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NEWS AND ITS INFLUENCE ON THE VIABILITY OF NUCLEAR POWER PLANTS DEPLOYMENT – A MODIFIED EPIDEMIOLOGICAL MODEL FOR NEWS GENERATION

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ABSTRACT

The viability of nuclear power plants strongly depends on its popular acceptance and, in this sense, questions like risk perception, selective attention and selective retention of news about nuclear matters, produced by the media agents, become very relevant. Nowadays, the intense exposure of people to the news allows us to say licentiously that the means of news spreading is responsible for shaping up an important part of our collective conscience. This work is part of a series of studies intended to canvass subsidies about what steps can be taken to mitigate this apparent distortion related to the value perception [benefits/(costs+risks)] of the nuclear generating option. In this concern, it has been noticed in a previous work that the general public devotes a good credibility to journalists. To get some insight on the surge spread of media agents producing news on subjects related to events of world repercussion, data was collected on Chernobyl and on Concorde plane accidents and an epidemiological model was adapted to quantify the more important parameters governing the population of journalists producing news on those subjects for a period of up 2 years from the event dates. The contagious potential and media persistence of nuclear related event was by far stronger and of slower decay than that of the other accident.

1. INTRODUCTION

The viability of nuclear power plants strongly depends on its public acceptance and questions like the risk perception, selective attention and retention of news about the nuclear energy has become a very important factor. The intense exposure of people to the news makes plausible the conjecture that this interaction is responsible for shaping up an important part of our collective common sense.

An adapted epidemiological model is used to study the magnitude and longevity of the repercussion, on the international media, of accidents or natural disasters with serious consequences. A news database containing many more than 50 of the most important international periodicals (news papers and weekly magazines), was surveyed to collect news about some emblematic events, like the Chernobyl accident - Ukraine (1986) and the crash of the Concorde airplane near Paris (2000).

The choice of the Google News repository [1] was very convenient since it encompasses a very large number of news paper and periodicals, in English language, whose news multiplication factors are very large. However most of the news source in the database is of USA origin and therefore events that have originated in or impacted the USA are usually more emphasized than others.

Our model uses parameters that can be related to: (a) the capacity and velocity to generate news of each targeted subject and (b) the longevity of its permanence on the media. The values of these parameters and their possible explanations related to the questions of risk perception, selective attention and selective retention of nuclear subjects by the media agents are also discussed in this work. In this analysis, a comparison of the media repercussions of above mentioned events are lined up and comparatively assessed. This comparison is used to show possible disproportions between the effects of a nuclear accident and its repercussion on the media as compared to accidents involving other segments of industrial activity.

This work is part of a series of studies intended to gather subsidies about what steps can be taken to mitigate this apparent distortion related to the value perception of the nuclear generating option. In this concern, a previous work [2] has noticed that the general public gives a good credibility to journalists. This fact and the results of the present work suggest that opinion surveys should be conducted with news agents to understand the causes of the observed distortions.

Epidemiological models that focus on the dynamics of traits transmitted between individuals, communities, or regions were the basis for the work. Applications of such models for social contagion process have been used since long [3-5] and more recently to the spread of ideas [6]. Recently this kind of application was done by Bettencourt et all [7] that in addition has presented a concise review of the more common models.

For the case at hand, it must be noticed that the spread of an idea, unlike a disease, is usually the result of intentional actions of the transmitter and or the adopter. Also direct or near contact is not necessary, as transmition can be mediated through written or spoken information or many media forms. Depending on the complexity of the concepts involved, a maturation or learning period may be needed. Moreover, a contaminated (influenced) person rarely wants to get rid of the idea and no automatic fighting mechanisms like the immune system will be acting to restore the influenced individual to its previous state. Additionally, it is currently considered as an asset to be a very informed (updated) person, that is, the contaminated state is a desired one.

