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The article consists an application of the methodology of Systemic Geopolitical Analysis in the primary national-statist Complex of Syria, a country torn by crisis. Indicators are chosen from the four pillars of power according to Systemic Geopolitical Analysis with the aid of simple mathematical tools. The text aims not only to advance the application of the theoretical approach of Systemic Geopolitical Analysis but also to facilitate its perception from laureates of theoretical sciences, both humanistic and social sciences.

Proffessor I.Th. Mazis

Text

APPLICATION OF SIMPLE AND COMPOSITE INDICATORS OF THE FOUR GEOPOLITICAL PILLARS IN THE METHODOLOGY OF SYSTEMIC GEOPOLITICAL ANALYSIS: THE CASE OF SYRIA

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TABLE OF USED TERMINOLOGY/DEFINITIONS

Geographical space: Geography is 'the science that describes and analyzes physical space, as well as dialectical syntheses of this space with human societies which constitute human spaces. The production of these dialectical interactions is defined as primary, secondary and tertiary geographical spaces' (Mazis 2002, Mazis 2012).

System is the exact sum of the territorial units comprising Geopolitical Sub-systems which in turn are defined in relation to a specific **Geopolitical Factor** which is located in these Sub-systems and functions steadily producing results (Mazis 2002, Mazis 2012).

Complex is the wider from a spatial point of view geographical unity of the System (Mazis 2002, Mazis 2012).

Supra-system is the total of the Poles of International Power which influence the action of the Geopolitical Factors in the interior of the Sub-systems and the corresponding System which entails these (Mazis 2002, Mazis 2012).

Sub-system is the homogeneous territorial unity that corresponds to the action and function of a Geopolitical Factor (Mazis 2002, Mazis 2012).

Geopolitical Indicator is the quantification of a subject under study, i.e. data that show the power redistribution in the System/Complex. The Geopolitical Indicator is defined as $\Gamma\Delta t = d(t)/D$, where d(t) is the καταμετρούμενο μέγεθος in a given time t and D is a level of identification for each indicator. Geopolitical Indicators can be composite or simple (Mazis 2012).

CHAPTER 1: THE BASIS

1.1 Methodological background of Systemic Geopolitical Analysis

The basis of Systemic Geopolitical Analysis, as well as a primary scientific and methodological duty of a geopolitical analyst consists of: i) definition of the Geographical Complex to be studied on the map, ii) definition of the Geopolitical Factor through which power redistribution is manifested in the interior of the Geographical/Geopolitical Complex, and iii) formulation of a model of tendencies of power redistribution in the said Complex. Therefore, an attempt is made to predict power redistribution in the said Complex.

The principle of geographic definition is the common basis of reference for all physical and human-made interactions in the framework of all Special and Complete Composite Spaces (See Section 2.1: Definitions and Types of Spaces). These interactions take place in a specific Geographical Complex which forms the basic System of our analysis.

It is therefore important to categorize all these interactions, so as to be able afterwards to define the entities and the tools of mathematical models constructed by each analyst. As we have already noted[1] a geopolitical analysis should research, i.e. locate, describe and study, the specific characteristics, the structure and the function of the four fundamental Pillars (categories) or the *components* of Power which form and prescribe the final power balance and its distribution in the intra-systemic framework of the Geographical/Geopolitical Complex, as well as influences and mutations exerted on these Pillars from the external environment in relation to the Complex. These influences are exerted from the International Poles of Power which comprise the Supra-system; each of these Poles influences in a positive or negative manner the given Geopolitical Factor. The latter in turn influences the four Pillars in the interior of all the Sub-systems of the System under study.

This procedure should be carried out using as a first step selection, spatial location, quantitative and qualitative presentation of the Pillars, as well as quantification and de-

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1. **Mazis, I. Th.** (2002). "La geopolitica contemporanea: basi e defi nizioni di metodo", DADAT, Universita degli Studi di Napoli-Federico II, Dipartimento delle Dinamiche Ambientali e Territoriali, *Saggi di Geopolitica*, (pp. 1–11), Napoli. also in: Mazis, I. Th., *Dissertationes Academicae Geopoliticae*, papazissis, 2015, 195-206

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Mazis, John Th. & Daras, Nicholas J. (2015c), **"**Systemic geopolitical modeling Part 2: subjectivity in prediction of geopolitical events", *GeoJournal [*Springer Verlag], vol. 80. no. 4, ISSN 0343-2521, DOI 10.1007/s10708-015-9670-2 (Author's personal e-copy)

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scription of their systemic function, in the framework of the structure of the national-statist actor (Table 2).

The Geopolitical Pillars are therefore four:

i. Defense/Security, including all geopolitical indicators of defensive nature, for example methods in battlefields, weapons' distribution, power of strikes, range of weapon systems, technological indicators, dynamics of internal fronts and destabilization of the political system, asymmetric threats and internal security, terrorism and its origins, correlation with international collective systems of security etc.

ii. Economy, including all geopolitical indicators of economic nature used in geopolitical analysis, as GDP, deficit, national debt, trade balance of imports and exports, indicators of production and productivity, unemployment rates etc. Available energy resources, natural resources and deposits can also be used in this framework.

iii. Politics, including all geopolitical indicators of political nature, as political system of government, stability of political system, relations between centre and periphery etc.

iv. Culture/Information, including all geopolitical indicators of cultural nature and information extraction and distribution, as education and its quality, access to education for specific social groups, soft power of national cultural models, influences on the national framework exerted by international cultural models, culturalist models, ethnic actors, disinformation, propaganda etc.

CHAPTER 2: DIALECTICAL THEORY OF GEOGRAPHICAL SPACES

2.1 Definitions and Types of Spaces

In the case of Modern Systemic Geopolitical Analysis, as proposed by Ioannis Th. Mazis, the subject consists of Geographical Space and its special causal[2] and resultative[3] forms.

Distinction of these geographical spaces is made in relation to their place in the dialectical process of their production as wholes of specific ontological characteristics which in turn are defined on a quantitative and qualitative level. These geographical sub-spaces function either as the dialectical cause in the secondary and tertiary phase of the dialectical process or as the dialectical effect of the relevant phase in the framework of each corresponding dialectical phase.

These spatial dialectical 'results' describe the specific mathematical and therefore abstract flat sub-spaces; the latter gather groups of homogeneous characteristics (defensive, economic, political and cultural) of the subject under study inside a limited space, as defined on a cartographic level. These sub-spaces override each other constituting as a whole the 'totality' of characteristics of the geographical space under study. Therefore, they are linked ontologically to the identity of power of space, i.e. to the Geopolitical Complex, a term explained below.

This causal interpretative mechanism allows us to create four theoretical axioms which in turn function as definitions of the four Types of Spaces:[4]

1. Primary Spaces, which are causal and infrastructural spaces.

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2. I.Th. Mazis, *Geopolitics: Theory and Application*, Papazissi/ELIAMEP, Athens 2002, 34-7.

3. I.Th. Mazis, *Geopolitics*, op.cit.

4. I.Th. Mazis, *Geopolitics*, op.cit.

The notion of infrastructural space refers to the characteristics of the fundamental notion of Althusserian sub-structure: "*In the first place, it is impossible to think the existence of this totality in the Hegelian category of the contemporaneity of the present. The co-existence of the different structured levels, the economic, the political, the ideological, etc., and therefore of the economic infrastructure, of the legal and political superstructure, of ideologies and theoretical formations (philosophy, sciences) can no longer be thought in the co-existence of the Hegelian present, of the ideological present in which temporal presence coincides with the presence of the essence with its phenomena. And in consequence, the model of a continuous and homogeneous time which takes the place of immediate existence, which is the place of the immediate existence of this continuing presence, can no longer be regarded as the time of history.*

As a first approximation, we can argue from the specific structure of the Marxist whole that it is no longer possible to think the process of the development of the different levels of the whole in the same historical time. Each of these different 'levels' does not have the same type of historical existence. On the contrary, we have to assign to each level a peculiar time, relatively autonomous and hence relatively independent, even in its dependence, of the 'times' of the other levels. We can and must say: for each mode of production there is a peculiar time and history, punctuated in a specific way by the development of the productive forces; the relations of production have their peculiar time and history, punctuated in a specific way; the political superstructure has its own history . . . ; philosophy has its own time and history . . . ; aesthetic productions have their own time and history . . . ; scientific formations have their own time and history, etc.

Each of these peculiar histories is punctuated with peculiar rhythms and can only be known on condition that we have defined the concept of the specificity of its historical temporality and its punctuations (continuous development, revolutions, breaks, etc.). The fact that each of these times and each of these histories is relatively autonomous does not make them so many domains which are independent of the whole: the specificity of each of these times and of each of these histories -- in other words, their relative autonomy and independence – is based on a certain type of articulation in the whole, and therefore on a certain type of dependence with respect to the whole".[5]

According to Mazis's proposal these Primary Spaces can be further divided into two types:

1a. Natural Space, a primary space in the dialectical process and thereof a causal and infrastructural space. Natural Space refers to flora and fauna, terrain, subsoil, climate, natural resources and natural deposits.

1b. Elementary Human Space, a primary space in the dialectical process and thereof a causal and infrastructural space. Elementary Human Space refers to man-made elements, as social structures, population concentrations, demographic composition and other demographic data etc. Elementary Human Space does not include national-statist or ethnic formations, as these have been produced on a secondary level, through economic, cultural and political processes which are self-evidently secondary.

2. Secondary Spaces, which are resultative, supra-structural spaces and can be further divided into two Sub-spaces:

2a. Political Space, a secondary space in the dialectical process, which is supra-structural space and a dialectical product of interactions of conservation, reproduction, rupture and evolu-

5. L. Althusser & E. Balibar, *Reading Capital*, trans. B. Brewster, NLB, London 1970. 99-100. Cf. A. Lipietz, *Le capital et son Espace*, Maspero, Paris 1977, 17-20.

tion of the systems of material or immaterial production related to social formations of any scale.[6]

2b. Economic Space, a secondary space in the dialectical process, which is supra-structural space.[7]

3. Tertiary Spaces, which are resultative supra-structural spaces and can be further divided into two Sub-spaces:

3a. Cultural Space, a dialectical product of the synthesis between the Economic Space and the Political Space.

3b. National-statist Space and Ethnic-statist Space, dialectical products of the synthesis between the Political Space and the Cultural Space.[8]

4. Synthetic Spaces, which are spaces of a higher dialectical order and can be further divided into two types:

4a. Complete Synthetic Spaces or Complete Spatial Grids, perceived as the sum of the dialectical primary, secondary and tertiary characteristics, as defined above.

4b. Special Synthetic Spaces or Special Spatial Grids, which are the result of the sub-structural overlapping of the primary spatial entities, i.e. of Natural Space and Elementary Human Space, and of the corresponding secondary and tertiary structural characteristics, as these have been defined above.

CHAPTER 3: THE METHOD

3.1 Outline of the General Methodological Proposal of Systemic Geopolitical Analysis[9]

3.1.1 Decoding of the title of the subject under study

The title of the topic of a study of geopolitical analysis (should) define(s) the facts and the objectives of our problem. In particular it defines:

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6. For a more detailed theoretical presentation concerning the Political Space see I.Th. Mazis, *Geopolitics*, op.cit, 35-6.
7. For a more detailed theoretical presentation concerning the Economic Space according to a Marxist view and the differences between the Marxist and the methodological Geographical Dipole see I.Th. Mazis, *Geopolitics*, op.cit., 35.
8. For a more detailed theoretical presentation concerning the Political Space see I.Th. Mazis, *Geopolitics*, op.cit, 36-7.
9. **Mazis, I. Th.** (2002). "La geopolitica contemporanea: basi e defi nizioni di metodo", DADAT, Universita degli Studi di Napoli-Federico II, Dipartimento delle Dinamiche Ambientali e Territoriali, *Saggi di Geopolitica*, (pp. 1–11), Napoli. also in: Mazis, I. Th., *Dissertationes Academicae Geopoliticae*, papazissis, 2015, 195-206
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i. The boundaries of the Geographical Complex which constitutes the geographical area to be analyzed.

ii. The (internal or external) space of the Complex under study as a field of distribution or redistribution of power due to the activity of a specific Geopolitical Factor.

iii. The aforementioned Geopolitical Factor, the impact of which may affect the distribution of power, within or outside this Geographical Complex.

3.1.2 Identifying the boundaries of the Geopolitical Systems under study

At this stage, we identify the boundaries of the Geopolitical Systems within which we are going to study the activity (or activities) of the Geopolitical Factor defined in the title. There are three levels of Systems defined according to the extent of the geographic area they refer to:

i. Sub-systems, which are subsets of the Systems.

ii. The System, which belongs to the geographical space of the Geographical Complex under study or is identical to the Geographical Complex under investigation.

iii. Supra-Systems, containing the main System under study as a subset along with other Systems that may not concern the current analysis. In order to define the Geopolitical System/Complex in question in terms of geographical extent, a qualitative trait is also required, one that will identify -with its very presence, its forms and its level of influences- the extent of the geographical areas of the above-mentioned Systemic levels/scales, i.e. Supra-system, System and Sub-systems. Without this qualitative trait and its particular characteristics, the definition of the three aforementioned levels of Systems would not only be impossible, but also meaningless.

3.1.3 Defining the fields of influence of the Geopolitical Factor

Once we have defined the three levels of Systems, we should identify the fields of geopolitical influence of the Geopolitical Factor under study. In other words, we should determine which combination of the four fields or Geopolitical Pillars of the given Geopolitical Factor we are going to investigate, always within the framework of the chosen Systemic scale (e.g. on the level of System or on the level of Sub-systems).

In order to follow a rational order in the examination of the influences of the Geopolitical Factor we should start the investigation from the Supra-systems level and continue with the System level. Such a sequential order should prove that, in most cases, if the analysis of the influences of the Geopolitical Factor on the level of the Sub-systems is completed, and if Sub-systems have been correctly identified, the respective analysis on the level of the whole System is also completed.

The Geopolitical Pillars are as follows:

a) Defense/Security.

b) Economy.

c) Politics.

d) Culture/Information.

The aforementioned Pillars are examined in terms of power, e.g. economic power, political power, cultural power, power of information dissemination etc. It should be reminded that each of these Geopolitical Pillars can be analyzed in its structural components; these are called Geopolitical Indicators and are divided into simple and composite.

3.1.4 Identifying the function of the Geopolitical factor for the specific Pillars of influence

At this stage we are going to identify the **geopolitical trends-dynamics** for each designated Sub-system. These trends are identified only and exclusively in terms of power and examine the following issues:

1) The Pillars (Defense, Economy, Politics, Culture/Information), where the Geopolitical Factor under study prevails and consequently already determines or may determine their attitude within the framework of each Sub-system. This type of conclusion is defined as **positive Sub-systemic component trend of power** of the Geopolitical Factor in the interior of the Sub-system and defines on a qualitative level the total effect of Power of the whole System, as the latter consists of Sub-systems.

2) The Pillars which absorb the influence of the Geopolitical Factor and consequently the whole attitude of the Sub-system is not influenced. This form of conclusion is defined as **zero Sub-systemic component trend of power** of the Geopolitical Factor in the interior of the Sub-system and defines on a qualitative level the total effect of Power of the whole System, as the latter consists of Sub-systems.

3.1.5 Synthesis of a Model of Power Redistribution Trends

Definition: The term *synthesis* refers to the procedure through which we can detect the Resultant Power Trend of the given Geopolitical Factor on whichever final systemic scale (e.g. Sub-system, System or Supra-system level)[10].

In case we have detected and defined the particular power components (of the Geopolitical Factor at hand) on the Sub-system level, and our objective is the Component of the System on the systemic level, then the stage of synthesis is complete on the level of the System.

The vector sum of the **Power Performances** of each Geopolitical Pillar in the framework of each Sub-system presents the final Power Performance of each Sub-system. The vector sum the Power Performances of all Sub-systems of the System creates the final component of the whole System and being of a vector nature also the final trend of power

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10. **Mazis, I. Th.** (2002). "La geopolitica contemporanea: basi e defi nizioni di metodo", DADAT, Universita degli Studi di Napoli-Federico II, Dipartimento delle Dinamiche Ambientali e Territoriali, *Saggi di Geopolitica*, (pp. 1–11), Napoli. also in: Mazis, I. Th., *Dissertationes Academicae Geopoliticae*, papazissis, 2015, 195-206

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redistribution in relation to the Geopolitical Factor under study and its effect in the specific System.

3.1.6 Conclusions: of a Geopolitical Model

The last stage of the geopolitical analysis is that of Conclusions. At this stage we have to create a model of power redistribution and to describe the geopolitical dynamics, to which the component of power of the Geopolitical Factor under study subjects the attitude of the System examined, in the context of the Supra-system.

We must stress that: At this stage of the study, as in any other stage of the aforementioned geopolitical analysis, we make no proposals nor project our own wishes of a national, ideological, cultural nature. Geopolitical analysis is completely oriented to real and verified facts.

i. At this stage, we discover: structures, actions, functions, influences, forms and dynamics of the Geopolitical Factor and describe them.

ii. We also describe how these forms and dynamics affect the attitude of the System.

Proposals do not form part of a Geopolitical Analysis. They are part of the geostrategic approach which may be carried out, only if asked and by exploiting the results of the geopolitical analysis preceding[11]

CHAPTER 4: EPISTEMOLOGICAL BASIS OF THE METHOD

4.1 Lakatosian Structure of the Systemic Geopolitical Analysis

4.1.1 Definition of the fundamental axiomatic assumptions (elements) of the hard core of the geopolitical research program

According to the Lakatosian meta-theoretical approach, as it has been summed by C. Elman and M.F. Elman, the hard core (fundamental assumptions) constitutes the basic premise of a research program. The hard core is protected by negative heuristics, in short, by the rule that prohibits researchers to contradict the fundamental ideas of a given research program, i.e., with the hard core of the program (as an attempt to address new empirical data which tend to invalidate the theory). Any alteration of the hard core would lead to creation of a new research program, as the hard core defines the primary characteristics of the research program. It is thus clear from a Lakatosian point of view that alteration of the hard core leads to alteration of the research program.

According to these observations we conclude the following[12]

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11. **Mazis, I. Th.** (2015a). *Analyse metathéorique des Relations Internationales et de la Geopolitique. Le Cadre du Neopositivisme, Papazissis,Athens (en français)*

12. **Mazis, I. Th.** (2002). "La geopolitica contemporanea: basi e definizioni di metodo", DADAT, Universita degli Studi di Napoli-Federico II, Dipartimento delle Dinamiche Ambientali e Territoriali, *Saggi di Geopolitica*, (pp. 1–11), Napoli. also in: Mazis, I. Th., *Dissertationes Academicae Geopoliticae*, papazissis, 2015, pp. 195-206

Mazis, I. Th. (2008). [China-Bei Jing], "Writing Methodology of a Geopolitical Analysis [Structure, Concepts and Terms]",C.I.I.S.S./I.A.A.: China Institute for International Strategic Studies (C.I.I.S.S.)/Defence Analyses Institute (D.A.I.), Cooperation on Defence Diplomacy, Athens/Beijing at May 2008, *Defensor Pacis* (Vol. 23, pp. 53–59) (Special, Issue I.A.A./C.I.I.S.S.), Special Issue

i. The **first fundamental axiomatic assumption** (element 1), which constitutes the center of the hard core of the geopolitical research program, is that all the characteristics of the aforementioned Sub-spaces of the Geographical Complex are countable or can be counted, through the countable results which they produce, e.g., the concept of democratic dimension of a polity (according to Western standards, since there are no other). This is a concept identified as a Geopolitical Index within the framework of the secondary resultative Political Space, as defined above. The Geopolitical Index can be counted by means of a multitude of specific results, which it produces in the society where this form of political governance is applied. Such are for example the number of printed and electronic media in the specific society, the number of political prisoners or their absence, the level of protection of children of single-parent families, the number of reception areas for immigrants and density of the latter per m2 etc., etc. These figures are classified, systematized and evaluated according to their specific gravity concerning the function of the figure to be quantified, and constitute the Geopolitical Indices that we are going to present and examine in detail below.

ii. The **second fundamental axiomatic assumption** (element 2) of the hard core of the systemic geopolitical program is that, within the framework of the geographical area under study, there exist more than two consistent and homogeneous Poles which are: i) self-determined (as to what they consider gain and loss for themselves), and also in relation to their international environment; ii) hetero-determined, uniformly and identically to their international environment which is determined by the international actors that dwell within them and their common systemic relation is their characteristic[13]

4.1.2 Definition of the auxiliary hypotheses of the protective belt of the geopolitical research program[14]

According to the Lakatosian meta-theoretical approach, a research program has the protective belt of complementary hypotheses, i.e., proposals that are subject to control,

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Mazis, I Th. (2013). "L'Analyse Geopolitique Systemique:Propositions Terminologiques et Definitions Metatheoriques selon l'exigence metatheorique lakatienne", *Geographies, Geopolitiques et Geostrategies Regionales*, 1(1),21–32

Mazis, I. Th. (2015a). *Analyse metathéorique des Relations Internationales et de la Geopolitique. Le Cadre du Neopositivisme, Papazissis,Athens (en français)* pp. 335-336.

