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Global physics: from percolation to terrorism, guerilla warfare and clandestine activities

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Abstract

The September 11 attack on the US has revealed an unprecedented terrorism with worldwide range of destruction. It is argued to result from the first worldwide percolation of passive supporters. They are people sympathetic to the terrorism cause but without being involved with it. They just do not oppose it in case they could. This scheme puts suppression of the percolation as the major strategic issue in the fight against terrorism. Acting on the population is shown to be useless. Instead a new strategic scheme is suggested to increase the terrorism percolation threshold and in turn suppress the percolation. The relevant associated space is identified as a multi-dimensional social space including both the ground earth surface and all various independent flags displayed by the terrorist group. Some hints are given on how to shrink the geographical spreading of terrorism threat. The model apply to a large spectrum of clandestine activities including guerilla warfare as well as tax evasion, corruption, illegal gambling, illegal prostitution and black markets.

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1. Defining the problem

Terrorism is a daily reality of horror for millions people in the world. Though it has always existed, its various expressions have been confined within quite precise areas. However, September 11 has revealed an unprecedented worldwide spreading of a given terrorist group. In response to such a new and permanent world threat,

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enormous military, police and information efforts are put in to try to curb this new terrorism. But in spite of a certain number of significant but always specific successes, the current terrorist challenge remains incredibly powerful and present.

It is worth to note, though at a different scale, the same holds true for more traditional terrorism like Basque, Irish and Corsican ones. After years of anti-terrorism fight they are still not eradicated quite to the contrary. It thus seems that the techniques used to fight terrorism are not adapted to the task. We suggest here focusing onto the social space in which the terrorists live, moves and acts. While much effort are devoted to study terrorist networks themselves, their structure, their means, their motivation, and their potential targets [1,2], very little is known about the human environment in which terrorists evolve. This space includes the terrorists themselves, their potential targets and also each one of us.

The following of the paper is organized as follows. Section 2 introduces the notion of social permeability to terrorism. The problem of the range of terrorism threat is then analyzed in terms of a percolation phenomenon. Traditional terrorism corresponds to non-percolating situations while international terrorism is associated to a worldwide percolation. Curbing terrorism using only military means is found to be ineffecient in Section 3. Section 4 suggests a new strategy to reduce current worldwide terrorism threat without hurting its passive supporters. Some hint on how to shrink the terrorism threat without massive military destruction are singled out. The last section discuss the universality of the model. In particular, it is applicable to guerilla warfare as well as tax evasion, corruption, illegal gambling, illegal prostitution and black markets.

2. The social permeability

We study the social permeability to terrorist individual moves. Permeability is used here to mean a free passage granted to a terrorist. It is assumed to result from passive support to the terrorist cause by some subset of the population. It holds without any involvement with either the terrorist group or its activities. It is an individual dormant attitude associated to a personal opinion. It does not need to be explicitly set. We denote these people as passive supporters. They just do not oppose a terrorist act in case they could (see Fig. 1). They go unnoticeable and most of them reject the violent aspect of the terrorist action. They only share in part their cause.

We are dealing here with a distribution of individual passivities in sharing independently a common sympathy towards the terrorist cause. Passive supporters do not need to communicate among them. Within a metaphorical representation, it can be said that each individual is looking only out of its own window, and not beyond. In this schematic way, each person occupies and observes some portion of a territory from its personal window. Each one can then decide to close or open its window curtains independently from each other at the time a suspect observation could be done.

Accordingly, to move freely and safely a terrorist must find a series of contiguous windows of closed curtains. To be reachable from the terrorist base a potential target must be connected by at least one continuous path of closed curtain windows. Since indeed each window state is independent of the terrorist will, it is in fact all of the