The population under study is that of the media agents, that are journalists, columnists and contributors to the news papers and periodicals included in the Google database. The mechanism of contamination is that of news exposure. It is assumed that media agents scan a large number of news sources every day and, as soon as the initiating event gets noticed, it happens to attract the selective attention of some part of the population that, subsequently start to produce more news on or touching the subject.

2. MODEL FORMULATION

A simple model was chosen, but adequate to reasonably represent the focused reality and compatible with the amount and diversity of data that is available. State variables are considered solely function of time and they represent global or mean values quantities of interest.

The population under study, as commented before, is that of media agents (J), subdivided into the group of susceptible (S) – those that are not yet writing about the event and its generated subjects and the group of influenced (I) – those that are writing about it. No incubation period is considered because agility is a strong characteristic of news making. The total population (J) was assumed constant, since the lifetime of a subject under the news headlight is usually much shorter than the permanence of a news agent in the system database. The model can be described by the following equations:

$$\frac{d}{dt}S = -FS + \mu I \tag{1}$$

$$\frac{d}{dt}I = FS - \mu I \tag{2}$$

Where, differently from the common epidemiological models, F has a more complicated form,

$$F = \{R_o + R_1 \exp[-\beta(t - t_o)]\}\frac{Q}{N},\ for\ t \geq t_0\ and\ 0\ otherwise \tag{3}$$

Table 1. Notation definition.

Variable	Definition
J	Total number of news agents in the system
S	Susceptible news agents
I	Influenced news agents
N	Total news rate for a 7 day period (N=Q+P)
Q	Influenced news rate for a 7 day period
P	Non Influenced news rate for a 7 day period
F	Probability of producing influenced news after being exposed to it
R_1	Event's news surge coefficient
R_0	Event's long lasting coefficient
P	Average productivity of the news agents
M	Decaying constant (recovering from the influenced state)

Using the fact that $N \approx N_0$=constant and the definitions P=pS, Q=pI and N=pJ, the governing equations can be transformed to:

$$\frac{d}{dt}\hat{S} = -F(t)\hat{S} + \mu\frac{Q_o}{P_o}\hat{I} \tag{4}$$

$$\frac{d}{dt}\hat{I} = F(t)\frac{P_o}{Q_o}\hat{S} - \mu\hat{I} \tag{5}$$

$$F = \{r_o + r_1 \exp[-\beta(t - t_o)]\}Q, t \geq 0 \tag{6}$$

Where:

$$r_o = \frac{R_o}{N_o}, r_1 = \frac{R_1}{N_0}, \hat{S} = \hat{P} = \frac{P}{P_0} \; and \; \hat{I} = \hat{Q} = \frac{Q}{Q_0} \tag{7}$$

Setting t_0=0 and noting that $\hat{S} = \frac{N_0 - Q_0 \hat{I}}{P_0}$, a single equation for Î can be written:

$$\frac{d}{dt}\hat{I} = -\left[R_0 + R_1 e^{-\beta t}\right]\frac{Q_0}{N_0}(\hat{I})^2 - \left[\mu - \left(R_0 + R_1 e^{-\beta t}\right)\right]\hat{I} \tag{8}$$

3. DATA GATHERING AND TREATMENT

In order to build the time histories needed for the study, an automated procedure was scripted, using Python programming language [8], to go through all the sources and collect the data in an appropriate format for further processing with spreadsheet programs and MATLAB.