Mazis,I. Th. (2016). "L'Analyse Géopolitique Systémique: Propositions terminologiques et définitions Métathéoriques selon l'exigence Métathéorique Lakatienne", *Civitas Gentium* 4:1 (2016), pp. 51-52.

13. **Mazis, I. Th.** (2002). "La geopolitica contemporanea: basi e definizioni di metodo", DADAT, Universita degli Studi di Napoli-Federico II, Dipartimento delle Dinamiche Ambientali e Territoriali, *Saggi di Geopolitica*, (pp. 1–11), Napoli. also in: Mazis, I. Th., *Dissertationes Academicae Geopoliticae*, papazissis, 2015, pp. 195-206

Mazis, I. Th. (2008). [China-Bei Jing], "Writing Methodology of a Geopolitical Analysis [Structure, Concepts and Terms]",C.I.I.S.S./I.A.A.: China Institute for International Strategic Studies (C.I.I.S.S.)/Defence Analyses Institute (D.A.I.), Cooperation on Defence Diplomacy, Athens/Beijing at May 2008, *Defensor Pacis* (Vol. 23, pp. 53–59) (Special, Issue I.A.A./C.I.I.S.S.), Special Issue

Mazis, I. Th. (2015a). *Analyse metathéorique des Relations Internationales et de la Geopolitique. Le Cadre du Neopositivisme, Papazissis,Athens (en français)* pp. 335-336.

Mazis,I. Th. (2016). "L'Analyse Géopolitique Systémique: Propositions terminologiques et définitions Métathéoriques selon l'exigence Métathéorique Lakatienne", *Civitas Gentium* 4:1 (2016), pp. 52-53.

14. **Mazis, I. Th.** (2002). *Ibid.*, **Mazis, I. Th.** (2008). *Ibid.,* **Mazis, I. Th.** (2015a). *Ibid*., p. 336, **Mazis, I. Th.** (2016). *Ibid.*, pp. 53-54.

adaptation and re-adaptation, and that are replaced when new empirical data come to light. Moreover, given Lakatos dictum that in the positive heuristic of a programme there is, right at the start, a general outline of how to build the protective belts and that "*a research program* [is defined] *as degenerating even if it anticipates novel facts but does so in a patched-up development rather than by a coherent, pre-planned positive heuristic*"[15], we should proceed by formulating a (provisional) definition of that protective belt for our research program. Consequently, following the Lakatosian meta-theoretical paradigm, the protective belt of the geopolitical research program should be defined complemented with the following five (e1-5) auxiliary hypotheses-elements[16]:

First auxiliary hypothesis of the protective belt of the geopolitical research program (element e1): the size of the power is analyzed in four fundamental entities (Defense, Economy, Politics, Culture/Information), which in turn are analyzed in a number of Geopolitical Indices. These Geopolitical Indices, as already mentioned, are countable or can be counted and they are detected and counted in the internal structures of the those Poles that each time constitute the Sub-systems of the Geographical Complexes under geopolitical analysis.

Second auxiliary hypothesis of the protective belt of the geopolitical research program (element e2): the above Poles constitute fundamental structural components of an international, and always changing, unstable System.

Third auxiliary hypothesis of the protective belt of the geopolitical research program (element e2): these Poles express social volitions or volitions of the deciding factors that characterize the international attitude of the Pole. Consequently, these poles can be national states, collective international institutions (e.g., international collective security systems, international development institutions, and international cultural institutions), economic organizations of an international scope (i.e., multinational companies, bank consortia) or combinations of the above which, however, present uniformity of action within the international framework concerning their systemic function.

Fourth auxiliary hypothesis of the protective belt of the geopolitical research program (element e4): This consists of the aforementioned causal and causative notions of the Primary, Secondary and Tertiary Spaces, as well as their combinations (Complete and Special Composite Spaces).

Fifth auxiliary hypothesis of the protective belt of the geopolitical research program (element e5) is the premise that the international system has a completely unstable and changing structure.

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15. **Lakatos, I.** [1971b]: "History of Science and its Rational Reconstructions", in R.C. Buck and R. S. Cohen (*eds.*)*: PSA 1970, Boston Studies in the Philosophy of Science, 8,* p. 125.

16. **Mazis, I. Th.** (2002). "La geopolitica contemporanea: basi e definizioni di metodo", DADAT, Universita degli Studi di Napoli-Federico II, Dipartimento delle Dinamiche Ambientali e Territoriali, *Saggi di Geopolitica*, (pp. 1–11), Napoli. also in: Mazis, I. Th., *Dissertationes Academicae Geopoliticae*, papazissis, 2015, pp. 195-206.

Mazis, I. Th. (2008). [China-Bei Jing], "Writing Methodology of a Geopolitical Analysis [Structure, Concepts and Terms]",C.I.I.S.S./I.A.A.: China Institute for International Strategic Studies (C.I.I.S.S.)/Defence Analyses Institute (D.A.I.), Cooperation on Defence Diplomacy, Athens/Beijing at May 2008, *Defensor Pacis* (Vol. 23, pp. 53–59) (Special, Issue I.A.A./C.I.I.S.S.), Special Issue

Mazis, I. Th. (2015a). *Analyse metathéorique des Relations Internationales et de la Geopolitique. Le Cadre du Neopositivisme, Papazissis,Athens (en français)* pp. 337-339.

Mazis,I. Th. (2016). "L'Analyse Géopolitique Systémique: Propositions terminologiques et définitions Métathéoriques selon l'exigence Métathéorique Lakatienne", *Civitas Gentium* 4:1 (2016), pp. 53-54.

Sixth auxiliary hypothesis of the protective belt of the geopolitical research program (element e6): Systemic Geopolitical Analysis aims to formulate conclusions of praxeology, shortly, of some theory of practice[17], and lead to the construction of a predictive model of the trends of power redistribution and in no case to offer guidelines for action under some specific national or polarized perspective. The latter is nothing but the geostrategic biased synthesis, not a geopolitical analysis. This equals the use of the results (of the model of power redistribution) of the geopolitical analysis and follows the stage of geopolitical analysis.

It must be noted that the historicity of the elements of the research program is represented by the cultural formations developing in the context of the fourth Geopolitical Pillar. Thus, their measurability is possible in the same way as is for the rest of the Geopolitical Pillars that have a qualitative nature, by means of the Geopolitical Indices of the Cultural Pillar.

4.1.3 Positive heuristics of the Geopolitical Research Program

1. At this stage it should not be forgotten that replacing a set of auxiliary assumptions by another set, is an intra-program problem shift, since only the protective belt and not the hard core is altered. The intra-program problem shifts should be made in accordance with the positive heuristics of the problem that is with a set of suggestions or advices that function as guidelines for the development of particular theories within the program.

2. It should also be emphasized that, a key concern of the Geopolitical Research Program is to describe the suggestions to the researcher that will determine the content of the positive heuristics of the Program in question. Without them, it is impossible to assess the progressivism of the geopolitical analysis according to the necessary novel empirical content expected in our analytical spatial paradigm (model).

Given these necessary clarifications concerning the elements of the positive heuristics of the Geopolitical Research Program, we mark the following:

i. The methodology of each theoretical approach should remain stable until a possible detection of continuous degeneration.

ii. The requirement of predictive ability and the expansion of the empirical basis of the theoretical approach should be maintained.

iii. The empirical facts should constitute the final measure for assessing competitive theoretical approaches of the same set (research program).

iv. The facts that have been used to test a theoretical approach should not be the only ones used for verifying this approach but, with the progress of time of research, the testing of the theoretical approach should be refereed also with facts that derive from the expansion of the empirical basis of the given approach[18].

4.1.4 Definition of Systemic Geopolitical Analysis

We cite the full definition of Systemic Geopolitical Analysis of a geographical system of uneven distribution of power as "the geographical method that studies, describes and predicts

17. **Aron, R.** (1967). "Qu'est-ce qu'une theorie des relations internationales?", *Revue francaise de science politique*, 17(5)
18. **Mazis, I. Th.** (2002). *op. cit.*, **Mazis, I. Th.** (2008). *op. cit.,* **Mazis, I. Th.** (2014). *op. cit.*, **Mazis, I. Th.** (2015a). *op. cit.*, pp. 343-344, **Mazis, I. Th.** (2015b). *op. cit*., pp. 1071-1072, **Mazis,I. Th.** (2016). *op. cit.*, pp. 57-58.

the attitudes and the consequences ensuing from relations between the opposing and distinct political practices for the redistribution of power as well as their ideological metaphysics, within the framework of the geographical complexes where these practices apply"[19].

Systemic Geopolitical Analysis is an important methodological tool used in research of international relations and relative redistributions of power (defensive, economic, political and cultural) on all Systems of national social formations of the planet (nation-statist and ethnic), as well as in research of the phenomena and entities influencing the formation, the structure and the interactions of power between these formations.[20]

The aforementioned definition and connected remarks make it clear that there exist two fundamental categories of information which should be processed during the analysis of a System. The first category consists of the geographical characteristics (spatial data) of a System described by coordinates. The second category is information related to Power and is represented by indices related to Defense/Security, Economy, Politics and Culture/Information.

The present study aims to emphasize those quantitative methodological tools that can assist geopolitical analysts in their application of Systemic Geopolitical Analysis. The scheme below is a summary and practical methodological tool that assists researchers, i.e. a praxeological approach of the Method of Systemic Geopolitical Analysis.

First step of the researcher/research institute

Read carefully the title of the research and locate on the map the geographical complex of the research. Recognize the geopolitical factor in the title of the research and divide the area in question into subsystems and supra-system, based on the geopolitical factor of the research. Sum up the subsystems and set the boundaries of the geopolitical system**.** Define the type of geographical space which applies to the research.

Second step of the researcher/research institute

Define/choose the geopolitical pillars of power according to which the researcher or the research institute is going to analyze the action and operation of the geopolitical factor regarding the redistribution of power.

The four geopolitical pillars of power are:

1. Defense/Security
2. Politics
3. Economy
4. Culture/Information

Third step of the researcher/research institute

After the selection of the geopolitical pillars of power, choose similar simple or complex geopolitical indicators (i.e. –concerning the Defense/Security geopolitical pillar of power, simple geopolitical indicators could be military spending in US dollars or the number of military bases. An example of compound geopolitical indicator could be the projection of

19**. Mazis, I. Th.** (2002). *op. cit.*, p. 21, **Mazis, I. Th.** (2015b). *op. cit.*, p. 1063, **Mazis, John Th. - Daras, Nicholas J.** (2015c), **"**Systemic geopolitical modeling. Part 2: subjectivity in prediction of geopolitical events", *GeoJournal, [Springer Verlag]*, vol. 80, no 4, ISSN 0343 2521, DOI 10.1007/s10708-015-9670-2 (Authors personal e-copy)**, Mazis, I. Th.** (2016). *op. cit.*, p. 59.

20. I.Th. Mazis, *Post-theoretical Critique of International Relations and Geopolitics: The Neo-positivist Framework,* Papazissis, Athens 2012 [in Greek].

defense force in a geographical complex). Please note that the researcher/research institute should put limitations in the research and choose accordingly those geopolitical indicators he or she deems essential.

Fourth step of the researcher/research institute

After the selection of the geopolitical indicators (measurable data) it is easy to make a simple, comparative presentation or to use simple and complex quantitative tools in data processing. If the researcher is acquainted with Mathematics and Informatics, he or she can use the first three sections of the following Geoinformatics fields. The fields of Geoinformatics are:

1. Neural Networks
2. Fuzzy Logic
3. Artificial Intelligence Transmitters
4. Genetic Algorithms
5. Cellular Automation

After the application of the aforementioned Geoinformatics fields, the "geopolitical model of redistribution of power" has been created by the results. This model forms the starting point of the geostrategic synthesis. The geopolitical model of redistribution of power is the pure outcome, after the data process. However, the different approach of the geopolitical model involves a specific point of view. This is the geostrategic synthesis which should not be confused with the Systemic Geopolitical Analysis and the production of the "geopolitical model of redistribution of power".

The validity of the geopolitical model depends on the commitment and dedication that the researcher or research institute will demonstrate in the systemic geopolitical analysis. Moreover, it depends on the critical choice of data and the use of valid sources. Last but not least, it is reinforced by interdisciplinarity, a really essential notion for the production of the "geopolitical model of redistribution of power", in a range of topics.

Better understanding of the issues raised in this study, along with presentation of the methodology, is presented below in a case study concerning Syria.

CHAPTER 5: A MODEL CASE STUDY[21]

5.1 Analysis of a title on the map

The case study that shall be used as an aid to understanding of the Methodology applied is titled 'The Role of the Islamist Movement (ISIS and other Islamist movements) in the national-statist system of Syria: Interpretative value of Defense/Security Pillar'.

5.2 Definition of the Geopolitical Factor

Using the title the analyst has defined the state of Syria as Geographical Complex/System. The Geopolitical Factor that can influence distribution of power in the interior or the

21. Quantitative calculation of indicators in the model of the Syrian Complex is hypothetical and used as a point of elaboration of our thesis.

exterior of the Geographical Complex is the Islamist Movement in general (ISIS and other Islamist movements).

5.3 Definition of Sub-systems according to the Geopolitical Factor

The analyst using his knowledge of empirical data concerning the geographical area and with the aid of the following map of power distribution in the territory of the Syrian Republic makes a distinction of the component parts into four (4) Sub-systems:

i. Sub-system A: Regime forces (pink color)
ii. Sub-system B: Kurdish forces (yellow color)
iii. Sub-system C: Other Islamist forces (green color)
iv. Sub-system D: ISIS forces (purple color)

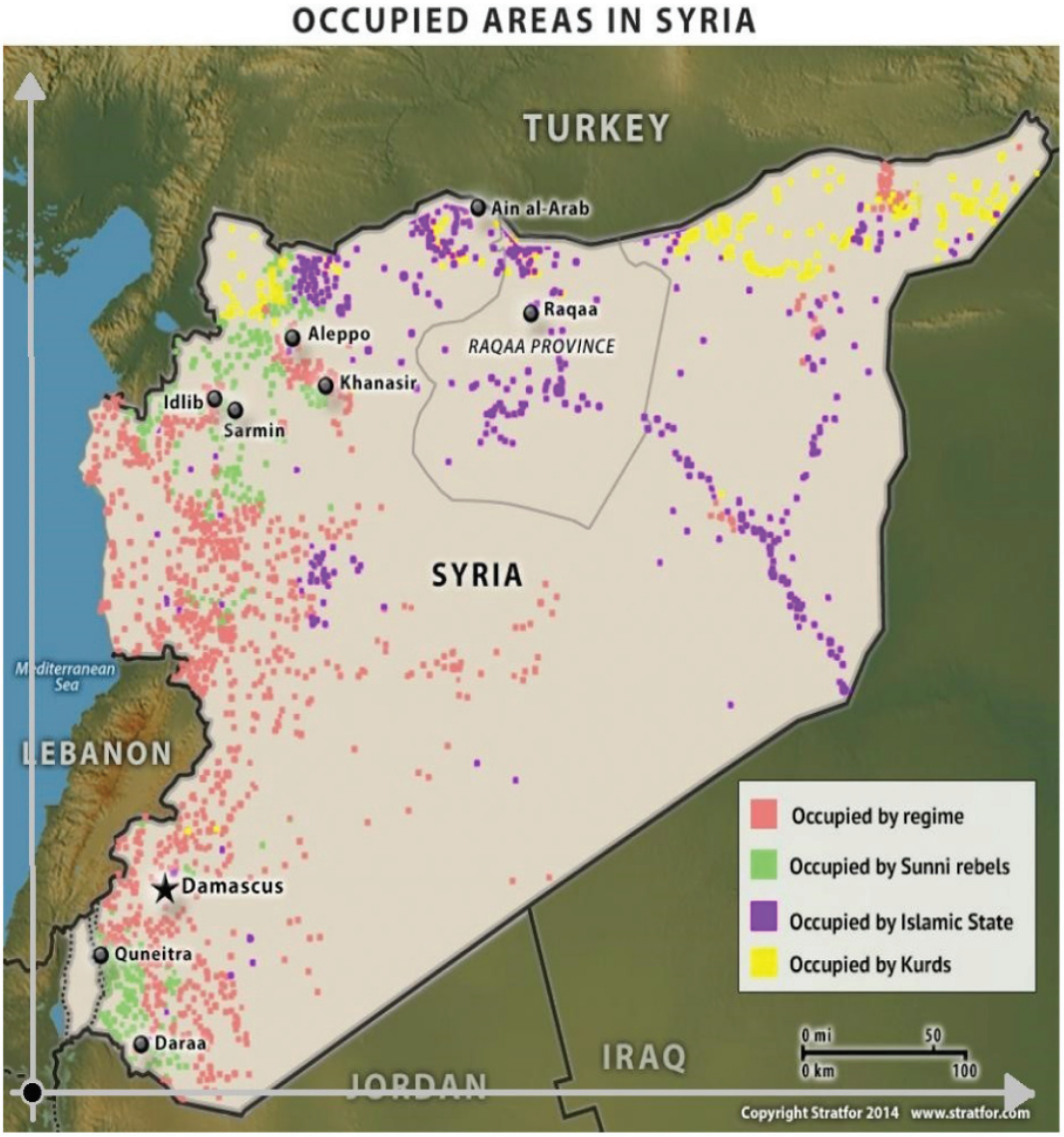


Fig. 1: Power distribution in Syria (sources: Strafor 2014, cartographical intervasion: I. Th. Mazis, A. Digas)

5.4 Selection of Geopolitical Pillar for the analysis

After the definition of Sub-systems the analyst defines the geopolitical trends/dynamics in terms of Power (Pillars) which can be influenced by the Geopolitical Factor. In the specific case study the analyst chooses the Geopolitical Pillar Defense/Security.

This choice has been carried out on the basis of the knowledge of the empirical data of the Geographical Complex by the analyst. Using this knowledge the analyst has deemed the Geopolitical Pillar Defense/Security as the most important. The analyst chooses indices in order to describe the Pillar in an effective and thorough manner. Selection of indices is being made in an inclusive way, so that as many as possible dimensions and parameters of the Pillar can be assessed and information overlapping can be avoided. It should also be noted that the analyst needs to resort to a unified data base which shall be updated and shall draw information from reliable sources.

5.5 Selection of Geopolitical Indicators of Pillar Defense/Security

Geopolitical Indicators (figures and statistical data) chosen by the analyst for the description of the Pillar Defense/Security are:

i. Military Expenditure (% of GDP).

ii. Armed Forces Personnel (Total).

iii. Arms Imports (SIPRI trend indicator values).

Remark: Many more indicators can be chosen in order to conduct an analysis. Still the use of 3 to 5 Geopolitical Indicators is deemed as sufficient in the context of desirable timeframe for extracting information and maintaining the quality of analysis.

These Geopolitical Indicators used for the Pillar Defense/Security for each of the Subsystems defined by the analyst. The Table below presents the values of these Geopolitical Indicators for the period 2010-2016.

Table 1: Geopolitical Indicators of Defense/Security (2010-2016) for the System of Syria[22]

Sub-system	Regime			Kurds		
Geopolitical Indicator	Military Expenditure (% of GDP)	Armed Forces Personnel (Total)	Arms Imports (SIPRI trend indicator values) (€)	Military Expenditure (% of GDP)	Armed Forces Personnel (Total)	Arms Imports (SIPRI trend indicator values) (€)
2010	5.26	401,000	276,000,000	2.05	125,000	9,000,000
2011	5.21	403,000	193,000,000	2.33	150,000	12,000,000
2012	6.25	403,000	298,000,000	2.29	190,000	25,000,000
2013	5.54	178,000	368,000,000	3.45	210,000	30,000,000
2014	5.03	178,000	371,000,000	6.69	180,000	60,000,000
2015	4.39	178,000	361,000,000	6.54	190,000	98,000,000
2016	4.10	280,500	350,000,000	5.90	202,000	127,000,000

22. Values of the indicators for the period 2010-2016 presented in Table 1 are not real ones, as we mentioned above. This is due to the fact that no unified data base presenting the situation in Syria in an exact manner is available. The figures are random and are used exclusively for better understanding of the theory.

