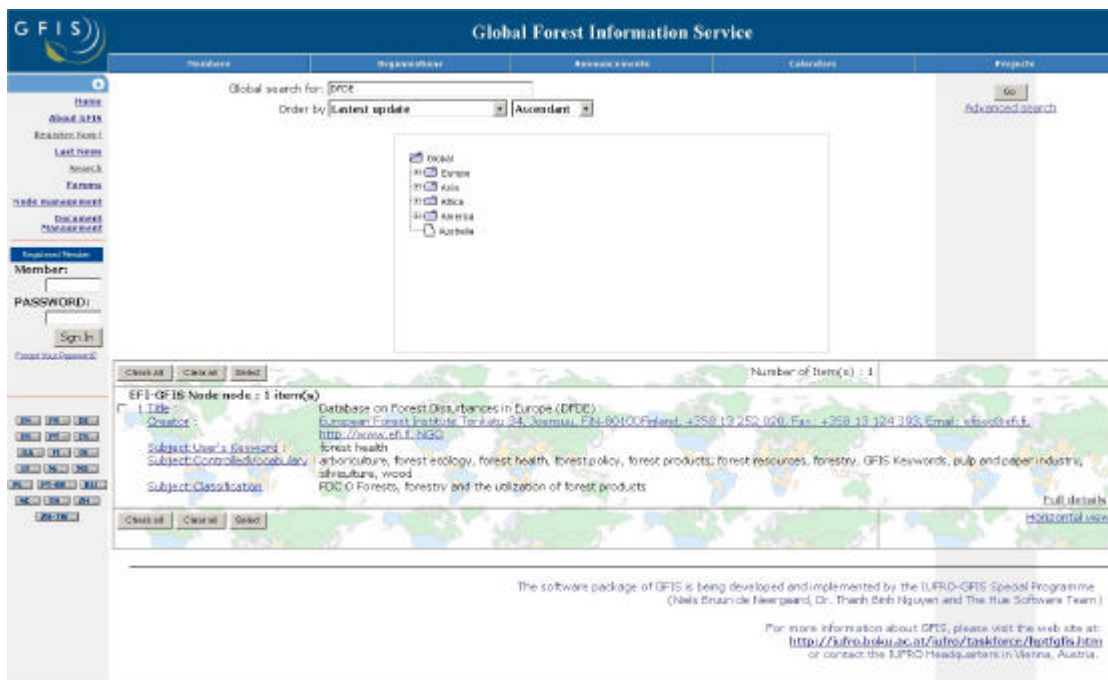


Figure 11. Search for the DFDE using the IUFRO - Global Forest Information Service.

In summary the DFDE and its data have the potential to serve both the EFI and Alterra in future projects. Such projects should include, however, also efforts for verifying data records, adding new occurrences of disturbances or to complement already existing data. An interaction with regional and local authorities should be initiated in order to supplement data at a more detailed level, both spatial and temporal.

The DFDE, as it is open to the general public, also allows users from various disciplines to familiarise with information on disturbances and give them the option to utilise these data in a specific context serving their research or data needs.

Due to the openness of the DFDE and its encouragement to experts to pinpoint to further sources of data, the DFDE has the potential of becoming a first stop shop website and database on forest disturbances in Europe.

The Database on Forest Disturbances in Europe is accessible at the European Forest Institute Website at <http://www.efi.fi/projects/dfde/>.

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Annex 1. Classification of disturbance types

Damage type	Cause of damage	Detailed cause of damage
Abiotic	Wind	
	Frost	
	Hail	
	Ice	
	Rime	
	Snow	
	Fire	21 causes
	Drought	
	Summer drought	
	Winter drought	
	Waterlogging	
	Other	
	Unknown	
	Anthropogenic	Air pollution
Theft		
Tourism		
Other		
Biotic	Diseases	2 species
	Insects	209 species
	Fungi	46 species
	Plants	2 species
	Mammals	16 species
Complex	Decline	
Other/Unknown		

Annex 2. Number of records in the database per country and per type of disturbance

