

## Suicidal death in Northern Ireland in relation with solar interplanetary and geomagnetic activity parameters (1986 to 2010)

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### Abstract:

*We have studied the relationship between death due to suicide incident in Northern Ireland and various Solar, Interplanetary and Geomagnetic Activity parameters, such as Sunspot Numbers (SSN), Solar Flare Index (SFI), Sudden Storm Commencements (SSC), and geomagnetic activity  $A_p$ , and  $K_p$  Indices observed during the period of 1986 to 2010. The data shows that the number of deaths due to suicide of males and females is well correlated with the yearly mean of Sunspot Numbers (SSN), Solar Flare Index (SFI), Sudden Storm Commencements (SSC), and geomagnetic activity parameter  $A_p$ , and  $K_p$  Indices. We have calculated a large negative correlation, with correlation coefficients of  $-0.71$ ,  $-0.64$ , between yearly total number of deaths due to suicide and the geomagnetic activity parameters  $K_p$ ,  $A_p$ , index. Negative correlation, with correlation coefficients of  $-0.709$ ,  $-0.635$  has been obtained between the yearly total number of male deaths due to suicide and the geomagnetic activity parameters  $K_p$ ,  $A_p$ , index where as medium good negative correlation, with correlation coefficients of  $-0.56$ ,  $-0.50$ , between the yearly total number of female deaths due to suicide and the geomagnetic activity parameters  $K_p$ ,  $A_p$ , index has been obtained. Further we have determined negative correlation, with a correlation coefficient of  $-0.43$ ,  $-0.42$ , between yearly total number of deaths due to suicide and the yearly mean of the SSN and SFI,  $-0.38$  and  $-0.33$ , between yearly total number of female deaths due to suicide and the SSN, SFI,  $-0.41$  and  $-0.41$ , between*

*yearly total number of male deaths due to suicide and the SSN, SFI .From the statistical analysis of sudden storm commencements (SSC), and death due to suicide, we have obtained a negative correlation, with correlation coefficient of -0.36 , between the yearly total number of male deaths due to suicide and Sudden Storm Commencements (SSC), as well as a negative correlation, with a correlation coefficient of -0.29 , between the yearly total number of female deaths due to suicide and Sudden Storm Commencements (SSC).*

**Key words:** Suicide Incidents, Sunspot Numbers (SSN), Solar Flare Index (SFI), and Sudden storm Commencements (SSC), Geomagnetic Activity Indices.

## **Introduction**

Conditions on the Sun and in the solar wind, the interplanetary space, magnetosphere, ionosphere and thermosphere constitute the so called “Space Weather” (Song, et al 2001, Scherer, et al 2005). They can influence not only the performance and reliability of space-borne and ground-based technological systems, but can also endanger many kinds of human activities, particularly in connection to human life itself and human health. The effects of space weather and geomagnetic environment on human physiological state or living organism are studied in the branch of science Heliobiology (sometimes the term “cosmobiology” is used; “heliomedicine” also appears in some papers and reports, and “clinical cosmobiology”) was introduced as a new branch of biology (E. Stoupel in 1989, Shimshoni, et al. 1990). In the last decades, many scientists have worked on the impact of space weather parameters, through the geomagnetic field, on different diseases (Dorman et al., 2001; Stoupel, 2002; Gmitrov and Ohkubo, 2002; Gmitrov and Gmitrova, 2004; Dimitrova et al., 2004). It has been revealed that cardiovascular circulatory, nervous and other functional systems react under changes of geophysical factors (Kay, 1994; Watanabe et al., 1994; Persinger and Richards,