Sub-system	Sunni Rebels			Islamic State		
Geopolitical Indicator	Military expenditure (% of GDP)	Armed Forces Personnel (Total)	Arms imports (SIPRI trend indicator values) (€)	Military expenditure (% of GDP)	Armed forces personnel, total	Arms imports (SIPRI trend indicator values) (€)
2010	0.64	45,000	2,500,000	4.52	190,000	98,000,000
2011	0.82	64,000	8,000,000	4.86	250,000	150,000,000
2012	1.10	25,000	7,000,000	5.03	208,000	210,000,000
2013	0.90	33,000	11,000,000	6.24	174.000	320,000,000
2014	1.30	41,000	9,000,000	5.89	150,000	400,000,000
2015	1.01	64,000	14,000,000	6.89	120,000	250,000,000
2016	1.25	50,000	35,000,000	5.20	115,000	220,000,000

CHAPTER SIX: A MATHEMATICAL MODEL FOR THE TOTAL TREND OF POWER REDISTRIBUTION

As mentioned in the previous chapter, Systemic Geopolitical Analysis is an important methodological tool for exploring international political events and relations, associated with redistribution of power within a system of national social formations in the world.[23]

Therefore, when building a model to calculate global power redistribution in a System, management and analysis of information into two main categories is required. The first category includes geographical characteristics (spatial information) that describe the System and the individual Sub-systems. The second category includes information associated with Power' this information is organized into Geopolitical Indicators relayed with the four Pillars of Power (Defense/ Security, Economy, Politics and Culture/ Information).

6.1 Spatial Information

Spatial information is derived primarily from the science of Cartography, which provides an analyst with all necessary information concerning the terrain of a specific area. In addition to the above, of high value is the presentation of the special characteristics of a System in combination with terrain morphology, in the form of composite maps. These maps may contain further useful information for an analyst, such as the dispersion of an army in the field, location of critical strategic installations and government buildings, supply channels, etc. This information can be represented either as a) dots or as b) surfaces.

Figure 2 is a representative example of a composite map that depicts dispersion of Assad's Regime, Islamic State, Kurds and Sunni Rebel forces (Sub-systems) in Syrian System as dots, while in the next map the same information is represented as surfaces.

23. I.Th. Mazis, *Post-theoretical Critique of International Relations and Geopolitics*, op.cit.

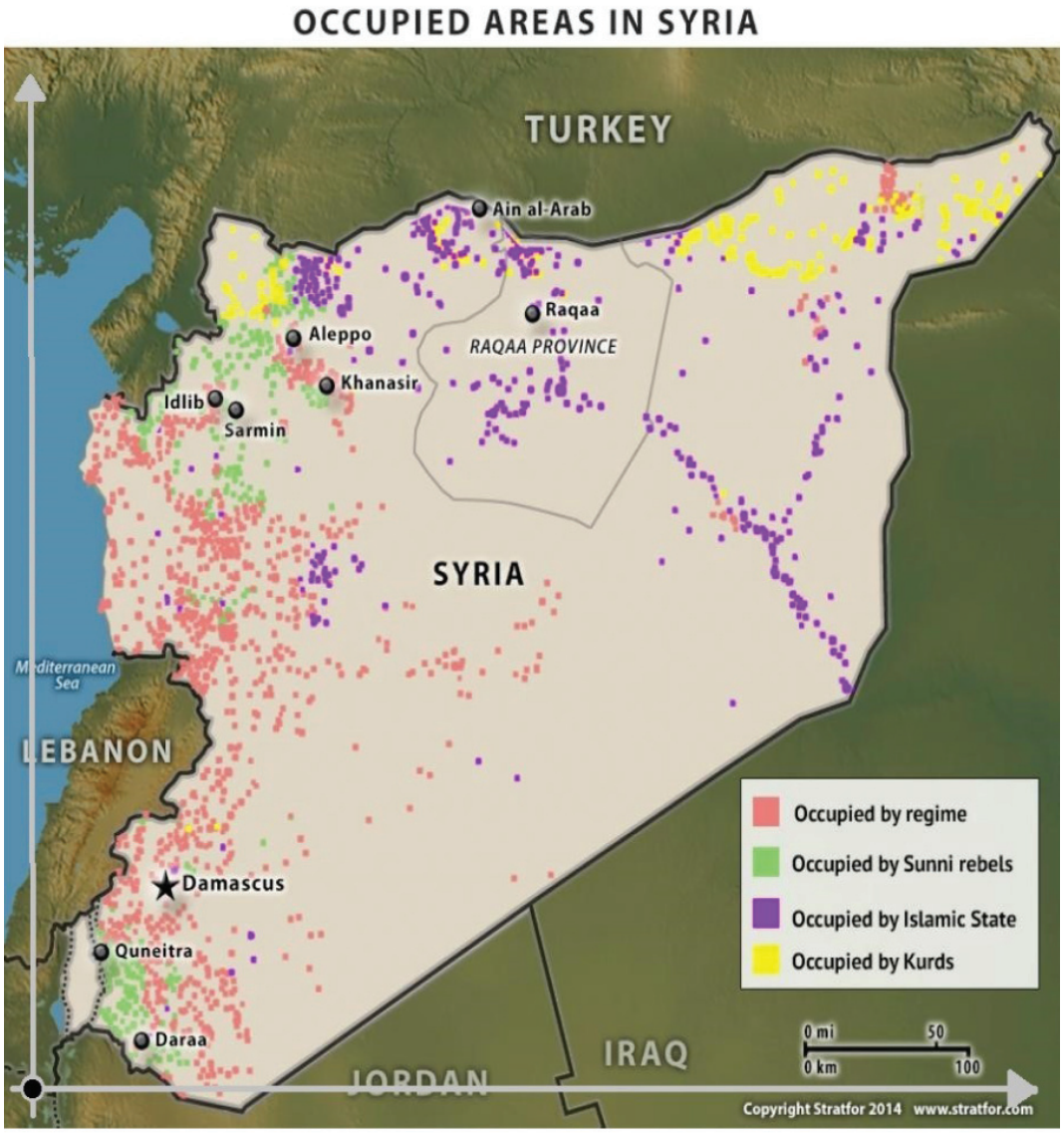


Figure 2: Map with information in the form of dots (sources: Strafor 2014, cartographical intervasion: I. Th. Mazis, A. Digas)

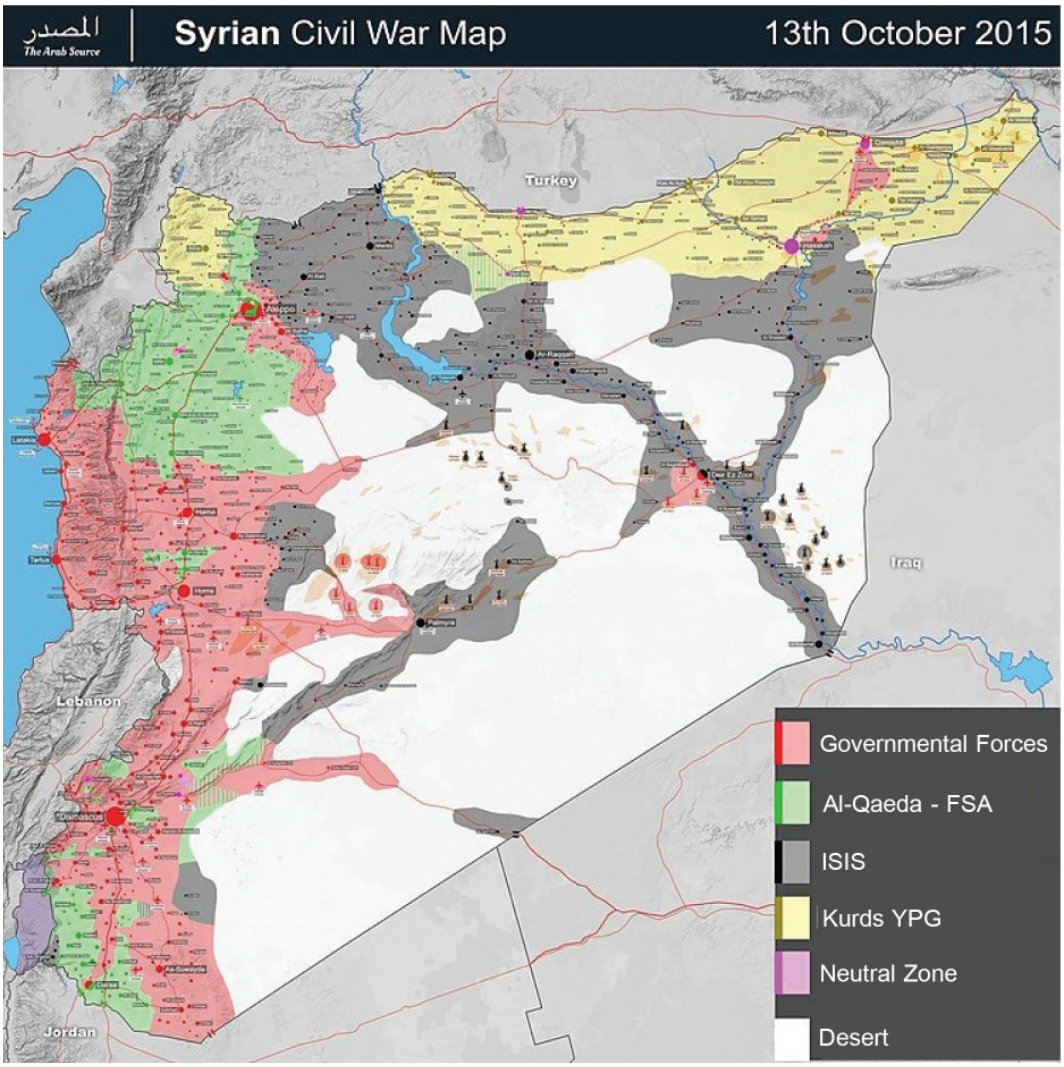


Figure 3: Map with information in the form of surfaces

All spatial information obtained from the aforementioned maps is used in order to determine the **spatial Center of Gravity** of:

- the individual Sub-systems represented on the maps (Assad's regime, ISIS, Kurds, etc).
- The System in total (Syria).

Depending on how the spatial information is represented, as *dots* or as *surfaces*, different calculation methodologies are used in order to determine the center of gravity.

6.2 Spatial information represented as dots

In this case, spatial information is represented as dots on the map, each one of them identified by some coordinates. Accordingly, the Center of Gravity of a Sub-system, itself a dot, is identified by a specific longitude and latitude. To calculate these coordinates, it is sufficient to calculate the average of all the longitudes and latitudes of the dots contained in the Sub-system.

Alternatively, if the study object is a certain area, then a system of coordinates has to be defined, which will contain the System in total, and a point of reference according to which all coordinates will be measured. Figure 4 shows the point of reference (black dot, bottom left) and the system of coordinates used above in Figure 2. Additionally, it is important to define the axes measurement unit in order. The most common unit to measure distance is kilometers (km), but it could be miles also.

Application to the Case Study

In order to understand better the remarks above, we choose in random ten (10) dots contained in the Sub-system Regime from the map in Figure 4, the coordinates of which were determined on the basis of the reference point (black dot) and presented in the Table below.

Table 2: Representative dots of Sub-system Regime

Sub-system A: Regime		
Dot	Abscissa (X) (km)	Ordinate (Y) (km)
1	137	27
2	143	100
3	504	493
4	23	328
5	433	145
6	193	190
7	109	239
8	110	32
9	392	150
10	25	138

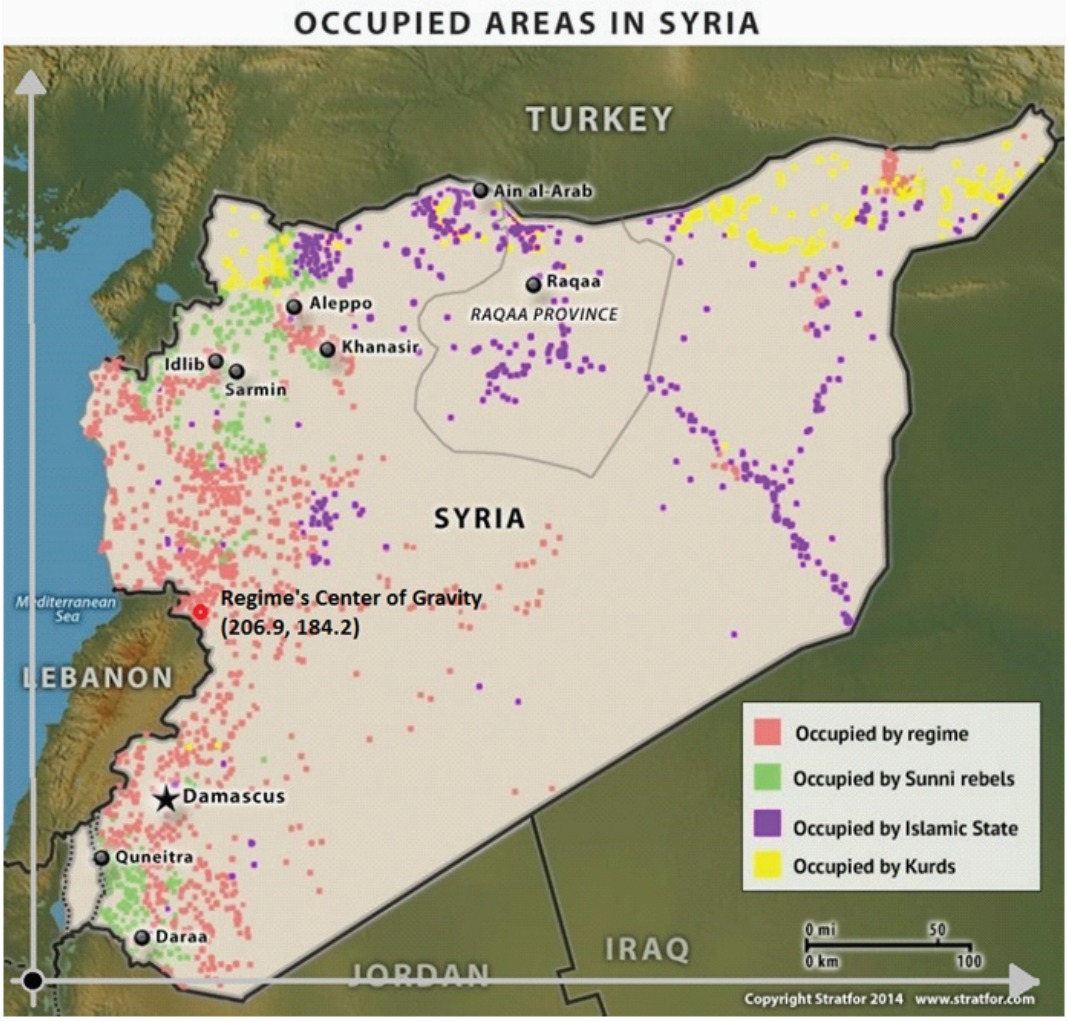


Figure 4: Center of Gravity of the Sub-system Regime (sources: Strafor 2014, cartographical intervasion: I. Th. Mazis, A. Digas)

If we add the abscissas of all the above dots, i.e. the values of the second column of Table 1 and divide them by the number of these dots -in our case ten (10)- the ensuing result is the **abscissa (X) of the Sub-system's Center of Gravity**.

$$X = \frac{137+143+504+23+433+193+109+110+392+25}{10} = 206.9$$

Similarly, if we add the ordinates of all dots, i.e. the values of the third column of table 1 and divide them by the number of dots, the ensuing result is the **ordinate (Y) of the Sub-system's Center of Gravity**.

$$Y = \frac{27+100+493+328+145+190+239+32+150+138}{10} = 184.2$$

Therefore, the Center of Gravity of the Sub-system Regime is (X = 206.9, Y = 184.2), as shown in Figure 4.

Another issue that arises from the analysis of data is the type of information that each dot represents. In the map above although at first sight each dot seems to have the same

information (dispersion of forces for each of the Sub-systems), it gives no information whatsoever about the nature of the forces involved. The latter may consist of Infantry, Artillery or Special Forces; even if we knew that all dots were Infantry units, no information is incorporated about the crowd or the equipment of the soldiers. A military unit equipped with special weapons at a particular point on the map, could be critical information, which should shift the Center of Gravity of a Sub-system. The new Center of Gravity calculated by the integration of the entire information is called **Balanced Center of Gravity**.

For this reason an analyst, in accordance with his judgment and experience, should predetermine and assign gravity factors for each of the dots, depending on the type of information one wishes to incorporate.

For a better understanding of the above, we return again to the ten indicative dots for the Sub-system Regime; only this time we have additional data about the type of units represented by the dots, as shown in Table 3.

Table 3: Indicative dots and type of units for the Sub-system Regime

Sub-system Regime			
Dot	**Type**	**Abscissa (X) in km**	**Ordinate (Y) in km**
1	Infantry	137	27
2	Armored Tanks	143	100
3	Infantry	504	493
4	Engineers	23	328
5	Special Forces	433	145
6	Special Forces	193	190
7	Engineers	109	239
8	Armored Tanks	110	32
9	Armored Tanks	392	150
10	Infantry	25	138

The analyst, therefore, rates each type of unit on the basis of its importance on the Pillar of Defense/Security, in a scale from 1-10, based on his experience and judgment. The results of this evaluation are shown in Table 4.

Table 4: Gravity factors of military units

Type of Military Unit	Gravity Factor (scale 1-10)
Infantry	2
Engineers	6
Armored Tanks	8
Special Forces	9

Combining information contained in Table 4 with data in Table 3 produces the following results presented in Table 5:

Table 5: Indicative dots, types and gravity factors of the units of the Sub-system Regime

Sub-system Regime				
Dots	Type	Factor	Abscissa (X) in km	Ordinate (Y) in km
1	Infantry	2	137	27
2	Armored Tanks	8	143	100
3	Infantry	2	504	493
4	Engineers	6	23	328
5	Special Forces	9	433	145
6	Special Forces	9	193	190
7	Engineers	6	109	239
8	Armored Tanks	8	110	32
9	Armored Tanks	8	392	150
10	Infantry	2	25	138
	Sum of Factors	**60**		

Calculation of the Balanced Center of Gravity for the Sub-system Regime is made by adding the product of the abscissas of all dots, with their relevant factors and by dividing these by the sum of the factors - in our case sixty (60). The ensuing result is the abscissa the Regime's Balanced Center of Gravity.

$$X = \frac{2*137+8*143+2*504+6*23+9*433+9*193+6*109+8*110+8*392+2*25}{60} = 215.3$$

Similarly we add the ordinates of all dots, i.e. the values of column 3 of Table 2 and divide them by the sum of Factors. The ensuing result is the ordinate of the Balanced Center of Gravity for the Sub-system Regime.

$$Y = \frac{2*27+8*100+2*493+6*328+9*145+9*190+6*239+8*32+8*150+2*138}{60} = 166.4$$

Therefore, the Balanced Center of Gravity for the Sub-system Regime is (215.3, 166.4) and compared with the Center of Gravity found at the beginning (206.9, 184.2), it is shifted closer to Damascus, which is the Center of Gravity, as shown in the map of Figure 6.