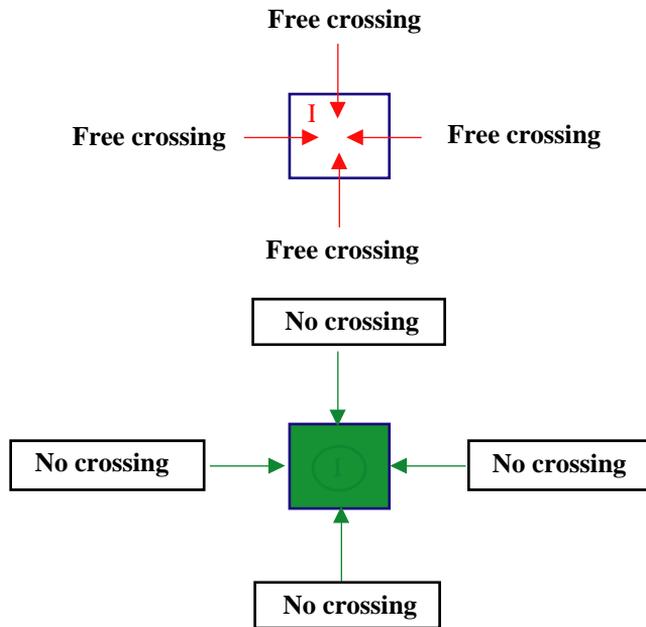


Fig. 1. On top a box in passive position, “closed curtains”, a terrorist can cross the box from any of its four sides. On bottom, a box in active position, “opened curtains”, a terrorist cannot cross safely. From any side the box is under scrutiny.

existing possible paths starting from the terrorist base, which determine the social space open to terrorist action. We call it the active open space (AOS). Several open spaces (OS) are expected to exist simultaneously but are not accessible to terrorist action, not being connected to the terrorist base. An illustration is given in Fig. 2

It is worth to note the huge majority of passive supporters will never be faced with a terrorist crossing by. These individual sympathies are dormant and almost never activated. It makes them invisible and non-identifiable within an anti-terrorist fight. They are completely scattered and randomly distributed on a given territory. Nevertheless, it is their geometrical aggregation by simple adjacent juxtaposition, which creates a series of labyrinths of permeable paths to terrorist moves. Notwithstanding their invisibility they determine the whole spectrum of targets potentially accessible to a terrorist action. In return any attempt to circumvent the terrorist threat cannot be successfully achieved without an evaluation of the current degree of social permeability. It is indeed both a strategic and a conceptual challenge. And here is where Physics can prove useful.

At this stage, applying percolation theory to terrorism social permeability appears quite natural in order to build a coherent and unified framework to the geographical deployment of terrorist action [3]. An illustration is exhibited in Fig. 3. Such a “Global Physics” approach [4] is part of a new growing trend of research [5]. In the last years a growing number of physicists have been studying social and political behaviors using concepts and tools from statistical physics [6–11]. Among others, a rumor formation

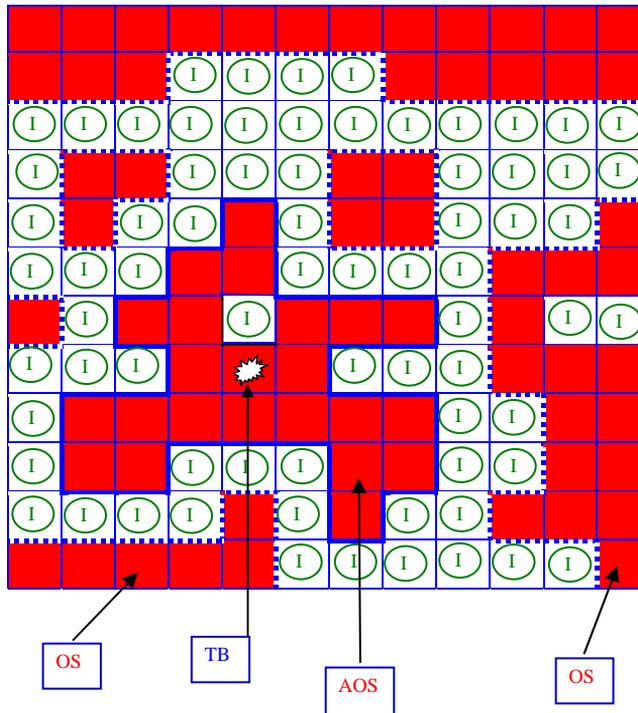


Fig. 2. A portion of 12×12 box grid. Passive supporters occupy dark boxes, their curtains are closed. The boxes are free to terrorist crossing. On the other hand, white boxes have open curtains, they are closed to terrorist movement. The nearest neighbor juxtaposition of dark boxes produces open spaces (OS) to terrorist action. But only the one including the terrorist base (TB) is active (AOS) with an effective terrorist threat. Other OS are inaccessible to terrorist action.

model has been used recently to explain the French Pentagon Hoax case [12]. Percolation theory [13] has been also used to describe connectivity problems [14,15]. Here it allows to connect the range of a given terrorism threat to the surrounding population attitude towards that specific terrorism [3]. However, it is worth stressing we are not investigating either the terrorist net itself or its internal mechanisms.