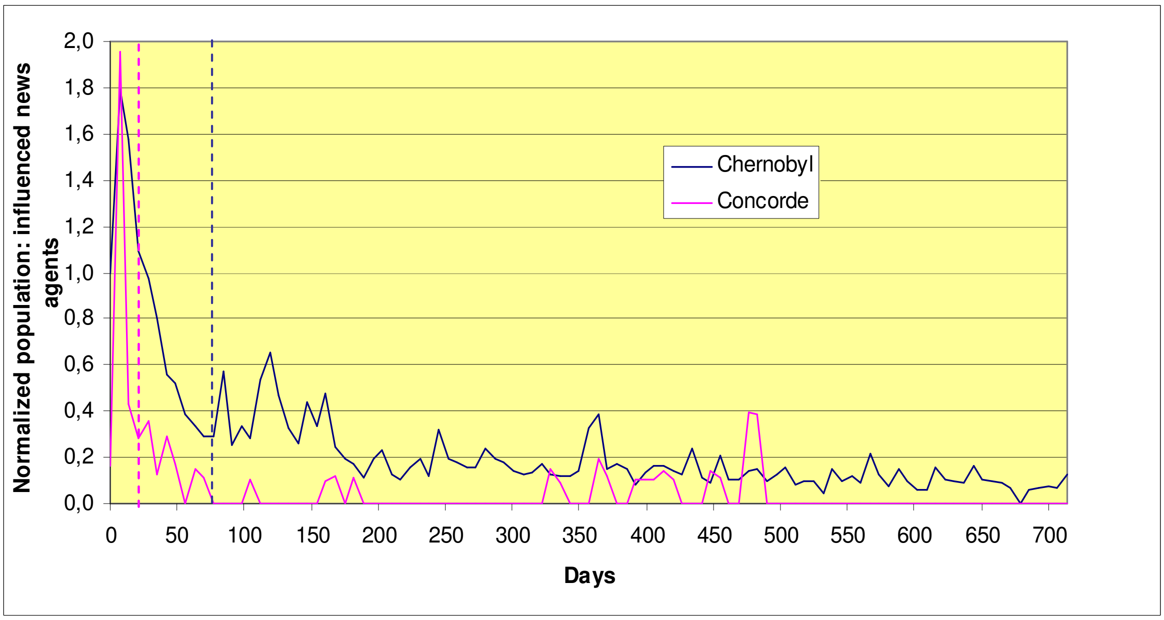

Figure 1. Normalized raw data for Chernobyl (Î) and Concorde accidents.

Note that a further normalization factor ($N_{0,concorde}$/ $N_{0,chenobyl}$) was applied to Concorde data to allow for direct comparison between the two curves, since the average amount of total news in 1986 was much smaller than that in 2000. The model needs a non null value of Q_0 and only accounts to a single large surge of news that comes directly from the originating event. All the other smaller surges are caused by secondary events like measures and initiatives taken by concerned governments and international organizations that generate a secondary cascade of related news. Given the date of these occurrences, additional terms can be included in the function F as products of step functions and functions similar to the one in equation (6).

Because of the above considerations, all secondary surges were treated as outliers. An algorithm that tries to mimic visual inspection was applied and all identified outliers were substituted by the proper smoothed fitting, based on a decreasing moving average. The smoothed data is then used for parameters identification, based on proper fitting of the analytical solution of equation (8). This is a Bernoulli type equation whose analytical solution, even with some approximation, is awfully complicated and the algorithms from curve fitting tool boxes can not handle it. It was then necessary to resort to another approximate scheme.

4. RESULTS

As the analytical solution was of no use for the identification of the system parameters (R_0, R_1, β, μ), approximated procedures were used to get four relations and solve for the parameters. The first was obtained with an analytical formula for the maximum value. The second from an approximate analytical solution for the decaying region that was fitted to the smoothed data, as it is exemplified in figure 2 below. Two more relations were obtained by using modified Euler's method to get a discrete approximation of equation (8), which was then applied to some data points of the region covering the beginning of the transient (the rise to and the decay from the first peak – 28 days for the Concorde and 77 for Chernobyl). This leads to an over determined system, which, through residue minimization, yields the values of the two constants that are related to the system parameters. This procedure allowed for the numerical determination of the system parameters.

Table 2 below presents a summary of the results of parameters identification.

Table 2. Summary of the results of parameters identification.