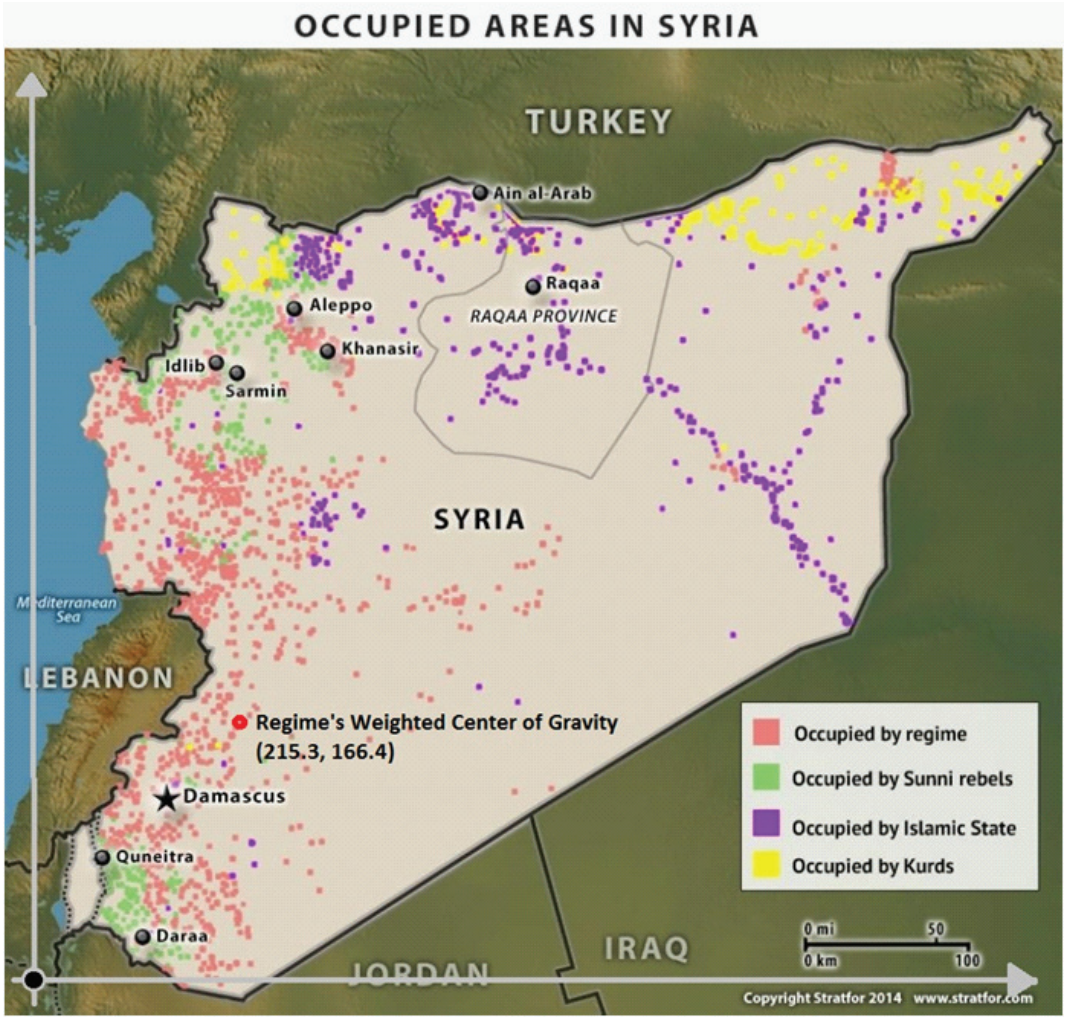


Figure 6: Balanced Center of Gravity for the Sub-system Regime (sources: Strafor 2014, cartographical intervasion: I. Th. Mazis, A. Digas)

6.3 Spatial information represented as surfaces

In this case spatial information is shown in the form of surfaces. Usually these surfaces have an indeterminate shape and follow the morphology of the terrain, as shown in Figure 7.

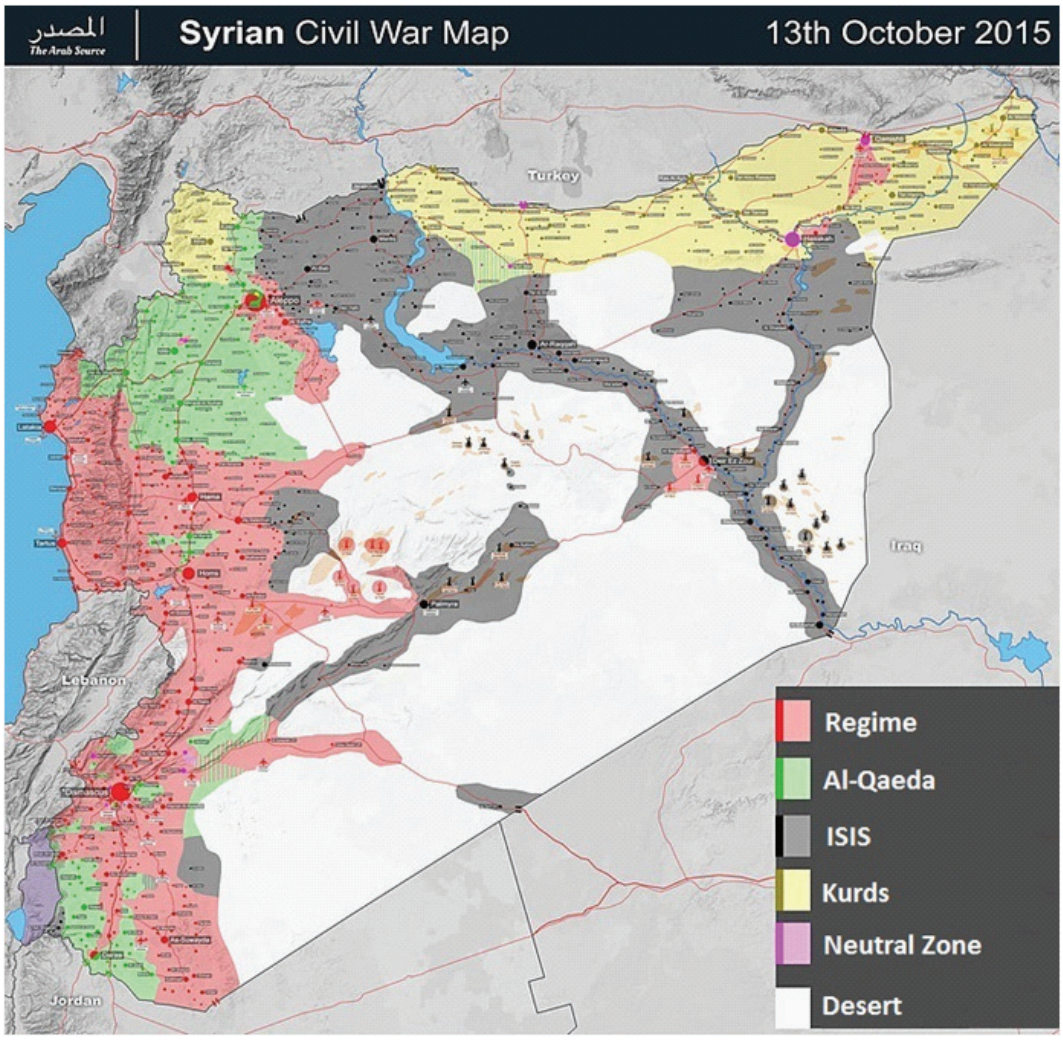
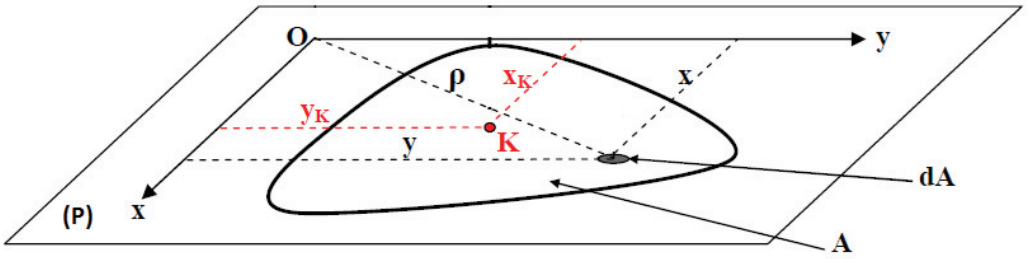


Figure 7: Spatial information represented as surfaces

In general, we have a flat surface (A), which is part of an overall level (P) in an orthogonal coordinate system.



We perceive surface (A) as being divided into an infinite number of elementary surfaces dA and the total area is given by:

$$A = \int_A dA$$

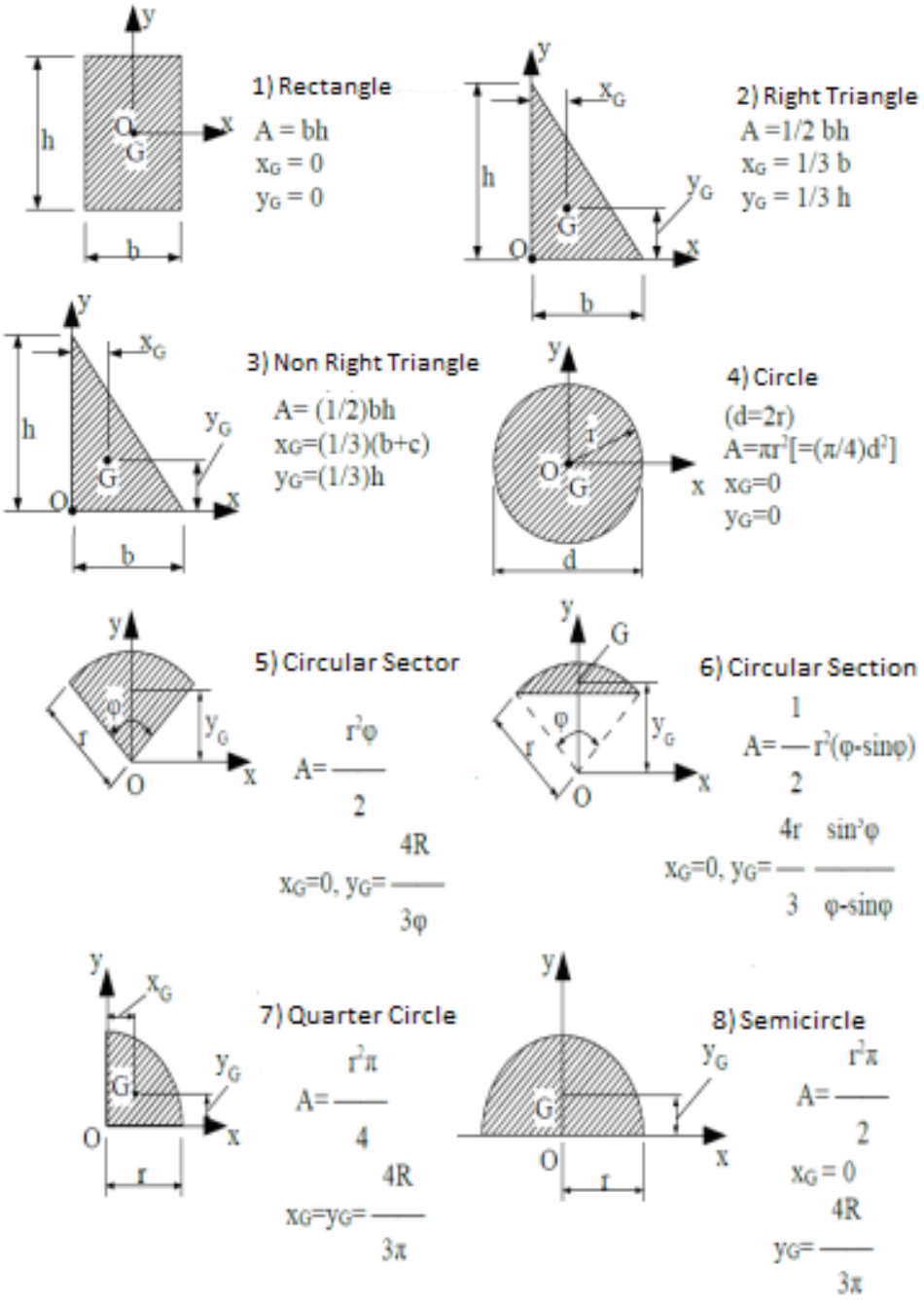
Accordingly the abscissa of the Center of Gravity for surface (A) is given by the formula:

$$x_K = \frac{\int_A x \cdot dA}{\int_A dA} = \frac{\int_A x \cdot dA}{A}$$

The ordinate is given by the formula:

$$y_K = \frac{\int_A y \cdot dA}{\int_A dA} = \frac{\int_A y \cdot dA}{A}$$

These concern the general case of locating the Center of Gravity of a surface whose shape is undefined. Formulas cited can be considerably simplified if the surfaces were known shapes, such as triangles, squares, circles, etc. In particular, the simplified formulas for calculating the coordinates of the Center of Gravity of known shapes are:



Downloaded at 30/3/2017: http://elearning.teicm.gr/file.php/19/kef5_6_KB_RA.pdf

In case of a map with the Sub-systems appearing as undefined surfaces –as in Figure 7- we can calculate the Center of Gravity of each Sub-system, by turning those surfaces into known shapes.

The steps to be followed in order to calculate the Center of Gravity are:

1. A fixed coordinate system is selected.
2. The surface is split into individual known shapes, which are named / numbered.
3. The areas of the individual known shapes (A1, A2, A3, etc.) are calculated.
4. The coordinates of the Center of Gravity (x1, x2, x3 ... y1, y2, y3 etc.) are calculated.
5. The Center of Gravity of each Sub-system is calculated.

Steps 1, 2 for the Sub-system Regime make use of the Map in Figure 8:

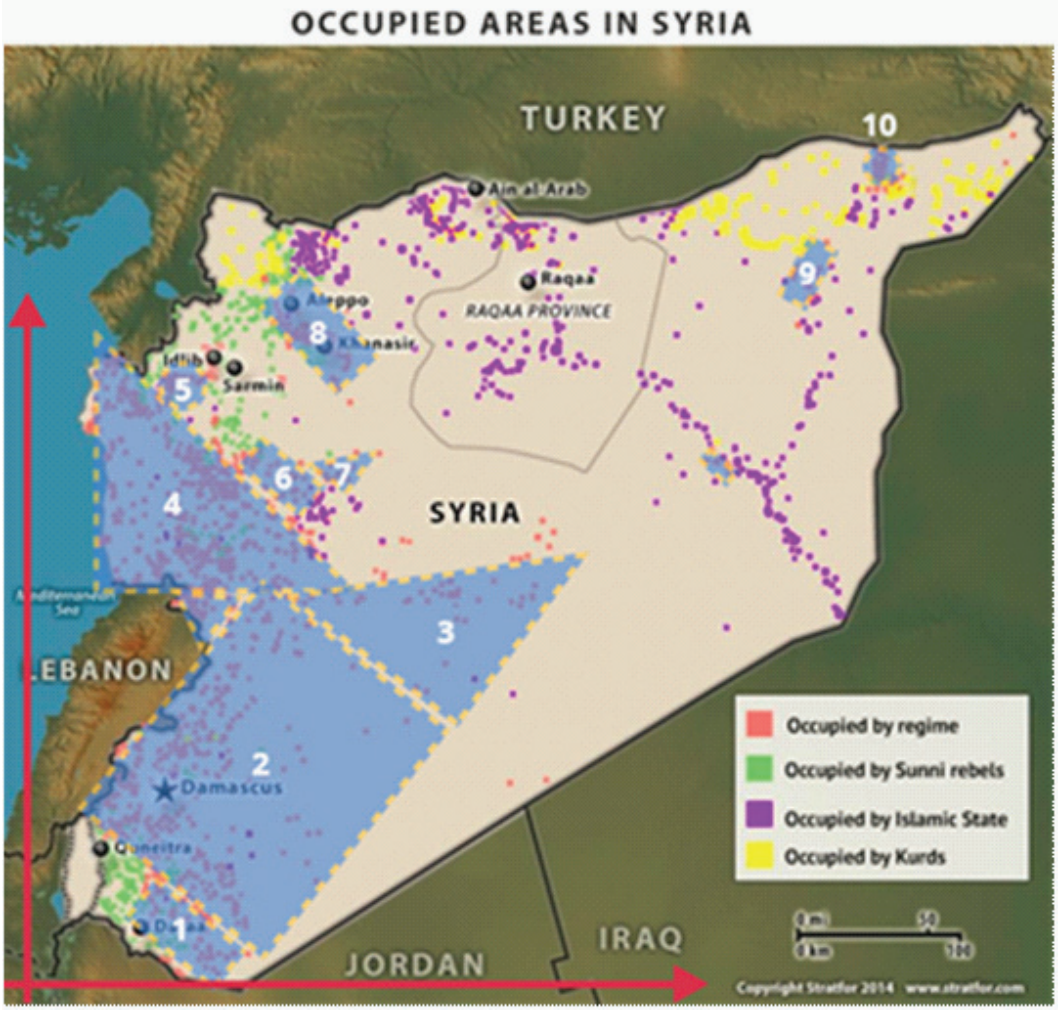


Figure 8: Map of Syria with simplified shapes (sources: Strafor 2014, cartographical intervasion: I. Th. Mazis, A. Digas)

In order to calculate the coordinates and areas of known shapes of steps 3 and 4, we will use the simplified formulas mentioned earlier, while in step 5 we will calculate the Center of Gravity (coordinates) of the Sub-system, using the formulas:

$$x_G = \frac{x_1 A_1 + x_2 A_2 + \ldots}{A_1 + A_2 + \ldots} \quad \text{and} \quad y_G = \frac{y_1 A_1 + y_2 A_2 + \ldots}{A_1 + A_2 + \ldots}$$

It is worth noting that this method doesn't satisfactorily incorporate the information of a selected region, because the distribution of forces within a surface is not uniform.

6.4 Indicators of Power (Geopolitical Indicators)

Definition: Geopolitical Indicator is the indicator that defines the value of a measured intra-systemic size at a given time. A set of indicators with similar characteristics can be grouped into each of the four Geopolitical Pillars (Defense/Security, Economy, Politics and Culture/Information).

As mentioned above, these four Pillars form the ontological description of each of the Sub-systems included in a System. Thus, analyzing the performance of the Geopolitical Indicators for each of the Pillars that form a Sub-system, we can draw quantitative conclusions about the System. In order to understand better the previous remarks, we have created the following flow chart in Figure 9 depicting necessary steps in order to measure the Total Trend of Power Redistribution of a System.

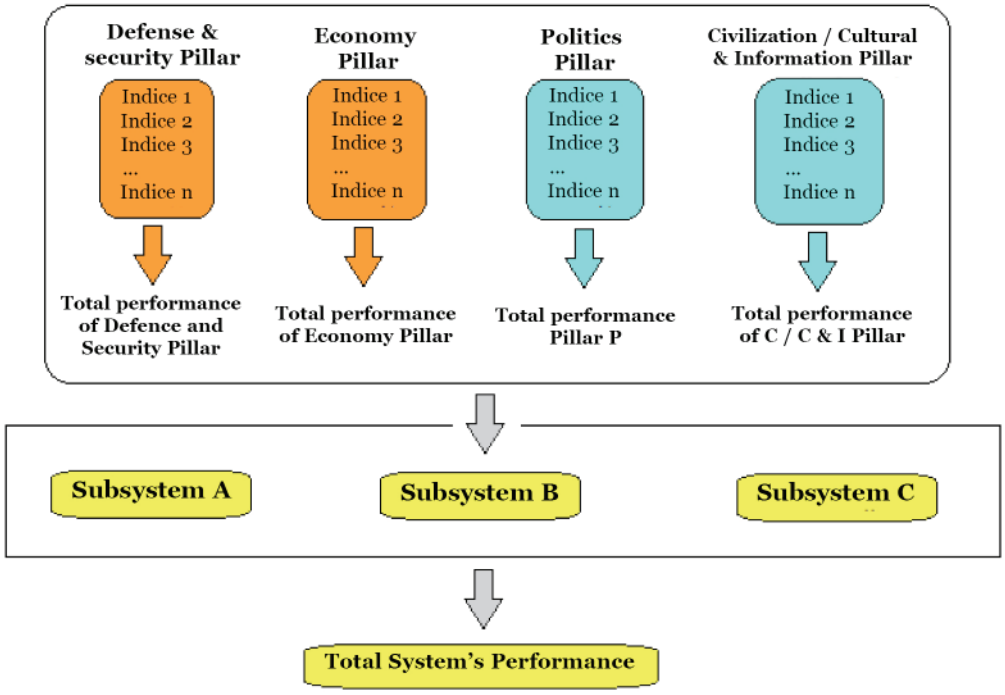


Figure 9: Model formation concerning calculation of the Total Trend of Power Redistribution

6.5 Calculation of Trend of Power Redistribution of a Pillar

Calculation of Trend of Power Redistribution of a Pillar of a Sub-system aims to result at a final number of a composite indicator, incorporating numbers and specific characteristics of indicators related to the Pillar. This process also highlights the relationship between the indicators and, if possible, avoids information overlapping due to the fact that many composite indicators provide similar or related information. To this end, one of the main problems encountered in need of a solution is the inability to integrate individual indicators into one composite indicator, due to the different way that each one of them presents information.