Moreover, our work does not aim at an exact description of terrorism complexity. Making some crude approximations allow exhibiting an essential characteristics of terrorism by linking its capacity of destruction to the surrounding population attitude. In particular, a target is set to be reachable once it is located within an area covered by a cluster of people who are passively consenting to the terrorist cause. The September 11 terrorist attack on the US is given an explanation in terms of the first worldwide percolation of such a cluster of passively consenting people [3]. On this basis some clues are obtained on how to curb terrorism threat without using large range military destruction [16].

3. The no solution scenario

At this stage, we can conclude that for a given territory the distribution and the size of passive supporter aggregated spaces yield the range of terrorist action. It is the relative value of the passive support p of the population compared to the value of the critical threshold p_c of the corresponding space, which determines the effective amplitude of the terrorist threat. If the passive support density is less than the percolation threshold ($p < p_c$), most of the territory is safe with only one restricted area under terrorist threat as shown in Fig. 3. At contrast as soon as the passive support density gets larger than the percolation threshold ($p > p_c$), all the territory falls under the terrorist threat (see Fig. 4).

However, while in a physical system the size is infinite, here the delimitation of the size of the territory considered is an essential data. One can have a density of passive

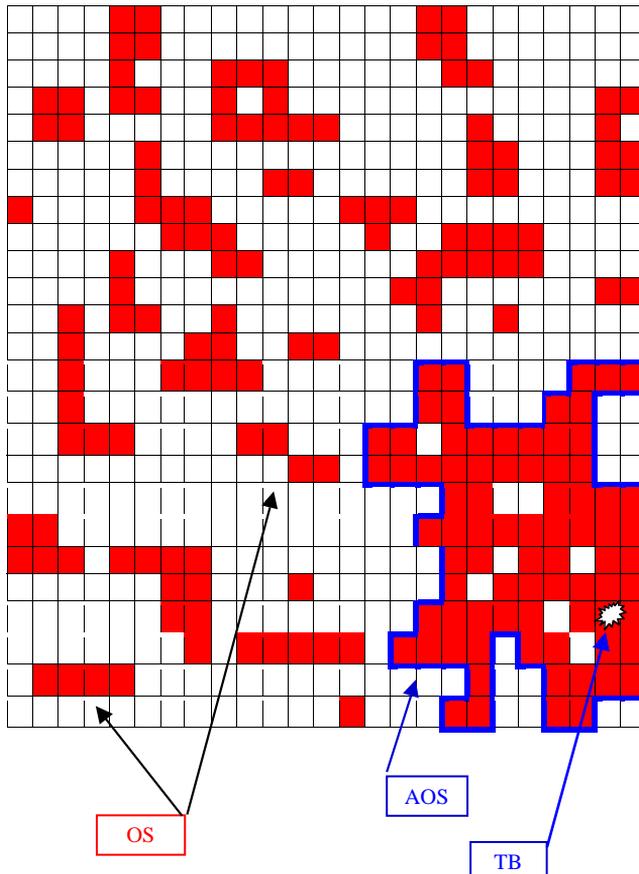


Fig. 3. A whole country sparse with little and disjointed OS of more or less wide. They are indicated in dark. The country is not under total terror threat.