1995; Gurfinkel et al., 1995; Zhadin, 2001; Cornelissen et al., 2002). It has long been claimed that geomagnetic storms and other electromagnetic variations are associated with changes in the incidence of various diseases, myocardial infarctions and strokes (Halberg et al., 2000). Geomagnetic activity (GMA) is relatively new but interesting studies have been carried out with remarkable results (Cornelissen et al., 2002; Dzvonič et al., 2006; Stoupeľ et al., 2007). These results refer not only to the possible influence of GMA disturbances on the human cardiovascular state through variations of physiological parameters such as heart rate (HR) and arterial diastolic and systolic blood pressure (Dimitrova et al., 2009) but also on the central and vegetative nervous system through changes of the human brain's functional state and the psycho - emotional state (Babayev and Allahverdiyeva, 2007). At the same time it was shown that very low GMA could affect adversely human cardiovascular system also (Stoupeľ et al., 2004, 2005, 2006, 2007) and that is why it is suggested that the role of environmental physical factors becoming more active in low GMA, like CR (neutron) activity should be object of further studies (Stoupeľ, 2006). Different human physiological parameters have been used in recent studies in order to determine the relationship between cardio - health state and geomagnetic and cosmic ray activity. For example, in Dimitrova et al. (2009) HR appeared to be a rather stable cardiovascular parameter and did not react statistically significantly under geomagnetic changes, whereas a statistically significant increment was revealed for arterial systolic and diastolic blood pressure during increased GMA. On the other hand Villoresi et al. (1995) showed that HR is better related to GMA. Moreover Mavromichalaki et al. (2008) showed that HR increased with GMA increase and the accompanied CRI decrease. Over the previous year's many studies have been carried out concerning the possible effect that solar and geomagnetic activity might have on human physiological state (Dorman et al., 2001; Ptitsyna et al., 1996; Dorman, 2005,

Villoresi et al., 1994, 1995; Ptitsyna et al., 1998, Villoresi et al., 1994, 1998; Dorman, 2005; Cornelissen et al., 2002; Dimitrova, 2006). Verma (2012) has studied the relationship between death due to suicide in India and various Solar Activity (SA) parameters; i.e. Sunspot Numbers (SSN), Solar Flare Index (SFI), Coronal Index (CI) and Cosmic Ray Intensity (CRI) observed during the period of 1989 to 2011. The data shows that the number of Suicide Incidents of male, female, and average is well correlated with yearly averages of the SSN, SFI, and CI; as well as being positively correlated with CRI. Verma (2013) studied Suicide Incidents in relation to the geomagnetic activity parameters, such as the planetary Ap, Kp, and Dst Indices for the period of 1989-2010, and found large negative correlations between Suicide Incidents and the yearly averages of geomagnetic activity parameters: the Kp, Ap, and Dst indices. In this investigation the Suicide Incident in Slovakia is considered for statistical analysis with the Solar, Interplanetary and Geomagnetic Activity parameters for the period of 1986-2010, in order to explore which of the Solar, Interplanetary and Geomagnetic phenomena are responsible for this event. In this investigation an attempt has been made to get possible relationship between death suicide incident in Northern Island and solar and geomagnetic activity parameters during the period 1986-2010.

## **2. Data Sources**

Solar Activity (SA) parameters, Sunspot Numbers (SSN), Solar Flare Index (SFI), and interplanetary parameters, such as Sudden Storm Commencement (SSC) are taken from STP Solar Data (<http://www.ngdc.noaa.gov/stp/solardataservices>). Data of geomagnetic activity parameter Kp, and Ap, Indices' values have been taken from OMNI Web Data System (<http://omniweb.gsfc.nasa.gov>). The data of Suicide Incidents in

Northern Ireland has been taken from the Northern Ireland statistics and research agency available at [www.nisra.gov.uk](http://www.nisra.gov.uk).

**Table 1- Suicidal death in Northern Ireland an Solar, Interplanetary and Geomagnetic Activity Parameters during the Period of 1986-2010**

Social death in Northern Ireland				Yearly Mean of SSN	Yearly Mean of SFI	Yearly Total of Kp Index	Yearly Total of Ap Index	Frequency of Shocks /SSC
Year	male	Female	Total					
1986	123	51	174	13.4	1.13	7893	4570	21
1987	80	42	122	29.4	2.66	7569	4021	24
1988	139	44	183	100.2	8.14	8002	4681	36
1989	103	31	134	157.6	17.39	10116	7126	69
1990	121	47	168	142.6	12.2	9305	5954	43
1991	105	43	148	145.7	15.16	11022	8577	59
1992	103	25	128	94.3	7.74	9450	6053	47
1993	120	31	151	54.6	4.23	8677	5516	27
1994	117	34	151	29.9	1.58	9872	6638	13
1995	105	41	146	17.5	0.86	7895	4636	23
1996	114	19	143	8.6	0.42	6937	3432	9
1997	108	30	138	21.5	1.01	5657	3090	28
1998	113	37	150	64.3	4	7364	4404	35
1999	127	27	154	93.3	6.39	7983	4593	30
2000	140	45	185	119.6	7.61	8621	5524	45
2001	132	26	158	110.9	6.8	7649	4744	42
2002	142	41	183	104.1	4.56	8236	4805	46
2003	112	32	144	63.56	3.46	10444	7966	13
2004	105	41	146	40.44	1.6	7960	4916	28
2005	167	46	213	29.78	1.91	7719	4945	26
2006	227	64	291	15.18	0.54	5887	3120	20
2007	175	67	242	7.5	0.47	5530	2751	14
2008	218	64	282	2.86	0.03	5329	2566	19
2009	205	55	260	3.09	0.02	3290	1451	21
2010	240	73	313	16.5	0.39	4584	2196	15

