Forecasting the numbers of people affected annually by natural disasters up to 2015

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Introduction

The vast majority of people affected by natural disasters suffer from climate-related disasters. To make this clear, between 1980 and 2007, 98% of all those affected by natural disasters suffered from climate-related ones (as opposed to, for example, earthquakes). This analysis therefore considers only trends in climate-related disasters, but the results for all natural disasters would be virtually identical (see **Technical annex, Table 2**).

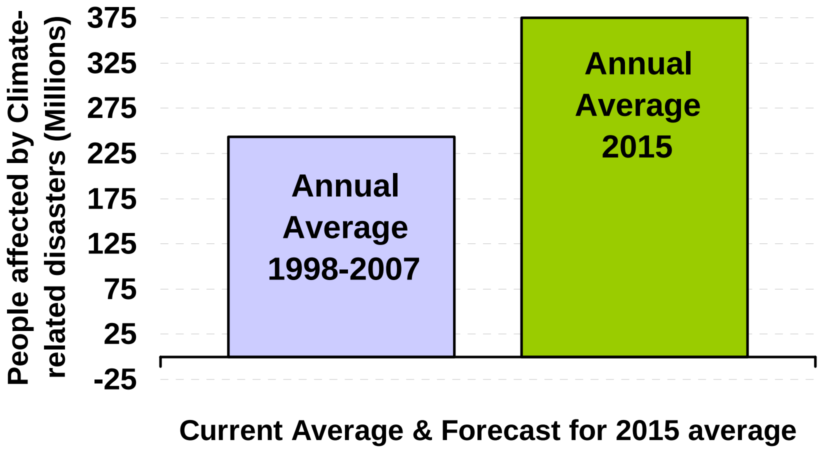
This analysis does not include the numbers of people affected by conflicts. This might be an area for future research, but would face significantly greater challenges in identifying an underlying trend and projecting it into the future.

Headline result

By 2015, on average over 375 million people per year are likely to be affected by climate-related disasters. This is over 50% more than have been affected in an average year during the last decade.

In figures:

Numbers of people affected by climate-related natural disasters	
Annual average, 1998–2007	243 million
Forecast, 2015	375 million
% Change	Increase by 54%



Source: CRED EM-DAT Global natural disaster occurrence and impact: 1980–2007.

See also **Chart 1** & **Chart 2**

The CRED EM-DAT Database

The Centre for Research on the Epidemiology of Disasters (CRED) maintains a publicly accessible database on emergency events. The EM-DAT (Emergency Events Database) is a comprehensive database carrying data for various types of natural disasters by both country and date (year & month) going back to 1900. It is generally accepted that EM-DAT data are more reliable from the beginnings of the 1980s onwards. For the forecast shown here we have only used quarterly data from after 1980.

Three groups of disasters are distinguished in EM-DAT: natural disasters, technological disasters and complex emergencies. Natural disasters are in turn categorised into five main groups (biological, climatological, geophysical, hydrological and meteorological) and then into 11 main types (see Technical annex, Table 1). For the purposes of this paper Oxfam has categorised 6 of these 11 natural hazard types as being climate-related. Predicted changes in the global climate could be expected to increase the frequency and severity of these natural hazards. That is not to say, however, that the projected increase in the numbers of people affected by these climate-related disasters should be solely attributed to climate change. There are a number of other factors involved, including the greater number of people who are likely to be vulnerable to those disasters because of, for example, their location or their poverty.

For a disaster to be entered into the database at least one of the following criteria must be fulfilled: ten or more people reported killed; 100 people reported affected; declaration of a state of emergency; or a call for international assistance. The main sources for events listed are UN agencies, but information also comes from national governments, insurance organisations, and the media.

Between 1980 and 2007 EM-DAT contains records of over 6,500 climate-related natural hazard events, with an average of 343 events per year over the past decade (77% of all natural hazard events, see **Technical annex, Table 2a**). The EM-DAT database not only gives counts of the numbers of disaster events over time, but also the total number of those affected by the event (**Technical annex, Table 2b**). The total number of people affected by an event includes those who suffered physical injuries or illness, as well as those made homeless or who otherwise required immediate assistance during a period of emergency. Between 1998 and 2007 in an average year, some 243 million people were affected by climate-related disasters (98% of all the people affected by natural disasters in this period).