	Abiotic	Biotic	Anthropogenic	Other	Total
Albania	188				188
Austria	276	454		5	735
Belarus	67				67
Belgium	79	2			81
Bosnia Hercegovina	60				60
Bulgaria	53				53
Croatia	165	46			211
Cyprus	70				70
Czeck Republic	475	346	53	96	970
Denmark	277	503			780
Estonia	89				89
Finland	82	1			83
France	476	3		1	480
Georgia	3				3
Germany	1329	2410	2	336	4077
Greece	95	1			96
Hungary	13	22		48	83
Ireland	72				72
Italy	353	26			379
Latvia	86				86
Lithuania	96	222			318
Luxembourg	44				44
Macedonia	91				91
Moldova	47				47
Norway	40	20			60
Poland	240	430	81	20	771
Portugal	45				45
Romania	206	43			249
Russian Federation	76				76
Slovak Republic	229	402	22	90	743
Slovenia	117	28		14	159
Spain	14717	4			14721
Sweden	81	80		3	164
Switzerland	371	87		5	463
The Netherlands	206	1			207
Turkey	346	1			347
Ukraine	58	117			175
United Kingdom	187				187
USSR	18	1			19
Yugoslavia	5	1			6
Combinations	24	6		1	31
Total	21552	5257	158	619	27586

Annex 3. Total volume in the database per country and per type of disturbance (1000 m³)

	Abiotic	Biotic	Anthropogenic	Other	Total
Albania					0
Austria	124145	22017		7	146169
Belarus					0
Belgium	7966	500			8466
Bosnia Hercegovina					0
Bulgaria	86				86
Croatia					0
Cyprus					0
Czech Republic	379406	117113	13355	106440	616314
Denmark	34044				34044
Estonia					0
Finland	21700				21700
France	443418	750		1300	445468
Georgia					0
Germany	1609083	74080		44336	1727499
Greece					0
Hungary				3600	3600
Ireland	1685				1685
Italy	1263	33			1296
Latvia					0
Lithuania	400				400
Luxembourg	3200				3200
Macedonia					0
Moldova					0
Norway		14311			14311
Poland	13985	55433	5606	166494	241517
Portugal					0
Romania	140202				140202
Russian Federation					0
Slovak Republic	55215	23810	3727	41018	123771
Slovenia	3194	3057		2242	8492
Spain	13				13
Sweden	133400	550			133950
Switzerland	76194	5979			82173
The Netherlands	5300				5300
Turkey	3000				3000
Ukraine	2805				2805
United Kingdom	34098				34098
USSR	31393				31393
Yugoslavia					0
Combinations	419700	169026			588726
Total	3544896	486659	22688	365437	4419680

Annex 4. Total area in the database per country and per type of disturbance (1000 hectare)

	Abiotic	Biotic	Anthropogenic	Other	Total
Albania	11				11
Austria	7	549		0	556
Belarus	57				57
Belgium	5				5
Bosnia Hercegovina	13				13
Bulgaria	131				131
Croatia	526	528			1054
Cyprus	13				13
Czech Republic	23	13510	11	389	13932
Denmark	3	1			5
Estonia	10				10
Finland	132				132
France	2556				2556
Georgia					0
Germany	997	4734	3	947	6680
Greece	3378				3378
Hungary	18	591		1723	2332
Ireland	12				12
Italy	5090	10			5100
Latvia	32				32
Lithuania	8	296			304
Luxembourg	0				0
Macedonia	77				77
Moldova	0				0
Norway	7				7
Poland	414	14101	15925	4	30443
Portugal	1902				1902
Romania	9	1885			1894
Russian Federation	41730				41730
Slovak Republic	3	450	6	2	461
Slovenia	15				15
Spain	42804	352			43156
Sweden	30	735			765
Switzerland	128				128
The Netherlands	96				96
Turkey	6258				6258
Ukraine	202	909			1112
United Kingdom	49				49
USSR	7089				7089
Yugoslavia	70				70
Combinations	1159	104			1263
Total	115062	38754	15944	3064	172824

Annex 5. List of literature references in the DFDE

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