### 3. Methods of Analysis

In this study a statistical method correlation has been used. The correlation is one of the most common, as well as the most useful statistics. A correlation is a single number that describes the degree of relationship between two variables. The correlation coefficient, symbolized as  $r$ , is a numerical summary of a bivariate relationship and can range from -1.00 to +1.00. Any  $r$  that is positive indicates a direct or positive relationship between two measured variables. Negative  $r$  indicates indirect or inverse relationship.

The formula for the correlation is:

$$r = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}}$$
, Where:

N= number of pairs of scores,  $\sum XY$  = sum of the products of paired scores,  $\sum X$  = sum of x scores,  $\sum Y$  = sum of y scores,  $\sum X^2$  = sum of squared scores,  $\sum Y^2$  = sum of squared score

The scale of correlation coefficient is

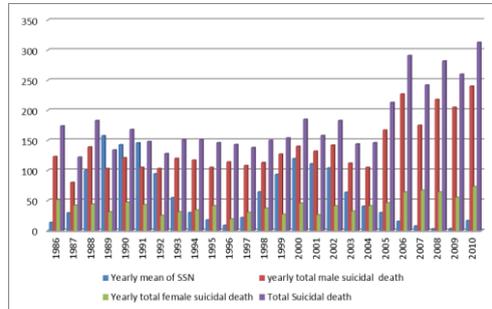
- .8 to 1.0 or -.8 to -1.0 (very large relationship)
- .6 to .8 or -.6 to -.8 (large relationship)
- .4 to .6 or -.4 to -.6 (good medium relationship)
- .2 to .4 or .2 to -.4 (weak relationship)
- .0 to .2 or .0 to -.2 (weak or no relationship)

#### 4. Data Analysis and Results

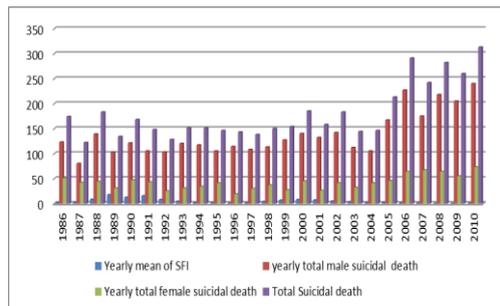
From the data analysis of Table 1 and Figures 1, 2, it is inferred that the death due to suicide in Northern Ireland are related to the yearly mean of SSN and SFI. Around Solar Maximum, where the Sunspot Numbers (SSN) and Solar Flare Index (SFI) are at a maximum, the death of male, females, total due to suicide have been found to be comparatively low in comparison to corresponding Solar Minimum where the Sunspot Number (SSN) and Solar Flare Index (SFI) are at minimum.

Analysis of the data also shows that death due to suicide is related to Interplanetary and Geomagnetic Activity parameters. The deaths of males, female and total due to suicide are negatively correlated with the annual Sudden Storm Commencements (SSC), the yearly total of Geomagnetic Activity parameters Kp, and Ap, Index. The following main results have been obtain through the statistical analysis of

Sunspot Numbers (SSN), Solar Flare Index (SFI), Sudden Storm Commencements (SSC), and geomagnetic activity parameter Kp, Ap, Indices along with the male, female Suicide Incidents. (Figure 3, 4, 5, 6, 7, 8, 9)



**Figure-1:** Shows bar diagram of yearly average of Sunspot Numbers (SSN) and male, female and total suicide incidents in Northern Ireland for the period of 1986-2010.



**Figure-2:** Shows bar diagram of yearly average of Solar Flare Index (SFI) and male, female and total suicide incidents in Northern Ireland for the period of 1986-2010.

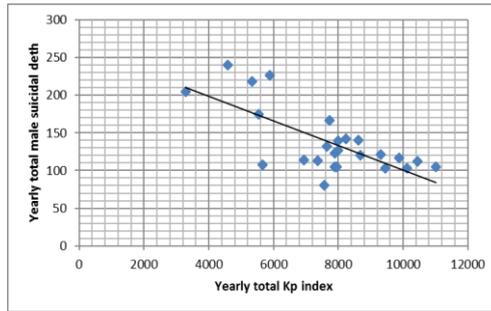


Figure -3-Shows scatter plot between yearly total of Kp index and yearly total number of male death due to suicide in Northern Ireland for the period of 1986-2010, showing large negative correlation with correlation coefficient - 0.709.