Parameter	Chernobyl	Concorde
R_0	6.1	7.0
R_1	0.157	1.2669
B	0.2606	0.165
M	6.105856	7.3896

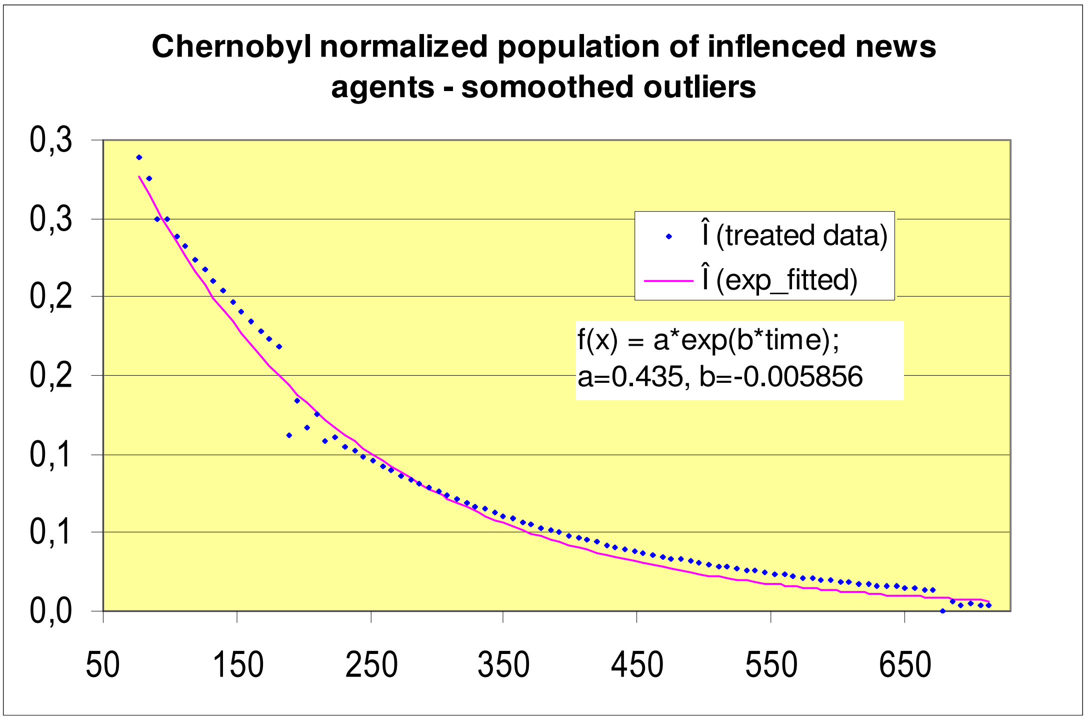

Figure 2. Decay region for normalized population of influenced news agents: smoothed data and the fitted approximated solution.

5. ANALYSIS AND CONCLUSIONS

Just by looking at figure 1, it is evident that a nuclear event gets much more selective attention and retention from the news agents than other events. Comparing the two curves and keeping the proportions, almost four times more news were generated for Chernobyl than for the Concorde accident. Also after 18 months, the media has gone completely blank on the Concord while the Chernobyl accident keeps being remembered until today. We have followed the database much longer and it is very rare when there is no Chernobyl news for a period of two or three weeks and on every “anniversary” of the event a large peak appears. As a matter of fact, 20 years after the Chernobyl event, a voluminous peak of news appeared on the media, almost as high as the original one.

Looking at equation (8), it can be noticed that the first term on the right hand side (RHS) is always negative and has a small influence, except on the very beginning of the transient where it is influential in the determination of the peaking time. The larger value of Chenobyl’s β was compensated by its much smaller value of R_1 causing the news on both events to peak at about the same period after their respective occurrence. If data from a finer collecting period was available, then a better measure of this time would be possible and little better parameters could be obtained. The second term on the RHS is the dominant one and a larger value of R_1 contribute to a greater peak value, as it is the case for the Concorde. The value of $\mu - R_0$ is determinant on how fast the transient dies off and this value is about 70 times higher for Chernobyl, what accounts for the much greater persistence of this subject on the news. The amazing fact was the susceptibility to resurgences in the case of Chernobyl and a more detailed and explicative model would be need to get more insight on this matter.

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