The forecasting model

There is a large number of factors that can affect vulnerability of different populations to natural disasters, including the rising number of disasters themselves, population growth, including in vulnerable areas, and the range of factors that can make people more vulnerable to the disasters that occur. For that reason forecasting the number of people that are affected by natural disasters is an imprecise science, and the figures presented here should be treated accordingly.

The EM-DAT data shows a significant variation in the number of people affected from one year (or one quarter) to another. This reflects a number of extremely large natural disaster events that have a significant impact on the quarterly and annual totals. These extreme events seem to happen at regular intervals (see Charts 1 & 2), so removing them from the forecast model altogether would not give an accurate impression of the numbers of people affected by climate-related natural hazards. One approach to forecasting with ‘noisy’ data is to use a statistical ‘smoothing’ technique to even out the extremes of highs and lows in the data so as to give a clearer picture of any underlying trend. Smoothing tends to reduce the impact of extreme events on the overall forecast.

The 2015 forecast predictions shown here were made using a simple two-step process:

- **'smoothing'** the very volatile historical quarterly data on numbers of people affected in climate-related disasters;
- using a technique called **Linear Regression** to fit a straight trend-line through the smoothed data so as to get a reasonable forecast up to 2015.

The type of smoothing used here is called 'Double Exponential Smoothing', which takes into account historic data from across the time series but gives more importance (a higher weighting) to more recent disaster events than to those longer ago (see Technical Annex for more information).

When using Linear Regression to estimate a time-series trend, it is possible to calculate the upper and lower probable 'range' of a future forecast. These are known as upper and lower 'confidence intervals'. The convention is to estimate a 95% confidence interval. (See **Technical annex, Table 3**). In other words, we can be 95% confident that the number of people affected by climate-related natural disaster in 2015 will be between 336 million and 413 million in an average year.

As noted above, the data shows a significant variation in the number of people affected from one year to another. Such 'volatility' in the data means that different forecasting models could lead to different results. It also means, however, that a highly sophisticated model is unlikely to be more precise than the relatively simple model used here. The headline result above, therefore, is a reasonable forecast; it is not the only possible forecast that could be made from the data available.

Part of this volatility may be due to the way data on disasters is collected and recorded. It is likely that the reporting of natural hazards (and especially estimates of the numbers of people affected), as well as data collection standards, definitions and sources, have changed considerably both over time and in different locations. Different types of disasters may also be reported more or less consistently over time. In addition estimates of people 'affected' by an event are likely to be less consistent and more volatile than counts of people actually killed.

It is reasonable to assume that more recent data is likely to be more accurate than older data (hence the use of Exponential Smoothing before forecasting, and also restricting this analysis to data from post-1980).

This paper was written by Wayne Diamond and Shamanthy Ganeshan. It is published as background to the Oxfam International report *The Right to Survive*, see **www.oxfam.org.uk/right-to-survive**

The information in this publication is correct at the time of going to press.

For further information on the issues raised in this paper please email: enquiries@oxfam.org.uk