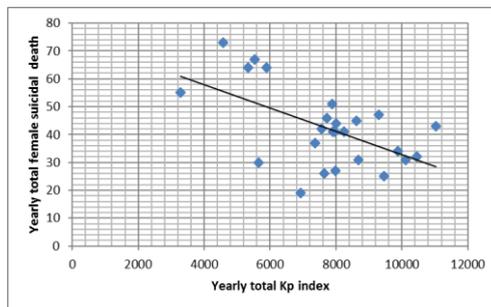


Figure - 4-Shows scatter plot between yearly total of Kp index and yearly total number of female death due to suicide in Northern Ireland for the period of 1986-2010, showing negative correlation with correlation coefficient -0.562.

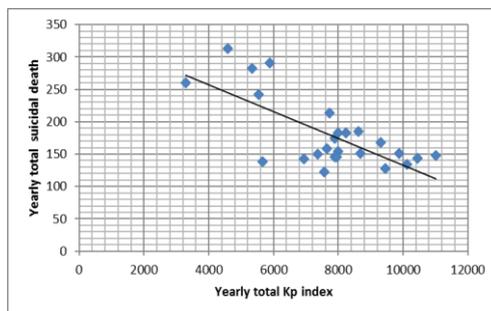


Figure -5-Shows scatter plot between yearly total of Kp index and yearly total number of death due to suicide in Northern Ireland for the period of 1986-2010, showing large negative correlation with correlation coefficient -0.708.

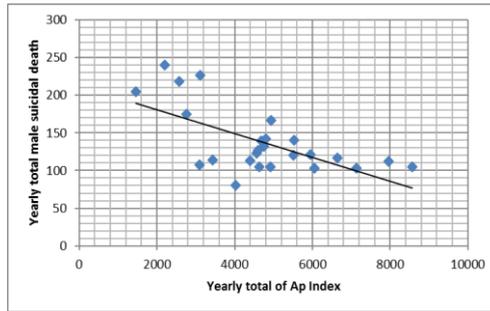


Figure -6-Shows scatter plot between yearly total of Ap index and yearly total number of male death due to suicide in Northern Ireland for the period of 1986-2010, showing large negative correlation with correlation coefficient - 0.635.

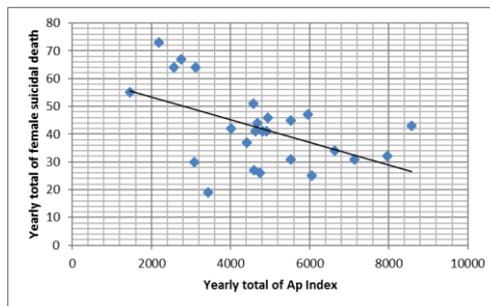


Figure -7-Shows scatter plot between yearly total of Ap index and yearly total number of female death due to suicide in northern Ireland for the period of 1986-2010, showing large negative correlation with correlation coefficient - 0.502.

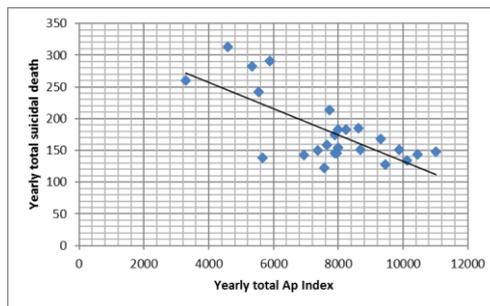
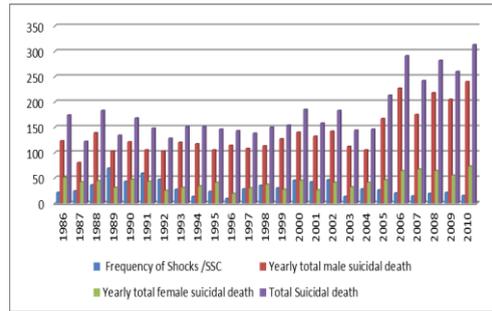


Figure -8-Shows scatter plot between yearly total of Ap index and yearly total number of death due to suicide in Northern Ireland for the period of 1986-2010, showing large negative correlation with correlation coefficient -0.637.