Indicators can quantify sizes such as monetary values, population, surface sizes and performance based on a predetermined scale of measure or even qualitative characteristics expressed in verbal variables (good, bad, medium, etc.). Two main categories of indicators can be discerned, the first including indicators described by **numerical values** and the other indicators described by **verbal values**.

Calculation of a composite indicator consisting of various individual indicators described by numerical values is possible through inclusion of all data in a common data base, so that they are comparable. This is a priority, due to the aforementioned fact that, each indicator presents the information in a different way (Euro, persons, mileage, etc.).

6.5.1 Normalization

The process by which we bring our data in a common data base is called Normalization. This is a procedure of data transformation, in which numerical values are replaced with other, more appropriate ones, so that indicators can become comparable. There are numerous methodologies developed in international bibliography to achieve all the above, the most common ones being the following:

i. Normalization min-max.

With this method of normalization we transform numerical values, so that they lie within a predetermined range of our preference. Assuming a set of values of an indicator A, where the highest value is maxA and the lowest value MinA, we transform all the values within a new range using as a lower limit the new minA and as an upper limit the new maxA according to the following formula, in which x is the numerical value of the indicator and x' is the value obtained after transformation.

$$x' = \frac{x - min_A}{max_A - min_A}(new\_max_A - new\_min_A) + new\_min_A$$

Advantages of this method is the fact that the analyst can predetermine the range he wants to work with the indicators (usually in the interval [0.1]), and the fact that transformed data keep the initially existing ratio between the values.

ii. Normalization Z-score.

This method transforms numerical data using the mean and the standard deviation. For a numerical value x with an average value MA and standard deviation σA of a set of values A, the value x' represents the new transformation rate, according to the following formula:

$$x' = \frac{x - M_A}{\sigma_A}$$

This method presents significant advantages in cases where the numerical indicator contains outliers, unlike normalization min-max, which would reduce the bulk of the values in a particular portion of the selected range, using the remainder to describe outliers. In this method though, we cannot predetermine the working range, as the latter shall result from the distance between the highest and the lowest values from the average value MA.

iii. Decimal Scale Normalization .

This method transforms the values of an indicator, by dividing them with the appropriate power of 10, so that the transformed highest value is less than 1, according to the following formula:

$$x' = \frac{x}{10^k}$$

Concerning indicators described verbally the procedure is somewhat different. Transformation of word variables into numerical values, in order to express the data in a common base, is closely linked to the plurality of word alternatives that are used to describe the indicator and to the range of values we want to transform the data.

An indicator described verbally can be described by at least two alternatives (True/ False or Yes /No) and more. For more than two alternatives the matching of word variables with numerical values is based on an escalation related to the number of the alternatives (very poor, poor, average, good and very good). Using this escalation turns verbal data into numerical ones. This should be preceded by a selection of the desirable working range of numerical prices for the data to be converted. The most common range selected for ease of operations and better understanding of numbers, is the interval [0.1].

Assuming that we have an indicator describing incorporation of an International Directive (for example 3rd package of EU measures on energy) in the institutional framework of countries (Greece, Germany, Italy, France, Spain), this consists of a total of 5 alternatives (inadequate, low, medium, large, full). The performance of each country for this indicator is presented in the following table:

Year	Greece	Germany	Italy	France	Spain
2014	Low	Full	Large	Medium	Inadequate
2015	Medium	Full	Full	Large	Low

Given that the working range will be the interval [0.1], the analyst gives the numerical value 0 to the word with the weakest meaning, Inadequate in our case. The same applies for the word with the strongest meaning, which in our case is Full presented by value 1. Therefore, from now on, Inadequate = 0 and Full = 1.

Then, the analyst allocates the other alternatives in the working range with the following procedure: each time he escalates one step, he adds the result of the operation $\frac{1}{\nu-1}$ to the previous value, ν being the total number of alternatives used to describe an indicator (in this case 5). In this way, we have:

$$\frac{1}{5-1} = \frac{1}{4} = \mathbf{0.25}$$

Therefore, for the alternative Low:

$$\mathbf{Low = Inadequate + 0.25 = 0 + 0.25 = 0.25}$$

In a similar manner for the alternative Medium:

$$\mathbf{Medium = Low + 0.25 = 0.25 + 0.25 = 0.5}$$

Finally, for the alternative Large:

$$\mathbf{Large = Medium + 0.25 = 0.5 + 0.25 = 0.75}$$

All verbal variables have been transformed into numerical values presented in the following Table:

Year	Greece	Germany	Italy	France	Spain
2014	0.25	1	0.75	0.50	0
2015	0.50	1	1	0.75	0.25

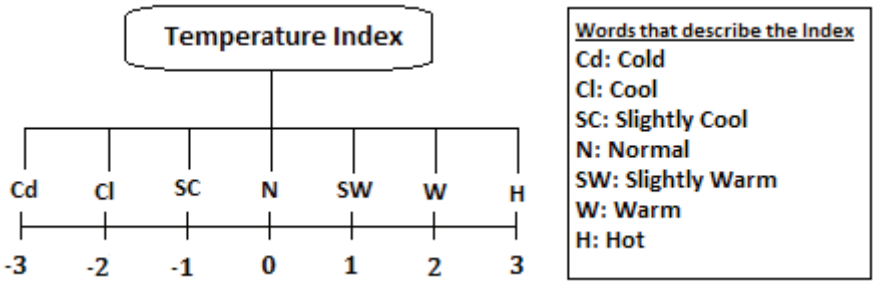
Generally, in order to distribute evenly the alternatives of a verbal variable to a selected working range, we follow the following formula:

(Upper Range Limit - Lower range limit) / (Number of alternatives: 1)

In a more complex example a temperature indicator is described by seven different alternatives with the price range being the interval [-3.3]:

$$\frac{3-(-3)}{7-1}=\frac{6}{6}=1$$

Therefore, every time we escalate one step, we add the value 1, starting with the word with the weakest meaning, in our case Cold, that takes the value -3. The data transformation is given in the figure below.



The method of normalization chosen by the analyst for this case study is Normalization Min-Max which transforms numerical values, so that these fluctuate within a certain range of prices chosen by the analyst. Methodology is based on the following type

$$x' = \frac{x - min_A}{max_A - min_A}(new\_max_A - new\_min_A) + new\_min_A$$

- min_A: The lowest value of the data set for an indicator.
- max_A: The highest value of the data set for an indicator.
- new_min_A: The new lowest value of the value range, decided by the analyst.
- new_max_A: The new highest value of the value range, decided by the analyst.

As the goal is to draw conclusions about the System as a whole, the lowest and highest value for each indicator will be taken from the data set which includes all Sub-systems. In

this way we look at the system as a whole and making each Sub-system data set comparable with the others.

The value range chosen by the analyst, in this case, is the interval [0.1]. Therefore, for the above formula we know:

- $new\_min_A = 0$.
- $new\_max_A = 1$

Thus the formula is greatly simplified:

$$x' = \frac{x - min_A}{max_A - min_A}$$

Concerning the indicator **Military expenditure (% of GDP)** from the System's data set, we have:

Max	6.89
Min	0.64

By solving the aforementioned formula we have:
(x = the absolute value of each year)

2010: $\frac{5{,}26-0{,}64}{6{,}89-0{,}64} = 0.74$

2011: $\frac{5{,}21-0{,}64}{6{,}89-0{,}64} = 0.73$

2012: $\frac{6{,}25-0{,}64}{6{,}89-0{,}64} = 0.90$

2013: $\frac{5{,}54-0{,}64}{6{,}89-0{,}64} = 0.78$

2014: $\frac{5{,}03-0{,}64}{6{,}89-0{,}64} = 0.70$

2015: $\frac{4{,}39-0{,}64}{6{,}89-0{,}64} = 0.60$

2016: $\frac{4{,}10-0{,}64}{6{,}89-0{,}64} = 0.55$

Thus, transformed data for **Military Expenditure Index (% of GDP)** are:

Year	Military Expenditure (% of GDP)
2010	0.74
2011	0.73
2012	0.90
2013	0.78
2014	0.70
2015	0.60
2016	0.55
Max	**6,89**
Min	**0.64**

Similarly, for **Armed Forces Personnel Index (Total)**, the maximum and minimum values from System's data set, are:

Max	403.000
Min	25.000

By solving the above formula we have:
(x = the absolute value of each year)

$$\textbf{2010}: \frac{\textbf{401.000}-\textbf{25.000}}{403.000-25.000} = 0.99$$

$$\textbf{2011}: \frac{\textbf{403.000}-\textbf{25.000}}{403.000-25.000} = 1.00$$

$$\textbf{2012}: \frac{\textbf{403.000}-\textbf{25.000}}{403.000-25.000} = 1.00$$

$$\textbf{2013}: \frac{\textbf{178.000}-\textbf{25.000}}{403.000-25.000} = 0.40$$

$$\textbf{2014}: \frac{\textbf{178.000}-\textbf{25.000}}{403.000-25.000} = 0.40$$

$$\textbf{2015}: \frac{\textbf{178.000}-\textbf{25.000}}{403.000-25.000} = 0.40$$

$$\textbf{2016}: \frac{\textbf{280.500}-\textbf{25.000}}{403.000-25.000} = 0.68$$

Thus, transformed data for **Armed Forces Personnel Index (Total)** are:

Year	Armed Forces Personnel (Total)
2010	0.99
2011	1,00
2012	1,00
2013	0.40
2014	0.40
2015	0.40
2016	0.68
Max	**403,000**
Min	**25,000**

Similarly, for **Arms imports Index (SIPRI trend indicator values),** the maximum and minimum values from System's data set, are:

Max	400.000.000
Min	2,500.000

By solving the above formula we have:
(x = the absolute value of each year)

$$\textbf{2010}: \frac{\textbf{276.000.000}-\textbf{2.500.000}}{400.000.000-2.500.000} = 0.69$$

$$\textbf{2011}: \frac{\textbf{193.000.000}-\textbf{2.500.000}}{400.000.000-2.500.000} = 0.48$$

$$\textbf{2012}: \frac{\textbf{298.000.000}-\textbf{2.500.000}}{400.000.000-2.500.000} = 0.74$$

$$\textbf{2013}: \frac{\textbf{368.000.000}-\textbf{2.500.000}}{400.000.000-2.500.000} = 0.92$$

$$\textbf{2014}: \frac{\textbf{371.000.000}-\textbf{2.500.000}}{400.000.000-2.500.000} = 0.93$$

$$\textbf{2015}: \frac{\textbf{361.000.000}-\textbf{2.500.000}}{400.000.000-2.500.000} = 0.90$$

$$\textbf{2016}: \frac{\textbf{350.000.000}-\textbf{2.500.000}}{400.000.000-2.500.000} = 0.87$$

Thus, transformed data for **Arms Imports Index (SIPRI trend indicator values)** are:

Year	Arms Imports (SIPRI trend indicator values)
2010	0.69
2011	0.48
2012	0.74
2013	0.92
2014	0.93
2015	0.90
2016	0.87
Max	**400,000,000 €**
Min	**2,500,000 €**

The following table includes transformed data for all Sub-systems related to the case study:

Sub-system A: Regime			
Year	**Military Expenditure (% of GDP)**	**Armed Forces Personnel (Total)**	**Arms Imports (SIPRI trend indicator values)**
2010	0.74	0.99	0.69
2011	0.73	1.00	0.48
2012	0.90	1.00	0.74
2013	0.78	0.40	0.92
2014	0.70	0.40	0.93
2015	0.60	0.40	0.90
2016	0.55	0.68	0.,87

6.5.2 Calculation of the Power Performance of a Pillar

After the transformation of the values the analyst can proceed to the calculation of the Total Performance of each Pillar. Calculation of the performance can be made by adding the individual transformed values of indicators, characterizing the respective Pillar each year. This simplified methodology though assumes that each indicator contributes equally to the performance of the Pillar, which is not totally true. Some indicators represent information that may be of particular importance and significance, when an analysis of a Pillar is taking place.

For this reason, an appropriate method for calculating the Total Performance of a Pillar can be the sum product of the individual indicators, with gravity factors.

According to his experience and judgment, the analyst attributes gravity factors to each of the indicators related to a Pillar, in a way that gives significance to those indicators considered critical. It is important to note that the sum of all gravity factors should be 1.

Application to the Case Study: Calculation of Total Performance of a Pillar

In order to calculate the Total Performance of the Pillar Defense/Security the analyst adds data included in each indicator per year; at the same time he assigns gravity factors to each of them according to his judgment and experience.

For this case study each indicator contributes to the Pillar with the following gravity factors:

- Military Expenditure (% of GDP): **30% or 0.3.**
- Armed Forces Personnel (Total): **50% or 0.5.**
- Arms Imports (SIPRI trend indicator values): **20% or 0.2.**

Note: Concerning application of gravity factors, it should be noted that all gravity factors if added, should be equal to one (1). In our own case this is verified, as:
0.3 + 0.5 + 0.2 = 1

Performance of the Pillar Defense/Security for the year 2010 is:

2010 = **0.3***$0.74_{m.e.}$ + **0.5***$0.99_{a.f.p.}$ + **0.2***$0.69_{a.i.}$ = **0.86**

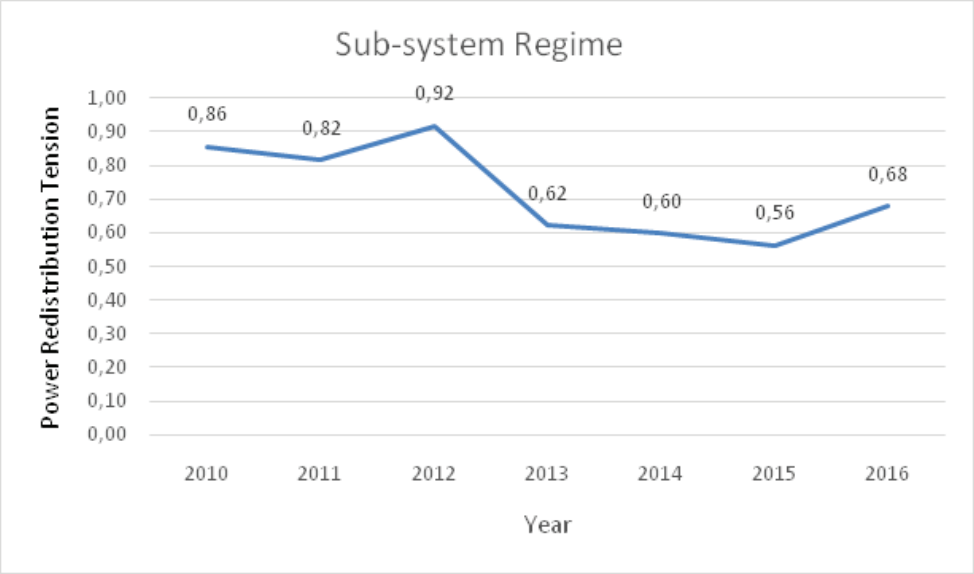
Similarly, for the rest of the years:

2011 = **0.3***$0.73_{m.e.}$ + **0.5***$1.00_{a.f.p.}$ + **0.2***$0.48_{a.i.}$ = **0.82**
2012 = **0.3***$0.90_{m.e.}$+**0.5***$1,00_{a.f.p.}$+**0.2***$0.74_{a.i.}$ = **0.92**
2013 = **0.3***$0.78_{m.e.}$+**0.5***$0.40_{a.f.p.}$+**0.2***$0.92_{a.i.}$ = **0.62**
2014 = **0.3***$0.70_{m.e.}$+**0.5***$0.40_{a.f.p.}$+**0.2***$0.93_{a.i.}$ = **0.60**
2015 = **0.3***$0.60_{m.e.}$+**0.5***$0.40_{a.f.p.}$+**0.2***$0.90_{a.i.}$ = **0.56**
2016 = **0.3***$0.55_{m.e.}$+**0.5***$0.68_{a.f.p.}$+**0.2***$0.87_{a.i.}$ = **0.68**

According to the calculations above, we can fill the following table with the Total Performances of the Pillar Defense/Security (2010-2016) for the Sub-system Regime.

Sub-system Regime	
Year	**Total Performance of Pillar Defense/Security**
2010	0.86
2011	0.82
2012	0.92
2013	0.62
2014	0.60
2015	0.56
2016	0.68

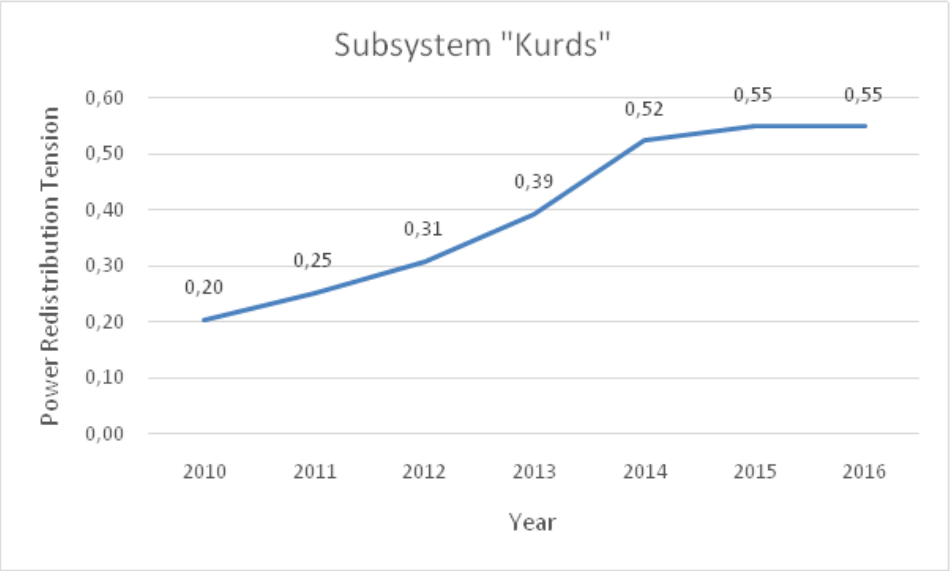
We represent these values in a diagram, in order to make more understandable the historical development of Pillar Defense/Security for the Sub-system Regime.



Similarly, we make the same calculations for the other three Sub-systems of the Case Study. For the Sub-system Kurds we have:

Sub-system Kurds	
Year	**Total Performance of Pillar Defense/ Security**
2010	0.20
2011	0.25
2012	0.31
2013	0.39
2014	0.52
2015	0.55
2016	0.55

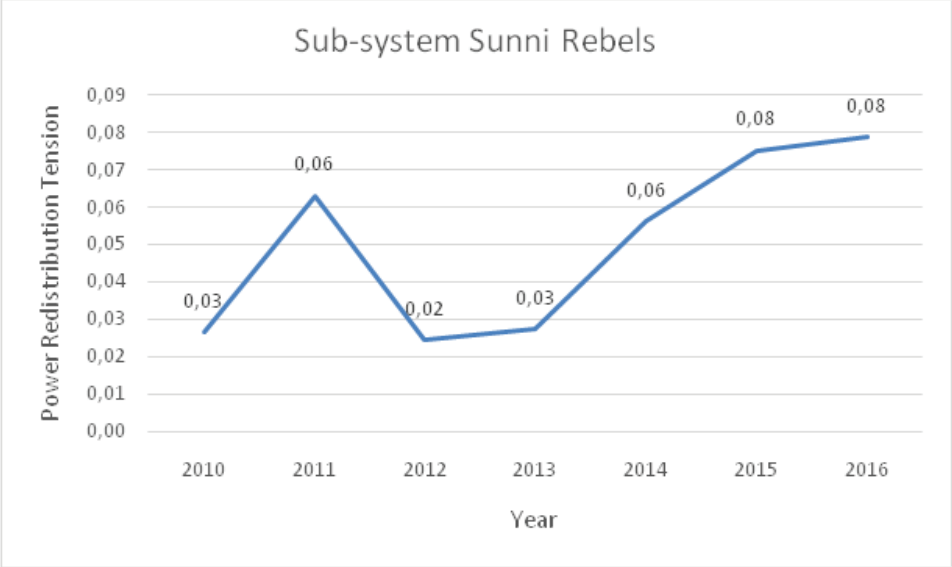
We represent these values in a diagram, in order to render the historical development of Pillar Defense/Security for the Sub-system Kurds more understandable.