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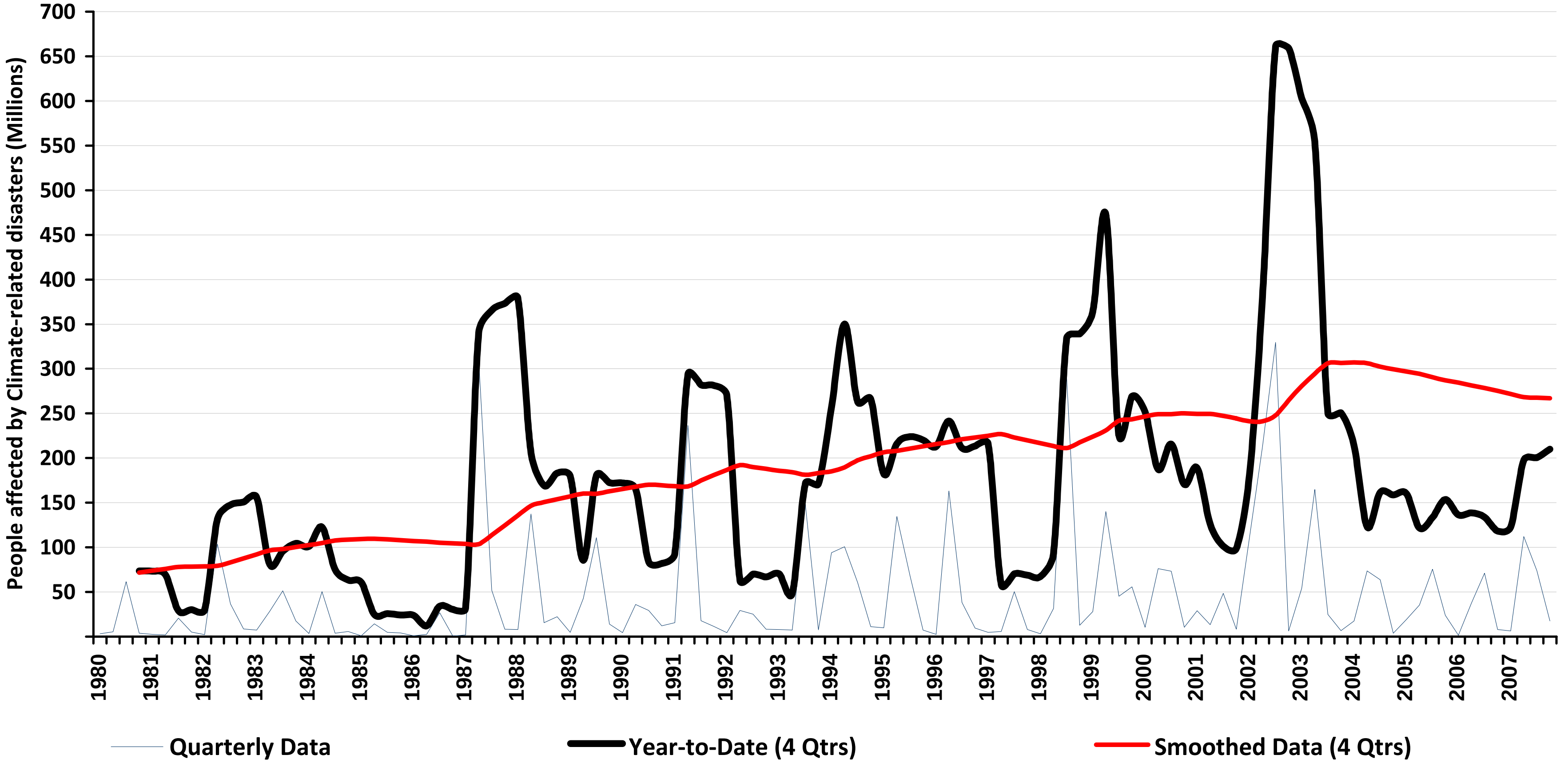
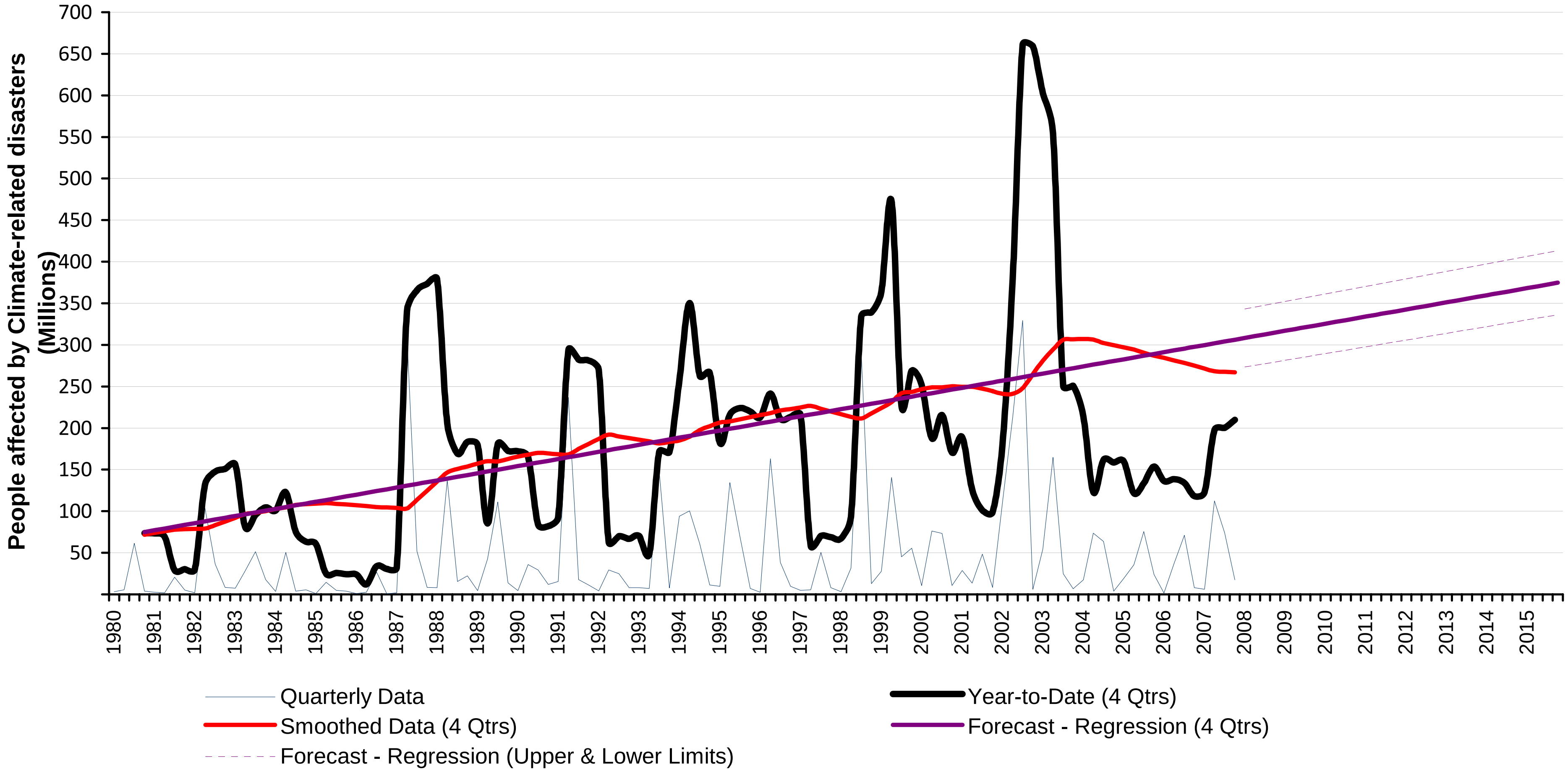
Chart 1: People affected by climate-related disasters 1980 to 2007 (millions, Quarterly & Year-to-Date Actual & Smoothed Trend)