**Figure:-** 9-Shows bar diagram of annual Sudden Storm Commencements (SSC) and male, female and total suicide Incidents in Northern Ireland for the period of 1986-2010.

## Main Results

(a) - Large negative correlation, with a correlation coefficient of  $-0.709$ , has been found between the yearly total of  $K_p$  index and the yearly total number of male deaths due to suicide.

(b) - Good medium negative correlation, with a correlation coefficient of  $-0.56$ , has been found between the yearly total of  $K_p$  index and the yearly total number of female deaths due to suicide.

(c) - Large negative correlation, with a correlation coefficient of  $-0.708$ , has been found between the yearly total of  $K_p$  index and the yearly total number of deaths due to suicide.

(d) - Large negative correlation, with a correlation coefficient of  $-0.635$ , has been found between the yearly total of  $A_p$  index and the yearly total number of male deaths due to suicide.

(e) - Good medium negative correlation, with a correlation coefficient of  $-0.502$ , has been found between the yearly total of  $A_p$  index and the yearly total number of female deaths due to suicide.

(f) - Large negative correlation, with a correlation coefficient of  $-0.637$ , has been found between the yearly total of  $A_p$  index and the yearly total number of deaths due to suicide.

(g) - Medium negative correlation, with a correlation coefficient of  $-0.412$ , has been found between the yearly average of the

Sunspot Numbers (SSN) and the yearly total number of male deaths due to suicide.

(h) - Medium negative correlation, with a correlation coefficient of -0.385, has been found between the yearly average of Sunspot Numbers (SSN) and the yearly total number of female deaths due to suicide.

(i) - Medium negative correlation, with a correlation coefficient of -0.432, has been found between the yearly average of Sunspot Numbers (SSN) and the yearly total number of deaths due to suicide.

(j) - Negative correlation, with a correlation coefficient of -0.411, has been found between the yearly mean of the Solar Flare Index (SFI) and the yearly total number of male deaths due to suicide.

(k) - Negative correlation, with correlation coefficient of -0.33, has been found between the yearly mean of the Solar Flare Index (SFI) and the yearly total number of female deaths due to suicide.

(l) - Negative correlation, with correlation coefficient of -0.42, has been found between the yearly mean of the Solar Flare Index (SFI) and the yearly total number of deaths due to suicide.

(m) - Negative correlation, with correlation a coefficient of -0.36, has been found between yearly total number of Sudden Storm Commencements (SSC) and the yearly total number of male deaths due to suicide.

(n) - Negative correlation, with a correlation coefficient of -0.29, has been found between yearly total number of Sudden Storm Commencements (SSC) and the yearly total number of female deaths due to suicide.

(o) - Negative correlation, with a correlation coefficient of -0.37, has been found between yearly total number of Sudden Storm Commencements (SSC) and the yearly total number of female deaths due to suicide.

## 5. Discussion and Conclusion

In this study, the significant correlations between the yearly number of male, female and total deaths due to suicide and Solar, Interplanetary, and Geomagnetic Activity parameters lead to the conclusion that variations in Solar, Interplanetary and Geomagnetic Field can directly or indirectly affect the human organism, mainly through the impact on the functional activity of the brain by changing its background state and infringing on the adequacy of reacting (responding) during transition from test phase to “normal” activity. These external perturbations particularly infringe on the balance of synchronic and non-synchronic systems, ergo (activating) - and trophotropic (braking) the episegmentary vegetative centers. These changes are most likely connected to the dysfunction of central integrative brain apparatus accompanied by the strengthening of activating systems and through insufficiency (deficit) of inhibiting mechanisms. Dysfunction affects, in turn, the episegmentary vegetative centers, which are followed by the non-adequacy of vegetative securing of routine activity. Some scientists have studied Solar and Geomagnetic Activity in relation to the human physiological state and have concluded that there is a positive relation between the level of aggression in rats and Geomagnetic Activity (Persinger, 1997), as well as an connection between the increase of anxiety, aggression and Geomagnetic Activity, Interplanetary Magnetic Field (Grigoryev 2008). Although there is currently no known geophysical mechanism to explain this phenomenon, it is expected that particular changes in the ambient electromagnetic and acoustical signals caused by Heliogeophysical factors could promote the exacerbation of the mental state and even act as a trigger of the suicidal behavior. However, the clarification of the mechanisms behind the impact of Solar, Interplanetary and Geophysical factors on humans requires more detailed studies.

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