For Subsystem “Sunni Rebels”, we have:

Subsystem “Sunni Rebels”	
Year	**Total Performance of pillar “Defense & Security”**
2010	0,03
2011	0,06
2012	0,02
2013	0,03
2014	0,06
2015	0,08
2016	0,08

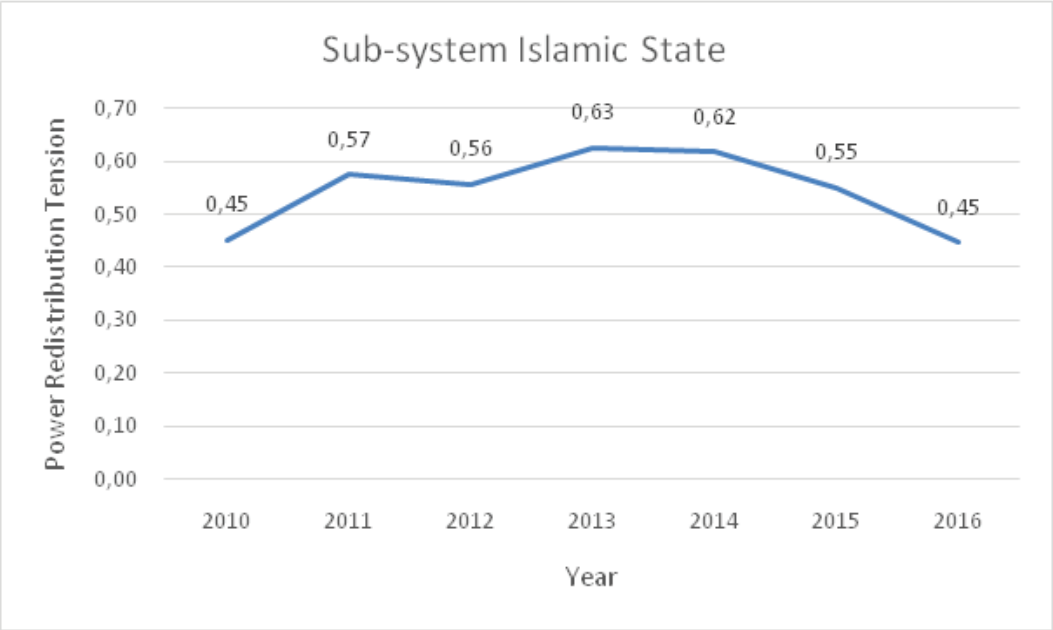
We represent these values in a diagram, in order to make more understandable the historical development of pillar “Defense & Security” for Subsystem “Sunni Rebels”.



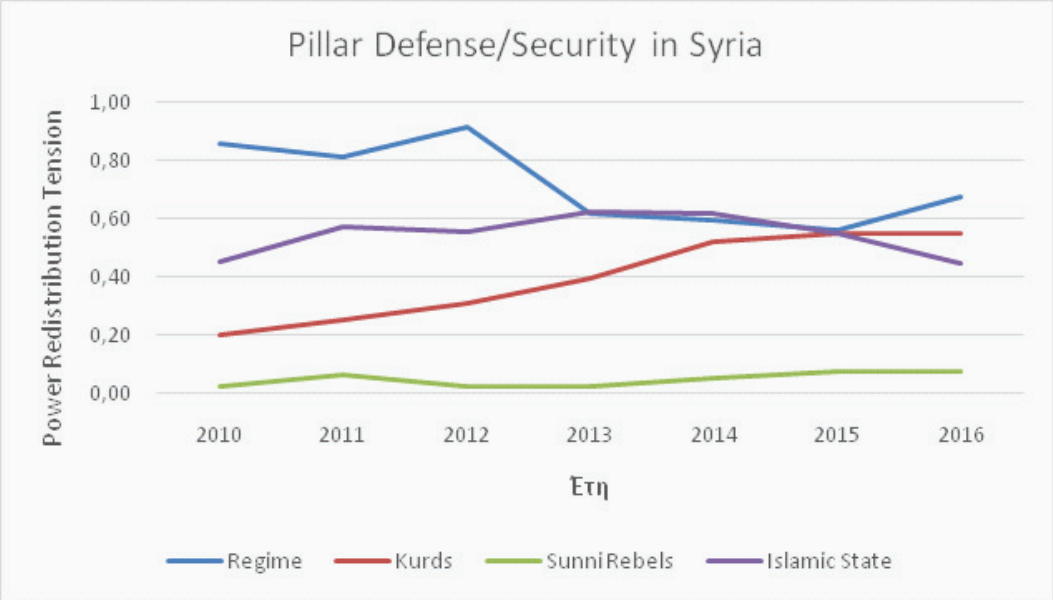
For the Sub-system Islamic State we have:

Sub-system Islamic State	
Year	**Total Performance of Pillar Defense/ Security**
2010	0.45
2011	0.57
2012	0.56
2013	0.63
2014	0.62
2015	0.55
2016	0.45

We represent these values in a diagram, in order to render the historical development of Pillar Defense/Security for Sub-system Islamic State more understandable.



An overview for the Power Redistribution Tension of the pillar "Defense & Security" in Syria as a system is presented in the following graph.



6.5.3 Calculation of the Total Performance of a Sub-system under the influence of a given Geopolitical Factor: Theory

After the calculation of all the Performances of the four Pillars that characterize a Sub-system, we must incorporate all data to a total performance of a Sub-system.

Calculation of the Total Performance of a Sub-system can be made simply by adding the individual performances of the Pillars. The same problem appeared in the calculation of the performance of an individual Pillar; still, it appears again, as it is assumed that each Pillar contributes equally to the Total Performance of the Sub-system, an assumption normally not true.

The most suitable methodology for the synthesis of all the Performances of the various Pillars in a Total Performance of a Sub-system is adding the individual Power Performances of the individual Pillars, with gravity factors. So, according to his experience and judgment the analyst attributes gravity factors to the Power Performance of each Pillar of the Sub-System, in order to enhance the importance of those Pillars deemed most critical. In this way, any changes of the Pillar possessing the highest gravity factor shall affect to a greater degree the Total Performance of the Sub-system. It is important to note that the sum of all gravity factors should be equal to one (1).

Implementation to the case study: Calculation of the Total Performance power of a Sub-system

Assuming that in this specific Case Study we examined the other three Pillars of Power, i.e. Economy, Politics and Culture/Information, so as to obtain an overview of each Sub-System, the following Power Performances of these Pillars would ensue, as presented in the Table below.

Sub-system Regime				
Year	**Defense/ Security**	**Economy**	**Politics**	**Culture/Information**
2010	0.86	0.43	0.65	0.71
2011	0.82	0.55	0.42	0.65
2012	0.92	0.62	0.33	0.40
2013	0.62	0.59	0.47	0.33
2014	0.60	0.60	0.55	0.28
2015	0.56	0.71	0.79	0.25
2016	0.68	0.73	0.82	0.18

In order to calculate the Total Performance of the Sub-system the analyst adds the data included in each Pillar per year, while he attributes gravity factors to each of them, according to his judgment and experience. For this case study, he decides that each Pillar contributes to the Sub-system with the following gravity factors:

- Defense/Security: **40% or 0.4.**
- Economy: **30% or 0.3.**
- Politics: **20% or 0.2.**
- Culture/ Information: **10% or 0.1.**

Note: Concerning application of gravity factors, it should be noted that all gravity factors if added, should be equal to one (1). In our own case this is verified, as:
0.4 + 0.3 + 0.2 + 0.1 = 1

Thus, Total Performance of the Sub-system Regime for 2010 is:

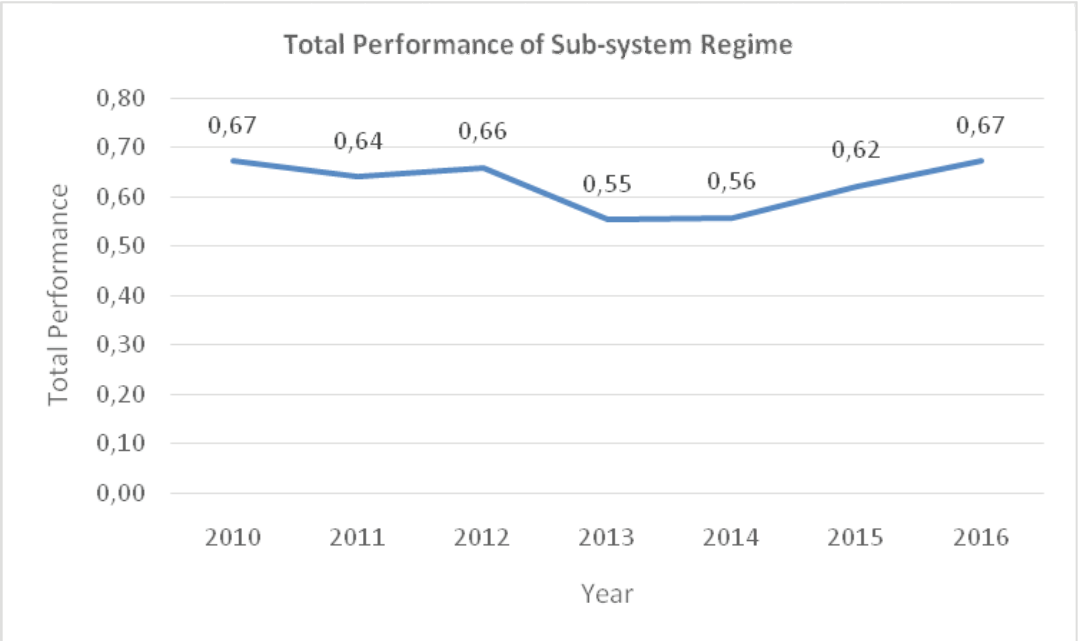
2010 = **0.4***0.86+**0.3***0.43+**0.2***0.65+**0.1***0.71 = **0.67**

Total Performances for the rest of the years are:

2011 = 0.4*0.82+0.3*0.55+0.2*0.42+0.1*0.65 = **0.64**
2012 = 0.4*0.92+0.3*0.62+0.2*0.33+0.1*0.40 = **0.66**
2013 = 0.4*0.62+0.3*0.59+0.2*0.47+0.1*0.33 = **0.55**
2014 = 0.4*0.60+0.3*0.60+0.2*0.55+0.1*0.28 = **0.56**
2015 = 0.4*0.56+0.3*0.71+0.2*0.79+0.1*0.25 = **0.62**
2016 = 0.4*0.68+0.3*0.73+0.2*0.82+0.1*0.18 = **0.67**

The following table includes the above results for Total Performances of the Sub-system Regime through years 2010-2016.

Sub-system Regime	
Year	**Total Performance**
2010	0.67
2011	0.64
2012	0.66
2013	0.55
2014	0.56
2015	0.62
2016	0.67



6.6 Prediction of Power Redistribution in a System

Internationally, a large number of methodologies have been developed for predictions, providing analysts with a wide range of analytical tools. In this study we will deal with two of the most common methods, Time Series and Least Squares method.

6.6.1 Time series

Time series measure the dependence of a future value of a size, from its previous values in the past. In order to implement this methodology, it is important that the values of an indicator show a pattern (typology) in earlier periods. If they have no relationship between them, then another method should be chosen. A prerequisite to identify typologies in historical values of an indicator is the existence of a database, which keeps data based on reliable sources. The concept of prediction is identical to both management and processing of data, in order to extract knowledge from these.

Typologies can be:

- Trends: upward or downward.
- Periodicity: with variations that repeat periodically.

Indicatively, some of the methodologies that can be used depending on the typology related to data are:

- Moving Average.
- Exponential Smoothing.
- Regression.
- Winter Method.

Indicatively, one of the methods commonly used is that of Balanced Moving Average. This method is used to perform predictions based on previous time periods, the number of which is defined by the analyst.

Prediction errors are directly related to the number of periods chosen by the analyst. Generally, as the number decreases, so decreases the error in prediction; however, what also increases is sensitivity to random fluctuations and extreme values.

More specifically, if we define:

t: the present period

N: the number of periods chosen by the analyst

P: the period for which the forecast is carried out

A: the indicator values for a specific period

n: the gravity factors matched by the analyst in each period then:

$$\Pi_{t+1} = (n_t A_t + n_{t-1} A_{t-1} + \ldots + n_{t-N+1} A_{t-N+1})/N$$

The name of the method includes the term *moving* because the periods included in the calculation of the prediction are continuously updated, so the final number of periods remains constant. One of the major advantages is that it enables the analyst to match gravity factors in previous periods, thus allowing very rapid incorporation of new information.

Making a prediction presupposes that the analyst initially must define:

1. the time horizon for which he carries out the forecast.
2. the number of previous periods on which the prediction will be based
3. the gravity factors attributed to each of the previous periods, depending on their significance.

In order to make a prediction we add the sum products of weights and values of the previous periods and divide these by the number of previous periods.

Implementation to the Case Study: Forecast

For our Case Study the analyst wants to carry out a forecast for 2020 determining the number of previous periods on which the prediction shall be based, as six (6). According to his experience and judgment, the gravity factors will be attributed to the periods, in a way that gives greater value to the periods closer to the present year. If N is the number of periods used for the prediction, then the gravity factors for each one of the periods are presented below:

- Weight **0.4** to period **N-1.**
- Weight **0.25** to period **N-2.**
- Weight **0.15** to period **N-3.**
- Weight **0.1** to period **N-4.**
- Weight **0.075** to period **N-5.**
- Weight **0.025** to period **N-6.**

Note: Concerning application of gravity factors, it should be noted that all gravity factors if added, should be equal to one (1). In our own case this is verified, as:
0.4+0.25+0.15+0.1+0.075+0.025 = 1

The analyst matches the gravity factors to each of the Total Performances of the Sub-system Regime:

Sub-system Regime	
Year	**Total Performance**
2010	**0.86**
2011	**0.82 (Period N-6, Weight 0.025)**
2012	**0.92 (Period N-5, Weight 0.075)**
2013	**0.62 (Period N-4, Weight 0.1)**
2014	**0.60 (Period N-3, Weight 0.15)**
2015	**0.56 (Period N-2, Weight 0.25)**
2016	**0.68 (Period N-1, Weight 0.4)**

For the year 2017 the prediction shall be based on years 2016, 2015, 2014, 2013, 2012, 2011 and according to the gravity factors attributed by the analyst:

$$\Pi 2017=0.4*0.68N\text{-}1+0.25*0.56N\text{-}2+0.15*0.60N\text{-}3+0.1*0.62N\text{-}4+0.075*0.92N\text{-}5+0.025*0.82N\text{-}6= 0.65$$

Since the analyst calculated the value for 2017, he can now use it to perform predictions for future periods, such as 2018:

П2018 = 0.4*0.65+0.25*0.68+0.15*0.56+0.1*0.60+0.075*0.62+0.025*0.92= **0.64**

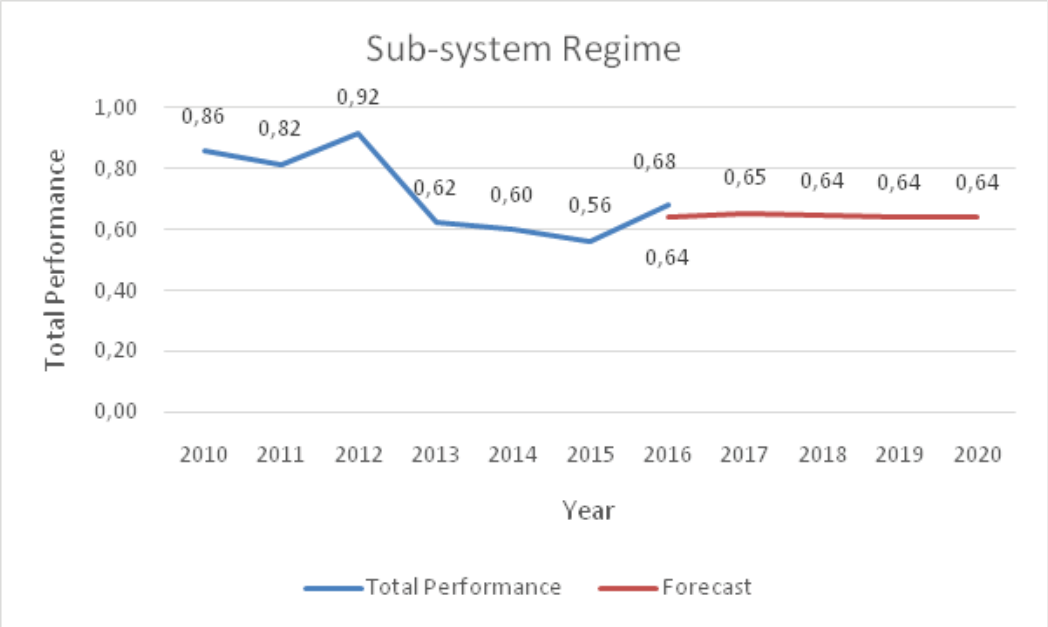
П2019 = 0.4*0.64+0.25*0.65+0.15*0.68+0.1*0.56+0.075*0.60+0.025*0.62= **0.64**

П2020 = 0.4*0.64+0.25*0.64+0.15*0.65+0.1*0.68+0.075*0.56+0.025*0.60= **0.64**

Thus, the analyst can fill the following Table, with current and predicted values for the Total Performance of the Sub-system Regime:

Sub-system Regime		
Year	Total Performance	Prediction
2010	0.86	-
2011	0.82	-
2012	0.92	-
2013	0.62	-
2014	0.60	-
2015	0.56	-
2016	0.68	-
2017	-	**0.65**
2018	-	**0.64**
2019	-	**0.64**
2020	-	**0.64**

If we represent the aforementioned data in a single graph, we have:



We observe that in the prediction curve (orange color), the value for the period 2016 is included. The reason that 2016 has been included is to compare the deviation of the actual value for 2016, with the forecast for 2016, so that the analyst can determine the quality of the prediction. For Sub-system Kurds we have the following data:

Sub-system Kurds	
Year	Total Performance
2010	0.20
2011	0.25
2012	0.31
2013	0.39 **(Period N-1,** Weight 0.1**)**
2014	0.52 **(Period N-3,** Weight 0.2**)**
2015	0.55 **(Period N-2,** Weight 0.3**)**
2016	0.55 **(Period N-1,** Weight 0.4**)**

Normally, the number of periods used to make a prediction along with the gravity factors should be common for all Sub-systems. For further practice and better understanding of time series methodology though, we will change the number of periods into four (4). If N is the number of periods used for prediction, then the gravity factors for each of the periods are presented below:

- Weight **0.4** to period **N-1.**
- Weight **0.3** to period **N-2.**
- Weight **0.2** to period **N-3.**
- Weight **0.1** to period **N-4.**

Note: Concerning application of gravity factors, it should be noted that all gravity factors attributed to each period, if added, should be equal to one (1). In our own case this is verified, as:
0.4+0.3+0.3+0.1 = 1

For the period 2017, the prediction shall be based on years 2016, 2015, 2014, and 2013 and according to the gravity factors matched by the analyst, we have:

$$\mathbf{\Pi 2017} = 0.4*0.55+0.3*0.55+0.2*0.52+0.1*0.39 = 0.53$$

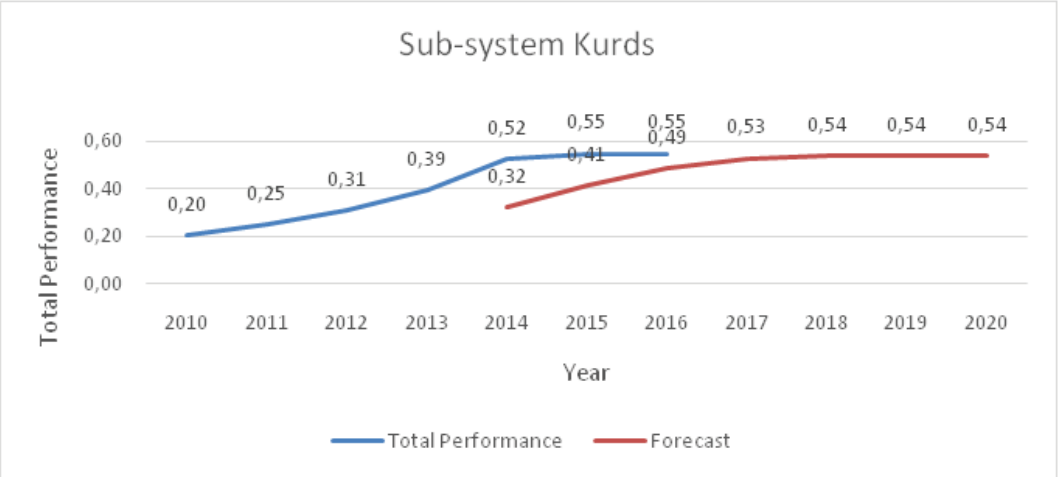
Since the analyst calculated the value for 2017, he can now use it to perform forecast for future periods, such as 2018:

$$\mathbf{\Pi 2018} = 0.4*0.53+0.3*0.55+0.2*0.55+0.1*0.52 = 0.54$$
$$\mathbf{\Pi 2019} = 0.4*0.54+0.3*0.53+0.2*0.55+0.1*0.55 = 0.54$$
$$\mathbf{\Pi 2020} = 0.4*0.54+0.3*0.54+0.2*0.53+0.1*0.55 = 0.54$$

Thus, the analyst can fill the following Table, with current and predicted values for the Total Performance of the Sub-system Kurds:

Sub-system Kurds		
Year	Total Performance	Prediction
2010	0.20	-
2011	0.25	-
2012	0.31	-
2013	0.39	-
2014	0.52	-
2015	0.55	-
2016	0.55	-
2017	-	0.53
2018	-	**0.54**
2019	-	**0.54**
2020	-	**0.54**

If we represent the aforementioned data in a single graph, we have:



We observe that in the prediction curve (orange color), the values for the period 2014, 2015 and 2016 are included. The reason these years have been included is to compare the deviation of the actual values, with those of the prediction, so that the analyst can determine the quality of the prediction.