Source: CRED EM-DAT Global natural disaster occurrence and impact: 1980–2007.
Notes: Year-to-date (4 Qtrs) shows the sum of four consecutive quarters. Events with unknown starting month are averaged over four quarters. Smoothed trend series estimated using Double Exponential Smoothing (with a smoothing weight equivalent to using 112 quarters).

Chart 2: People affected by climate-related disasters 1980 to 2007 (millions) with forecast to 2015



Source: CRED EM-DAT Global natural disaster occurrence and impact: 1980–2007.

Notes: Year-to-date (4 Qtrs) shows the sum of four consecutive quarters. Events with unknown starting months are averaged over four quarters. Smoothed trend series estimated using Double Exponential Smoothing (with a smoothing weight equivalent to using 112 quarters). Linear regression forecast model is based on smoothed data. 95% upper and lower confidence intervals for the regression forecast are shown.

Technical annex

Glossary of statistical terms

Exponential Smoothing is a popular method of producing a smoothed Time Series. Whereas in simple Moving Average models the past observations are all given equal importance (weighted equally), Exponential Smoothing assigns exponentially decreasing weights as the observations get older. In other words, recent observations are given relatively more weight in forecasting than the older observations. **Double Exponential Smoothing** is used when there is reason to believe there is an underlying trend in the time series (i.e. the number of people affected by disasters in this case).

Robust standard errors The linear regression forecast we have estimated assume that the number of people affected by disasters is a function of time. That is to say, as time progresses, more people will be affected by natural disasters. While there is good reason to believe this is the case, we also have to acknowledge the fact that there are many other variables that can influence the number of people affected by natural hazards. For example, increasing national income may lessen the impact of natural disasters and so reduce the numbers affected, while increasing population in areas most likely to be affected by climate change (low-lying coastal areas) may increase the numbers affected. These omitted factors are not likely to be independent over time. In other words, factors such as income and population levels are also likely to change with time. For this reason it is standard practice when using Linear Regression forecast models of this type to calculate what are known as ‘robust standard errors’ for our regressions. This means our forecasts and confidence intervals are more conservative than they would otherwise be.

Data cleaning: Dealing with missing months

Between 1980 and 2007 there were 123 climate-related natural hazard events (out of 6,527) without an event start month in the CRED data. These events could not be directly coded in year and quarter. Instead, the annual totals for people affected in these events were divided equally between all four quarters in the respective start years.

Tables

Table 1: Categorisation of natural hazard disaster types from CRED EM-DAT database, with total affected (thousands)

Natural hazard sub-group	Natural hazard disaster type	Classified by Oxfam as climate-related	Total affected 1998–2007 (thousands)
Biological	Epidemic		6,046
	Insect infestation		-
Climatological	Drought	✓	739,747
	Extreme temperature	✓	6,139
	Wildfire	✓	2,255
Geophysical	Earthquake (seismic activity)		42,163
	Mass movement (dry)		-
	Volcano		1,405
Hydrological	Flood	✓	1,288,688
	Mass movement (wet)	✓	1,741
Meteorological	Storm	✓	389,368
	Total – all natural hazards		2,477,552
	Total for climate-related		2,427,938
	Percentage climate-related		98%

Source: CRED EM-DAT Global natural disaster occurrence and impact: 1998–2007.

Table 2a: CRED: Numbers of natural hazard events per year by main type (1980–2007)

	Number of natural hazard events						
Year	**All natural hazards**	Biological	Climato-logical	Geophysical	Hydrological	Meteoro-logical	**Oxfam climate-related**
1980	140	8	21	27	42	42	105
1981	143	5	19	18	51	50	120
1982	160	7	19	23	59	52	130
1983	211	6	46	36	64	59	169
1984	158	12	16	20	53	57	126
1985	181	15	24	26	65	51	140
1986	174	24	12	23	59	56	127
1987	231	40	29	23	81	58	168
1988	238	37	23	26	92	60	175
1989	188	16	15	23	61	73	149
1990	297	18	29	48	64	138	231
1991	272	44	34	42	86	66	186
1992	232	28	27	35	66	76	169
1993	266	7	15	34	102	108	225
1994	256	10	35	31	99	81	215
1995	278	29	26	31	111	81	218
1996	271	45	16	18	115	77	208
1997	324	63	47	27	108	79	234
1998	362	74	50	34	116	88	254
1999	413	76	53	38	140	106	299
2000	528	115	88	37	186	102	376
2001	450	71	59	31	181	108	348
2002	506	84	62	45	191	124	377
2003	420	60	53	42	180	85	318
2004	402	47	35	48	145	127	307
2005	489	55	64	33	207	130	401
2006	460	59	41	37	247	76	364
2007	448	34	54	26	229	105	388
Decade Average 1998–2007							
98–07	448	68	56	37	182	105	343
		15%	12%	8%	41%	23%	77%

Source: CRED EM-DAT Global natural disaster occurrence and impact: 1980–2007.