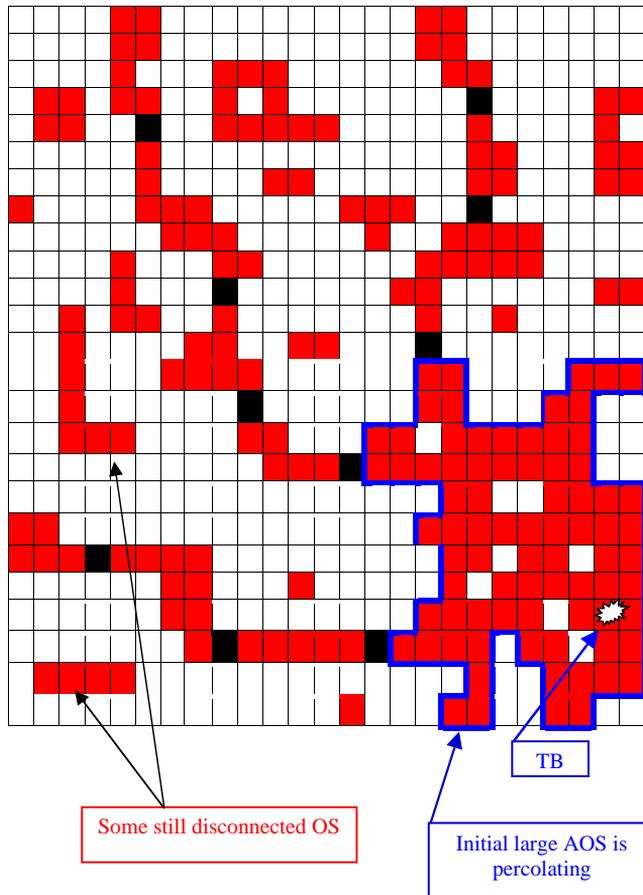


Fig. 4. Few additional passive supporters have appeared with respect to Fig 3. They are sufficient to create a percolation phenomenon. The whole country is now under total terror threat (shown in dark). Some sparse OS are still disjoined from the percolating cluster.

supporters p which satisfies the condition $p > p_c$ over a given geographical surface, and at the same time for a larger territory including the first one another density p satisfying $p' < p_c$. Indeed, always the number of passive supporters strongly decreases far from the home area of terrorism. That is the case of traditional terrorism already mentioned previously. For example in the Corsican case, terrorism does percolate at the level of the associated island but not at the level of France and even less at the world level.

Terrorist deployment thus obeys a universal scheme of activity with two phases, a percolating one and a non-percolating one. The only difference from one terrorism to another is the scale on which passive supporters are spread and the geographical area on which a percolation may take place. Obviously, if the change of scale does not

change the nature of the terrorist phenomenon, it modifies in a substantial manner the number of threatened people. It is clearly not a negligible difference. It is the case of September 11, which while revealing for the first time the existence of a world percolation showed that simultaneously from now on the whole world population is in danger.

In this context, for a territory under active terrorist threat, the lifting of the threat requires the suppression of the passive supporter percolation. If any destruction of a terrorist cell has obvious immediate advantages, it is without effect on the range and acuity of the threat. As soon as a new terrorist group is formed, it can strike again and immediately in all the space which remains accessible to its members. The strategic challenge is thus to bring back the condition $p > p_c$ to some new condition $p < p_c$ by lowering the density of passive supporters from p to p . Such a reduction induces a sudden shrinking of the whole territory accessible to terrorist action. Such a condition would reduce the AOS to a narrow geographical area. However, a solid implementation of such a programm on the military level is simply terrifying.

Therefore, an efficient military solution is completely unacceptable for ethical reason as well as from the point of view of moral and justice. Its feasibility would lead destroying a good part of the planet, although existing weapons of massive destruction would allow it. At the same time, any partial military solution appear to be useless since without effect on the level of the terrorist threat. At this stage, the conclusion from our study seems to show no hope in curbing terrorism. Accordingly, international terrorism would be a fatality against which nothing can be done. The anti-terrorist fight being limited to specific actions against the networks themselves. The current danger would thus remain unchanged with a world social permeability activated on request from a terrorist group.

4. The social space of terrorism

From above, no solution conclusion, reversing the usual physical scheme to suppress a percolation can prove useful in providing an alternative to the problem. Instead of changing the density of sites, a solution may exist on modifying the value of the percolation threshold itself without touching on the sites themselves.

Percolation thresholds depends primarily on two independent parameters, the connectivity of the network q and the dimension of the space d . For instance, for a square lattice with $q = 4$ and $d = 2$, $p_c = 0.59$. On the other hand, the cubic extension has $d = 3$, $q = 6$ and $p_c = 0.31$. The hypercube at four dimensions has $q = 8$ and $p_c = 0.20$. Increasing the dimension or and the connectivity creates more possible ways to connect from one site away. It leads to a reduction in the value of the percolation threshold. However, very few geometrical networks allow an exact calculation of their percolation threshold, most of them being calculated numerically.

For a social application of percolation, connectivity may be of the order of 16 for a dimension of a priori 2, the surface of the earth. It would correspond to an unknown network in Physics. Thus its percolation threshold is unknown. But fortunately, it turns out that few years ago a universal formula for all percolation thresholds was