For the Sub-system Sunni Rebels we have the following data:

Sub-system Sunni Rebels	
Year	Total Performance
2010	0.03
2011	0.06
2012	0.02
2013	0.03
2014	0.06
2015	0.08 (**Period N-2,**Weight 0.3)
2016	0.08 (**Period N-1,**Weight 0.7)

The analyst, because of fluctuations observed in historical values for the Sub-system's Total Performance, chooses to reduce the number of periods to two (2) in order to incorporate changes more rapidly in the analysis. If N is the number of periods used for the prediction, then the gravity factors for each of the periods are presented below:

- Weight **0.7** to period **N-1.**
- Weight **0.3** to period **N-2.**

Note: Concerning application of gravity factors, it should be noted that all gravity factors attributed to each period, if added, should be equal to one (1). In our own case this is verified, as:
0.7+0.3 = 1

For the period 2017, the forecast will be based on years 2016-2015 and according to the gravity factors attributed by the analyst, we have:

$$\mathbf{\Pi 2017} = 0.7*0.08+0.3*0.08 = 0.08$$

Since the analyst calculated the value for 2017, he can now use it to perform forecast for future periods, such as 2018:

$$\mathbf{\Pi 2018} = 0.7*0.08 + 0.3*0.08 = \mathbf{0.08}$$

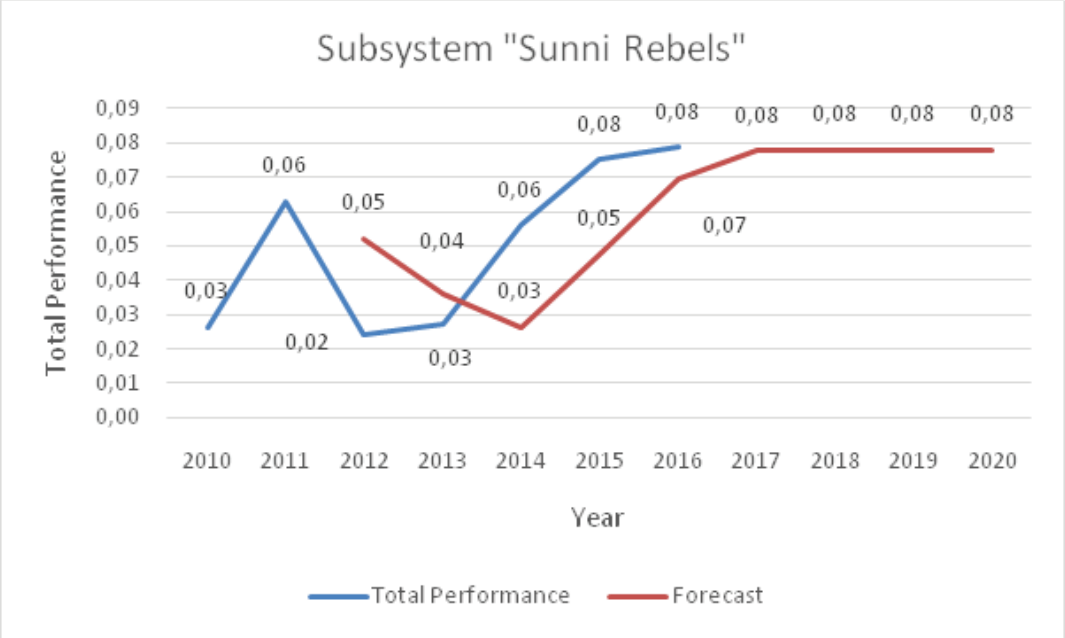
$$\mathbf{\Pi 2019} = 0.7*\mathbf{0.08} + 0.3*0.08 = 0.08$$

$$\mathbf{\Pi 2020} = 0.7*0.08 + 0.3*\mathbf{0.08} = 0.08$$

Thus, the analyst can fill the following Table, with current and predicted values for the Total Performance of the Sub-system Sunni Rebels:

Sub-system Sunni Rebels		
Year	Total Performance	Prediction
2010	0.03	-
2011	0.06	-
2012	0.02	-
2013	0.03	-
2014	0.06	-
2015	0.08	-
2016	0.08	-
2017	-	**0.08**
2018	-	**0.08**
2019	-	**0.08**
2020	-	**0.08**

If we represent the above mentioned data in a single graph, we have:



We observe that in the prediction curve (orange color), values for the period 2012, 2013, 2014, 2015 and 2016 are included. The reason these years have been included is to compare the deviation of the actual values, with those of the prediction, so that the analyst can determine the quality of the prediction.

For the Sub-system Islamic State we have the following data:

Sub-system Islamic State	
Year	Total Performance
2010	0.45
2011	0.57
2012	0.56
2013	0.63
2014	0.62
2015	0.55 **(Period N-1,** Weight **0.5)**
2016	0.45 **(Period N-1,** Weight **0.5)**

The analyst, because of fluctuations observed in historical values for the Sub-system's Total Performance, chooses to reduce the number of periods to two (2) in order to incorporate changes more rapidly in the analysis. If N is the number of periods used for the prediction, then the gravity factors for each of the periods are presented below:

- Weight **0.5** to period **N-1.**
- Weight **0.5** to period **N-2.**

Note: Concerning application of gravity factors, it should be noted that all gravity factors attributed to each period, if added, should be equal to one (1). In our own case this is verified, as:
0.5+0.5 = 1

For the period 2017, the forecast shall be based on years 2016-2015 and according to the gravity factors attributed by the analyst, we have:

$$\mathbf{\Pi 2017} = 0.5*0.45+0.5*0.55 = 0.50$$

Since the analyst calculated the value for 2017, he can now use it to perform forecast for future periods, such as 2018:

$$\mathbf{\Pi 2018} = 0.5*0.50 + 0.5*0.45 = 0.47$$

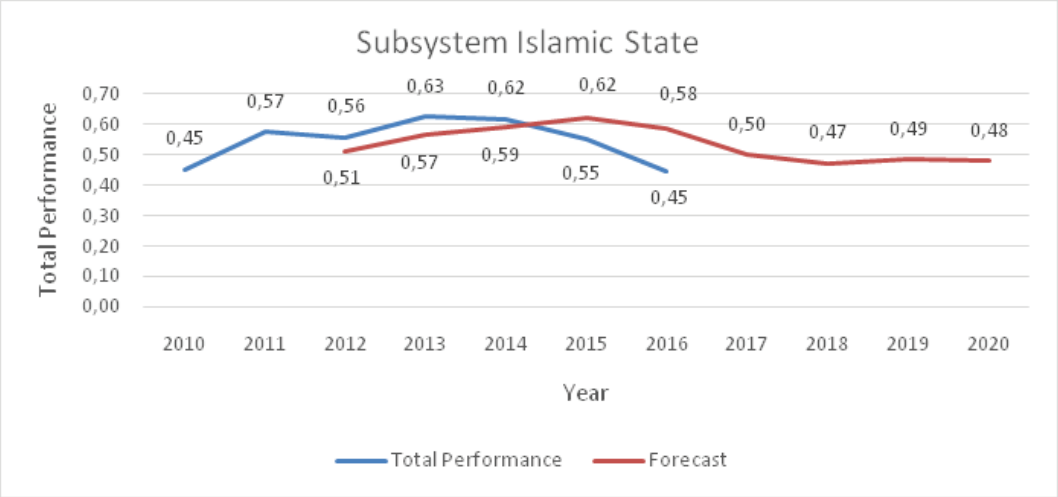
$$\mathbf{\Pi 2019} = 0.5*0.47 + 0.5*0.50 = 0.49$$

$$\mathbf{\Pi 2020} = 0.5*0.49 + 0.5*0.47 = 0.48$$

Thus, the analyst can fill the following Table, with current and predicted values for the Total Performance of the Sub-system Sunni Rebels:

Sub-system Islamic State		
Year	Total Performance	Prediction
2010	0.45	-
2011	0.57	-
2012	0.56	-
2013	0.63	-
2014	0.62	-
2015	0.55	-
2016	0.45	-
2017	-	**0.50**
2018	-	**0.47**
2019	-	**0.49**
2020	-	**0.48**

If we represent the above mentioned data in a single graph, we have:



We observe that in the prediction curve (orange color), the values for the period 2012, 2013, 2014, 2015 and 2016 are included. The reason these years have been included is to compare the deviation of the actual values, with those of the prediction, so that the analyst can determine the quality of the prediction.

6.6.2 Least Squares Method

The Least Squares method is used when one wishes το associate/describe two variables using a theoretical equation. This equation may have various forms such as linear, parabolic, exponential, etc.

In this study we will deal with linear equations, which have the form $\mathbf{Y = \alpha X + \beta}$ wherein:

- X, Y: the two variables.
- α: the slope of the line.

- β: constant.

The purpose of the method is to identify optimally the parameters (α) and (β) so as the data to be described in a satisfactory manner. The way to achieve the above is by minimizing the sum of squared deviations between the actual data and corresponding represented on the line. Therefore the values α, β are calculated according to the following formulas:

$$\alpha = \overline{Y} - \frac{S_{xY}}{S_{xx}}\overline{x}$$

και

$$\beta = \frac{S_{xY}}{S_{xx}}$$

where:

$\bar{X}$: the average of variable X

$\bar{Y}$: the average of variable Y

$$S_{xx} = \sum_{i=1}^{n} (x_i - \overline{x})^2$$

$$S_{xY} = \sum_{i=1}^{n} (x_i - \overline{x})(Y_i - \overline{Y})$$

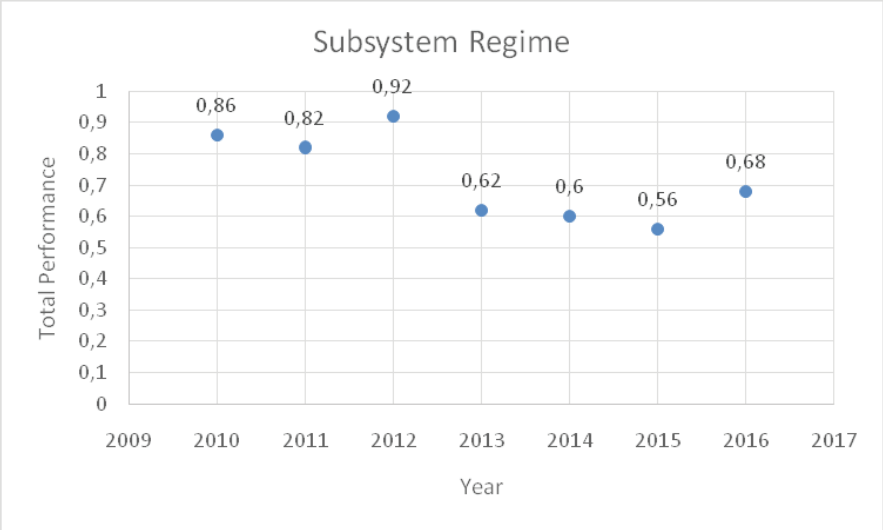
Using the equation of the trend line, we can make predictions about future values of an indicator. Such a procedure should be made cautiously, as this equation calculates the linear trend versus time. The trend can be upward, downward or rarely neutral. If we attempt to make long-term predictions based on a trend line, it is quite likely to lead to false conclusions as future values of an indicator, either continuously will increase or will continuously decrease. Therefore this method is commonly used for short-term predictions.

Implementation to the Case Study: Prediction using the Least Squares methodology

It is known that every indicator is described by two distinct variables, the first one being the performance of the indicator itself and the second one the year to which the performance refers. We name each variable, as X being the years referred to a specific performance and Y being the actual performance of an indicator. Therefore, for the Total Performance of Sub-system Regime, we have:

Sub-system Regime	
Year (Variable X)	**Total Performance (Variable Y)**
2010	0.86
2011	0.82
2012	0.92
2013	0.62
2014	0.60
2015	0.56
2016	0.68

If the above values were represented on a graph wherein the X axis has years and the Y axis the Total Performance, we have:



Afterwards we calculate the average for each of X and Y variables.

$$\bar{X} = \frac{2010+2011+2012+2013+2014+2015+2016}{7} = 2013$$

$$\bar{Y} = \frac{0,86+0,82+0,92+0,62+0,6+0,56+0,68}{7} = 0.72$$

Next, we remove the average from each of the variables X and Y, respectively.

For variable X:

$X_{2010} - \bar{X} = 2010 - 2013 = -3$
$X_{2011} - \bar{X} = 2011 - 2013 = -2$
$X_{2012} - \bar{X} = 2012 - 2013 = -1$
$X_{2013} - \bar{X} = 2013 - 2013 = 0$
$X_{2014} - \bar{X} = 2014 - 2013 = 1$
$X_{2015} - \bar{X} = 2015 - 2013 = 2$
$X_{2016} - \bar{X} = 2016 - 2013 = 3$

For variable Y:

$Y_{2010} - \bar{Y} = 0.86 - 0.72 = 0.14$
$Y_{2011} - \bar{Y} = 0.82 - 0.72 = 0.10$
$Y_{2012} - \bar{Y} = 0.92 - 0.72 = 0.20$
$Y_{2013} - \bar{Y} = 0.62 - 0.72 = -0.10$
$Y_{2014} - \bar{Y} = 0.60 - 0.72 = -0.12$
$Y_{2015} - \bar{Y} = 0.56 - 0.72 = -0.16$
$Y_{2016} - \bar{Y} = 0.68 - 0.72 = -0.04$

Based on the above we fill the following table:

Year (X)	Total Performance (Y)	$X - \bar{X}$	$Y - \bar{Y}$
2010	0.86	-3	0.14
2011	0.82	-2	0.10
2012	0.92	-1	0.20
2013	0.62	0	-0.10
2014	0.60	1	-0.12
2015	0.56	2	-0.16
2016	0.68	3	-0.04

From the following formulas:

$$S_{xx} = \sum_{i=1}^{n} (x_i - \bar{x})^2 \quad \text{and} \quad S_{xY} = \sum_{i=1}^{n} (x_i - \bar{x})(Y_i - \bar{Y})$$

it is sufficient to calculate the $(X - \bar{X})^2$ and multiplying $(X - \bar{X})(Y - \bar{Y})$ to calculate S_{xx} and S_{xY} respectively. For $(X - \bar{X})^2$, we have:

2010: $(-3)^2 = 9$
2011: $(-2)^2 = 4$
2012: $(-1)^2 = 1$
2013: $0^2 = 0$
2014: $2^2 = 1$
2015: $2^2 = 4$
2016: $3^2 = 9$

By adding all the above, we have S_{xx}:

$$\mathbf{S_{xx}} = 9+4+1+0+1+4+9 = \mathbf{28}$$

For $(X - \bar{X})(Y - \bar{Y})$, we have:

2010: -3 * 0.14 = -0.42
2011: -2 * 0.10 = -0.20
2012: -1 * 0.20 = -0.20
2013: 0 * (-0.10) = 0
2014: 1 * (-0.12) = -0.12
2015: 2 * (-0.16) = -0.32
2016: 3 * (-0.04) = -0.12

By adding all the above, we have S_{xY}

$$\mathbf{S_{xY}} = (-0.42)+(-0.20)+(-0.20)+0+(-0.12)+(-0.32)+(-0.12) = \mathbf{-1.38}$$

From all the above, we can fill the following table:

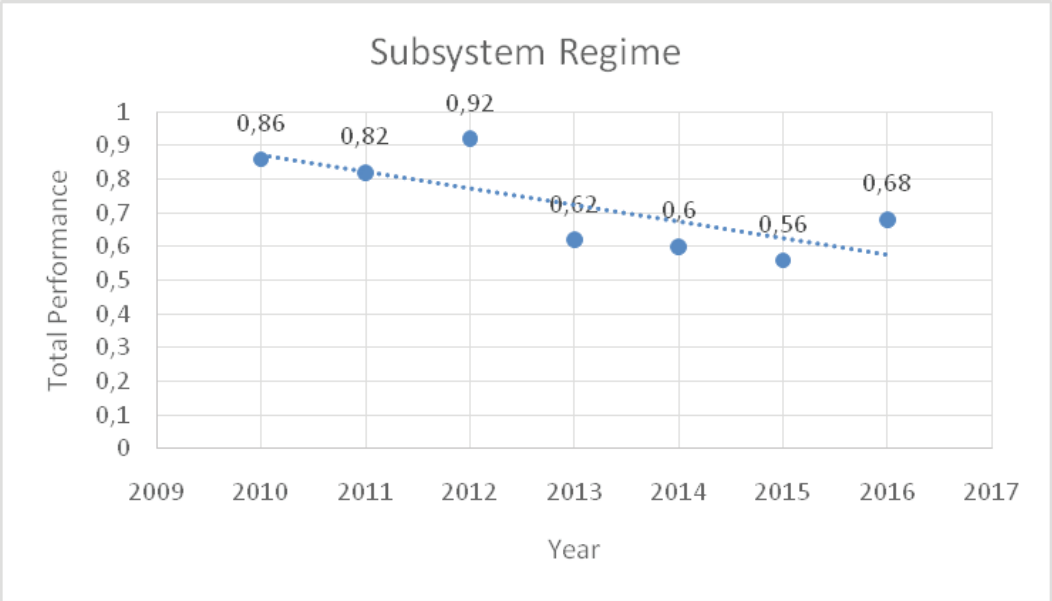
Year (X)	**Total Performance (Y)**	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(X - \bar{X})(Y - \bar{Y})$
2010	0.86	-3	0.14	9	-0.42
2011	0.82	-2	0.10	4	-0.20
2012	0.92	-1	0.20	1	-0.20
2013	0.62	0	-0.10	0	0
2014	0.60	1	-0.12	1	-0.12
2015	0.56	2	-0.16	4	-0.32
2016	0.68	3	-0.04	9	-0.12
				$S_{xx} = 28$	**$S_{xY} = -1.38$**

With $\mathbf{S_{xx}}$ and $\mathbf{S_{xY}}$ known, we can calculate α and β of the trend line which describes the data. So:

$$\alpha = 0.72 - 2013 \left(-\frac{1,38}{28}\right) = 0.72 + 2013 * 0.0492 = 0.72 + 99,03 = 99,75$$

$$\beta = -\frac{1,38}{28} = -0.0492$$

The formula of the trend line that describes our data is **Y = -0.0492*X + 99.75** and we can represent it, in the following graph:



In order to perform a prediction, all we have to do is put in the variable X, the values 2017 or 2018 and calculate the outcome of the variable Y, i.e. the Total Performance, as follows:

2017: Y = -0.0492 * 2017 + 99.75 = -99.2364 + 99,75 = **0.5136**
2018: Y = -0.0492 * 2018 + 99.75 = -99.2856 + 99,75 = **0.4644**

6.6.3 Improving a Prediction

A very effective methodology for improving a prediction widely used in Economics is Exponential smoothing. With this methodology, prediction of the future value of a time series is calculated as a balanced average of the values included in the indicator. More specifically, if we know the value of a time series Y_t for a specific period t, the prediction for the period t + 1 is given by the following formula:

$$\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha)\hat{Y}_t$$

A Prerequisite in order to perform the methodology is that the prediction for period 2 equals to the original value for period 1, as there is no other way to calculate it. Additionally, we call "a" a normalization constant, which takes values between $0 \leq a \leq 1$. So, "a" equals to the MSE (Mean Squared Error), which is given by the following formula:

$$MSE = \frac{\sum_{t=1}^{n}\left(Y_t - \hat{Y}_t\right)^2}{n}$$

where n: the number of years for which a forecast is made.