Table 2b: CRED: People affected annually by natural hazards (1980–2007)

Number of people affected annually by natural hazards (thousands)							
Year	**All natural hazards**	Biological	Climato-logical	Geophysical	Hydrological	Meteoro-logical	**Oxfam GB climate-related**
1980	**75,459**	27	9,645	1,683	45,202	18,902	**73,749**
1981	**30,520**	65	5,959	163	20,786	3,548	**30,292**
1982	**151,819**	175	104,947	880	37,367	8,450	**150,763**
1983	**108,181**	7	79,399	3,600	21,682	3,493	**104,574**
1984	**64,307**	38	3,252	894	51,595	8,529	**63,375**
1985	**27,999**	23	510	3,723	17,702	6,041	**24,253**
1986	**32,402**	608	885	1,132	15,076	14,701	**30,662**
1987	**374,254**	613	317,222	445	50,092	5,883	**373,196**
1988	**206,661**	107	54,200	23,306	108,015	21,034	**183,248**
1989	**172,725**	23	17,085	365	104,425	50,826	**172,337**
1990	**84,583**	39	17,804	2,616	46,654	17,469	**81,928**
1991	**285,707**	2,191	30,153	2,171	227,888	23,304	**281,345**
1992	**68,569**	691	28,600	1,118	19,674	18,487	**66,760**
1993	**171,862**	462	6,532	402	149,406	15,059	**170,997**
1994	**273,925**	6,577	99,191	1,024	130,092	37,041	**266,324**
1995	**222,458**	454	11,419	1,966	194,229	14,391	**220,038**
1996	**219,754**	697	3,348	5,497	182,433	27,779	**213,561**
1997	**70,395**	382	9,339	1,304	44,687	14,683	**68,709**
1998	**343,761**	921	14,257	3,686	293,875	31,021	**339,154**
1999	**277,099**	1,121	94,884	6,890	149,101	25,102	**269,087**
2000	**174,236**	1,082	81,292	2,605	74,120	15,137	**170,549**
2001	**108,974**	239	32,300	9,822	34,623	31,991	**98,914**
2002	**661,540**	1,208	377,687	1,130	168,074	113,441	**659,202**
2003	**255,125**	137	69,756	4,219	169,920	11,093	**250,769**
2004	**161,868**	149	20,132	3,200	117,003	21,383	**158,518**
2005	**160,676**	432	29,560	6,528	75,038	49,117	**153,715**
2006	**122,602**	293	20,221	4,237	30,742	67,109	**118,072**
2007	**211,672**	464	8,051	1,250	177,932	23,974	**209,958**
Decade Average 1998–2007 (thousands)							
98–07	**247,755**	605	74,814	4,357	129,043	38,937	**242,794**
		0%	30%	2%	52%	16%	98%

Source: CRED EM-DAT Global natural disaster occurrence and impact: 1980–2007.

Table 3: People affected by climate-related disaster: Forecast for 2015

	Affected annually (millions)	% Increase from current average
Annual average 1998–2007	243m	
2015 Regression forecast	375 m	
Difference	132 m	54%
Lower estimate (95% CI)	336 m	38%
Upper estimate (95% CI)	413 m	70%

Source: CRED EM-DAT Global natural disaster occurrence and impact: 1980–2007.

Table 4: Forecasting model parameters

Model	Parameters / Coefficients
Double Exponential Smoothing	Smoothing Constant = 0.01769
	Smoothing Period = Approx. 112 quarters
Linear Regression Forecast (based on Smoothed Values)	
Constant	-24,900,000
Quarter	535,323 x Quarter

Source: CRED EM-DAT Global natural disaster occurrence and impact: 1980–2007.

Output from Linear Regression on Smoothed Time Series data

```
Linear regression                                      Number of obs =     112
                                                       F(  1,   110) = 1433.00
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.9484
                                                       Root MSE      =  4.1e+06

------------------------------------------------------------------------------
             |               Robust
      smd112 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       qtrid |     535323   14141.43    37.85   0.000       507298      563348
       _cons |  -2.49e+07    1717484   -14.49   0.000    -2.83e+07   -2.15e+07
------------------------------------------------------------------------------
```

```
* Syntax:
tssmooth dexponential smd112 = affected, parms(0.017699) forecast(32)
reg smd112 qtr if qtr<=191, robust
```