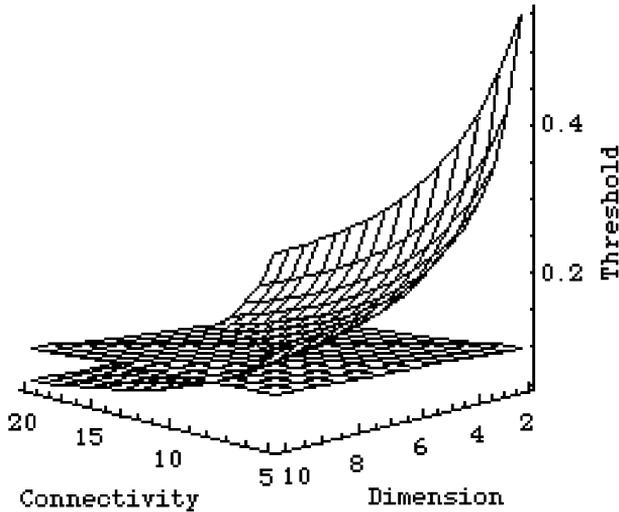


Fig. 5. Representation of the Galam–Mauger universal formula [17] for all the thresholds of percolation as function of connectivity and dimension. The formula writes $p_c = a[(d - 1)(q - 1)]^{-b}$, where d is the dimension, q the connectivity, $a = 1.2868$ and $b = 0.6160$.

discovered [17]:

$$p_c = a[(d - 1)(q - 1)]^{-b}, \quad (1)$$

where d is the dimension, q the connectivity, $a = 1.2868$ and $b = 0.6160$. The Galam–Mauger formula [17] yields with the percent close all known thresholds. In addition it can predict the value of the threshold for any network defined by the values of both its connectivity and dimension. The formula is shown in three dimensions in Fig. 5.

Having the formula, assuming $q = 16$ the challenge is to estimate the dimension of the terrorism social space. Here we make the hypothesis that in a social movement additional dimensions are produced by social paradigms in which individuals may position themselves in a similar way they do on earth. Thus it is necessary to consider the “flags” by which terrorists ground their fight in addition to the earth surface two dimensions [16]. To each one of these flags, people may identify with more or less support.

Typically for most terrorist groups, the first flag is a territorial claim either independence or autonomy. This flag constitute the first social dimension independent of those from the geography. Also, as soon as a terrorist group enters in action, it induces some state repression against it, which in turn determines a new additional flag. People may disapprove the repression hardness. That gives already four dimensions. Thus, any terrorist social dimension seems to be at least of a value four.

For $q = 16$ and $d = 4$ the Galam–Mauger formula [17] yields a percolation threshold at $p_c = 0.12$ to be compared with the value $p_c = 0.65$ for a square system with $q = 4$ and $d = 2$. It means that as soon as a terrorist causes is supported by more than 12%

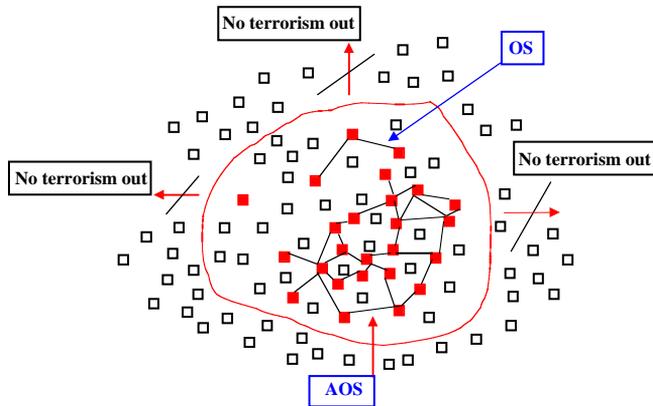


Fig. 6. Diagram for Corsica with an AOS, which percolates at the level of the island but with no possible extension beyond. Black squares are passive supporters while white ones are not.

of a population, the corresponding terrorist group can move with complete freedom on all the associated territory. This value is not very high making it certainly reached in traditional terrorism in Corsica, North Ireland and Basque area (see Fig. 6). It may explain the continuous on going incapacity of the respective authorities to cut short these terrorist groups.

In above cases, within the framework of our model, not much seem to be possible since a dimension of four is irreducible. It is the dimensional lower limit of any terrorist activity. Traditional terrorism of low dimension could thus keep alive, except finding how to yield a drop in the density of passive supporters down to less than 12%. It is interesting, and perhaps useful to note that, within the present framework the absence of repression would bring down the dimension at $d=3$ making the threshold up to 16%. Such numbers would suggest that for instance, in case the popular Corsican support for independence ranges between 12% and 16%, it is indeed the repression which allows it to percolate all over the Corsican territory.

With regard to the new international terrorism the situation seems qualitatively and quantitatively different. Indeed, it is difficult to believe it has a support of more than 10% of the world population. At the same time it appears to be clearly successful in having its passive supporters to percolate worldly. Using the Galam–Mauger formula [17], to carry out a percolation with only a few percent of people and a connectivity of 16 requires a space of higher dimension larger than the four value of traditional terrorism as shown in Fig. 7.