Implementation to the Case Study: Improving the Prediction

From the Least Squares Method for Sub-system "Regime", we know the following data:

Sub-system Regime	
Year	Total Performance
2010	0.86
2011	0.82
2012	0.92
2013	0.62
2014	0.60
2015	0.56
2016	0.68
2017	0.65
2018	0.64
2019	0.64
2020	0.64

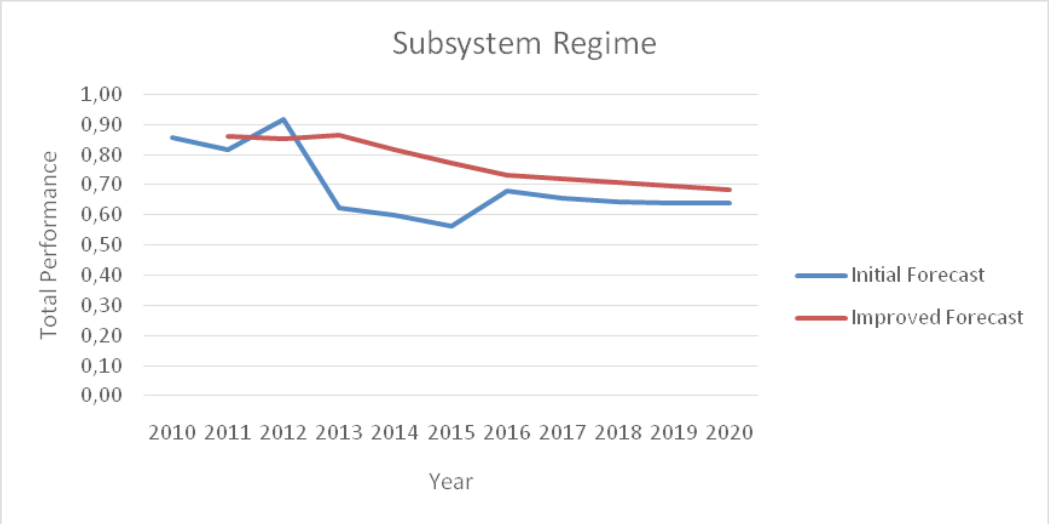
MSE calculation process is quite complex and time consuming. For this reason, we use mathematical tools such as Excel, Matlab and the programming language R. In this case, we used Excel's Solver, in order to calculate the value of the constant "a", which was 0.2. From the data of the previous Table, we make the following calculations:

2011: $\bar{Y} = Y_{2010} = 0.86$
2012: $\bar{Y} = \mathbf{0.2}*0.82 + (1-\mathbf{0.2})*0.86 = 0.85$
2013: $\bar{Y} = \mathbf{0.2}*0.92 + (1-\mathbf{0.2})*0.85 = 0.86$
2014: $\bar{Y} = \mathbf{0.2}*0.62 + (1-\mathbf{0.2})*0.86 = 0.82$
2015: $\bar{Y} = \mathbf{0.2}*0.60 + (1-\mathbf{0.2})*0.82 = 0.77$
2016: $\bar{Y} = \mathbf{0.2}*0.56 + (1-\mathbf{0.2})*0.77 = 0.73$
2017: $\bar{Y} = \mathbf{0.2}*0.68 + (1-\mathbf{0.2})*0.73 = 0.72$
2018: $\bar{Y} = \mathbf{0.2}*0.65 + (1-\mathbf{0.2})*0.72 = 0.71$
2019: $\bar{Y} = \mathbf{0.2}*0.64 + (1-\mathbf{0.2})*0.71 = 0.69$
2020: $\bar{Y} = \mathbf{0.2}*0.64 + (1-\mathbf{0.2})*0.69 = 0.68$

According to these calculations we obtain an improved set of predictions for the Sub-system Regime presented below:

Sub-system Regime		
Year	Total Performance (Initial)	Improved Prediction
2010	0.86	-
2011	0.82	0.86
2012	0.92	0.85
2013	0.62	0.86
2014	0.60	0.82
2015	0.56	0.77
2016	0.68	0.73
2017	0.65	0.72
2018	0.64	0.71
2019	0.64	0.69
2020	0.64	0.68

For a better understanding of the difference between the initial and the improved Total Performance we represent the data into a graph:



6.7 Calculation of the Total Power Performance of a System

From the data obtained from both data analysis and the prediction of the Total Power Performance of the Sub-systems, we gain an overview of the Geographic System located within the boundaries of the given Geopolitical Complex. Every Sub-system though, interacts with the others within the System based on its specific interests. In fact, the interests which determine and influence these interactions are characterized by great complexity and variability. For this reason, we make some assumptions to simplify the computational model.

The assumption to be made is that the Sub-systems, based on the convergence of interests can be grouped into categories. In order to group the Sub-systems into categories of interest, the analyst can add or multiply with a specific percentage, based on his judgment and experience.

Implementation to the Case Study: Grouping of Sub-systems into categories of interest

For this Case Study, the first assumption is that individual interests are grouped into two main categories:

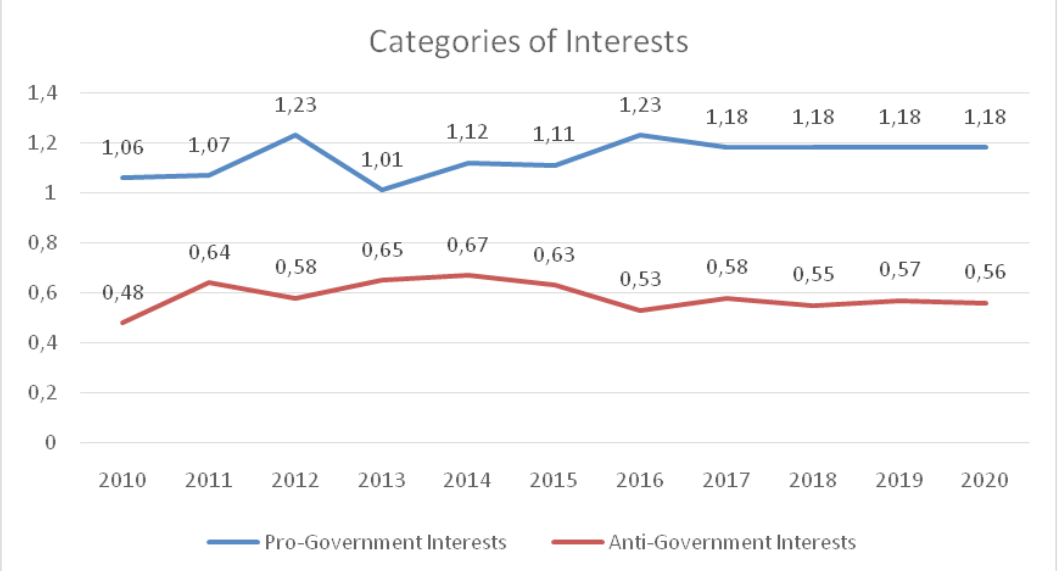
1. The first category of interests is one that fully reflects the aspirations of the Syrian Central Government and hereinafter called Pro-Government Interests.
2. The second category represents the aspirations of the dissidents and hereinafter called Anti-Government Interests.

From a factual standpoint, the analyst knows that the four individual Sub-systems have alliances and relationships of dependence, in order to survive. In his opinion Sub-system Regime and Sub-system Kurds share similar interests and are therefore grouped in the first category, while the Sub-systems Sunni Rebels and Islamic State are grouped in the 2nd category. By aggregating the Total Performances of the Sub-systems grouped in each category, we can draw conclusions about the overall performance of the system.

Year	Sub-system Regime	Sub-system Kurds	Pro-government Interests
2010	0.86	0.20	**1.06**
2011	0.82	0.25	**1.07**
2012	0.92	0.31	**1.23**
2013	0.62	0.39	**1.01**
2014	0.60	0.52	**1,12**
2015	0.56	0.55	**1.11**
2016	0.68	0.55	**1.23**
2017	0.65	0.53	**1.18**
2018	0.64	0.54	**1.18**
2019	0.64	0.54	**1.18**
2020	0.64	0.54	**1.18**

Year	Sub-system Sunni Rebels	Sub-system Islamic State	Anti-government Interests
2010	0.03	0.45	**0.48**
2011	0.06	0.57	**0.64**
2012	0.02	0.56	**0.58**
2013	0.03	0.63	**0.65**
2014	0.06	0.62	**0.67**
2015	0.08	0.55	**0.63**
2016	0.08	0.45	**0.53**
2017	0.08	0.50	**0.58**
2018	0.08	0.47	**0.55**
2019	0.08	0.49	**0.57**
2020	0.08	0.48	**0.56**

We represent all the above data into a single graph:



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Mazis, John Th. & Daras, Nicholas J. (2015c), **"**Systemic geopolitical modeling Part 2: subjectivity in prediction of geopolitical events", *GeoJournal [*Springer Verlag], vol. 80. no. 4, ISSN 0343-2521, DOI 10.1007/s10708-015-9670-2 (Author's personal e-copy)

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Guidelines for the Writers & a format model for the articles submitted to be reviewed & published in the journal

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Guidelines for the Writers & a format model for the articles submitted to be reviewed & published in the journal

The Title of the paper must be centered, and the font must be Times New Roman, size 12, in Uppercase, in Bold

For the writers' personal information use the Times New Roman font, size 11, in bold, and centered. Use lowercase for the first name and uppercase for the last name. The line below the name includes the professional title and workplace; use the Times New Roman font, size 10, centered. In the third line write only the contact e-mail address in Times New Roman 10, centered.

Name LAST NAME
Professional Title, Workplace
E-mail Address

Name LAST NAME
Professional Title, Workplace
E-mail Address

Abstract

The abstract consists of a single paragraph, no longer than 250 words. The font must be Times New Roman, size 11. The text must be justified. The title "Abstract" must be aligned left, in Times New Roman, size 11, in bold. A space of one line must be left between the title and the text of the abstract. The abstract must contain sufficient information, be factual, and include the basic data of the paper.

Keywords: Use 3 to 5 keywords, separated by commas

JEL classification: We kindly request that you classify your paper according to the JEL system, which is used to classify articles, dissertations, books, book reviews, and a variety of other applications. The use of the JEL classification is necessary so that your paper be properly indexed in databases such as EconLit. Select the codes that represent your article and separate them by commas. You can find information on the JEL system here: https://www.aeaweb.org/jel/guide/jel.php

1. Introduction

All articles must begin with an introduction, a section which demarcates the theoretical background and the goals of the paper.

The present document provides the necessary information and formatting guidelines for you to write your article. We recommend that you copy this file to your computer and insert your own text in it, keeping the format that has already been set. All the different parts of the article (title, main text, headers, titles, etc.) have already been set, as in the present document-model. The main text must be written in regular Times New Roman font, size 11, justified, with a 0.5 cm indent for the first line of each paragraph.

We recommend that you save this document to your computer as a Word document model. Therefore, it will be easy for you to have your article in the correct format and ready to be submitted. **The only form in which the file will be accepted is MS Word 2003**. If you have a later version of Microsoft Office / Word, you can edit it as follows:

- Once you have finished formatting your text, create a pdf file, and then save your file as a Word "97-2003" (.doc) file.

- Compare the two files – the pdf one and the Word "97-2003" (.doc) one.
- If you do not note any significant differences between the two, then – and only then – you can submit your article to us, **sending both the pdf and the Word "97-2003" (.doc) files** to our e-mail address.

If you use a word processor other than Microsoft Word, we recommend that you follow the same procedure as above, creating a pdf file and using the appropriate add-on in order to save your document in MS Word "97-2003" (.doc) form. Once you compare the two files (and find no significant differences), send us both.

2. General Guidelines on Paper Formatting

2.1. Body

The body of the text consists of different sections which describe the content of the article (for example: Method, Findings, Analysis, Discussion, etc.). You can use up to three levels of sections – sub-sections. For the Body of the text, use the default format style in Word, selecting the Times New Roman font, size 11, justified, with a 0.5 cm indent for the first line of each paragraph (this is further detailed in the section "Paragraphs").

2.2. References

The references included in the paper must be cited at the end of the text. All references used in the body of the paper must be listed alphabetically (this is further detailed in the section "References").

2.3. Appendices

The section "Appendices" follows the section "References".

3. Page formatting

3.1. Page size

The page size must be A4 (21 x 29,7 cm), and its orientation must be "portrait". This stands for all the pages of the paper. "Landscape" orientation is inadmissible.

3.2. Margins

Top margin: 2,54cm
Bottom margin: 1,5cm
Left and right margins: 3,17cm
Gutter margin: 0cm

3.3. Headers and Footers

Go to "Format" → "Page", and select a 1,25cm margin for the header and a 1,25cm margin for the footer. Do not write inside the headers and footers, and do not insert page numbers.

3.4. Footnotes

The use of footnotes or endnotes is expressly prohibited. In case further explanation is deemed necessary, you must integrate it in the body of the paper.

3.5. Abbreviations and Acronyms

Abbreviations and acronyms must be defined in the abstract, as well as the first time each one is used in the body of the text.

3.6. Section headers

We recommend that you use up to three sections – sub-sections. Select a simple numbering for the sections – sub-sections according to the present model.

3.7. First level header format

For the headers of the main sections use the Times New Roman font, size 11, in bold and underlined, and leave a size 12 spacing before the paragraph and a size 6 spacing after the paragraph. The header must be aligned left. Use a capital letter only for the first letter of the header.

3.8. Second level header format

For second level headers, follow this model. Use the Times New Roman font, size 11, in bold, and leave a size 12 spacing before the paragraph and a size 3 spacing after the paragraph. Select a 0.5 cm indent. The header must be aligned left. Use a capital letter only for the first letter of the header.

3.8.1. Third level header

For third level headers, follow this model. Use the Times New Roman font, size 11, in bold and italics, and leave a size 6 spacing before the paragraph and a size 0 spacing after the paragraph. The header must be aligned left, with a left indent of 1 cm. Use a capital letter only for the first letter of the header.

4. Paragraphs

In every paragraph, use the Times New Roman font, size 11, with single line spacing. We recommend you modify the default (normal) format style in Word and use that in your text. For all paragraphs, the spacings before and after the paragraph must be size 0, and the line spacing single. Use a 0,5cm indent only for the first line of each paragraph. Leave no spacings nor lines between paragraphs.

4.1. Lists

In case you need to present data in the form of a list, use the following format:

- Bullet indent: 1,14cm
- Text:
    - Following tab at: 1,5 cm
    - Indent at: 1,5cm

Use the same format (the above values) if you use numbering for your list.

1. Example of numbered list 1
2. Example of numbered list 1

5. Figures, images, and tables

5.1. Figures and images

Insert your figures and images directly after the part where they are mentioned in the body of text. They must be centered, numbered, and have a short descriptive title.

Figures put together "as they are", using Office tools, are absolutely inadmissible. The figures used must have been exclusively inserted as images in Word, in gif, jpg, or png form (with an analysis of at least 200dpi), and in line with the text. The width of an image must not exceed 14,5cm so that it does not exceed the margins set above.

The images, figures, and tables must be inserted "as they are" in the text, in line with it. **Figures and images which have been inserted in a text box are absolutely inadmissible.**

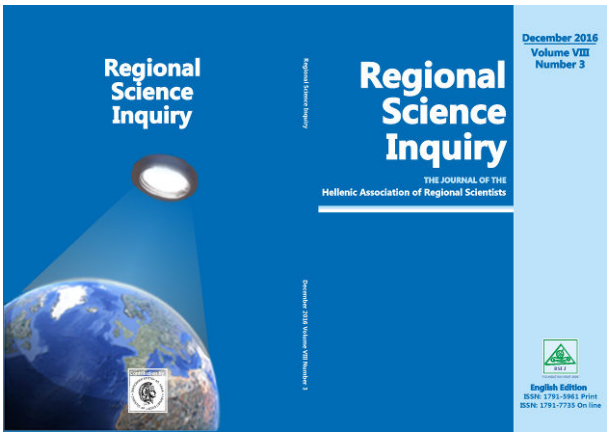
5.1.1. Reference inside the text

Avoid phrases such as "the table above" or the "figure below" when citing figures and images. Use instead "in Table 1", "in Figure 2", etc.

5.1.2. Examples

A model of how to format figures/images follows. For the title, use the Times New Roman font, size 10, in bold. Write the title above the figure, and set a size 6 spacing before the title and a size 0 spacing after it. The line spacing of the title must be 1.5 line. Both the image and its title must be centered.

Image 1: Title



Source: cite the source

Directly below the figure you must cite the source from which you took the image, or any note regarding the figure, written in Times New Roman, size 10. Write it below the figure, leaving a size 0 spacing before and after it, use a line spacing of 1.5 line, and make it centered.

5.2. Tables

For the title, use the Times New Roman font, size 10, in bold. Write the title above the table, and set a size 6 spacing before the title and a size 0 spacing after it. The line spacing of the title must be 1.5 line. Both the table and its title must be centered. The width of the table must not exceed 14,5cm so that it does not exceed the page margins set.

Table 1. Example of how a table must be formatted

Age	Frequency	Percentage %
Under 40	44	32.1
40 - 49	68	49.6
Over 50	25	18.2
Total	**137**	**100.0**

Source: cite the source

If the table needs to continue on the next page, select in the "Table properties" that the first line be repeated as a header in every page, as in the above example of Table 1. **Tables (or figures or images) which are included in pages with a "Landscape" orientation are absolutely inadmissible.**

Every table must have horizontal lines 1 pt. wide at the top and bottom, as shown in the example. The use of vertical lines and color fill at the background of the cells is strictly prohibited.

Directly below the table you must cite the source or any note regarding the table, written in Times New Roman, size 10. Write it below the table, leaving a size 0 spacing before and a size 6 spacing after it, and make it centered.

6. Mathematical formulas

There is a variety of tools in order to insert and process mathematical formulas, such as the "Mathematics", found in the most recent editions of Word, "Math Type", "Fast Math Formula

Editor", "MathCast Equation Editor", "Math Editor". Since it is impossible for us to provide you with compatibility with all these tools in all their editions, **we can only admit your paper if it contains mathematical formulas solely in the form of images.**

Keep a continuous numbering for the mathematical formulas and center them in the page, as shown in the following example:

$$y = ax^2 + bx + c \tag{1}$$

The same stands for formulas or particular mathematical symbols you may have integrated in your text. For instance, if you want to use the term ax^2 in your text, you must insert it as an imaged, in line with the text. The images containing the mathematical formulas must be legible (at least 300dpi).

In the exceptional case of a text which may contain a great number of mathematical formulas, the writer may send it to us in TeX form if they so wish.

7. References

We recommend that you use the Chicago Manual of Style Author-Date system, as it is recommended by the AEA (American Economic Association) for the journals included in the EconLit database, and it is the dominant style of bibliography in the field of Economics. For more information you can go to the following links:

- https://www.aeaweb.org/journals/policies/sample-references
- http://www.chicagomanualofstyle.org/tools_citationguide.html
- http://libguides.williams.edu/citing/chicago-author-date#s-lg-box-12037253

7.1. Online references (internet citations)

Check your links again before sending your file, to confirm that they are active.

Avoid long internet links. Where possible, also cite the title of the website operator-owner. Return the font color to black, and remove the hyperlink. Links such as the following are impractical and distasteful, therefore should be avoided.

Example of an inadmissible hyperlink

https://el.wikipedia.org/wiki/%CE%9F%CE%B9%CE%BA%CE%BF%CE%BD%CE%BF%CE%BC%CE%B9%CE%BA%CE%AC

7.2. References Formatting

For your list of references, use the Times New Roman font, size 10, with single line spacing. The paragraph format must include a size 0 spacing before the paragraph and a size 0 spacing after it, aligned left. Use a 0,5 cm indent only for the first line of each paragraph. Leave no spacings or lines between paragraphs.

7.3. Example of how References must be formatted

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