And indeed, what characterizes current international terrorism is the broad spectrum of flags on which it deploys its claims [16]. In addition to traditional territorial claims, it has at least a religious dimension, an ethnic dimension, a bipolarizing dimension of partitioning the world, a social dimension, a regional dimension and a historical dimension. That brings its social dimension to 10. Such a value results in a lowering of the percolation threshold down to only 6%, which becomes a more realistic estimate for its world support.

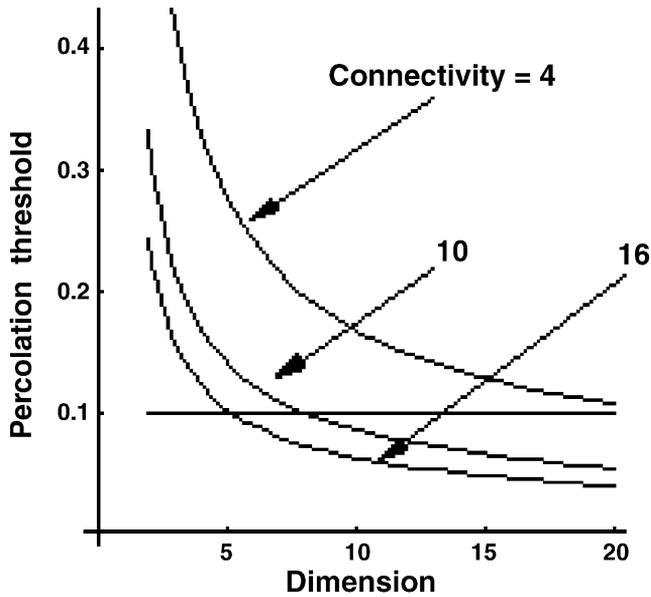


Fig. 7. Representation of the universal formula Galam–Mauger [17] for fixed connectivity as function of dimension. It is seen that the threshold values drop with dimension.

5. Hints for global terror curb

Current world terrorism by creating a large number of independent flags has drastically increased its potential range of world destruction. That process has enabled a world percolation of only few percent of passive supporters all over the world. But simultaneously, it provides hints to envision some solution in curbing current world threat. In particular, contrary to low-dimension terrorism for which a dimension reduction is impossible, here action becomes possible to reduce the number of dimensions deployed by international terrorism [16]. More specifically, political, economic and psychological actions should be capable to neutralize a certain number of these flags without use of military means.

For example, to lower the social dimension from $d = 10$ to 6 makes the threshold to soar from 6% to 10%. Such an increase would suppress at once the world percolation. Accordingly, terrorism would immediately reduce to only one area of the world as for other terrorism. Of course, the solid measures on how to put in action the flag neutralization process is out the scope of physicists. It requires an interdisciplinary collaboration with specialists in the other concerned disciplines.

At this stage the possibility of an efficient non-destructive large scale fight against international terrorism passes through a deep interdisciplinary research. What may turn a challenge may be more difficult than the fight against terrorism. Last but not least it is worth to restate the current analysis does not claim at an exact quantitative description of terrorism reality. It only aims in shedding a new light on linking passive individual

support to a terrorism cause and the associated range of action of the corresponding terrorist group.

6. From terrorism to guerilla warfare and underground activities

Our model to terror threat is indeed much more universal than the field of terrorism. First, we have to define more precisely what terrorism is. In particular, what is denoted terrorism by legal and institutional organizations is called freedom fights by other underground groups. Most of the time, terrorism is what the others do. Nevertheless, some consensus seems to exist along for instance the so called “Mitchell report”, which was accepted by both the Palestinian Authority and the Israeli Government, defining terror as attack on random, unarmed people.

While our model definitively apply for above definition, it also applies equally well to the murder of a specific target by a clandestine group, like the killing of Israel’s tourism minister Ze’evi, which is not terrorism in the Mitchell sense. Accordingly guerilla warfare may be a more appropriate word for violent activities modeled by the model.

Moreover, the same mathematics also applies to lots of other clandestine activities like tax evasion, corruption, illegal gambling, illegal prostitution, black markets, etc. Without undocumented immigrants, the economy of California might break down. On this basis we can conclude that we have presented indeed a universal model to clandestine cooperation. It would be now very fruitful to confront our general frame to real cases with data and facts But clearly such a tasks beyond the physicist skill.

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